Integrated Mosquito Management Program

Solano County Mosquito Abatement District

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Table of Contents

Appendices

Tables

Figures

Acronyms

°C	degrees Celsius
°F	degrees Fahrenheit
µg/kg	microgram(s) per kilogram
µg/L	microgram(s) per liter
2,4-D	2,4-dichlorophenoxyacetic acid
AB	Assembly Bill
APAP	Aquatic Pesticide Application Plan
APEs	alkylphenol ethoxylates
ATCM	Airborne Toxic Control Measure
ATV	all-terrain vehicle
BAAQMD	Bay Area Air Quality Management District
Basin Plan	Water Quality Control Plan
BCDC	San Francisco Bay Conservation and Development Commission
BMP	best management practice
Bs	*Bacillus sphaericus*
Bti	*Bacillus thuringiensis israelensis*
CAA	Clean Air Act of 1970
CAAQS	California Ambient Air Quality Standards
CAL FIRE	California Department of Forestry and Fire Protection
Cal-EPA	California Environmental Protection Agency
CARB	California Air Resources Board
cc	cubic centimeter(s)
CCD	colony collapse disorder
CCR	California Code of Regulations
CDC	Centers for Disease Control and Prevention
CDFA	California Department of Food and Agriculture
CDFW	California Department of Fish and Wildlife (formerly Fish and Game [CDFG])
CDPH	California Department of Public Health (formerly Health Services [CDHS])
CDPR	California Department of Pesticide Regulation
CEC	California Energy Commission
CEDEN	California Environmental Data Exchange Network
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CH_4	methane
CNEL	Community Noise Equivalent Level

CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent(s)
CUPA	Certified Unified Program Agency
CWA	Clean Water Act
dB	decibel(s)
dBA	A-weighted sound level/decibel(s)
DCPA	chlorthal dimethyl
DPM	diesel particulate matter
EBMUD	East Bay Municipal Utility District
EBRPD	East Bay Regional Parks District
FAA	Federal Aviation Administration
FFDCA	Federal Food, Drug, and Cosmetic Act
FHSZ	Fire Hazard Severity Zone
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
GHG	greenhouse gas
GPS	global positioning system
GWP	global warming potential
HCP	Habitat Conservation Plan
HPS	Hantavirus Pulmonary Syndrome
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
IVM	Integrated Vector Management
IVMP	Integrated (Mosquito and) Vector Management Program
JH	juvenile hormone
LC50	50 percent lethal concentration
LD50	50 percent lethal dose
L_{dn}	day/night average sound level
L_{eq}	energy-equivalent sound/noise descriptor
LOAEL	lowest observed adverse effect level
LS	less than significant
MBUAPCD	Monterey Bay Unified Air Pollution Control District
MCLs	Maximum Contaminant Levels
MEI	Maximally Exposed Individual
mg/L	milligram(s) per liter
MMT	million metric tonne(s)
MRP	Monitoring and Reporting Program

MSDS	material safety data sheet
MT	metric tonne(s)
MVCAC	Mosquito Vector Control Association of California
N	no impact
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NCPP	Natural Community Conservation Plan
ng/L	nanogram(s) per liter
NMFS	National Marine Fisheries Service
NO	nitric oxide
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no observed adverse effect level
NOP	Notice of Preparation
NO_X	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NSCAPCD	Northern Sonoma County Air Pollution Control District
O_3	ozone
OP	organophosphate
PAP	Pesticide Application Plan (NPDES)
Pb	lead
PBO	piperonyl butoxide
PCBs	polychlorinated biphenyls
PEIR	Programmatic Environmental Impact Report
PERP	Portable Equipment Registration Program
PHG	Public Health Goal
PM_{10}	respirable particulate matter
$PM_{2.5}$	fine particulate matter
POD	pelagic organism decline
ppb	part(s) per billion
ppm	part(s) per million
ppt	part(s) per trillion
PUP	Pesticide Use Proposal (USFWS)
RHA	Rivers and Harbors Act
RIM	rotational impoundment management
ROC	reactive organic compound
ROG	reactive organic gas

RWQCBs	Regional Water Quality Control Boards
SF_6	sulfur hexafluoride
SFBAAB	San Francisco Bay Area Air Basin
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SIP	State Implementation Plan
SLE	Saint Louis encephalitis
SM	potentially significant but mitigable
SO_2	sulfur dioxide
SU	significant and unavoidable
SUP	Supplemental Use Proposal (USFWS)
SWRCB	California State Water Resources Control Board
TMDL	total maximum daily load
TPA	tetrachloroterephthalic acid
ULV	ultralow volume
USACE	US Army Corps of Engineers
USDA	US Department of Agriculture
USEPA	US Environmental Protection Agency
USFS	USDA Forest Service
USFWS	US Fish and Wildlife Service
VBDS	Vector Borne Disease Section
VCMS	Vector Control Management System
VOC	volatile organic compound
WEE	western equine encephalomyelitis
WNV	West Nile virus

Summary

This summary of the Solano County Mosquito Abatement District's Programmatic Environmental Impact Report (PEIR) on the continuation of their Integrated Mosquito Management Program (IMMP or Program) presents an overview of the PEIR contents. It introduces key components of the Proposed Program and provides a summary of the potential environmental impacts of the Program alternatives. The text of the PEIR is supplemented by five technical reports included as appendices. The District, as Lead Agency under the California Environmental Quality Act (CEQA), has prepared this PEIR for their ongoing program of surveillance and control of mosquitoes as a vector of human disease and discomfort.

S.1 Background

The District was established in 1930 to reduce the risk of mosquito-borne disease and discomfort to the residents of its Service Area. The District engages in activities and management practices to control mosquitoes and to address the specific situations within its Service Area. These management practices emphasize the fundamentals of integrated pest management (IPM), specifically integrated mosquito management (IMM) wherein source reduction, habitat modification, and biological control are used when appropriate before using pesticides. When pesticides are used, they are applied in a manner that minimizes risk to human health and ecological health. To avoid or manage the risk to human and animal health requires effective mosquito-borne disease surveillance and control strategies that may fluctuate temporally and regionally. Factors that influence the selected strategies include mosquito and pathogen biology, environmental factors, land use patterns, and resource availability to support production of mosquitoes in quantities that threaten human and animal health.

S.1.1 Mosquito-Borne Diseases in Program Areas

Mosquitoes (known as vectors) can transmit a number of diseases. A vector is defined by the State of California as "any animal capable of transmitting the causative agent of human disease or capable of producing human discomfort or injury, including, but not limited to, mosquitoes, flies, other insects, ticks, mites, and rats, but not including any domesticated animal…" [California Health and Safety Code Section 2200(f)]. The mosquito-transmitted diseases of most concern in the District's Program Area are as follows:

> West Nile virus, western equine encephalomyelitis, Saint Louis encephalitis, dog heartworm, malaria, and myxomatosis.

Depending on the disease, both human and domestic animal health can be at risk of disability, illness, and/or death. Furthermore, potential exists for introduction of new diseases into the District's Service Area at any time.

S.1.2 Authority to Implement Vector Control

A number of legislative and regulatory actions form the basis for the District's authority to engage in mosquito control. The District's principal authority is derived from the California Health and Safety Code. It is a regulatory agency formed pursuant to California Health and Safety Code Section 2000 et seq. **State law charges the District with the authority and responsibility to take all necessary or proper steps for the control of mosquitoes in the District.**

In accordance with California Health and Safety Code Section 2053:

(a) A district may request an inspection and abatement warrant pursuant to Title 13 (commencing with Section 1822.50) of Part 3 of the Code of Civil Procedure. A warrant issued pursuant to this section shall apply only to the exterior of places, dwellings, structures, and premises. The warrant shall state the geographic area which it covers and shall state its purposes. A warrant may authorize district employees to enter property only to do the following:

(1) Inspect to determine the presence of vectors or public nuisances.

(2) Abate public nuisances, either directly or by giving notice to the property owner to abate the public nuisance.

(3) Determine if a notice to abate a public nuisance has been complied with.

(4) Control vectors and treat property with appropriate physical, chemical, or biological control measures.

The California Department of Pesticide Regulation's (CDPR's) Pesticide Regulatory Program provides special procedures for vector control agencies that operate under a Cooperative Agreement with the California Department of Public Health (CDPH). The application of pesticides by vector control agencies is regulated by a special and unique arrangement among the CDPH, CDPR, and County Agricultural Commissioners. CDPR does not directly regulate vector control agencies. CDPH provides regulatory oversight for vector control agencies that are signatory to the Cooperative Agreement. Signatories to the agreement use only pesticides listed by CDPH, maintain pesticide use reports, and ensure that pesticide use does not result in harmful residues on agricultural products.

The District maintains a cooperative agreement with CDPH. Its employees are certified by CDPH as vector control technicians, which helps to ensure that employees are adequately trained regarding safe and proper vector control techniques including the handling and use of pesticides and compliance with laws and regulations relating to vector control and environmental protection.

S.2 Program Objectives and Purpose

The District undertakes mosquito control activities through its Program to control all mosquitoes that are vectors of disease and/ or discomfort in the Program Area. It may also include the control of certain noxious/invasive weeds under special circumstances in the future.

The Proposed Program's specific objectives are as follows:

- Reduce the potential for human and animal disease caused by mosquitoes
- Reduce the potential for human and animal discomfort or injury from mosquitoes
- Accomplish effective and environmentally sound mosquito management by means of:
  - Surveying for mosquito abundance/human contact
  - Establishing treatment criteria
  - Appropriately selecting from a wide range of Program tools or components

Most of the relevant mosquito species are quite mobile and cause the greatest hazard or discomfort at a distance from where they breed. Each potential mosquito vector has a unique life cycle, and most of them occupy several types of habitats. To effectively control them, an IMMP must be employed. District policy is to identify those species that are currently vectors, to recommend techniques for their prevention and control, and to anticipate and minimize any new interactions between these mosquitoes and humans or domestic animals.

S.3 Public Involvement Summary

Public involvement for this PEIR includes the following actions.

The Solano County Mosquito Abatement District (District) distributed a Notice of Preparation (NOP) of a Draft Programmatic Environmental Impact Report (PEIR) for the Integrated Mosquito Management Program (Program) pursuant to the CEQA Guidelines (Section 15082) on May 24, 2012. The NOP was sent to forty-seven (47) agencies, organizations, and individuals, including the following state responsible and trustee agencies:

> California Department of Fish and Game (now Wildlife): Bay Delta Region

> California Department of Parks and Recreation: Capital District

> California Department of Pesticide Regulation

> California Department of Public Health

> California Department of Transportation: District 4

> California Regional Water Quality Control Board: Central Valley Region

> California State Water Resources Control Board

The NOP provided a description of the Program, the location of Program activities, and the resources and environmental concerns planned for analysis in the PEIR. The NOP announced a public scoping meeting and requested the comments on the content of the PEIR and the Program alternatives be submitted within 30 days of receipt. The public scoping meeting was held at the following location and time:

> Solano County Mosquito Abatement District Office, Fairfield, California, on June 19, 2012, at 7:00 pm.

Comments received during scoping on the content of the PEIR are addressed primarily in the resource chapters.

S.4 Areas of Known Public Environmental Concerns

CEQA Guidelines Section 15123 requires that the Summary "shall identify areas of controversy known to the lead agency." The areas of greatest public concern and debate are, based on comments from public scoping and comments made during other District activities, are:

> Use of Pesticides for Mosquito Control: Members of the public are distrustful of pesticide use for mosquito control. They prefer other methods to eliminate suitable habitat to deal with mosquito problems rather than spraying pesticides. If adulticides must be used, ensure use is justified with documented, mosquito-borne disease activity within or within flight range of the tidal marsh. Concern exists about pesticide applications drifting into backyards where the property owner wants to ensure their area is pesticide-free. The concern is not only with impacts to humans and "sensitive populations" but also to domestic animals and wildlife including nontarget insects.

> Use of Herbicides for Vegetation Management: Request for specific vegetation management information about the proposed chemical vegetation control agents (herbicides), the types, amounts and locations of chemical stored, application methods and rates, and their effects on the environment.

> Use of Biological Control Agents: Controversy exists over the use of some proposed biological control agents, in particular the use of mosquitofish and potential for them to impact sensitive species such as the California red-legged frog.

> District's Authority to Enter Public and Private Property for Control Activities: Some public agencies want the District to obtain an Encroachment Permit with notification of Park Supervisors for activities such as surveillance, physical control, or vegetation management where access to parkland is needed. Water districts insist that mosquito abatement materials and practices proposed for use on watershed lands must be thoroughly vetted and approved by CDPH.

S.5 Proposed Program Alternatives

S.5.1 Proposed Program

The District has, for at least the past 2 decades, taken an integrated systems approach to mosquito control, utilizing a suite of tools that consist of surveillance, vegetation management, and physical, biological, and chemical controls along with public education. These Program "tools" or components are described herein as "Program alternatives" for the CEQA process (except for public education, which is exempt from CEQA). Program implementation is weighted heavily towards vegetation management and physical and biological control, in part, to reduce the need for chemical control. To realize effective and environmentally sound mosquito management, control must be based on several factors:

1. Carefully monitoring or surveying mosquito abundance and/or potential contact with people
2. Establishing treatment criteria (thresholds)
3. Selecting appropriate tools from a wide range of control methods

This ongoing Program consists of a dynamic combination of surveillance, treatment criteria, and use of multiple control activities in a coordinated program with public education that is generally known as Integrated Pest Management (IPM) or specifically for the District as Integrated Mosquito Management (IMM).

While these Program components or tools together encompass the District's IMMP, it is important to acknowledge that the specific tools District staff use vary from day to day and from site to site in response to the mosquito species that are active, their population size or density, their age structure, location, time of year, local climate and weather, potential for mosquito-borne disease, proximity to human populations, including (a) proximity to sensitive receptors, (b) District staff's access to mosquito habitat, (c) abundance of natural predators, (d) availability and cost of control methods, (e) effectiveness of previous control efforts at the site, (f) potential for development of resistance in mosquito populations, (g) landowner policies or concerns, (h) proximity to special-status species, and (i) applicability of Endangered Species Recovery Plans, Habitat Conservation Plans (HCPs), Natural Community Conservation Plans (NCCPs), and local community concerns, among other variables. Therefore, the specific actions taken in response to current or potential mosquito activity at a specific place and time depend on factors of mosquito and pathogen biology, physical and biotic environment, human settlement patterns, local standards, available control methods, and institutional and legal constraints. While some consistent mosquito sources are exposed to repeated control activity, many areas with minor mosquito activity are not routinely treated, and most of the land within the District's Service Area has never been directly treated for mosquitoes.

The District has implemented a number of procedures and practices under current Program activities that would continue into the future for the Proposed Program. These best management practices (BMPs) represent measures to avoid, minimize, or eliminate potential adverse effects on the human, biological, and physical environments and on District Staff. While similar to mitigation measures under CEQA, these BMPs are already in use and would continue as part of the Proposed Program. Subsequent environmental impact assessments in this PEIR reflect the continued use of these measures, which are organized under the following categories:

> Pesticide Applications to Product Label Requirements

> Pesticides/Herbicides Applications with Best Management Practices

> Nonchemical Vector Control Best Management Practices

> Hazardous Materials Spill Management

The District anticipates combining the following ongoing alternatives into its Proposed Program, a continuation of its existing Program. The five alternatives evaluated in this PEIR are summarized below.

S.5.1.1 Surveillance

Mosquito surveillance, which is an integral part of the District's responsibility to protect public health and welfare, involves monitoring mosquito populations and habitat, their disease pathogens, and human/mosquito interactions. Mosquito surveillance provides the District with valuable information on what mosquito species are present or likely to occur, when they occur, where they occur, how many they are, and if they are carrying disease or otherwise affecting humans. Mosquito surveillance is critical to an IMMP because the information it provides is evaluated against treatment criteria to decide when and where to institute mosquito control measures. Information gained is used to help form action plans that can also assist in reducing the risk of contracting disease. Equally important is the use of mosquito surveillance in evaluating the efficacy, cost effectiveness, and environmental impacts of specific mosquito control actions. Examples include field counting/sampling and trapping, arbovirus surveillance, field inspection of known of suspected habitats, and documenting public service inquiries and requests.

S.5.1.2 Physical Control

Physical control is managing mosquito habitat to reduce mosquito production through "source control' measures that are nonchemical or nonbiological techniques. In many cases, physical control activities involve restoration and enhancement of natural ecological functioning. For mosquitoes, these activities include, but are not limited to, water management and maintenance of channels, tide gates, levees, and other water control facilities to improve water circulation.

S.5.1.3 Vegetation Management

The species composition and density of vegetation are basic elements of the habitat value of any area for mosquitoes, for mosquito predators, and for protected flora and fauna. District staff periodically advise property owners/managers to undertake vegetation management activities on their property as a tool to reduce the habitat value of sites for mosquitoes or to aid production or dispersal of mosquito predators, as well as to allow District staff's access to mosquito habitat for surveillance and other control activities. District staff does not normally perform direct vegetation management.

Although rarely done in recent years, the District may choose to do any of the following activities in the future if feasible. For vegetation management, the District may use hand tools or other mechanical means (i.e., heavy equipment) for vegetation removal or thinning or apply herbicides (chemical pesticides with specific toxicity to plants) to improve surveillance or reduce mosquito habitats. Vegetation removal or thinning would primarily occur in aquatic habitats to assist with the control of mosquitoes. To reduce the potential for mosquito breeding associated with water retention and infiltration structures, District staff may request the owners of the structures to clear weeds and other obstructing vegetation in wetlands and retention basins. In particular, thinning and removal of cattail overgrowth should be done to provide a maximum surface coverage of 30 percent or less. In some sensitive habitats and/or where sensitive species concerns exist, vegetation removal and maintenance actions would be restricted to those months or times of the year that minimize disturbance/impacts. Vegetation management may be performed (under special circumstances) to assist other agencies and landowners with the management of invasive/nonnative weeds. These actions are typically performed under the direction of the concerned agency, which also maintains any required permits. The District may also decide to use herbicides in the future to manage vegetation for control of mosquitoes or to control invasive plant species.

S.5.1.4 Biological Control

Pathogens

Mosquito pathogens are highly host-specific and usually infect mosquito larvae when they are ingested. Upon entering the host, these pathogens multiply rapidly, destroying internal organs and consuming nutrients. The pathogen can be spread to other mosquito larvae in some cases when larval tissue disintegrates and the pathogens are released into the water to be ingested by uninfected larvae. Examples of bacteria pathogenic to mosquitoes are *Bacillus sphaericus* (*Bs*), the several strains of *Bacillus thuringiensis israelensis* (*Bti*), and *Saacharopolyspora spinosa*. Two bacteria, *Bs* and *Bti*, produce proteins that are toxic to most mosquito larvae, while *Saacharopolyspora spinosa* produces compounds known as spinosysns, which effectively control all larval mosquitoes. *Bs* can reproduce in natural settings for some time following release. *Bti* materials the District applies do not contain live organisms, but only spores made up of specific protein molecules.

Predators

Mosquito predators are represented by highly complex organisms, such as insects, fish, birds, and bats that consume larval or adult mosquitoes as prey. Predators are opportunistic in their feeding habits and typically forage on a variety of prey types, which allows them to build and maintain populations at levels sufficient to control mosquitoes, even when mosquitoes are scarce. Examples of mosquito predators include representatives from a wide variety of taxa: coelenterates, *Hydra* spp.; platyhelminths, *Dugesia dorotocephala, Mesostoma lingua, and Planaria* spp.; insects, *Anisoptera, Zygoptera, Belostomidae, Geridae, Notonectidae, Veliidae, Dytiscidae, and Hydrophilidae*; arachnids, *Pardosa* spp.; mosquitofish, *Gambusia affinis*, *Gasterosteus aculeatus*; bats; and birds, *anseriformes, apodiformes, charadriiformes, and passeriformes*. Only mosquitofish are commercially available to use at present, while the District supports the presence of the other species as practical. The District's rearing and stocking of mosquitofish in mosquito habitat is the most commonly used biological control agent for mosquitoes in the world.

S.5.1.5 Chemical Control

Chemical control is a Program tool that consists of the application of nonpersistent insecticides (and herbicides noted above) to directly reduce populations of larval or adult mosquitoes as threats to public health . If and when inspections reveal that mosquitoes are present at levels that trigger the District's criteria for chemical control – based on mosquito abundance, density, species composition, proximity to human settlements, water temperature, presence of predators, and other factors – District staff will apply pesticides to the site in strict accordance with the pesticide label instructions. All of the chemical tools the District uses now and potentially in the future are evaluated in Appendix B, Ecological and Human Health Risk Assessment.

The primary pesticides used for mosquito abatement can be divided between "larvicides," which are specifically toxic to mosquito and other insect larvae, and "adulticides," which are used to control adult mosquito populations. Larvicides are applied when the chemical control criteria for mosquito larvae are present and application rates vary according to time of year, water temperature, the level of organic content in the water, the type of mosquito species present, larval density, and other variables. Larvicide applications may be repeated at any site at recurrence intervals ranging from annually to weekly. In addition to chemical control of mosquito larvae, the District may use pesticides for control of adult mosquitoes when no other tools are available and if specific criteria are met, including species composition, population density (as measured by landing count or other quantitative method), proximity to human populations, and/or human disease risk. As with larvicides, adulticides are applied in strict conformance with label requirements. Adulticiding is the only known effective measure of reducing an adult mosquito population in a timely manner. All mosquito adulticiding activities follow reasonable guidelines to avoid affecting nontarget species including bees. Timing of applications (when mosquitoes are most active), avoiding sensitive areas, working and coordinating efforts with California Department of Fish and Wildlife (CDFW) or United States Fish and Wildlife Service (USFWS), and following label instructions all result in effective mosquito control practices.

S.5.2 Alternatives Eliminated From Further Consideration

These alternatives are identified and evaluated in the District's Alternatives Analysis Report (Appendix E) and summarized in Section 15.2 of this PEIR. They include the following:

> **Biological Control (Viruses).** None of the mosquito viruses listed (in Appendix E, Section 2.5) are generally commercially available for mosquito control at present.

> **Biological Control (Parasites).** None of the mosquito parasites listed (in Appendix E, Section 2.7) are generally available commercially for mosquito control at present.

> **Mass Trapping.** This tool is not an economically feasible tool due to extensive labor involved in trap placement and retrieval.

> **Attract and Kill.** This has not been proven to be an effective control tool to date. This tool is too labor intensive for District use.

> **Inundative Releases (Parasites).** No parasites for mosquitoes are available for commercial use at present.

> **Inundative Releases (Predators).** With the exception of mosquitofish, there are no other proven, commercially available predators for mosquito control at present.

> **Regulatory Control.** These actions only prevent the human-aided movement of unwanted pests. They do not reduce existing pest numbers or the ability of the pest to spread on its own.

> **Repellents.** Have no value as a control tool; they are strictly a personal protective measure.

S.5.3 Environmentally Superior Alternative

Table S-1 presents a summary of all of the impacts associated with each Program Alternative and, therefore, the overall Program of all of the alternatives combined. Nearly all of the potentially significant impacts can be mitigated to less than significant, but there are two exceptions involving the present and future use of mosquitofish in natural waterways and the possible infrequent future use of naled as a mosquito adulticide. Clearly, there are tradeoffs among biological and water resources primarily, but also to air quality, where potentially significant impacts could occur (prior to mitigation) or remain in making a determination of the environmentally superior alternative.

> The Physical Control Alternative has the potential for greater impacts to biological resources/aquatic habitats if sensitive species are present when the drainage control measures are implemented. It also has the potential to impact aquatic habitats if there are conflicts with any HCP/NCCPs adopted within the District's Program Area.

> The Vegetation Management Alternative has the potential for significant impacts to aquatic biological resources from conflicts with the provisions of adopted HCP and NCCPs.

> The Biological Control Alternative has the potential for significant impacts to aquatic resources and ecological health from the use of mosquitofish in natural waterways. While mitigation would substantially reduce these impacts, the risk of impacts would not be eliminated, resulting in a significant and unavoidable residual impact.

> The Chemical Control Alternative has potentially significant impacts to surface water resources from the application of permethrin, resmethrin, and naled as mosquito adulticides. Furthermore, there is the potential for subjecting people to objectionable odors depending on the formulation used and proximity of treatment locations to human activities.

From a biological resource perspective, elements of the Physical Control Alternative dealing with drainage control in aquatic habitats, with Vegetation Management's potential conflicts with HCP/NCCPs, and with the Biological Control's residual impacts from using mosquitofish in natural waterways would not make any of these environmentally superior alternatives. Protection of surface water resources mean components of the Chemical Treatment Alternative would not make this alternative environmentally superior. To the extent the District can modify elements of these alternatives to avoid identified impacts and lessen mitigation requirements, without increasing reliance on elements with greater potential for environmental impacts, then the environmentally superior alternative would be a complete Program of all five alternatives by incorporating modifications to three alternatives as components of the overall control Program: Physical Control, Biological Control, and Chemical Control Alternatives. See Section 15.4 for a discussion of the Reduced Physical Control, Reduced Biological Control, and Reduced Chemical Control Alternatives. The District could select any or all of the three "reduced alternatives" as part of the overall Program.

The No Program Alternative is not the environmentally superior alternative due to its potentially significant impacts to the following resources and concerns identified in Section 15.2.2: urban and rural land uses, aquatic and terrestrial biological resources, ecological health, human health, and public services and hazard response.

S.6 Summary of Environmental Impacts and Mitigation Measures

Table S-1 provides a summary of all of the environmental impacts and mitigation for the Program alternatives. The existing condition (2012) sets the baseline against which the alternatives are evaluated for CEQA. Impact statements are presented in their entirety in the resource sections. For Table S-1, impact areas or environmental concerns are merely listed using brief terms for ease of comparison. Symbols used in the table for CEQA determinations of impact are:

SU = Significant and Unavoidable Impact

SM = Potentially Significant but Mitigable Impact

LS = Less-than-Significant Impact

N = No Impact

na = Not Applicable

Tables S-2 through S-5 present only the potentially significant impacts for the Program alternatives, the mitigation required, and the significance following mitigation implementation. The Program alternatives with potentially significant but mitigable impacts are Physical Control, Vegetation Management, and Chemical Control. Under Physical Control, the environmental concerns are with draining aquatic habitats and potentially affecting special-status species and provisions of an HCP/NCCP. Under the Vegetation Management Alternative, one concern exists: the potential to conflict with an HCP/NCCP. Under the Chemical Control Alternative, potentially significant impacts to surface waters exist from permethrin and resmethrin. Mitigation measures represent actions the District (or other agency) will take to reduce all of these impacts to a level of insignificance. If mitigation is not feasible or practical to implement, or simply not enough to reduce the impact to less than significant, then the impact is "significant and unavoidable." All of the potentially significant impacts associated with Program alternatives can be mitigated to a less-than-significant level with two exceptions.

The Biological Control Alternative has the potential for significant impacts to aquatic resources and ecological health from the use of mosquitofish in natural waterways. While mitigation would substantially reduce these impacts, the risk of impacts would not be eliminated, resulting in a significant and unavoidable residual impact after mitigation.

One potentially significant and unavoidable impact is associated with the Chemical Control Alternative related to the use of naled for control of adult mosquitoes. Impact WR-21 states that due to the toxicity of its breakdown product but its importance in the District's IMMP, the application of naled is considered a potentially significant and unavoidable impact to surface and groundwater resources. Naled is an organophosphate insecticide and may be used in rotation with pyrethrins or pyrethroids to avoid the development of pesticide resistance. Naled is the most commonly used material for this purpose, but the District would use it infrequently. Naled has low water solubility but is mobile in soils with low organic matter content. It is moderately toxic to mammals, fish, and aquatic invertebrates but degrades readily in water, under sunlight, in soil under aerobic and anaerobic conditions, in air, and on plants. Dichlorvos, a breakdown product of naled, and itself a registered pesticide, may be present in toxic concentrations after naled is no longer detectable. However, naled and other organophosphates are important chemicals that help prevent or control resistance to alternative products such as pyrethrins and pyrethroids by providing an alternative chemistry/mode of action.

Table S-1 Summary Comparison of Impacts of Alternatives

Environmental Concern	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
3. Urban and Rural Land Uses					
Quantity and/or quality of recreational opportunities	LS	LS	LS	N	LS
Conflict with applicable land use regulations	N	N	N	N	N
4. Biological Resources – Aquatic					
Aquatic habitats	LS	LS except: SM when draining seasonal wetlands’	LS	N	LS
Native fish or aquatic invertebrates	LS	LS except : SM when draining seasonal wetlands	LS	N	LS
Special-status species (SSS)	LS	LS except: SM when SSS are present and: draining shallow freshwater areas; draining seasonal wetlands; improving drainage in freshwater marshes/duck club or saline or brackish habitats	LS	N	LS
Conflict with appropriate HCP/NCCPs	LS	SM	SM	SU	SM
5. Biological Resources – Terrestrial					
Reduction of the amount or quality of habitat available	LS	LS	LS	N	LS
Native terrestrial plant or animal populations through direct mortality	LS	LS	LS	N	LS

Table S-1 Summary Comparison of Impacts of Alternatives

Environmental Concern	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Special-status species	LS	LS	LS	N	LS
Conflict with appropriate HCP/NCCPs	LS	LS	LS	N	LS
6. Ecological Health					
Impacts on nontarget ecological receptors	LS	LS	LS	SU	LS
7. Human Health					
Impacts on human health	N	LS	LS	N	LS
8. Public Services and Hazard Response					
Increase demand for police, fire, or health-care services	N	N	N	N	N
Create a significant hazard to the public or the environment through routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment	N	N	N	N	N
Expose people or structures to a significant risk of loss, injury, or death involving wildland fires	N	N	N	N	N
9. Water Resources					
Impacts on surface water resources	N	LS	LS	LS	LS except: SM for Permethrin SM for Resmethrin SU for Naled
Impacts on groundwater resources	N	LS	LS	LS	LS except: SU for Naled

Table S-1 Summary Comparison of Impacts of Alternatives

Environmental Concern	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
10. Air Quality					
SIP emission inventory and the compliance with applicable air regulations	LS	LS	LS	LS	LS
Ambient air quality standard	LS	LS	LS	LS	LS
Cumulatively considerable increase of nonattainment pollutants	LS	LS	LS	LS	LS
Expose sensitive receptors to substantial pollutant concentrations	LS	LS	LS	LS	LS
Subject people to objectionable odors	N	N	N	N	SM
11. Greenhouse Gases and Climate Change					
Cumulatively considerable amount of GHGs	LS	LS	LS	LS	LS
Conflict with applicable plans, policies, or regulations for reducing GHG emissions	LS	LS	LS	LS	LS
12. Noise					
Exceedance of noise standards	LS	LS	LS	LS	LS
Substantial temporary increase in noise	LS	LS	LS	LS	LS

Table S-2 Significant Impacts and Mitigation for Physical Control Alternative

Affected Resource and Area of Potential Impact	Identified Impact	Mitigation Measures	Significance After Mitigation
4. Biological Resources – Aquatic			
Special-Status Species	**Impact AR-4:** Draining areas of shallow freshwater habitats would have a **potentially significant but mitigable** impact on special-status species, if these species are present when the habitat is drained.	**Mitigation Measure AR-4:** The District will coordinate with appropriate resource agency personnel whenever a habitat treatment is under consideration in an area potentially supporting sensitive species. If shallow habitats associated with natural waterways where sensitive species could be present need draining, the District will schedule such activity at a time of year when these species are absent from the treatment site. In the event that such activity cannot be postponed, or must be performed in habitat that has the potential for continuous occupancy, the District will have a qualified biologist conduct surveys to determine if sensitive fish species are present. This treatment would be avoided where sensitive species are present. > Location: Areas with potential presence of sensitive aquatic species. > Monitoring/Reporting Action: Assess likelihood of presence through consultation with agency biologists, consideration of species life-history timing, and, if necessary, site specific surveys by a qualified biologist. Finding will be documented with resource agencies. > Effectiveness Criteria: Mitigation will be considered effective if treatment of areas with potential presence of sensitive species is avoided. > Responsible Agency: the District > Timing: Dependent on need for treatment activities	Less than significant
Aquatic Habitats, Native Fish or Aquatic Invertebrates, and Special-Status Species	**Impact AR-5:** Draining seasonal wetlands in areas supporting sensitive fish species would have a **potentially significant but mitigable** impact on aquatic habitats, native fish or aquatic invertebrates, and special-status species.	**Mitigation Measure AR-5:** Same as above	Less than significant

Table S-2 Significant Impacts and Mitigation for Physical Control Alternative

Affected Resource and Area of Potential Impact	Identified Impact	Mitigation Measures	Significance After Mitigation
Special-Status Species	**Impact AR-7:** Improving drainage in freshwater marshes and seasonal wetlands managed as waterfowl habitat would have a **potentially significant but mitigable** impact on special-status species if such species are present.	**Mitigation Measure AR-7:** Same as above	Less than significant
Special-Status Species	**Impact AR-9:** Improving drainage in saline and brackish habitats would have a **potentially significant but mitigable** impact on special-status species if such species are present.	**Mitigation Measure AR-9:** Same as above	Less than significant
Provisions of an HCP/NCCP	**Impact AR-14:** Physical control measures could have a **potentially significant but mitigable** impact by conflicting with the provisions of an HCP/NCCP.	**Mitigation Measure AR-14:** To avoid conflicts with the provisions of an HCP/NCCP, the District will determine whether any of its treatment areas lie within the boundaries of an HCP/NCCP. Prior to application of any treatments, excluding surveillance monitoring, the District will review the requirements of the HCP/NCCP and determine whether this activity will conflict with the provisions of that HCP/NCCP. The District will work with the HCP/NCCP holder and appropriate regulatory agencies to identify alternatives to avoid or minimize any potential impacts to a species or habitat protected by the HCP/NCCP. Such determination will be documented and relayed to the HCP/NCCP holder and the regulating entity (USFWS, NOAA Fisheries, CDFW). > Location: Treatment areas within the boundaries of an HCP/NCCP. > Monitoring/Reporting Action: Contact HCP manager to discuss treatment activities prior to implementation. Review the requirements of the HCP/NCCP and determine whether this activity will conflict with the provisions of that HCP/NCCP. > Effectiveness Criteria: Mitigation will be considered effective if treatment of areas with potential presence of sensitive species is avoided. Document discussion and appropriate treatment activities with the HCP/NCCP holder and the regulating entity (USFWS, NOAA Fisheries, CDFW)	Less than significant

Table S-2 Significant Impacts and Mitigation for Physical Control Alternative

Affected Resource and Area of Potential Impact	Identified Impact	Mitigation Measures	Significance After Mitigation
		> Responsible Agency: the District > Timing: Dependent on need for treatment activities	

Table S-3 Significant Impacts and Mitigation for Vegetation Management Alternative

Affected Resource and Area of Potential Impact	Identified Impact	Mitigation Measures	Significance After Mitigation
4. Biological Resources - Aquatic			
Provisions of an HCP/NCCP	**Impact AR-16:** Vegetation management measures could have a **potentially significant but mitigable** impact by conflicting with the provisions of an HCP/NCCP.	**Mitigation Measure AR-16:** To avoid conflicts with the provisions of an HCP/NCCP, the District will determine whether any of its treatment areas lie within the boundaries of an HCP/NCCP. Prior to application of any treatments, excluding surveillance monitoring, the District will review the requirements of the HCP/NCCP and determine whether this activity will conflict with the provisions of that HCP/NCCP. Such determination will be documented and relayed to the HCP/NCCP holder and the regulating entity (USFWS, NOAA Fisheries, CDFW). > Location: Treatment areas within the boundaries of an HCP/NCCP. > Monitoring/Reporting Action: Contact HCP manager to discuss treatment activities prior to implementation. Review the requirements of the HCP/NCCP and determine whether this activity will conflict with the provisions of that HCP/NCCP. > Effectiveness Criteria: Mitigation will be considered effective if treatment of areas with potential presence of sensitive species is avoided. Document discussion and appropriate treatment activities with the HCP/NCCP holder and the regulating entity (USFWS, NOAA Fisheries, CDFW) > Responsible Agency: the District > Timing: Dependent on need for treatment activities	Less than significant

Table S-4 Significant Impacts and Mitigation for Biological Control Alternative

Affected Resource and Area of Potential Impact	Identified Impact	Mitigation Measures	Significance After Mitigation
4. Biological Resources – Aquatic			
Special-Status Species and Provisions of an HCP/NCCP	**Impact AR-18.** Planting of mosquitofish in natural waterways or artificial environments that drain to natural waterways would have a **potentially significant** impact on native fish or aquatic invertebrates, special-status fish species, and applicable HCP/NCCPs. The mitigation measures for this action would reduce the ecological risks associated with planting of mosquitofish in natural waters, but these risks would not be eliminated. Because of this, the residual impact of this action would be **significant and unavoidable**.	To minimize the potential impacts of planting mosquitofish in natural waterways, the District will implement a policy incorporating the following elements: 1. Limiting such plantings to areas where the District's historic and ongoing Surveillance Program indicates that mosquito breeding is likely to occur. 2. Consulting appropriate federal and state fish and wildlife department websites, including the USFWS website, CDFW website, and CalFish.org to determine if the area under consideration for treatment, including a 1 mile radius around the site, is a known habitat for threatened and/or endangered species. 3. Not planting in streams until flows have become discontinuous, and stream habitat consists of isolated pools to minimize the potential for the movement of mosquitofish to areas where treatment was not intended. 4. Not planting mosquitofish if there have been reported sightings of threatened and/or endangered species within this area without further surveys by a biologist qualified to perform such surveys, or consultation with agency biologists. 5. District staff conducting a site survey and preparing a written report relating to the occurrence of sensitive species and not planting mosquitofish if the survey identifies the potential presence of sensitive species. Unless prohibited by the guidelines above, the site will be planted with mosquitofish. The District will keep records of all plantings made by watershed and location, as well as records of any plantings that were planned and discontinued for any of the reasons provided above.	Significant and unavoidable

Table S-4 Significant Impacts and Mitigation for Biological Control Alternative

Affected Resource and Area of Potential Impact	Identified Impact	Mitigation Measures	Significance After Mitigation
		> Location: All natural waters to be treated with mosquitofish. > Monitoring/Reporting Action: Consult appropriate websites for locations of species of concern or designated critical habitat for listed species. Have surveys performed by a biologist qualified to perform surveys for any sensitive species that might occur based on the above or consult with resource agency biologists prior to planting. In treatment areas more than one mile from locations where sensitive species are thought to occur, District staff will perform a site assessment and complete a site assessment report, to be kept on file at the District offices. If sensitive species are observed, mosquitofish will not be planted without consulting the regulatory agencies. > Effectiveness Criteria: Mitigation will be considered effective if treatment of areas with potential presence of sensitive species is avoided. > Responsible Agency: the District > Timing: Dependent on need for treatment activities	

Table S-4 Significant Impacts and Mitigation for Biological Control Alternative

Affected Resource and Area of Potential Impact	Identified Impact	Mitigation Measures	Significance After Mitigation
6. Ecological Health			
Nontarget aquatic species and HCPs/NCCPs	**Impact ECO-8:** Planting of mosquitofish in natural waterways or artificial environments that drain to natural waterways would have a **potentially significant** impact on native fish or aquatic invertebrates, special-status fish species, and applicable HCP/NCCPs. The mitigation measures for this action would reduce the ecological risks associated with planting of mosquitofish in natural waters, but these risks would not be eliminated. Because of this, the residual impact of this action would be **significant and unavoidable**.	To minimize the potential impacts of planting mosquitofish in natural waterways, the District will implement a policy incorporating the following elements: 1. Limiting such plantings to areas where the District's historic and ongoing Surveillance Program indicates that mosquito breeding is likely to occur. 2. Consulting appropriate federal and state fish and wildlife department websites, including the USFWS website, CDFW website, and CalFish.org to determine if the area under consideration for treatment, including a 1 mile radius around the site, is a known habitat for threatened and/or endangered species. 3. Not planting in streams until flows have become discontinuous, and stream habitat consists of isolated pools to minimize the potential for the movement of mosquitofish to areas where treatment was not intended. 4. Not planting mosquitofish if there have been reported sightings of threatened and/or endangered species within this area without further surveys by a biologist qualified to perform such surveys, or consultation with agency biologists. 5. District staff conducting a site survey and preparing a written report relating to the occurrence of sensitive species and not planting mosquitofish if the survey identifies the potential presence of sensitive species. Unless prohibited by the guidelines above, the site will be planted with mosquitofish. The District will keep records of all plantings made by watershed and location, as well as records of any plantings that were planned and discontinued for any of the reasons provided above.	Significant and unavoidable

Table S-4 Significant Impacts and Mitigation for Biological Control Alternative

Affected Resource and Area of Potential Impact	Identified Impact	Mitigation Measures	Significance After Mitigation
		> Location: All natural waters to be treated with mosquitofish. > Monitoring/Reporting Action: Consult appropriate websites for locations of species of concern or designated critical habitat for listed species. Have surveys performed by a biologist qualified to perform surveys for any sensitive species that might occur based on the above or consult with resource agency biologists prior to planting. In treatment areas more than one mile from locations where sensitive species are thought to occur, District staff will perform a site assessment and complete a site assessment report, to be kept on file at the District offices. If sensitive species are observed, mosquitofish will not be planted without consulting the regulatory agencies. > Effectiveness Criteria: Mitigation will be considered effective if treatment of areas with potential presence of sensitive species is avoided. > Responsible Agency: the District > Timing: Dependent on need for treatment activities	

Table S-5 Significant Impacts and Mitigation for Chemical Control Alternative

Affected Resource and Area of Potential Impact	Identified Impact	Mitigation Measures	Significance After Mitigation
4. Biological Resources - Aquatic			
Provisions of an HCP/NCCP	**Impact AR-25.** The Chemical Control Alternative could have a **potentially significant but mitigable** impact by conflicting with the provisions of an HCP/NCCP.	**Mitigation Measure AR-25:** To avoid conflicts with the provisions of an HCP/NCCP, the District will determine whether any of its treatment areas lie within the boundaries of an HCP/NCCP. Prior to application of any treatments, excluding surveillance monitoring, the District will review the requirements of the HCP/NCCP and determine whether this activity will conflict with the provisions of that HCP/NCCP. Such determination will be documented and relayed to the HCP/NCCP holder and the regulating entity (USFWS, NOAA Fisheries, CDFW). > Location: Treatment areas within the boundaries of an HCP/NCCP. > Monitoring/Reporting Action: Contact HCP manager to discuss treatment activities prior to implementation. Review the requirements of the HCP/NCCP and determine whether this activity will conflict with the provisions of that HCP/NCCP. > Effectiveness Criteria: Mitigation will be considered effective if treatment of areas with potential presence of sensitive species is avoided. Document discussion and appropriate treatment activities with the HCP/NCCP holder and the regulating entity (USFWS, NOAA Fisheries, CDFW) > Responsible Agency: the District > Timing: Dependent on need for treatment activities	Less than significant

Table S-5 Significant Impacts and Mitigation for Chemical Control Alternative

Affected Resource and Area of Potential Impact	Identified Impact	Mitigation Measures	Significance After Mitigation
9. Water Resources			
Surface and Groundwater	**Impact WR-16:** Because of its high toxicity and potential persistence, the application of permethrin is considered a **potentially significant but mitigable** impact to surface water resources. Mitigation is required. For groundwater, because of its strong tendency to adsorb to soil surfaces, permethrin is unlikely to leach to groundwater and therefore its application is considered a less-than-significant impact to groundwater resources and no mitigation is required.	**Mitigation Measure WR-16a:** Application of permethrin would occur only when other IPM options have been exhausted. Alternative mosquito adulticides should be considered whenever possible. With implementation of other chemicals, the impact is reduced to less than significant. **Mitigation Measure WR-16b:** Application of these chemicals would not occur in locations where receiving waters are 303(d) listed for pyrethroids or sediment toxicity. Consistent with the District's current IPM plan, application of chemicals would occur only when other IPM options have been exhausted. Because permethrin has relatively high toxicity and persistence in comparison to other pyrethroids, the District's current IPM plan will be updated to give lower priority to the use of permethrin than other pyrethroids in areas requiring chemical control. Permethrin use will be reserved for specific cases where alternative pesticides would not be as effective. Prior to chemical applications, the location of the application area will be reviewed with respect to proximity to impaired water bodies. Application of permethrin would not occur in locations where receiving waters are 303(d) listed for pyrethroids or sediment toxicity. Location: Areas requiring chemical control at or near water bodies and locations where receiving waters are 303(d) listed for pyrethroids or sediment toxicity > Monitoring/Reporting: : District staff to Board of Trustees > Effectiveness Criteria: Implementation of updated IPM plan > Responsible Agency: District > Timing: Prior to chemical control	Less than significant

Table S-5 Significant Impacts and Mitigation for Chemical Control Alternative

Affected Resource and Area of Potential Impact	Identified Impact	Mitigation Measures	Significance After Mitigation
Surface and Groundwater	**Impact WR-19:** Due to its high toxicity and potential persistence, the application of resmethrin is considered a **potentially significant but mitigable** impact to surface water resources. Mitigation is required. For groundwater, because of its strong tendency to adsorb to soil surfaces, permethrin is unlikely to leach to groundwater and therefore its application is considered a less-than-significant impact to groundwater resources and no mitigation is required.	**Mitigation Measure WR-19a:** Application of resmethrin would occur only when other IPM options have been exhausted. Alternative mosquito adulticides should be considered. **Mitigation Measure WR-19b:** Application of these chemicals would not occur in locations where receiving waters are 303(d) listed for pyrethroids or sediment toxicity. Consistent with the District's current IPM plan, application of chemicals would occur only when other IPM options have been exhausted. Because resmethrin has relatively high toxicity and persistence in comparison to other pyrethroids, the District's current IPM plan will be updated to give lower priority to the use of resmethrin than other pyrethroids in areas requiring chemical control. Resmethrin use will be reserved for specific cases where alternative pesticides would not be as effective. Prior to chemical applications, the location of the application area will be reviewed with respect to proximity to impaired water bodies. Application of resmethrin would not occur in locations where receiving waters are 303(d) listed for pyrethroids or sediment toxicity. Location: Areas requiring chemical control at or near water bodies and locations where receiving waters are 303(d) listed for pyrethroids or sediment toxicity > Monitoring/Reporting: District staff to Board of Trustees > Effectiveness Criteria: Implementation of updated IPM plan > Responsible Agency: District > Timing: Prior to chemical control	Less than significant
Surface and Groundwater	**Impact WR-21:** Due to the toxicity of its breakdown product but its importance in the District's IMMP, the application of naled is considered a **significant and unavoidable** impact to surface and groundwater resources.	Not available	Significant and unavoidable

Table S-5 Significant Impacts and Mitigation for Chemical Control Alternative

Affected Resource and Area of Potential Impact	Identified Impact	Mitigation Measures	Significance After Mitigation
10. Air Quality			
Objectionable Odors	**Impact AQ-25:** The Chemical Control Alternative could subject people to objectionable odors. Impacts could be **potentially significant but mitigable.**	**Mitigation Measure AQ-25a:** Maintain appropriate buffer zones between spray areas and sensitive receptor locations when possible for the application of the treatment compounds, especially true for aerial applications. > Location: Areas to receive treatment with pesticides that are near residential and commercial land uses > Monitoring/Reporting Action: District staff to check current land use maps or aerial photos prior to treatments > Effectiveness Criteria: Document odor complaints from the public > Responsible Agency: District > Timing: Prior to chemical treatments **Mitigation Measure AQ-25b:** When possible, defer application of treatment compounds until such time that favorable wind conditions would reduce or avoid the risk of drift into populated areas. > Location: Areas to receive treatment with pesticides that are near residential and commercial land uses > Monitoring/Reporting Action: District staff to check current land use maps or aerial photos prior to treatments > Effectiveness Criteria: Document odor complaints from the public > Responsible Agency: District > Timing: Prior to chemical treatments	Less than significant

Table S-5 Significant Impacts and Mitigation for Chemical Control Alternative

Affected Resource and Area of Potential Impact	Identified Impact	Mitigation Measures	Significance After Mitigation
		Mitigation Measure AQ-25c: Use GPS dataloggers that document site-specific compliance with all label requirements for drift mitigation. > Location: Areas to receive treatment with pesticides that are near residential and commercial land uses > Monitoring/Reporting Action: District staff to check current land use maps or aerial photos prior to treatments > Effectiveness Criteria: Document odor complaints from the public > Responsible Agency: District > Timing: Prior to chemical treatments **Mitigation Measure AQ-25d:** Use precision application technology to reduce drift and the total amount of material applied. This measure can include (1) precision guidance systems that minimize ground or aerial spray overlap (e.g., GPS and Real Time Kinetics – GPS/RTK), and (2) computer-guided application systems that integrate real-time meteorological data and computer model guidance to reduce drift from aerial application (e.g., trade names "AIMMS," "Wingman™ GX," and "NextStar™ Flow Control"). > Location: Areas to receive treatment with pesticides that are near residential and commercial land uses > Monitoring/Reporting Action: District staff to check current land use maps or aerial photos prior to treatments > Effectiveness Criteria: Document odor complaints from the public > Responsible Agency: District > Timing: Prior to chemical treatments	

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1 Introduction

The Solano County Mosquito Abatement District, as Lead Agency under the California Environmental Quality Act (CEQA), has prepared this Programmatic Environmental Impact Report (PEIR) for their ongoing program of surveillance and control of mosquitoes that are vectors of human disease and discomfort.

1.1 History and Background

This section presents the history of why the District was established in 1930 to control the mosquitoes transmitting diseases and producing discomfort to humans and their domesticated animals within the District's Service Area. It begins with a description of the diseases of concern, the potential for human and animal illness to occur, and the legislative and regulatory actions leading to the District's establishment of an Integrated Mosquito Management Program (IMMP or Program).

1.1.1 Mosquito-Borne Diseases in Program Area

The District's IMMP is designed to protect the public health from potential diseases transmitted by mosquitoes (also known as vectors). A *vector is* an insect or other organism that transmits a pathogenic fungus, virus, bacterium, etc. such as a mosquito, tick, or rat. According to the California Health and Safety Code [Section 2002(k)], "vector" means any animal capable of transmitting the causative agent of human disease or capable of producing human discomfort or injury, including, but not limited to, mosquitoes, flies, mites, ticks, other arthropods, and rodents and other vertebrates.

1.1.1.1 Mosquitoes

Diseases of concern within the District's Service Area that are spread by mosquitoes include the following at present: West Nile virus (WNV), Western equine encephalomyelitis (WEE), St. Louis encephalitis (SLE), malaria, dog heartworm disease, and myxomatosis. The potential for the introduction of new diseases exists at any time.

1.1.1.1.1 West Nile Virus

WNV is transmitted during blood-meal feeding by mosquitoes that have previously fed on the blood of infected birds. Humans, horses, and most other mammals are all potential incidental hosts (CDC 2004a). Approximately 80 percent of people who become infected with WNV develop no clinical illnesses or symptoms and, of those who do develop symptoms, most develop what has been termed West Nile fever. Depending on the degree to which the central nervous system is affected, other more severe diseases could develop including West Nile meningitis, West Nile encephalitis, and West Nile poliomyelitis (CDC 2004b). Out of 429 reported human cases of WNV in 2012 in California, 19 persons died from the disease.

1.1.1.1.2 Western Equine Encephalomyelitis

WEE virus primarily cycles between birds and mosquitoes infecting humans and horses. Horses infected with WEE do not develop a significant viremia[1] and are true dead-end hosts, meaning the horse is a host from which infectious agents are not transmitted to other susceptible hosts.

WEE can also cycle between mosquitoes and blacktail jackrabbits. WEE usually shows no symptoms or is mild in adults, with nonspecific signs of illness and few deaths. The disease is most severe in children, particularly infants under 1 year of age. Infants under 3 months most often experience permanent, severe

[1] Viremia is a medical condition where viruses enter the bloodstream and, hence, have access to the rest of the body.

neurological damage. Horses can also experience asymptomatic infections or mild symptoms; however, more severe infections can occur. Horses that recover from encephalitis have a high incidence of residual symptoms (Iowa State University 2008).

1.1.1.1.3 St. Louis Encephalitis

The SLE virus is transmitted to mosquitoes while feeding on the blood of infected birds. Humans and domestic mammals can acquire SLE infection, but are dead-end hosts, hosts that do not develop a significant viremia to be passed on (CDC 2009a). Most SLE infections show no signs, with clinical infections resulting in less than 1 percent of infections that can range from mild nonspecific fever to meningitis or encephalitis. Older age increases the risk of severe disease and fatality. According to the Centers for Disease Control and Prevention (CDC 2009b), almost 90 percent of elderly persons with SLE develop encephalitis.

1.1.1.1.4 Malaria

Malaria parasites are transmitted to humans after being bitten by an infected female *Anopheles* mosquito. It is endemic to tropical and subtropical parts of the world where climatic factors favor mosquito and parasite development. The mosquito must have been infected by previously feeding on the blood of an infected person. Uncomplicated malaria manifests in patients as flu-like symptoms while severe malaria can cause neurologic abnormalities, anemia, kidney failure, acute respiratory distress syndrome, and hypoglycemia (CDC 2012a). The parasite is most often seen in travelers and immigrants from countries where malaria is endemic; however, outbreaks of locally transmitted cases have been observed; and due to the existence of suitable vectors, the potential risk for the disease to reemerge is present, especially in the southern states (CDC 2010a).

1.1.1.1.5 Dog Heartworm Disease

Heartworm disease is caused by a parasitic worm and results in severe lung disease, heart failure, organ damage, and death in domesticated mammals, mainly dogs and cats. Worms are spread through blood-meal feeding of mosquitoes, with adults maturing in the heart, lungs, and associated blood vessels. The severity of heartworm disease is correlated to how many worms are living inside the animal, how long the animal has been infected, and the animal's response to the heartworms' presence. Signs of the disease can range from no symptoms to tiredness, coughing, and heart failure. The most severe cases are known as caval syndrome in which blood flow to the heart is blocked by a large worm mass. If left untreated, heartworm disease will progress and damage to internal organs will eventually cause death. In some rare cases, humans have contracted heartworms after being bitten by an infected mosquito; however, larvae usually die before they can migrate to the heart or lungs (United States Food and Drug Administration 2010).

1.1.1.1.6 Myxomatosis

Myxomatosis is a fatal disease of domesticated rabbits caused by the myxoma virus, characterized by mucinous skin lesions. In the United States, the disease is restricted to coastal areas of California and Oregon. Outbreaks occur infrequently but sporadic cases are common. Transmission occurs through the biting of blood-sucking insects, such as mosquitoes, fleas, and biting flies, as well as direct contact. Initial signs of the disease are conjunctivitis and milky discharge from the eyes, progressing to swelling of the face with discharge coming from the nasal cavity. Eventually breathing becomes labored and the rabbit will go into coma just before dying (McClure 2011).

1.1.2 Potential for Human and Animal Illness

To avoid or manage the risk to human and animal health from the diseases listed above requires effective mosquito-borne disease surveillance and control strategies that may fluctuate temporally and regionally. Such factors include mosquito and pathogen biology, environmental factors, land use patterns, and resource availability to support production of mosquitoes in quantities that threaten human and animal health. For example, detecting and monitoring WNV activity is accomplished by testing mosquitoes, dead birds, sentinel chickens, horses, and humans. The District identifies the mosquito species present, its locations and densities within the Service Area, and then the disease potential.

The District engages in activities and management practices to control mosquitoes and to address the specific situations within its Service Area. These management practices emphasize the fundamentals of integrated pest management (IPM) wherein source reduction, habitat modification, and biological control are used when appropriate before resorting to pesticides. When pesticides are used, they are applied in a manner that minimizes risk to human health and ecological health.

1.1.3 Legislative and Regulatory Actions

A number of legislative and regulatory actions form the basis for the District's authority to engage in vector control. The District is a regulatory agency formed pursuant to California Health and Safety Code Section 2000 et seq. State law charges the District with the authority and responsibility to take all necessary or proper steps for the control of mosquitoes and other vectors in the District.

Pursuant to Sections 2040-2045, the District may conduct all of the following activities:

(a) Conduct surveillance programs and other appropriate studies of vectors and vector-borne diseases.

(b) Take any and all necessary or proper actions to prevent the occurrence of vectors and vector-borne diseases.

(c) Take any and all necessary or proper actions to abate or control vectors and vector-borne diseases.

(d) To purchase the supplies and materials, employ the personnel, and contract for the services that may be necessary or proper to carry out the purposes and intent of this chapter.

(e) To build, repair, and maintain on any land the dikes, levees, cuts, canals, or ditches that may be necessary or proper to carry out the purpose and intent of this chapter.

(f) To engage necessary personnel, to define their qualifications and duties, and to provide a schedule of compensation for the performance of their duties.

(g) To participate in, review, comment, and make recommendations regarding local, state, or federal land use planning and environmental quality processes, documents, permits, licenses, and entitlements for projects and their potential effects on the purposes and intent of this chapter.

(h) A district may contract with other public agencies and federal agencies to provide any service, project, or program authorized by this chapter within the district's boundaries. A district may contract with other public agencies to provide any service, project, or program authorized by this chapter within the boundaries of the other public agencies and federal agencies.

In accordance with California Health and Safety Code Section 2053:

(a) A district may request an inspection and abatement warrant pursuant to Title 13 (commencing with Section 1822.50) of Part 3 of the Code of Civil Procedure. A warrant issued pursuant to this section shall apply only to the exterior of places, dwellings, structures, and premises. The warrant shall state the geographic area which it covers and shall state its purposes. A warrant may authorize district employees to enter property only to do the following:

   (1) Inspect to determine the presence of vectors or public nuisances.

   (2) Abate public nuisances, either directly or by giving notice to the property owner to abate the public nuisance.

(3) Determine if a notice to abate a public nuisance has been complied with.

(4) Control vectors and treat property with appropriate physical, chemical, or biological control measures.

(b) Subject to the limitations of the United States Constitution and the California Constitution, employees of a district may enter any property, either within the district or property that is located outside the district from which vectors may enter the district, without hindrance or notice for any of the following purposes:

(1) Inspect the property to determine the presence of vectors or public nuisances.

(2) Abate public nuisances pursuant to this chapter, either directly or by giving notice to the property owner to abate the public nuisance.

(3) Determine if a notice to abate public nuisance has been complied with.

(4) Control vectors and treat property with appropriate physical, chemical, or biological control measures.

1.1.3.1.1 Cooperative Agreement between the California Department of Public Health and Local Vector Control Agencies

Due to their public health mission, the California Department of Pesticide Regulation's (CDPR's) Pesticide Regulatory Program provides special procedures for vector control agencies that operate under a Cooperative Agreement with the California Department of Public Health (CDPH). The application of pesticides by vector control agencies is regulated by a special and unique arrangement among the CDPH, CDPR, and County Agricultural Commissioners. CDPR does not directly regulate vector control agencies. CDPH provides regulatory oversight for vector control agencies that are signatory to the Cooperative Agreement. Signatories to the agreement use only pesticides listed by CDPH, maintain pesticide use reports, and ensure that pesticide use does not result in harmful residues on agricultural products. The District maintains a cooperative agreement with CDPH. Its employees are certified by CDPH as vector control technicians, which help to ensure that employees are adequately trained regarding safe and proper vector control techniques including the handling and use of pesticides and compliance with laws and regulations relating to vector control and environmental protection (SCMAD 2013).

1.1.3.1.2 California Pesticide Regulatory Program

CDPR regulates the sale and use of pesticides in California. CDPR is responsible for reviewing the toxic effects of pesticide formulations and determining whether a pesticide is suitable for use in California through a registration process. Although CDPR cannot require manufacturers to make changes in labels, it can refuse to register products in California unless manufacturers address unmitigated hazards by amending the pesticide label. Consequently, many pesticide labels that are already approved by the United States Environmental Protection Agency (USEPA) also contain California-specific requirements. Pesticide labels defining the registered applications and uses of a chemical are mandated by USEPA as a condition of registration. The label includes instructions telling users how to make sure the product is applied only to intended target pests, and includes precautions the applicator should take to protect human health and the environment. For example, product labels may contain such measures as restrictions in certain land uses and weather (i.e., wind speed) parameters.

1.2 Program Objectives/Purpose and Need

1.2.1 Program Objectives

The District undertakes mosquito control activities through its Program to control all mosquitoes that are vectors of disease and/ or discomfort in the Program Area. Its Program may also include the control of certain noxious/invasive weeds under special circumstances in the future.

The Proposed Program's specific objectives are as follows:

> Reduce the potential for human and animal disease caused by mosquitoes
> Reduce the potential for human and animal discomfort or injury from mosquitoes
> Accomplish effective and environmentally sound mosquito management by means of:
  - Surveying for mosquito abundance/human contact
  - Establishing treatment criteria
  - Appropriately selecting from a wide range of Program tools or components

Most of the relevant mosquito species are quite mobile and cause the greatest hazard or discomfort at a distance from where they breed. Each potential mosquito vector has a unique life cycle, and most of them occupy several types of habitats. To effectively control them, an IMMP must be employed. District policy is to identify those species that are currently vectors, to recommend techniques for their prevention and control, and to anticipate and minimize any new interactions between these mosquitoes and humans or domestic animals.

1.2.2 Purpose and Need

The District was established in 1930 to reduce the risk of mosquito-borne disease and discomfort to the residents of its Service Area. In addition to being nuisances by disrupting human activities and enjoyment of public and private areas, certain mosquito species can transmit a number of diseases. A vector is defined by the State of California as "any animal capable of transmitting the causative agent of human disease or capable of producing human discomfort or injury, including, but not limited to, mosquitoes, flies, other insects, ticks, mites, and rats, but not including any domesticated animal…" [California Health and Safety Code Section 2200(f)]. The mosquito-transmitted diseases of most concern in the Program Area are as follows WNV, WEE, SLE, dog heartworm, malaria, and myxomatosis.

Depending on the disease, both human and domestic animal health can be at risk of disability, illness, and/or death. Furthermore, potential exists for introduction of new diseases into the District's Service Area at any time.

1.3 Alternatives Considered in this Programmatic Environmental Impact Report

The District's Program is an ongoing series of related actions for control of mosquitoes as a vector of human disease and discomfort. The District's activities involve the identification of mosquito problems; responsive actions to control existing populations of mosquitoes, prevent new sources of mosquitoes from developing, and manage habitat to minimize mosquito production; education of landowners and others on measures to minimize mosquito production or interaction with mosquitoes; and provision and administration of funding and institutional support necessary to accomplish District objectives.

For at least the past two decades, the District has taken an integrated systems approach to mosquito control utilizing a suite of tools that consist of:

> Surveillance
> Physical Control
> Vegetation Management
> Biological Control
> Chemical Controls
  - Larvicides

  - Adulticides

> Public Education

These first five tools are called “alternatives,” are part of the present Program, and all would continue and be combined as the overall Proposed Program along with public education. These alternative Program “tools” or components are described in the subsequent subsection as “Program alternatives” for the CEQA process (except for public education, which is exempt from CEQA). Program implementation is weighted heavily towards vegetation management and physical and biological control, in part, to reduce the potential for environmental impacts. To realize effective and environmentally sound mosquito management, control must be based on several factors:

> Carefully monitoring or surveying mosquito abundance and/or potential contact with people

> Establishing treatment criteria (thresholds)

> Selecting appropriate tools from a wide range of control methods

This Program consists of a dynamic combination of surveillance, treatment criteria, and use of multiple control activities in a coordinated program with public education that is generally known as integrated pest management (IPM) or specifically for the District as Integrated Mosquito Management (IMM).

The District’s IMMP, like any IPM program, seeks by definition to use procedures that will minimize potential environmental impacts. The District’s IMMP employs IPM principles by first identifying the species and abundance of mosquitoes through evaluation of public service requests and field surveys of immature and adult mosquito populations and, then, if the populations exceed predetermined criteria, using the most efficient, effective, and environmentally sensitive means of control. For all mosquito species, public education is an important control strategy. In some situations, water management or other physical control activities can be instituted to reduce mosquito-breeding sites. The District also uses biological control such as the planting of mosquitofish in some settings. When these approaches are not effective, or are otherwise deemed inappropriate, then pesticides are used to treat specific mosquito-producing or mosquito-harboring areas.

Three core tenets are essential to the success of a sound IMMP:

> *First*, a proactive approach is necessary to minimize impacts and maximize successful mosquito management. Elements such as thorough surveillance and a strong public education program make all the difference in reducing potential human mosquito interactions.

> *Second*, long-term environmentally based solutions (e.g., water management, reduction of harborage and enhancement of predators and parasites) are optimal as they reduce the potential pesticide load in the environment as well as other potential long- and short-term impacts.

> *Lastly*, utilizing the full array of options and tools (public education, surveillance, physical control, biological control, and when necessary chemical control) in an informed and coordinated approach supports the overall goal of an environmentally sensitive mosquito management program.

The No Program Alternative is defined as the District not engaging in any of the control strategies and tools for mosquito control. Past practices would not continue into the future. The District would not continue to operate and would close. In the absence of the District, CDPH would provide mosquito “oversight” to local jurisdictions commensurate with their budget constraints.

1.4 Public Involvement

Public involvement for this PEIR includes the following actions.

1.4.1 CEQA Public Scoping

The Solano County Mosquito Abatement District (District) distributed a Notice of Preparation (NOP) of a Draft Programmatic Environmental Impact Report (PEIR) for the Integrated Mosquito and Vector Management Program (Program) pursuant to the CEQA Guidelines (Section 15082) on May 24, 2012. The NOP was sent to forty-seven (47) agencies, organizations, and individuals, including the following state responsible and trustee agencies:

- California Department of Fish and Game (now Wildlife): Bay Delta Region
- California Department of Parks and Recreation: Capital District
- California Department of Pesticide Regulation
- California Department of Public Health
- California Department of Transportation: District 4
- California Regional Water Quality Control Board: Central Valley Region
- California State Water Resources Control Board

The NOP provided a description of the Program, the location of Program activities, and the resources and environmental concerns planned for analysis in the PEIR. The NOP announced a public scoping meeting and requested the comments on the content of the PEIR and the Program alternatives be submitted within 30 days of receipt. The public scoping meeting was held at the following location and time:

- Solano County Mosquito Abatement District Office, Fairfield, California, on June 19, 2012, at 7:00 pm.

1.4.2 Public Scoping for Programmatic Environmental Impact Report

Public scoping resulted in the following comments that are focused on additional public notification during Program implementation.

- Possible violations of the Williamson Act pertaining to several businesses nearby.
- Request for Geological Investigation to determine correlation between pollution and the leaching effect from nearby pollution sources. Concerned with stormwater and ground water natural flow.
- Request for numerous scientific investigations (to be performed by both a licensed US Fish and Game biologist and an independent licensed biologist) to identify Critical Habitat, and create a detailed project area map of all habitat types along with impacts to species within area.
- DFW may require a Lake and Streambed Alteration Agreement (LSAA) within the Suisun Marsh and delta waterway and other DFG-jurisdictional waters.
- Construction Storm Water General Permit requirements: where one or more acres of soil is disturbed or where <1 ac but part of larger common plan that disturbs 1+ ac. Excludes regular maintenance.
- Phase I and II Municipal Separate Storm Sewer System (MS4) Permits: to reduce pollutants and runoff flows from new development and redevelopment.
- Industrial Storm Water General Permit: associated with industrial sites.
- Clean Water Act Section 404 Permit: for discharge of dredged or fill material in navigable waters or wetlands.

> Clean Water Action Section 401 Permit: if a USACE/other federal permit is required due to the disturbance of waters, then Water Quality Certification must be obtained prior to initiation of project activities.

> Waste Discharge Requirements: WDR for non-jurisdictional waters of the State.

> Request for investigation on a possible "Conflict of Interest" concerning the PGT-PG&E Pipeline Expansion Project.

Comments related to this PEIR are addressed under Section 2.4, Public Education, and Section 2.8.2, Agency Coordination.

1.4.3 Areas of Known Public Concern

CEQA Guidelines Section 15123 requires that the Summary "shall identify areas of controversy known to the lead agency." The areas of greatest public concern and debate are based on comments from public scoping and comments made during other District activities. These areas of controversy are explained here and then incorporated into the preceding Summary chapter:

> Use of Pesticides for Mosquito Control: Members of the public are distrustful of pesticide use for mosquito control. They prefer other methods to eliminate suitable habitat to deal with mosquito problem rather than spraying pesticides. If adulticides must be used, ensure use is justified with documented, mosquito-borne disease activity within or within flight range of the tidal marsh. Concern exists about pesticide applications drifting into backyards where the property owner wants to ensure their area is pesticide-free. The concern is not only with impacts to humans and "sensitive populations" but also to domestic animals and wildlife including nontarget insects.

> Use of Herbicides for Vegetation Management: Request for specific vegetation management information about the proposed chemical vegetation control agents (herbicides), the types, amounts and locations of chemical stored, application methods and rates, and their effects on the environment.

> Use of Biological Control Agents: Controversy exists over the use of some proposed biological control agents, in particular the use of mosquitofish and potential for them to impact sensitive species such as the California red-legged frog.

> District's Authority to Enter Public and Private Property for Control Activities: Some public agencies want the District to obtain an Encroachment Permit with notification of Park Supervisors for activities such as surveillance, physical control, or vegetation management where access to parkland is needed. Water districts insist that mosquito abatement materials and practices proposed for use on watershed lands must be thoroughly vetted and approved by CDPH.

Section 1.5, Environmental Concerns, presents a summary of the environmental concerns by resource or issue area for analysis in the PEIR.

1.4.4 Distribution of the Programmatic Environmental Impact Report

The District has distributed the Notice of Availability of the Draft PEIR to the following agencies, organizations, and individuals.

> Benicia Public Library

> City of Benicia – Planning Division

> City of Dixon – Planning Division

> City of Fairfield – Planning Division

> City of Rio Vista – Community Development Department

> City of Suisun City – Planning Division

- City of Vacaville – Planning Division
- City of Vallejo – Planning Division
- Contra Costa County Clerk
- Contra Costa County – Department of Conservation & Development
- Delta Keeper
- Dixon Public Library
- Fairfield Civic Center Library
- Fairfield Cordelia Library
- John F. Kennedy Library
- June Guidotti
- Lake Solano Park
- Law Library Hall of Justice
- Napa County Clerk
- Napa County – Planning Division
- Rio Vista Library
- Sacramento County Clerk
- Sacramento County – Environmental Review & Assessment
- Sandy Beach Park
- San Francisco Bay Chapter Sierra Club
- San Francisco Bay Conservation Development Commission
- San Francisco Baykeeper
- San Pablo Bay National Wildlife Refuge
- Solano County Clerk
- Solano County Resource Management Department
- Solano County Local Agency Formation Commission
- Solano Irrigation District
- Solano Resource Conservation District
- Sonoma County Clerk
- Sonoma County Permit/Resource Management Department
- State of California Central Valley Regional Water Quality Control Board
- State of California Clearinghouse, Office of Planning & Research
- State of California Department of Fish and Game
- State of California Department of Parks and Recreation
- State of California Department of Pesticide Regulation
- State of California Department of Public Health

> State of California Department of Transportation

> State of California San Francisco Regional Water Quality Control Board

> State of California Water Resource Control Board

> United States Army Corps. of Engineers

> United States Department of the Interior

> Yolo County Clerk

> Yolo County Planning and Public Works

> Solano Community College Library

> Springtown Library

> Suisun City Library

> Suisun Resource Conservation District

> Vacaville Public Library Cultural Center

> Vacaville Public Library Town Square

1.5 Environmental Concerns

Below is a listing of environmental concerns by resource (i.e., by PEIR section), including but not limited to issues raised by agencies and the public. These concerns are those most appropriate to the environmental impact analysis rather than questions concerning Program implementation or future coordination activities between the District and other agencies and individuals. Additional environmental concerns can be addressed through responses to public comments on the Draft PEIR.

1.5.1 Urban and Rural Land Uses

The following concerns are associated with land uses, both urban/developed lands and rural/open space/undeveloped lands. They are addressed primarily in Chapter 3, Urban and Rural Land Uses:

> Need to analyze and minimize aspects of the Program that diminish recreational experience of park visitors of the regional parks and trails within the Program Area.

> Discuss the population density (age, health, disabilities, etc.) within the designated residential developments and list the effects of pesticides on their health and daily activity.

> Expressed concern on impacts at school sites.

1.5.2 Biological Resources-Aquatic

The following concerns are associated with biological resources in aquatic environments and are addressed in Chapter 4 of this PEIR or in Appendix A, Biological Resources Technical Report:

> Employ techniques associated with the physical control of vectors and their habitat that conform to Habitat Conservation Plan (HCP) avoidance, minimization, and mitigation measures.

> Consider direct/indirect effects of using mosquitofish as control. Do not stock mosquitofish (*Gambusia affinis*) in ponds, creeks, or reservoirs. As the mosquitofish used (*Gambusia affinis)* are nonnative predatory fish, describe how their impact on native fish populations is considered.

> The PEIR should include a detailed description and complete assessment of the biological control impacts (current and future, direct and indirect) on habitats (including endangered, threatened, and

locally unique species and sensitive habitats) and on species (sensitive fish, wildlife, or plants) and ensure CEQA requirements are met.

> The PEIR should include a detailed description and complete assessment of the chemical control impacts (current and future, direct and indirect) on habitats (including endangered, threatened, and locally unique species and sensitive habitats) and on species (sensitive fish, wildlife, or plants) and ensure CEQA requirements are met.

> Ensure the Draft PEIR includes appropriate measures to ensure complete take avoidance of protected species while coordinating with United States Fish and Wildlife Service (USFWS), United States Department of Agriculture, Forest Service (USFS), and California Department of Fish and Wildlife (CDFW).

1.5.3 Biological Resources-Terrestrial

The following concerns are associated with biological resources in terrestrial environments and are addressed in Chapter 5 of this PEIR or in Appendix A, Biological Resources Technical Report:

> Discuss potential impacts on insect pollinators/bees from chemicals in treatment applications.

> Describe the effects of all chemicals that are used and/or proposed for use on wildlife and natural ecosystems, including insect prey, birds, mammals, fish, vegetation and site topography. The loss of prey for birds is a particular concern. Also, consider unwanted effects of the “inactive” portion of the pesticides. What effects will the carrier portion of the chemicals have on the environment?

> Discuss the potential impact of *Bs*/*Bti* products on native species.

> Describe the role of mosquitoes within the food chain, and subsequent impacts if they were removed in terms of amphibians, birds, reptiles, fish and insects. This issue is also addressed in Section 6.2.

> Pesticides can also kill the natural predators of mosquitoes, which have great difficulty in recovery from pesticides.

> Pesticide efficacy attenuation and possible long-term resistance is an issue for all chemically based mosquito control programs. It is addressed by the use of different control methods and different agents over time where possible (BMP and IMM techniques are designed to identify these issues early and modify applications as appropriate and feasible.

> Note that the Program Area includes potential habitat for several California and federally threatened and other sensitive plant and wildlife species including, but not limited to, California tiger salamander and Santa Cruz long-toed salamander and, as such, comprehensive biological studies should be implemented.

> Coordinate with CDFW, California Natural Diversity Database, USFWS, and USFWS’ Information, Planning, and Conservation planning tool to identify special-status plant or wildlife species. If impacts are found to be significant, the PEIR should identify adequate mitigation measure to reduce impacts to lower levels.

> A primary concern is the environmental impact on natural resources in terms of vegetation removal, soil erosion, and possible wildlife impact.

> Ensure mosquito abatement staff minimizes impact to tidal marsh and vernal pool habitats (especially during breeding season). Restrict operation of vehicles to levees and existing roads, and avoid vernal pool plants during blooming season (March–June).

> Concern for spread of invasive weeds, erosion, and sedimentation.

> The PEIR should include a detailed description and complete assessment of the biological control impacts (current and future, direct and indirect) on habitats (including endangered, threatened, and locally unique species and sensitive habitats) and on species (sensitive fish, wildlife, or plants).

> The PEIR should include a detailed description and complete assessment of the chemical control impacts (current and future, direct and indirect) on habitats (including endangered, threatened, and locally unique species and sensitive habitats) and on species (sensitive fish, wildlife, or plants).

> Ensure the Draft PEIR includes all appropriate measures to ensure complete take avoidance of protected species while coordinating with USFWS, USFS, and CDFW.

1.5.4 Ecological Health Hazards

The following concerns are associated with ecological health and are addressed in Chapter 6 of this PEIR or in Appendix B, Ecological and Human Health Assessment Report:

> Require additional information regarding, chemical agents in sanitary sewers concerning components and effects. Could pose a significant impact on the operation of wastewater treatment plant.

> Describe the effects of all chemicals that are used and/or proposed for use on wildlife and natural ecosystems, including insect prey, birds, mammals, fish, vegetation, and site topography. The loss of prey for birds is a particular concern.

> Discuss the potential impact of *Bacillus sphaericus* on native species. What would justify its use? What native species would be impacted?

> Discuss impacts on bees from chemicals in treatment applications.

> Concern over the “inactive” portion of the pesticides. What effects will the carrier portion of the chemicals have on the environment?

> Address the effect of pesticides on the natural predators of mosquitoes.

> The continued spray program leads to survival of mosquitoes resistant to pesticides – “the pest mill”.

> Describe the role of mosquitoes within the food chain, and subsequent impacts if they were removed in terms of amphibians, birds, reptiles, fish, and insects.

> Upon application and broadcast of pesticides, what is the fate and transport of these chemicals? Look at droplet size, dispersal patterns given wind, conversion products (both in storage and environment), and impacts of conversion products. Discuss the persistence of proposed treatment substances in the environment as well as the potential for bioaccumulation.

> The PEIR should include monitoring programs that are designed to validate assumptions regarding the environmental fate and transport of materials.

> The PEIR should include a detailed description and complete assessment of the chemical control impacts (current and future, direct and indirect) on habitats (including endangered, threatened, and locally unique species and sensitive habitats) and on species (sensitive fish, wildlife, or plants) and ensure CEQA requirements are met.

> The PEIR should include a detailed description and complete assessment of the biological control impacts (current and future, direct and indirect) on habitats (including endangered, threatened, and locally unique species and sensitive habitats) and on species (sensitive fish, wildlife, or plants) and ensure CEQA requirements are met.

1.5.5 Human Health Hazards

The following concerns are associated with human health and are addressed in Chapter 7 of the PEIR or in Appendix B, Ecological and Human Health Assessment Report.

> Address Program impacts on people and pets through ingestion and absorption pathways and proposed mitigation. Address impacts on chemically sensitive people and sensitive populations such as children, the elderly, and pregnant women. Exposure to pesticides can result in compromised immune system, which would allow for development of allergies or autoimmune disorders.

> The PEIR must list any and all biological or chemical agents proposed for use.

> Require additional information regarding chemical agents in sanitary sewers concerning components and effects. Could pose a significant impact on the operation of wastewater treatment plant.

> Concern over public safety and health with regards to existing vegetable gardens and fruit trees within the Program Area. Local swimming holes could be a potential habitat for breeding mosquitoes, and chemical treatment could impact humans.

> Concerned with use of Zenivex®; it mimes chrysanthemums but is a harmful neurotoxin.

> Concerned that adulticides may present danger to humans, as many pesticides are known carcinogens and endocrine disruptors.

> Concerned that pyrethrins may disrupt the normal functioning of sex hormones while piperonyl butoxide (PBO) may affect the functioning of hormone-related organs.

> In addition to short-term effects, what are the long-term effects of repeated exposure to these chemicals?

1.5.6 Public Services and Hazard Response

While no scoping comments directly dealt with public services and hazard responses, the following issues are addressed in Chapter 8 of the PEIR:

> Risk of aerial equipment failure during applications of pesticides.

> Safe storage and disposal of chemical-related materials.

1.5.7 Water Quality

Chapter 9, Water Resources, addresses concerns related to the following potential impacts to surface water and groundwater resources:

> Concern for spread of invasive weeds, erosion and sedimentation.

> CDPH must thoroughly vet and approve mosquito abatement materials and practices proposed for use on watershed lands.

> The Water Agency requests to integrate “Source Reduction” strategies in Water Agency-owned flood control channels with our Stream Maintenance Program approaches. (Sonoma County Water Agency)

> The Water Agency and the District requests the opportunity to review environmental documents and design plans for “Source Reduction” strategies when they become available.(Sonoma County Water Agency)

> Describe, quantify, and evaluate impacts of dredge or fill activities.

> Potential for drift from aerial and ground applications on water bodies.

> Identify watershed impacts from aerial and ground applications including the potential to impact drinking water supplies.

1.5.8 Air Quality and Climate Change

The following environmental concerns are addressed in Chapter 10, Air Quality, and Chapter 11, Greenhouse Gases and Climate Change, in this PEIR and in Appendix C, Air Quality and GHG Technical Report:

> Spraying/fogging will adversely affect air quality for humans and pets alike.

> Address impacts of emissions of air pollutants from control and treatment methods and combustion of fuels.

> Discuss impacts on greenhouse gases and climate change.

1.5.9 Noise

The following environmental concerns are addressed in Chapter 11, Noise, in this PEIR and in Appendix D, Noise Analysis Technical Report:

> Evaluate noise-related impacts on humans, in particular consistency with local noise regulations.

> Evaluate noise-related impacts on wildlife. For example, describe the impact of using motorized vehicles in marshes. Can these sites be treated in other ways to reduce or eliminate impact?

1.6 Impacts Not Given in-Depth Evaluation in this Programmatic Environmental Impact Report

The Proposed Program's surveillance, physical control, vegetation management, biological control, and chemical and nonchemical treatment alternatives were determined to have no impacts or less-than-significant impacts on the resources listed below; therefore, further analysis of these resources was not necessary for the reasons identified below. The resources not considered thereafter in the PEIR, or those partially considered (and how they are considered), include:

> Aesthetics. In general, the implementation of the mosquito control strategies and methods would not impact the aesthetics of the Program Area. No new construction of facilities would occur, the application of materials from the ground or the air would not have a visual impact because the Program alternatives are too small in scale to be noticeable in the open areas, and they would blend in with the habitat where they would be applied, including physical control and vegetation removal for mosquito control. None of the materials to be applied would change the appearance of existing structures or visual features of the landscape. The applied materials would not harm painted surfaces of structures, signs, and roadways.

> Cultural Resources. The activities associated with mosquito control would not include any construction of facilities or subsurface ground disturbance beyond drainage control, including sediment and vegetation removal to improve water circulation in aquatic habitats. Material application would not occur on existing historical resources; therefore, cultural resources would not be impacted. However, if during the application of material in either developed or undeveloped areas human remains are encountered, the applicable county coroner would be contacted and appropriate measures implemented, consistent with State Health and Safety Code Section 7050.5, which prohibits unauthorized disinterring, disturbing, or removing of human remains from any location.

> Geology and Soils. The activities associated with mosquito control would not include any facilities construction or significant ground disturbance nor induce erosion or loss of topsoil; therefore, geology and soils would not be impacted in this manner. Program activities would not be affected by landslides or ground failure, because aerial application would be used primarily in open-space areas if needed. The issue of impacts to soil microbes is addressed in the fate and transport analysis of the chemical treatments.

> Mineral Resources. The activities associated with mosquito control would not include any new construction or alteration of subsurface resources beyond drainage control; therefore, the Program would not result in the loss of availability of a known mineral resource.

> Population and Housing. The Program would not add new housing or increase the resident population within the Program Area; therefore, the Program is not expected to impact population and housing growth. Because the Program would not result in new development, it would not place a substantial demand on most public services including public facilities. However, the Program's potential to impact public health and emergency response services is addressed in Chapter 8, Public Services and Hazard Response.

> Transportation and Traffic. The Program would not include the use of a substantial amount of new vehicles or block existing roadways for mosquito control efforts. Light truck and automobile trips would be required to transport workers, materials, and equipment for the surveillance, monitoring, and physical control activities, and ground and aerial applications of pesticides and/or herbicides. These trips would be consistent with present trips and not result in a substantial change in vehicle use over existing conditions. Therefore, no impacts would be associated with Program transportation or traffic.

> Utilities and Service Systems. The Program would not include any new construction or the addition of housing or new workers to a community that would result in a substantial increase in demand for new utilities and service systems. Therefore, the Program is not expected to impact the utilities, including electricity, cable, water, and wastewater, in the Program Area. Water resources are addressed in Chapter 9, Water Resources.

1.7 Report Organization and Significance Terminology

The PEIR evaluates potential environmental impacts (direct, indirect, and cumulative) on the following environmental resources and concerns: human health, ecological health, agricultural economics and land use, nonagricultural land uses, public services/hazard response, water quality (surface water and groundwater), air quality, climate change (greenhouse gas production), noise, and biological resources, including cumulative impacts. The human and ecological risk assessments are a technical appendix to the PEIR with important results summarized in the appropriate sections of the PEIR.

> Chapter 1, Introduction, provides the Program's history and authority, Program objectives, a summary of public involvement activity and the public's concerns, impacts not further evaluated, and the PEIR's organization.

> Chapter 2, Program Description, presents the Program objectives, chemical treatment and nonchemical treatment alternatives, and best management practices (BMPs) to minimize environmental impacts. It also describes equipment use, public education, and required permits and agency coordination.

> Chapter 3, Urban and Rural Land Uses, explains the environmental setting and potential environmental impacts for each alternative.

> Chapter 4, Biological Resources – Aquatic, explains the environmental setting and potential environmental impacts for each alternative.

> Chapter 5, Biological Resources – Terrestrial, explains the environmental setting and potential environmental impacts for each alternative.

> Chapter 6, Ecological Health, explains the environmental setting and potential environmental impacts for each alternative.

> Chapter 7, Human Health, explains the environmental setting and potential environmental impacts for each alternative.

> Chapter 8, Public Services and Hazard Response, explains the environmental setting and potential environmental impacts for each alternative.

> Chapter 9, Water Resources, explains the environmental setting and potential environmental impacts for each alternative.

> Chapter 10, Air Quality, explains the environmental setting and potential environmental impacts for each alternative.

> Chapter 11, Greenhouse Gases and Climate Change, explains the environmental setting and potential environmental impacts for each alternative.

> Chapter 12, Noise, explains the environmental setting and potential environmental impacts for each alternative.

> Chapter 13, Cumulative Impacts, is a comprehensive assessment of all of the cumulative impacts to each of the resources contained in Chapters 3 through 12.

> Chapter 14, Other Required Disclosures, is comprised of other analyses required by CEQA including growth-inducing impacts and irreversible or irretrievable commitments of resources.

> Chapter 15, Alternatives, presents the District's consideration of a reasonable range of alternatives and the screening of those alternatives to the ones included in the Proposed Program. It evaluates the No Program Alternative for impacts, and identifies alternative tools or options for reducing potentially significant impacts from alternatives under the Proposed Program.

> Chapter 16, Report Preparers, lists the persons and organizations involved in the preparation of this PEIR.

> Chapter 17, References, identifies the organizations and persons consulted and references cited in this PEIR.

> Appendix A, Biological Resources Technical Report

> Appendix B, Ecological and Human Health Risk Assessment

> Appendix C, Air Quality and Greenhouse Gas Emissions Technical Report

> Appendix D, Noise Analysis Technical Report

> Appendix E, Alternatives Analysis Report

For each resource evaluated, the key environmental issues and criteria, for determining whether an adverse impact is significant under CEQA, are discussed first. A "significant impact" is defined as:

> *"a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project including land, air, water, minerals, flora, fauna, ambient noise, and objects of historic or aesthetic significance. An economic or social change by itself shall not be considered a significant effect on the environment, but may be considered in determining whether the physical change is significant"* (CEQA Guidelines Section 15382).

The environmental impact analysis section for each resource defines the criteria used to judge whether an impact is significant. These criteria include the "Mandatory Findings of Significance" set forth in CEQA Guidelines Section 15065. These criteria also include the criteria set forth in the Initial Study checklist (CEQA Guidelines, Appendix G), agency regulatory standards, or other criteria relevant to the specific project.

In describing the significance of adverse impacts, **the following categories of significance** are applied, based on the best professional judgment of the PEIR preparers:

- **Significant and Unavoidable (SU):** An impact that cannot be avoided or reduced to below the threshold level, even with the imposition of all feasible mitigation measures. "Significant" also covers the concept of potentially significant, which may be used when substantial uncertainty exists. This PEIR does not distinguish between "significant" or "potentially significant" in impact conclusion statements; both result in a determination that the impact is significant. All significant impacts from No Program are unavoidable.
- **Potentially Significant but Mitigable (SM):** An impact that can be reduced to below the threshold level (i.e., to less than significant) given feasible mitigation measures. For example, the statement is made that the impact to surface water resources from permethrin is potentially significant but mitigable. With the application of a mitigation measure to avoid application of permethrin in locations where the receiving waters are 303(d) listed for pyrethroids or sediment toxicity, the impact can be reduced to less than significant.
- **Less than Significant (LS):** An impact that may be adverse but does not exceed the threshold levels or covers an effect that is small or minimal, and does not require mitigation measures.
- **No Impact (N):** Where an impact is neutral or is clearly deemed "no effect." it is stated to have "no impact."

Mitigation measures for one resource may have environmental impacts on other resources or not be sufficient to reduce the target impact to less than significant. Where a mitigation measure could have a significant environmental impact, this impact is discussed.

1.8 Use of this PEIR for Future CEQA Compliance

At issue is CEQA compliance in the future, once the District's Program is approved, and the need for supplemental documentation. A subsequent or supplemental EIR could be required if any of the following occur (CEQA Guidelines Section 15162(c)):

- There are substantial changes proposed for the District's IMMP that would require major revisions to this PEIR because of new significant environmental impacts that cannot be mitigated below a level of significance or a substantial increase in the severity of the previously identified significant impacts in this PEIR.
- There could be substantial changes to the circumstances under which the District's IMMP is undertaken that would require major revisions to this PEIR because of new significant environmental impacts that cannot be mitigated below a level of significance or a substantial increase in the severity of the identified significant impacts in this PEIR.
- There could be new information of substantial importance that shows there would be significant effects not discussed in this PEIR that cannot be mitigated below a level of significance; significant effects would be substantially more severe; mitigation measures found to be infeasible would, in fact, be feasible and substantially reduce one of more significant effects but the District decides not to adopt them; or mitigation measures or alternatives considerably different from those analyzed in this PEIR would substantially reduce one of more significant effects but the District decides not to adopt them.

This PEIR evaluates the potential environmental impacts associated with the District's current Program and its future Program when the activities and materials can be identified at present. For example, all pesticides in current use have been evaluated in the PEIR (mostly under the Chemical Control Alternative), including the supporting Appendix B risk assessment report, along with a number of pesticides not currently in use but with the potential for use in the foreseeable future. A similar scenario occurs for herbicides. Under the Vegetation Management Alternative, the herbicides most likely to be used are addressed in this PEIR.

The PEIR reports on the Appendix B's evaluation of 42 pesticide (insecticides and herbicides) active ingredients, and four adjuvants for a total of 46 chemical ingredients. An adjuvant is any compound that is added to an herbicide formulation or tank mix to facilitate the mixing, application, or effectiveness of that herbicide. The actual pesticide formulations for the District are listed by active ingredient in Table 6-1 (15 insecticides) and Table 6-2 (4 herbicides). The PEIR also considers materials such as piperonyl butoxide (PBO) which acts as a synergist. Synergists are chemicals that primarily enhance the pesticidal properties of other active ingredients, such as pyrethrins and synthetic pyrethroids. There are no pesticide products that contain only PBO.

Future formulations are likely to be based on the existing active ingredients, adjuvants, surfactants, and synergists with toxicity and potential effects similar to those reported in this PEIR. When considering a new pesticide formulation for use, the District will follow the following procedures to determine whether the information in this PEIR is applicable and sufficient to support the same conclusions on potential environmental impacts to human and ecological health or whether there is sufficiently different information identified that would mean additional evaluation and analysis under CEQA would be appropriate prior to its inclusion in the District's IMMP.

1. Obtain the materials safety data sheets and laboratory test information on the new formulation or material from the company producing the product or from the appropriate federal or state regulatory agencies.
2. For the new formulation review, consider whether it is in the same toxicity hazard category as the active ingredients, adjuvants, and synergists addressed in this PEIR. The general toxicity hazard categories for humans, mammals, birds, fish, aquatic invertebrates, honeybee, and other receptors are found in Table 4.1 of the PEIR:
    a. Very Low
    b. Low
    c. Moderate
    d. High
    e. Nontoxic

Table 1-1 presents the EPA toxicity categories for human health risk assessments.

Table 1-1 EPA Toxicity Categories

Toxicity Study	Category I High Toxicity	Category II Moderate Toxicity	Category III Low Toxicity	Category IV Very Low Toxicity
Acute Oral	Up to and including 50 mg/kg	> 50 thru 500 mg/kg	> 500 thru 5000 mg/kg	> 5000 mg/kg
Acute Dermal	Up to and including 200 mg/kg	> 200 thru 2000 mg/kg	> 2000 thru 5000 mg/kg	> 5000 mg/kg
Acute Inhalation	Up to and including 0.05 mg/liter	> 0.05 thru 0.5 mg/liter	> 0.5 thru 2 mg/liter	> 2 mg/liter
Eye Irritation	Corrosive (Irreversible destruction of ocular tissue) or corneal involvement or irritation persisting for more than 21 days	Corneal involvement or irritation clearing in 8-21 days	Corneal involvement or irritation clearing in 7 days or less	Minimal effects clearing in less than 24 hours
Skin Irritation	Corrosive (tissue destruction into the dermis and/or scarring)	Severe irritation at 72 hours (severe erythema or edema)	Moderate irritation at 72 hour (moderate erythema)	Mild or Slight irritation (no irritation or slight erythema)

1. If reported toxicity is similar to, or less than the related formulation or material addressed in Appendix B, and the conclusion in the PEIR for the similar formulation or material was that its impacts on human health and on ecological health are less than significant, then the District can reasonably proceed to make the finding that the information contained in the PEIR is sufficient to support a finding that no additional analysis under CEQA is required.
2. If the reported toxicity of the new formulation is greater than the reported toxicity in the PEIR for the similar formulation or material, leading to a conclusion that the impacts would likely be substantially more severe, then a subsequent PEIR would be prepared addressing the major revisions needed, or a supplemental PEIR would be prepared addressing any minor revisions needed, in order to adequately evaluate the new product for incorporation into the District's IMMP.

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2 Program Description

2.1 Program Area and Vicinity

The Solano County Mosquito Abatement District (Lead Agency and Program Sponsor) is preparing this PEIR to evaluate the effects of the continued implementation of a suite of control strategies and methods prescribed in its Integrated Mosquito Management Program (IMMP or Program). The District implements its Program primarily within a countywide Service Area. The activities described herein are conducted throughout Solano County.

Located approximately equal distance between the cities of San Francisco and Sacramento and bordered by Contra Costa, Sonoma, Napa, Yolo and Sacramento counties, Solano County covers 909.4 square miles, is populated by 413,786 people and includes within its boundaries the incorporated cities of Vallejo, Fairfield, Vacaville, Suisun City, Benicia, Dixon and Rio Vista. A portion of the San Pablo Bay National Wildlife Refuge and all of the Suisun Marsh are found within its 84.2 square miles of water area, and its 675.4 square miles of rural land area is composed mainly of irrigated farmland.

The environmental impact analysis of the Program will focus on the potential for impacts within the County from the District's proposed Program and identify the potential for control activities within the Service Area to affect any adjacent jurisdictions. Under California law, the District also can take direct but limited action in adjacent areas bordering its Service Area (Yolo, Sacramento, Napa, Sonoma and Contra Costa counties), if needed to provide control of mosquitoes originating in adjacent areas for the health and safety of residents of the immediate Service Area [California Health and Safety Code Section 2270(a)]. Control activities may also be provided in adjacent areas upon request of the adjacent jurisdictions to protect the health and safety of residents in adjacent jurisdictions. Actions that would be taken outside of the Service Area are the same types of actions undertaken within the Service Area and in similar types of habitats or sites. In summary, the Program occurs in an area that is somewhat larger than the District's Service Area; this larger area is called the Program Area, the area in which potential impacts could occur. The Program Area and its location within the State of California are shown on Figure 2-1, Solano County Mosquito Abatement District Program Area.

Mosquito control activities are conducted at a wide variety of locations or sites throughout the District's Service Area, including tidal marshes, seasonal wetlands managed as waterfowl habitat (both publicly and privately owned), other diked marshes, lakes and ponds, rivers and streams, vernal pools and other seasonal wetlands, stormwater detention basins, flood control channels, spreading grounds, street drains and gutters, wash drains, irrigated pastures, or agricultural ditches, as well as animal troughs, artificial containers, tire piles, fountains, ornamental fishponds, swimming pools and liquid waste detention ponds. Within the larger Program Area, activities would be conducted at similar sites.

2.2 Program Objectives

2.2.1 <u>Purpose and Need</u>

The District was established in 1930 to reduce the risk of mosquito-borne disease and discomfort to the residents of its Service Area. In addition to being problematic by disrupting human activities and enjoyment of public and private areas, certain mosquito species can transmit a number of diseases and are considered to be vectors. A vector is defined by the State of California as "any animal capable of transmitting the causative agent of human disease or capable of producing human discomfort or injury, including, but not limited to, mosquitoes, flies, other insects, ticks, mites, and rats, but not including any domesticated animal…" [California Health and Safety Code Section 2002(k)]. The mosquito-transmitted illnesses of most concern in the Program Area are as follows: WNV, WEE, SLE, dog heartworm, and malaria

Depending on the disease, both human and domestic animal health can be at risk of disability, illness, and/or death. Furthermore, potential exists for introduction and transmission of new diseases by current vectors and for new disease vectors to be introduced into the District's Service Area.

2.2.2 Program Objectives

The District undertakes mosquito control activities through its Program to control mosquitoes that are responsible for disease and/ or discomfort in the Program Area.

The Proposed Program's specific objectives are as follows:

> Reduce the potential for human and animal disease caused by mosquitoes

> Reduce the potential for human and animal discomfort or injury from mosquitoes

> Accomplish effective and environmentally sound mosquito management by means of:

- Surveying for mosquito abundance/human contact
- Establishing treatment criteria
- Appropriately selecting from a wide range of Program tools or components

Most of the relevant mosquito species are quite mobile and cause the greatest hazard or discomfort at a distance from where they breed. Each species has a unique life cycle, and most of them occupy several types of habitats. To effectively control them, an IMMP must be employed. District policy is to identify those species that are currently vectors, to recommend techniques for their prevention and control, and to anticipate and minimize any new interactions between these mosquitoes and humans ***or*** domestic animals.

2.3 Proposed Program

The District's Program is an ongoing series of related actions for the control of mosquitoes. The District's activities involve the identification of mosquito problems; responsive actions to control existing populations of mosquitoes and the education of landowners and public land managers on techniques of managing habitat to prevent or minimize mosquito production and potential interaction with humans and domestic animals; the provision and administration of funding and institutional support necessary to accomplish District objectives.

The District has, for at least the past 2 decades, taken an integrated systems approach to mosquito control, utilizing a suite of tools that consist of surveillance, vegetation management, physical, biological, and chemical controls along with public education. These Program "tools" or components are described in the subsequent subsection as "Program alternatives" for the CEQA process (except for public education, which is exempt from CEQA). Program implementation is weighted heavily towards (advice) on vegetation management, physical control methods, and biological control, in part, to reduce the need for chemical control. To realize effective and environmentally sound mosquito management, mosquito control must be based on several factors:

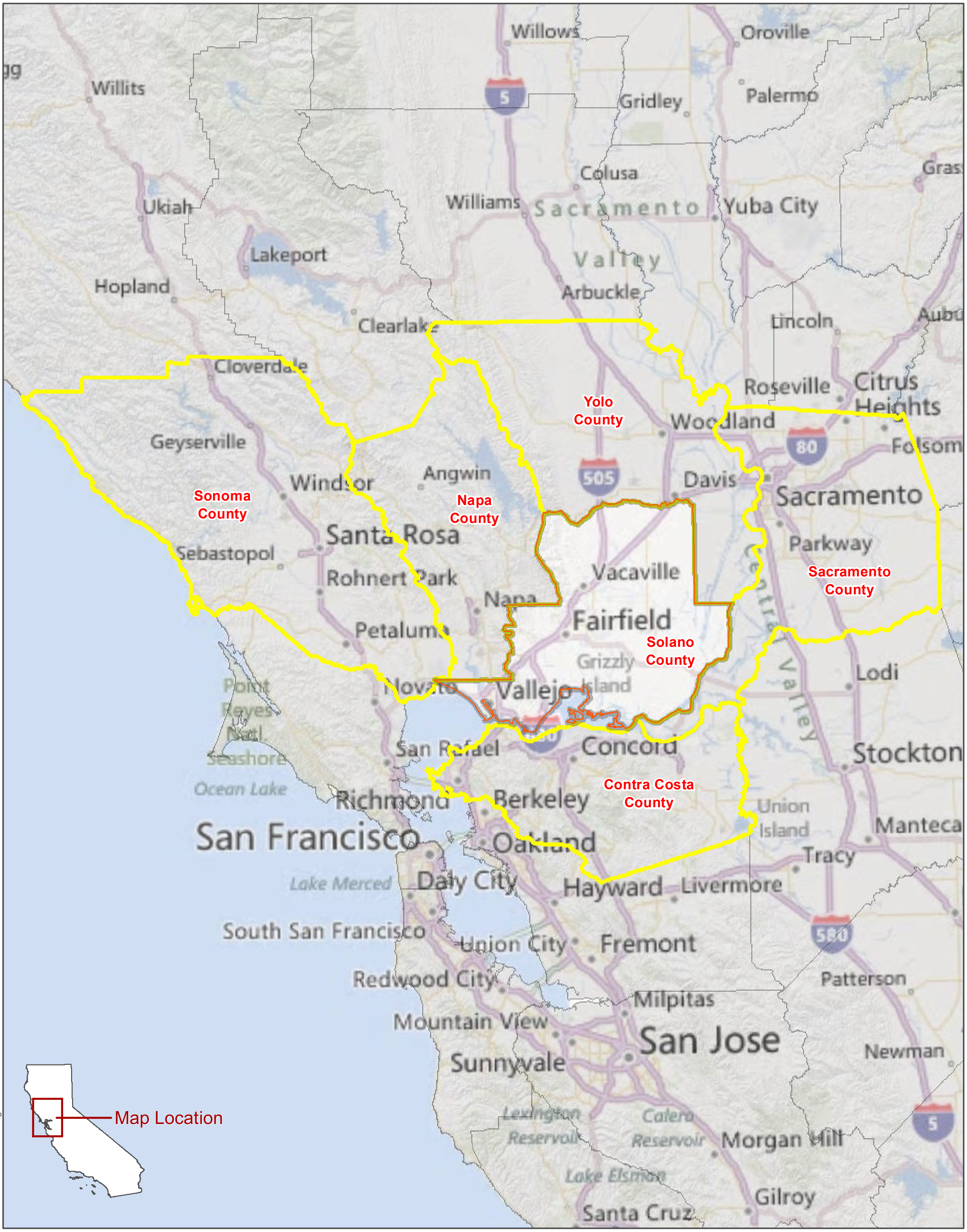
> Carefully monitoring or surveying mosquito abundance and/or potential contact with people

> Carefully monitor and survey for mosquito diseases and their antecedent factors that initiate and/or amplify disease

> Establishing treatment criteria (thresholds)

> Selecting appropriate tools from a wide range of control methods

This Program consists of a dynamic combination of surveillance, treatment criteria, and use of multiple control activities in a coordinated program with public education that is generally known as Integrated Pest Management (IPM) or Integrated Mosquito Management (IMM).



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Source: Cardno ENTRIX, 2013

Service Area
Adjacent Counties

0 10 20
Scale in Miles
N

INTEGRATED MOSQUITO MANAGEMENT PROGRAM PEIR

Solano County Mosquito Abatement District

Figure 2-1 - Program Area

While these Program components or tools together encompass the District's Program, it is important to acknowledge that the specific tools District staff use vary from day to day and from site to site in response to the mosquito species that are active, their population size or density, their age structure, location, time of year, local climate and weather, potential for mosquito-borne disease, proximity to human populations, including (a) proximity to sensitive receptors, (b) District staff's access to mosquito habitat, (c) abundance of natural predators, (d) availability and cost of control methods, (e) effectiveness of previous control efforts at the site, (f) potential for development of resistance in mosquito populations, (g) landowner policies or concerns, (h) proximity to special-status species, and (i) applicability of Endangered Species Recovery Plans, Habitat Conservation Plans, Natural Community Conservation Plans, and local community concerns, among other variables. Therefore, the specific actions taken in response to current or potential mosquito activity at a specific place and time depend on factors of mosquito and pathogen biology, physical and biotic environment, human settlement patterns, local standards, available control methods, and institutional and legal constraints. While some consistent mosquito sources are exposed to repeated control activity, many areas with minor mosquito activity are not routinely treated, and most of the land within the District's Service Area has never been directly treated for mosquitoes.

The District's IMMP Program, like any IPM program, seeks by definition to use procedures that will minimize potential environmental impacts. The District's IMMP employs IPM principles by first determining the species and abundance of mosquitoes through evaluation of field surveys of immature and adult mosquito populations, and public service requests and, then, if the populations exceed predetermined criteria, using the most efficient, effective, and environmentally sensitive means of control. For all mosquito species, public education is an important control strategy. In some situations, water management or other physical control activities can be instituted to reduce mosquito-breeding sites. The District also uses biological control such as the planting of mosquitofish in some settings: ornamental fish ponds, water troughs, water gardens, fountains, unmaintained swimming pools and other areas where not prohibited. When these approaches are not effective, or are otherwise deemed inappropriate, then pesticides are used to treat specific mosquito-producing or mosquito-harboring areas.

Three core tenets are essential to the success of a sound IMMP.

> First, a proactive approach is necessary to minimize impacts and maximize successful mosquito management. Elements such as thorough surveillance and a strong public education program make all the difference in reducing potential human mosquito interactions.

> Second, long-term environmentally based solutions (e.g., water management, reduction of harborage and enhancement of predators and parasites) are optimal as they reduce the potential pesticide load in the environment as well as other potential long- and short-term impacts.

> Lastly, utilizing the full array of options and tools (public education, surveillance, physical control, biological control, and when necessary chemical control) in an informed and coordinated approach supports the overall goal of an environmentally sensitive mosquito management program.

The District's Program consists of the following alternatives, which are general types of coordinated and component activities, as described below. The Proposed Program is a combination of these alternatives with the potential for all of these alternatives to be used in their entirety along with public education.

Chemical methods to control mosquitoes (under the Vegetation Management and Chemical Control alternatives described below) are employed independently at specific application sites. The pesticides used as part of the District's Proposed Program are applied at low concentrations to avoid potential impacts to nontarget organisms from acute and/or chronic exposures. Manufacturers carefully establish application amounts mandated by product use requirements for treatment efficacy and low potential risk to nontarget organisms, and they are substantially below the thresholds used for toxicity studies in the laboratory. The pesticides the District selects are designed to degrade rapidly in the environment, thereby reducing the opportunity for residual presence and environmental persistence. As different chemicals are selected for potential rotational use in a given area (i.e., larvicides first, followed by adulticides if needed), District staff take care both in the selection of the chemicals used and the application process so that co-exposures to nontarget receptors are highly unlikely. This type of practice reduces the probability of additive or synergistic effects that could occur as a result of simultaneous exposures to more than one chemical.

Synergists, and in some cases adjuvants (used with herbicides to also facilitate mixing and application), are applied to increase the efficacy of some chemical control measures. This application could lead to co-exposures of synergists such as PBO and primary chemical treatments. However, synergists allow for reduced treatment amounts of primary pesticide chemicals, since their performance is improved via conjunctive use. Another example of chemicals sometimes used together is the co-application of methoprene and *Bti*. This particular treatment is employed to prevent pesticide resistance and to ensure the control of all larval stages of nuisance mosquitoes while minimizing the potential for impacts to nontarget receptors from co-exposures.

2.3.1 Surveillance Alternative

Mosquito surveillance, which is an integral part of the District's responsibility to protect public health and welfare, involves monitoring mosquito populations, and habitat, their disease pathogens, and human/mosquito interactions. Surveillance provides the District with valuable information on what mosquito species are present or likely to occur, when they occur, where they occur, how many there are, and if they are carrying disease or otherwise affecting humans. Surveillance is critical to an IMMP because the information it provides is evaluated against treatment criteria to decide when and where to institute mosquito control measures. Information gained is used to help form action plans that can also assist in reducing the risk of contracting disease. Equally important is the use of mosquito surveillance in evaluating the efficacy, cost effectiveness, and environmental impacts of specific mosquito control actions.

2.3.1.1 Surveillance *Methodologies*

Mosquitoes in nature are distributed within their environment in a pattern that maximizes their survival to guarantee reproductive success. Immature stages develop in water and later mature to a winged adult that is capable of both long- and short-range dispersal. This duality of their life history presents mosquito control agencies with unique circumstances that require separate surveillance strategies for the aquatic versus terrestrial life stages. Sampling for the presence and abundance of mosquito populations tends to occur in areas where the citizenry would have a likelihood of exposure to them; field counts take place both at immature and adult stages of the mosquito development or life cycle. The District routinely uses a variety of traps for the surveillance of adult mosquitoes, regular field investigation of known mosquito sources for direct sampling for immature stages, public service requests for adult mosquitoes, and low ground pressure ATVs to access these sites when necessary. The District conducts surveillance by way of a variety of activities that include:

> **Field sampling/counting of aquatic/immature stages.** Mosquito immatures include eggs, four larval stages (instars), and a transitional pupal stage. Mosquito control agencies routinely target the larval and pupal stages to preclude an emergence of adults. Operational evaluation of the presence and abundance of immature mosquitoes is limited to the larval and pupal stages, although the District may sample eggs for research reasons. Sampling and collection of the immature stages involves the use of a 16 oz. dipper (standardized small plastic cup (ladle) attached to a 3 foot wooden or extendable (aluminum) handle. The dipper is used to collect ("dip") a small amount of water from the mosquito-breeding site. Operationally, the abundance of the immatures in any identifiable "breeding" source is measured through direct sampling, which provides relative local abundance as the number of immature per unit volume area of the sampling device otherwise known as the number of larvae per dip. This method requires access by field personnel to within about 3 feet of larval sites at least every 2 weeks in warm weather for most sources to as frequently as multiple times per week for sources in irrigated pastures and seasonal wetlands during the summer and fall months. The spatial patchiness of larvae requires access to multiple locations within each source, rather than to single "bell-weather" stations.

> **Field inspection of known or suspected habitats where mosquitoes live and breed.** Sites where water can collect, be stored, or remain standing for more than a few days are potential habitats for mosquito breeding that require continuous inspection and surveillance. Water runoff into catch basins and stormwater detention systems from land uses including, but not limited to, residential communities, parks and recreation areas, and industrial sites, as well as ornamental ponds, unmaintained swimming pools, seeps/seepages, seasonal wetlands, tidal and diked marshes, freshwater marshes, wastewater ponds, sewer plants, canning waste/agricultural ponds, managed waterfowl ponds, canals, creeks, streams, tree holes, tires, man-made containers, flooded basements/crawl spaces, and other standing waters are likely sources. It is District policy that staff to use preexisting roads, trails, walkways, and open areas to conduct routine and essential surveillance activities with the least impact on the environment. Surveillance is conducted using ATVs, but offroad access is minimized and used only when roads and trails are not available. Some access for inspection is conducted on foot.

> **Adult stage and use of trapping.** Most adult female mosquitoes require a blood meal for egg development. Males subsist on primarily flower nectar and plant juices and lack the piercing mouthparts necessary to penetrate the skin. Females are sampled to determine the direct threat posed by their presence and abundance plus the fact that females of certain species are the vectors of mosquito-borne diseases (WNV, WEE, SLE and malaria). Various methodologies have been developed to both capture and quantify the relative abundance of mosquito species that affect human welfare. The District routinely uses a variety of traps for surveillance of adult mosquitoes. These include various types of traps that are mechanically configured to attract mosquitoes to the trap where they are captured by suction and sequestered in an escape-proof net or glass enclosure. Three kinds of traps, host-seeking traps, light traps, and gravid/oviposition traps, are used as described below.

- *Host-seeking traps.* Host seeking traps modified from the standard Center for Disease Control (CDC)-type portable light trap use dry ice (carbon dioxide) to attract female mosquitoes behaviorally cued to seek a host to blood feed. The trap's components include a dry ice container, battery power source, a low ampere motor/fan combination, a small light source (i.e. D cell flashlight bulb or LED light source), and a collection container for holding captured adults.
- *Light traps* (commonly called New Jersey Light traps) use a source of photo-attraction such as an incandescent lamp (25 watt) or compact fluorescent lamp (5 watt) where mosquitoes are pulled in by the suction provided by an electric (110 v AC) appliance motor/fan combination. Mosquitoes picked up by the suction are directed downward (via screened cone) inside the trap body to a plastic or glass collection jar containing a piece of pest strip (approx. 1" x 2.75") infused with dichlorvos. The collection jar is enclosed within an expanded metal cage with a hinged trap door that is padlocked. The District currently uses 28 light traps, which are placed throughout the 909.4 square miles within its boundaries.
- *Oviposition traps* are used to collect gravid *Culex* spp. mosquitoes and/or to measure their egg-laying activity. As an example, they may use 5-day-old hay-infused water contained in a small plastic dish pan that has a 6-volt battery-operated fan directly above to draw the gravid female mosquitoes into the small collection net.

> **Arbovirus Surveillance (Mosquito-borne Arboviruses).** The viruses actively transmitted by mosquitoes to humans are diseases of wild birds, and humans only become exposed as a consequence of an accidental exposure to the bite of infected mosquito vectors. Three viruses of greatest public health concern in California are West Nile virus (WNV), western equine encephalomyelitis (WEE) and St. Louis Encephalitis (SLE). Surveillance to determine the likelihood and occurrence of mosquito-borne illness is accomplished by three methods.

- *Sentinel Chickens.* The first involves the placement of caged chickens as "sentinel birds." "Flocks" of 10 to 12 chickens are placed in a coop structure (4 feet x 8 feet x 6 feet, which exceeds CDPH requirements) containing a nesting box and self-feeding and watering units. Each coop is situated on a concrete slab. This serves to both prevent entry by burrowing rodents and facilitate cleaning of the coop. Each flock is monitored several times each week. Manure is removed as needed to reduce fly production. Fresh rice hulls are spread on the floor of the coop to provide a more natural surface and act as an absorbent. Chickens are used as the early detection system for virus transmission as they are unaffected by the presence of these viruses in their systems. Blood samples are collected every 2 weeks and sent to the Richmond laboratory of the Vector-Borne Disease Section of the CDPH for testing to detect virus-specific antibodies. At the end of the mosquito season, the chickens are adopted out.

- *Mosquito Pools.* The second method involves the use of host-seeking traps to capture female mosquitoes. Captured females are sorted into groups (pools) of up to 50 and submitted to UC Davis Center for Vectorborne Diseases (CVEC) to test for the presence of mosquito-borne viruses.
- *Dead Bird Testing.* The last method involves the testing of dead birds of the family Corvidae that includes American Crows, Magpies, Western-Scrub Jays and Yellow-billed Magpies. Members of the public can report dead birds to the California Department of Health Services Dead Bird Hotline (1-877-WNV-BIRD). Calls are screened and suitable birds are picked up by District staff and tested in-house via an oral swab sample that is tested using a rapid antigen test.

> **Analysis of public service requests and surveys and other methods of data collection.** The District's mosquito surveillance activities are conducted in compliance with accepted federal and state guidelines, in particular the *California Mosquito-Borne Virus Surveillance & Response Plan* (CDPH et al. 2013) and *Best Management Practices for Mosquito Control in California* (CDPH and MVCAC 2012).These guidelines recognize that local conditions will necessarily vary and, thus, call for flexibility in selection and specific application of control methods.

2.3.2 Physical Control Alternative

An important part of the District's physical control activities involves the prevention of mosquito breeding sites initially through proper design and water management. The District provides as guidelines, mosquito prevention criteria that were endorsed by the California Department of Public Health and the San Francisco Bay Conservation and Development Commission in 1978 as part of the Suisun Marsh Protection Plan under California Assembly Bill 1717. These criteria cover various types of sources (see Appendix E - Mosquito Prevention Criteria) and are sent to various governmental agencies and private parties involved in the planning process for projects that may have the potential for creating mosquito-breeding problems.

The District can become involved in source reduction activities as they pertain to the enforcement of regulations through issuing a notice to abate a nuisance. This is pursuant to Section 2000 et seq. of the California Health and Safety Code.

Managing mosquito habitat to reduce mosquito production or migration, either directly or through public education, is often the most cost-effective and environmentally benign element of an IMMP. This approach to the control of mosquitoes is often called "physical control" to distinguish it from those mosquito management activities that directly rely on application of chemical pesticides (chemical control) or the introduction or relocation of living agents (biological control). Other terms that have been used for mosquito habitat management include "source reduction," which emphasizes the significance of reducing the habitat value of an area for mosquitoes, "or "permanent control," to contrast with the temporary effectiveness of pesticide applications.[1] Mosquito habitat management is important because its use can virtually eliminate the need for pesticide use in and adjacent to the affected habitat and, in some

[1] This terminology can be misleading if periodic maintenance is needed for physical control devices or structure.

situations, can virtually eliminate mosquito production from specific areas for long periods of time, reducing the potential disturbances associated with frequent biological or chemical control activities. The intent is to reduce the abundance of mosquitoes produced or sheltered by an area while protecting or enhancing the habitat values of the area for desirable species. In many cases, physical control activities involve restoration and enhancement of natural ecological functioning, including production and dispersal of special-status species and/or predators of mosquitoes.

Physical control for mosquitoes consists of the management of mosquito-producing habitat (including freshwater marshes and lakes, saltwater marshes, temporary standing water for 1 week or more, and wastewater treatment facilities) especially through water control and maintenance or improvement of channels, tide gates, levees, and other water control facilities. Physical control is usually the most effective mosquito control technique because it provides a long-term solution by reducing or eliminating mosquito developmental sites and ultimately reduces and potentially eliminates the need for chemical applications. The physical control practices may be categorized into three groups: maintenance, new construction, and cultural practices.

Maintenance activities are conducted within tidal, managed tidal, and nontidal marshes, seasonal wetlands, diked, historic bay lands, and in some creeks adjacent to these wetlands. They include connection of backwaters or isolated pools on floodplains to the main channels of streams and rivers and increased drainage rates and areas in managed wetlands. The following activities are classified as maintenance:

- Removal of sediments from existing water circulation ditches
- Repair of existing water control structures
- Removal of debris, weeds, and emergent vegetation in natural channels
- Clearance, trimming, and removal of brush for access to streams tributary to wetland areas
- Filling of existing, nonfunctional water circulation ditches to achieve required water circulation dynamics and restore ditched wetlands

New construction typically involves the creation of new ditches to enhance tidal flow preventing stagnant water. Although the District has not been involved with the creation of new ditches in many years, it may choose to use this tool in the future.

Cultural practices include vegetation and water management, placing culverts or other engineering works, and making other physical changes to the land. They reduce mosquito production directly by improving water circulation and indirectly by improving habitat values for predators of larval mosquitoes (fish and invertebrates), or by otherwise reducing a site's habitat value to mosquito larvae.

The District does not currently perform these physical control activities but may choose to use this tool in the future. Should these activities be undertaken it will be in accordance with all appropriate environmental regulations (e.g., wetland fill and dredge permits, endangered species review, water quality review, streambed alteration permits, see Section 2.7), and in a manner that generally maintains or improves habitat values for desirable species. Major physical control activities or projects (beyond the scope of the District's 5-year regional wetlands permits with the United States Army Corps of Engineers (USACE), San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) and San Francisco Bay Conservation and Development Commission (BCDC) are addressed under this PEIR where known and identified. Minor physical control activities (covered by the regional wetlands permits) are also addressed in this PEIR. The average amount of ditch maintenance for the past 5-year period was 1,204 feet with 6,020 feet being done in 2008. No other maintenance work has been performed since that time, but may become necessary in the future. Under the regional permits, the District's work plans are reviewed annually by trustee and other responsible agencies prior to initiation of the planned work. USACE, USFWS, CDFW, and other responsible agencies can inspect completed work.

The District may request/require landowners and stewards to maintain and clear debris from drainage channels and waterways; excavate built-up spoil material; remove water from tires and other urban containers; cut, trim, mow, and harvest aquatic and riparian plants (but not including any mature trees, threatened or endangered plant species, or sensitive habitat areas); and install minor trenching and ditching.

The remainder of this subsection describes physical control or “source reduction” practices by type of potential mosquito habitat.

2.3.2.1.1 Freshwater Habitats

The District Service Area includes a number of areas, generally man-made, that are permanently ponded with fresh water. Examples include the margins of reservoirs with shallow water and emergent vegetation, artificial ponds for holding drinking water for livestock, and retention ponds created for holding of rainwater. Some retention ponds have been constructed within freeway interchanges and others have been built in cities and towns to provide wildlife habitat and flood protection. Natural lakes are usually not a mosquito problem because most of the water is deep, and little emergent vegetation may exist.

Source reduction activities to control mosquito populations in freshwater habitats, i.e., marshes and ponds, generally consist of consultation with landowners or land stewards to implement measures including constructing and maintaining channels to reduce mosquito production in floodplains and marshes. The primary principle governing source reduction is to manipulate water levels in low-lying areas to eliminate or reduce the need for chemical control applications. Physical control of mosquitoes in nontidal habitats typically involves improving the habitat value or dispersal potential of the site for mosquito predators; reducing the habitat value for mosquitoes through vegetation management, increased circulation, steepening banks, or changes in water quality; or by reducing the duration of standing water in areas that produce mosquitoes by filling small areas or improving drainage. Filling or draining artificially ponded areas (low spots in flood-irrigated fields, etc.) can be cost-effective and environmentally acceptable, but is not an appropriate strategy in natural areas (however small), large permanent water bodies, or in areas set aside for stormwater or wastewater retention. In such situations, the other options are more appropriate. At this time, the District is not involved in new drainage projects directly (see Section 2.3.3 for vegetation management including the use of herbicides). The District staff will advise landowners to remove or thin vegetation in order to improve surveillance or reduce mosquito habitats.

Ditches are a traditional technique for mosquito control, and they function in a number of ways. In addition to providing drainage if they lead from high to low ground, ditches can serve as a larvivorous fish (i.e., fish that eat mosquito larvae) reservoir. As rainfall increases, larvivorous fish move outward to adjacent areas to prey on immature mosquitoes, and as water levels decrease, larvivorous fish retreat to water in the ditches. Also, sills or weirs constructed in ditches can intentionally decrease water flow, decrease emergent aquatic weeds, prevent depletion of the water table, and allow larvivorous fish year-round refuge. Over the past several decades, urban development has occurred in areas where mosquito control drainage ditches have existed as the primary drainage systems. In many cases, maintenance responsibility for mosquito control projects has been taken over by city and county public works departments and integrated into their comprehensive stormwater management programs.

The District considers two mosquito control strategies when advising on freshwater source reduction for mosquito habitat. One strategy involves reducing the amount of standing water or reducing the length of time that water can stand in low areas following significant rainfall or artificial flooding events. In light of this strategy, District staff will advise landowners to construct channels or ditches with control elevations low enough to allow for a certain amount of water to leave an area before immature mosquitoes can complete their life cycle. However, the District does not encourage land managers and/or owners to alter vernal pool habitat. The other strategy relies on vegetation management (see Section 2.3.3). District staff will advise landowners to remove or thin vegetation to improve surveillance or reduce mosquito habitats.

As environmental laws, including Clean Water Act Section 404, greatly restrict mosquito habitat manipulations in freshwater habitats, the District is generally precluded from undertaking permanent physical control of these areas. Consequently, the District does not currently undertake physical control projects in freshwater bodies including marshes and ponds but may choose to do so in the future if feasible.

2.3.2.1.2 Seasonal Wetlands and Vernal Pools

The Service Area's Mediterranean climate results in large numbers of seasonally flooded areas, which may produce large numbers of mosquitoes during part of the year. Vernal pools are a specific type of seasonally flooded wetland, distinguished by a subsurface hardpan and often an assemblage of protected plants and invertebrates. Peripheral areas of tidal and historically tidal marshes can produce mosquitoes in response to seasonal rains, as well as following unusually high tides. Physical control methods include those described above for nontidal habitats.

2.3.2.1.3 Freshwater Marshes and Seasonal Wetlands Managed as Waterfowl Habitat

Within federal and state property, a number of marshes have been created and operated to provide aquatic habitats for wildlife, especially waterfowl, and are both publicly and privately owned. Some of these marshes are drained and refilled periodically to enhance the primary productivity of the habitat, and under certain circumstances, can result in large populations of mosquitoes. The major waterfowl management areas in the District Service Area include CDFW's Grizzly Island Wildlife Refuge (fresh-brackish diked marsh) which encompasses areas south of Highway 12 (near Suisun), on Grizzly Island and along Highway 680 between Fairfield and Benicia. Physical control methods include those described above for nontidal habitats.

2.3.2.1.4 Saline and Brackish Habitats

Saline and brackish marsh habitats of concern are along the edge of San Pablo and Suisun Bays that are subject to tidal action, but they can include reclaimed or other brackish/salt marshes that are not subject to natural tidal action. These brackish areas are usually contained by levees, rotary ditches, or other water control structures. Physical control measures are those used for freshwater marshes (nontidal) and increasing tidal circulation such as:

- Circulation ditches to enhance drainage or to allow larvivorous fish access to mosquito breeding locations (with enhancement through the creation of permanent water bodies that act as predatory fish reservoirs
- Small ditches formed by a speed scavel that are up to 18 inches wide and 18 inches deep to enhance water circulation
- Rotary ditching, which involves the construction of shallow ditches usually 4 feet wide and 2 to 3 feet deep, using high-speed rotary equipment with the spoil material evenly distributed in a very thin layer over the marsh surface, with limitations on its use based on the size of ditch needed, soil types, access, adjacent terrain, and vegetation present
- Impoundments that involve keeping a sheet of water across a salt-marsh substrate
- Rotational impoundment management (RIM), which is a formal strategy of impoundment management that achieves multipurpose management by allowing the impoundment to (1) control salt-marsh mosquito production from the marsh through means other than insecticides, (2) promote survival and revegetation by maintaining open periods and sufficiently low water levels during the summer flooding period, and (3) allow marine life to use the previously unavailable impounded high marsh.
- Excavation using a low ground pressure excavator

These ecologically sensitive areas require careful implementation of any physical modifications to avoid damage to the habitat and sensitive species that may be present. Physical control measures can reduce salt-marsh mosquito production through enhancement of the frequency and duration of tidal inundation or through other water management strategies.

2.3.2.1.5 Temporary Standing Water and Artificial Ponds

Temporary standing water can occur from a variety of conditions including irrigation of parks, golf courses, and agricultural fields in addition to ponding from rainfall events in natural areas. As environmental laws generally prevent/restrict permanent draining or filling of small artificial ponds, the District provides recommendations on other options that are effective in controlling mosquitoes, which include periodic draining, providing deepwater sanctuary for larvivorous fish, minimizing emergent and standing vegetation, and maintaining steep banks. The elimination of standing water through improved drainage is one effective tool for source reduction in such habitats. The second is the use of irrigation practices for those agricultural areas that require artificial watering. Proper water management, land preparation, and adequate drainage are the most effective means of physically controlling mosquitoes in these types of sources. The District provides advice to landowners who are interested in improving drainage and employing irrigation practices that will reduce mosquito production.

Eliminating standing water issues include working with landowners to identify leaky pipes or other water conveyance such as overgrown ditches,

2.3.2.1.6 Riparian Areas

Control measures will vary depending on the density of the human population, proximity of sensitive species, the mosquito potential of the mosquito causing the complaint, and access to the larval breeding or adult resting habitat. Minor physical control activities with insignificant environmental impacts can be accomplished using hand tools to connect small ponded areas to the channel along the edge of streams with highly variable flows. Generally, thick brush and complex microtopography preclude extensive physical control in these areas, or chemical control is generally more effective.

2.3.2.1.7 Tree Holes

Control measures are very limited here due to the large numbers of tree holes in most impacted areas, difficulties in access, concerns for staff safety, and in some cases the age and size of the tree (heritage trees). The control methods used are also dependent on the location and numbers of people and pets affected by the mosquitoes produced from this habitat. Current control measures include public education, habitat modification and chemical control. Public education includes advising homeowners of measures that can be taken by them such as the filling of some holes with sand to displace larval habitat or using other inert materials such as absorbent gel (available in home and garden centers) to displace larval habitat. Chemical control methods (larvicides, adulticides, or aerosols) may be used by District Staff.

2.3.2.1.8 Wastewater Treatment Facilities/Septic Systems

Wastewater recycling and reuse help to conserve and replenish freshwater supplies. Concern for water quality conditions in lakes, rivers, and marine areas has resulted in the enactment of new state laws that will greatly limit future disposal of wastewater into these aquatic systems. To adjust to these changing conditions, many communities must implement wastewater reuse and recycling programs. Mosquito problems are frequently associated with some of the conventional wastewater treatment operations, and the expanded use of wastewater recycling and reuse by both municipal and commercial/industrial operations may inadvertently create even more mosquito habitats.

Pond management options that are effective in controlling mosquitoes include periodic draining, providing deepwater sanctuary for larvivorous fish, minimizing emergent and standing vegetation, and maintaining steep banks. The District routinely advises property owners on the BMPs for ponds to reduce mosquito development.

Onsite treatment systems, such as septic tanks and associated drain fields, can flow laterally into nearby swales and ditches, especially in rural areas. Physical control requires maintenance and repair of these systems by the property owner and ditch maintenance where lateral flow occurs.

2.3.2.1.9 Artificial Container Habitats

Artificial containers, such as flowerpots, cans, barrels, and tires, provide opportunities for mosquitoes to breed in urban areas. A container-breeding mosquito problem can be solved by properly disposing of such materials, covering them, or tipping them over to ensure that they do not collect water. The District includes articles in local papers, PSAs on radio stations and has brochures that address urban container-breeding problems. In some instances, house-to-house surveillance in limited areas is done in response to detection of arbovirus activity.

2.3.3 Vegetation Management Alternative

The species composition and density of vegetation are basic elements of the habitat value of any area for mosquitoes, for predators of these mosquitoes, and for protected flora and fauna. District staff may periodically advise property owners/managers to undertake vegetation management activities on their property, as a tool to reduce the habitat value of sites for mosquitoes or to aid production or dispersal of mosquito predators, as well as to allow District staff's access to mosquito habitat for surveillance and other control activities. District staff does not normally perform direct vegetation management. Instead, it provides advice on activities to reduce the mosquito habitat value of sites by improving water circulation or access by fish and other predators, or to allow District staff 's access to standing water for inspections and treatment.

Although rarely done in recent years, the District may choose to do any of the following activities in the future if feasible. For vegetation management, the District may use hand tools or other mechanical means (i.e., heavy equipment) for vegetation removal or thinning or apply herbicides (chemical pesticides with specific toxicity to plants) to improve surveillance or reduce mosquito habitats. Vegetation removal or thinning would primarily occur in aquatic habitats to assist with the control of mosquitoes. To reduce the potential for mosquito breeding associated with water retention and infiltration structures, District staff may request the owners of the structures to clear weeds and other obstructing vegetation in wetlands and retention basins. In particular, thinning and removal of cattail overgrowth should be done to provide a maximum surface coverage of 30 percent or less. In some sensitive habitats and/or where sensitive species concerns exist, vegetation removal and maintenance actions would be restricted to those months or times of the year that minimize disturbance/impacts. Vegetation management may be performed (under special circumstances) to assist other agencies and landowners with the management of invasive/nonnative weeds. These actions are typically performed under the direction of the concerned agency, which also maintains any required permits.

Tools ranging from shovels and pruners to chain saws and "weed-whackers" up to heavy equipment can all be used at times to clear plant matter that either prevent access to mosquito breeding sites or that prevent good water management practices that would minimize mosquito populations. The District does not currently perform any brushing activities, however should it decide to, it will do so in the following manner: "brushing" activities would rely almost entirely on hand tools. Trimmed vegetation would either be removed and disposed of properly from the site or broadcast in such a way as to minimize visual degradation of the habitat. Trimming would also be kept to a minimum to reduce the possibility of the invasion of exotic species of plants and animals. Surveys for special-status plants using the California Natural Diversity Database and other online sources of information including relevant HCPs, coordination with the landowner, and acquisition of necessary permits would be completed before any work was undertaken. Follow-up surveys would also be conducted to verify that the work undertaken was effective and that the physical manipulation of the vegetation did not result in any unintended overall habitat degradation.

In addition, the use of water management to control vegetation is in some ways an extension of physical control, in that water control structures created as part of a physical control project may be used to directly manipulate hydroperiod (flood frequency, duration, and depth) as a tool for vegetation management. Where potential evapotranspiration rates are high, water management can also become a mechanism for salinity management and, indirectly, vegetation management through another path.

Table 2-1 (Herbicides Solano County Mosquito Abatement District May Use for Vegetation Management in the Future) identifies the herbicides the District may use to manage vegetation for control of mosquitoes or to control invasive plant species (noxious weeds). None of these are used at present; however, both Aquamaster (labeled for aquatic applications) and Roundup (labeled for terrestrial applications) may be used for spot control of actively growing vegetation. All herbicides would be applied in strict conformance with label requirements. Additional information on herbicides proposed for possible future use is contained in Appendix B (Table 3-2, Table 4-1, Section 4.6, and Attachment A, Tables A46 – A50).

2.3.4 Biological Control Alternative

Biological control of mosquitoes involves the intentional use of mosquito pathogens (diseases), parasites, and/or predators to reduce the population size of target mosquitoes. It is one of the principal components of a rational and integrated mosquito control management program. Biological control is used as a method of protecting the public from mosquitoes and the diseases they transmit without the use of pesticides and potential problem of pesticide resistance; however, the use of pathogens involves USEPA-registered materials regulated and labeled as chemical insecticides. The different types of biological controls are described in the following paragraphs.

2.3.4.1 Mosquito Pathogens

Mosquito pathogens include an assortment of viruses and bacteria. Pathogens are highly host-specific and usually infect mosquito larvae when they are ingested. Upon entering the host, these pathogens multiply rapidly, destroying internal organs and consuming nutrients. The pathogen can be spread to other mosquito larvae in some cases when larval tissue disintegrates and the pathogens are released into the water to be ingested by uninfected larvae. Examples of viruses that can infect mosquitoes are mosquito iridoviruses, densonucleosis viruses, nuclear polyhedrosis viruses, cytoplasmic polyhedrosis viruses, and entomopoxviruses. Examples of bacteria pathogenic to mosquitoes are *Bacillus sphaericus* (*Bs*), the several strains of *Bacillus thuringiensis israelensis* (*Bti*), and *Saacharopolyspora spinosa*. Two bacteria, *Bs* and *Bti*, produce proteins that are toxic to most mosquito larvae, while *Saacharopolyspora spinosa* produces compounds known as spinosysns, which effectively control all larval mosquitoes. *Bs* can reproduce in natural settings for some time following release. *Bti* materials the District applies do not contain live organisms, but only spores made up of specific protein molecules.

All three bacteria are naturally occurring soil organisms that are commercially produced as mosquito larvicides. Because the potential environmental impacts of *Bs* or *Bti* application are generally similar to those of chemical pesticide applications, these materials and Spinosad are evaluated under the Chemical Control Alternative in Section 2.3.5.

Table 2-1 Herbicides Solano County Mosquito Abatement District May Use for Vegetation Management In the Future

Herbicide Product Name	Common Name/Active Ingredients	CAS or EPA Number	Mode of Action	Timing of Application	Method of Application	Sites
Aquamaster	Glyphosate -53.8%	EPA #524-343	Shikimic acid pathway disruptor	Not currently used, but may consider for future use: Spring-Fall	Truck- or ATV-mounted sprayer; hand can	Ditches, interior margins of wastewater ponds; marshes; access roads; levees; right-of-ways
Habitat	Isopropyl amine Salt of Imazapyr-28.7%	EPA #241-426	Amino acid synthesis inhibitor	Not currently used, but may consider for future use: Spring-Fall	Truck- or ATV-mounted sprayer; hand can	Undesirable floating and emergent aquatic vegetation in areas that may include estuarine and marine sites
No Foam Defoamer	Polydimethylsiloxane and Silicon	No EPA # CAS #2935-50137	Adjuvant	Not currently used, but may consider for future use: Spring-Fall	Truck- or ATV-mounted sprayer; hand can	Interior margins of wastewater ponds, access roads and pond levees; tops and exterior slopes of wastewater ponds
Polaris	Imazapyr-27.7%	EPA #228-534	Amino acid synthesis inhibitor	Not currently used, but may consider for future use: Spring-Fall	Truck- or ATV-mounted sprayer; hand can	Upland marsh corridors for control of invasive pepperweed
Pro-Spreader Activator	Alkylphenol Ethoxylates / Isopropanol	No EPA # CAS #1050775-50022-AA	Adjuvant	Not currently used, but may consider for future use: Spring-Fall	Truck- or ATV-mounted sprayer; hand can	Interior margins of wastewater ponds; access roads and pond levees; tops and exterior slopes of wastewater ponds
R-11 Spreader Activator	Alkylphenol Ethoxylates / Butyl alcohol	No EPA # CAS #2935-50142	Adjuvant	Not currently used, but may consider for future use: Spring-Fall	Truck-or ATV-mounted sprayer; hand can	Interior margins of wastewater ponds; access roads and pond levees; tops and exterior slopes of wastewater ponds

Table 2-1 Herbicides Solano County Mosquito Abatement District May Use for Vegetation Management In the Future

Herbicide Product Name	Common Name/Active Ingredients	CAS or EPA Number	Mode of Action	Timing of Application	Method of Application	Sites
Rodeo ®	Glyphosate-53.8%	EPA #62719-324	Shikimic acid pathway disruptor	Not currently used, but may consider for future use: Spring-Fall	Truck- or ATV-mounted sprayer; hand can	Ponds; drainage ditches; wastewater treatment facilities; wildlife habitat restoration and management areas
Roundup Pro®	Glyphosate-41.0%	EPA #524-475	Shikimic acid pathway disruptor	Not currently used, but may consider for future use: Spring-Fall	Truck- or ATV-mounted sprayer; hand can	Access roads and pond levees; tops and exterior slopes of wastewater ponds
Roundup Pro Max®	Glyphosate-48.7%	EPA #524-579	Shikimic acid pathway disruptor	Not currently used, but may consider for future use: Spring-Fall	Truck- or ATV-mounted sprayer; hand can	Access roads and pond levees; tops and exterior slopes of wastewater ponds
Tripleline Foam-Away	Polydimethylsiloxane	No EPA # CAS #1050775-50023-AA	Adjuvant	Not currently used, but may consider for future use: Spring-Fall	Truck or ATV mounted sprayer; hand can	Interior margins of wastewater ponds; access roads and pond levees; tops and exterior slopes of wastewater ponds
Turf Trax Blue	Polymeric Colorant (proprietary)	Exempt	N/A	Not currently used, but may consider for future use: Spring-Fall	Boat-mounted sprayer, backpack sprayer, hand can	Ponds, lakes, reservoirs, canals, ditches, marshes, wetlands

N/A = Not Applicable

2.3.4.2 Mosquito Parasites

The life cycles of mosquito parasites are biologically more complex than those of mosquito pathogens and involve intermediate hosts, organisms other than mosquitoes. Mosquito parasites are ingested by the feeding larva or actively penetrate the larval cuticle to gain access to the host interior. Once inside the host, parasites consume the internal organs and food reserves until the parasite's developmental process is complete. The host is killed when the parasite reaches maturity and leaves the host (*Romanomermis culicivorax*) or reproduces (*Lagenidium giganteum*). Once free of the host, the parasite can remain dormant in the environment until it can begin its developmental cycle in another host. Examples of mosquito parasites are the fungi *Coelomomyces* spp., *Lagenidium giganteum, Culicinomyces clavosporus*, and *Metarhizium anisopliae*; the protozoa *Nosema algerae, Hazardia milleh, Vavraia culicis, Helicosporidium* spp*., Amblyospora californica, Lambornella clarki*, and *Tetrahymena* spp.; and the nematode *Romanomermis culicivorax*. These parasites are not generally available commercially for mosquito control at present.

2.3.4.3 Mosquito Predators

Mosquito predators are represented by highly complex organisms, such as insects, fish, birds, and bats that consume larval or adult mosquitoes as prey. Predators are opportunistic in their feeding habits and typically forage on a variety of prey types, which allows them to build and maintain populations at levels sufficient to control mosquitoes, even when mosquitoes are scarce. Examples of mosquito predators include representatives from a wide variety of taxa: coelenterates, *Hydra* spp.; platyhelminths, *Dugesia dorotocephala, Mesostoma lingua, and Planaria* spp.; insects, *Anisoptera, Zygoptera, Belostomidae, Geridae, Notonectidae, Veliidae, Dytiscidae, and Hydrophilidae*; arachnids, *Pardosa* spp.; mosquitofish, *Gambusia affinis*, *Gasterosteus aculeatus*; bats; and birds, *anseriformes, apodiformes, charadriiformes, and passeriformes*. Only mosquitofish are commercially available to use at present, or able to be reproduced/reared, while the District supports the presence of the other species as practical (also see Section 15.2). The District's rearing and stocking of mosquitofish in mosquito habitat is the most commonly used biological control agent for mosquitoes in the world. These fish are ideal control agents for several reasons. They feed primarily at the water's surface, where larvae can be found. They can tolerate a significant range in water temperature and water quality. They are also easy to handle, transport, stock, and monitor. Correct use of this fish can provide safe, effective, and persistent suppression of a variety of mosquito species in many types of mosquito sources. As with all safe and effective control agents, the use of mosquitofish requires a good knowledge of operational techniques and ecological implications, careful evaluation of stocking sites, use of appropriate stocking methods, and regular monitoring of stocked fish. Mosquitofish reproduce in natural settings, for at least some time after release. Due to concerns that mosquitofish may potentially impact red-legged frog and tiger salamander populations, the District has established a policy regarding the distribution of mosquitofish to the public. Furthermore, it has incorporated a number of safeguards within the District's policy regarding the planting of mosquitofish in natural waterways by staff.

2.3.4.3.1 Mosquitofish Distribution to the Public

District policy is to take a number of precautions in regard to the distribution of mosquitofish. Residents requesting mosquitofish are required to provide the District with a certain amount of information before receiving fish. The request is then discussed with a District employee prior to fish being provided.

During the discussion, the legal restrictions on planting fish by the public as described in the written statement that is handed to each resident are discussed. Mosquitofish are appropriate in ornamental ponds, horse troughs, non-maintained swimming pools or any other water source that does not connect to a waterway.

Limiting the introduction of the mosquitofish by homeowners to these sources should prevent their migration into habitats used by threatened, endangered, or rare species.

2.3.4.3.2 District Planting of Mosquitofish in Natural Waterways

To minimize the potential impacts of planting mosquitofish in natural waterways, the District will implement a policy incorporating the following elements:

1. Limiting such plantings to areas where the District's historic and ongoing Surveillance Program indicates that mosquito breeding is likely to occur.
2. Consulting appropriate federal and state fish and wildlife department websites, including the USFWS website, CDFW website, and CalFish.org to determine if the area under consideration for treatment, including a 1 mile radius around the site, is a known habitat for threatened and/or endangered species.
3. Not planting in streams until flows have become discontinuous, and stream habitat consists of isolated pools to minimize the potential for the movement of mosquitofish to areas where treatment was not intended.
4. Not planting mosquitofish if there have been reported sightings of threatened and/or endangered species within this area without further surveys by a biologist qualified to perform such surveys, or consultation with agency biologists.
5. District staff conducting a site survey and preparing a written report relating to the occurrence of sensitive species and not planting mosquitofish if the survey identifies the potential presence of sensitive species.

Unless prohibited by the guidelines above, the site would be planted with mosquitofish. The District will keep records of all plantings made by watershed and location, as well as records of any plantings that were planned and discontinued for any of the reasons provided above.

The following information is part of the mitigation measure AR-18 proposed for the Program in Section 4.2.10.3:

> **Location:** All natural waters to be treated with mosquitofish.

> **Monitoring/Reporting Action:** Consult appropriate websites for locations of species of concern or designated critical habitat for listed species. Have surveys performed by a biologist qualified to perform surveys for any sensitive species that might occur based on the above or consult with resource agency biologists prior to planting. In treatment areas more than one mile from locations where sensitive species are thought to occur, District staff will perform a site assessment and complete a site assessment report, to be kept on file at the District offices. If sensitive species are observed, mosquitofish will not be planted without consulting the regulatory agencies.

> **Effectiveness Criteria:** Mitigation will be considered effective if treatment of areas with potential presence of sensitive species is avoided.

> **Responsible Agency:** the District

> **Timing:** Dependent on need for treatment activities

On average, the District produces and releases about 120 pounds of mosquitofish annually, 20 of which are distributed to the public. The District's rearing and stocking program occurs at the District office. The small-scale fish hatchery produces a discharge that averages 75 to 100 gallons per week. This hatchery wastewater is not being placed into the sanitary sewer system or stormwater system. Pond water is allowed to evaporate from the in-ground pond (2 total), requiring maintenance over time.

2.3.5 Chemical Control Alternative

Chemical control is a Program tool that consists of the application of nonpersistent selective insecticides (noted in Section 2.3.3 above) to directly reduce populations of larval or adult mosquitoes. If and when inspections reveal that mosquito populations are present at levels that trigger the District's criteria for chemical control – based on the mosquito's abundance, density, species composition, proximity to human settlements, water temperature, presence of predators and other factors – District staff will apply pesticides to the site in strict accordance with the pesticide label instructions. The total number of applications and weight or volumes of specific pesticides the District applied in Summer 2011 through Spring 2012 are presented in Appendix B, Attachment A of this PEIR.

The vast majority of chemical control tools are used for mosquito abatement. The primary pesticides used can be divided between "larvicides," which are specifically toxic to mosquito larvae, and "adulticides," which are used to control adult mosquito populations. These pesticides and their applications are described in the following paragraphs.

2.3.5.1 Larvicides

Larvicides are applied when the chemical control criteria for mosquito larvae are present. Application rates (for some larvicides) may vary according to time of year, water temperature, the level of organic content in the water, the type of mosquito species present, larval density, and other variables such as emergent vegetation. Larvicide applications may be repeated at any site (as necessary to continue control of production) at recurrence intervals that can range from annually to weekly.

Larvicides the District routinely uses include *Bti*, *Bs*, Methoprene (Altosid), BVA-2, and Agnique.

> ***Bti*** is a biological larvicide. *Bti* is a bacterium that is ingested by mosquito larvae and that disrupts their gut lining, leading to death before pupation. The District may apply *Bti* as a liquid or bonded to an inert substrate (sand or corncob granules) to assist penetration of vegetation. Persistence is low in the environment, and efficacy depends on careful timing of application to coincide with periods in the life cycle when larvae are actively feeding. Pupae and late fourth stage larvae do not feed and, therefore, will not be controlled by *Bti*. Low water temperature inhibits larval feeding behavior, reducing the effectiveness of *Bti* during very cold periods. High organic conditions also reduce the effectiveness of *Bti*. Therefore, use of *Bti* requires frequent inspections of larval sources during periods of larval production, and may require frequent applications of material. Application can be by hand, from an ATV, from watercraft, or from aircraft (either fixed- wing or helicopter).

> ***Bs*** is a biological larvicide. *Bs* is a bacterium that when ingested by mosquito larvae produce microbial gut toxins that destroy the insect gut wall, leading to paralysis and death. *Bs* is a biological larvicide the District may apply as a liquid or bonded to an inert substrate (corncob granule) to assist penetration of vegetation. The mode of action is similar to that of *Bti,* but *Bs* may be used more than *Bti* in some sites because of its higher effectiveness in water with higher organic content and residual properties that allow longer larvicidal action. Persistence is low in the environment, and efficacy depends on careful timing of application to coincide with periods in the life cycle when larvae are actively feeding. Pupae and late fourth stage larvae do not feed and, therefore, will not be controlled by *Bs*. Low water temperature inhibits larval feeding behavior, reducing the effectiveness of ***Bs*** during very cold periods. *Bs* is also ineffective against certain mosquito species such as those in the genus *Aedes*. Knowing the stage and species present can increase the effectiveness of this material, restricting it to sources containing susceptible species. Therefore, use of *Bs* requires frequent inspections of larval sources during periods of larval production and may require frequent applications of material. Application can be by hand, from an ATV, from watercraft, or from aircraft (either fixed-wing or helicopter).

> **s-Methoprene** is the active ingredient in Altosid products as well as MetaLarv a new product (made by a different company). It is a synthetic mimic of a naturally occurring insect hormone called juvenile hormone (JH) that is found during aquatic life stages of the mosquito and other insects, but is most prevalent during the early instars. As mosquito larvae mature, the level of JH steadily declines until the 4th instar molt, when levels are very low. This is considered to be the sensitive period when all the physical features of the adult begin to develop. s-Methoprene in the aquatic habitat can be absorbed on contact and the insect's hormone system becomes unbalanced. This results in the disruption of the transformation of a juvenile mosquito into a physiologically normal adult. Methoprene products must be applied (or present, if using a slow release formula) prior to the pupal stage of mosquitoes. Methoprene can be applied in liquid, granular, pellet, or briquette formulation. Sustained-release products can persist for up to 30 days (pellet formulation) to 150 days (XR Briquets). Application can be performed by hand, from an ATV, from watercraft, or from aircraft (either fixed-wing or helicopter).

> **BVA-2** and Masterline Mosquito Larvicide are highly refined petroleum distillates (mineral oil). These new larvicides demonstrate a low level of toxicity to plant growth (phytotoxicity) and rapid environmental breakdown. BVA-2 larvicide oil has a water-white clear color and is also practically odorless. It forms a thin film on water and kills larvae through suffocation and/or direct toxicity. It is typically applied at application rates of 3 to 5 gallons per acre and can be applied by hand, from an ATV, from watercraft, or from aircraft (either fixed-wing or helicopter).

> **Agnique** is the trade name for a surface film larvicide, comprised of ethoxylated alcohol that kills mosquito larvae and pupae. Agnique forms an invisible monomolecular film that is odorless and visually undetectable. This film interrupts the critical air/water interface (surface tension) in the mosquito's larval and pupal development cycle causing them to drown. Because the layer is thin, larvae can still temporarily penetrate the film to get air allowing for them to survive for up to 5 days. Mortality rate is somewhat dependent on life-cycle stage. Larvae are typically killed within 48 to 72 hours; however, with some species and under certain environmental conditions (such as cool temperatures when development is slow) larval control may take upwards of 120 hours. Water temperature will affect oxygen demands and rate of maturation, thus slowing control. Pupae are typically controlled within 24 to 72 hours, and any pupae that attempt to emerge will be controlled due to the presence of the film. The District may use Agnique as an alternative to BVA-2 in limited areas under certain conditions, although costs, limits of application, and effective duration are issues of concern. Because the application rate of Agnique is much lower than that of BVA-2, 0.35 to 1 gallon per acre, this potential shift would not include an increase in volume of materials applied.

> **CoCoBear Oil**[2] is a food grade, highly refined petroleum distillate but mostly plant derived oil (mineral oil) that the company is now producing to replace the discontinued Golden Bear 1111. This new larvicide has similar characteristics and properties to Golden Bear Oil 1111 in that it also demonstrates low-level toxicity to plant growth (phytotoxicity) and rapid environmental breakdown. It forms a thin film on water and kills larvae through suffocation and/or direct toxicity. It is typically applied at application rates of 3 to 5 gallons per acre and can be applied by hand, from an ATV, from watercraft, or from a truck.

Mosquito pathogens and other larvicides most likely to be used are listed in Table 2-2 Pathogens and other Larvicides Solano County Mosquito Abatement District Uses for Mosquito Abatement. Application equipment and types of sites are listed on the last page of Table 2-2.

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2 Denotes material not currently used but included in Table 2-2 as an option for future use.

Table 2-2 Pathogens and Other Larvicides Solano County Mosquito Abatement District Uses for Mosquito Abatement

Pesticide Product Name	Common Name / Active Ingredients	EPA Number	Mode of Action	Timing of Application	Method of Application	Sites
Pathogens / Biological Control in Use						
FourStar 180 *Bs/Bti*	*Bs* 6% *Bacillus thuringiensis* 1%180 day briquette	EPA 83362-3	Larvicide; when ingested, produce microbial gut toxins that destroy insect gut wall leading to paralysis and death.	Spring-Fall	F	Currently used on limited basis in source type 1. Future use areas may include: 2-8,15,1719-24,26
VectoLex WSP *Bs*	*Bs* 7.5% biological larvicide granules in water soluble pouch	EPA 73049-20	Mosquito midgut disruptor	Spring-Fall	F	Currently used on limited basis in source type 1. Future use areas may include: 2,5,6
Pathogens / Biological Control Under Consideration for Future Use						
FFAST™ *Bti*	*Bti* 10.0% Liquid	EPA 432-1515	Mosquito midgut disruptor.	Spring-Fall	A, B, D, I	2,4,5,6,7,8,20,25, 26,27,28,30
FourStar 45 *Bs/Bti*	*Bs* 6% *Bti* 1% 45 day briquette	EPA 83362-3	Mosquito midgut disruptor.	Spring-Fall	F	1,2,3,4,5,6,18,19, 21,23
FourStar CRG *Bs/Bti*	*Bs* 9% Bti 1% Multi-Brood Controlled Release Granule	EPA 85685-2	Mosquito midgut disruptor	Spring-Fall	B,C,D,E	2,4,5,7,8,11,13,14,26,27 ,28
FourStar MBG *Bs/Bti*	*Bs* 3% *Bti* 3% Multi-Brood Granule	EPA 85685-3	Mosquito midgut disruptor	Spring-Fall	B,C,D,E	2,4,5,7,8,11,13,14,26,27 ,28
Fourstar SBG *Bti*	*Bti* 2.5% Single Brood Granule	EPA 85685-1	Mosquito midgut disruptor.	Spring-Fall	B,C,D,E	2,4,5,7,8,11,13,14,26,27 ,28

Table 2-2 Pathogens and Other Larvicides Solano County Mosquito Abatement District Uses for Mosquito Abatement

Pesticide Product Name	Common Name / Active Ingredients	EPA Number	Mode of Action	Timing of Application	Method of Application	Sites
Pathogens / Biological Control Under Consideration for Future Use (continued)						
Teknar SC *Bti*	*Bti* 5.6% aqueous suspension	EPA 73049-404	Mosquito midgut disruptor.	Spring-Fall	A,B,D,I	2,4,5,6,7,8,20,25, 26,27,28,29,30
VectoLex CG *Bs*	*Bs* 7.5% biological larvicide granules	EPA 73049-20	Mosquito midgut disruptor.	Spring-Fall	C,D,E	2,4,5,6,8,25,26
VectoLex WDG *Bs*	*Bs 51.2%* biological larvicide water dispersible granule	EPA 73049-57	Mosquito midgut disruptor	Spring-Fall	A,D,I	2,4,5,6,8,25,26
VectoMax CG[3] *Bs/Bti* [3]	*Bs* 2.7% *Bti* 4.5% biological larvicide granules	EPA 73049-429	Mosquito midgut disruptor	Spring-Fall	B,C,D,E	Only used as part of UC Davis study and on a trial basis in #27. Future use areas may include: 2,4,5,7,8,20,26,28,30
VectoMax WSP *Bs/Bti*	*Bs* 2.7% *Bti* 4.5% Biological larvicide granules in water-soluble pouch.	EPA 73049-429	Mosquito midgut disruptor	Year-round	F	1,5,6,18,19,21,22,23
Natular 2EC™	20.6% Spinosid (mixture of Spinosad A and D) liquid	EPA 8329-82	Microbial, alters acetylcholine receptors causing involuntary neurological impacts	Year-round	A,D,I	4,5,7,20,24
Natular G ™		EPA 8329-80	Microbial, causes involuntary neurological impacts.	Year-round	C,D,H	4,5,7,20,24

[3] Only used as part of UC Davis study and on trial basis. Not currently used operationally, but may consider for expanded future use.

Table 2-2 Pathogens and Other Larvicides Solano County Mosquito Abatement District Uses for Mosquito Abatement

Pesticide Product Name	Common Name / Active Ingredients	EPA Number	Mode of Action	Timing of Application	Method of Application	Sites
Natular™ XRT	6.25% Spinosid extended release (up to 180 days) tablet.	EPA 8329-84	Microbial, causes involuntary neurological impacts.	Year-round	F	4,5,15,17,19,21,22,23,24,32
Insect Growth Regulators In Use						
Altosid Liquid SR5	Methoprene 5.00% liquid	EPA 2724-392	Insect growth regulator	Year round	A, B, H	2,5,6,7.8,12,16,20,25,26,27,28,29,30,31
Altosid Pellets	Methoprene 4.25% (effective up to 30 days) pellets	EPA 2724-448	Insect growth regulator	Year round	B, C, D, E, F	2,4,5,6,7,8,11,12, 13,14,16,20,25,26, 27,28,29,32
Altosid SBG Single Brood Granule	Methoprene 0.2% granules	EPA 2724-489	Insect growth regulator	Year round	B, C, D, E	2,4,5,7,8,26,27,28,29,30
Altosid XR Extended Residual Briquet	Methoprene 2.10% (effective up to 150) day briquets	EPA 2724-421	Insect growth regulator	Year round	F	1,3,6,15,18,21,22,23
Insect Growth Regulators Under Consideration for Future Use						
Altosid Briquets 30-day	Methoprene 8.62% briquets	EPA 2724-375	Insect growth regulator	Year round	F	1,3,4,5,6,7,8,15, 18,21,22,23
Altosid XR-G	Methoprene 1.5% (effective up to 21 days) granules	EPA 2724-451	Insect growth regulator	Year round	B, C, D, E, F	2,4,5,7,8,26,27,28,29,30
MetaLarv S-PT	Methoprene 4.25% (effective up to 42 days)	EPA-73049-475	Insect growth regulator	Year round	B, C, D, E, F	2,4,5,6,7,8,11,12, 13,14,16,20,25,26, 27,28,29,32

Table 2-2 Pathogens and Other Larvicides Solano County Mosquito Abatement District Uses for Mosquito Abatement

Pesticide Product Name	Common Name / Active Ingredients	EPA Number	Mode of Action	Timing of Application	Method of Application	Sites
Surfactants Currently Used						
Agnique MMF	Poly (oxy-1,2-ethanediyl), α-(C16-20 branched and linear alkyl)-ω-hydroxy (32.0%) granule	EPA 53263-28	Surfactant	Year round	A,D,I	1-8,11-14,16,18, 20,25,26,28,32
Agnique MMF G	Poly (oxy-1,2-ethanediyl), α-(C16-20 branched and linear alkyl)-ω-hydroxy (32.0%) granule	EPA 53263-30	Surfactant	Year round	C,D,E	2-8,11-14,16 20,25,26
BVA-2	Petroleum Distillate Mineral Oil 97% liquid	EPA 70589-1	Surfactant	Year round	A, B, I	1-8,11-14,16,18, 20,25,26,28,32
Other Surfactants Under Consideration for Future Use						
CoCoBear™	Petroleum Distillate-Mineral Oil (10.0%) liquid	EPA 8329-93	Surfactant	Year round	A, B, I	1-8,11-14,16,18, 20,25,26,28,32
MasterLine Kontrol Mosquito Larvicide Oil for Larva and Pupa Control	Petroleum Distillate-Mineral Oil 97% Liquid	EPA 73748-10	Surfactant	Year round	A, B, I	1-8,11-14,16,18, 20,25,26,28,32
Organophosphates (OP) Under Consideration for Future Use						
Abate 4-E Insecticide	Temephos (O,O,O'-(thiodi-4, 1-phenylene) O,O,O',O'-tetramethyl phosphorothiolate). 44.6% liquid	EPA 8329-69	OP-cholinesterase inhibitor-disrupts proper functioning of nervous system, eventually leading to paralysis and death of mosquito larvae.	Year round	A,D,I	15,18,24

Table 2-2 Pathogens and Other Larvicides Solano County Mosquito Abatement District Uses for Mosquito Abatement

Pesticide Product Name	Common Name / Active Ingredients	EPA Number	Mode of Action	Timing of Application	Method of Application	Sites
5% Skeeter Abate	Temephos 5.0% pellets	EPA 8329-70	OP-cholinesterase inhibitor-disrupts proper functioning of nervous system, eventually leading to paralysis and death of mosquito larvae.	Year round	C,D	15,18,24

Application Sites:

1. Swimming pool
2. Ponds
3. Water trough
4. Retention basin
5. Manmade pond
6. Fish pond
7. Dredge spoil pond
8. Permanent pond
9. Alfalfa
10. Row crop
11. Contour pasture
12. Pasture ditch
13. Flooded pasture
14. Strip check pasture
15. Sump
16. Tail water drain
17. Septic tank
18. Container
19. Tires
20. Waterline leak
21. Electrical box
22. Catch basin
23. Valve box
24. Waste/sewer pond
25. Roadside ditch
26. Depression/swale
27. Seasonal wetlands managed as waterfowl habitat
28. Seasonal wetland
29. Tidal marsh
30. Reclaimed marsh
31. Streams/creeks
32. Treehole
33. Vernal pools

Equipment:

A. ATV mounted hose sprayer
B. Fixed-wing/Helicopter
C. Hand-held granular spreader
D. Backpack blower
E. Herd seeder
F. Hand
G. ULV machine- hand held
H. ULV machine-Truck or ATV mounted
I. Hand can
J. Agnique spray bottle

2.3.5.1.1 Larviciding Techniques

Because of the wide range of mosquito sources in the Service Area, and the variety of pesticide formulations described above, the District uses a variety of techniques and equipment to apply larvicides, including handheld sprayers, backpack sprayers and blowers, ATV-mounted spray rigs, watercraft, and aircraft (fixed-wing or helicopter). See Section 2.6 for more detailed information on equipment the District uses.

Ground Larviciding Techniques

The District uses ARGO and other All-Terrain Vehicles (ATVs) as larvicide vehicles. ATVs have a chemical container mounted on the vehicle, a 12-volt electric pump supplying high-pressure, low-volume flow, and booms and/or hose and spray gun allowing for application while steering the vehicle. ATVs are ideal for treating areas such as agricultural fields, pastures, and other offroad sites. Additional training in minimizing habitat impacts, recognizing sensitive flora and fauna, and ATV safety and handling is provided to employees before operating these machines.

Additional equipment used in ground applications of liquid formulations includes handheld sprayers (handcans or spray bottles). Handheld sprayers (handcans) are standard 2- or 3-gallon garden style pump-up sprayers used to treat very small isolated areas also used are smaller sprayers and spray bottles (1 qt. /1/2 gallon). Generally, a pellet or small granular material is applied by hand with a hand crank “belly grinder” or from vehicles with larger units such as a gas-powered backpack sprayer/blower or ATV-mounted Herd Seeder designed to evenly distribute the pellets or granules.

Using ground application equipment, both when on foot and when conveyed by vehicles, has several advantages. Ground larviciding allows applications while in close proximity to the actual treatment area and, consequently, treatments occur to only those microhabitats where larvae are actually present. This method also reduces both the unnecessary pesticide load on the environment and the financial cost of the amount of material used and its application. Both the initial and the maintenance costs of ground equipment are generally less than for aerial equipment. Furthermore, ground larviciding applications are less affected by weather conditions than are aerial applications.

However, ground larviciding is impractical for large or densely vegetated areas. Also, risk of chemical exposure for the applicators (workers) is greater than during aerial larviciding operations. Damage may occur from the use of a ground vehicle in some natural areas. Ruts and vegetation damage may occur, although both these conditions are reversible and generally short-lived. Technicians are trained to recognize sensitive habitat areas and to use good judgment to avoid impacting these areas.

Aerial Larviciding Techniques

When large areas or areas difficult to reach are simultaneously producing mosquito larvae at densities exceeding District treatment thresholds, then the District may use fixed-wing or helicopter to apply any of the larvicides discussed above or listed in Table 2-2. The District contracts with independent flying services to perform aerial applications, with guidance to the target site that District staff provides. Aerial application of larvicides is a relatively infrequent activity for the District with the exception of the annual fall flooding of seasonal wetlands managed as waterfowl habitat. The 5-year average (2008-2012) for the number of applications made to non-seasonal waterfowl habitat areas was 9 with the average number of acres treated per application being 289.5 acres. The 5-year average (2008-2012) for the number of applications made to seasonal waterfowl habitat was 27. The average number of acres treated per application during this period was 197 acres. However, larval production can vary substantially, and the District is capable of undertaking more frequent or extensive operations if necessary.

The larvicides, excluding granular and pellet formulations, are typically combined with water and applied as a low-volume wet spray mix at 2 gallons per acre. Depending on weather conditions, the volume of final mix can be increased to 5 gallons per acre without changing the actual amount of larvicidal active ingredient that is applied per acre. Adjusting the final mix volume per acre to 5 gallons per acre has the advantage of increasing the droplet size to help minimize potential drift and the disadvantage of substantially increasing the flying time, which also increases costs. Aerial application of liquid larvicides typically occurs during daylight hours and at an altitude above the treatment site of less than 40 feet.

Granular and pellet formulations of larvicides are applied using a large mechanical spreader with a bucket (or hopper) that can hold several hundred pounds of granules/material beneath the aircraft. Granular and pellet formulations are generally much more expensive than liquid formulations of larvicides and are used to penetrate dense vegetation. Application rates can range between 3 and 10 pounds per acre for pellets/granules impregnated with methoprene. Applications of methoprene pellets above 5 pounds per acre are highly unlikely due to the high cost. Applications are around 8 to 10 pounds per acre for corncob or other granules impregnated with *Bti* or *Bs* or both. Rates depend on the density of vegetative cover and the organic content of the mosquito breeding water being treated. It is also significant to note that granular applications occur during daylight hours and are at an altitude that is less than 50 feet.

Using aerial application equipment has are three advantages compared to ground application. First, it can be more economical for large target areas with extensive mosquito production. Second, by covering large areas more quickly, it can free District staff to conduct other needed surveillance or control. Third, it can be more practical for remote or inaccessible areas, such as islands, large marshes, and densely vegetated tule areas, than ground larviciding. However, risk of drift is greater with aerial applications, especially with liquid or ultralow volume (ULV) aerial larviciding and, consequently, more potential risk of nontarget exposure exists. In addition, accuracy in hitting the target area temporarily requires additional manpower for flagging or electronic guidance systems, which can increase costs. Finally, in addition to the timing constraints inherent in most larvicide use, the potential application window can be very narrow for aerial activities due to weather conditions.

2.3.5.1.2 Mosquito Adulticides

In addition to chemical control of mosquito larvae, the District may use pesticides for control of adult mosquitoes when no other tools are available and if specific criteria are met, including species composition, population density (as measured by landing count or other quantitative method), proximity to human populations, and/or human disease risk. As with larvicides, adulticides are applied in strict conformance with label requirements (Appendix B). Adulticides the District may use include Pyrethrins (MGK® Pyrocide®, Pyrenone 25-5®); Pyrenone Crop Spray®, and the synthetic pyrethroids Resmethrin (Scourge®) and Permethrin (Kontrol 4-4, Biomist 4-12)). Table 2-3 lists the adulticides the District uses for mosquito abatement for 2014 and beyond. Adulticide materials are used infrequently and only when necessary to control mosquito populations.

Ground Adulticiding Techniques

The most common form of adulticide application is via insecticide aerosols at very low dosages. This method is commonly referred to as the ULV method. This method employs specially designed ULV equipment mounted on trucks, ATVs, golf carts, and boats or handheld for ground applications. Barrier or residual treatments for adult mosquitoes consist of an application using a material generally applied with a compressed air sprayer to the preferred foliage, buildings, or resting areas of the targeted mosquito species. Although this is not a technique currently used by the District, it may become a necessary “tool” in the future if WNV outbreaks occur.

Table 2-3 Adulticides Solano County Mosquito Abatement District Uses for Mosquito Abatement

Pesticide Product Name	Common Name / Active Ingredients	EPA Number	Mode of Action	Timing of Application	Method of Application	Sites
Adulticides in Use						
MGK Pyrocide Mosquito Adulticiding Concentrate for ULV Fogging 7396	5.0% Pyrethrins and 25.0% PBO, Technical.	EPA 1021-1569	Adulticide; interferes with sodium channel function in the nervous system	Feb. – Nov.	Truck or ATV mounted ULV, Hand-held ULV and Aircraft (air potentially)	Rural, semirural, urban
MGK Pyrocide Mosquito Adulticide 7067	5.0% Pyrethrins and 25.0% PBO, Technical.	EPA 1021-1199		Feb. – Nov.	Truck or ATV mounted ULV, Hand-held ULV and air (potentially)	Rural, semirural, urban
Bayer Pyrenone 25-5 Public Health Insecticide	5.0% Pyrethrins and 25.0% PBO, Technical	EPA 432-1050		Feb. – Nov.	Truck or ATV mounted ULV, Hand-held ULV and air (potentially)	Rural, semirural, urban
MasterLine Kontrol 4-4	4.6% Permethrin and 4.6% PBO Technical	EPA 73748-4		Feb.—Nov.	Truck or ATV mounted ULV, Hand-held ULV	Rural, semirural, urban
Clarke Biomist 4 + 12 ULV	4.0% Permethrin and 12.0% PBO, Technical	EPA 8329-34		Feb.—Nov.	Hand-held ULV	Urban

Table 2-3 Adulticides Solano County Mosquito Abatement District Uses for Mosquito Abatement

Pesticide Product Name	Common Name / Active Ingredients	EPA Number	Mode of Action	Timing of Application	Method of Application	Sites
Adulticides Under consideration for Future Use						
MGK EVERGREEN Mosquito Adulticide EC 60-6	6.0% Pyrethrins and 60.0% PBO, Technical	EPA 1021-1770	Adulticide; interferes with sodium channel function in the nervous system	Summer-late fall	B	Rural, semirural, urban
Prentox Pyronyl Oil Concentrate # 525	5.0% Pyrethrins and 25.0% PBO, Technical	EPA 655-471		Feb. – Nov.	Truck or ATV mounted ULV, Hand-held ULV and air (potentially)	Rural, semirural, urban
Prentox Pyronyl Crop Spray	6.0% Pyrethrin and 60.0% PBO Technical	EPA 655-489		Feb.- Nov.	Truck or ATV mounted ULV, Hand-held ULV and air (potentially)	Rural, semirural, urban
Scourge 18% + 54%*	18.0% Resmethrin and 54.0% PBO Technical	EPA 432-667		Feb. – Nov.	Truck or ATV mounted ULV, Hand-held ULV and air (potentially)	Rural, semirural, urban
Scourge 4% + 12%*	4.14% Resmethrin and 12.42% PBO Technical	EPA 432-716		Feb. – Nov.	Truck or ATV mounted ULV, Hand-held ULV and air (potentially)	Rural, semirural, urban
Clarke Anvil 10+10 ULV	10.0% Phenothrin (Sumithrin) and 10.0% PBO	EPA 1021-1688		Feb. – Nov.	Truck or ATV mounted ULV, Hand-held ULV and air (potentially)	Rural, semirural, urban
Clarke Duet™ Dual-action Adulticide	1.0% Prallethrin and 5.0% Sumithrin and 5.0% PBO	EPA 1021-1795-8329		Feb. – Nov.	Truck or ATV mounted ULV, Hand-held ULV and air (potentially)	Rural, semirural, urban

Table 2-3 Adulticides Solano County Mosquito Abatement District Uses for Mosquito Abatement

Pesticide Product Name	Common Name / Active Ingredients	EPA Number	Mode of Action	Timing of Application	Method of Application	Sites
Zenivex E4 RTU	4.0% Etofenprox	EPA 2724-807		Feb. – Nov.	Truck or ATV mounted ULV, Hand-held ULV and air (potentially)	Rural, semirural, urban
AMVAC Trumpet EC Insecticide*	78.0% Naled	EPA 5481-481	Organophosphate adulticide; interferes with cholinesterase inhibitor	Summer-late fall	B	Rural, semirural, urban

* This chemical would only be used in an Emergency situation (i.e. threat of disease outbreak) when other adulticides are not available or have shown to be ineffective against the target species of mosquito.

EPA Number = Registered with the US Environmental Protection Agency

Cold aerosol generators, cold foggers, and ULV aerosol machines were developed to eliminate the need for great quantities of petroleum oil diluents necessary for earlier fogging techniques. These units are constructed by mounting a vortex nozzle on the forced air blower of a thermal fogger. Insecticide is applied as technical material or at moderately high concentrations (as is common with the pyrethroids), which translates to very small quantities per acre and is, therefore, referred to as ULV. In agriculture, this rate is assumed less than 36 ounces per acre, but mosquito control ground adulticiding operations rarely exceed 1 ounce per acre. The optimum sized droplet for mosquito control with cold aerosols applied at ground level has been determined to be in the range of 5 to 20 microns.

Adulticiding is the only known effective measure of reducing an adult mosquito population in a timely manner. All mosquito adulticiding activities follow reasonable guidelines to avoid affecting nontarget species including bees. Timing of applications (when mosquitoes are most active), avoiding sensitive habitat areas, working and coordinating efforts with CDFW or USFWS when appropriate, and following label instructions all result in environmentally sound mosquito control practices.

Aerial Adulticiding Techniques

Aerial applications may be the only reliable means of obtaining effective control in areas bordered by extensive mosquito production sites or with a small, narrow, or inaccessible network of roads. Aerial adulticiding is often the only means available to cover a very large area quickly in case of severe mosquito outbreaks or mosquito-borne disease epidemics.

Two aerial adulticiding techniques are used in California: low-volume spraying and ULV aerosols. Low-volume (<2-gallon-per-acre) sprays are applied with the pesticide diluted in light petroleum oils or water and applied as a rather wet spray. The size of the droplets reduces drift, thus limiting swath widths, and may not be ideal certain circumstances for impinging on mosquitoes. The technique is compatible with equipment commonly used for aerial liquid larviciding.

A common aerial adulticiding technique applies the insecticide in a technical concentrate or in a very high concentration formulation as a ULV cold aerosol. Lighter aircraft, including helicopters, can be used because the insecticide load is a fraction of the other techniques. If the aircraft are capable of >120 knots, fine droplets can be created by the high-speed air stream impacting the flow from hydraulic nozzles. Slower aircraft and most helicopters typically use some variety of rotary atomizers to create the required droplet spectrum. ULV applications can be difficult to accurately place with any regularity. Without the visual cues, drift and settling characteristics can be difficult to access.

The flight parameters differ by program and technique. Some operations fly during hours of daylight so their applications begin either at morning's first light or before sunset and work into twilight. At these times, the pilots should be able to see towers and other obstructions as well as keep track of the spray plume. The aircraft can be flown at less than a 200-foot altitude, which may make it easier to hit the target area.

Other operations may be conducted in darkness, typically after twilight or during pre-dawn hours.. The aircraft typically is flown between a 200- and 300-foot altitude. Swath widths vary from operation to operation but are normally set somewhere between 400 and 1,200 feet. Most mosquito flight activity is crepuscular, so these flights catch the adults at their peak activity.

Swaths are flown as close to perpendicular with the wind as is possible, working into the wind and commonly forming a long, tight S pattern. A number of factors affect the spray-drift offset and settling such as wind speed, droplet size, aircraft wake turbulence, altitude, and even characteristics of the individual aircraft. Pilots rely somewhat on experience for determining this offset, and some use telltale smoke or paper markers for swath alignment.

Aerial applications may be conducted over, but are not limited to, the following land uses within the Program Area: salt marsh, diked marsh, and seasonal wetlands; evaporation ponds and wastewater ponds; and agricultural, residential, commercial, industrial, and recreational areas.

In the event that aerial adulticiding becomes required for suppression of the vectors of WNV, a third private aerial company that specializes in this type of work would be contracted with.

2.4 Public Education

Public education is a key component of the District's Program that is used to encourage and assist reduction and prevention of mosquito habitats on private and public property. While this component is a critical element of the District's Program, public education activities are categorically exempt from CEQA review (CEQA Guidelines Section 15322) based on a finding by the State Secretary of Resources that these activities do not have a significant effect on the environment. Therefore, these activities will not be further reviewed in this document.

A solid mosquito prevention program includes good public education. The District's education program teaches the public how to recognize, prevent, and suppress mosquito breeding on their property. This part of the project is accomplished through the distribution of brochures, fact sheets, participation in local events (upon request), presentations to community organizations (upon request), newspaper and radio advertising, public service announcements, and contact with District staff in response to service requests.

Educational activities also include making recommendations on specific property development and land and water management practices or proposals, in response to ongoing or proposed developments or management practices that may create sources of mosquitoes. To ensure that the District does not indirectly encourage environmental impacts without CEQA review, the District informs landowners and others who might modify the physical environment in response to our educational programs that they have specific environmental obligations, including compliance with CEQA and permit requirements. The District is not a permitting agency and it is not responsible for implementing or approving the recommendations; therefore, property owners or developers are required to prepare and submit their own documents for projects, which may require CEQA review.

2.5 Emergency Activities

In the event of emergency conditions, comprising an actual or imminent disease outbreak declared by the CDPH, the District's Program activities will temporarily vary from its routine operational tools through increases in scope or intensity of methods, and potentially through use of legal pesticides, in strict conformance with label requirements, that the District does not routinely use. Because of their temporary nature and their similarity to routine activities, emergency activities are not evaluated separately in this PEIR. In addition, the state has recognized that emergency conditions may require prompt action of a nature or intensity above typical levels as a means to protect public health, welfare, safety, or property, and has exempted these activities from requirements for further environmental review (CEQA Guidelines Sections 15269, 15359).

2.6 Vehicles and Equipment Used to implement the Program

Equipment listed and described herein is those mechanized items with engines or applicators that have the potential to affect air quality, greenhouse gas emissions, noise, or hazard evaluations for the environmental impact analyses. The specific types of District vehicles and equipment, and aerial equipment used by other pesticide applicators under contract, used in its Program are listed in Table 2-4 (District Vehicle and Equipment List). The list includes vehicles, vehicle-borne pesticide applicators, personnel-borne applicators, and power tools. Nonmechanized equipment, such as trailers and hand rakes, is not included.

Table 2-4 Solano County Mosquito Abatement District Vehicles and Equipment

Type of Vehicle/Equipment	Engine	Fuel Type
Ground Surveillance and Applications/Management		
Chevrolet Astro Van	4.3L	Gasoline
Ford Pickup Truck	6.8L	Gasoline
Ford Pickup Truck x 2	6.2L	Gasoline
Ford Pickup Truck x 4	4.6L	Gasoline
Clark Forklift	Nissan 4 cylinder	Propane
Kubota Tractor	27hp	Diesel
Pro-Mist 25HD	Electric	Electric
Leco 500 ULV Fogger x 2	Briggs 5.5hp	Gasoline
London Fog M.A.G. ULV Fogger x 3	Briggs 3hp	Gasoline
Colt handheld ULV Fogger x 6	Tecumseh TCII	Gas/Oil Mix
Snapper Rear Engine Riding Mower	Briggs 12.5hp	Gasoline
Toro Push Mower	Kawasaki 6.5hp	Gasoline
Stihl 025 Chainsaw	44cc	Gas/Oil Mix
Stihl FS83 Weedeater	25.4cc	Gas/Oil Mix
Stihl HS Hedge trimmer	25.44cc	Gas/Oil Mix
Stihl BG55 Leaf Blower	27cc	Gas/Oil Mix
Craftsman 24” Leaf Vac	Briggs 190cc	Gasoline
Maruyama MD155DX Backpack Sprayer x 5	Kawasaki 40.2cc	Gas/Oil Mix
Water Surveillance and Applications/Management		
Argo ATV Magnum	Koehler 18hp	Gasoline
Argo ATV Conquest	Kawasaki FD620	Gasoline
Argo ATV Avenger	Koehler Aegis 25	Gasoline
Argo ATV Avenger	Koehler Aegis 26	Gasoline
Honda ATV TRX500FM	500cc	Gasoline
Honda ATV TRX400FE	400cc	Gasoline
Honda ATV TRX350FM		Gasoline
Honda ATV TRX300FW x 2	300cc	Gasoline
Invader boat 19’	Mercury 90hp	Gasoline
Achilles Inflatable boat	Electric	Electric

Table 2-4 Solano County Mosquito Abatement District Vehicles and Equipment

Type of Vehicle/Equipment	Engine	Fuel Type
Aerial Applications		
1968 Bell 206 Jet Ranger helicopter (Operated by Alpine Helicopter – Contractor) 120 gal material tank	Allison 250-C20J turboshaft, 420 shp	Jet fuel
1989 Bell 206 Jet Ranger helicopter (Operated by Alpine Helicopter – Contractor) 120 gal material tank	Allison 250-C20J turboshaft, 420 shp	Jet fuel
1960 Hiller Soloy helicopter (Operated by Alpine Helicopter – Contractor) 120 gal material tank	Allison 250-C20J turboshaft, 420 shp	Jet fuel
Isolair Air spray system model 3900 (helicopter-mounted)	n/a	
Isolair 4400 bucket system (helicopter-mounted)	n/a	
Isolair 4500 broadcaster (helicopter-mounted)	n/a	

2.6.1 Vehicles and Equipment for Ground Surveillance and Chemical Application

The District uses 4-wheel drive pickup trucks that have been modified for the particular Program activity. When treatment sites cannot be accessed by roads, access is by way of ATVs or by foot (if vehicle access is prohibited), and treatments are made using handheld sprayers or belly grinders (for granular or pellet formulations). Some situations where flooding and wetlands preclude access by 4-wheel drive vehicles or reasonable walking distance in waders/boots do require the use of an approved ATV. District staff does not use ATVs where environmental conditions (e.g., impenetrable vegetation/terrain, endangered/threatened plants, sensitive habitat) can result in causing an accident, personal injury, or significant environmental damage. When used, ATVs are fitted with a chemical container mounted on the vehicle, a 12-volt electric- or gasoline-engine-powered pump supplying high-pressure, low-volume flow, and a hose and spray tip allowing for application while steering the vehicle. ATVs are ideal for treating areas like agricultural fields, pastures, salt marshes, and other offroad sites.

Additional equipment used in ground applications include seeders, and backpack sprayers/blowers. Handheld sprayers (handcans) are standard 1- or 2- or 2- or 3-gallon garden style pump-up sprayers used to treat small isolated areas with precision. Backpack sprayer/blowers are either gas or hand powered and are fitted with chemical tanks that can hold granular or pellet formulations in addition to liquid. Generally, for smaller areas, pellet or small granular material is applied with a mechanical hand-crank spreader, seeder, or backpack blower.

2.6.2 Boats for Water Surveillance and Application

District personnel use a 19-foot fiberglass outboard-equipped boat or an airboat to inspect and treat large deepwater bodies and islands. They are commonly used for inspections of several seasonal waterfowl areas in the Suisun Marsh that are not accessible by truck. The boat is the best access to inspect and treat the aquatic plant mats, algae mats, and islands for mosquitoes. Boat use minimizes vehicle travel in offroad areas of the creek beds and hazardous terrain along shorelines for carrying treatment equipment on foot. Further, boat operations do not have lasting environmental impacts.

2.6.3 Aerial Application

The District uses a contract agricultural application service to provide helicopter and fixed-wing treatments to large or problematic/difficult access source areas (50 acres up to 1,000 acres). Helicopter and fixed-wing operations are done at very low altitude in areas away from people. An advantage of using a helicopter is the high rate of application to large areas without contact with the ground surface (no disturbance of vegetation) at a reasonable per acre cost. A helicopter can treat up to 200 acres per hour. Helicopter treatments occur during daylight hours, typically before noontime when little or no wind occurs, and at an altitude that is less than 40 feet above the surface of the site being treated. A 120-gallon tank is used with a typical application rate of 2 gallons of final mix per acre. Although very cost prohibitive, the application rate can exceed 5 gallons per acre in “special” circumstances when a larger droplet size is desired to further minimize potential drift issues or penetrate vegetation. Typically, aerial larvicide treatments are done using granular and pellet formulations of Altosid at a target rate of 7 lb. per acre for the granules and 3 lb. per acre (for the 30 day) pellet formulation. The *Bs* and *Bti* formulations are applied at a target rate of around 10-20 pounds per acre depending on the density of vegetation. If dense vegetation is present, application rates may increase to up to 20 pounds per acre.

The District also uses a contract agricultural application service to provide fixed-wing aircraft treatments to areas up to 1,000 acres in size. Fixed-wing aircraft treatments occur during daylight hours, typically before noon, when little or no wind (less than 5 miles per hour) occurs, at an altitude that is less than 60 feet above the surface being treated. Typically aerial larvicide treatments are done using Altosid Liquid Larvicide SR 5 at 4 oz. per acre of product and a final mix of 2 gal. of final mix per acre.

2.7 Program Alternatives

The District has developed a range of project alternatives partially as a result of input from the scoping process, and these alternatives and others are briefly described and evaluated in a technical report to the PEIR (Appendix E). This technical report is also summarized in Chapter 15 of this PEIR.

2.7.1 No Program Alternative

CEQA Guidelines require an analysis of the “No Project” Alternative, which is defined as what would be reasonably expected to occur in the foreseeable future if the project were not approved, based on current plans and consistent with available infrastructure and community services [Section 15126.6, Subdivision (e)(2)]. For Program purposes, the No Project Alternative would be equivalent to “no action” or to discontinue the Program described above. In the absence of continuing the current Program, the District would not exist solely to engage in public education control activities. See Section 15.2.2 for more information on the No Program Alternative.

2.7.2 Alternatives Eliminated from Further Consideration

These alternatives are identified and evaluated in the District’s Alternatives Analysis Report (Appendix E) and summarized in Section 15.2 of this PEIR. They include the following:

- **Biological Control (Viruses).** None of the mosquito viruses listed (in Appendix E, Section 2.5) are generally commercially available for mosquito control at present.
- **Biological Control (Parasites).** None of the mosquito parasites listed (in Appendix E, Section 2.7) are generally available commercially for mosquito control at present.
- **Mass Trapping.** This tool is not an economically feasible tool due to extensive labor involved in trap placement and retrieval.
- **Attract and Kill.** This has not been proven to be an effective control tool to date. This tool is too labor intensive for District use.
- **Inundative Releases (Parasites).** No parasites for mosquitoes are available for commercial use at present.
- **Inundative Releases (Predators).** With the exception of mosquitofish, there are no other proven, commercially available predators for mosquito control at present.

- **Regulatory Control.** These actions only prevent the human-aided movement of unwanted pests. They do not reduce existing pest numbers or the ability of the pest to spread on its own.
- **Repellents.** Have no value as a control tool; they are strictly a personal protective measure.

2.7.3 Other Alternatives

While no other alternatives are considered feasible or appropriate to achieve the District's Program objectives, and all of the Program alternatives would be combined into the District's Proposed Program, potential options or alternative methods within some of the Program alternatives could be used to modify those alternatives, thus minimizing impacts to the environment or replacing chemical treatments previously used.

2.7.4 Environmentally Superior Alternative

Table S-1 presents a summary of all of the impacts associated with each Program Alternative and, therefore, the overall Program of all of the alternatives combined. Nearly all of the potentially significant impacts can be mitigated to less than significant, but there are two exceptions involving the present and future use of mosquitofish in natural waterways and the possible infrequent future use of naled as a mosquito adulticide. Clearly, there are tradeoffs among biological and water resources primarily, but also to air quality, where potentially significant impacts could occur (prior to mitigation) or remain in making a determination of the environmentally superior alternative.

- The Physical Control Alternative has the potential for greater impacts to biological resources/aquatic habitats if sensitive species are present when the drainage control measures are implemented. It also has the potential to impact aquatic habitats if there are conflicts with any HCP/NCCPs adopted within the District's Program Area.
- The Vegetation Management Alternative has the potential for significant impacts to aquatic biological resources from conflicts with the provisions of adopted HCP and NCCPs.
- The Biological Control Alternative has the potential for significant impacts to aquatic resources and ecological health from the use of mosquitofish in natural waterways. While mitigation would substantially reduce these impacts, the risk of impacts would not be eliminated, resulting in a significant and unavoidable residual impact.
- The Chemical Control Alternative has potentially significant impacts to surface water resources from the application of permethrin, resmethrin, and naled as mosquito adulticides. Furthermore, there is the potential for subjecting people to objectionable odors depending on the formulation used and proximity of treatment locations to human activities.

From a biological resource perspective, elements of the Physical Control Alternative dealing with drainage control in aquatic habitats, with Vegetation Management's potential conflicts with HCP/NCCPs, and with the Biological Control's residual impacts from using mosquitofish in natural waterways would not make any of these environmentally superior alternatives. Protection of surface water resources mean components of the Chemical Treatment Alternative would not make this alternative environmentally superior. To the extent the District can modify elements of these alternatives to avoid identified impacts and lessen mitigation requirements, without increasing reliance on elements with greater potential for environmental impacts, then the environmentally superior alternative would be a complete Program of all five alternatives by incorporating modifications to three alternatives as components of the overall control Program: Physical Control, Biological Control, and Chemical Control Alternatives. See Section 15.4 for a discussion of the Reduced Physical Control, Reduced Biological Control, and Reduced Chemical Control Alternatives. The District could select any or all of the three "reduced alternatives" as part of the overall Program.

The No Program Alternative is not the environmentally superior alternative due to its potentially significant impacts to the following resources and concerns identified in Section 15.2.2: urban and rural land uses, aquatic and terrestrial biological resources, ecological health, human health, and public services and hazard response.

2.8 Other Required Permits and Agency Coordination

2.8.1 <u>Required Permits</u>

2.8.1.1 California Department of Public Health

The District's Program as a whole, including the registration and continuing education of state-certified field personnel, is reviewed and approved by the CDPH, through a formal Cooperative Agreement that is renewed annually. The CDPH also performs onsite biennial inspections of the District's equipment, operations, safety training, and records. The last inspection was conducted on November 30, 2012.

2.8.1.2 Statewide General NPDES Permit for Vector Control

The application of pesticides at, near, or over waters of the US that results in discharges of pollutants requires coverage under a NPDES permit. In response to the Sixth Circuit Court's decisions and previous decisions by other courts on pesticide regulation, the State Water Resources Control Board (SWRCB) has adopted four Pesticide Permits. Water Quality Order No. 2011-0002-DWQ (General Permit No. CAG 990004) is the Permit for Biological and Residual Pesticide Discharges to waters of the US from vector control applications. The District completed application requirements, including preparation of a Pesticide Application Plan (PAP) and public notice requirements, and received permit approval on October 31, 2011.

This General Permit covers the point source discharge of biological and residual pesticides resulting from direct to water and spray applications for vector control using (1) larvicides containing monomolecular films, methoprene, *Bti*, *Bs*), temephos, petroleum distillates, or Spinosad; and (2) adulticides containing malathion, naled, pyrethrin, permethrin, resmethrin, sumithrin, prallethrin, PBO (an inert ingredient), etofenprox, or N-octyl bicycloheptene dicarboximide (or MGK-264). Users of products containing these active ingredients (and the inert PBO) are required to obtain coverage under this General Permit prior to application to waters of the US. This General Permit only covers the discharge of larvicides and adulticides that are currently registered in California.

Pursuant to California Water Code Section 13389, SWRCB and Regional Water Resources Control Boards (RWQCBs) are exempt from the requirement to comply with Public Resources Code, Chapter 3, Division 13 when adopting NPDES permits (SWRCB 2011a).

2.8.1.3 Statewide General NPDES Permit for Algae and Aquatic Weed Control

This General Permit regulates the discharge of aquatic pesticides (algaecides and aquatic herbicides) used for algae and aquatic weed control to waters of the United States. These are algaecides and aquatic herbicides with registration labels that explicitly allow direct application to water bodies. This General Permit becomes effective on December 1, 2013.

Except for discharges on tribal lands that are regulated by a federal permit, this General Permit covers the point source discharge to waters of the United States of residues resulting from pesticide applications using products containing 2,4-D, acrolein, copper, diquat, endothall, fluridone, glyphosate, imazamox, imazapyr, penoxsulam, sodium carbonate peroxyhydrate, and triclopyr-based algaecides and aquatic herbicides, and adjuvants containing ingredients represented by the surrogate nonylphenol. This General Permit covers only discharges of algaecides, and aquatic herbicides that are currently registered for use in California, or that become registered for use and contain the above-listed active ingredients and ingredients represented by the surrogate of nonylphenol.

A Discharger under this General Permit includes any entity involved in the application of algaecides and aquatic herbicides that results in a discharge of algaecides and aquatic herbicides and their residues and degradation byproducts to waters of the United States, and meets either or both of the following two criteria:

- The entity has control over the financing for or the decision to perform algaecide and aquatic herbicide applications that result in discharges, including the ability to modify those decisions; or
- The entity has day-to-day control of algaecide and aquatic herbicide applications or performs activities that are necessary to ensure compliance with this General Permit. For example, the entity is authorized to direct workers to carry out activities required by this General Permit or perform such activities themselves.

2.8.1.4 United States Army Corps of Engineers

For minor physical control activities, the District obtains 5-year regional permits from the USACE (with review by the SFBRWQCB and/or the USFWS, as needed), and from the BCDC (as needed). The current USACE permit runs through December 31, 2012, and the BCDC permit runs through April 1, 2014. A proposed extension of up to 2 years for the USACE permit is being considered as an interim measure until the District completes additional biological assessments and other permit requirements in 2013 and this PEIR.

2.8.1.5 United States Fish and Wildlife Service

The District is required to submit an annual Pesticide Use Proposal (PUP) and apply for a Supplemental Use Permit (SUP) whenever performing mosquito control activities on USFWS lands. Depending on the location and nature of the work, the District may also be required to consult with the USFWS under Section 7 of the federal Endangered Species Act to address potential impacts to sensitive species and habitats. In addition to SUPs and PUPs, the USFWS reviews and may also comment on the District's proposed annual minor physical control projects (see Section 2.8.1.4 above on the USACE permit).

2.8.1.6 Solano County Agricultural Commissioner

County Agricultural Commissioners also regulate sale and use of pesticides in California. In addition, County Agricultural Commissioners issue Use Permits for applications of pesticides that are deemed as restricted materials by CDPR. For chemical control activities, the District reports to and is periodically reviewed by the Solano County Agricultural Commissioner. The District's Use Permit was issued on December 4, 2013. An annual facilities inspection, which also includes the inspection of pesticide storage facilities, pesticide use records and safety training records, was last conducted on December 4, 2013.

During the permitting process, County Agricultural Commissioners determine if the pesticide use will result in substantial adverse environmental impact, whether appropriate alternatives were considered, and if any potential adverse effects are mitigated. The Use Permit conditions contain minimum measures necessary to protect people and the environment. The County Agricultural Commissioners may choose to rely on this PEIR in making their determination.

2.8.1.7 Solano County Department of Resource Management

The Solano County Department of Resource Management-Environmental Health Services Division Hazardous Materials Section oversees the Certified Unified Program Agency (CUPA) within Solano County. The District is required to participate in the (CUPA) which involves: (1) submitting and maintaining a current Hazardous Materials Business Plan (which will now be filed electronically with the California Environmental Protection Agency; (2) undergoing a biennial facilities and records inspection (which includes safety training) and (3) paying an Annual CUPA Fee. The last facilities inspection was conducted on August 22, 2013. An updated Hazardous Materials Business Plan was submitted to the State electronically on October 16, 2013.

2.8.2 Agency Coordination

For work on State of California lands and riparian zones, wetlands, or other sensitive habitats, the District coordinates and reviews activities with the CDFW and the California State Lands Commission as Trustee Agencies.

2.9 Best Management Practices

The District has implemented a number of procedures and practices under current Program activities that would continue into the future for the Proposed Program. These BMPs represent measures to avoid, minimize, eliminate, rectify, or compensate for potential adverse effects on the human, biological, and physical environments and District staff. While similar to mitigation measures under CEQA, these BMPs are already in use and would continue to be used as part of the Proposed Program. Subsequent environmental impact assessments in this PEIR reflect the continued use of these measures, which are organized under the following categories:

> Pesticide Applications to Product Label Requirements
> Pesticides/Surfactants/Herbicides Applications with Best Management Practices
> Nonchemical Mosquito Control Best Management Practices
> Hazardous Materials Spill Management
> Worker Illness and Injury Prevention Program and Emergency Response Plan.

The District will observe all state and federal regulations. The Districts will follow all appropriate laws and regulations pertaining to the use of pesticides and herbicides and safety standards for employees and the public, as governed by the USEPA, CDPR, and local jurisdictions (with some exceptions). Although the products the District uses are all tested, registered, and approved for use by the USEPA and/or CDPR, Districts provide additional margins of safety with the adherence to additional internal guidance based on BMPs and the principles embodied in District IMMP policies, where applicable.

> Ensure all District and contracted applicators are appropriately licensed by the state.
> District staff or contractors will coordinate with the County Agricultural Commissioners, and obtain and verify all required licenses and permits as current prior to pesticide/herbicide application.
> All applicators and handlers will use proper personal protective equipment.
> The District has an Emergency Response Plan to protect the environment and District staff from accidental spills and releases of hazardous materials (SCMAD 2013).

2.9.1 Pesticide Applications to Product Label Requirements

2.9.1.1 California Pesticide Regulatory Program

CDPR regulates the sale and use of pesticides in California. CDPR is responsible for reviewing the toxic effects of pesticide formulations and determining whether a pesticide is suitable for use in California through a registration process. Although CDPR cannot require manufacturers to make changes in labels, it can refuse to register products in California unless manufacturers address unmitigated hazards by amending the pesticide label. Consequently, many pesticide labels that are already approved by USEPA also contain California-specific requirements. Pesticide labels defining the registered applications and uses of a chemical are mandated by USEPA as a condition of registration. The label includes instructions telling users how to make sure the product is applied only to intended target pests and includes precautions the applicator should take to protect human health and the environment. For example, product labels may contain such measures as restrictions for applications in certain land uses and weather (i.e., wind speed) parameters.

> District staff will conduct applications with strict adherence to product label directions that include approved application rates (minimum to maximum amounts) and methods, storage, transportation, mixing, and container disposal.

> District selects option to use ULV applications rather than larvicide application sprays at the suggested label guidance.

> In some cases, the material is applied at concentrations and in amounts less than the label maximum application rate allows (but equal to or greater than the minimum amount needed for product effectiveness).

2.9.2 Other BMPs for Mosquito Control

Many BMPs the District directly practices can be found in the *Best Management Practices for Mosquito Control in California* (CDPH and MVC 2012). These BMPS are incorporated by reference into this PEIR. A summary of the BMPs is included below:

BMPs for Applications of Pesticides, Surfactants, and/or Herbicides

> Avoid use of surfactants in sites with aquatic nontargets or natural enemies of mosquitoes present such as nymphal damselflies and dragonflies, dytiscids, hydrophilids, corixids, notonectids, ephydrids, etc. Use a microbial treatment (*Bti*, *Bs*) or methoprene instead.

> Conduct all storage, loading, and mixing of herbicides activities beyond a buffer zone of reasonable distance (the distance from any aquatic feature or special-status species or their habitat or sensitive natural communities, e.g., at least 300 feet). Handle all mixing and transferring within a contained area. Conduct any transfer or mixing on the ground within containment pans or over protective tarps.

> Postpone or cease application when predetermined weather parameters exceed product label specifications or when wind speeds exceed a predetermined velocity (e.g., 7 miles per hour) and when a high chance of rain is predicted (e.g., a greater than 40 percent chance of precipitation is forecasted for a 24-hour period).

> Applicators to remain aware of wind conditions prior to and during spray events to minimize any possible drift to unwanted water bodies, and other areas adjacent to the application areas.

> Adjust spray nozzles to produce larger droplet size rather than smaller droplet size. Use low nozzle pressures where possible (e.g., 30 to 70 pounds per square inch). Keep spray nozzles within a predetermined maximum distance of target weeds or pests (e.g., within 24 inches of vegetation during spraying). Adjusting droplet size would only apply to larvicides and non-ULV applications. Use ULV sprays that are calibrated to be effective and environmentally safe at the proper droplet size (about 15 microns).

> Clean containers at an approved site and dispose of at a legal dumpsite or recycle in accordance with manufacturer's instructions if available.

> Special-Status Aquatic Wildlife Species:

- A qualified person (e.g., a District biologist) will conduct CNDDB and other online surveys and report on all treatment areas prior to work to determine whether any aquatic features are located on site that have the potential to support special status species. Use only pesticides, herbicides, and adjuvants approved for aquatic areas or manual treatments within a predetermined distance from aquatic features (e.g., within 15 feet of aquatic features). Aquatic features are defined as any natural or man-made lake, pond, river, creek, drainage way, ditch, spring, saturated soils, or similar feature that holds water at the time of treatment or typically becomes inundated during winter rains.
- If it is found that aquatic features are present within the boundary of the proposed treatment area, the District will not implement treatment actions in those areas or if the District wishes to continue

treatment actions in these areas, it will further investigate the work area (e.g., using aerial photos and biological data developed for other permits) prior to treatment to determine presence of suitable habitat or critical habitat for special-status species.

- If suitable habitat necessary for special-status species is found, including vernal pools, and if aquatic-approved pesticides, herbicides, and adjuvants treatment methods have the potential for affecting the potential species, then the District will coordinate with the CDFW, USFWS, and/or National Marine Fisheries Service (NMFS) before conducting treatment activities within this boundary or cancel activities in this area. If the District determines no suitable habitat is present, treatment activities may occur without further agency consultations.

> Conduct worker environmental awareness training for all treatment field crews and contractors for special-status species and sensitive natural communities a qualified person (e.g., District biologist) determines to have the potential to occur on the treatment site. Conduct the education training prior to starting work at the treatment site and upon the arrival of any new worker onto sites with the potential for special-status species or sensitive natural communities.

> Survey all predetermined treatment sites every year prior to work to determine the potential presence of special-status plants and terrestrial wildlife using the CNDDB, relevant Habitat Conservation Plans (HCPs), NOAA Fisheries and USFWS websites, CalFish (calfish.org).org, and other biological information developed for other permits. Establish a predetermined buffer of reasonable distance from known special-status species locations and do not allow application of pesticides/herbicides/rodenticides (including fumigants) within this buffer without further agency consultations.

> District staff will monitor sites post-treatment to determine if the target pest or weeds were effectively controlled with minimum effect to the environment and nontarget organisms. Design future treatment methods in the same season or future years to respond to changes in site conditions

> Do not apply pesticides that could affect insect pollinators during the day when honeybees are active or at dawn/dusk when other pollinators are active. Applications of these specific pesticides are to occur after dark.

> The District will perform public education and outreach activities upon request.

BMPs for Surveillance and Nonchemical Physical Control and Vegetation Management

> If suitable habitat necessary for special-status species is found, including vernal pools, and if nonchemical physical and vegetation management control methods have the potential for affecting the potential species, then the District will coordinate with the CDFW, USFWS, and/or NMFS before conducting control activities within this boundary or cancel activities in this area. If the District determines no suitable habitat is present, control activities may occur without further agency consultations.

> When using heavy equipment for vegetation management, District staff (and contractors) will not operate such equipment in the water and will provide appropriate containment and cleanup systems to avoid, contain, and clean up any leakage of toxic chemicals into the aquatic environment, controlling turbidity and minimizing the area that is affected by the vegetation management activity.

> Properly train all staff, contractors, and volunteer crew leaders to prevent spreading weeds and pests to other sites.

> Operation of noise-generating equipment (e.g., chainsaws, wood chippers, brush-cutters, pickup trucks) will abide by the time-of-day restrictions established by the applicable local jurisdiction (i.e., City and/or County) if such noise activities would be audible to receptors (e.g., residential land uses,

schools, hospitals, places of worship) located in the applicable local jurisdiction. Shut down all motorized equipment when not in use.

> For operations that generate noise expected to be of concern to the public, the following measures would be implemented:
  - Measure 1: Provide Advance Notices. A variety of measures are implemented depending on the nature/magnitude of the activities, including press releases, social media, District websites, hand-delivered flyers, posted signs, emails, and/or phone alerts. Public agencies and elected officials also may be notified of the nature and duration of the activities, including the local Board of Supervisors or City Council, environmental health and agricultural agencies, emergency service providers, and airports.
  - Measure 2: Provide Mechanism to Address Complaints. The District staff is available during regular business hours to respond to service calls and may staff phone lines to address concerns during nighttime operations.
  - Measure 3: Follow Established Procedures for Airboat Operations. Airboat operators are limited to certain areas and follow the guidelines established for those areas.

> The District will perform public education and outreach activities upon request.

2.9.3 Hazardous Materials Spill Management

Concerning the use of pesticides and/or herbicides, all small spills will be handled according to the District's procedures for cleanup of small spills of 5 gallons or less as follows:

> Exercise adequate caution to prevent spillage of pesticides during storage, transportation, mixing or application of pesticides. Report all pesticide spills and cleanups (excepting cases where dry materials may be returned to the container or application equipment).

> Maintain a pesticide spill cleanup kit and proper protective equipment at the District Shop and in each vehicle used for pesticide application or transport.

> Manage the spill site to prevent entry by unauthorized personnel. Contain and control the spill by stopping it from leaking or spreading to surrounding areas, cover dry spills with polyethylene or plastic tarpaulin, and absorb liquid spills with appropriate absorbent materials.

> Properly secure the spilled material, label the bags with service container labels identifying the pesticide, and deliver them to the Field Supervisor for disposal.

> Maintain list of hazardous materials sites pursuant to Government Code Section 65962.5 (CalEPA 2013).

2.9.4 Worker Illness and Injury Prevention Program and Emergency Response

The District's Illness and Injury Prevention Program and the Emergency Response Plan (SCMAD 2013) provide safety training for all employees who may be affected by any substance, process, procedure, or equipment that represents a potential hazard. Training programs are conducted for the safe use of equipment, machinery, or tools and the safe use and disposal of pesticides. After completing the training, employees are required to take a comprehensive examination and are enrolled in a continuing education program.

> Equip all vehicles used in wildland areas with a shovel and a fire extinguisher during the dry season.

> Train employees on the safe use of equipment and machinery, including vehicle operation.

3 Urban and Rural Land Uses

Chapter 3 evaluates potential impacts to urban and rural land uses from Program implementation. The focus of this chapter is on the consistency of the Program with local and regional land use plans and policies in effect in the Program Area. Because the exact location and timing of potential mosquito control activities are unknown, this analysis has been conducted at a programmatic level.

Section 3.1, Environmental Setting, presents an overview of the types of land uses found in the Program Area, including a description of public lands in the Program Area where mosquito control measures could be implemented. It also presents federal, state, and local ordinances and regulations that are related to pesticide use in the Program Area. Section 3.2, Environmental Impacts and Mitigation Measures, presents the following:

- Environmental concerns and evaluation criteria
- Evaluation methods and assumptions
- Discussion of the land use impacts from the No Program and Program alternatives, and recommendations for mitigation, if required, for those impacts
- Cumulative impacts related to land use
- Summary of environmental impacts due to land use conflicts

3.1 Environmental Setting

3.1.1 Overview of Urban and Rural Land Use

Generally, implementation of District's mosquito control activities could occur on a wide range of land uses within the District's principle Service Area in Solano County (Figure 2-1). In addition, actions can also be taken in adjacent counties as needed, including Contra Costa, Napa, Sacramento, Sonoma, and Yolo counties. Solano County and these five adjacent counties represent the Program Area. The Program Area is characterized by both urban and rural settings. Urban areas include residential, commercial, and industrial uses that tend to be located in incorporated areas. In fact, portions of the Program Area cover cities which are densely populated. Other parts of the Program Area are rural in character, including agricultural land, rural residential, open space, and other public lands that are generally undeveloped.

Control measures specific to mosquitoes are focused on aquatic habitats, including natural areas, such as marshes, lakes and ponds, rivers and streams, vernal pools and other seasonal wetlands, and irrigated pastures. These types of habitats typically are found in rural areas. Mosquito control measures can also occur at developed facilities found in urban areas or other areas that retain water, such as stormwater detention basins, flood control channels, spreading grounds, street drains and gutters, wash drains, animal troughs, artificial containers, tire piles, fountains, ornamental fishponds, and swimming pools.

3.1.2 Public Lands

Although mosquito control measures can be implemented on lands irrespective of land ownership, large expanses of aquatic and terrestrial habitat are commonly found on public lands, such as the San Pablo Bay National Wildlife Refuge administered at the federal level by the USFWS. Table 3-1 presents the extent of federal land in the Program Area. The Program Area also has extensive areas of public land managed by state agencies, namely California State Parks, as well as community and regional parks managed by local parks and recreation departments of affected municipalities and special districts.

Table 3-1 Federal Lands in the Program Area, FY-2012 (acres)

County	Agency						
	BLM	**USFS**	**USBR**	**NPS**	**USACE**	**USFWS***	**Total**
Contra Costa	74	0	1,875	336	0	0	2,285
Napa	31,737	0	28,585	0	5	0	60,327
Sacramento	4,500	0	4,447	0	674	0	9,621
Solano	2,157	0	881	0	2,720	1,702	7,460
Sonoma	7,158	0	0	0	14,317	0	21,475
Yolo	29,692	0	391	0	1,180	0	31,263
Total	**75,318**	**0**	**36,179**	**336**	**18,896**	**1,702**	**132,431**

Source: US Department of Interior (2013)

Notes:

*Many lands within the National Wildlife Refuge system administered by USFWS are not eligible for payments in lieu of taxes and are not included in the table. The District identified the 1,702 acres for Solano County.

BLM = Bureau of Land Management
NPS = National Park Service
USACE = US Army Corps of Engineers
USBR = US Bureau of Reclamation
USFS = USDA Forest Service
USFWS = US Fish and Wildlife Service

3.1.3 Regulatory Setting

3.1.3.1 Federal

No federal regulations and/or policies govern land use in the Program Area, except for management plans related to federal land holdings. However, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)[1] regulates, at the federal level, pesticide distribution, sale, and use. For more information on FIFRA, refer to Section 7.1.5.1 (Human Health).

3.1.3.2 State

Similar to the federal level, the State of California has no direct authority on local land use on private lands with the exception of requirements related to general plan development and zoning consistency. Specifically, California Government Code Section 65300 et seq. establishes the obligation of cities and counties to adopt and implement general plans. A general plan is a comprehensive, long-term strategy document that sets forth the expected location and general type of physical development expected in the city or county developing the document. In addition, State Zoning Law (California Government Code Section 65800 et seq.) establishes that zoning ordinances, which are laws that define allowable land uses in a specific district, are required to be consistent with the general plan and any applicable specific plans. Land use on state-managed public lands is regulated pursuant to any applicable land use plans and policies administered by each state agency.

From a land use perspective, the key regulatory consideration at the state level is related to the concept of preemption. Preemption refers to laws at one level of government taking precedence over laws of a

[1] 7 United States Code Section 136 et seq. (1996)

lower level. As such, no entity at the lower level can pass a law inconsistent with the law at the higher level. The California Constitution also allows the state to preempt local jurisdictions. California Food and Agricultural Code Section 11501.1 states that no ordinance or regulation of local government "may prohibit or in any way attempt to regulate any matter relating to the registration, sale, transportation, or use of pesticides, and any of these ordinances, laws or regulations are void and of no force or effect."

3.1.3.3 Local

Each of the municipalities (i.e., counties and incorporated cities) in the Program Area maintains its own general plan and/or zoning ordinance that regulates allowable land use within its jurisdiction. Typically, policies and programs related directly to pesticide use are outside the purview of local planning and zoning regulation. However, some cities and counties have enacted regulations on pesticide use as part of their municipal code. Local governing bodies may pass ordinances that regulate or restrict pesticide use in their own operations. The County of Contra Costa, for example, requires county departments to create, implement, and periodically review IPM programs. However, restrictions do not apply to state operations and would not be applicable to treatments proposed by the District under the Program because California state law preempts local regulation and restriction of pesticide use. The District is a regulatory agency formed pursuant to California Health and Safety Code Section 2000 et seq. State law charges the District with the authority and responsibility to take all necessary or proper steps for the control of mosquitoes in the District (see Section 1.1.3).

3.2 Environmental Impacts and Mitigation Measures

The evaluation of land use impacts in the Program Area is presented below. Program impacts on urban and rural land uses were evaluated based on the significance criteria presented in Section 3.2.1.

3.2.1 Evaluation Concerns and Criteria

The following concerns associated with urban and rural land uses were raised during the public scoping process:

> Aspects of the Program that diminish recreational experience of park visitors of the regional parks and trails within the Program Area. Effects on recreational land use are covered in this section.

> Population density (age, health, disabilities, etc.) within the designated residential developments and effects of pesticides on the health and daily activity of affected residents. The Program would not affect the extent or distribution of residential land uses nor population levels throughout the Program Area. Public health effects are covered in Chapter 7, Human Health.

> Impacts at school sites. The Program would not alter land uses at public or private school sites and schools would continue to operate similarly to existing conditions. Public health effects on sensitive populations, including school-aged children, are covered in Chapter 7, Human Health.

> Local community regulations regarding pesticides. Potential effects related to consistency with local community regulations are covered in this section.

Based on the State CEQA Guidelines and professional judgment, Program impacts to urban and rural land uses would be considered potentially significant if the Program would:

> Physically divide an established community. The Program does not propose any change in land use or new developments and, therefore, would have no impact related to physically dividing an established community; as a result, this criterion is not applicable to the Program.

> Result in adverse impacts on the quantity and/or quality of recreational land uses.

> Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the Program (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect.

> Conflict with any applicable habitat conservation plan or natural community conservation plan. The Program's potential to conflict with any applicable habitat conservation plan or natural community conservation plan is discussed in Chapter 4, Biological Resources – Aquatic.

The environmental impact topics of the potential to conflict with applicable plans, policies, or regulations within the Program treatment areas and effects on recreational land uses are evaluated for each Program alternative below.

3.2.2 Evaluation Methods and Assumptions

The methodology for evaluating land use impacts consists of (1) reviewing existing recreational opportunities in the Program Area and analyzing how proposed mosquito control measures would affect recreational land uses and (2) reviewing the Program alternatives in the context of state and local laws and regulations pertaining to pesticide use.

3.2.3 Surveillance Alternative

Impacts on Recreational Land Uses

The Surveillance Alternative involves utilization of various methods to monitor mosquitoes in terms of their location and distribution. District staff may implement surveillance techniques in recreational settings, but they would not likely interfere with existing recreational uses. Recreationists would continue to utilize recreation areas and potential impacts on the quality of the recreational experience, such as from noise, would be minor.

Impact LU-1: Surveillance of mosquitoes would not appreciably impact the quantity and/or quality of recreational opportunities in the Program Area. This impact is **less than significant** and no mitigation is required.

Conflict with Applicable Land Use Regulations and Policies

This alternative does not involve the use of chemical pesticides to control mosquitoes and, therefore, would not conflict with local ordinances restricting pesticide use.

Impact LU-2: Surveillance of mosquitoes would not conflict with applicable land use regulations. **No impact** would occur.

3.2.4 Physical Control Alternative

Impacts on Recreational Land Uses

The Physical Control Alternative entails changes to the extent or composition of mosquito habitats as a means of mosquito control or "source reduction." Alterations of certain types of habitats for mosquito control may adversely affect the recreational quality of that habitat, particularly applicable to aquatic habitats that are used either directly or indirectly for recreational purposes, e.g., water bodies used by anglers or waterfowl that are targeted by hunters. The District is not directly involved in the undertaking of new physical control projects at this time, but reserves the right to do so in the future should it become feasible. Potential management areas may include freshwater bodies and saline habitats, including marshes and ponds, consistent with regulatory requirements (see Section 2.7) in a manner that generally maintains or improves habitat values for desirable species to control mosquitoes. The control of mosquitoes in aquatic habitats prevents them from annoying/biting recreationists, which enhances the recreational experience. As a result, this alternative would continue with practices used under existing conditions, and would not likely be to interfere with existing recreational uses except on a limited basis, and recreationists would continue to utilize recreation areas in a similar fashion to the present. Potential impacts on the quality of the recreational experience, including noise-related effects, would be minor.

> **Impact LU-3:** Physical control of mosquito habitat would not appreciably impact the quantity and/or quality of recreational opportunities in the Program Area. This impact is **less than significant** and no mitigation is required.

Conflict with Applicable Land Use Regulations and Policies

This alternative does not involve the use of chemical pesticides to control mosquitoes and, therefore, would not conflict with local ordinances restricting pesticide use.

> **Impact LU-4:** Physical control of mosquitoes would not conflict with applicable land use regulations. **No impact** would occur.

3.2.5 Vegetation Management Alternative

Impacts on Recreational Land Uses

The Vegetation Management Alternative involves control or removal of vegetation in an effort to control mosquitoes and invasive plants and could occur in parks and wildlife refuges. Recreational uses generally do not rely on vegetation removal to be carried out, except for trail maintenance; and vegetation management techniques including herbicides would not likely interfere with existing recreational uses. The herbicides would be applied from the ground using trucks or ATV-mounted sprayer or by hand using a can sprayer. These methods would not require closure of treated areas. Recreationists would maintain access and continue to utilize recreation areas, and potential impacts on the quality of the recreational experience, including noise-related effects, would be minor.

> **Impact LU-5:** Vegetation management would not appreciably impact the quantity and/or quality of recreational opportunities in the Program Area. This impact is **less than significant** and no mitigation is required.

Conflict with Applicable Land Use Regulations and Policies

This alternative involves the use of herbicides to control mosquitoes and, therefore, would conflict with local ordinances restricting pesticide use if those ordinances apply to herbicide use. However, because state law preempts local restrictions on the use of pesticides, local ordinances prohibiting their use are not applicable to the Program.

> **Impact LU-6:** Vegetation management would not conflict with applicable land use regulations because state law preempts local ordinances. **No impact** would occur.

3.2.6 Biological Control Alternative

Impacts on Recreational Land Uses

The Biological Control Alternative entails the use of pathogens and predators to control mosquitoes. Mosquito pathogens are covered under the Chemical Control Alternative. The predator technique requires placement of mosquitofish in controlled water bodies such as ornamental ponds and water gardens and in selected natural waters. Such methods would not be noticeable in recreational settings and would not likely interfere with existing recreational uses. Recreationists would maintain access and continue to utilize recreation areas as they do under existing conditions, and potential impacts on the quality of the recreational experience would be negligible.

> **Impact LU-7:** Biological control of mosquitoes would not appreciably impact the quantity and/or quality of recreational opportunities in the Program Area. **No impact** would occur.

Conflict with Applicable Land Use Regulations and Policies

This alternative does not involve the use of chemical pesticides to control mosquitoes and, therefore, would not conflict with local ordinances restricting pesticide use.

> **Impact LU-8:** Biological control of mosquitoes would not conflict with applicable land use regulations. **No impact** would occur.

3.2.7 Chemical Control Alternative

Impacts on Recreational Land Uses

The Chemical Control Alternative entails the periodic use of insecticides to control mosquitoes, which would be implemented based on a number of factors, including but not limited to the mosquito abundance, density, species composition, proximity to human settlements, water temperature, and presence of predators. Chemical applications may occur in public recreation areas, such as parks and refuges, thereby potentially affecting recreational uses.[2] Chemical applications in recreation areas would improve the quality of recreational opportunities due to the elimination of nuisance effects from mosquitoes. However, some factors may result in adverse effects on recreation. First, chemical application techniques may involve the use of ATVs or aircraft for aerial applications, which would diminish the quality of the recreational experience realized by recreationists. Such equipment generates noise, particularly aircraft, and alters the visual landscape, which is inconsistent with the overall character of many recreation areas. Second, the potential exists that chemical applications would deter people from recreating in certain areas in an effort to avoid direct exposure, thereby limiting recreational access for local residents and visitors. Fixed-wing or helicopter applications require the District to close walking trails and restrict access into flight areas for public safety. The public education component of the Proposed Program calls for public notification in advance of chemical application in public areas (as necessary), which would allow recreationists to adjust their recreational patterns, e.g., visiting alternative recreation sites in the region. Together, potential impacts on recreational quality from the use of ATVs in public areas and impacts on recreational access from deterred visitors would generate impacts on recreational land uses in the Program Area. However, chemical applications in recreation areas would be isolated events similar to existing conditions and implemented on an as-needed basis; therefore, impacts on recreation would be temporary.

> **Impact LU-9:** Chemical application to control mosquitoes would impact recreational access and the quality of recreational opportunities in the Program Area. However, because these impacts would be isolated and short term, they are considered **less than significant** and no mitigation is required.

Conflict with Applicable Land Use Regulations and Policies

The Chemical Control Alternative could conflict with local land use regulations that restrict pesticide use in some jurisdictions, such as those outlined in Section 3.1.3.3. However, because state law preempts local restrictions on the use of pesticides, local ordinances prohibiting their use are not applicable to the Program.

> **Impact LU-10:** The Chemical Control Alternative would not conflict with applicable land use regulations because state law preempts local ordinances. **No impact** would occur.

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[2] Table 3-1 shows the extent of federal land holdings in the Program Area, which include areas used for recreational purposes.

3.2.8 Cumulative Impacts

See Section 13.1 for a complete discussion of cumulative impacts including a definition of what constitutes a significant cumulative impact. In summary, due to the extensive recreational opportunities on public lands within the Program Area (i.e., no existing significant cumulative impact within the Program Area), the small incremental potential impacts on recreational opportunities from five of the Proposed Program alternatives when combined would not likely cumulatively contribute to recreational impacts in the region. **No cumulative significant impacts to urban and rural land uses** are anticipated when all of the Program's incremental impacts and the impacts of other activities in the region are considered together.

3.2.9 Environmental Impacts Summary

Table 3-2 presents a summary of impacts related to land use including recreational opportunities and applicable land use regulations.

Table 3-2 Summary of Land Uses Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Effects on Land Uses					
Impact LU-1: Surveillance of mosquitoes would not appreciably impact the quantity and/or quality of recreational opportunities in the Program Area. This impact is **less than significant** and no mitigation is required.	LS	na	na	na	na
Impact LU-2: Surveillance of mosquitoes would not conflict with applicable land use regulations. **No impact** would occur.	N	na	na	na	na
Impact LU-3: Physical control of mosquito habitat would not appreciably impact the quantity and/or quality of recreational opportunities in the Program Area. This impact is **less than significant** and no mitigation is required.	na	LS	na	na	na
Impact LU-4: Physical control of mosquitoes would not conflict with applicable land use regulations. **No impact** would occur.	na	N	na	na	na
Impact LU-5: Vegetation management would not appreciably impact the quantity and/or quality of recreational opportunities in the Program Area. This impact is **less than significant** and no mitigation is required.	na	na	LS	na	na
Impact LU-6: Vegetation management would not conflict with applicable land use regulations because state law preempts local ordinances. **No impact** would occur.	na	na	N	na	na
Impact LU-7: Biological control of mosquitoes would not appreciably impact the quantity and/or quality of recreational opportunities in the Program Area. **No impact** would occur**.**	na	na	na	N	na
Impact LU-8: Biological control of mosquitoes would not conflict with applicable land use regulations. **No impact** would occur.	na	na	na	N	na
Impact LU-9: Chemical application to control mosquitoes would impact recreational access and the quality of recreational opportunities in the Program Area. However, because these impacts would be isolated and short term, they are considered **less than significant** and no mitigation is required.	na	na	na	na	LS
Impact LU-10: The Chemical Control Alternative would not conflict with applicable land use regulations because state law preempts local ordinances. **No impact** would occur.	na	na	na	na	N

LS = Less-than-significant impact
N = No impact
na = Not applicable
SM = Potentially significant but mitigable impact
SU = Significant and unavoidable impact

3.2.10 Mitigation and Monitoring

No mitigation or monitoring is required as it relates to land use.

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4 Biological Resources – Aquatic

This chapter evaluates the potential impacts of the Program alternatives on aquatic resources. These results are provided at a programmatic level. Section 4.1, Environmental Setting, presents an overview of the aquatic resources in the Program Area and vicinity.

Section 4.2, Environmental Impacts and Mitigation Measures, presents the following:

> Environmental concerns and evaluation criteria to determine whether the Program alternatives would cause significant impacts to aquatic resources

> Evaluation methods and assumptions

> Discussion of the impacts from the No Program and Program alternatives, and recommendations for mitigation, if required, for those impacts

> Mitigation measures summary

> Cumulative impacts

> A summary of environmental impacts

> Monitoring of recommended mitigation measures

This chapter depends heavily on the information provided in Appendix A, Biological Resources Technical Report, Appendix B, Human and Ecological Health Assessment Report, and Chapter 6, Ecological Health. Terrestrial resources are addressed in Chapter 5.

4.1 Environmental Setting

Section 4.1.1 identifies the zoogeographic provinces in the District's Program Area, Section 4.1.2 describes the special-status aquatic species that have the potential to occur within the Program Area, and Section 4.1.3 provides an overview of federal, state, and local ordinances and regulations pertinent to these resources that are applicable to the Program. Section 4.1.4 identifies the Habitat Conservation Plans (HCPs) and Natural Community Conservation Plans (NCCPs) in the Program Area.

4.1.1 Aquatic Resources within the Program Area

The Program will be implemented within the District's principal Service Area in Solano County and in adjacent counties bordering its Service Area (Yolo, Sacramento, Napa, Sonoma and Contra Costa counties). Solano County and these five adjacent counties represent the Program Area. The Program Area encompasses a range of aquatic habitats and a diverse array of fish and other aquatic species. The zoogeographic provinces and species assemblages presented in Moyle (2002) have been used to describe the areas where the Program activities and treatments would be implemented and are shown on Figure 4-1. The zoogeographic provinces are described in Appendix A.

4.1.2 Special-Status Species

A number of special-status species are found in the Program Area. Special-status species are those that are listed as endangered, threatened or candidate species under the federal Endangered Species Act, endangered or threatened under the California Endangered Species Act, or listed as species of special concern by the State of California. Brief life-history descriptions for special-status species represented in Appendix A, Attachment A, Table A-3. These species are listed in Table 4-1.

4.1.3 Regulatory Setting

The regulatory setting includes the federal, state, and local laws, statues, and regulations pertinent to the Program Area and vicinity and the aquatic resources residing therein. These laws include the following:

Federal

> Endangered Species Act of 1973

> Magnusson-Stevenson Fishery Conservation and Management Act of 1996

> Clean Water Act of 1977

> Executive Order 11990

State

> Porter-Cologne Water Quality Control Act of 1970

> California Fish and Game Code Section 1600 et seq.

> California Endangered Species Act of 1984

> California Fish and Game Code Section 5650

> Natural Community Conservation Planning Act

> California Food and Agricultural Code, Section(s) 12976 and 12981

Local

> Local governing bodies may pass ordinances that regulate or restrict pesticide use within their jurisdictional areas.

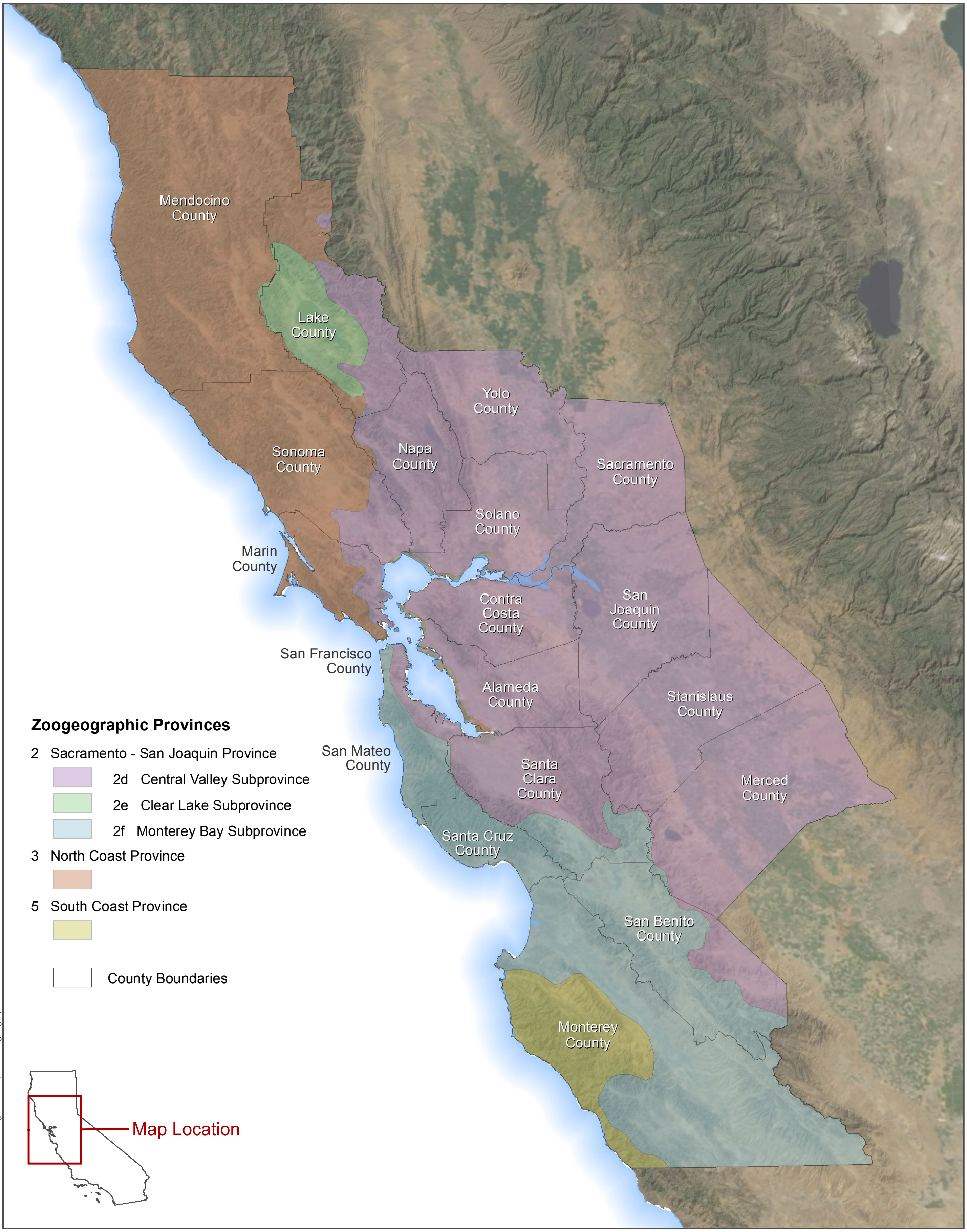
A description of these laws and regulations is provided in Appendix A, Section 2.5.

4.1.4 Habitat Conservation Plans and Natural Community Conservation Plans

HCPs are planning documents required as part of an application by a nonfederal entity for incidental take of a species listed under the federal Endangered Species Act as part of their proposed activities. An HCP describes the proposed action(s), and its anticipated effects on the individuals and populations of listed species. It also will describe how impacts will be minimized and mitigated. An HCP also can include protections for species that are candidates for listing or are proposed for listing. The HCP is reviewed by USFWS or National Oceanic and Atmospheric Administration (NOAA) Fisheries, when reviewing a project. If a project is approved by the USFWS or NOAA Fisheries, they will issue an incidental take permit for the project actions, which provides for take of these species based on the actions provided for in the HCP, as well as additional measures that the USFWS or NOAA Fisheries might include.

The California Natural Community Conservation Planning Act was first passed by the state legislature in 1991, and was updated and superseded in 2003. The primary objective of the NCCP program is to conserve natural communities at the ecosystem level, while accommodating compatible land use. It focuses on the long-term stability of wildlife and habitat, and seeks to avoid controversy and delays associated with species listings.

A number of HCPs and NCCPs are in effect or development within the Program Area. Table 4-2 was developed through review of information available on the USFWS and CDFW's websites. The District is not signatory to these HCPs or NCCPs, but will consult with HCP managers and agency biologists when their activities occur within the boundaries of an existing HCP or NCCP or those that may be developed during the Program lifetime, to ensure that their activities comply with the provisions of those plans.



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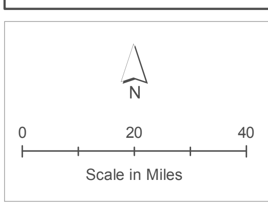

Source: Chris Mari van Dyck, 2000

INTEGRATED MOSQUITO MANAGEMENT PROGRAM

Aquatic Zoogeographic Provinces

Figure 4-1

Table 4-1 California Natural Diversity Database Occurrences for Special-Status Fish Species in the SCMAD Service Area and Adjacent Program Area Counties

Species Name	Status	Habitat	SCMAD	SCMAD adjacent
Green sturgeon *Acipenser medirostris*	FT[1]	Preferred spawning habitat contains large cobble in deep and cool pools with turbulent water. Occur in shallow water and move to deeper more saline areas as they mature. Adult and juvenile green sturgeon are thought to use the same migratory routes as Chinook salmon.	☒	☒
Sacramento splittail *Pogonichthys macrolepidotus*	SSC	Endemic to the lakes and rivers of the Central Valley, but now confined to the Delta, Suisun Bay, and associated marshes. Found in slow-moving river sections and sloughs. Requires flooded vegetation for spawning and foraging for young.	☒	☒
Delta smelt *Hypomesus transpacificus*	SE, FT	Primarily inhabit low-salinity waters of estuary prior to migrating into freshwater habitats to spawn. Spawning occurs in slough and shallow edge area in the Delta and Sacramento River. Rearing juveniles remain in spawning areas, near or just above the X2 region of the Delta. Adult delta smelt abundance in the fall has been in the northwestern Delta in the channel of the Sacramento River.	☒	☒
Chinook salmon *Oncorhynchus tshawytscha*	ST[2], SE[3], FT[4], FE[5]	Migrate to upstream freshwater habitat from ocean to spawn. Once juveniles emerge from the gravel, they seek low-velocity, shallow-water areas to finish absorbing their yolk sac. In general, juvenile Chinook use deeper, faster water as they grow larger.	☒	☒
Rainbow trout / Steelhead *Oncorhynchus mykiss*	FT[6], FE[7]	Spawning occurs in tributaries to mainstem rivers of coastal and inland drainages. Habitat preferences depend on fish size/age, with fry concentrating in shallow water along stream edges with low water velocities, juveniles occurring in deeper, faster water among rocks or other cover, and larger fish seeking out a wide variety of deeper habitats close to fast water.	☒	☒

Table 4-1 California Natural Diversity Database Occurrences for Special-Status Fish Species in the SCMAD Service Area and Adjacent Program Area Counties

Species Name	Status	Habitat	SCMAD	SCMAD adjacent
Sacramento perch *Archoplites interruptus*	SSC	Warm-water, lacustrine fish found mostly in reservoirs and farm ponds of the Central Valley. Often associated with beds of rooted, submerged, and emergent vegetation.	☐	☒
Tidewater goby *Eucyclogobius newberryi*	FE, SSC[8]	Brackish water habitat along the coast from San Diego County to the mouth of the Smith River. Found in shallow lagoons and lower stream reaches, they need fairly still but not stagnant water and high oxygen levels.	☒	☐

Listing status abbreviations

DPS = Distinct Population Segment
ESU = Evolutionarily Significant Unit
FE = Federally listed as Endangered
FT = Federally listed as Threatened
SE = State-listed as Endangered
SSC = California Species of Concern
ST = State-listed as Threatened

[1] Southern DPS
[2] Sacramento River Spring-run
[3] Winter-run
[4] California Coastal ESU, Central Valley spring-run
[5] Sacramento River winter-run
[6] Northern CA ESU, Central CA Coast ESU, South-Central CA Coast ESU, Central Valley ESU
[7] Southern CA ESU
[8] Populations in Orange County and south; populations north of Orange County delisted

Table 4-2 Habitat Conservation Plans and Natural Community Conservation Plans Potentially in the Program Area

Plan Title	Location	Covered Species Listed and Nonlisted	Date Permit Issued	Size	Duration	Source
Basin A, Willow Pass Grade	Multiple Counties	Frog, California red-legged (Entire)	10/6/1997	5 acres	20 years	1
California Department of Corrections Statewide Electrified Fence Project	26 sites throughout California	45 species	6/12/2002	2,937 acres	50 years	1
East Bay Municipal Utility District	Alameda County, Contra Costa County, CA	6 species	No info	28,000 acres	TBD	1
East Contra Costa County HCP/NCCP	Contra Costa County, CA	36 species	7/25/2007	175,435 acres	30 years	1
Shiloh III	Montezuma Hills Wind Resources Area, 3 miles west of Rio Vista and south of Highway 12, Solano County, CA	Salamander, California tiger (USA Central CA DPS)	5/18/2011	4,600 acres	36 years	1
Shiloh IV	Montezuma Hills Wind Resource Area in Solano County, CA	Salamander, California tiger (USA Central CA DPS)	4/10/2012	0 acre	36 years	1
Shimboff Low Effect	City of Vacaville, Solano County, CA	Beetle, valley elderberry longhorn (Entire)	11/26/2003	0.05 acre	1 years	1
Solano Multispecies Habitat Conservation Plan	Solano and Yolo Counties	37 species	Not Reported	585,000 acres		
Sonoma County Office of Education LE HCP	3255 and 3267 Dutton Ave, Santa Rosa, CA	2 species	9/12/2008	4.42 acres	5 years	1
Teichert Esparto Mining Project	Yolo County, CA	Beetle, valley elderberry longhorn (Entire)	12/20/1999	148 acres 4 elderberry shrubs adversely affected	5 years	1
University of California, Davis -- 2002 Campus Projects	Land owned by the University of California, Davis, Yolo and Solano counties	Beetle, valley elderberry longhorn (Entire)	7/31/2002	12.25 acres	10 years	1

Table 4-2 Habitat Conservation Plans and Natural Community Conservation Plans Potentially in the Program Area

Plan Title	Location	Covered Species Listed and Nonlisted	Date Permit Issued	Size	Duration	Source
University of California, Davis -- La Rue Housing/Bowley Center	Yolo Co., CA	Beetle, valley elderberry longhorn (Entire)	3/10/1999	16.7 acres Impacts are to 14 elderberry shrubs with 168 stems greater than 1-inch diameter.	10 years	1
Bay Delta Conservation Plan	Overlaps 5	57 Species	Not Reported	947,075	Not Reported	2
Yolo Natural Heritage Program	Yolo County, CA	57 Species	Not Reported	653,663	Not Reported	2

DPS = Distinct Population Segment

LE = low effect

[1] USFWS ECOS website accessed April 10, 2013: http://ecos.fws.gov/conserv_plans/PlanReport?region=8&type=HCP&rtype=2&hcpUser=&view=report

[2] CDFW NCCP website accessed April 10, 2013: http://www.dfg.ca.gov/habcon/nccp/status/NCCP Summary Table.pdf

The District will review these websites periodically to determine if new HCP/NCCPs are being considered for or have been implemented in their area.

4.2 Environmental Impacts and Mitigation Measures

This section presents the environmental concerns associated with the various alternatives and presents significance criteria used to evaluate the likely impacts of the various Program alternatives under CEQA. The significance criteria establish thresholds for determining whether an impact rises to a level that is biologically significant. The environmental issues describe the mechanisms by which such impacts might occur. Mitigation measures to reduce potentially significant impacts to less than significant are listed after each potentially significant but mitigable impact with additional explanation of the measure provided in Section 4.2.11 Mitigation and Monitoring.

4.2.1 Evaluation Concerns and Criteria

The Program alternatives are implemented as part of an IMMP as described in Section 2.3. The IMMP uses alternative nonchemical and chemical treatments in sequential manner to minimize potential environmental impacts; evaluating each treatment site and situation and implementing the least harmful technique that is applicable for that situation. Treatments with higher potential risk to the environment are only implemented when treatments with lower potential risk are ineffective or cannot be applied to that site. This approach minimizes the overall Program risk, but environmental concerns relating to different alternatives remain.

4.2.1.1 Environmental Concerns

Some Program alternatives have the potential to affect aquatic resources directly by affecting physical habitat and through direct toxicity to nontarget organisms. The Program alternatives may also affect aquatic resources indirectly through effects on nontarget organisms that may affect food webs, making food less available.

Direct impacts would include habitat modifications, such as draining or changing the hydrology of waterways through removal of or placement of sediment and fill, removal of debris and weeds, and trimming or removal of emergent and riparian vegetation. The District may also request or require other landowners to perform similar activities. These activities may be undertaken in a variety of habitats including freshwater habitats (streams, rivers, ponds, and lakes), seasonal wetlands and vernal pools, marshes, and saline or brackish water habitats.

Introduction of mosquito predators, specifically mosquitofish, into natural, and some artificial, environments could adversely affect nontarget organisms including insects, amphibians, and fish. These organisms may prey upon these nontarget species directly or may compete with them for food resources.

Chemical control alternatives, including larvicides, adulticides, herbicides (under the Vegetation Management Alternative), and the biological agents Bs, Bti, and Saacropolyspora spinosa have the potential to affect nontarget organisms, either through direct toxicity or through effects on nontarget organisms, which could affect the foodweb. Similar types of effects could occur through the use of surfactants.

Concerns identified during public scoping include the following, which are addressed as elements of the broader issues explained above:

> Employ techniques associated with the physical control of mosquitoes and their habitat that conform to Habitat Conservation Plan (HCP) avoidance, minimization, and mitigation measures.

> Ensure mosquito abatement staff minimize impact to tidal marsh habitats (especially during breeding season).Restrict operation of vehicles to levees and existing roads.

> Consider direct/indirect effects of using mosquitofish as control. Do not stock mosquitofish (*Gambusia affinis*) in ponds, creeks, or reservoirs without first taking mitigation measures. As the mosquitofish used (*Gambusia affinis)* are nonnative predatory fish, describe how their impact on native fish populations is considered.

> The PEIR should include a detailed description and complete assessment of the biological control impacts (current and future, direct and indirect) on habitats (including endangered, threatened, and locally unique species and sensitive habitats) and on species (sensitive fish, wildlife, or plants) and ensure CEQA requirements are met.

> The PEIR should include a detailed description and complete assessment of the chemical control impacts (current and future, direct and indirect) on habitats (including endangered, threatened, and locally unique species and sensitive habitats) and on species (sensitive fish, wildlife, or plants) and ensure CEQA requirements are met.

> Ensure the Draft PEIR includes appropriate measures to ensure complete take avoidance of protected species while coordinating with United States Fish and Wildlife Service (USFWS), United States Department of Agriculture, Forest Service (USFS), and California Department of Fish and Wildlife (CDFW).

4.2.1.2 Significance Criteria

Significance criteria were developed based on applicable regulations and management policies, a review of the available information, and the professional judgment of the authors.

The CEQA Guidelines include several criteria for determining whether there is a potentially significant impact to biological resources in the CEQA Appendix G, Environmental Checklist Form, Section IV. Those that could apply to the Proposed Program as thresholds of significance for biological resources have been used in the following evaluation. Impacts were considered potentially significant if they would:

> Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the CDFW, USFWS, or USFS.

> Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan.

In the analysis that follows, these criteria are compiled into four criteria, incorporating the above:

> Adversely affect aquatic habitats (including wetlands and riparian areas) through reduction of the amount or quality of habitat available.

> Adversely affect native fish or aquatic invertebrate populations through direct mortality.

> Adversely affect species listed as endangered, threatened or candidate species by the USFWS or NMFS, or as endangered, threatened or species of concern by the CDFW (jointly referred to as special-status species) by direct or indirect mechanisms.

> Conflict with the adoption of a HCP or NCCP, or other approved habitat conservation plan.

4.2.2 Evaluation Methods and Assumptions

Impacts are evaluated with regard to desired fish species (e.g., native and listed species), macroinvertebrate communities, and effects on food supply for fish, using the criteria described above. Potential impacts were assessed using available information on the types of control and treatment and the toxicity of the various chemicals used, the treatment descriptions, and assuming that all applicable BMPs as described in Chapter 2, Program Description, CDPH's *Best Management Practices for Mosquito Control in California*, the Statewide General NPDES Permit for Biological and Residual Pesticide Discharges to Waters of the US from Spray Applications (SWRCB Water Quality Order No. 2011-0004-DWQ; NPDES No. CAG 990007; Spray Applications Permit) and District-specific BMPs, as indicated in the PAPs and Aquatic Weed Control Permits (Aquatic Pesticide Application Plans [APAPs]) are implemented. This assessment also considers the physical and biological connections between treatment areas and aquatic ecosystems. This information was evaluated in the context of the treatment alternatives and the existing environment under baseline conditions in the Program Area as described in Section 4.1.1.

The potential effects of the treatment alternatives will vary depending on the specific treatment applied, the size and location of the treated area, the type of habitat treated, and the timing and frequency of treatment. Small treatment areas or less frequent applications of a treatment would generally be expected to result in lesser effects than the same treatment applied over a larger area or more frequently.

The potential impacts of the nonchemical alternatives are based on the type and location of habitats treated and the magnitude and frequency of treatment. The potential impacts of the chemical alternatives were evaluated based on the magnitude and duration of the treatments and the toxicity and application information presented in Chapter 6, Ecological Health, and Appendix B, Human and Ecological Health Assessment Report. The evaluation of all alternatives considered the life histories of the different listed fish species and ecological interactions including impacts to the aquatic food chain.

This evaluation does not incorporate any assumptions about which alternative treatment strategy or strategies would be applied in any given area. Therefore, each treatment alternative is considered as a stand-alone option, although the Program may include multiple alternative treatments within a given area, i.e., physical controls followed by larvicide application. This evaluation assumes that all chemical treatments would be made in accordance with label instructions and guidance provided by the USEPA and CDPR.

Assumptions related to the analysis of hazards, toxicity, and exposure for chemical treatment methods are explained below, including the definition of key terms. The ecological food web concept is explained as well, and it is addressed primarily in Section 6.1.1.1, Toxicity and Exposure.

4.2.2.1 Hazardous Material

A “hazardous material” is defined in California Health and Safety Code Section 25501 (p): as “any material that, because of its quantity, concentration, or physical or chemical characteristics, poses a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment. "Hazardous materials" include, but are not limited to, “hazardous substances, hazardous waste, and any material that a handler or the administering agency has a reasonable basis for believing that it would be injurious to the health and safety of persons or harmful to the environment if released into the workplace or the environment.” Any liquid, solid, gas, sludge, synthetic product, or commodity that exhibits characteristics of toxicity, ignitability, corrosiveness, or reactivity has the potential to be considered a “hazardous material.”

4.2.2.2 Toxicity and Exposure

Toxicology is the study of a compound’s potential to elicit an adverse effect in an organism. The toxicity of a compound is dependent upon exposure, including the specific amount of the compound that reaches an organism’s tissues (i.e., the dose), the duration of time over which a dose is received, the potency of the chemical for eliciting a toxic effect (i.e., the response), and the sensitivity of the organism receiving the dose of the chemical. Toxicity effects are measured in controlled laboratory tests on a dose/response scale, whereby the probability of a toxic response increases as dose increases. Exposure to a compound is necessary for potential toxic effects to occur. However, exposure does not, in itself, imply that toxicity will occur. Thus, toxic hazards can be mitigated by limiting potential exposure to ensure that doses are less than the amount that may result in adverse health effects.

The toxicity data included in the numerous tables and charts in this document are generally derived from rigidly controlled laboratory animal studies designed to determine the potential adverse effects of the chemical under several possible routes of exposure. In these studies, the species of interest is exposed to 100 percent chemical at several doses to determine useful information such as the lowest concentration resulting in a predetermined adverse effect (LOAEL) on numerous selected physiological and behavioral systems. The second component of these tests is to determine the highest concentration of chemical that results in no measurable adverse effect (NOAEL).

However, these, and other, coordinated and focused laboratory tests are designed to document the effects of the chemical when a continuous, controlled, exposure exists and do not realistically reflect the likely exposures or toxicity in the District field application scenarios. As such, the toxicity information is intended as an overview of potential issues and guidance for understanding the completely "safe" maximum exposure levels of applications that would not adversely impact humans or nontarget plant and animal species.

Although the regulatory community uses this basic information to provide a relative comparison of the potential for a chemical to result in unwanted adverse effects and this information is reflected in the approved usage labels and MSDSs, in actual practice, the amounts applied in the District's Program Area are often substantially less than the amounts used in the laboratory toxicity studies. Because of the large safety factors used to develop recommended product label application rates, the amount of chemical resulting in demonstrated toxicity in the laboratory is much higher than the low exposure levels associated with an actual application. The application concentrations consistent with the labels or MSDSs are designed to be protective of the health of humans and other nontarget species (i.e., low enough to not kill them, weaken them, or cause them to fail to reproduce). However, adverse effects may still occur to some nontarget organisms.

The toxicity of a chemical is also affected by various biological, chemical, and physical parameters that affect the behavior of a compound in the environment and its potential toxicity. The chemistry, fate, and transport of a compound must be analyzed to fully estimate potential exposure to a given receptor. The fate and transport of a compound is determined by the physical and chemical properties of the compound itself and the environment in which it is released. Thus, the following characteristics of a compound must be evaluated: its half-life in various environmental media (e.g., sediment, water, air); photolytic half-life; lipid and water solubility; adsorption to sediments and plants; and volatilization. Environmental factors that affect fate and transport processes include temperature, rainfall, wind, sunlight, water turbidity, dissolved oxygen concentrations, and water and soil pH. Information pertaining to these parameters allows evaluation of how compounds may be transported between environmental media (e.g., from sediments to biota), how a compound may be degraded into various breakdown products, and how long a compound or its breakdown products may persist in different environmental media. Appendix B provides a discussion of the environmental fate of the pesticide active ingredients and other chemicals associated with specific pesticide formulations used in the Program alternatives.

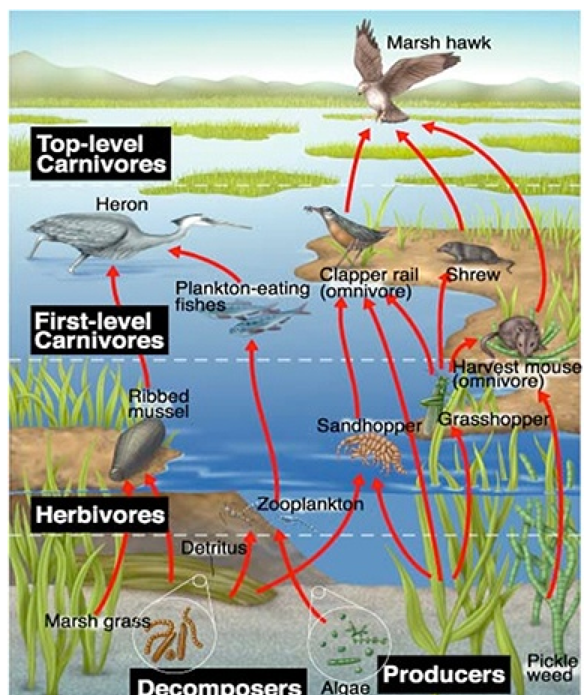

Figure 4-2 Ecological Food Web Concept

4.2.2.3 Ecological Food Web

While it is important to evaluate the potential adverse impacts of a pesticide application to potentially affected nontarget species, it is not practical to evaluate those potential impacts to all of the food webs present in the various ecosystems under consideration. An ecological food web is represented in the illustration representing some of the multitude of possible biotic and food uptake interactions in an ecosystem. Figure 4-2 depicts a highly simplified food web. In an ecological system each level in the food web is occupied by dozens or hundreds of species, with consumers using those resources (in this case species from a lower trophic level) in different ways depending on availability and competition for those resources. Their utilization of these resources shifts by time of day and season, and multiple resources being used simultaneously or alternatively. If the availability of one resource deceases, the consumer can generally replace that with another resource. Each of the possible connections between species is also associated with other interactions, such as competitive release, where the abundance of a species increases in response to the decline in a competitor's abundance, or competitive interactions between consumers where one consumer can use a particular resource better than its competitor.

Although ecological food webs could be used to describe the complex system interactions that might be associated with District application scenarios, it is neither feasible nor practical to evaluate those potential impacts using a food-web approach. The numerous, interactions in typical food webs are highly complex and would be subject to substantial uncertainty. This would make it exceedingly difficult to confidently assess relevant impacts. Because of these constraints and complexity, it is neither practical nor productive to attempt to predict food-web interactions for each of the numerous application scenarios the District uses. It is appropriate, however, to use a food-web analysis to identify and consider the first level of potentially adverse effects to nontarget species that might result from a pesticide application. This information is used to assure a minimal impact to nontarget species and is typically a part of the MSDS and Toxicology profiles, providing the basis for the more reasonable, technically feasible approach to evaluate the environmental compatibility of the pesticides the District commonly uses.

4.2.3 Surveillance Alternative

The Surveillance Alternative would affect small areas with the intent of monitoring mosquito populations to determine where control alternatives are required. Small numbers of mosquito and nontarget organisms are trapped through this Program strategy at sites with the potential to support substantial mosquito populations. These sites are dispersed throughout the District. Chemicals may be used within some adult mosquito traps (New Jersey adult mosquito traps use a pest strip infused with dichlorvos), but these chemicals are confined to the traps and do not enter the environment.

Small impacts to upland and riparian habitats in the vicinity of aquatic ecosystems may occur when the District is required to maintain paths and clearings to access surveillance sites and facilitate sampling. Most such areas are located on preexisting roads, trails, and walkways, however, avoiding such impacts. These activities are not anticipated to directly impact aquatic habitats and are of small size, so indirect impacts to aquatic habitats are inconsequential.

> **Impact AR-1.** The Surveillance Alternative would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, special-status species, or HCP/NCCPs. These effects would result through maintenance of access routes to sampling locations in and adjacent to surveillance monitoring sites. No mitigation is required.

4.2.4 Physical Control Alternative

4.2.4.1 Mosquitoes

This alternative modifies habitats that support mosquito larva to make these habitats less suitable for mosquitoes and/or more suitable for their predators. This alternative includes maintenance of ditches and water control structures, removal of debris and weeds, clearance of brush for access to areas to be treated, and filling of nonfunctional water circulation ditches. It may also include reconnecting backwaters or isolated pools on the floodplains of streams and rivers, and increased drainage rates and areas in managed wetlands. These activities are conducted in accordance with all appropriate environmental regulations. The District's annual work plans are submitted for review by other responsible agencies prior to implementation. Completed work is available for inspection by the USACE, USFWS, and CDFW upon request. Impacts are evaluated based on the types and locations of habitats where such activities would be performed. District activities largely involve maintenance of existing facilities in the same manner they do under baseline conditions. The District is rarely involved in new drainage projects, and when they are, they consult with the appropriate agencies and acquire all required permits for implementing that work, which provides protection for native and special-status fish species.

4.2.4.1.1 Freshwater Habitats and Riparian Areas

The freshwater habitats that could be treated include the margin of reservoirs, artificial ponds for stock water, runoff retention ponds, and freshwater marshes. With the exception of freshwater marsh, these areas are generally man-made habitats and if they support fish, these fish will largely consist of introduced species. Some reservoirs and ponds are also stocked with rainbow trout. While rainbow trout are native to the region, these stocked fish are not considered to be natural populations, and are treated as introduced fish.

Mosquitoes typically breed in shallow areas, with emergent vegetation, and little to no current, and where fish are excluded. Treatment of these areas by increasing circulation (water flow) to areas that are problem areas for mosquitoes increases the accessibility of these areas to young fish, which then eat the mosquito larvae. This access provides these fish with a previously inaccessible food source. Additionally, these areas can be important for young fish, as they provide protection from predation by larger fish and tend to be warmer, with higher primary productivity, providing good conditions for the growth of young fish. Most young fish eat insect larvae during at least the first few months of their lives, and some species eat insect larvae throughout their lives. Special-status fish species would not be impacted in reservoirs and ponds, and ditches, as these species do not occur in these habitats.

> **Impact AR-2.** Increasing circulation in shallow areas would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status species. No mitigation is required.

Draining areas of shallow freshwater habitat to reduce the amount of standing water or reduce the amount of time such water remains standing could result in adverse effects to young fish using those habitats, leaving fish that cannot vacate the area without water, requiring fish that can leave the area to move to new locations, and reducing the amount of larval rearing habitat present. Where native or special-status fish species are not present, these impacts would be negligible. Where native or special-status species are present, these areas could be important nursery areas for young fish, depending on location, season, fish species present, accessibility for adult fish to enter these areas to deposit eggs, and amount of other habitat available to the species.

Because their rapid currents do not provide suitable habitat for mosquitoes, streams and rivers generally do not support substantial numbers of mosquitoes, although, some mosquitoes can be found in slow eddies and back channels, or in pools isolated on the banks as flows recede. Streams and rivers may support sensitive fish species including steelhead, Chinook salmon, and Sacramento perch. Isolated ponds and back channels may provide habitat for mosquito larva, but these areas may also provide excellent rearing habitat for young fish and amphibians, as they provide warmer water temperatures, higher primary productivity and protection from predaceous fish. Habitat alterations to drain or reconnect such areas should be avoided.

> **Impact AR-3.** Draining areas of shallow freshwater habitats would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, as only a small proportion of such habitat would be drained. No mitigation is required.

> **Impact AR-4.** Draining areas of shallow freshwater habitats would have a **potentially significant but mitigable** impact on special-status species, if these species are present when the habitat is drained.

Mitigation Measure AR-4. The District will coordinate with appropriate resource agency personnel, whenever a habitat treatment is under consideration in an area potentially supporting sensitive species, as indicated by the California Natural Diversity Database, Calfish.org, NOAA Fisheries, and USFWS websites. If shallow freshwater habitats associated with natural waterways where sensitive species could be present need to be drained, the District will schedule such activity at a time of year when these species are absent from the treatment site. In the event that such activity cannot be postponed, or must be performed in habitat that has the potential for continuous occupancy, the District will have a qualified biologist conduct surveys to determine if sensitive fish species are present. This treatment would be avoided where sensitive species are present. With implementation of this mitigation measure, the impact of this activity would be **less than significant**.

4.2.4.1.2 Seasonal Wetlands and Vernal Pools

The USACE defines wetlands as "*those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. (33 [Code of Federal Regulations] CFR 328.3(b); 40 CFR 230.3(t)).*"For the purposes of this document, seasonal wetlands are areas that are flooded for 1 week or more during the year, generally during the rainy season. Impacts to vernal pools, a subclass of seasonal wetlands underlain by impermeable substrates, are discussed in Chapter 5, Biological Resources – Terrestrial. Seasonal wetlands may be flooded by increased runoff, rainfall, or unusually high tides. Fish may use these areas for spawning and rearing. Splittail, for instance, use floodplain habitats to spawn and rear (Moyle 2002).Their young may live in these seasonally flooded habitats for several weeks, until these habitats dry out. Chinook salmon can use flooded wetlands and floodplains for rearing habitat during their outward migration toward the ocean. Young salmonids using these seasonally flooded wetlands have higher growth rates than the fish that remain in the mainstem rivers (Sommer et al. 2003; Swenson et al. 2003; Moyle et al. 2007). Coho salmon also may use backwater channels and ponds during the winter months to shelter from the higher currents in the main channel of river or stream habitats (Moyle 2002).The availability of such habitats has been substantially reduced by human land use practices and flood control measures. Reducing the frequency or duration with which such habitats are flooded would adversely affect habitat and aquatic resources.

Impact AR-5. Draining seasonal wetlands in areas supporting sensitive fish species would have a **potentially significant but mitigable** impact on aquatic habitats, native fish or aquatic invertebrates, and special-status species.

Mitigation Measure AR-5. Same as Mitigation Measure AR-4. With implementation of this mitigation measure, the impact of this activity would be **less than significant**.

Vernal pools do not support fish but do support a number of sensitive invertebrates, plants, and amphibians. As such, physical control measures should not be applied to vernal pool habitats. Impacts to other plants and animals using vernal pools are discussed in Chapter 5.

4.2.4.1.3 Freshwater Marshes and Seasonal Wetlands Managed as Waterfowl Habitat

The San Francisco Bay-Delta once supported vast tracts of freshwater, brackish, and saline marsh habitat. The vast majority of these marsh habitats have been converted to human uses such as farming, industrial uses, and urbanization. Some of the remaining marsh lands are maintained and operated to provide habitat for wildlife or as privately or publicly owned seasonal wetlands managed as waterfowl habitat. These areas are primarily located in Suisun Bay and the Delta. These wetlands can be important sources of mosquitoes seasonally. These marshes take water from the Delta to facilitate their operation and are seasonally flooded and drained to optimize habitat for ducks, geese, and other wildlife. Because of this procedure, a variety of special-status fish species including all races of Central Valley Chinook salmon, steelhead, green sturgeon, delta smelt, Sacramento splittail, and Sacramento perch could use these marshes. These marshes, however, do not provide primary habitat for these species.

The same physical control measures previously described can be employed in these areas to reduce mosquito populations. The District may perform these actions on an as needed basis. Increasing circulation of water in these areas would not substantially affect fish populations. Improving drainage of low-lying areas within these managed areas, which would be drained with or without mosquito control activities, could decrease the likelihood that fish become trapped or stranded. Construction of channels could result in temporary increases in turbidity, which could adversely affect fish. BMPs would be implemented to control and localize this turbidity. They may include constructing new channels during periods when the marsh is dry or isolating areas where new channels are being constructed from the surrounding environment. These turbidity increases would be short term and temporary and, thus, would not substantially affect aquatic species.

Impact AR-6. Improving drainage in freshwater marshes and seasonal wetlands managed as waterfowl habitat would have a **less-than-significant** impact on aquatic habitats, and native fish or aquatic invertebrates. No mitigation is required.

Impact AR-7. Improving drainage in freshwater marshes and seasonal wetlands managed as waterfowl habitat would have a **potentially significant but mitigable** impact on special-status species if such species are present.

Mitigation Measure AR-7. Same as Mitigation Measure AR-4. With implementation of this mitigation measure, the impact of this activity would be **less than significant**.

4.2.4.1.4 Saline and Brackish Habitats

These habitats occur along the margins of San Francisco, San Pablo, and Suisun bays and are subject to tidal action. A variety of special-status fish species including all races of Central Valley Chinook salmon, steelhead, green sturgeon, delta smelt, Sacramento splittail, and Sacramento perch could use these marshes. They are typically bounded by levees and water control structures. Physical measures to control mosquitoes in these areas include maintenance of ditches and water control structures, removal of debris and weeds, clearance of brush for access to areas to be treated, and filling of nonfunctional water circulation ditches, as described previously. Other measures include retaining water on the surface of the area, and rotational impoundment monitoring, which reduces mosquito populations by increasing the frequency with which suitable habitats are inundated and drained. These actions would have similar effects to those described in Section 4.2.4.1.3, Freshwater Marshes and Seasonal Wetlands Managed as Waterfowl Habitat.

Impact AR-8. Improving drainage in saline and brackish habitats would have a **less-than-significant** impact on aquatic habitats, and native fish or aquatic invertebrates. No mitigation is required.

Impact AR-9. Improving drainage in saline and brackish habitats would have a **potentially significant but mitigable** impact on special-status species if such species are present.

Mitigation Measure AR-9. Same as Mitigation Measure AR-4. With implementation of this mitigation measure, the impact of this activity would be **less than significant**.

4.2.4.1.5 Temporary Standing Waters and Artificial Ponds

Temporary standing waters refers to water ponding on an upland habitat because of rainfall or irrigation. Artificial ponds include stock ponds, golf course water hazards, or ornamental ponds. These habitats do not provide habitat for special-status fish species. While native fish species may occur in some artificial ponds, these ponds are not primary habitats for these species and do not contribute to the survival of the species.

Impact AR-10. Physical control of temporary standing waters and artificial ponds would have **no impact** on native or special-status fish species, as these areas do not provide habitat for or support these species.

4.2.4.1.6 Tree Holes

Tree holes do not provide habitat for fish or support fish populations nor do they support special-status invertebrates or substantive populations of other invertebrates.

Impact AR-11. Physical control of mosquito habitat in tree holes would have **no impact** on native or special-status fish species, as tree holes do not provide habitat for fish.

4.2.4.1.7 Wastewater Treatment Facilities/Septic Systems

Wastewater treatment facilities do not provide habitat for native or special-status fish species, although such facilities may lie close to suitable habitats in streams or the San Francisco Bay Delta system and connectivity may exist between the system and the natural environment that could allow aquatic resources to enter the system. The extent to which these species may enter these facilities is unknown. Because of the limited number of such facilities and the very limited use of such facilities by fish species, physical control measures are not anticipated to substantially affect these fish species.

Septic systems and their associated leach fields do not provide habitat for native fish or special-status fish species. This type of facility would only affect fish if they drained into a waterbody supporting fish, in which case the physical control measures for freshwater habitats and Mitigation Measure AR-4 would apply.

Impact AR-12. Physical control measures in wastewater treatment facilities and septic systems would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.

4.2.4.1.8 Artificial Container Habitat

Artificial containers do not provide habitat for fish or support populations of native or special-status fish or invertebrates.

Impact AR-13. Physical control of mosquito habitat in an artificial container habitat would have **no impact** on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species, as these containers do not provide habitat for these fish species.

4.2.4.2 Habitat Conservation Plans and Natural Community Conservation Plans

HCP/NCCPs generally incorporate measures to protect sensitive habitats. Protective measures or restoration goals for wetland, riverine, and lacustrine habitats are often included in these documents and their accompanying permits. The Physical Control Alternative specifically seeks to alter habitats to make them less suitable to mosquito larvae. As a result, this alternative, when applied within the boundaries of an HCP/NCCP, could conflict with the provisions of that HCP/NCCP.

Impact AR-14. Physical control measures could have a **potentially significant but mitigable** impact by conflicting with the provisions of an HCP/NCCP.

<u>Mitigation Measure AR-14</u>. To avoid conflicts with the provisions of an HCP/NCCP, the District will determine whether any of its treatment areas lie within the boundaries of an HCP/NCCP. Prior to application of any treatments, excluding surveillance monitoring, the District will review the requirements of the HCP/NCCP and determine whether this activity will conflict with the provisions of that HCP/NCCP. The District will work with the HCP/NCCP holder and appropriate regulatory agencies to identify alternatives to avoid or minimize any potential impacts to a species or habitat protected by the HCP/NCCP. Such determination will be documented and relayed to the HCP/NCCP holder and the regulating

entity (USFWS, NOAA Fisheries, CDFW).With implementation of this mitigation measure, the impacts would be **less than significant**.

4.2.5 Vegetation Management Alternative

The vegetation within and surrounding aquatic habitats is an important component of the aquatic ecosystem. This vegetation provides shade, helping to keep the water cool; increases structure and habitat complexity; and contributes organic material and insect drop, subsidizing the food web. It provides fish and other aquatic organisms with cover from aquatic and terrestrial predators and provides visual separation that increases the density of territorial species. Vegetation also helps slow runoff from the surrounding land surface, protecting the aquatic environment from sediments and toxins that may wash in from upland areas.

The removal of vegetation would not have a substantial effect on aquatic ecosystems if the amount of vegetation removed from within and around a waterbody is limited to less than 20 percent. This level of removal would continue to provide the ecosystem services described in the preceding paragraph. The manual removal of vegetation, which is the primary method of vegetation removal, would be expected to have minimal effects on aquatic resources, because it would not be anticipated to affect substantial patches of vegetation. The use of unspecified heavy equipment could have substantial effects if used in waterways supporting native or special-status fish species. Appropriate BMPs will be employed when using heavy equipment for vegetation management, including not operating such equipment in the water, providing appropriate containment and cleanup systems to avoid, contain, and clean up any leakage of toxic chemicals into the aquatic environment, controlling turbidity, and minimizing the area that is affected by the vegetation management activity.

Although herbicides are not currently used for vegetation management, they may potentially be used in the future. Table 2-1 provides a list of herbicides that the District may use for vegetation management. These chemicals would be used in strict compliance with label requirements. As indicated in Table 4-3, a number of the herbicides in Table 2-1 such as glyphosate and imazapyr have low toxicity to fish and aquatic invertebrates. These herbicides would be used in areas near aquatic environments potentially supporting native or special-status fish species. Herbicides with moderate to high toxicity to fish and aquatic invertebrates would not be used in these areas, but may be used in less sensitive areas where needed. Additionally, limited information regarding the toxicity of polydimethylsiloxane on aquatic organisms could be found. The use of these herbicides in and around aquatic environments will be avoided until the product is shown to be safe to aquatic organisms. Additional toxicity information for these herbicides can be found in Appendix B and Chapter 6.

Table 4-3 Herbicide Toxicity[1,2] to Fish and Aquatic Invertebrates

	Toxicity to	
Chemical	**Fish**	**Aquatic Invertebrates**
Imazapyr, glyphosate	Low	Low
Alkylphenol ethoxylates (APEs)	High	High
Polydimethylsiloxane,	Unknown	Unknown

[1] Toxicity information is summarized from the information provided in Appendix B (Table 4-1).

[2] The toxicity data are derived from rigidly controlled laboratory animal studies designed to determine the potential adverse effects of the chemical under several possible routes of exposure (see Appendix B for further information).In these studies, the species of interest is continuously exposed to 100 percent chemical at several doses. In actual practice, the amounts applied in the District's Program Area are substantially less than the amounts used in the toxicity studies, and organisms are not continuously exposed to the chemical. Furthermore, actual application rates by the District may be less than label requirements. Thus, the laboratory test results do not provide a realistic assessment of field exposure.

Impact AR-15. The Vegetation Management Alternative would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species, when applied in compliance with the BMPs above. No mitigation is required.

4.2.5.1 Habitat Conservation Plans and Natural Community Conservation Plans

HCP/NCCPs generally incorporate measures to protect sensitive habitats and sensitive species, including plants. Protective measures or restoration goals for wetland, riverine, and lacustrine habitats are often included in these documents and their accompanying permits. The Vegetation Management Alternative would alter habitats to make them less suitable to mosquito larvae. As a result, this alternative, when applied within the boundaries of an HCP/NCCP, could conflict with the provisions of that HCP/NCCP.

Impact AR-16. Vegetation management measures could have a **potentially significant but mitigable impact** by conflicting with the provisions of an HCP/NCCP.

Mitigation Measure AR-16. See Mitigation Measure AR-14. With implementation of this mitigation measure, the impacts would be **less than significant**.

4.2.6 Biological Control Alternative

This alternative consists of the introduction of mosquito predators, specifically mosquitofish (*Gambusia affinus*), into habitats occupied by mosquito larvae. These fish are ideal candidates for this use because they are highly tolerant of a wide range of temperature and water quality conditions(including stagnant waters where mosquitoes commonly breed), they can reproduce rapidly, and they are highly effective at locating and consuming mosquito larvae. Mosquitofish are widely used throughout the world to control larval mosquitoes and such use dates back more than a century. However, there has been increasing recognition in recent years that mosquitofish may adversely affect native amphibians, fish, invertebrates, and aquatic foodwebs (CDFW 2012).

Mosquitofish are also opportunistic omnivores, eating other invertebrates when they are more abundant and feeding at algae during times when insects are not abundant. This species can affect aquatic foodwebs. They are known to feed on fish and amphibian eggs and larvae (Moyle 2002; Nico et al. 2013). Mosquitofish can compete with other small fish for food and can also prey on other fish and insect mosquito predators when those species are present. While there is no irrefutable proof that mosquitofish will impact native fish and amphibians, there is considerable evidence that such effects could occur. Therefore, the use of mosquitofish in a given situation is given careful consideration by the District with regard to the potential ecological consequences of such introductions.

District policy is to provide mosquitofish to the public for use in artificial environments that are isolated from waterways. The public is provided with information describing appropriate locations for the placement of mosquitofish and citing CDFW regulations prohibiting the planting of mosquitofish in waters of the state without a permit. This limits the use of mosquitofish by the public to artificial waterbodies (ornamental fish ponds, water troughs, water gardens, fountains, and unused swimming pools), where they do not pose a threat to natural environments or native fish and amphibians. These artificial habitats are not included in HCP/NCCPs.

The District also uses mosquitofish in natural waters within their Service Area, where the District judges that mosquitofish are the best method for controlling larval mosquitoes. Such plantings have the potential to affect sensitive species and aquatic ecosystems, as described above.

Impact AR-17. Planting mosquitofish in artificial environments that do not connect to natural waterbodies would have **no impact** on aquatic habitats, native fish or aquatic invertebrates, special-status fish species, or HCP/NCCPs. No mitigation is required.

Impact AR-18. Planting of mosquitofish in natural waterways or artificial environments that drain to natural waterways would have a **potentially significant impact** on native fish or aquatic invertebrates, special-status fish species, and applicable HCP/NCCPs.

Mitigation Measure AR-18. The District has a policy of restricting its planting of mosquitofish to natural waters to situations where the potential environmental effects are likely to be low. Such plantings are subject to a series of measures to minimize environmental effects, including:

1. Limiting such plantings to areas where the District's historic and ongoing Surveillance Program indicates that mosquito breeding is likely to occur.
2. Consulting appropriate federal and state fish and wildlife department websites, including the USFWS website, CDFW website, and CalFish.org to determine if the area under consideration for treatment, including a 1 mile radius around the site, is a known habitat for threatened and/or endangered species.
3. Not planting in streams until flows have become discontinuous, and stream habitat consists of isolated pools to minimize the potential for the movement of mosquitofish to areas where treatment was not intended.
4. Not planting mosquitofish if there have been reported sightings of threatened and/or endangered species within this area without further surveys by a biologist qualified to perform such surveys, or consultation with agency biologists.
5. District staff conducting a site survey and preparing a written report relating to the occurrence of sensitive species and not planting mosquitofish if the survey identifies the potential presence of sensitive species.

Unless prohibited by the guidelines above, the site will be planted with mosquitofish. The District will keep records of all plantings made by watershed and location, as well as records of any plantings that were planned and discontinued for any of the reasons provided above.

It is expected that mosquitofish planted will reproduce and become more numerous within these environments over time. Breeding slows in the fall months and most adults die with the onset of colder temperatures. However, mosquitofish may survive the winter in some areas (Moyle 2002). Therefore, these fish may spread through a watershed once continuous flow resumes in the areas where the fish are planted, and thus may enter areas where special status species do occur. Therefore, the risks of planting mosquitofish in natural waters to sensitive species are not completely eliminated by these measures.

The mitigation measures for this action would reduce the ecological risks associated with planting of mosquitofish in natural waters, but these risks would not be eliminated. Because of this, the residual impact of this action would be **significant and unavoidable**.

Mosquito pathogens such as *Bs*, *Bti,* and *Saacharopolyspora spinosa* may be considered biological control agents, but are regulated by USEPA. Therefore, they are addressed in the Chemical Control Alternative below.

4.2.7 Chemical Control Alternative

A wide variety of chemicals and formulations are available for use to control mosquitoes. These chemicals can be used as mosquito larvicides, adulticides, or both.

These chemicals are used in accordance with all applicable BMPs as described in Section 2.9.1, CDPH's *Best Management Practices for Mosquito Control in California*, the Statewide General NPDES Permit for Biological and Residual Pesticide Discharges to Waters of the US from Spray Applications (SWRCB Water Quality Order No. 2011-0004-DWQ; NPDES No. CAG 990007; Spray Applications Permit) and

District-specific BMPs as indicated in the PAPs and APAPs. All of these measures are designed to minimize impacts to nontarget organisms.

The toxicity data included in the tables in this section are generally derived from rigidly controlled laboratory animal studies designed to determine the potential adverse effects of the chemical under several possible routes of exposure. In these studies, the species of interest is exposed to 100 percent chemical at several doses to determine useful information such as the lowest concentration resulting in a predetermined adverse effect (lowest observed adverse effect level [LOAEL]) on numerous selected physiological and behavioral systems. The second component of these tests is to determine the highest concentration of chemical that results in no measurable adverse effect (no observed adverse effect level [NOAEL]).

However, these, and other, coordinated and focused laboratory tests are designed to document the effects of the chemical when a continuous, controlled, exposure exists and do not realistically reflect the likely exposures or toxicity in the District field application scenarios. As such, the toxicity information is intended as an overview of potential issues and guidance for understanding the completely “safe” maximum exposure levels of applications that would not adversely impact humans or nontarget plant and animal species.

Although the regulatory community uses this basic information to provide a relative comparison of the potential for a chemical to result in unwanted adverse effects and this information is reflected in the approved usage labels and MSDSs. In actual practice, the amounts applied in the District’s Program Area are often substantially less than the amounts used in the laboratory toxicity studies. Because of the large safety factors used to develop recommended product label application rates, the amount of chemical resulting in demonstrated toxicity in the laboratory is much higher than the low exposure levels associated with an actual application. The application concentrations consistent with the labels or MSDSs are designed to be protective of the health of humans and other nontarget species (i.e., low enough to not kill them, weaken them, or cause them to fail to reproduce). However, adverse effects may still occur to some nontarget organisms.

This assessment also considers the physical and biological connections between treatment areas and aquatic ecosystems. These chemicals are grouped into classes based on their composition, mechanism of action, and relative effect on aquatic resources (Table 4-4). This section focuses on the potential impacts of these chemicals on fish and aquatic invertebrates, exclusive of vernal pool ecosystems, which are covered under Chapter 5, Terrestrial Biology. These chemicals are discussed in greater detail in Chapter 6, Ecological Health, and Appendix B.

Table 4-4 Chemical Classes and their Toxicity[1] to Fish and Nontarget Aquatic Invertebrates

Class	Chemical	Mechanism of Action	Toxicity to	
			Fish	Nontarget Invertebrates
Mosquito Larvicides				
Bacterial Larvicides	*Bs*, *Bti*, spinosad	Paralyzes gut or disrupts central nervous system	Low	Low
Hydrocarbon esters	Methoprene	Interferes with maturation process of insects	Moderate	High
Surfactants	Alcohol ethoxylated surfactant, aliphatic solvents	Drowns larvae	Very low	Affects Only Surface Breathing Insects
Organo-phosphates	Temephos	Cholinesterase inhibitor	Slight to Moderate	High
Mosquito Adulticides				
Pyrethroids	Pyrethrins, phenothrin, prallethrin, resmethrin, permethrin, etofenprox	Interferes with operation of sodium channels in insect neurons	High	High
Piperonyl butoxide		Synergist. Enhances operation of other active ingredients by inhibiting their breakdown	Moderate to High	High
Organo-phosphates	Naled	Cholinesterase inhibitor	Moderate	Moderate

[1] Toxicity information is summarized for each group from the information provided in Appendix B (Table 4-1).

[2] The toxicity data are derived from rigidly controlled laboratory animal studies designed to determine the potential adverse effects of the chemical under several possible routes of exposure (see Appendix B for further information).In these studies, the species of interest is continuously exposed to 100 percent chemical at several doses. In actual practice, the amounts applied in the District's Program Area are substantially less than the amounts used in the toxicity studies and organisms are not continuously exposed to the chemical. Furthermore, actual application rates by the District may be less than label requirements. Thus, the laboratory test results do not provide a realistic assessment of field exposure.

4.2.7.1 Mosquito Larvicides

4.2.7.1.1 Bacterial Larvicides

These larvicides are developed from bacteria that have natural insecticidal properties. Concentrates are prepared that include fermentation solids, bacterial spores, and insecticidal toxins. These larvicides act by paralyzing the gut when ingested, causing the larvae to starve. *Bs* may persist in the environment for 2 to 4 weeks; *Bti* generally persists for 1 to 4 days.

Neither *Bs* nor *Bti* are acutely toxic to nontarget species including fish and invertebrates, nor are they toxic to predators of mosquito larvae (Appendix B). *Bti* may affect some dipterans (chironomids, simullids, ceratopogonids, and dixids), but only at concentrations 10 to 1,000 times higher than used for mosquito control.

Spinosad is a biologically derived insecticide produced from the fermentation of *Saacharopolyspora spinosa*, a naturally occurring soil organism. Spinosad activates the central nervous system of insects through interaction with neuroreceptors and causes continuous stimulation of the insect nervous system. In water, spinosad is degraded primarily through photolysis, which has a half-life of less than 1 day. It is slightly to moderately toxic to fish and most aquatic invertebrates. It may have slight impacts on some aquatic invertebrates with chronic exposure, but application for mosquitoes tends to be episodic, and given the rapid breakdown of spinosad in the environment, chronic exposure is unlikely.

> **Impact AR-18.** The use of bacterial larvicides at the label concentrations listed for control of mosquito larva in natural and man-made aquatic habitats would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special--status fish species. No mitigation is required.

4.2.7.1.2 Hydrocarbon Esters

Methoprene is an insect growth regulator and selective larvicide. Methoprene is used primarily against mosquitoes, but can also be used for flies, moths and butterflies, and beetles. Methoprene interferes with the development of larval insects, preventing them from becoming adults. Within the aquatic environment, methoprene has a half-life of a few hours to a couple of days, but is sometimes applied in an extended release format, which may persist for many days or even months in the environment. Methoprene is effective for mosquito control at concentrations of 0.5 to 3 microgram per liter (µg/L), with the District generally applying it within that range at the lowest effective concentration . At these application rates, some effects may occur to some nontarget midges (*Chironomidae*) and blackflies (*Simuliidaes*), but these populations recover quickly after treatment (Appendix B; Maffei, pers. comm., 2013). No other invertebrates have shown signs of toxicity at these concentrations. Methoprene can be toxic to fish, but the lowest 50 percent lethal dose[1](LD50 4.62 milligrams per kilogram [mg/L]) is several orders of magnitude greater than the dose used by the District to control mosquitoes.

> **Impact AR-19.** The use of methoprene at the label concentrations listed for control of mosquito larvae in natural and man-made aquatic habitats would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.

4.2.7.1.3 Surfactants

Surfactants (alcohol ethoxylated surfactants and aliphatic solvents) work by making it difficult for mosquito larvae to attach to the water's surface, causing them to drown. Surfactants affect only the uppermost layer of the water. They are nontoxic to most organisms at label application rates, but may impact other surface-breathing aquatic insects. The numbers of these nontarget surface-breathing insects were temporarily reduced following treatment, but recovered within a few days at Don Edwards Wildlife Area (Miles et al. 2002). These short-term impacts on a small portion of the food chain are unlikely to result in substantive impacts to nontarget species in the aquatic environment.

> **Impact AR-20.** The use of surfactants at the label concentrations listed for control of mosquito larva in natural and man-made aquatic habitats would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.

4.2.7.1.4 Organophosphate Insecticides

Organophosphates (OPs) are a class of chemicals that kill insects by interfering with their production of the acetylcholinestarase enzyme, resulting in nervous and respiratory system damage. Temephos is used as a larvicide to help prevent mosquitoes from developing resistance to the bacterial larvicides (Section 4.2.7.4). It is persistent in the environment, with a half-life in excess of 15 days via most degradation pathways. While applied widely in some areas of the country, the District uses this chemical infrequently to treat man-made mosquito sources, such as tire piles, that are resistant to other treatments.

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[1] LD_{50} refers to the lethal single dose of a chemical (amount of chemical regardless of the volume of liquid in which it is delivered) that that would kill 50 percent of a group of test animals treated with that dose.

Temephos is effective in highly polluted water. Temephos can be used to control dipteran midges and blackflies, but it is applied at higher concentrations for this application than for mosquito control.

Temephos is not toxic to fish at the concentrations the District uses for mosquito control and is not applied in natural water bodies where fish or sensitive invertebrates would be present. It has been observed to be toxic to some planktonic crustaceans (copepods and cladocerans), as well as stoneflies (Plecopterans) and mayflies (Ephemerellids). Because of this toxicity, its use is restricted to isolated, man-made habitats, where sensitive species are absent.

> **Impact AR-21.** The use of temphos in isolated, man-made habitats would have **no impact** on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species.

4.2.7.2 Mosquito Adulticides

4.2.7.2.1 Pyrethrins and Pyrethroids

Pyrethrins are naturally occurring products distilled from the flowers of the *Chrysanthemum* species. Pyrethroid insecticides are synthetic compounds that are chemically similar to the pyrethrins that have been modified to increase stability and activity against insects. They are highly potent insecticides, but are highly toxic to fish and aquatic invertebrates as well, sometimes at environmental concentrations of less than 1 µg/L. The presence of these pesticides in aquatic environments can result in lethal and sublethal effects on fish and aquatic invertebrates. Where substantial numbers of such organisms are affected, food supplies can be diminished, resulting in indirect effects to secondary and tertiary consumers dependent on the aquatic food web, including aquatic invertebrates, fish, amphibians, and birds. Both sets of compounds tend to break down relatively quickly in the environment, often within hours, and usually within a few days. Of the pyrethroids that are applied adjacent to aquatic environments, phenothrin and permethrin are more persistent than the other chemicals in this group, with half lives of days to months in water under aerobic conditions.

Pyrethrins and pyrethroids are applied in ULV applications by aircraft, truck, ATV, or handheld foggers include pyrethrins, phenothrin, and permethrin. Numerous studies have found that these ULV applications result in concentrations in the aquatic environment of 0.23 to 3.77 µg/L and had little to no effect on fish or nontarget aquatic invertebrates (see Appendix B).

On rare occasions, pyrethrins are applied directly in aquatic environments as mosquito larvicides in accordance with label specifications, and guidance from the USEPA and CDPR. These areas are preferentially treated with Bs, Bti, or methoprene (discussed above).

> **Impact AR-22.** The use of pyrethrin or pyrethroid pesticides in or near aquatic habitats would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.

4.2.7.2.2 Piperonyl Butoxide

PBO is a synergist, a chemical applied with a pesticide to enhance the effectiveness of the pesticide (Appendix B). PBO works by interfering with an insect's ability to detoxify pyrethrins and pyrethroids. PBO is moderately toxic to fish (LD_{50}=1.9 to 3.94 mg/L) and moderately to highly toxic (0.51 to 12.0 mg/L) to aquatic invertebrates. However, its toxicity is much lower than that of the pesticides it is used with. PBO can break down relatively rapidly by photolysis (half-life of 8.4 hours), but has a half-life exceeding 30 days based on aerobic metabolism in water. Although it degrades rapidly, release of PBO to the environment may "activate" persistent pyrethroids that are already present in the sediment. Field tests indicate that PBO concentrations were very low (~2 µg/L) immediately after 3 consecutive nights of treatment, declined rapidly thereafter, and was undetectable 8 days after application (see Appendix B). A number of studies indicate that PBO, when applied at the levels used for mosquito control, did not have any detectable effect on sentinel species (Appendix B). These studies also indicate that PBO does not persist in the environment very long after application. This information indicates that the use of PBO will not substantially affect aquatic organisms.

Impact AR-23. The use of PBO over, in or near aquatic habitats would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.

4.2.7.2.3 Organophosphate Insecticides

OPs are a class of chemicals that kill insects by interfering with their production of the acetylcholinestarase enzyme, resulting in nervous and respiratory system damage. Naled may be used infrequently (one application every few years) in rotation with pyrethrins or pyrethroids to avoid the development of pesticide resistance. It is used as a mosquito adulticide. Naled breaks down rapidly in water (hours to a few days). It is moderately to highly toxic to fish (minimum 0.08 mg/L), and highly toxic to aquatic invertebrates (minimum of 0.35 µg/L). As reported in Appendix B, environmental concentrations observed immediately after application in field tests ranged from 0.71 µg/L by truck to 20.15 µg/L from aircraft. The latter values appears to be exceptionally high, but reasons for such high values are unknown. In another field test, the environmental concentration following aerial application was 0.19 µg/L. The chemical was not detected in any of the field tests after 12.45 hours. At the lower concentrations reported, no mortality of fish or invertebrates was reported. At the higher concentration, mortality of invertebrates was significant, but no effect on fish was detected. Dichlorvos, a breakdown product of naled, and itself a registered pesticide, may be present in toxic concentrations after naled is no longer detectable. Dichlorvos has a half-life of a few hours to 5 days, depending on medium. It has a similar toxicity to fish, but is more toxic to invertebrates. Naled is typically used to combat resistance to pyrethrins and pyrethroids in mosquito populations. As such, it is used infrequently. For example, this product was not used by any District in 2011-2012. It was used in 2010 within the various counties for agricultural and landscape purposes (CDPR website accessed April 18, 2013: http://www.cdpr.ca.gov/docs/pur/purmain.htm). As adulticiding is conducted only when larval control activities are ineffective, naled would be used infrequently. Because the District would use this product infrequently and under emergency conditions and because of the relatively short half-life of naled and its breakdown product, dichlorvos, the effect of the District's use of it would be short term and temporary.

Impact AR-24. The use of naled over, in, or near aquatic habitats would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.

4.2.7.2.4 Habitat Conservation Plans and Natural Community Conservation Plans

The Chemical Control Alternative has the potential to affect nontarget species included in HCP/NCCPs. As a result, this alternative, when applied within the boundaries of an HCP/NCCP, could conflict with the provisions of that HCP/NCCP.

Impact AR-25. The Chemical Control Alternative could have a **potentially significant but mitigable** impact by conflicting with the provisions of an HCP/NCCP.

Mitigation Measure AR-25. See Mitigation Measure AR-14. With implementation of this mitigation measure, the impacts would be **less than significant**.

4.2.8 Cumulative Impacts

Cumulative impacts on aquatic resources are discussed in Section 13.2. The determination is whether a proposed project's incremental contribution to a cumulative impact results in a potentially "considerable" (i.e., significant) cumulative impact is summarized herein.

The following is a summary of the Program impacts that could become cumulatively considerable with other impacts in the region. To make this determination, consideration is given to the combined contribution of Program impacts considered together with impacts that exist outside of the Program Area.

4.2.8.1 Regional Fisheries Trends

4.2.8.1.1 Pelagic Organism Decline (POD)

POD refers to the recent (2002–present) steep decline of pelagic fishes (i.e., fish that occupy open-water habitats) within the Bay-Delta estuary (Armor et al. 2005; CDWR and CDFG 2007; Sommer 2007; Baxter et al. 2010). This environmental issue has emerged as one of overwhelming concern in the Delta.

In areas bordering San Pablo Bay, Suisun Bay, and the Delta, the Physical Control and Vegetation Management alternatives would contribute to landscape habitat modifications, while the Chemical Control Alternative would contribute to contaminants

> The District's Physical Control and Vegetation Management alternatives are limited to small areas of highly modified habitat. These areas are not primary habitat for POD species. Because the areas where these activities occur are very small relative to the overall area of wetlands in the region, these activities are not expected to have any substantive effect on food production for POD species. Therefore, these alternatives do not contribute substantially to POD.

> The Chemical Control Alternative includes the use of pyrethroid pesticides, which have been linked to POD. The District uses pyrethroid pesticides as part of an IPM approach, where application of pyrethroids is several levels down in the selection of control measures, so the use of pyrethroids is limited. When pyrethroids are used, the District preferentially uses pyrethroids with limited persistence in the environment, The District does not use pyrethroids over aquatic habitats and uses the minimal effective amounts of these chemicals. Thus, the Chemical Control Alternative does not contribute substantially to the concentrations of pyrethroids in the environment or to the POD.

> The Surveillance and Biological Control Alternatives involve access, monitoring, and control activities with very limited potential to impact POD.

Therefore, all of the Program alternatives have a **less-than-significant cumulative impact on POD**.

4.2.8.1.2 Salmonid Population Trends

Salmonid population trends were evaluated in a number of 5-year status reviews completed by NOAA Fisheries in 2011 (NOAA Fisheries 2011a-f).These reviews indicated that most populations of salmonids showed some evidence of decline. However, based on the status reviews for these species, the principal factors resulting in their listing include:

> Loss, degradation, simplification, and fragmentation of habitat caused by a variety of activities including logging, road construction, urban development, mining activities, agriculture, ranching, and recreation

> Reduction or elimination of habitat or blocked access to habitat caused by water storage, withdrawal, conveyance and diversion facilities for agriculture, flood control, and domestic and hydropower purposes

> Point and nonpoint sources of pollution

> Loss of riparian habitats

The Physical Control and Vegetation Management alternatives would contribute to the first and last factors, while the Chemical Control Alternative would contribute to the third factor. These activities generally occur over small areas and have little impact on primary salmonid habitat. With the BMPs associated with the implementation of these alternatives substantially reduce these potential effects to be less-than-significant at the Program level and do not contribute substantially to the total amount of habitat loss for salmonids in the region. The Surveillance and Biological Control Alternatives involve access, monitoring, and control activities with very limited potential to impact salmonids. Therefore, all of the Program alternatives have a **less-than-significant cumulative impact on salmonid population trends**.

4.2.8.2 Program Alternatives

The Surveillance Alternative's maintenance of access routes and the sampling/ monitoring of mosquito populations have less-than-significant impacts on aquatic habitats, native fish or aquatic invertebrates, special-status species, or HCPs and NCCPs along with the Biological Control Alternative's use of mosquitofish in artificial/man-made water bodies and in selected natural waters (with restrictions contained in Mitigation Measure AR-18) are not cumulatively considerable given their limited disruption to natural habitats. Consequently, the focus of the analysis below is on the Physical Control, Vegetation Management, and Chemical Control Alternatives.

4.2.8.2.1 Physical Control Alternative

The draining or filling of shallow-water habitats in natural areas under the Physical Control Alternative would be cumulative with historic and ongoing impacts to these habitats from other land management practices including flood control, urbanization, and channelization. The majority of such activities occurring as part of the action would occur in artificial environments such as drainage ditches, retention ponds, etc.

Activities affecting wetlands are subject to permitting requirements from a variety of agencies including the USACE, SWRCB or RWQCBs, CDFW, and others. However, wetlands continue to be affected by urban and agricultural development, roadwork, and other activities (California Natural Resources Agency 2010), an existing significant cumulative impact. The District's activities within this context do not contribute substantially to the cumulative effects of other activities within the region in part due to the constraints of required permits. Therefore, the Program would have a **less-than-significant cumulative impact on the amount or quality of aquatic habitat**.

4.2.8.2.2 Vegetation Management Alternative

The vegetation within and around aquatic habitats is an important component of the aquatic ecosystem, as described in Section 4.2.5.

Invasive weeds can disrupt native habitats. They compete with and may displace native plants, which may interfere with ecosystem functions, by altering and reducing the food resources available to primary and secondary consumers. Weed control activities the District(s) perform would be cumulative with those performed by other entities. These activities would focus on areas with dense concentrations of weeds and not on individual weed plants distributed broadly in otherwise natural habitats. Thus, weed control activities may affect native plants, as these species may lie within treatment areas, but the effects on individuals of native species are minimized, and the overall effect is likely beneficial, as native species will have less competition in treated areas and, thus, would be expected to be more successful. Therefore, there is not an existing significant cumulative impact to native habitats. The District's incremental activities associated with the **control of invasive weeds would not be cumulatively considerable (i.e., less-than-significant)**.

4.2.8.2.3 Chemical Control Alternative

The uses of pesticides under the Chemical Control Alternative would be cumulative with uses of pesticides by agricultural, industrial, governmental, and residential users, an existing significant cumulative impact. Contaminants and pesticides have been hypothesized to contribute to declines in fish populations. The District's relative contribution to the loads of such concentrations is small compared with other users. The District preferentially uses nonchemical alternatives and when using chemical alternatives, uses chemicals that are not persistent in the environment when chemicals are applied. As such, the District's Chemical Control Alternative does not contribute substantively to pesticide and herbicide loads in the aquatic environment. The Chemical Control Alternative has a **less-than-significant cumulative impact on herbicide and pesticide loads**.

4.2.9 Environmental Impacts Summary

Table 4-5 provides a summary of the environmental impacts of the Program alternatives on aquatic resources. Discussion of these impacts is provided in the preceding sections.

Table 4-5 Summary of Biological Aquatic Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Effects on Biological Resources – Aquatic					
Impact AR-1. The Surveillance Alternative would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, special-status species, or HCP/NCCPs. These effects would result through maintenance of access routes to sampling locations in and adjacent to surveillance monitoring sites. No mitigation is required.	LS	na	na	na	na
Impact AR-2. Increasing circulation in shallow areas would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status species. No mitigation is required.	na	LS	na	na	na
Impact AR-3. Draining areas of shallow freshwater habitats would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, as only a small proportion of such habitat would be drained. No mitigation is required.	na	LS	na	na	na
Impact AR-4. Draining areas of shallow freshwater habitats would have a **potentially significant but mitigable** impact on special-status species, if these species are present when the habitat is drained.	na	SM	na	na	na
Impact AR-5. Draining seasonal wetlands in areas supporting sensitive fish species would have a **potentially significant but mitigable** impact on aquatic habitats, native fish or aquatic invertebrates, and special-status species.	na	SM	na	na	na
Impact AR-6. Improving drainage in freshwater marshes and seasonal wetlands managed as waterfowl habitat would have a **less-than-significant** impact on aquatic habitats, and native fish or aquatic invertebrates. No mitigation is required.	na	LS	na	na	na
Impact AR-7. Improving drainage in freshwater marshes and seasonal wetlands managed as waterfowl habitat would have a **potentially significant but mitigable** impact on special-status species if such species are present.	na	SM	na	na	na
Impact AR-8. Improving drainage in saline and brackish habitats would have a **less-than-significant** impact on aquatic habitats, and native fish or aquatic invertebrates. No mitigation is required.	na	LS	na	na	na

Table 4-5 Summary of Biological Aquatic Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact AR-9. Improving drainage in saline and brackish habitats would have a **potentially significant but mitigable** impact on special-status species if such species are present.	na	SM	na	na	na
Impact AR-10. Physical control of temporary standing waters and artificial ponds would have **no impact** on native or special-status fish species, as these areas do not provide habitat for or support these species.	na	N	na	na	na
Impact AR-11. Physical control of mosquito habitat in tree holes would have **no impact** on native or special-status fish species, as tree holes do not provide habitat for fish.	na	N	na	na	na
Impact AR-12. Physical control measures in wastewater treatment facilities and septic systems would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.	na	LS	na	na	na
Impact AR-13. Physical control of mosquito habitat in an artificial container habitat would have **no impact** on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species, as these containers do not provide habitat for these fish species.	na	N	na	na	na
Impact AR-14. Physical control measures could have a **potentially significant but mitigable** impact by conflicting with the provisions of an HCP/NCCP.	na	SM	na	na	na
Impact AR-15. The Vegetation Management Alternative would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species, when applied in compliance with the BMPs above. No mitigation is required.	na	na	LS	na	na
Impact AR-16. Vegetation management measures could have a **potentially significant but mitigable** impact by conflicting with the provisions of an HCP/NCCP.	na	na	SM	na	na
Impact AR-17. Planting mosquitofish in artificial environments that do not connect to natural waterbodies would have **no impact** on aquatic habitats, native fish or aquatic invertebrates, special-status fish species, or HCP/NCCPs. No mitigation is required.	na	na	Na	N	na

Table 4-5 Summary of Biological Aquatic Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact AR-18. Planting of mosquitofish in natural waterways or artificial environments that drain to natural waterways would have a **potentially significant** impact on native fish or aquatic invertebrates, special-status fish species, and applicable HCP/NCCPs. The mitigation measures for this action would reduce the ecological risks associated with planting of mosquitofish in natural waters, but these risks would not be eliminated. Because of this, the residual impact of this action would be **significant and unavoidable**.	na	na	na	SU	na
Impact AR-19. The use of methoprene at the label concentrations listed for control of mosquito larvae in natural and man-made aquatic habitats would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.	na	na	na	na	LS
Impact AR-20. The use of surfactants at the label concentrations listed for control of mosquito larva in natural and man-made aquatic habitats would have a **less-than-significant** impact **on** aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.	na	na	na	na	LS
Impact AR-21. The use of temphos in isolated, man-made habitats would have **no impact** on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species.	na	na	na	na	N
Impact AR-22. The use of pyrethrin or pyrethroid pesticides in or near aquatic habitats would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.	na	na	na	na	LS
Impact AR-23. The use of PBO over, in or near aquatic habitats would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.	na	na	na	na	LS
Impact AR-24. The use of naled over, in, or near aquatic habitats would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.	na	na	na	na	LS

Table 4-5 Summary of Biological Aquatic Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact AR-25. The Chemical Control Alternative could have a **potentially significant but mitigable** impact by conflicting with the provisions of an HCP/NCCP.	na	na	na	na	SM

LS = Less-than-significant impact

N = No impact

na = Not applicable

SM = Potentially significant but mitigable impact

SU = Significant and unavoidable impact

4.2.10 Mitigation and Monitoring

4.2.10.1 Physical Control: Draining Habitats (AR-4, AR-5, AR-7, AR-9)

The District will determine the potential for a sensitive species to occur in an area to be treated based on the California Natural Diversity Database, USFWS, and NMFS species lists, species listing packages and periodic status reviews, critical habitat designations, and other publically available information. If the District determines that a sensitive species could be present, the District will coordinate with appropriate resource agency personnel. If shallow habitats associated with natural waterways where sensitive species could be present need draining, the District will schedule such activity at a time of year when these species are absent from the treatment site. In the event that such activity cannot be postponed, or must be performed in habitat that has the potential for continuous occupancy, the District will have a qualified biologist conduct surveys to determine if sensitive fish species are present. This treatment would be avoided where sensitive species are present.

> Location: Areas with potential presence of sensitive aquatic species.

> Monitoring/Reporting Action: Assess likelihood of presence through consultation with agency biologists, consideration of species life-history timing, and, if necessary, site specific surveys by a qualified biologist. Finding will be documented with resource agencies.

> Effectiveness Criteria: Mitigation will be considered effective if treatment of areas with potential presence of sensitive species is avoided.

> Responsible Agency: the District

> Timing: Dependent on need for treatment activities

With implementation of this mitigation measure, the impact of this activity would be **less than significant**.

4.2.10.2 Conflicts with the Provisions of an HCP/NCCP (AR-14, AR-16, AR-25)

To avoid conflicts with the provisions of an HCP/NCCP, the District will determine whether any of its treatment areas lie within the boundaries of an HCP/NCCP. Prior to application of any treatments, excluding surveillance monitoring, the District will review the requirements of the HCP/NCCP and determine whether this activity will conflict with the provisions of that HCP/NCCP. The District will work with the HCP/NCCP holder and appropriate regulatory agencies to identify alternatives to avoid or minimize any potential impacts to a species or habitat protected by the HCP/NCCP. Such determination will be documented and relayed to the HCP/NCCP holder and the regulating entity (USFWS, NOAA Fisheries, CDFW).

> Location: Treatment areas within the boundaries of an HCP/NCCP.

> Monitoring/Reporting Action: Contact HCP manager to discuss treatment activities prior to implementation. Review the requirements of the HCP/NCCP and determine whether this activity will conflict with the provisions of that HCP/NCCP.

> Effectiveness Criteria: Mitigation will be considered effective if treatment of areas with potential presence of sensitive species is avoided. Document discussion and appropriate treatment activities with the HCP/NCCP holder and the regulating entity (USFWS, NOAA Fisheries, CDFW).

> Responsible Agency: the District

> Timing: Dependent on need for treatment activities

With implementation of this mitigation measure, the impact of this activity would be **less than significant**.

4.2.10.3 Planting Mosquitofish in Natural Waterways (AR-18)

To minimize the potential impacts of planting mosquitofish in natural waterways, the District will implement a policy incorporating the following elements:

1. Limiting such plantings to areas where the District's historic and ongoing Surveillance Program indicates that mosquito breeding is likely to occur.
2. Consulting appropriate federal and state fish and wildlife department websites, including the USFWS website, CDFW website, and CalFish.org to determine if the area under consideration for treatment, including a 1 mile radius around the site, is a known habitat for threatened and/or endangered species.
3. Not planting in streams until flows have become discontinuous, and stream habitat consists of isolated pools to minimize the potential for the movement of mosquitofish to areas where treatment was not intended.
4. Not planting mosquitofish if there have been reported sightings of threatened and/or endangered species within this area without further surveys by a biologist qualified to perform such surveys, or consultation with agency biologists.
5. District staff conducting a site survey and preparing a written report relating to the occurrence of sensitive species and not planting mosquitofish if the survey identifies the potential presence of sensitive species.

Unless prohibited by the guidelines above, the site will be planted with mosquitofish. The District will keep records of all plantings made by watershed and location, as well as records of any plantings that were planned and discontinued for any of the reasons provided above.

- Location: All natural waters to be treated with mosquitofish.
- Monitoring/Reporting Action: Consult appropriate websites for locations of species of concern or designated critical habitat for listed species. Have surveys performed by a biologist qualified to perform surveys for any sensitive species that might occur based on the above or consult with resource agency biologists prior to planting. In treatment areas more than one mile from locations where sensitive species are thought to occur, District staff will perform a site assessment and complete a site assessment report, to be kept on file at the District offices. If sensitive species are observed, mosquitofish will not be planted without consulting the regulatory agencies.
- Effectiveness Criteria: Mitigation will be considered effective if treatment of areas with potential presence of sensitive species is avoided.
- Responsible Agency: the District
- Timing: Dependent on need for treatment activities

The mitigation measures for this action would reduce the ecological risks associated with planting of mosquitofish in natural waters, but these risks would not be eliminated. Because of this, the residual impact of this action would be **significant and unavoidable**.

5 Biological Resources – Terrestrial

Chapter 5 evaluates the potential impacts of the Program alternatives on terrestrial resources. Results of the evaluation are provided at the programmatic level. Section 5.1, Environmental Setting, presents an overview of the environmental settings and contains federal regulations, state regulations, and local ordinances and regulations that are applicable to the Program. Section 5.2, Environmental Impacts and Mitigation Measures, presents the following:

> Environmental concerns and evaluation criteria: A discussion of whether the Program alternatives would cause any potentially significant impacts to terrestrial resources and addressing concerns from the public scoping

> Discussion of methods and assumptions, including findings from Appendix B, Ecological and Human Health Assessment Report

> Discussion of the potential impacts of the Program alternatives, and recommendations for mitigation, if required, for those impacts

> Cumulative impacts summary

> A summary of estimated environmental impacts to terrestrial resources

Aquatic resources are addressed in Chapter 4.

5.1 Environmental Setting

The Program Area is defined as the District's principal Service Area in Solano County and the five adjacent counties: Yolo, Sacramento, Napa, Sonoma and Contra Costa. The Program Area is impacted by pests that must be controlled to assure the health and quality of life for residents and recreationists. Control activities may be provided in the five counties adjacent to the District's Solano County Service Area upon request of the adjacent jurisdictions to protect the health and safety of residents in adjacent jurisdictions. Actions that would be taken outside of the District's Service Area are the same types of actions undertaken within the District's Service Area and in similar types of habitats or sites. Section 5.1.1 identifies the ecoregion provinces in the District's Program Area, Section 5.1.2 describes the special-status terrestrial species that have the potential to occur within the Program Area, Section 5.1.3 provides an overview of federal, state, and local ordinances and regulations pertinent to these resources that are applicable to the Program. Section 5.1.4 identifies the Habitat Conservation Plans (HCPs) and Natural Community Conservation Plans (NCCPs) in the Program Area.

Background information on hazards, toxicity, and exposure is provided in Section 5.2.2.2.

5.1.1 Terrestrial Resources within the Program Area

The Program Area is located in the following six counties of the state: Solano, Yolo, Sacramento, Napa, Sonoma and Contra Costa. This area encompasses a range of terrestrial habitats and a diverse array of wildlife and plants. The ecoregion provinces (McNab and Avers 1996) have been used to describe the areas where the Program activities and treatments would be implemented and are shown on Figure 5-1. The ecoregion provinces are described in Appendix A, Biological Resources Technical Report.

5.1.2 Special-Status Species

A number of special-status species are found in the Program Area and vicinity. Special-status species are those that are listed as endangered, threatened, or candidate species under the federal Endangered Species Act, endangered or threatened under the California Endangered Species Act, or listed as species of special concern by the state. Brief life-history descriptions for special-status species as well as their presence or absence within the Program Area are presented in Tables 5-1 (plants) and 5-2 (wildlife).

5.1.3 Regulatory Environment

The regulatory setting includes the federal, state, and local laws, statues, and regulations pertinent to the Program Area and vicinity and the terrestrial resources residing therein. These laws include the following:

Federal

> Endangered Species Act of 1973
> Magnusson-Stevenson Fishery Conservation and Management Act of 1996
> Clean Water Act of 1977
> Executive Order 11990

State

> Porter-Cologne Water Quality Control Act of 1970
> California Fish and Game Code Section 1600 et seq.
> California Endangered Species Act of 1984
> California Fish and Game Code Section 5650
> Natural Community Conservation Planning Act
> California Food and Agricultural Code, Section(s) 12976 and 12981

Local

> Local governing bodies may pass ordinances that regulate or restrict pesticide use within their jurisdictional areas.

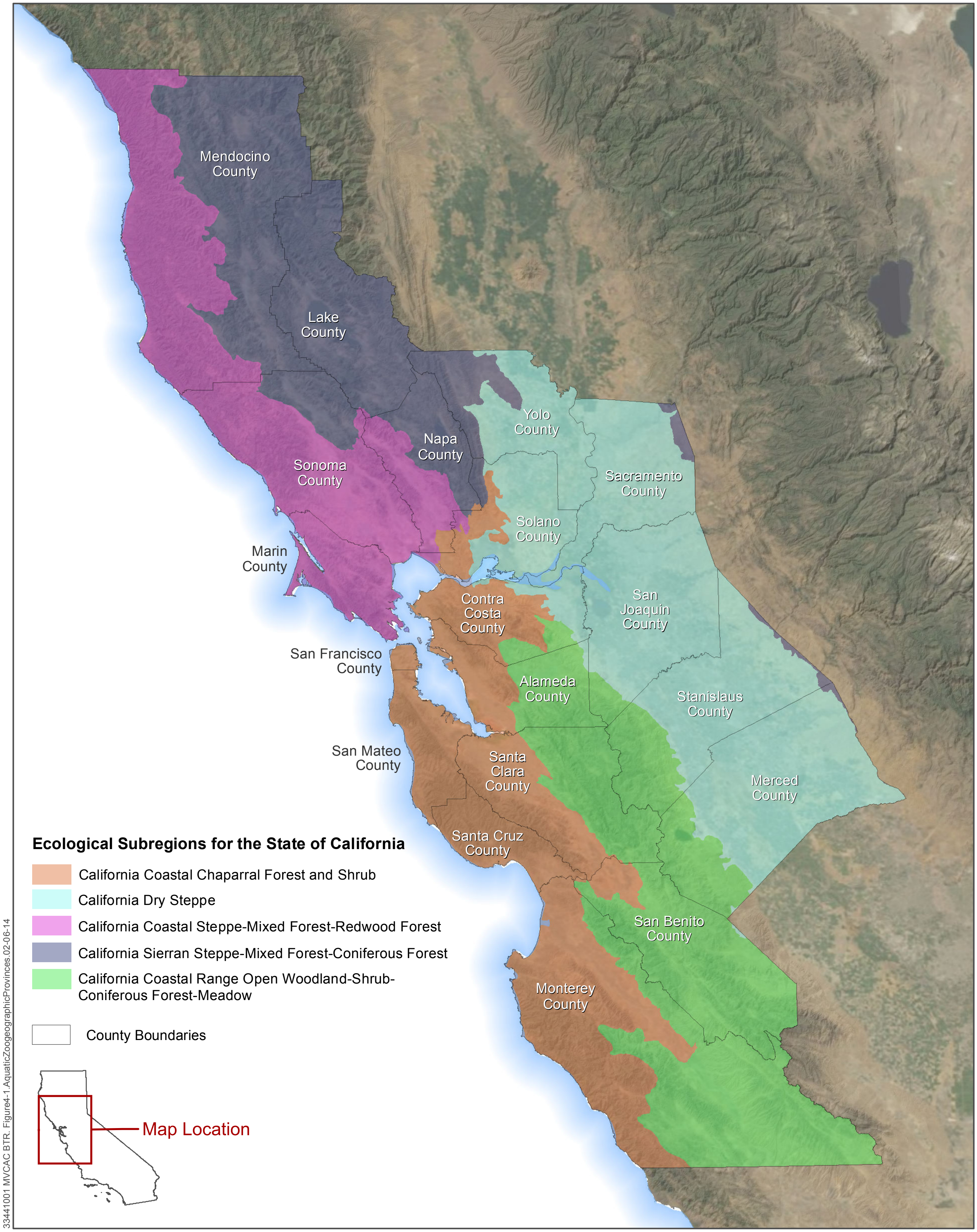
A description of these laws and regulations is provided in Appendix A, Section 2.5.

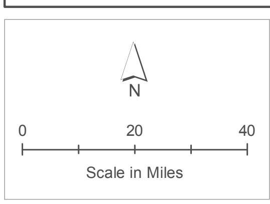
5.1.4 Habitat Conservation Plans and Natural Community Conservation Plans

HCPs are planning documents required as part of an application by a nonfederal entity for incidental take of a species listed under the federal Endangered Species Act as part of their proposed activities. An HCP describes the proposed action(s), and anticipated effects on the individuals and populations of listed species. It also describes how impacts will be minimized and mitigated. An HCP also can include protections for species that are candidates for listing or are proposed for listing. The USFWS or NOAA Fisheries review the HCP, when reviewing a project. If they approve a project, they will issue an incidental take permit for the project actions, which provides for take of these species based on the actions provided for in the HCP, as well as additional measures that they might include.

The California legislature first passed the California Natural Community Conservation Planning Act in 1991, then updated and superseded it in 2003. The primary objective of the NCCP program is to conserve natural communities at the ecosystem level, while accommodating compatible land use. It focuses on the long-term stability of wildlife and habitat and seeks to avoid controversy and delays associated with species listings.

A number of HCPs and NCCPs are in effect or development within the District's Program Area. See Table 4-2 in Section 4.1.4, which was developed through review of information available on the USFWS and CDFW's websites. The District is not signatory to these HCPs or NCCPs, but will comply with the provisions of these documents, when their activities occur within the boundaries of an existing HCP or NCCP or those that may be developed during the Program lifetime.





Source: US Forest Service, Pacific Southwest Region, Ecological Subregions for the State of California

INTEGRATED MOSQUITO MANAGEMENT PROGRAM

Terrestrial Ecoregion Provinces

Figure 5-1

Table 5-1 CNDDB Occurrences for Special-status Plant Species in the Solano County Mosquito Abatement District Program Area

Species Name	Status	Habitat	Solano County (Service Area)	Adjacent Program Area Counties
Napa false indigo *Amorpha californica* var. *napensis*	RPR, 1B	Broadleafed upland forest, chaparral, cismontane woodland. Openings in forest or woodland or in chaparral. 150-2000 m		●
bent-flowered fiddleneck *Amsinckia lunaris*	RPR, 1B	Cismontane woodland, valley and foothill grassland. 50-500 m.		●
Konocti manzanita *Arctostaphylos manzanita* ssp. *elegans*	RPR, 1B	Chaparral, cismontane woodland, lower montane coniferous forest. Volcanic soils. 395-1400 m.		●
Rincon Ridge manzanita *Arctostaphylos stanfordiana* ssp. *decumbens*	RPR, 1B	Chaparral. Highly restricted endemic to red rhyolites in Sonoma County. 75-310 m.		●
Clara Hunt's milk-vetch *Astragalus claranus*	FE, ST, RPR, 1B	Cismontane woodland, valley and foothill grassland, chaparral. Open grassy hillsides, esp. On exposed shoulders in thin, volcanic clay soil moist in spring. 75-235 m.		●
Jepson's milk-vetch *Astragalus rattanii* var. *jepsonianus*	RPR, 1B	Cismontane woodland, valley and foothill grassland, chaparral. Commonly on serpentine in grassland or openings in chaparral. 320-700 m.		●
Ferris' milk-vetch *Astragalus tener* var. *ferrisiae*	RPR, 1B	Meadows, valley and foothill grassland. Subalkaline flats on overflow land in the central valley; usually seen in dry, adobe soil. 5-75 m.		●
alkali milk-vetch *Astragalus tener* var. *tener*	RPR, 1B	Alkali playa, valley and foothill grassland, vernal pools. Low ground, alkali flats, and flooded lands; in annual grassland or in playas or vernal pools. 1-170 m.		●
heartscale *Atriplex cordulata* var. *cordulata*	RPR, 1B	Chenopod scrub, valley and foothill grassland, meadows. Alkaline flats and scalds in the central valley, sandy soils. 1-150(600)m.		●
brittlescale *Atriplex depressa*	RPR, 1B	Chenopod scrub, meadows, playas, valley and foothill grassland, vernal pools. Usually in alkali scalds or alk. Clay in meadows or annual grassland; rarely associate with riparian, marshes, or v.p's. 1-320 m.		●
San Joaquin spearscale *Atriplex joaquinana*	RPR, 1B	Chenopod scrub, alkali meadow, valley and foothill grassland. In seasonal alkali wetlands or alkali sink scrub with *distichlis spicata*, *frankenia*, etc. 1-250 m.	●	●
vernal pool small scale *Atriplex persistens*	RPR, 1B	Vernal pools. Alkaline vernal pools. 10-115 m.	●	

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Table 5-1 CNDDB Occurrences for Special-status Plant Species in the Solano County Mosquito Abatement District Program Area

Species Name	Status	Habitat	Solano County (Service Area)	Adjacent Program Area Counties
big-scale balsamroot *Balsamorhiza macrolepis*	RPR, 1B	Valley and foothill grassland, cismontane woodland. Sometimes on serpentine. 35-1000 m.	●	●
big tarplant *Blepharizonia plumose*	RPR, 1B	Valley and foothill grassland. Dry hills and plains in annual grassland. Clay to clay-loam soils; usually on slopes and often in burned areas. 15-455 m.	●	
watershield *Brasenia schreberi*	RPR 2	Freshwater marshes and swamps. Aquatic from water bodies both natural and artificial in California.		●
narrow-anthered brodiaea *Brodiaea leptandra*	RPR, 1B	Broadleafed upland forest, chaparral, lower montane coniferous forest. 110-915 m.		●
round-leaved filaree *California macrophylla*	RPR, 1B	Cismontane woodland, valley and foothill grassland. Clay soils. 15-1200 m.	●	●
Tiburon mariposa-lily *Calochortus tiburonensis*	FT, ST, RPR, 1B	Valley and foothill grassland. On open, rocky, slopes in serpentine grassland. 50-150 m.		●
bristly sedge *Carex comosa*	RPR 2	Marshes and swamps. Lake margins, wet places; site below sea level is on a delta island. -5-1005 m.		●
Tiburon paintbrush *Castilleja affinis* ssp. *neglecta*	FE, ST, RPR, 1B	Valley and foothill grassland. Rocky serpentine sites. 75-400 m.		●
pink creamsacs *Castilleja rubicundula* ssp. *rubicundula*	RPR, 1B	Chaparral, meadows and seeps, valley and foothill grassland. Openings in chaparral or grasslands. On serpentine. 20-900 m.		●
Rincon Ridge ceanothus *Ceanothus confuses*	RPR, 1B	Closed-cone coniferous forest, chaparral, cismontane woodland. Known from volcanic or serpentine soils, dry shrubby slopes. 75-1065 m.		●
Calistoga ceanothus *Ceanothus divergens*	RPR, 1B	Chaparral, cismontane woodland. Rocky, serpentine or volcanic sites. 165-950 m.		●
holly-leaved ceanothus *Ceanothus purpureus*	RPR, 1B	Chaparral. Rocky, volcanic slopes. 120-640 m.	●	●
Sonoma ceanothus *Ceanothus sonomensis*	RPR, 1B	Chaparral. Sandy, serpentine or volcanic soils. 210-800 m.		●

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Table 5-1 CNDDB Occurrences for Special-status Plant Species in the Solano County Mosquito Abatement District Program Area

Species Name	Status	Habitat	Solano County (Service Area)	Adjacent Program Area Counties
Congdon's tarplant *Centromadia parryi* ssp. *congdonii*	RPR, 1B	Valley and foothill grassland. Alkaline soils, sometimes described as heavy white clay. 1-230 m.	●	
pappose tarplant *Centromadia parryi* ssp. *parryi*	RPR, 1B	Coastal prairie, meadows and seeps, coastal salt marsh, valley and foothill grassland. Vernally mesic, often alkaline sites. 2-420 m.	●	●
hispid bird's-beak *Chloropyron molle* ssp. *hispidum*	RPR, 1B	Meadows, playas, valley and foothill grassland. In damp alkaline soils, especially in alkaline meadows and alkali sinks with *distichlis*. 10-155 m.	●	
soft bird's-beak *Chloropyron molle* ssp. *molle*	FE, SR, RPR, 1B	Coastal salt marsh. In coastal salt marsh with *distichlis*, *salicornia*, *frankenia*, etc. 0-3 m.	●	●
palmate-bracted bird's-beak *Chloropyron palmatum*	FE, SE, RPR, 1B	Chenopod scrub, valley and foothill grassland. Usually on pescadero silty clay which is alkaline, with *distichlis*, *frankenia*, etc. 5-155 m.		●
Bolander's water-hemlock *Cicuta maculata* var. *bolanderi*	RPR 2	Marshes, fresh or brackish water. 0-200 m.	●	●
Suisun thistle *Cirsium hydrophilum* var. *hydrophilum*	FE, RPR, 1B	Salt marsh. Grows with *scirpus*, *distichlis* near small watercourses within saltmarsh. 0-1 m.	●	
serpentine cryptantha *Cryptantha dissita*	RPR, 1B	Chaparral. Serpentine outcrops. 330-730 m.		●
Peruvian dodder *Cuscuta obtusiflora* var. *glandulosa*	RPR 2	Marshes and swamps (freshwater). Freshwater marsh. 15-280 m.		●
recurved larkspur *Delphinium recurvatum*	RPR, 1B	Chenopod scrub, valley and foothill grassland, cismontane woodland. On alkaline soils; often in valley saltbush or valley chenopod scrub. 3-685 m.	●	
dwarf downingia *Downingia pusilla*	RPR 2	Valley and foothill grassland (mesic sites), vernal pools. Vernal lake and pool margins with a variety of associates. In several types of vernal pools. 1-485 m.	●	●
Greene's narrow-leaved daisy *Erigeron greenei*	RPR, 1B	Chaparral. Serpentine and volcanic substrates, generally in shrubby vegetation. 75-1060 m.		●
Ione buckwheat *Eriogonum apricum* var. *apricum*	FE, SE, RPR, 1B	Chaparral. In gravelly openings on ione formation soil. 80-150 m.		●

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Table 5-1 CNDDB Occurrences for Special-status Plant Species in the Solano County Mosquito Abatement District Program Area

Species Name	Status	Habitat	Solano County (Service Area)	Adjacent Program Area Counties
Snow Mountain buckwheat *Eriogonum nervulosum*	RPR, 1B	Chaparral. Dry serpentine outcrops, balds, and barrens. 300-2100 m.		●
Mt. Diablo buckwheat *Eriogonum truncatum*	RPR, 1B	Chaparral, coastal scrub, valley and foothill grassland. Dry, exposed clay or sandy substrates. 3-350 m.	●	
Tuolumne button-celery *Eryngium pinnatisectum*	RPR, 1B	Vernal pools, cismontane woodland, lower montane coniferous forest. Volcanic soils; vernal pools and mesic sites within other natural communities. 250-450 m.		●
fragrant fritillary *Fritillaria liliacea*	RPR, 1B	Coastal scrub, valley and foothill grassland, coastal prairie. Often on serpentine; various soils reported though usually clay, in grassland. 3-410 m.	●	
adobe-lily *Fritillaria pluriflora*	RPR, 1B	Chaparral, cismontane woodland, foothill grassland. Usually on clay soils; sometimes serpentine. 55-820 m.	●	●
Boggs Lake hedge-hyssop *Gratiola heterosepala*	SE, RPR, 1B	Marshes and swamps (freshwater), vernal pools. Clay soils; usually in vernal pools, sometimes on lake margins. 5-2400 m.	●	●
Hall's harmonia *Harmonia hallii*	RPR, 1B	Chaparral. Serpentine hills and ridges. Open, rocky areas within chaparral. 500-900 m.		●
two-carpellate western flax *Hesperolinon bicarpellatum*	RPR, 1B	Serpentine chaparral. Serpentine barrens at edge of chaparral. 150-820 m.		●
Brewer's western flax *Hesperolinon breweri*	RPR, 1B	Chaparral, cismontane woodland, valley and foothill grassland. Often in rocky serpentine soil in serpentine chaparral and serpentine grassland. 30-885 m.	●	●
drymaria-like western flax *Hesperolinon drymarioides*	RPR, 1B	Closed-cone coniferous forest, chaparral, cismontane woodland, valley and foothill grassland. Serpentine soils, mostly within chaparral. 390-1000 m.		●
Tehama County western flax *Hesperolinon tehamense*	RPR, 1B	Chaparral, cismontane woodland. Serpentine barrens in chaparral. 225-1155 m.		●
woolly rose-mallow *Hibiscus lasiocarpos* var. *occidentalis*	RPR, 1B	Marshes and swamps (freshwater). Moist, freshwater-soaked riverbanks and low peat islands in sloughs; in California, known from the delta watershed. 0-150 m.	●	●

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Species Name	Status	Habitat	Solano County (Service Area)	Adjacent Program Area Counties
Carquinez goldenbush *Isocoma arguta*	RPR, 1B	Valley and foothill grassland. Alkaline soils, flats, lower hills. On low benches near drainages and on tops and sides of mounds in swale habitat. 1-20 m.	●	
Northern California black walnut *Juglans hindsii*	RPR, 1B	Riparian forest, riparian woodland. Few extant native stands remain; widely naturalized. Deep alluvial soil associated with a creek or stream. 0-395 m.	●	●
Ahart's dwarf rush *Juncus leiospermus* var. *ahartii*	RPR, 1B	Vernal pools. Restricted to the edges of vernal pools. 30-100 m.		●
Santa Lucia dwarf rush *Juncus luciensis*	RPR, 1B	Vernal pools, meadows, lower montane coniferous forest, chaparral, great basin scrub. Vernal pools, ephemeral drainages, wet meadow habitats and streamsides. 300-2040 m.		●
Burke's goldfields *Lasthenia burkei*	FE, SE, RPR, 1B	Vernal pools, meadows and seeps. Most often in vernal pools and swales. 15-580 m.		●
Contra Costa goldfields *Lasthenia conjugens*	FE, RPR, 1B	Valley and foothill grassland, vernal pools, cismontane woodland. Extirpated from most of its range; extreme. Endangered. Vernal pools, swales, low depressions, in open grassy areas. 1-445 m.	●	●
Coulter's goldfields *Lasthenia glabrata* ssp. *coulteri*	RPR, 1B	Coastal salt marshes, playas, valley and foothill grassland, vernal pools. Usually found on alkaline soils in playas, sinks, and grasslands. 1-1400 m.		●
Delta tule pea *Lathyrus jepsonii* var. *jepsonii*	RPR, 1B	Freshwater and brackish marshes. Often found with *typha*, *aster lentus*, *rosa calif.*, *juncus* spp., *scirpus*, etc. Usually on marsh and slough edges.	●	●
Colusa layia *Layia septentrionalis*	RPR, 1B	Chaparral, cismontane woodland, valley and foothill grassland. Scattered colonies in fields and grassy slopes in sandy or serpentine soil. 145-1095 m.		●
legenere *Legenere limosa*	RPR, 1B	Vernal pools. Many historical occurrences are extirpated. In beds of vernal pools. 1-880 m.	●	●
Heckard's pepper-grass *Lepidium latipes* var. *heckardii*	RPR, 1B	Valley and foothill grassland, vernal pools. Grassland and sometimes vernal pool edges. Alkaline soils. 3-30 m.	●	●

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Species Name	Status	Habitat	Solano County (Service Area)	Adjacent Program Area Counties
Jepson's leptosiphon *Leptosiphon jepsonii*	RPR, 1B	Chaparral, cismontane woodland. Open to partially shaded grassy slopes. On volcanics or the periphery of serpentine substrates. 100-500 m.		●
Mason's lilaeopsis *Lilaeopsis masonii*	SR, RPR, 1B	Freshwater and brackish marshes, riparian scrub. Tidal zones, in muddy or silty soil formed through river deposition or river bank erosion. 0-10 m.	●	●
Sebastopol meadowfoam *Limnanthes vinculans*	FE, SE, RPR, 1B	Mesic meadows, vernal pools, valley and foothill grassland. Swales, wet meadows and marshy areas in valley oak savanna; on poorly drained soils of clays and sandy loam. 15-115 m.		●
Delta mudwort *Limosella australis*	RPR 2	Riparian scrub, freshwater marsh, brackish marsh. Probably the rarest of the suite of delta rare plants. Usually on mud banks of the delta in marshy or scrubby riparian associations; often with lilaeopsis masonii. 0-3 m.	●	●
San Joaquin woollythreads *Monolopia congdonii*	FE, RPR, 1B	Chenopod scrub and valley and foothill grassland. Alkaline or loamy plains; sandy soils, often with grasses and within chenopod scrub. 60-800 m.		●
Baker's navarretia *Navarretia leucocephala* ssp. *bakeri*	RPR, 1B	Cismontane woodland, meadows and seeps, vernal pools, valley and foothill grassland, lower montane coniferous forest. Vernal pools and swales; adobe or alkaline soils. 5-950 m.	●	●
few-flowered navarretia *Navarretia leucocephala* ssp. *pauciflora*	FE, ST, RPR, 1B	Vernal pools. Volcanic ash flow, and volc substrate vernal pools. 400-855 m.		●
pincushion navarretia *Navarretia myersii* ssp. *myersii*	RPR, 1B	Vernal pools, valley and foothill grassland. Clay soils within nonnative grassland. 20-330 m.		●
Marin County navarretia *Navarretia rosulata*	RPR, 1B	Closed-cone coniferous forest, chaparral. Dry, open rocky places; can occur on serpentine. 200-635 m.		●
Colusa grass *Neostapfia colusana*	FT, SE, RPR, 1B	Vernal pools. Usually in large, or deep vernal pool bottoms; adobe soils. 5-110 m.	●	●
Antioch Dunes evening-primrose *Oenothera deltoides* ssp. *howellii*	FE, SE, RPR, 1B	Interior dunes. Remnant river bluffs and sand dunes east of Antioch. 0-30 m.		●
San Joaquin Valley Orcutt grass *Orcuttia inaequalis*	FT, SE, RPR, 1B	Vernal pools. 30-755 m.	●	

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Species Name	Status	Habitat	Solano County (Service Area)	Adjacent Program Area Counties
slender Orcutt grass *Orcuttia tenuis*	FT, SE, RPR, 1B	Vernal pools. 30-1735 m.		●
Sacramento Orcutt grass *Orcuttia viscid*	FE, SE, RPR, 1B	Vernal pools. 30-100 m.		●
Sonoma beardtongue *Penstemon newberryi* var. *sonomensis*	RPR, 1B	Chaparral. Crevices in rock outcrops and talus slopes. 180-1390 m.		●
bearded popcornflower *Plagiobothrys hystriculus*	RPR, 1B	Vernal pools, valley and foothill grassland. Wet sites. 10-50 m.	●	●
Calistoga popcornflower *Plagiobothrys strictus*	FE, ST, RPR, 1B	Broadleafed upland forest, meadows and seeps, valley and foothill grassland, vernal pools. Alkaline sites near thermal springs and on margins of vernal pools in heavy, dark, adobe-like clay. 90-160 m.		●
Napa blue grass *Poa napensis*	FE, SE, RPR, 1B	Meadows and seeps, valley and foothill grassland. Moist alkaline meadows fed by runoff from nearby hot springs. 100-125 m.		●
Marin knotweed *Polygonum marinense*	RPR 3	Marshes and swamps. Coastal salt marshes and brackish marshes. 0-10 m.	●	●
California beaked-rush *Rhynchospora californica*	RPR, 1B	Bogs and fens, marshes and swamps, lower montane coniferous forest, meadows and seeps. Freshwater seeps and open marshy areas. 45-1000 m.		●
Sanford's arrowhead *Sagittaria sanfordii*	RPR, 1B	Marshes and swamps. In standing or slow-moving freshwater ponds, marshes, and ditches. 0-610 m.	●	●
marsh skullcap *Scutellaria galericulata*	RPR 2	Marshes and swamps, lower montane coniferous forest, meadows and seeps. Swamps and wet places. 0-2100 m.		●
side-flowering skullcap *Scutellaria lateriflora*	RPR 2	Meadows and seeps, marshes and swamps. Wet meadows and marshes. In the delta, often found on logs. -3-500 m.		●
chaparral ragwort *Senecio aphanactis*	RPR 2	Cismontane woodland, coastal scrub. Drying alkaline flats. 20-575 m.	●	
Napa checkerbloom *Sidalcea hickmanii* ssp. *napensis*	RPR, 1B	Chaparral. Rhyolitic substrates. 415-610 m.		●

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Keck's checkerbloom *Sidalcea keckii*	FE, RPR, 1B	Cismontane woodland, valley and foothill grassland grassy slopes in blue oak woodland. 180-425 m.	●	●
marsh checkerbloom *Sidalcea oregana* ssp. *hydrophila*	RPR, 1B	Meadows and seeps, riparian forest. Wet soil of streambanks, meadows. 545-2300 m.		●
Socrates Mine jewel-flower *Streptanthus brachiatus* ssp. *brachiatus*	RPR, 1B	Chaparral, closed-cone coniferous forest. Serpentine areas and serpentine chaparral. 480-970 m.		●
green jewel-flower *Streptanthus hesperidis*	RPR, 1B	Chaparral, cismontane woodland. Openings in chaparral or woodland; serpentine, rocky sites. 130-760 m.		●
slender-leaved pondweed *Stuckenia filiformis*	RPR 2	Marshes and swamps. Shallow, clear water of lakes and drainage channels. 15-2310 m.	●	
Suisun Marsh aster *Symphyotrichum lentum*	RPR, 1B	Marshes and swamps (brackish and freshwater). Most often seen along sloughs with *phragmites*, *scirpus*, blackberry, *typha*, etc. 0-3 m.	●	●
Napa bluecurls *Trichostema ruygtii*	RPR, 1B	Cismontane woodland, chaparral, valley and foothill grassland, vernal pools, lower montane coniferous forest. Often in open, sunny areas. Also has been found in vernal pools. 30-590 m.	●	●
showy rancheria clover *Trifolium amoenum*	FE, RPR, 1B	Valley and foothill grassland, coastal bluff scrub. Sometimes on serpentine soil, open sunny sites, swales. Most recently sited on roadside and eroding cliff face. 5-560 m.	●	●
saline clover *Trifolium hydrophilum*	RPR, 1B	Marshes and swamps, valley and foothill grassland, vernal pools. Mesic, alkaline sites. 0-300 m.	●	●
coastal triquetrella *Triquetrella californica*	RPR, 1B	Coastal bluff scrub, coastal scrub valley and foothill grasslands. Grows within 30 m from the coast in coastal scrub, grasslands and in open gravels on roadsides, hillsides, rocky slopes,		●
Crampton's tuctoria or Solano grass *Tuctoria mucronata*	FE, SE, RPR, 1B	Vernal pools, valley and foothill grassland. Clay bottoms of drying vernal pools and lakes in valley grassland. 5-10 m.	●	●
oval-leaved viburnum *Viburnum ellipticum*	RPR 2	Chaparral, cismontane woodland, lower montane coniferous forest. 215-1400 m.		●

1A = plants believed to be extinct in California
1B = plants rare or endangered in California and elsewhere
2 = plants rare or endangered in California, but more common elsewhere
3 = plants for which more information is needed

FE = federally listed as endangered
FT = federally listed as threatened
RPR = state Rare Plant Rank

SE = listed by California as endangered
SR = listed by California as rare
ST = listed by California as threatened

Table 5-2 CNDDB Occurrences for Special-status Wildlife Species in the Solano County Mosquito Abatement District Program Area

Species Name	Status	Habitat	Solano County (Service Area)	Adjacent Program Area Counties
Invertebrates				
Conservancy fairy shrimp *Branchinecta conservatio*	FE	Endemic to the grasslands of the northern two-thirds of the Central Valley; found in large, turbid pools. Inhabit astatic pools located in swales formed by old, braided alluvium; filled by winter/spring rains, last until June.	●	●
vernal pool fairy shrimp *Branchinecta lynchi*	FT	Endemic to the grasslands of the Central Valley, central coast mountains, and south coast mountains, in astatic rain-filled pools. Inhabit small, clear-water sandstone-depression pools and grassed swale, earth slump, or basalt-flow depression pools.	●	●
valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	FT	Occurs only in the Central Valley of California, in association with blue elderberry (Sambucus mexicana). Prefers to lay eggs in elderberries 2-8 inches in diameter; some preference shown for “stressed” elderberries.	●	●
Delta green ground beetle *Elaphrus viridis*	FT	Restricted to the margins of vernal pools in the grassland area between Jepson Prairie and Travis AFB. Prefers the sandy mud substrate where it slopes gently into the water, with low-growing vegetation, 25-100% cover.	●	
vernal pool tadpole shrimp *Lepidurus packardi*	FE	Inhabits vernal pools and swales in the Sacramento valley containing clear to highly turbid water. Pools commonly found in grass bottomed swales of unplowed grasslands. Some pools are mud-bottomed and highly turbid.	●	●
California freshwater shrimp *Syncaris pacifica*	FE, SE,	Endemic to Marin, Napa, and Sonoma Counties. Found in low elevation, low gradient streams where riparian cover is moderately shallow pools away from main streamflow. Winter: undercut banks with exposed roots. Summer: leafy branches touching water.		●
Fish				
Sacramento perch *Archoplites interruptus*	SSC	Historically found in the sloughs, slow-moving rivers, and lakes of the Central Valley. Prefers warm water. Aquatic vegetation is essential for young. Tolerates wide range of physio-chemical water conditions.		●
Delta smelt *Hypomesus transpacificus*	FT, SE	Sacramento-San Joaquin Delta. Seasonally in Suisun Bay, Carquinez Strait and San Pablo Bay. Seldom found at salinities > 10 ppt. Most often at salinities < 2ppt.	●	●
steelhead - central California coast DPS *Oncorhynchus mykiss irideus*	FT	From Russian River, south to Soquel Creek and to, but not including, Pajaro River. Also San Francisco and San Pablo Bay basins.		●

FC = federal candidate species
FE = federally listed as endangered
FP = California Fully Protected species
FT = federally listed as threatened
SE = listed by California as endangered
SSC = California species of concern
ST = listed by California as threatened

Table 5-2 CNDDB Occurrences for Special-status Wildlife Species in the Solano County Mosquito Abatement District Program Area

Species Name	Status	Habitat	Solano County (Service Area)	Adjacent Program Area Counties
Chinook salmon - Sacramento River winter-run ESU *Oncorhynchus tshawytscha*	FE, SE	Sacramento river below Keswick Dam. Spawns in the Sacramento river but not in tributary streams. Requires clean, cold water over gravel beds with water temperatures between 6 and 14 c for spawning.		●
Chinook salmon - Central Valley spring-run ESU *Oncorhynchus tshawytscha*	FT, ST	Adult numbers depend on pool depth and volume, amount of cover, and proximity to gravel. Water temps >27 c is lethal to adults federal listing refers to pops spawning in Sacramento River and tributaries.		●
Sacramento splittail *Pogonichthys macrolepidotus*	SSC	Endemic to the lakes and rivers of the Central Valley, but now confined to the delta, Suisun Bay and associated marshes. Slow moving river sections, dead end sloughs. Requires flooded vegetation for spawning and foraging for young.	●	●
Amphibians				
California tiger salamander *Ambystoma californiense*	FT, ST, SSC	Central Valley DPS federally listed as threatened. Santa Barbara and Sonoma Counties DPS federally listed as endangered. Need underground refuges, especially ground squirrel burrows and vernal pools or other seasonal water sources for breeding	●	●
foothill yellow-legged frog *Rana boylii*	SSC	Partly-shaded, shallow streams and riffles with a rocky substrate in a variety of habitats. Need at least some cobble-sized substrate for egg-laying. Need at least 15 weeks to attain metamorphosis.	●	●
California red-legged frog *Rana draytonii*	FT, SSC	Lowlands and foothills in or near permanent sources of deep water with dense, shrubby or emergent riparian vegetation. Requires 11-20 weeks of permanent water for larval development. Must have access to estivation habitat.	●	●
western spadefoot *Spea hammondii*	SSC	Occurs primarily in grassland habitats, but can be found in valley-foothill hardwood woodlands. Vernal pools are essential for breeding and egg-laying.		●
Reptiles				
western pond turtle *Emys marmorata*	SSC	A thoroughly aquatic turtle of ponds, marshes, rivers, streams and irrigation ditches, usually with aquatic vegetation, be need basking sites and suitable (sandy banks or grassy open fields) upland habitat up to 0.5 km from water for egg-laying.	●	●
giant garter snake *Thamnophis gigas*	FT, ST	Prefers freshwater marsh and low gradient streams. Has adapted to drainage canals and irrigation ditches. This is the most aquatic of the garter snakes in California.	●	●

FC = federal candidate species
FE = federally listed as endangered
FP = California Fully Protected species
FT = federally listed as threatened
SE = listed by California as endangered
SSC = California species of concern
ST = listed by California as threatened

Table 5-2 CNDDB Occurrences for Special-status Wildlife Species in the Solano County Mosquito Abatement District Program Area

Species Name	Status	Habitat	Solano County (Service Area)	Adjacent Program Area Counties
Birds				
tricolored blackbird *Agelaius tricolor*	SSC	Highly colonial species, most numerous in Central Valley and vicinity. Largely endemic to California. Requires open water, protected nesting substrate, and foraging area with insect prey within a few km of the colony.	●	●
grasshopper sparrow *Ammodramus savannarum*	SSC	Dense grasslands on rolling hills, lowland plains, in valleys and on hillsides on lower mountain slopes. Favors native grasslands with a mix of grasses, forbs and scattered shrubs. Loosely colonial when nesting.	●	
golden eagle *Aquila chrysaetos*	FP	Rolling foothills, mountain areas, sage-juniper flats, and desert. Cliff-walled canyons provide nesting habitat in most parts of range; also, large trees in open areas.	●	●
short-eared owl *Asio flammeus*	SSC	Found in swamp lands, both fresh and salt; lowland meadows; irrigated alfalfa fields. Tule patches/tall grass needed for nesting/daytime seclusion. Nests on dry ground in depression concealed in vegetation.	●	
burrowing owl *Athene cunicularia*	SSC	Open, dry annual or perennial grasslands, deserts and scrublands characterized by low-growing vegetation. Subterranean nester, dependent upon burrowing mammals, most notably, the California ground squirrel.	●	●
Swainson's hawk *Buteo swainsoni*	SSC	Breeds in grasslands with scattered trees, juniper-sage flats, riparian areas, savannahs, and agricultural or ranch lands requires adjacent suitable foraging areas such as grasslands, or alfalfa or grain fields supporting rodent populations.	●	●
western snowy plover *Charadrius alexandrinus nivosus*	FT, SSC	Sandy beaches, salt pond levees and shores of large alkali lakes. Needs sandy, gravelly or friable soils for nesting.		●
mountain plover *Charadrius montanus*	SSC	Short grasslands, freshly plowed fields, newly sprouting grain fields, and sometimes sod farms short vegetation, bare ground and flat topography. Prefers grazed areas and areas with burrowing rodents.	●	●
northern harrier *Circus cyaneus*	SSC	Coastal salt and fresh-water marsh. Nest and forage in grasslands, from salt grass in desert sink to mountain cienagas. Nests on ground in shrubby vegetation, usually at marsh edge; nest built of a large mound of sticks in wet areas.	●	●

FC = federal candidate species
FE = federally listed as endangered
FP = California Fully Protected species
FT = federally listed as threatened
SE = listed by California as endangered
SSC = California species of concern
ST = listed by California as threatened

Table 5-2 CNDDB Occurrences for Special-status Wildlife Species in the Solano County Mosquito Abatement District Program Area

Species Name	Status	Habitat	Solano County (Service Area)	Adjacent Program Area Counties
western yellow-billed cuckoo *Coccyzus americanus occidentalis*	FC, SE	Riparian forest nester, along the broad, lower flood-bottoms of larger river systems. Nests in riparian jungles of willow, often mixed with cottonwoods, with lower story of blackberry, nettles, or wild grape.		●
black swift *Cypseloides niger*	SSC	Coastal belt of Santa Cruz and Monterey County; central and southern Sierra Nevada; San Bernardino and San Jacinto Mountains. Breeds in small colonies on cliffs behind or adjacent to waterfalls in deep canyons and sea-bluffs above the surf; foraging		●
white-tailed kite *Elanus leucurus*	FP	Rolling foothills and valley margins with scattered oaks and river bottomlands or marshes next to deciduous woodland. Open grasslands, meadows, or marshes for foraging close to isolated, dense-topped trees for nesting and perching.	●	●
American peregrine falcon *Falco peregrinus anatum*	SSC	Near wetlands, lakes, rivers, or other water; on cliffs, banks, dunes, mounds; also, human-made structures. Nest consists of a scrape or a depression or ledge in an open site.	●	●
saltmarsh common yellowthroat *Geothlypis trichas sinuosa*	SSC	Resident of the San Francisco Bay region, in fresh and salt water marshes. Requires thick, continuous cover down to water surface for foraging; tall grasses, tule patches, willows for nesting.	●	●
bald eagle *Haliaeetus leucocephalus*	SE	Ocean shore, lake margins, and rivers for both nesting and wintering. Most nests within 1 mile of water. Nests in large, old-growth, or dominant live tree with open branches, especially ponderosa pine. Roosts communally in winter.		●
yellow-breasted chat *Icteria virens*	SSC	Summer resident; inhabits riparian thickets of willow and other brushy tangles near watercourses. Nests in low, dense riparian, consisting of willow, blackberry, wild grape; forages and nests within 10 ft of ground.	●	
California black rail *Laterallus jamaicensis coturniculus*	ST	Inhabits freshwater marshes, wet meadows and shallow margins of saltwater marshes bordering larger bays. Needs water depths of about 1 inch that does not fluctuate during the year and dense vegetation for nesting habitat.	●	●
Suisun song sparrow *Melospiza melodia maxillaris*	SSC	Resident of brackish-water marshes surrounding Suisun Bay. Inhabits cattails, tules and other sedges, and salicornia; also known to frequent tangles bordering sloughs.	●	●

FC = federal candidate species FP = California Fully Protected species SE = listed by California as endangered ST = listed by California as threatened
FE = federally listed as endangered FT = federally listed as threatened SSC = California species of concern

Table 5-2 CNDDB Occurrences for Special-status Wildlife Species in the Solano County Mosquito Abatement District Program Area

Species Name	Status	Habitat	Solano County (Service Area)	Adjacent Program Area Counties
San Pablo song sparrow *Melospiza melodia samuelis*	SSC	Resident of salt marshes along the north side of San Francisco and San Pablo Bays. Inhabits tidal sloughs in the salicornia marshes; nests in grindelia bordering slough channels.	●	●
purple martin *Progne subis*	SSC	Inhabits woodlands, low elevation coniferous forest of Douglas-fir, ponderosa pine, and Monterey pine. Nests in old woodpecker cavities mostly, also in human-made structures. Nest often located in tall, isolated tree/snag.		●
California clapper rail *Rallus longirostris obsoletus*	FE, SE	Salt-water and brackish marshes traversed by tidal sloughs in the vicinity of San Francisco Bay. Associated with abundant growths of pickleweed, but feeds away from cover on invertebrates from mud-bottomed sloughs.	●	●
bank swallow *Riparia riparia*	ST	Colonial nester; nests primarily in riparian and other lowland habitats west of the desert. Requires vertical banks/cliffs with fine-textured/sandy soils near streams, rivers, lakes, ocean to dig nesting hole.		●
California least tern *Sternula antillarum browni*	FE, SE	Nests along the coast from San Francisco Bay south to northern Baja California. Colonial breeder on bare or sparsely vegetated, flat substrates: sand beaches, alkali flats, landfills, or paved areas.	●	
least Bell's vireo *Vireo bellii pusillus*	FE, SE	Summer resident of southern California in low riparian in vicinity of water or in dry river bottoms; below 2000 ft. Nests placed along margins of bushes or on twigs projecting into pathways, usually willow, baccharis, mesquite.		●
yellow-headed blackbird *Xanthocephalus xanthocephalus*	SSC	Nests in freshwater emergent wetlands with dense vegetation and deep water. Often along borders of lakes or ponds. Nests only where large insects such as odonata are abundant, nesting timed with maximum emergence of aquatic insects.		●
Mammals				
pallid bat *Antrozous pallidus*	SSC	Deserts, grasslands, shrublands, woodlands and forests. Most common in open, dry habitats with rocky areas for roosting. Roosts must protect bats from high temperatures. Very sensitive to disturbance of roosting sites.	●	●
Townsend's big-eared bat *Corynorhinus townsendii*	SSC	Throughout California in a wide variety of habitats. Most common in mesic sites. Roosts in the open, hanging from walls and ceilings. Roosting sites limiting. Extremely sensitive to human disturbance.		●

FC = federal candidate species
FE = federally listed as endangered
FP = California Fully Protected species
FT = federally listed as threatened
SE = listed by California as endangered
SSC = California species of concern
ST = listed by California as threatened

Table 5-2 CNDDB Occurrences for Special-status Wildlife Species in the Solano County Mosquito Abatement District Program Area

Species Name	Status	Habitat	Solano County (Service Area)	Adjacent Program Area Counties
western red bat *Lasiurus blossevillii*	SSC	Roosts primarily in trees, 2-40 ft above ground, from sea level up through mixed conifer forests. Prefers habitat edges and mosaics with trees that are protected from above and open below with open areas for foraging.	●	●
salt-marsh harvest mouse *Reithrodontomys raviventris*	FE, SE	Only in the saline emergent wetlands of San Francisco Bay and its tributaries. Pickleweed is primary habitat. Do not burrow, build loosely organized nests. Require higher areas for flood escape.	●	●
Suisun shrew *Sorex ornatus sinuosus*	SSC	Tidal marshes of the northern shores of San Pablo and Suisun Bays. Require dense low-lying cover and driftweed and other litter above the mean high tide line for nesting and foraging.	●	
salt-marsh wandering shrew *Sorex vagrans halicoetes*	SSC	Salt marshes of the south arm of San Francisco Bay. Medium high marsh 6-8 ft above sea level where abundant driftwood is scattered among salicornia.		●
American badger *Taxidea taxus*	SSC	Most abundant in drier open stages of most shrub, forest, and herbaceous habitats, with friable soils. Needs sufficient food, friable soils and open, uncultivated ground. Preys on burrowing rodents. Digs burrows.	●	●

FC = federal candidate species
FP = California Fully Protected species
SE = listed by California as endangered
ST = listed by California as threatened
FE = federally listed as endangered
FT = federally listed as threatened
SSC = California species of concern

5.2 Environmental Impacts and Mitigation Measures

This section identifies the environmental issues and concerns associated with the Program alternatives and presents the significance criteria used to evaluate the likely impacts of the various Program alternatives on terrestrial resources under CEQA. The significance criteria establish thresholds, utilizing the intent of the HCPs and NCCPs associated with each area, for determining whether an impact rises to a level that is biologically significant. The environmental issues describe the mechanisms by which such impacts might occur.

5.2.1 Evaluation Concerns and Criteria

The Program alternatives are implemented as part of an IMMP as described in Section 2.3. The IMMP uses alternative nonchemical and chemical treatments in sequential manner to minimize potential environmental impacts evaluating each treatment site and situation and implementing the least harmful technique that is applicable for that situation. Treatments with higher potential risk to the environment are only implemented when treatments with lower potential risk are ineffective or cannot be applied to that site. This approach minimizes the overall Program risk, but environmental concerns relating to different alternatives remain. As discussed previously in this PEIR, the Program Area is distributed across the District rather than in a single particular location. The effects on terrestrial organisms are largely attributable to the physical alteration of terrestrial habitats and potential for post-application contamination of soils or vegetation leading to ingestion of pesticide chemicals or reduction in habitat/cover. Additionally, organisms may come into direct dermal contact with pesticides.

5.2.1.1 Environmental Concerns

The Program alternatives have the potential to affect terrestrial resources directly by affecting physical habitat and through acute or chronic toxicity to nontarget organisms. Habitat alterations such as removal or reduction of habitat and vegetative cover may also indirectly result in impacts to the ranges and abundance of prey animals. Exposure of nontarget organisms can result in acute or chronic toxicity, depending on the concentrations encountered. Additionally, indirect exposure may occur via ingestion of contaminated prey animals, bioaccumulation of chemicals, or biotransformation of pesticide active ingredients to different compounds.

The following key issues associated with potential indirect impacts to nontarget receptors, including known terrestrial resources, are derived from the public scoping concerns and addressed in the impact analyses contained herein:

- Discuss potential impacts on insect pollinators/bees from chemicals in treatment applications.
- Describe the effects of all chemicals that are used and/or proposed for use on wildlife and natural ecosystems, including insect prey, birds, mammals, fish, vegetation and site topography. The loss of prey for birds is a particular concern. Also, consider unwanted effects of the “inactive” portion of the pesticides. What effects will the carrier portion of the chemicals have on the environment?
- Discuss the potential impact of Bs/Bti products on native species.
- Describe the role of mosquitoes within the food chain, and subsequent impacts if they were removed in terms of amphibians, birds, reptiles, fish and insects. This issue is also addressed in Section 6.2.

  Although mosquitoes serve a positive role as prey items for some avian insectivores, bats, and small reptiles and amphibians, the loss of a focus area (infested or large population of mosquitoes) will not affect the predator populations overall. The recovery times are short and mosquitoes are generally only one prey source for those predators.

- Pesticides can also kill the natural predators of mosquitoes, which have great difficulty in recovery from pesticides.

In general, the pesticides used for mosquito control exhibit low or no toxicity to birds or mammals. Little information is available regarding toxic effects to reptile or terrestrial amphibian mosquito predators. Although mosquito pesticides may also affect invertebrate predators (e.g., dragonflies), recovery of predator populations is usually rapid as the predator populations extend beyond the application areas and will rapidly replace any lost individuals.

> Pesticide efficacy attenuation and possible long-term resistance is an issue for all chemically based mosquito control programs. It is addressed by the use of different control methods and different agents over time where possible (BMP and IMM techniques are designed to identify these issues early and modify applications as appropriate and feasible.

5.2.1.2 Significance Criteria

Significance criteria were developed based on applicable regulations and management policies, a review of the available information, including the HCPs and NCCPs associated with each area, and the professional judgment of the authors.

The CEQA Guidelines include several criteria for determining whether there is a potentially significant impact to biological resources in the CEQA Environmental Checklist Appendix G. Those that could apply to the Proposed Program as thresholds of significance for biological resources have been used in the following evaluation. Impacts were considered significant if they would:

> Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the CDFW, USFWS, or USFS.

> Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan.

In the analysis that follows, these criteria are compiled into four criteria, incorporating the above:

> Adversely affect terrestrial habitats (including vernal pools) through reduction of the amount or quality of habitat available.

> Adversely affect native terrestrial plant or animal populations through direct mortality.

> Adversely affect species listed as endangered, threatened, or candidate species by the USFWS or NMFS, or as endangered, threatened, or species of concern by the CDFW (jointly referred to as special-status species) by direct or indirect mechanisms.

> Conflict with the adoption of an HCP, NCCP, or other approved habitat conservation plan.

5.2.2 Evaluation Methods and Assumptions

Pesticides the District uses were investigated to provide a preliminary assessment of the potential impacts to nontarget ecological receptors. An ecological health assessment was the principal method used to evaluate concerns associated with the Program alternatives (discussed in detail in Appendix B). A comprehensive literature review of published toxicity and fate and transport information was conducted. In addition, the District supplied information specific to pesticide and herbicide products used in the Program Area to support the potential exposure and toxicity assessment, including:

> Pesticides the District uses or proposes to use

> Pesticide label requirements

> Types of application sites (e.g., habitat types)

> Application procedures

> Frequency of applications

> Total amount used per treatment for each application site, based on seasonal uses

> Physicochemical properties of the pesticides/active ingredients

> Pesticide target (mosquito) efficacy

> Reported adverse effects (e.g., reproductive, developmental, carcinogenic).

The pesticide application scenarios that result in reasonable efficacy with minimal unwanted estimated risk are preferred and are the basis of IPM approaches and BMPs the District employs. BMPs are described in Section 2.9. Each of the pesticides and herbicides identified as warranting further evaluation in Appendix B (as a subset of all pesticides and herbicides in use) are known to exhibit at least one parameter that appears to have a significant role in the resulting potential or perceived risk.

5.2.2.1 Methodology

The methodology used to prepare this programmatic impact analysis section is as follows:

> Obtain source-specific data for Program-specific chemical constituents.

> Evaluate Appendix B sections related to the Program.

> Identify terrestrial resource impacts and mitigation measures for Program activities, considering the appropriate HCPs and NCCPs for the area that may result in effects to nontarget terrestrial organisms.

Appendix B provides the results of review and evaluations of the 42 pesticide (insecticides, herbicides) active ingredients and four adjuvants. Tables 2-2 and 2-3 list the pathogens, adulticides, and pesticides the District currently uses or may use in the future for mosquito abatement. The District currently does not use herbicides for vegetation management, but in the future they could use herbicides for weed control and other vegetation management activities. Table 2-1 lists the herbicides the District may use in the future. Application information, including the target organisms, number of treatments, total amount applied, and specific habitat types was obtained from the District. The total number of applications and weight or volumes of specific pesticides the District applied in Summer 2011 through Spring 2012 are presented in Appendix B, Attachment A of this PEIR. A comprehensive literature review was conducted to evaluate environmental fate and general toxicity characteristics for the active ingredients and adjuvants. The results of the assessment were used to rank the potential for adverse effects to human health and the environment. Chemical and application characteristics such as the likelihood of exposure for nontarget species and habitats, the potential for drift, and the possible transport and fate of the chemical in various media (i.e., air, surface water/groundwater, soil) were considered in the assessment. Those active ingredients that appear to exhibit a higher level of risk are listed in Table 5-5. These active ingredients may be subjected to additional examination using criteria that are more stringent.

Impacts are evaluated with regard to desired terrestrial plant and animal (e.g., native and listed species) communities, and effects on food supply for wildlife, using the criteria described above (Section 5.2.1.2). Potential impacts were assessed using available information on the types of control and treatment and the toxicity of the various chemicals used, the treatment descriptions, and the physical and biological connections between treatment areas and terrestrial ecosystems. This information was evaluated in the context of the treatment alternatives and the existing environment under baseline conditions in the Program Area as described in Section 5.1.1.

The potential effects of the treatment alternatives will vary depending on the specific treatment applied, the size and location of the treated area, the type of habitat treated, and the timing and frequency of treatment. More targeted treatments would be expected to have lesser effects than less targeted treatments. Small treatment areas or less frequent applications of a treatment would generally be expected to result in lesser effects than the same treatment applied over a larger area or more frequently.

The potential impact of the nonchemical alternatives is based on the type and location of habitats affected and the magnitude and frequency of control activities. The potential impacts of the chemical alternatives were evaluated based on the magnitude and duration of the treatments and the toxicity information presented in Chapter 6, Ecological Health, and in Appendix B. The evaluation of alternatives considered the life histories of the different listed terrestrial species and ecological interactions including impacts to the terrestrial food chain.

This evaluation assumes that all pesticides are applied in accordance with product label instructions and USEPA and CDPR requirements. The USEPA requires mandatory statements on pesticide product labels that include directions for use; precautions for avoiding certain dangerous actions; and where, when, and how the pesticide should be applied. This guidance is designed to ensure proper use of the pesticide and prevent unreasonable adverse effects to humans and the environment. All pesticide labels are required to include the name and percentage by weight of each active ingredient in the product/formulation. Toxicity categories for product hazards and appropriate first-aid measures must be properly and prominently displayed. Pesticide labels also outline proper use, storage, and disposal procedures, as well as precautions to protect applicators. The directions for use specify the target organism (pest), appropriate application sites, application rates or dosages, contact times, and required application equipment for the pesticide. Warnings regarding appropriate wind speeds, droplet sizes, or habitats to avoid during application are also prominently displayed.

This evaluation does not include assumptions about which alternative treatment strategy or strategies would be applied in any given area. Therefore, each treatment alternative is considered as a stand-alone option, although the Program may include multiple alternative implementations within a given area (i.e., physical controls followed by larvicide application). Criteria used to trigger a particular alternative based on mosquito abundance and other variables are included in District-specific operating procedures. This evaluation assumes that important parameters such as sediment half-life are dependent on the specific conditions at the time of pesticide application; therefore, the values listed herein serve as reference values.

5.2.2.2 Assumptions

The following assumptions were used in the assessment of potential terrestrial resource impacts from the Program alternatives:

> Site-specific evaluation of terrestrial resource impacts is not within the scope of this programmatic evaluation.
> Site-specific locations within the Program Area are not addressed for a PEIR.
> The programmatic evaluation is based on the current proposed control methods and is subject to change based on the results of initial treatment.
> Existing baseline environmental soil and tissue concentration data related to Program chemicals are unavailable for most areas.

Assumptions related to the analysis of hazards, toxicity, and exposure for chemical treatment methods are explained below, including the definition of key terms. The concept of ecological food web is explained as well.

5.2.2.2.1 Hazardous Material

A "hazardous material" is defined in California Health and Safety Code Section 25501 (p): as "any material that, because of its quantity, concentration, or physical or chemical characteristics, poses a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment. "Hazardous materials" include, but are not limited to, "hazardous substances, hazardous waste, and any material that a handler or the administering agency has a reasonable basis for believing that it would be injurious to the health and safety of persons or harmful to the environment if released into the workplace or the environment." Any liquid, solid, gas, sludge, synthetic product, or commodity that exhibits characteristics of toxicity, ignitability, corrosiveness, or reactivity has the potential to be considered a "hazardous material."

5.2.2.2.2 Toxicity and Exposure

Toxicology is the study of a compound's potential to elicit an adverse effect in an organism. The toxicity of a compound is dependent upon exposure, including the specific amount of the compound that reaches an organism's tissues (i.e., the dose), the duration of time over which a dose is received, the potency of the chemical for eliciting a toxic effect (i.e., the response), and the sensitivity of the organism receiving the dose of the chemical. Toxicity effects are measured in controlled laboratory tests on a dose/response scale, whereby the probability of a toxic response increases as dose increases. Exposure to a compound is necessary for potential toxic effects to occur. However, exposure does not, in itself, imply that toxicity will occur. Thus, toxic hazards can be mitigated by limiting potential exposure to ensure that doses are less than the amount that may result in adverse health effects.

The toxicity data included in the numerous tables and charts in this document are generally derived from rigidly controlled laboratory animal studies designed to determine the potential adverse effects of the chemical under several possible routes of exposure. In these studies, the species of interest is exposed to 100 percent chemical at several doses to determine useful information such as the lowest concentration resulting in a predetermined adverse effect (LOAEL) on numerous selected physiological and behavioral systems. The second component of these tests is to determine the highest concentration of chemical that results in no measurable adverse effect (NOAEL).

However, these, and other, coordinated and focused laboratory tests are designed to document the effects of the chemical when a continuous, controlled, exposure exists and do not realistically reflect the likely exposures or toxicity in the District field application scenarios. As such, the toxicity information is intended as an overview of potential issues and guidance for understanding the completely "safe" maximum exposure levels of applications that would not adversely impact humans or nontarget plant and animal species.

Although the regulatory community uses this basic information to provide a relative comparison of the potential for a chemical to result in unwanted adverse effects and this information is reflected in the approved usage labels and MSDSs, in actual practice, the amounts applied in the District's Program Area are substantially less than the amounts used in the toxicity studies. Because of these large inherent safety factors in recommended product application rates, the amount of chemical resulting in demonstrated toxicity in the laboratory is nowhere near the low exposure levels associated with an actual application. The application concentrations consistent with the labels or MSDSs are designed to be protective of the health of humans and other nontarget species (i.e., low enough to not kill them, weaken them, or cause them to fail to reproduce).

The toxicity of a chemical is also affected by various biological, chemical, and physical parameters that affect the behavior of a compound in the environment and its potential toxicity. The chemistry, fate, and transport of a compound must be analyzed to fully estimate potential exposure to a given receptor. The fate and transport of a compound is determined by the physical and chemical properties of the compound itself and the environment in which it is released. Thus, the following characteristics of a compound must be evaluated: its half-life in various environmental media (e.g., sediment, water, air); photolytic half-life; lipid and water solubility; adsorption to sediments and plants; and volatilization. Environmental factors that affect fate and transport processes include temperature, rainfall, wind, sunlight, water turbidity, dissolved oxygen concentrations, and water and soil pH. Information pertaining to these parameters allows evaluation of how compounds may be transported between environmental media (e.g., from sediments to biota), how a compound may be degraded into various breakdown products, and how long a compound or its breakdown products may persist in different environmental media. Appendix B provides a discussion of the environmental fate of the pesticide active ingredients and other chemicals associated with specific pesticide formulations used in the Program alternatives.

5.2.2.2.3 Ecological Food Webs

While it is important to evaluate the potential adverse impacts of a pesticide application to potentially affected nontarget species, it is neither feasible nor practical to evaluate those potential impacts to a representative food web. An ecological food web is represented in the illustration representing some of the multitude of possible biotic and food uptake interactions in an ecosystem. Each of the possible connections between species is also associated with other interactions. These interactions can be the result of higher levels of animal species organization (trophic) or paired interactions between individuals that result in added, positive associations (symbiotic) for both species.

Although ecological food webs could be used to describe the complex system interactions that might be associated with District application scenarios, it is neither feasible nor practical to evaluate those potential impacts using a food-web approach. The numerous, complex interactions in typical food webs would be fraught with uncertainty and complex animal associations and, as such, difficult to confidently assess relevant impacts. Because of these constraints and complexity, it would be neither practical nor productive to attempt to predict food-web interactions for each of the numerous application scenarios the District uses. It is appropriate, however, to use a food-web analysis to identify and consider the first level of potentially adverse effects to nontarget species that might result from a pesticide application. This information is used to assure a minimal impact to nontarget species and is typically a part of the MSDS and Toxicology profiles, providing the basis for the more reasonable, technically feasible approach to evaluate the safety of the pesticides the District commonly uses. Figure 5-2 illustrates the ecological food web concept.

Various biological, chemical, and physical parameters affect the behavior of a compound in the environment and its potential toxicity. The chemistry, fate, and transport of a compound must be analyzed to fully estimate potential exposure. The fate and transport of a compound is determined by the physical and chemical properties of the compound itself and the environment in which it is released. Thus, the following characteristics of a compound must be evaluated: its half-life in various environmental media (e.g., sediment, water, air); photolytic half-life; lipid and water solubility; adsorption to sediments and plants; and volatilization. Environmental factors that affect fate and transport processes include temperature, rainfall, wind, sunlight, water turbidity, and water and soil pH. Information pertaining to these parameters allows evaluation of how compounds may be transported between environmental media (e.g., from sediments to biota), how a compound may be degraded into various breakdown products, and how long a compound or its breakdown products may persist in different environmental media. Appendix B provides a discussion of the environmental fate of the pesticide active ingredients and other chemicals associated with specific pesticide formulations used in the Program alternatives.

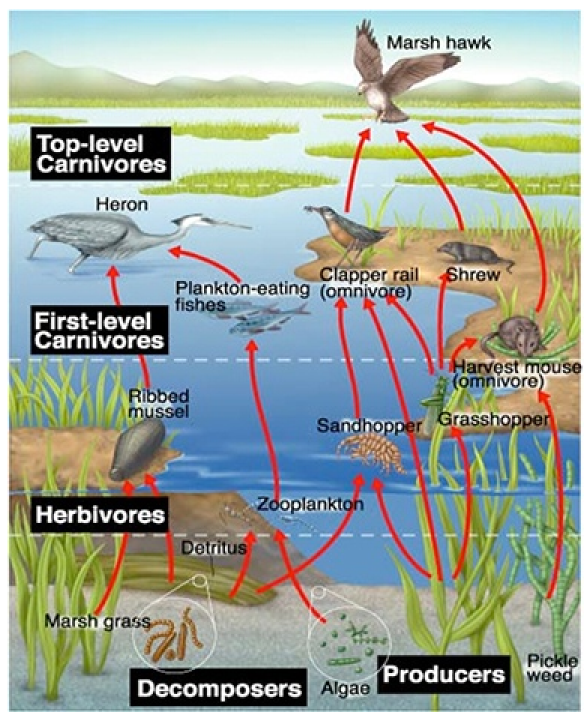

Figure 5-2 **Ecological Food Web Concept**

5.2.3 Surveillance Alternative

Surveillance activities involve monitoring the abundance of adult and larval mosquitoes, field inspection of mosquito habitat, testing for the presence of antibodies specific to encephalitis virus in domestic and wild fowl, collection and testing of ticks, small rodent trapping, and/or response to public service requests regarding mosquitoes. Mosquito populations are monitored through the use of traps, inspections, and sampling in mosquito habitats. Known and suspected habitats are anywhere that water can collect, be stored, or remain standing for more than a few days, including, but not limited to, catch basins, stormwater detention systems, residential communities, parks, ornamental ponds, unmaintained swimming pools, seeps, seasonal wetlands, tidal and diked marshes, wastewater ponds, sewer plants, winery waste/agricultural ponds, managed waterfowl ponds, canals, creeks, tree holes, and flooded basements. If preexisting roads and trails are not available, low ground pressure ATVs may be used to access sites. Offroad access is minimized and used only when roads and trails are not available.

Surveillance activities might result in some physical damage to habitat or associated vegetation from use of ATVs and foot traffic in areas without marked trails to access areas for potential vector inspection. Sensitive species could be directly impacted by these activities. The District investigates sites for the presence of special-status and sensitive species prior to initiating any further surveillance measures in natural habitat areas, and only small areas would be disrupted temporarily by access activities. Therefore, few impacts would occur to some terrestrial resources, including nontarget organisms, and conflicts with existing HCPs/NCCPs would be minimized.

> **Impact TR-1:** The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from the Surveillance Alternative would be **less than significant** and mitigation is not required.

5.2.4 Physical Control Alternative

Physical control for mosquitoes consists of the management of aquatic areas that provide mosquito-producing habitat (including freshwater marshes and lakes, saltwater marshes, temporary standing water, vernal pools, and wastewater treatment facilities) especially through water control and maintenance or improvement of channels, tide gates, levees, and other water control facilities.

Physical control methods reduce or eliminate mosquito development sites by improving the habitat value for mosquito predators (i.e., providing deepwater sanctuary for larvivorous fish) or by reducing the habitat value for mosquitoes. Mosquitoes require stagnant standing water in order to complete their life cycle. The District attempts to reduce these habitats primarily through onsite education (of the responsible landowner/property manager or steward) by District Staff regarding techniques for vegetation management, increased water circulation, steepening banks, changes in water quality, or by reducing the duration that standing water is allowed to exist. (Vegetation management is discussed below in Section 5.2.5). Currently, the District rarely conducts physical control activities. Instead, it recommends that landowners and stewards implement maintenance activities, and advises landowners on source reduction techniques for mosquito habitat.

Three types of physical control practices are implemented:

- Maintenance activities include removal of sediments from existing water circulation ditches, repair of existing water control structures, removal of debris in natural channels, clearance of brush for access to streams tributary to wetlands areas, and filling of existing, nonfunctional water circulation ditches to achieve required water circulation dynamics and restore ditched wetlands.
- New construction typically involves the creation of new ditches to enhance tidal flow preventing stagnant water.
- Cultural practices include vegetation and water management (i.e. irrigation practices, placement culverts or other engineering works, and making other physical changes to the lands.

The District currently performs a limited amount of physical control activities, but may choose to include more in the future if feasible. Those activities performed are in accordance with all the appropriate environmental regulations and in a manner that generally maintains or improves habitat values for desirable species. Physical control activities can be relatively minor, typically consisting of reducing habitat for mosquitoes such as restoration of sections of border habitats, or temporary ponding associated with wetlands. These activities may occur in aquatic rather than terrestrial habitats, although by draining areas of standing water, new terrestrial habitat is created. While vernal pools provide developmental habitat for mosquitoes, they also provide habitat for many special-status or sensitive species in California. Therefore, destruction or impairment of vernal pool habitat should be avoided under the Physical Control Alternative. This BMP is listed in Section 2.9: If suitable habitat necessary for special-status or sensitive species is found, including vernal pools, and if nonchemical physical and vegetation management control methods have the potential for affecting these species, then the District will coordinate with the CDFW, USFWS, and/or NMFS before conducting control activities within this boundary or cancel activities in this area. If the District determines no suitable habitat is present, control activities may occur without further agency consultation.

HCP/NCCPs generally incorporate measures to protect sensitive habitats. Protective measures or restoration goals for upland and other terrestrial habitats are often included in these documents and their accompanying permits. The Physical Control Alternative specifically seeks to alter habitats to make them less suitable to mosquito larvae, but the habitats primarily affected are aquatic rather than terrestrial in order to control mosquitoes. As a result, this alternative, when applied within the boundaries of an HCP/NCCP, would not likely conflict with the provisions of that HCP/NCCP for terrestrial species.

> **Impact TR-2:** The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from the Physical Control Alternative would be **less than significant** and mitigation is not required.

5.2.5 Vegetation Management Alternative

Direct vegetation management is currently rarely done by the District but would generally consist of activities to reduce the mosquito habitat value of sites by improving water circulation or access by fish and other predators, or to allow access by District staff to standing water for inspections and treatment. The District may use hand tools (e.g., shovels, pruners, chain saws, and weed-whackers) and heavy equipment where necessary for vegetation removal or thinning. The District currently does not use herbicides but in the future it may apply herbicides to improve surveillance or reduce mosquito habitats. These activities primarily occur in or adjacent to aquatic habitats to assist with the control of mosquitoes. The District may also perform vegetation management to assist other agencies and landowners with the management of invasive/nonnative vegetation. These actions are typically performed under the direction of the concerned agency, which also maintains any required permits.

HCP/NCCPs generally incorporate measures to protect sensitive habitats and sensitive species, including plants. Protective measures or restoration goals for upland and other terrestrial habitats are often included in these documents and their accompanying permits. The Vegetation Management Alternative would alter habitats to make them less suitable to mosquito larvae, but this would primarily affect aquatic habitat. As a result, this alternative, when applied within the boundaries of an HCP/NCCP, would not likely conflict with the provisions of that HCP/NCCP for terrestrial species

5.2.5.1 Physical Management

Non-herbicide management actions may involve reducing standing vegetation using equipment. The use of weed-whackers, chain saws, or shovels may lead to physical injury of terrestrial plants and animals in the treatment area. Manual removal would be the primary method of vegetation removal and would not be anticipated to affect substantial patches of vegetation in the affected area. Use of heavy equipment for vegetation management could affect larger areas but would not affect a large enough area to change the quality or functionality of the habitat for nontarget species. Areas of vegetation managed with heavy equipment would generally not be larger than a few acres. The District would apply BMPs to reduce these impacts by (1) identifying sensitive species locations, if any, in the treatment area prior to commencing any vegetation removal actions, and (2) limiting the extent of heavy equipment use in order to minimize the area affected (Section 2.9.2). The potential impact on wildlife would be minimal at most as the animals would return to their selected habitats within a few hours after the cessation of the noise sources for most of the physical application techniques currently used by the District.

> **Impact TR-3:** The impact to terrestrial habitats through the selected reduction of a portion of the habitat, to native terrestrial plants or animals (including special-status species) or to HCP, NCCPs from the targeted use of the non-herbicide physical component of the Vegetation Management Alternative, would impact only a small fraction of the available habitat, would not substantially change the quality or functionality of the habitat for non-target species, and would thus be **less than significant** and mitigation is not required.

5.2.5.2 Herbicides

The District may use herbicides in the future to control vegetation in and around mosquito habitats to improve surveillance and reduce suitable mosquito habitats. The herbicides the District may use are listed in Table 2-1 and discussed in detail in Appendix B. The active ingredients in those herbicides are listed in Table 5-3.

Table 5-3 Herbicide Control Options for Mosquito Abatement as Discussed in Appendix B

Active Ingredient	Appendix B
Imazapyr	Section 4.6.1
Glyphosate	Section 4.6.2

The District proposes to use herbicides with an active ingredient consisting of either imazapyr or glyphosate, which are classified as broad-spectrum herbicides. These active ingredients exhibit low or no toxicity to mammals, birds, and terrestrial invertebrates. For detailed toxicity information see Appendix B. In addition, BMPs are applied to minimize the impact of herbicide use on nontarget terrestrial plants, including special-status plants. In particular, the District will take action to minimize drift of sprays to nontarget areas by carefully considering weather variables such as wind velocity and direction and chance of precipitation.

5.2.5.2.1 Glyphosate

The District may use glyphosate in the future. Although some recent concerns have been expressed about possible sub lethal effects of glyphosate products (e.g., endocrine disruption in humans), it is virtually nontoxic to mammals and practically nontoxic to birds, fish, and invertebrates on an acute basis. With BMP application techniques, glyphosate can be used safely when an adequate buffer to water sources is maintained (glyphosate is much more toxic to fish and aquatic invertebrates than to mammals, birds, or terrestrial invertebrates). In terrestrial systems, glyphosate is immobile and breaks down relatively quickly via microbial processes. Glyphosate does not pose a risk to nontarget terrestrial mammals, birds, or invertebrates based on current usage patterns and use of BMPs. This herbicide is nonselective and may affect many types of plants. Glyphosate is not effective on submerged or mostly submerged foliage and, therefore, is only applied to control emergent foliage (Schuette 1998; Siemering 2005). When BMPs are applied, the potential impact of glyphosate on special-status species or other nontarget plants is greatly reduced. They include using targeted, small-scale treatments and taking actions to minimize drift and runoff post-application (see Appendix B, Section 4.6.2, for a more detailed evaluation of this herbicide).

Impact TR-4: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from herbicide use for the Vegetation Management Alternative would be **less than significant** and mitigation is not required.

5.2.5.3 Adjuvants

An adjuvant is any compound that is added to an herbicide formulation or tank mix to facilitate the mixing, application, or effectiveness of that herbicide. Adjuvants can either enhance activity of an herbicide's active ingredient (activator adjuvant) or offset any problems associated with spray application, such as adverse water quality or wind (special purpose or utility modifiers). Activator adjuvants include surfactants, wetting agents, sticker-spreaders, and penetrants. Table 2-1 lists four adjuvants the District may use in the future for vegetation management. The active ingredients in those four adjuvants include isopropanol, butyl alcohol, polydimethylsiloxane and silicon. The environmental fate and toxicity of adjuvants the District may use are described in detail in Appendix B and listed in Table 5-4. A subset of the adjuvants available for District use was identified for further examination based upon use patterns and toxicity (Appendix B, Table 1-1). They are listed again in Table 5-4.

Table 5-4 Adjuvants for Weed Abatement as Discussed in Appendix B

Active Ingredient	Appendix B
APEs	Section 4.7.1
Polydimethylsiloxane Fluids	Section 4.7.2

Polydimethylsiloxanes are insoluble in water and typically sorb to particulates. Degradation time varies depending on moisture in soils. These chemicals appear to be relatively nontoxic to most organisms, but data are lacking. Although toxicity and environmental fate information for these products is scarce, the toxicity and environmental fate of polydimethylsiloxanes, using BMP application practices to reduce the transfer of polydimethylsiloxanes to nontarget areas post-application (i.e., targeted applications), these products should not result in unwanted adverse effects.

Alkyl phenol ethoxylates (APEs) include a broad range of chemicals that tend to bind strongly to particulates and persist in sediments. Nonylphenol and short-chain nonylphenol ethoxylates are moderately bioaccumulative and extremely toxic to aquatic organisms. Aside from use in agricultural herbicide mixtures, APEs are commonly present in detergents, cleaners, food packaging, and cosmetics. The acute toxicity of APEs to mammals is low. They are possible estrogen-mimics. Although the USEPA has recently recommended that this suite of chemicals be evaluated further due to their widespread use (past and present), persistence, and possible estrogen-mimicking behavior, current information about APEs is not adequate to determine the risk they may pose to nontarget terrestrial organisms (USEPA 2010). BMP application practices would reduce the transfer of APEs to nontarget areas.

Impact TR-5: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from adjuvants used for herbicide applications under the Vegetation Management Alternative would be **less than significant** and mitigation is not required.

5.2.6 Biological Control Alternative

Biological control of mosquitoes involves the intentional use of mosquito pathogens, parasites, and predators to reduce the mosquito population. It is one of the principal components of the District's IPM approach, in which the emphasis is on source reduction and control of mosquitoes in their immature stages.

5.2.6.1 Mosquito Larvae Pathogens

As part of their Biological Control Alternative, the District employs bacterial larvicides (Table 2-2 in Appendix B and Table 5-5 below) that are highly specific to mosquitoes. These biological controls include the active ingredients Bs, Bti, and spinosad. Because the potential environmental impacts of Bs or Bti application are generally similar to those of chemical pesticide applications, these materials and spinosad are evaluated below under Section 5.2.7.1.1, Chemical Control Alternative. The environmental fate and toxicity of these control agents is discussed further in Appendix B.

Table 5-5 Biological Control Options for Larval Mosquito Abatement as Discussed in Appendix B

Active Ingredient	Appendix B
Bs	Section 4.3.1
Bti	Section 4.3.2
Spinosad	Section 4.3.3

5.2.6.2 Mosquito Predators

Mosquitofish (*Gambusia affinis*) are presently the only commercially available mosquito predators. The District's rearing and stocking of these fish in mosquito habitats is the most commonly used biological control agent for mosquitoes in the world. Used correctly, this fish can provide safe, effective, and persistent suppression in various mosquito sources. However, due to concerns that mosquitofish may potentially impact red-legged frog and tiger salamander populations in natural water bodies, the District has implemented a number of BMPs. District policy when supplying mosquitofish to the public is to clearly stipulate that their usage is restricted to artificial environments that are isolated from waterways. The public is provided with information describing appropriate locations for the placement of mosquitofish and citing CDFW regulations prohibiting the planting of mosquitofish in waters of the state without a permit. This limits public use of mosquitofish to artificial water bodies such as ornamental fish ponds, water troughs, water gardens, fountains, and unused swimming pools. These artificial habitats are not included in HCPs/NCCPs. The use of mosquitofish by the District in natural waterways is evaluated in Section 4.2.6.

> **Impact TR-6: No impact** would occur to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCPs/NCCPs from the use of mosquitofish for the Biological Control Alternative.

5.2.7 Chemical Control Alternative

Chemical control consists of the application of chemicals to directly reduce populations of mosquitoes that pose a risk to public health. As part of their IMMP, the District prioritizes the least toxic materials available for control of the larval stages, focusing on bacterial larvicides, growth regulators, and surface films rather than organophosphates (OPs) or pyrethroids. Control of adult mosquitoes may become necessary under some circumstances, such as in the event of a disease outbreak (documented presence of infectious virus in active host-seeking adult mosquitoes), or lack of access to larval sources and habitats leading to the emergence of large numbers of biting adult mosquitoes. OP insecticides may be used in rotation with pyrethrins or pyrethroids to avoid the development of resistance. The active ingredients currently used for control of adult mosquitoes have been deliberately selected for lack of persistence and minimal effects on nontarget organisms when applied at label rates for ULV mosquito control.

Throughout this section, the evaluation of each chemical option under the Chemical Control Alternative includes consideration of the HCPs and NCCPs that reflect important aspects of the selection of significance criteria and action thresholds. By focusing on the intent of the HCPs and NCCPs, the evaluation process identifies impacts that may rise to a level that is biologically significant. The environmental issues describe the mechanisms by which such impacts might occur and the species populations likely affected.

All chemicals are applied in strict conformance with label requirements, which have been approved by CDPR for use in California. Pesticide labels are legal requirements and include instructions telling users how to apply the product and precautions the applicator should take to protect human health and the environment. In addition, chemicals are applied in conformance with the PAP as required by the NPDES Vector Control Permit. All BMPs included in the PAP and product labels are followed and include such measures as restrictions in certain land uses and weather (i.e., wind speed) parameters.

The chemicals the District uses for mosquito control are presented in Tables 6-1 and 6-2 in Chapter 6, Ecological Health. These pesticides are registered and approved for public health use by the USEPA and CDPR for use by certified employees of local mosquito and vector control agencies to control mosquitoes. When applied with strict adherence to product label requirements and additional BMPs listed in Section 2.9, their use should not result in adverse effects to nontarget organisms. Detailed discussions of the environmental fate and toxicity of these active ingredients are provided in Appendix B. A subset of the pesticides (Table 5-6) available for District use was identified for further examination based upon use patterns and toxicity (Appendix B, Table 1-1). The following discussion groups these chemicals based on their target organism or life stage and discusses these pesticides in reference to impacts to terrestrial nontarget organisms.

Table 5-6 Chemical Control Active Ingredients and Adjuvants Identified in Appendix B

Active Ingredient	Potential Issue
Methoprene	Prevalent use; toxicity to aquatics and insects
Bti	Toxicity to aquatic organisms; no synergist required
Etofenprox	Prevalent use; public concerns
Pyrethrins	Prevalent use; requires synergist (PBO)
Resmethrin	Requires synergist (e.g., PBO); potential endocrine disruptor
Vegetable Oil (coconut oil)/mix	Contains low percentage of petroleum distillate
Permethrin	Toxicity to aquatic organisms; potential endocrine disruptor
APEs	Toxicity to aquatic organisms; moderately bioaccumulative
Glyphosate	Prevalent use; possible endocrine disruptor

See Appendix B, Table 1-1

The Districts would use a variety of techniques and equipment to apply mosquito larvicides, including hand-held sprayers, backpack sprayers and blowers, truck- or ATV-mounted spray rigs, and helicopters or other aircraft. The Districts use conventional pickup trucks and ATVs as larvicide vehicles. Equipment used in ground applications of liquid formulations include hand-held sprayers (handcans or spray bottles), and backpack sprayers and blowers. Hand-held sprayers (handcans) are standard 1- or 2- or 3-gallon garden style pump-up sprayers used to treat very small isolated areas. Backpack sprayers are either hand pump-up for liquid applications and have a 2.5/3 to 5-gallon tank or are gas powered.

When large areas are simultaneously producing mosquito larvae at densities exceeding District treatment thresholds, then the District may use helicopters or other aircraft to apply larvicides. This may also be the case when adequate access by ground based vehicles is lacking. Aerial application of larvicides is a relatively infrequent activity for the District, with the exception of annual fall flooding of seasonal wetlands managed as waterfowl habitat .The 5-year average (2008-2012) for the number of applications made to non-seasonal waterfowl habitat areas was 9, with average number of acres treated per application being 289.5 acres. The 5-year average (2008-2012) for the number of applications made to seasonal waterfowl habitat was 27. The average number of acres treated per application during this period was 187.0 acres. Aerial application of liquid and granular larvicides typically occurs during daylight hours between dawn and sunset (depending upon climatic conditions) at an altitude above the treatment site of less than 40 feet for liquids and 50 feet for granules.

Aerial applications for adulticiding using helicopters or fixed-wing aircraft may be used in the future if necessary to suppress a disease outbreak or to obtain effective control in areas bordered by extensive mosquito production sites or with small, narrow, or inaccessible network of roads. The flight parameters differ by program and technique depending upon climatic conditions. Some operations fly during daylight hours so their applications begin either at dawn or before sunset and work into twilight. The aircraft can be flown at less than 200-foot altitude, which may make it easier to hit the target area. Other operations may be conducted night typically after twilight or before dawn during the peak periods of adult mosquito activity. The aircraft typically are flown between 200- and 300-foot altitudes. Swath widths vary from operation to operation but are normally set somewhere between 400 and 1,200 feet. Aerial applications may be conducted over, but are not limited to, the following land uses within the Program Area: salt marsh, diked marsh, seasonal wetlands; evaporation ponds and wastewater ponds; and agricultural, residential, commercial, industrial, and recreational areas.

The number and type of vehicles and equipment required would vary by District, as shown in Table 12-8 of Chapter 12 (Noise), which also shows the range of noise levels that they typically would generate at 50- and 400-foot distances from the source and the land uses that would be affected. Noise from helicopters also is shown at a 500-foot distance. All land use types potentially could be treated through aerial applications, although those shown are the most likely to be affected. Estimated noise levels and potential sources are included in Table 12-8 of Chapter 12, which addresses the potential impacts of noise on humans during routine operations that would be similar to future operations under the Proposed Program.

5.2.7.1 Mosquito Larvicides

As part of their Chemical Control Alternative, the District employs bacterial larvicides that are highly specific to mosquitoes (Table 2-2). These controls include the active ingredients Bs and Bti, and spinosad. Larvicides are used to manage immature life stages of mosquitoes including larvae and pupae in aquatic habitats. Temporary aquatic habitats are usually targeted because permanent water bodies generally support natural mosquito predators such as fish. The larvicides are applied using ground application equipment, fixed wing aircraft, and rotary aircraft. The potential impact of equipment noise on wildlife would be minimal, as the animals would return to their selected habitats within a few hours at most for application techniques currently used by the District.

The toxicity of *Bs*, *Bti*, spinosad, methoprene, and monomolecular films are discussed in detail in Appendix B and listed in Table 5-7. The District employs BMPs to reduce the relative potential impacts of these chemical alternatives to nontarget organisms as well as to applicators. Because Bs, Bti, and spinosad are applied to aquatic rather than terrestrial environments to control larval mosquitoes, the potential for exposure of terrestrial organisms is low, although some overspray could occur.

Table 5-7 Chemical Control Options for Larval Mosquito Abatement as Discussed in Appendix B

Chemical Classification	Active Ingredient	Appendix B
Bacterial larvicide	*Bs*	Section 4.3.1
Bacterial larvicide	*Bti*	Section 4.3.2
Bacterial larvicide	Spinosad	Section 4.3.3
Hydrocarbon ester	Methoprene	Section 4.3.4
Organophosphate	Temephos	Section 4.2.2
Surfactants	Alcohol Ethoxylated Surfactant (monomolecular film) and Aliphatic Petroleum Hydrocarbons	Section 4.3.5 Section 4.3.6

5.2.7.1.1 Bacterial Larvicides (*Bs*, *Bti*, spinosad)

Bacterial larvicides such as *Bti* (and *Bs* are highly selective microbial pesticides (for mosquitoes) that when ingested, produce gut toxins that cause destruction of the insect gut wall leading to paralysis and death. These microbial agents are delivered as endospores in granular, powder, or liquid concentrate formulations. *Bs* and *Bti* are applied directly to larval mosquito habitats (water) rather than to terrestrial environments and strictly adhere to product labels and other BMPs. Additionally, *Bs* and Bti are practically nontoxic to terrestrial organisms, including birds, bees, and mammals.

Spinosad is a natural insecticide derived from the fermentation of a common soil microorganism, Saacharopolyspora spinosa. Spinosad causes neurologic effects in insects consistent with the general activation of nicotinic acetylcholine receptors, but by a mechanism that is novel among known insecticides (Mayes et al. 2003). Exposure manifests as constant involuntary nervous system impacts ultimately leading to paralysis and death of the insect. Spinosad is highly effective against *lepidopteran* larvae (e.g., butterflies and moths), as well as some *Diptera* (mosquitoes and flies), *Coleoptera* (beetles), Thysanoptera (e.g., thrips), and *Hymenoptera* (e.g., bees, wasps) (Mayes et al. 2003). The effects of spinosad on beneficial pollinators such as honeybees are of concern. The District currently does not use spinosad; however upon doing so, it will incorporate BMPs that are designed to minimize exposure of bees to spinosad, such as avoiding aquatic areas near hives and maintaining buffer zones. Bees and other nontarget insects may contact spinosad residues following applications; however, residues are generally are below acute toxicity thresholds to honeybees. Field studies evaluating typical spinosad applications have demonstrated low risk to adult honeybees and little to no effect on hive activity and brood development, provided that the residue is allowed to dry for up to three hours (Mayes et al. 2003).

Spinosad is of low acute toxicity to birds and mammals. Generally, spinosad is applied directly to larval mosquito habitat, thereby reducing potential exposures of sensitive terrestrial insects including moths, butterflies, and honeybees. Application of spinosad follows strict product label descriptions.

> **Impact TR-7:** The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from bacterial larvicides used for the Chemical Control Alternative would be **less than significant** and mitigation is not required.

5.2.7.1.2 Hydrocarbon Esters (Methoprene)

Methoprene is a juvenile hormone analogue that interferes with insect larval development (growth regulator). This chemical does not exhibit the nonspecific target effects of neurological toxins such as pyrethrin.

Methoprene is used as a larvicide and, as such, is not applied to terrestrial environments. Some drift into terrestrial environments may occur when it applied, but it is almost irrelevant for hand and aerial (e.g., helicopter) applications since treatments are restricted at moderate to high wind speeds. Methoprene is considered one of the safest of all larvicide options, and the District uses methoprene prevalently during each season of the year. Methoprene is highly effective against mosquitoes at low concentrations (very low volume applications are used when possible) and degrades quickly in the environment, thereby reducing the potential exposure and risk to nontarget organisms. The District avoids applying methoprene to vernal pools due to the fact that vernal pools provide habitat for many special-status or sensitive species.

Methoprene has high toxicity to nontarget insects such as moths, butterflies, and beetles; however, moths, butterflies, and most species of beetles do not occupy aquatic habitats and so would have very limited exposure.

> **Impact TR-8:** The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from the use of methoprene for the Chemical Control Alternative would be **less than significant** and mitigation is not required.

5.2.7.1.3 Organophosphates

Temephos is the only OP with larvicidal use and is often used to help prevent mosquitoes from developing resistance to the bacterial larvicides. Temephos can be used on lakes, ponds, reservoirs, swamps, marshes, tidal areas, intermittently flooded areas, catch basins, drainage systems, irrigation systems, ornamental ponds, wastewater, and polluted and stagnant water, and is applied by Mosquito Abatement Districts (CDPR 2010). Temephos has extremely low water solubility and binds strongly to soils. It is moderately acutely toxic to mammals and fish, but highly toxic to nontarget aquatic invertebrates (e.g., stoneflies, mayflies). Temephos is applied following label requirements and at low concentrations. It is not expected to have direct impact on terrestrial animals and the use of temephos has declined over time in favor of bacterial larvicides, methoprene, and surface oils (USEPA 2000).

> **Impact TR-9:** The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from the use of temephos for the Chemical Control Alternative would be **less than significant** and mitigation is not required.

5.2.7.1.4 Surfactants (Alcohol Ethoxylated Surfactant, Aliphatic Solvents)

Petroleum- and plant-based (ethoxylated isostearyl alcohols) oils are used as surface-active agents effective against larvae and pupae. These oils are effective against these immature life stages when inhaled at the water surface or by physically forming a surface film that drowns the mosquito. These treatments may also be effective against adult mosquitoes during adult emergence. These treatments are specific to aquatic environments and are not applied to terrestrial environments, although some drift may occur.

> **Impact TR-10: No impact** would occur to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCPs/NCCPs from the use of surfactants for the Chemical Control Alternative.

5.2.7.2 Mosquito Adulticides

In addition to chemical control of mosquito larvae, the District may use pesticides for control of adult mosquitoes when no other tools are available and if specific criteria are met, including species composition, population density (as measured by landing count or other quantitative method), proximity to human populations, and/or human disease risk. Treatment of adults is a tertiary line of defense employed when physical controls and larviciding are not sufficiently effective. As with larvicides, adulticides are applied in strict conformance with label requirements (Appendix B). Adulticides the District uses (or may use) are listed in Table 2-3 and Table 5-8. Because of the ecological sensitivity of vernal pools, which support numerous species of listed plants and invertebrates, and the toxicity of these chemicals to nontarget organisms, the District avoids use of these adulticides in areas with vernal pools. A detailed discussion of the environmental fate and toxicity of these pesticides is provided in Appendix B. The potential impact on wildlife from noise associated with equipment use would be minimal, as the animals would return to their selected habitats within a few hours at most for application techniques currently used by the District.

Table 5-8 Chemical Control Options for Adult Mosquito Abatement as Discussed in Appendix B

Chemical Classification	Active Ingredient	Appendix B
Pyrethrin	Pyrethrin	Section 4.1.1
Synthetic Pyrethroid	Phenothrin (sumithrin or d-phenothrin)	Section 4.1.3
Synthetic Pyrethroid	Prallethrin	Section 4.1.4
Synthetic Pyrethroid	Resmethrin	Section 4.1.8
Synthetic Pyrethroid	Permethrin	Section 4.1.10
Pyrethroid-like	Etofenprox	Section 4.1.11
Synergist	PBO	Section 4.1.12
Organophosphate	Naled	Section 4.2.1

5.2.7.2.1 Pyrethrins

The District uses pyrethrin for mosquito control. is applied around vegetated areas near both man-made and natural sites including water residential, industrial, recreational and agricultural areas.

Pyrethrins readily degrade in water and soil, but may persist under anoxic conditions. They tend to strongly adsorb to soil surfaces and, hence, have low potential to leach into groundwater. These chemicals may have low to moderate acute toxicity to mammals; however, proper personal protective equipment would alleviate potential for human exposure, especially when delivered via ULV techniques. Pyrethrins may be highly toxic to fish (freshwater, estuarine, marine) and invertebrates, although exposures would likely be low during and following ULV applications, which are designed to prevent environmental persistence and potential impacts to nontarget ecological receptors.

Pyrethrins have low to moderate acute toxicity to mammals via the oral, dermal, and inhalation routes and are practically nontoxic to birds. The risks to nontarget insects such as honeybees are reduced by only applying pyrethrins typically after twilight or during predawn hours when bees and other pollinators are inactive. Little risk to nontarget terrestrial organisms is expected when this and other BMPs are applied.

> **Impact TR-11:** The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from the use of pyrethrins for the Chemical Control Alternative would be **less than significant** and mitigation is not required.

5.2.7.2.2 Pyrethroids and Pyrethroid-Like Compounds

Pyrethroid insecticides are synthetic compounds that are chemically similar to the pyrethrins but have been modified to increase stability and activity against insects. Some synthetic insecticides are similar to pyrethroids, such as etofenprox, but have a slightly different chemical composition. First generation or “Type I” photosensitive pyrethroids include d-allethrin, phenothrin (sumithrin), prallethrin, resmethrin, and tetramethrin. Typically, these pyrethroids are used indoors and around residential areas. The newer second-generation pyrethroids are mostly “Type II” pyrethroids. Type II pyrethroids are more toxic (than Type I pyrethroids) because they are less photosensitive and persist longer in the environment. The active ingredients that fall into this group include deltamethrin, esfenvalerate, lambda-cyhalothrin, and permethrin; and only permethrin is currently used by the District.

Pyrethroids affect insect neuroactivity by binding to a protein at the nerve fiber that regulates the voltage-gated sodium channel, This binding can delay the closing of sodium channels and/or cause a persistent activation of the sodium channels, which often results in repetitive activity (Type I pyrethroid) or blockage of nerve conduction (Type II pyrethroid). Most pyrethroids and pyrethroid-like compounds are of low toxicity to birds and mammals, but of high toxicity to honeybees. The risks to nontarget insects such as honeybees are reduced by restricting application of these compounds to night and predawn times, when bees and other pollinators are inactive. The active ingredients that have been selected for further evaluation in Appendix B (resmethrin, permethrin, and etofenprox) are discussed individually below.

Resmethrin

The District has used resmethrin in the past to treat outlying residential areas with tree hole mosquito problems, buffer areas adjacent to residential developments near reclaimed marshes, and industrial areas having high numbers of other species requiring control. Additionally, resmethrin use is declining in favor of nonresmethrin alternatives. Studies have shown rapid dissipation/low persistence following aerial ULV applications. Resmethrin is moderately toxic to birds and highly toxic to honeybees; however, little risk to nontarget terrestrial organisms is expected when BMPs are applied.

Permethrin

The District uses permethrin for mosquito during spring, summer, and fall. Permethrin products are used around residences in response to service requests. ground nests. Permethrin has low toxicity to mammals and is practically nontoxic to birds. It is highly toxic to honeybees; however, this pesticide is generally used with careful and strict BMP techniques such as using very small, localized applications. When used appropriately, little risk to nontarget terrestrial organisms is expected.

Etofenprox

Etofenprox is a pyrethroid-like compound that does not tend to persist in the environment or appear to pose a risk to mammals as it is frequently applied to backyards and patios and sometimes directly to domestic pets (for flea and tick control).

Etofenprox is not currently used, but would be applied during the nighttime and predawn hours when sensitive receptors such as honeybees are not active. Based on toxicity, environmental fate, and usage patterns, etofenprox, using BMPs, is not likely to result in adverse impacts to nontarget terrestrial organisms.

> **Impact TR-12:** The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from use of pyrethroids and pyrethroid-like compounds for the Chemical Control Alternative would be **less than significant** and mitigation is not required.

5.2.7.2.3 Synergist (Piperonyl Butoxide)

PBO was first registered in the 1950s and acts as a synergist. Synergists are chemicals that primarily enhance the pesticidal properties of other active ingredients, such as pyrethrins and synthetic pyrethroids. PBO is a registered active ingredient in products used to control many different types of flying and crawling insects and arthropods, although no products contain only PBO. It is registered for use in agricultural, residential, commercial, industrial, and public health sites. PBO interferes with the insect’s ability to detoxify pyrethrins and pyrethroids, by binding to microsomal enzymes in target organisms, thereby inhibiting the breakdown of other pesticides, including pyrethrins and pyrethroids (USEPA 2006a).

PBO degrades relatively rapidly in soil and water and, therefore, does not tend to persist in the environment. PBO may be highly toxic to some species of fish and aquatic invertebrates and is being evaluated as a possible endocrine disruptor. However, it is of low toxicity to terrestrial receptors such as mammals and honeybees. ULV applications of PBO are used whenever possible and in conjunction with BMPs for the co-applied pesticides.

> **Impact TR-13:** The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to HCP/NCCPs from use of the synergist PBO for the Chemical Control Alternative would be **less than significant** and mitigation is not required.

5.2.7.2.4 Organophosphates

Naled is used in rotation with pyrethrins or pyrethroids for control of adult mosquitoes to avoid the development of resistance. In addition to use for controlling adult mosquitoes, naled also has indoor and outdoor general use, and is used on food and feed crops, farms, dairies, pastureland, and in greenhouses and over standing water (CDPR 2010a). Naled tends to degrade quickly in surface waters especially following ULV applications. It has low water solubility and is mobile in some soils. Drift is almost irrelevant for hand and some aerial (e.g., helicopter) applications since treatments are restricted during moderate to high winds. In addition, spray setbacks are established to reduce spray drift for agricultural uses. The District strictly adheres to their BMPs and product label requirements, including the restriction of naled application to targets outside adequate buffer zones around permanent water bodies to reduce runoff and impacts to aquatic organisms. It is moderately toxic to mammals and birds.

Naled has been associated with mortality of honeybees when residue levels exceed 2,000 $\mu g/m^2$ following typical ULV applications in Florida (Zhong et al. 2004). If used, the District would spray during the evening when bees are inactive; however, bees tend to cluster outside around the entrance to the hive during the evening. To further minimize potential effects on nontarget pollinators, the District avoids spraying pesticides anywhere within a pre-determined proximity to bee hives. Naled is not currently used by the District; however, it may become a necessary rotational tool in the future to avoid the development of resistance in the event of a disease outbreak.

> **Impact TR-14:** The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to HCP/NCCPs from naled use for the Chemical Control Alternative would be **less than significant** and mitigation is not required.

5.2.7.2.5 Pyrethrin

The District uses pyrethrin for mosquito control. The potential impacts to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, or to special-status species are discussed above under Mosquito Adulticides (see TR-11) (Section 5.2.7.2).

5.2.7.2.6 Pyrethroids and Pyrethroid-like Compounds

Pyrethroid insecticides are synthetic compounds that are chemically similar to the pyrethrins but have been modified to increase stability and activity against insects. First generation or “Type I” photosensitive pyrethroids include d-allethrin, phenothrin (sumithrin), prallethrin, resmethrin, and tetramethrin. Typically, these pyrethroids are used indoors and around residential areas. The newer second-generation pyrethroids are mostly “Type II” pyrethroids. The active ingredients that fall into this group include deltamethrin, esfenvalerate, lambda-cyhalothrin, and permethrin. Type II pyrethroids are more toxic (than

Type I pyrethroids) because they are less photosensitive and persist longer in the environment. Most pyrethroids and pyrethroid-like compounds are of low toxicity to birds and mammals, but of high toxicity to honeybees. The potential impacts impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, or to special-status species are discussed above under Mosquito Adulticides (See TR-12) (Section 5.2.7.2).

The impacts of pyrethroids and pyrethroid-like insecticides are discussed above under Mosquito Adulticides (See TR-12) (Section 5.2.7.2).

> **Impact TR-15:** The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from pyrethroids use for the Chemical Control Alternative would be **less than significant** and mitigation is not required.

5.2.8 Cumulative Impacts

"Cumulative impacts" are defined as "two or more individual effects which, when considered together, are considerable or compound or increase other environmental impacts (CEQA Guidelines Section 15355). Cumulative impacts, as they relate to terrestrial resources, include past, present, and reasonably foreseeable actions that potentially impact terrestrial mammalian and avian wildlife, herptiles, aquatic organisms, nontarget invertebrates and pollinators, and botanical resources. Cumulative impacts can result from individually minor, but collectively significant, projects taking place over a period of time. The determination is whether a proposed project's incremental contribution to a cumulative impact results in a potentially "considerable" (i.e., significant) cumulative impact, and, if so, whether that project's incremental contribution can be mitigated to a less-than-significant level. The cumulative impacts analysis for terrestrial resources is contained in Section 1.3, and the determinations of cumulatively considerable impacts are summarized here.

The Surveillance, Physical Control, Vegetation Management, Chemical Control, and Other Nonchemical Control Alternatives" impacts to terrestrial resources were determined to be less than significant or in some cases "no impact." The Biological Control Alternative's use of mosquitofish had no impact to terrestrial resources. The key issues for consideration herein are potential effects on beneficial insect pollinators from chemical applications and the potential cumulative impacts associated with Vegetation Management and Chemical Control Alternatives' less-than-significant impacts.

- **Effects on Pollinators**: Colony collapse disorder (CCD) and the resulting decline in bee populations is an existing significant cumulative impact in the region. In general, while mosquito abatement activities may affect native pollinators near or adjacent to treatment areas, the District's careful practice of BMPs greatly reduces the potential cumulative impacts to nontarget pollinators. The Program's **less-than-significant impacts on insect pollinators related to mosquito abatement activities would not be cumulatively considerable or significant**.
- **Vegetation Management Alternative**: Weed and vegetation control activities the District **may** perform would be cumulative with those other entities perform within the Program Area. Weed control activities may affect native plants, as these species may lie within treatment areas, but the effects on individuals of native species are minimized, and the overall effect is likely beneficial, as native species will have less competition in treated areas and, thus, would be expected to be more successful. Based on this conclusion, the Program's incremental **less-than-significant effects relating to weed abatement activities would not, when considered with other weed abatement activities in the Program Area, be cumulatively considerable or significant**.
- **Chemical Control Alternative**: The uses of pesticides under the Chemical Control Alternative would be cumulative with uses of pesticides by agricultural, industrial, governmental, and residential users, an existing significant cumulative impact. The District's relative contribution to the loads of such concentrations is small compared with other users. The District preferentially uses nonchemical

alternatives and when using chemical alternatives, uses chemicals that are not persistent in the environment when chemicals are applied. As such, the District's Chemical Control Alternative does not contribute substantially to pesticide and herbicide exposures in the terrestrial environment. The Chemical Control Alternative has a **less-than-significant cumulative impact on terrestrial resource exposures to herbicides and pesticides**.

5.2.9 Environmental Impacts Summary

The Surveillance, Physical Control, Vegetation Management (excluding herbicide use), Biological Control, and Other Nonchemical Control/Trapping alternatives are expected to have less-than-significant to no impact on terrestrial resources (Table 5-9). The Chemical Control Alternative (including the mosquito larvicide, mosquito adulticide, and potential future herbicide application scenarios [under existing BMPs]) is expected to have only minimal impacts to nontarget terrestrial resources, and any unforeseen impacts are expected to be less than significant.

Table 5-9 Summary of Biological Resources - Terrestrial Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Effects on Biological Resources - Terrestrial					
Impact TR-1: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from the Surveillance Alternative would be **less than significant** and mitigation is not required.	LS	na	na	na	na
Impact TR-2: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from the Physical Control Alternative would be **less than significant** and mitigation is not required.	na	LS	na	na	na
Impact TR-3: The impact to terrestrial habitats through the selected reduction of a portion of the habitat, to native terrestrial plants or animals (including special-status species) or to HCP, NCCPs from the targeted use of the non-herbicide physical component of the Vegetation Management Alternative, would impact only a small fraction of the available habitat, would not substantially change the quality or functionality of the habitat for non-target species, and would thus be **less than significant** and mitigation is not required.	na	na	LS	na	na
Impact TR-4: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from herbicide use for the Vegetation Management Alternative would be **less than significant** and mitigation is not required.	na	na	LS	na	na
Impact TR-5: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from adjuvants used for herbicide applications under the Vegetation Management Alternative would be **less than significant** and mitigation is not required.	na	na	LS	na	na
Impact TR-6: No impact would occur to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCPs/NCCPs from the use of mosquitofish for the Biological Control Alternative.	na	na	na	N	na

Table 5-9 Summary of Biological Resources - Terrestrial Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact TR-7: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from bacterial larvicides used for the Chemical Control Alternative would be **less than significant** and mitigation is not required.	na	na	na	na	LS
Impact TR-8: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from the use of methoprene for the Chemical Control Alternative would be **less than significant** and mitigation is not required.	na	na	na	na	LS
Impact TR-9: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from the use of temephos for the Chemical Control Alternative would be **less than significant** and mitigation is not required.	na	na	na	na	LS
Impact TR-10: No impact would occur to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCPs/NCCPs from the use of surfactants for the Chemical Control Alternative.	na	na	na	na	N
Impact TR-11: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from the use of pyrethrins for the Chemical Control Alternative would be **less than significant** and mitigation is not required.	na	na	na	na	LS
Impact TR-12: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from use of pyrethroids and pyrethroid-like compounds for the Chemical Control Alternative would be **less than significant** and mitigation is not required.	na	na	na	na	LS
Impact TR-13: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to HCP/NCCPs from use of the synergist PBO for the Chemical Control Alternative would be **less than significant** and mitigation is not required.	na	na	na	na	LS

Table 5-9 Summary of Biological Resources - Terrestrial Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact TR-14: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to HCP/NCCPs from naled use for the Chemical Control Alternative would be **less than significant** and mitigation is not required.	na	na	na	na	LS
Impact TR-15: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from pyrethroids use for the Chemical Control Alternative would be **less than significant** and mitigation is not required.	na	na	na	na	LS

LS = Less-than-significant impact

N = No impact

na = Not applicable

SM = Potentially significant but mitigable impact

SU = Significant and unavoidable impact

5.2.10 Mitigation and Monitoring

Although most of the application scenarios are conducted using strict BMPs and schedules that avoid periods when the nontarget receptors may be more sensitive to stresses (nesting, migration likes, known movements between habitats (small mammals and reptiles), the District conducts surveillance and monitoring of results on a routine basis. When the District receives information about mosquito outbreaks or unwanted population expansions, they are dealt with on a case-by-case basis, yet still following BMPs and acknowledging the HCPs and NCCPs whenever possible and feasible. While the actual amount of the exposure of nontarget species to the active ingredient in each pesticide of concern is generally well below the levels that could result in toxicity in the laboratory test, the results of the pesticide application programs are constantly under surveillance and are monitored for total use, use per acre, timing of applications, and all parameters affecting the program application scenarios. The fate and transport of the chemicals of interest are discussed in detail in Appendix B.

No new mitigation measures are proposed as no potentially significant impacts to terrestrial resources were identified.

6 Ecological Health

This chapter evaluates the potential impacts of the Program alternatives on ecological health. The impact analysis relies heavily on Appendix B, Human and Ecological Health Assessment Report. Results of the evaluation are provided at the programmatic level. Section 6.1, Environmental Setting, presents an overview of hazards, toxicity, and exposure concepts, and contains federal, state, and local ordinances and regulations that are applicable to the Districts. Section 6.2, Environmental Impacts and Consequences, presents the following:

> Environmental concerns and evaluation criteria: A discussion of whether the Program alternatives would cause any potentially adverse impacts to ecological health

> Discussion of methods and assumptions

> Discussion of potential impacts of the Program alternatives and recommendations for mitigation, if required, for those impacts

> Cumulative impacts summary

> A summary of estimated ecological impacts

Ecological health is the integral relationship between the health and well-being of humans and the natural environment. This chapter places a particular emphasis on potential ecological receptors, in the broad sense that may or may not be at risk from Program alternatives. Chapters 4 and 5 provide evaluations of the potential impacts to species and groups of species (nontarget organisms), as well as habitats associated with aquatic and terrestrial resources, respectively. Chapter 7 evaluates the potential human health impacts related to the Program alternatives.

6.1 Environmental Setting

The Program Area is defined as the Solano County Mosquito Abatement District, which includes the entirety of Solano County and adjacent areas bordering its Service Area (Yolo, Sacramento, Napa, Sonoma, and Contra Costa counties) that are impacted by unwanted mosquitoes that must be controlled to minimize adverse effects, disease, and environmental impacts. The following section provides background information on the environmental fate and toxicity of pesticides and an overview of the regulatory setting with respect to chemical and biological pesticides.

6.1.1 Hazards, Toxicity, and Exposure in the Environmental Setting

A “hazardous material” is defined in California Health and Safety Code Section 25501 (p): as “any material that, because of its quantity, concentration, or physical or chemical characteristics, poses a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment. “Hazardous materials” include, but are not limited to, “hazardous substances, hazardous waste, and any material that a handler or the administering agency has a reasonable basis for believing that it would be injurious to the health and safety of persons or harmful to the environment if released into the workplace or the environment.” Any liquid, solid, gas, sludge, synthetic product, or commodity that exhibits characteristics of toxicity, ignitability, corrosiveness, or reactivity has the potential to be considered a “hazardous material.”

6.1.1.1 Toxicity and Exposure

Toxicology is the study of a compound’s potential to elicit an adverse effect in an organism. The toxicity of a compound is dependent upon exposure, including the specific amount of the compound that reaches an organism's tissues (i.e., the dose), the duration of time over which a dose is received, the potency of the chemical for eliciting a toxic effect (i.e., the response), and the sensitivity of the organism receiving the dose of the chemical. Toxicity effects are measured in controlled laboratory tests on a dose/response scale, whereby the probability of a toxic response increases as dose increases. Exposure to a compound is necessary for potential toxic effects to occur. However, exposure does not, in itself, imply that toxicity will occur. Thus, toxic hazards can be mitigated by limiting potential exposure to ensure that doses are less than the amount that may result in adverse health effects.

The toxicity data included in the numerous tables and charts in this document are generally derived from rigidly controlled laboratory animal studies designed to determine the potential adverse effects of the chemical under several possible routes of exposure. In these studies, the species of interest is exposed to 100 percent chemical at several doses to determine useful information such as the lowest concentration resulting in a predetermined adverse effect (LOAEL) on numerous selected physiological and behavioral systems. The second component of these tests is to determine the highest concentration of chemical that results in no measurable adverse effect (NOAEL).

However, these, and other, coordinated and focused laboratory tests are designed to document the effects of the chemical when a continuous, controlled, exposure exists and do not realistically reflect the likely exposures or toxicity in the District field application scenarios. As such, the toxicity information is intended as an overview of potential issues and guidance for understanding the completely "safe" maximum exposure levels of applications that would not adversely impact humans or nontarget plant and animal species.

Although the regulatory community uses this basic information to provide a relative comparison of the potential for a chemical to result in unwanted adverse effects and this information is reflected in the approved usage labels and MSDSs, in actual practice, the amounts actually applied in the District's Program Area are substantially less than the amounts used in the laboratory toxicity studies. Because of the large safety factors used to develop recommended product label application rates, the amount of chemical resulting in demonstrated toxicity in the laboratory is much higher than the low exposure levels associated with an actual application. The application concentrations consistent with the labels or MSDSs are designed to be protective of the health of humans and other nontarget species (i.e., low enough to not kill them, weaken them, or cause them to fail to reproduce). However, adverse effects may still occur to some nontarget organisms.

6.1.1.2 Chemistry, Fate, and Transport

Various biological, chemical, and physical parameters affect the behavior of a compound in the environment and its potential toxicity. The chemistry, fate, and transport of a compound must be analyzed to fully estimate potential exposure. The fate and transport of a compound is determined by the physical and chemical properties of the compound itself and the environment in which it is released. Thus, the following characteristics of a compound must be evaluated: its half-life in various environmental media (e.g., sediment, water, air); photolytic half-life; lipid and water solubility; adsorption to sediments and plants; and volatilization. Environmental factors that affect fate and transport processes include temperature, rainfall, wind, sunlight, water turbidity, and water and soil pH. Information pertaining to these parameters allows evaluation of how compounds may be transported between environmental media (e.g., from sediments to biota), how a compound may be degraded into various breakdown products, and how long a compound or its breakdown products may persist in different environmental media. Appendix B provides a discussion of the environmental fate of the pesticide active ingredients and other chemicals associated with specific pesticide formulations used in the Program alternatives.

6.1.2 Pesticides and the Environment

The pesticide and herbicide (not currently in use but may be used by the District for vegetation management in the future) formulations included in the Program are listed in Table 6-1 and Table 6-2. Appendix B provides the results of review and evaluations of the pesticide and herbicide active ingredients and adjuvants the District currently uses or proposes to use.

Table 6-1 Pesticide Active Ingredients

Active Ingredient	**Vector**
Biodegradable Alcohol Ethoxylated Surfactant	Mosquito
Petroleum Distillate-Mineral Oil Liquid	Mosquito
Bacillus sphaericus (*Bs*)	Mosquito
Bacillus thuringiensis israelensis (*Bti*)	Mosquito
Spinosad	Mosquito
Methoprene	Mosquito
Permethrin	Mosquito
Prallethrin	Mosquito
Pyrethrins	Mosquito
Resmethrin	Mosquito
Phenothrin (Sumithrin)	Mosquito
Etofenprox	Mosquito
PBO	Mosquito
Naled	Mosquito
Temephos	Mosquito

Table 6-2 Herbicide Active Ingredients and Adjuvants

Active Ingredient	**Vector**
Glyphosate	Weed
Imazapyr	Weed
Alkylphenol ethoxylates (APEs)	Weed
Polydimethylsiloxane	Weed

6.1.3 Regulatory Setting

Formulations proposed for each Program Alternative for vector control are and would be used according to federal and state regulatory requirements for the registration, transportation, and use of pesticides. The regulatory framework pertaining to the use of pesticides is discussed below.

6.1.3.1 Federal

The USEPA regulates pesticides under two major statutes: the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Federal Food, Drug, and Cosmetic Act (FFDCA). Under these acts, the USEPA mandates extensive scientific research to assess risks to humans, domestic animals, wildlife, plants, groundwater, and beneficial insects before granting registration for a pesticide. These studies allow the USEPA to assess the potential for human and ecological health effects. When new data raise concern about the safety of a registered pesticide, the USEPA may take action to suspend or cancel its registration. The USEPA may also perform an extensive special review of a pesticide's risks and benefits and/or work with manufacturers and users to implement changes in a pesticide's approved use (e.g., reducing application rates).

6.1.3.1.1 Federal Insecticide, Fungicide, and Rodenticide Act

FIFRA defines a pesticide as "any substance intended for preventing, destroying, repelling, or mitigating any pest." FIFRA requires USEPA registration of pesticides prior to their distribution for use in the US, sets registration criteria (testing guidelines), and mandates that pesticides perform their intended functions without causing unreasonable adverse effects on people and the environment when used according to USEPA-approved label directions. FIFRA defines an "unreasonable adverse effect on the environment" as "(1) any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of the pesticide, or (2) a human dietary risk from residues that result from a use of a pesticide in or on any food inconsistent with the standard under Section 408 of the Federal Food, Drug, and Cosmetic Act (21 USC 346a)."

FIFRA regulates only the active ingredients of pesticides, not inert ingredients, which manufacturers are not required to reveal. However, toxicity studies conducted under FIFRA are required to evaluate the active ingredient and the entire product formulation, through which any potential additive or synergistic effects of inert ingredients are established.

6.1.3.1.2 Clean Water Act and National Pollutant Discharge Elimination System

The Clean Water Act (CWA) establishes the principal federal statutes for water quality protection "to restore and maintain the chemical, physical, and biological integrity of the nation's water, to achieve a level of water quality which provides for recreation in and on the water, and for the propagation of fish and wildlife:"

- Section 303(d) requires each state to provide a list of impaired waters that do not meet or are expected not to meet state water quality standards as defined by that section. The CWA regulates potentially toxic discharges through the NPDES and ambient water quality through numeric and narrative water quality standards. The release of aquatic pesticides into waters of any state may require an NPDES permit, depending on the pesticide considered, and the conditions proposed for application.
- Section 402 requires permits for pollution discharges (except dredge or fill material) into US waters, such that the permitted discharge does not cause a violation of federal and state water quality standards. Biological and residual pesticides discharged into surface waters constitute pollutants and require coverage under an NPDES permit. In California, NPDES permits are issued by the SWRCB or the RWQCBs.

6.1.3.1.3 California Toxics Rule

In 2000, the USEPA developed water quality criteria for priority toxic pollutants to protect human health and the environment. A gap in California's water quality standards was created when the state's water quality criteria for priority toxic pollutants were overturned in 1994 (thus causing California to be out of compliance with the CWA). These established criteria are to be applied to inland surface waters, enclosed bays, and estuaries in California. The rule includes aquatic life criteria for 23 priority toxic pollutants, human health criteria for 57 priority toxics, and a compliance schedule.

6.1.3.2 State of California

California's programs for the registration of pesticides and commercial chemicals parallel federal programs, but many of California's requirements are stricter than federal requirements. The registration of pesticides and commercial chemicals in California is regulated by the California Environmental Protection Agency (Cal/EPA). Within the Cal/EPA, the CDPR) oversees pesticide evaluation and registration through use enforcement, environmental monitoring, residue testing, and reevaluation. The CDPR works with County Agricultural Commissioners, who evaluate, develop conditions of use, approve, or deny permits for restricted-use pesticides; certify private applicators; conduct compliance inspections; and take formal compliance or enforcement actions. The Secretary of Resources has certified California's pesticide regulatory program as meeting CEQA requirements (CDPR 2006).

California also requires commercial growers and pesticide applicators to report commercial pesticide applications to local County Agricultural Commissioners. The CDPR compiles this information in annual pesticide use reports. The CDPR's Environmental Hazards Assessment Program collects and analyzes environmental pesticide residue data, characterizes drift and other off-site pesticide movement, and evaluates the effect of application methods on movement of pesticides in air. If a pesticide is determined to be a toxic air contaminant, appropriate control measures are developed with the California Air Resources Board to reduce emissions to levels that adequately protect public health. Control measures may include product label amendments, applicator training, restrictions on use patterns or locations, and product cancellations.

6.1.3.2.1 Porter-Cologne Act and State NPDES Permitting

Under the Porter-Cologne Act (California Water Code Section 13000) the SWRCB, and the state's nine RWQCBs that it oversees, are responsible for administering federal and state water quality regulation and permitting duties.

The SWRCB oversees pesticide NPDES permitting in California. Users of specific larvicide and adulticide registered products are required to obtain coverage under the Statewide NPDES Permit for Biological and Residual Pesticide Discharges to Waters of the US from Vector Control Applications (SWRCB Water Quality Order No. 2012-0003-DWQ; NPDES No. CAG 990004; Vector Control Permit).Users of certain aquatic herbicides are required to obtain coverage under the Statewide General NPDES Permit for the Discharge of Aquatic Pesticides for Aquatic Weed Control in Waters of the US (SWRCB Water Quality Order No. 2004-0009-DWQ; NPDES No. CAG 990005; Aquatic Weed Control Permit).Pesticides and herbicides that require state NPDES permitting include *Bti*, *Bs*, temephos, spinosad, petroleum distillates, naled, pyrethrin, permethrin, resmethrin, prallethrin, PBO, etofenprox, 2,4-D, glyphosate, imazapyr, and triclopyr. Both permits are discussed in detail in Chapter 9, Section 9.1.2.2.9.

6.1.3.2.2 The Safe Drinking Water and Toxic Enforcement Act (Proposition 65)

This act, passed as a ballot initiative in 1986, requires the state to annually publish a list of chemicals known to the state to cause cancer or reproductive toxicity so that the public and workers are informed about exposures to potentially harmful compounds. Cal/EPA's Office of Environmental Health Hazard Assessment administers the act and evaluates additions of new substances to the list. Proposition 65 requires companies to notify the public about chemicals in the products they sell or release into the environment, such as through warning labels on products or signs in affected areas, and prohibits them from knowingly releasing significant amounts of listed chemicals into drinking water sources.

6.1.3.2.3 California Pesticide Regulatory Program

CDPR regulates the sale and use of pesticides in California. CDPR is responsible for reviewing the toxic effects of pesticide formulations and determining whether a pesticide is suitable for use in California through a registration process. Although CDPR cannot require manufacturers to make changes in labels, it can refuse to register products in California unless manufacturers address unmitigated hazards by amending the pesticide label. Consequently, many pesticide labels that are already approved by the United States Environmental Protection Agency (USEPA) also contain California-specific requirements. Pesticide labels defining the registered applications and uses of a chemical are mandated by USEPA as a condition of registration. The label includes instructions telling users how to make sure the product is applied only to intended target pests, and includes precautions the applicator should take to protect human health and the environment. For example, product labels may contain such measures as restrictions in certain land uses and weather (i.e., wind speed) parameters.

6.2 Environmental Impacts and Mitigation Measures

This section evaluates the potential ecological impacts from the Program Alternatives, which is primarily focused on the use of active ingredients in herbicides and/or pesticides under the Vegetation Management, Biological, and Chemical Control Alternatives.

6.2.1 Evaluation Concerns and Criteria

The public has requested that the PEIR evaluate the following issues and concerns related to ecological health, which were identified during the project scoping process. These concerns are addressed briefly below and in this chapter. While not required, the responses to the concerns help to direct the reader to the appropriate section or an appendix, or they provide explanatory information in concise form.

a. Describe the effects of all chemicals that are used and/or proposed for use on wildlife and natural ecosystems, including insect prey, birds, mammals, fish, vegetation and site topography. The loss of prey for birds is a particular concern.

   > The toxicity of the active ingredients and adjuvants is evaluated in Appendix B, and select pesticides are discussed in Section 6.2.7, including the potential impacts to nontarget ecological receptors associated with the major classes of active ingredients.

b. Discuss the potential impact of *Bacillus sphaericus* on native species. What would justify its use? What native species would be impacted?

   > *Bs* is a naturally occurring soil bacterium. Data indicate a high degree of specificity with *Bs* (and *Bti*) for mosquitoes and demonstrate no toxicity to chironomid larvae at any mosquito control application rate. *Bs* is capable of cycling in the aquatic environment providing weeks of effective mosquito control after a single dose. It is very effective in water with high organic content. The use, fate and transport, and potential toxicity of *Bs* is discussed in Section 6.2.7 and described in detail in Appendix B.

c. Discuss impacts on bees from chemicals in treatment applications.

   > Potential impacts on nontarget receptors, including bees, are discussed in Section 6.2.7 and Appendix B.

d. Concern over the “inactive” portion of the pesticides. What effects will the carrier portion of the chemicals have on the environment?

> FIFRA only regulates active ingredients; however, the toxicity studies performed under FIFRA also evaluate the entire product formulation. Cal-EPA and CDPR have approved the inactive ingredients in the Mosquito Vector Control Association of California's (MVCAC's) formulations in the NPDES permit. Thus, the potential additive or synergistic effect of inert ingredients is addressed through required laboratory testing protocols, which is beyond the scope of this PEIR.

e. Discuss the effects of pesticides on the natural predators of mosquitoes.

> As part of its IMMP, the District uses pesticides with high mosquito specificity and low toxicity to nontarget species when possible. The District also strictly adheres to labeling requirements to avoid nontarget species exposure.

f. The continued spray program leads to survival of mosquitoes resistant to pesticides – "the pest mill."

> The IPM approach the District uses to control mosquitoes is designed to minimize the potential for resistance to pesticides in the Program Area. Using this approach, the District implements the following practices: vegetative and biological control of mosquito populations, use of pesticides only when necessary, specific and localized spraying, ULV applications, use of pesticides with low persistence, and rotation of pesticides.

g. Describe the role of mosquitoes within the food chain, and subsequent impacts if they were removed in terms of amphibians, birds, reptiles, fish, and insects.

> Although larval and adult mosquitoes serve a positive role as prey items for some invertebrates, fish, avian insectivores, bats, small reptiles and amphibians, the loss of a focus area (infested or large population of mosquitoes) will not affect the predator populations overall. Many species of mosquitoes are short lived or seasonal, so they generally serve as only one prey source for predators. The decline in one prey species generally means that a predator will shift its food preference. No predators are known that rely exclusively on mosquitoes (larval or adult) for prey.

h. Upon application and broadcast of pesticides, what is the fate and transport of these chemicals? Look at droplet size, dispersal patterns given wind, conversion products (both in storage and environment), and impacts of conversion products. Discuss the persistence of proposed treatment substances in the environment as well as the potential for bioaccumulation.

> The use, fate, and transport of each pesticide included in the Program are described in detail in Appendix B.

i. The PEIR should include monitoring programs that are designed to validate assumptions regarding the environmental fate and transport of materials.

> The Surveillance Alternative is described in Section 6.2.3. Mitigation and monitoring is described in Section 6.2.11. Monitoring programs are beyond the scope of the PEIR and not needed based on information that suggests that the Program would not have a significant adverse effect.

j. The PEIR should include a detailed description and complete assessment of the chemical control impacts (current and future, direct and indirect) on habitats (including endangered, threatened, and locally unique species and sensitive habitats) and on species (sensitive fish, wildlife, or plants) and ensure CEQA requirements are met.

> Potential chemical control impacts are discussed in Section 6.2.7 and Appendix B. Potential impacts to sensitive aquatic and terrestrial species are discussed in Chapters 4 and 5, respectively.

k. The PEIR should include a detailed description and complete assessment of the biological control impacts (current and future, direct and indirect) on habitats (including endangered, threatened, and locally unique species and sensitive habitats) and on species (sensitive fish, wildlife, or plants) and ensure CEQA requirements are met.

 > Potential biological control impacts are discussed in Section 6.2.6 (mosquitofish), and biologically-based pathogens (the mosquito larvicides *Bs*, *Bti*, and spinosad) are discussed in Section 6.2.7.1 and Appendix B. Potential impacts to sensitive aquatic and terrestrial species are discussed in Chapters 4 and 5, respectively.

The CEQA Guidelines Appendix G, Environmental Checklist Form, does not contain criteria for determining significance of impacts to ecological health from the use of pesticides and herbicides. The closest criteria are those contained in Section 4.2.1.2 for biological resources. In short, the determination of significance is based on the potential to degrade the quality of the environment for natural communities and the species therein based on existing data and application methods. The specific concern is whether the activities used to control pest species could result in direct or indirect impacts to other organisms that may be present which are called nontarget ecological receptors.

6.2.2 Evaluation Methods and Assumptions

Pesticides the District uses were investigated to provide a preliminary assessment of the potential impacts to nontarget ecological receptors. An ecological health assessment was the principal method used to evaluate concerns associated with the Program alternatives (discussed in detail in Appendix B). A comprehensive literature review of published toxicity and fate and transport information was conducted. In addition, the District supplied information specific to pesticide and herbicide product use in the Program Area to support the potential exposure and toxicity assessment, including:

> Pesticides the District uses

> Pesticide label recommendations

> Types of application sites (e.g., habitat types)

> Application procedures

> Number of treatments per application site

> Total amount used per treatment for each application site, based on seasonal uses

> Physicochemical properties of the pesticides/active ingredients

> Pesticide target vector efficacy

> Reported adverse effects (e.g., reproductive, developmental, carcinogenic).

The pesticide application scenarios that result in reasonable efficacy with minimal unwanted estimated risk are preferred and are the basis of IPM/IMM approaches and BMPs the District employs. BMPs are described in Chapter 2. Each of the pesticides and herbicides identified as warranting further evaluation in Appendix B is known to exhibit at least one parameter that appears to drive potential or perceived risk.

This evaluation assumes that all pesticides are applied in accordance with product label instructions and USEPA and CDPR requirements. The USEPA requires mandatory statements to be included on pesticide product labels that include directions for use; precautions for avoiding certain dangerous actions; and where, when, and how the pesticide should be applied. This guidance is designed to ensure proper use of the pesticide and prevent unreasonable adverse effects to humans and the environment. All pesticide labels are required to include the name and percentage by weight of each active ingredient in the product/formulation. Toxicity categories for product hazards and appropriate first aid measures must be properly and prominently displayed. Pesticide labels also outline proper use, storage, and disposal procedures, as well as precautions to protect applicators. The directions for use indicate the target organism (pest), appropriate application sites, application rates or dosages, contact times, and required application equipment for the pesticide. Warnings regarding appropriate wind speeds, droplet sizes, or habitats to avoid during application are also prominently displayed.

This evaluation does not include assumptions about which alternative treatment strategy(ies) would be applied in any given area. Criteria used to trigger a particular alternative based on mosquito abundance and other variables are included in the District's operating procedures. This evaluation assumes that important parameters, such as soil or sediment half-life, are dependent on the specific conditions at the time of pesticide application, and values listed herein serve as references values.

This evaluation also does not include in an analysis of impacts to food webs.

While it is important to evaluate the potential adverse impacts of a pesticide application to potentially affected nontarget species, it is not practical to evaluate those potential impacts to all of the food webs present in the various ecosystems under consideration. An ecological food web is represented in the illustration representing some of the multitude of possible biotic and food uptake interactions in an ecosystem. Figure 6-1 depicts a highly simplified food web. In an ecological system, each level in the food web is occupied by dozens or hundreds of species, with consumers using those resources (in this case species from a lower trophic level) in different ways depending on availability and competition for those resources. Their utilization of these resources shifts by time of day and season, and multiple resources being used simultaneously or alternatively. If the availability of one resource deceases, the consumer can generally replace that with another resource. Each of the possible connections between species is also associated with other interactions, such as competitive release, where the abundance of a species increases in response to the decline in a competitor's abundance, or competitive interactions between consumers where one consumer can use a particular resource better than its competitor.

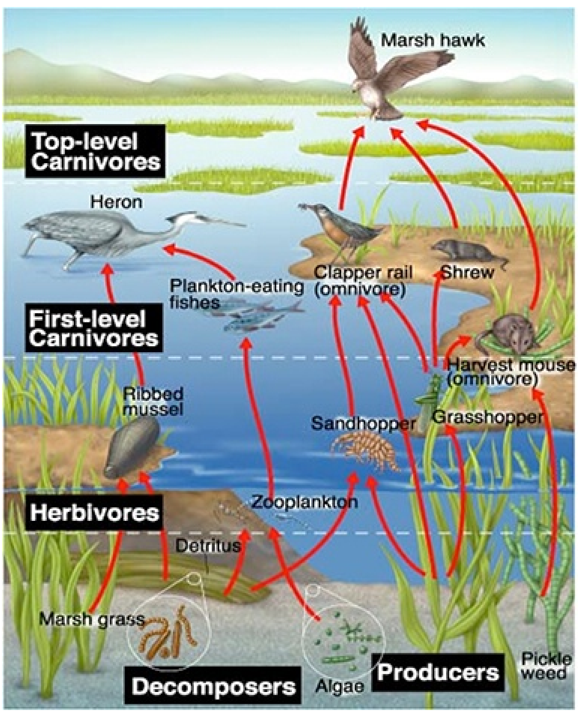

Figure 6-1 Ecological Food Web Concept

Although ecological food webs could be used to describe the complex system interactions that might be associated with District application scenarios, it is neither feasible nor practical to evaluate those potential impacts using a food-web approach. The numerous interactions in typical food webs are highly complex and would be subject to substantial uncertainty. This would make it exceedingly difficult to confidently assess relevant impacts. Because of these constraints and complexity, it would be neither practical nor productive to attempt to predict food-web interactions for each of the numerous application scenarios the District uses. It is appropriate, however, to utilize a food-web analysis to identify and consider the first level of potentially adverse effects to nontarget species that might result from a pesticide application. This information is used to assure a minimal impact to nontarget species and is typically a part of the MSDS and Toxicology profiles, providing the basis for the more reasonable, technically feasible approach to evaluate the safety of the pesticides the District commonly uses.

6.2.3 Surveillance Alternative

Mosquito surveillance is critical to IPM strategies because it provides information that is used to determine when and where to institute other mosquito control measures. The District's mosquito surveillance activities are conducted in compliance with accepted federal and state guidelines (e.g., *California Mosquito-Borne Virus Surveillance & Response Plan* (CDPH et al. 2013) and *Best Management Practices for Mosquito Control in California* (CDPH and MVC 2012). These guidelines allow for some reasonable flexibility in selection and specific application of control methods because local areas vary.

The Surveillance Alternative as the District practices would be a continuation of existing activities using applicable techniques, equipment, vehicles, and watercraft. Surveillance activities involve monitoring the abundance of adult and larval mosquitoes, field inspection of known/suspected mosquito habitat, monitoring and trapping of adult mosquitoes, testing for the presence of encephalitis virus-specific antibodies in sentinel chickens or wild birds, and/or response to public service requests regarding nuisance mosquitoes.

Small impacts to terrestrial and aquatic habitats could occur when the District is required to maintain paths and clearings to access surveillance sites and facilitate sampling capture and mortality of nontarget organisms. The District uses preexisting roads, trails, and walkways for surveillance activities. Therefore, habitat disturbance is minimal to negligible, reducing the potential indirect impacts to nontarget species and their habitat.

> **Impact ECO-1:** The Surveillance Alternative would have a **less-than-significant** impact on nontarget ecological receptors, including native or special-status plants and animals and mitigation is not required.

6.2.4 Physical Control Alternative

The Physical Control Alternative as the District may practice would be a continuation of potential activities using applicable techniques, equipment, vehicles, and watercraft.

Physical control for mosquitoes consists of the management of mosquito-producing habitat (including freshwater marshes and lakes, saltwater marshes, temporary standing water, and wastewater treatment facilities) especially through water control and maintenance or improvement of channels, tide gates, levees, and other water control facilities. Physical control is usually the most effective mosquito control technique because it provides a long-term solution by reducing or eliminating mosquito developmental sites and ultimately reduces the need for chemical applications. Physical control practices may be categorized into three groups: maintenance, new construction, and cultural practices.

The District does not currently perform these physical control activities but may choose to use this tool in the future. Should these activities be undertaken, they will be in accordance with all appropriate environmental regulations (wetland fill and dredge permits, endangered species review, water quality review, streambed alteration permits), and in a manner that generally maintains or improves habitat values for desirable species.

The Physical Control Alternative would not likely result in measurable adverse impacts to ecological receptors, including terrestrial and aquatic species. This alternative employs physical modifications to the natural and engineered environment providing a long-term solution to mosquito control while reducing the dependence on chemical controls. In addition, these practices are conducted to improve habitat for desirable species, such as native and special-status plants and animals (Appendix A).Chapter 4 discusses in greater detail the potential impacts of the Physical Control Alternative on aquatic resources, including sensitive and special-status species. Chapter 5 discusses impacts to terrestrial resources.

The District would employ a number of BMPs when implementing actions under the Physical Control Alternative. The District would perform these activities in accordance with all appropriate environmental regulations and in a manner that generally maintains or improves habitat values for desirable species.

Most of these activities occur in aquatic rather than terrestrial habitats, although by draining areas of standing water, new terrestrial habitat is created. Qualified personnel (e.g., District Biologists) survey sites to establish the presence or absence of special-status and sensitive species in aquatic, terrestrial, and temporary habitats (e.g., vernal pools). Vernal pools provide breeding habitat for mosquitoes but also provide habitat for many special-status or sensitive species in California. Therefore, destruction or impairment of vernal pool habitat should be avoided under the Physical Control Alternative. The presence of special-status or sensitive species at aquatic or terrestrial sites or the presence of suitable habitat for sensitive or special-status species would result in cancellation of scheduled physical control activities.

> **Impact ECO-2:** The Physical Control Alternative would have a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.

6.2.5 Vegetation Management Alternative

The Vegetation Management Alternative as the District may practice would be of activities using applicable techniques, equipment, vehicles, and watercraft.

The District may use hand tools (e.g., shovels, pruners, chain saws, and weed-whackers) and heavy equipment where necessary for vegetation removal or thinning and may sometimes apply herbicides to improve surveillance or reduce mosquito vector habitats. Vegetation removal or thinning primarily occurs in aquatic habitats to assist with the control of mosquitoes. To reduce the potential for mosquito breeding associated with water retention and infiltration structures, District staff may systematically clear weeds and other obstructing vegetation in wetlands and retention basins (or request the structures' owners to perform this task). Surveys for special-status plants, coordination with the landowner, and acquisition of necessary permits are completed before any work is undertaken. In some sensitive habitats and/or where sensitive species concerns exist, vegetation removal and maintenance actions would be restricted to those months or times of the year that minimize disturbance/impacts. Vegetation management may also perform to assist other agencies and landowners with the management of invasive/nonnative weeds. These actions would typically be performed under the direction of the concerned agency, which also maintains any required permits.

Vegetation management in the form of removal could include the use of weed-whackers, chain saws, and shovels. These activities could lead to physical injury to sensitive species of terrestrial plants and animals. The District would apply BMPs to reduce these impacts, including the identification of sensitive species in treatment areas prior to commencing any vegetation removal actions. The nonherbicide component of the Vegetation Management Alternative is not expected to result in adverse ecological effects. These activities would generally be coordinated with and monitored by public agencies and conducted during times to alleviate potential impacts to nontarget organisms.

> **Impact ECO-3:** The employment of a nonherbicide Vegetation Management Alternative in the form of physical removal would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.

Table 6-3 presents the herbicides the District may use in the future for vegetation management, as well as the section of Appendix B where they are described in detail.

Table 6-3 Herbicidesthe District May Use for Mosquito/Vegetation Management in the Future

Active Ingredient/Adjuvant	Appendix B
Imazapyr	Section 4.6.1
Glyphosate*	Section 4.6.2
APEs*	Section 4.7.1
Polydimethylsiloxane fluids	Section 4.7.2

*Identified for further evaluation in Appendix B and described below.

The District may consider the use of herbicides to control vegetation in and around mosquito habitats to improve surveillance and reduce suitable habitats. Herbicides are typically classified into the following major categories: pre-emergent herbicides (applied to the soil to prevent seedlings from germinating and emerging; post-emergent herbicides (applied after seedlings have emerged and control actively growing plants via contact damage or systemic impacts); contact herbicides (cause physical injury to the plant upon contact); and systemic herbicides (damage the internal functioning of the plant). Herbicides included in the Program have diverse chemical structures, act through distinct modes of action, and exhibit varying levels of potential toxicity to humans and nontarget species. The herbicides under consideration are nonselective and broad-spectrum (e.g., imazapyr and glyphosate). Imazapyr is a systematic, nonselective, pre- and post-emergent herbicide used for a broad range of terrestrial and aquatic weeds. Glyphosate represents a commonly used herbicide for the control and elimination of grass weeds and sedges. Most of the herbicides are moderately persistent in soil and water (for each herbicide's half-life in soil and water, please refer to Appendix B).

These herbicides are characterized by different of modes of action against target vegetation and, therefore, may exhibit unique toxicity to nontarget species, including aquatic and terrestrial organisms (see Appendix B for further details regarding toxicity and fate and transport characteristics of Program herbicides).

The District would apply BMPs to minimize the impact of herbicides on ecological receptors, including nontarget special-status terrestrial plants. In particular, the District would take action to minimize drift of sprays to nontarget areas, which is accomplished by carefully considering weather variables such as wind velocity and direction and chance of precipitation. To prevent potential impacts to aquatic systems, applications would be conducted when an adequate buffer to water sources is maintained.

> **Impact ECO-4:** The use of herbicides would be result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.

The majority of herbicides the District would consider for future use exhibit little to no toxicity to mammals, birds, and terrestrial invertebrates (Chapter 5). See Chapter 4 for a discussion of potential impacts to aquatic receptors. Select herbicides were identified for further evaluation based on use patterns and toxicity (Appendix B) and are discussed in further detail below.

6.2.5.1.1 Glyphosate

Glyphosate is a nonselective, post-emergent, and systemic herbicide registered for use in agricultural and nonagricultural areas. The District may use glyphosate. Although some recent concerns have been expressed about possible sublethal effects of glyphosate products, it is virtually nontoxic to mammals and practically nontoxic to birds, fish, and invertebrates. USEPA has identified glyphosate as a candidate for evaluation as a potential endocrine disruptor (USEPA 2009). Based on these issues, it is likely that

USEPA will provide an updated review of its potential risks in 2015, but until then, glyphosate products are effective, generally safe, products used for vegetation management (http://gmo-journal.com/2011/11/21/safety-review-of-glyphosate-herbicide-faces-tough-critics). The District would strictly adhere to their BMPs and product label requirements, including the restriction of glyphosate application to targets outside an adequate buffer zone separating water sources, which reduces the potential for impacts to special-status species or other nontarget receptors. Targeted, small-scale treatments would be conducted to minimize post-application drift and runoff.

Impact ECO-5: The use of glyphosate would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.

6.2.5.1.2 Adjuvants

An adjuvant is any compound that is added to an herbicide formulation or tank mix to facilitate the mixing, application, or effectiveness of that herbicide. Adjuvants can either enhance activity of an herbicide's active ingredient (activator adjuvant) or offset any problems associated with spray application, such as adverse water quality or wind (special purpose or utility modifiers). Activator adjuvants include surfactants, wetting agents, sticker-spreaders, and penetrants. Adjuvants that may be used for mosquito habitat control, as well as future vegetation management are presented in Table 6-4. The environmental fate and toxicity of adjuvants is described in detail in Appendix B. A subset of these adjuvants was identified for further examination based upon use patterns and toxicity (Appendix B) and is discussed below.

Table 6-4 Adjuvants the District May Use for Insect Abatement/Vegetation Management in the Future

Active Ingredient	Appendix B
APEs	Section 4.7.1
Polydimethylsiloxane Fluids	Section 4.7.2

APEs include a broad range of chemicals that tend to bind strongly to particulates and persist in sediments. Nonylphenol and short-chain nonylphenol ethoxylates are moderately bioaccumulative and extremely toxic to aquatic organisms. Aside from use in agricultural herbicide mixtures, APEs are commonly present in detergents, cleaners, food packaging, and cosmetics. The acute toxicity of APEs to mammals is low. They are possible estrogen-mimics. Although the USEPA (2010) has recently recommended that this suite of chemicals be evaluated further due to their widespread use (past and present), persistence, and possible estrogen-mimicking behavior, they are currently approved for use.

BMPs the District would employ include using adjuvants in limited amounts in areas that do not contain sensitive species and preventing exposures to nontarget habitats (post-application).

Impact ECO-6: The use of adjuvants would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.

6.2.6 Biological Control Alternative

The Biological Control Alternative as the District practices would be a continuation of existing activities using applicable techniques, equipment, vehicles, and watercraft.

Biological control of mosquitoes involves the intentional use of mosquito pathogens (diseases), parasites, and/or predators to reduce the population size of target mosquitoes. Biological control is employed as a method to protect the public from mosquitoes and associated diseases using mosquito parasites, pathogens, and predators. Mosquito parasites are not currently available in the commercial market. Pesticides used on mosquito larvae are bacteria and biological control. These products are not considered chemical treatment; however, they are registered and regulated by USEPA and are, therefore, covered more thoroughly in Section 6.2.7, Chemical Control Alternative. A discussion of mosquitofish as a biological control and potential impacts to aquatic resources is discussed in Chapter 4.

6.2.6.1 Mosquito Larvae Pathogens

Mosquito pathogens are highly host-specific bacteria or viruses that are ingested during filter-feeding behavior of mosquito larvae in aquatic environments. These pathogens multiply rapidly in the host, destroying internal organs and consuming nutrients. The pathogen can be spread to other mosquito larvae in some cases when larval tissue disintegrates and the pathogens are released into the water and subsequently ingested by other mosquito larvae. The District uses two types of pathogenic bacteria, including *Bs*, strains of *Bti*), and potentially may use a third type, *Saacharopolyspora spinosa* (Table 6-5). *Bs* and *Bti* produce proteins that are toxic to most mosquito larvae, while the fermentation of *S. spinosa* produces spinosysns, which are highly effective mosquito neurotoxicants. *Bs* can reproduce in natural settings for some time following release. *Bti* materials do not contain live organisms, but only spores made up of specific protein molecules.

All three bacteria are naturally occurring soil organisms, which are commercially produced as mosquito larvicides. Because these forms of biological control are applied in a similar manner to chemical pesticides, they are evaluated under Section 6.2.7, Chemical Control Alternative, including the discussion of potential impacts. The environmental fate and toxicity of these control agents are described in detail in Appendix B.

Table 6-5 Biological Control Agents Employed for Mosquito Larvae Abatement

Active Ingredient	Appendix B
Bs	Section 4.3.1
Bti	Section 4.3.2
Spinosad	Section 4.3.3

6.2.6.2 Mosquito Predators

Mosquitofish (*Gambusia affinis*) are presently the only commercially available mosquito predators. The District's rearing and stocking of these fish in mosquito habitats is the most commonly used biological control agent for mosquitoes in the world. Used correctly, this fish can provide safe, effective, and persistent suppression in various mosquito sources. However, there has been increasing recognition in recent years that mosquitofish may adversely affect native amphibians, fish, invertebrates, and aquatic foodwebs (CDFG 2012), as described in Section 4.2.6.

The District uses mosquitofish in artificial, man-made water bodies including ponds and fountains. It also uses mosquitofish in natural waters within their Service Area, where the District judges that mosquitofish are the best method for controlling larval mosquitoes. Such plantings have the potential to affect sensitive species and aquatic ecosystems, as described above.

> **Impact ECO-7:** Planting mosquitofish in artificial environments that do not connect to natural water bodies would have **no impact** on aquatic habitats, native fish or aquatic invertebrates, special-status fish species, or HCP/NCCPs. No mitigation is required.
>
> **Impact ECO-8:** Planting of mosquitofish in natural waterways or artificial environments that drain to natural waterways would have a **potentially significant** impact on native fish or aquatic invertebrates, special-status fish species, and applicable HCP/NCCPs.

Mitigation Measure ECO-8. The District has a policy of restricting its planting of mosquitofish to natural waters to situations where the potential environmental effects are likely to be low. Such plantings are subject to a series of measures to minimize environmental effects, including:

1. Limiting such plantings to areas where the District's historic and ongoing Surveillance Program indicates that mosquito breeding is likely to occur.
2. Consulting appropriate federal and state fish and wildlife department websites, including the USFWS website, CDFW website, and CalFish.org to determine if the area under consideration for treatment, including a 1-mile radius around the site, is a known habitat for threatened and/or endangered species.
3. Not planting in streams until flows have become discontinuous, and stream habitat consists of isolated pools to minimize the potential for the movement of mosquitofish to areas where treatment was not intended.
4. Not planting mosquitofish if there have been reported sightings of threatened and/or endangered species within this area without further surveys by a biologist qualified to perform such surveys, or consultation with agency biologists.
5. District staff conducting a site survey and preparing a written report relating to the occurrence of sensitive species and not planting mosquitofish if the survey identifies the potential presence of sensitive species.

Unless prohibited by the guidelines above, the site will be planted with mosquitofish. The District will keep records of all plantings made by watershed and location, as well as records of any plantings that were planned and discontinued for any of the reasons provided above.

It is expected that mosquitofish planted will reproduce and become more numerous within these environments over time. Breeding slows in the fall months and most adults die with the onset of colder temperatures. However, mosquitofish may survive the winter in some areas (Moyle 2002). Therefore, these fish may spread through a watershed once continuous flow resumes in the areas where the fish are planted, and thus may enter areas where special status species do occur. Therefore, the risks of planting mosquitofish in natural waters to sensitive species are not completely eliminated by these measures.

The mitigation measures for this action would reduce the ecological risks associated with planting of mosquitofish in natural waters, but these risks would not be eliminated. Because of this, the residual impact of this action would be **significant and unavoidable**.

6.2.7 Chemical Control Alternative

The Chemical Control Alternative as the District practices would be a continuation of existing activities using applicable techniques, equipment, vehicles, and watercraft.

Chemical control is a Program tool that consists of the application of nonpersistent selective insecticides to directly reduce populations of larval or adult mosquitoes). If and when inspections reveal that mosquito populations are present at levels that trigger the District's criteria for chemical control – based on the mosquito's abundance, density, species composition, proximity to human settlements, water temperature, presence of predators and other factors–staff will apply pesticides to the site in strict accordance with the pesticide label instructions. The threshold criteria for these response triggers are based on prescheduled application periods relating to the documented and previously monitored likely mosquito outbreaks or expansions or unwanted population expansions. Additional response triggers are based on verified outbreaks, nuisance issues, and public concern about select mosquito species.

The chemicals the District uses for mosquito control are presented in Tables 6-1 and 6-2. These pesticides are registered and approved for public health use by the USEPA and CDPR by certified employees of local mosquito and vector control agencies to control mosquitoes., When applied with strict adherence to product label requirements, should not result in adverse effects to nontarget organisms. Detailed discussions of the environmental fate and toxicity of these active ingredients are provided in Appendix B. A subset of these chemicals was selected for further examination based upon issues regarding use patterns, environmental fate, or toxicity characteristics (Table 6-6, including herbicides discussed previously in Section 6.2.5). These chemicals are highlighted in the following section specifically in reference to potential ecological health implications associated with their use for mosquito control.

Table 6-6 Chemicals Identified for Further Evaluation in Appendix B

Active Ingredient	Vector	Potential Issue
Methoprene	Mosquitoes	Prevalent use; toxicity to aquatics and insects
Etofenprox	Mosquitoes	Toxicity to aquatic organisms; no synergist required
Bti	Mosquitoes	Prevalent use; public concerns
Pyrethrins	Mosquitoes	Prevalent use; requires synergist (PBO)
Resmethrin	Mosquitoes	Requires synergist (e.g., PBO); potential endocrine disruptor
Permethrin	Mosquitoes	Toxicity to aquatic organisms; potential endocrine disruptor
APEs	Weeds	Toxicity to aquatic organisms; moderately bioaccumulative
Glyphosate	Weeds	Prevalent use; possible endocrine disruptor

6.2.7.1 Mosquito Larvicides

Larvicides are used to manage immature life stages of mosquitoes including larvae and pupae in aquatic habitats. Temporary aquatic habitats are usually targeted because permanent water bodies generally support natural mosquito predators such as fish. The larvicides are applied using ground application equipment, fixed wing aircraft, and rotary aircraft. The mosquito larvicides the District uses include bacterial larvicides, hydrocarbon esters, and surfactants (Table 6-7).

The toxicity of *Bs, Bti*, spinosad, methoprene, and monomolecular films are discussed in detail in Appendix B. The District employs practices that alleviate the potential for exposure and adverse effects to nontarget organisms (see Appendix A for an inventory of special-status organisms inhabiting the Program Area).

Table 6-7 Chemicals Employed for Larval Mosquito Abatement

Chemical Classification	Active Ingredient	Appendix B
Organophosphate	Temephos	Section 4.2.2
Bacterial larvicide	*Bs*	Section 4.3.1
Bacterial larvicide	*Bti*	Section 4.3.2
Bacterial larvicide	Spinosad	Section 4.3.3
Hydrocarbon ester	Methoprene	Section 4.3.4
Surfactants	Alcohol Ethoxylated Surfactant (monomolecular film, BVA-2, CoCoBear) and Aliphatic Solvents	Section 4.3.5 Section 4.3.6

6.2.7.1.1 Organophosphates

OP insecticides irreversibly block acetylcholinestarase activity, which causes accumulation of the neurotransmitter acetylcholine in the central nervous system, leading to excessive neuronal stimulation and then depression. OPs are quickly degraded and exhibit very low environmental persistence. The District may use OPs in rotation with other active ingredients to avoid the development of resistance.

Temephos

Temephos is a cholinesterase inhibitor registered by the USEPA in 1965 to control mosquito larvae (USEPA 2000). Temephos is the only OP employed as a mosquito larvicide. It is used in various water bodies including lakes, marshes, drainage systems, irrigation systems, and polluted and stagnant water (CDPR 2010a). Temephos is a broad-spectrum insecticide and has also been used operationally to control midges and black flies for many years. However, the concentration that effectively controls mosquito larvae is well below that needed for control of other insects.

Temephos has extremely low water solubility and binds strongly to soils. It has low toxicity for vertebrates at the levels used for mosquito control (USEPA 2000). It is moderately acutely toxic to mammals and fish, but highly toxic to nontarget aquatic invertebrates (e.g., stoneflies, mayflies). Field applications result in concentrations of temephos far lower than those at which fish are affected. Field studies have repeatedly demonstrated a lack of impact on fish inhabiting treated sites. In addition, many groups of aquatic invertebrates are only impacted at concentrations far above those used for mosquito control applications (USEPA 2000).

Temephos is an effective method of control in isolated sources that may be difficult to treat by other means, such as sources with high concentrations of organic material, and ones in which other less toxic alternatives have failed to produce adequate levels of control. Temephos was used prevalently in California for mosquito abatement from 1965 into the mid-1980s; however, microbial pesticides (e.g., *Bs, Bti*, spinosad), methoprene, and surface oils are used much more frequently now. Temephos can help prevent the development of resistance to bacterial larvicides and insect growth regulators in suitable habitat.

When applied using strict adherence to product label requirements and District BMPs, temephos applied at low concentrations for mosquito control (well below that required for other insects) should not cause adverse ecological effects.

> **Impact ECO-9:** The use of the organophosphate temephos would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.

6.2.7.1.2 Bacterial Larvicides (*Bs, Bti*, and spinosad)

Bacterial larvicides such as *Bs* and *Bti* are highly selective microbial pesticides (for mosquitoes) that, when ingested, produce gut toxins that cause destruction of the insect gut wall leading to paralysis and death. These microbial agents are delivered as endospores in granular, powder, or liquid concentrate formulations. The District applies Bs and Bti directly to mosquito habitats (marshes, wetlands, ditches, channels, standing water, ponds, waterways, sewers, and storm drains; see Appendix B, Attachment 1) rather than to terrestrial environments. Additionally, *Bs* and *Bti* are practically nontoxic to terrestrial organisms, including birds, bees, and mammals. Applications follow strict guidelines in District BMPs and product label requirements. Microbial larvicides are one of the safest forms of natural pesticides available for public health use. *Bti* is a naturally occurring toxicant of mosquito larvae and, therefore, does not pose risk to nontarget ecological receptors.

Spinosad is a natural insecticide derived from the fermentation of a common soil microorganism, *Saacharopolyspora spinosa*. Spinosad alters nicotine acetylcholine receptors in insects causing constant involuntary nervous system impacts, ultimately leading to paralysis and death. It is of low acute toxicity to birds, but is very highly toxic to moths and butterflies. The District does not currently use Spinosad, but should it decide to, it will strictly adhere to product label requirements and BMPs for the protection of ecological health.

> **Impact ECO-10:** The use of bacterial larvicides would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.

6.2.7.1.3 Hydrocarbon Esters (Methoprene)

The District widely uses methoprene, an insect growth regulator and selective larvicide. It exhibits toxicity to aquatic invertebrates and some nontarget insects such as moths, butterflies, and beetles. Methoprene is also moderately toxic to fish. The concentrations of methoprene applied for mosquito larvae control are unlikely to affect nontarget aquatic species, except for some fly species closely related to mosquitoes.

Although methoprene exhibits some toxicity to aquatic organisms and insects, it is effective at much lower concentrations than alternative larvicide products. Lower concentrations can translate to reduced acute exposures to nontarget organisms, as well as potential effects to a limited number of midges and chironomids. Extended release forms including granular and briquette varieties are also available (e.g., 90-day briquettes), which are longer lasting and require fewer applications. This product may be more residual in the environment; however, the methoprene active ingredient in this formulation has a short half-life in water and does not migrate through soil, significantly reducing the potential for groundwater impacts.

Considered one of the safest of larvicides available, the District uses methoprene prevalently during each season of the year. Liquid and granular forms are most prevalently used in residential and ornamental pond application scenarios. Treatments to wetlands including marshes may require the granular form (e.g., Altosid SBG Granules or Altosid Pellets) to penetrate dense aquatic vegetation including cattails tules and pickleweed. Methoprene may also sometimes co-applied with *Bti* to prevent resistance and ensure all larval stages are controlled.

The larger droplet sizes of aerial (e.g., helicopter) larvicide applications (e.g., methoprene) reduces drift (compared to that of ULV sprays). In addition, aerial treatments are restricted to times when light or no wind occurs. Methoprene is generally applied in extremely small amounts during treatments due to its efficacy against mosquitoes even at low concentrations. For example, the District applies it at a maximum concentration of 0.5 µg/L. At this application rate, little to no toxicity occurs to nontarget aquatic organisms with the exception of some midges (*Chironomidae*) and blackflies (*Simuliidaes*) (Chapter 4; Appendix B). Methoprene can be toxic to fish; however, the lowest LC_{50}(4.62 mg/L for bluegill) is several orders of magnitude greater than the concentration used to control mosquitoes (Maffei, pers. comm., 2013). When handled and applied using District BMPs, methoprene is one of the lease hazardous larvicides available.

> **Impact ECO-11:** The use of methoprene for mosquito larvae would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.

6.2.7.1.4 Alcohol Ethoxylated and Aliphatic Solvent Surfactants

Monomolecular films are alcohol ethoxylated surfactants, which are low-toxicity pesticides that spread a thin film on the surface of water that makes it difficult for mosquito larvae, pupae, and emerging adults to attach to the water's surface, causing them to drown (USEPA 2007). The films also disrupt larval respiration of some other classes of air-breathing aquatic insects. They are used on an assortment of water bodies including ornamental ponds, pastures, irrigation systems, drainage systems (CDPR 2013).

Alcohol ethoxylated and aliphatic solvent surfactant could result in reductions to populations of surface-breathing insects (other than mosquitoes) during treatment; however, it is unlikely that these reductions would result in lasting or observable effects on nontarget organisms when applied within product label limits. Monomolecular films are not environmentally persistent and typically degrade within 21 days, while the petroleum-based solvents degrade in 2–3 days. In addition, populations recover quickly following recolonization from adjacent and neighboring sites and habitats.

Impact ECO-12: The use of surfactants for the control of mosquito larvae would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.

6.2.7.2 Mosquito Adulticides

In addition to chemical control of mosquito larvae, the District may use pesticides for control of adult mosquitoes when no other tools are available and if specific criteria are met, including species composition, population density (as measured by landing count or other quantitative method), proximity to human populations, and/or human disease risk. Adulticide materials are used seasonally as needed to control mosquito populations.

Adulticides the District potentially uses include pyrethrins, synthetic pyrethroids, pyrethroid-like compounds, and synergists. Table 6-8 lists the adulticides the District uses (or may use) for mosquito abatement. A subset of these active ingredients required further evaluation in Appendix B and further discussion is provided below. A detailed discussion of the environmental fate and toxicity of these pesticides is provided in Appendix B.

Table 6-8 Chemicals Employed for Adult Mosquito Abatement

Chemical Classification	Active Ingredient	Vector	Appendix B
Pyrethrin	Pyrethrins	Mosquito	Section 4.1.1
Pyrethroid	Phenothrin (sumithrin or d-phenothrin)	Mosquito	Section 4.1.3
Pyrethroid	Prallethrin	Mosquito	Section 4.1.4
Pyrethroid	Resmethrin	Mosquito	Section 4.1.8
Pyrethroid	Permethrin	Mosquito	Section 4.1.10
Pyrethroid-like compound	Etofenprox	Mosquito	Section 4.1.11
Synergist	PBO	Mosquito	Section 4.1.12
Organophosphate	Naled	Mosquito	Section 4.2.1

6.2.7.2.1 Pyrethrins

Pyrethrins are naturally occurring products distilled from the flowers of certain Chrysanthemum species. Pyrethrins readily degrade in water and soil, but may persist under anoxic conditions. They tend to strongly adsorb to soil surfaces and, hence, have low potential to leach into groundwater. Pyrethrins may be highly toxic to fish (freshwater, estuarine, marine) and invertebrates, although exposures would likely be low during and following ULV applications, which are designed to prevent environmental persistence and potential impacts to nontarget ecological receptors.

The District uses pyrethrin for adult mosquito control. It is applied to vegetated areas adjacent to man-made and natural sites including, but not limited to outlying areas near tidal and reclaimed marshes, seasonal wetlands managed as waterfowl habitat and wooded areas with treeholes creating problems for residents nearby.

Pyrethrins are of concern because they are used prevalently and require the use of the synergist PBO, which is toxic to aquatic invertebrates and is currently under evaluation as a possible endocrine-disruptor (Section 6.2.7.2.2). However, the District uses pyrethrins only when absolutely necessary and, even then, minimal amounts are applied (ULV), thus reducing the potential for impacts to nontarget ecological receptors. As an additional measure, pyrethrin products are only used at night and during predawn hours when bees are not on the wing, and applications are canceled during less than ideal wind and potential drift conditions. The District ensures that all applications are made in accordance with label specifications and USEPA and CDPR recommendations for use with mosquitoes. Other practices that can alleviate risk to aquatic receptors include minimizing the amount, frequency, and area with which these pesticides are applied over water bodies, especially those with the potential to contain special-status species. The District also minimizes the amount, frequency, and area with which these pesticides are applied over waters draining directly to the waters above. In addition, the risks to nontarget insects such as honeybees are reduced by restricting pyrethrin applications to nighttime hours when bees and other pollinators are inactive. Also, note that pyrethrins are available in can form to the public but not in vessels used for ULV applications.

> **Impact ECO-13:** The use of pyrethrins for adult mosquitoes would result in a **less-than-significant** impact to nontarget ecological receptors including aquatic organisms and mitigation is not required.

6.2.7.2.2 Pyrethroids and Pyrethroid-like Compounds

Pyrethroids are synthetic compounds that are chemically similar to the pyrethrins but have been modified to increase stability and activity against insects. Pyrethroids bind to neuronal voltage-gated sodium channels, preventing them from closing; this persistent activation of the channels then leads to paralysis.

First generation or “Type I” pyrethroids include phenothrin (sumithrin), prallethrin, and resmethrin. These pyrethroids are used to control flying and crawling insects in a number of commercial and horticultural applications and are sold for residential use and application on pets to control fleas and ticks. They have effective insect knock-down capabilities but are unstable in sunlight (highly photosensitive). The newer second-generation/“Type II” pyrethroids (permethrin) contain an α-cyano group, which reduces their photosensitivity, thereby increasing their persistence and toxicity.

Some synthetic insecticides are similar to pyrethroids, such as etofenprox, but have a slightly different chemical composition. The pyrethroids that were identified for further evaluation in Appendix B are discussed below.

Resmethrin

Resmethrin is a pyrethroid (a synthetic class of compounds modified from pyrethrins to increase stability and insecticidal specificity) and the active ingredient in Scourge®. It a restricted-use pesticide due to its toxicity to fish and is available for this use only by certified pesticide applicators or persons under their direct supervision.

Resmethrin may also be persistent in environments free of light (e.g., bound to organic matter in anoxic soils and sediments). Due to the potential for persistence and high toxicity to both aquatic and estuarine/marine fish and invertebrates, use with PBO, as well as the potential for endocrine disruption, resmethrin may be of concern from an ecological health perspective.

The District has applied resmethrin around wooded areas with tree holes, residential areas near reclaimed marshes, and industrial areas for adult mosquito control. Studies have shown rapid dissipation/low persistence and no observed aquatic fish and invertebrate toxicity following aerial ULV applications. Scourge® may be phased out with a nonresmethrin alternative, making this product less problematic. The District uses resmethrin only when absolutely necessary and then in ULV applications so that the rapid degradation of the products reduces the potential for impacts to nontarget ecological receptors.

Permethrin

Permethrin is a pyrethroid that may persist in environments free of light (e.g., bound to organic matter in anoxic soils and sediments). Due the potential for persistence and high toxicity to both aquatic and estuarine/marine fish and invertebrates, use with PBO, as well as the potential for endocrine disruption, permethrin may be of concern from an ecological health perspective.

The District uses permethrin for mosquito control primarily in areas such as residences upon request, thickly wooded areas with treeholes, livestock areas where allowed and outlying marsh and wetland~~s~~ areas. control during spring, summer, and fall.

Studies have shown rapid dissipation/low persistence and no observed aquatic fish and invertebrate toxicity following aerial ULV applications. Based on its potential for endocrine disruption and usage patterns, this product is generally used with careful and strict BMP techniques such as in very small, localized applications. Permethrin use is restricted to situations when it is absolutely necessary and in ULV applications that are designed to degrade rapidly and, thus, reduce the potential for impacts to nontarget ecological receptors.

Etofenprox

Etofenprox is a pyrethroid-like insecticide that is the active ingredient in Zenivex®. It is frequently applied to backyards and patios and sometimes directly to domestic pets (by homeowners). Etofenprox does not tend to persist in the environment or appear to pose a risk to mammals. It does exhibit some toxicity to fish and aquatic invertebrates; however, it degrades rapidly in surface waters, thereby reducing the potential for long-term exposures and adverse effects. Zenivex® does not require synergists such as PBO; therefore, it likely exhibits less toxicity than others that require co-application. The District does not currently use this product; however, should it choose to the District will strictly adhere to BMPs and product label requirements. Etofenprox would generally be applied during the nighttime hours when sensitive receptors such as honeybees are not active.

> **Impact ECO-14:** The use of pyrethroids and pyrethroid-like compounds (e.g., resmethrin, permethrin, and etofenprox) for mosquitoes would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.

6.2.7.2.3 Synergists (PBO)

PBO is a pesticide synergist that enhances the effectiveness of pesticide active ingredients, such as pyrethrins and pyrethroids, by inhibiting microsomal enzymes and, thus, the breakdown of the other active ingredient(s) (USEPA 2006a). It is a registered active ingredient in products used to control flying and crawling insects and arthropods in agricultural, residential, commercial, industrial, and public health settings. No products contain only PBO. It degrades quickly in soil and water but exhibits toxicity to fish and aquatic invertebrates. As a synergist, PBO is applied using the same guidelines as those for pyrethroids and pyrethrins: ULV application (to prevent environmental persistence and adverse ecological effects) with a backpack mister or ATV-mounted or handheld ULV, and it is not applied when wind occurs.

> **Impact ECO-15:** The use of synergists (PBO) for mosquitoes would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.

6.2.7.2.4 Organophosphates

OP insecticides irreversibly block acetylcholinestarase activity, which causes accumulation of the neurotransmitter acetylcholine in the central nervous system, leading to excessive neuronal stimulation and then depression. OPs are quickly degraded and exhibit very low environmental persistence. The District may use OPs in rotation with other active ingredients to avoid the development of resistance.

Naled

Naled is an OP insecticide that has been registered for use in the US since 1959. It may be used in rotation with pyrethrins or pyrethroids for control of adult mosquitoes to prevent the development of resistance. Naled is an indoor and outdoor general use pesticide and is used on food and feed crops, farms, dairies, pastureland, in greenhouses, and over standing water. Currently, the District is not using Naled and future use would be limited.

Naled has been shown to be moderately to highly toxic to wide range of species, including aquatic fish and invertebrates, as well as waterfowl (mallards) and honeybees. It has low water solubility but may be mobile in soils. However, it is generally applied using ULV techniques, which are designed to prevent environmental persistence and potential impacts to nontarget ecological receptors, including aquatic species (see Section 6.2.7.2 for additional details of ULV techniques). Naled tends to degrade quickly in surface waters especially following ULV applications. Dichlorvos is a breakdown product of naled (also a registered pesticide) and also degrades rapidly in surface waters. Short-term naled and dichlorvos exposures to aquatic nontargets are possible; however, they would be limited due to rapid degradation. See Chapters 4, Biological Resources – Aquatic, and 9, Water Resources for further details.

Drift is almost irrelevant for hand and some aerial (e.g., helicopter) applications since treatments are restricted to times when no wind occurs. Should this product be used, the District will strictly adhere to their BMPs and product label requirements, including the restriction of naled application to targets outside adequate buffer zones around permanent water bodies to reduce runoff. In addition, spray setbacks will be established to reduce spray drift for agricultural uses.

> **Impact ECO-16:** The use of the organophosphate naled would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.

6.2.8 Cumulative Impacts

"Cumulative impacts" are defined as "two or more individual effects which, when considered together, are considerable or compound or increase other environmental impacts (CEQA Guidelines, Section 15355). Cumulative impacts, as they relate to ecological health include past, present, and reasonably foreseeable actions that potentially impact aquatic/terrestrial mammalian and avian wildlife, herptiles, aquatic organisms, nontarget invertebrates and pollinators, and botanical resources. Cumulative impacts can result from individually minor, but collectively significant, projects taking place over a period of time. The cumulative impact analysis is contained in Section 13.4 and focuses on the potential for the use of pesticides for mosquito and vector control to contribute to regional pesticide use, which is of concern for its potential impacts to nontarget ecological receptors. It includes Table 13-1, Historical Pesticide Use within the Solano County Mosquito Abatement District's Program Area for 2006–2010 and Table 13-2, Pesticide Use within the Solano County Mosquito Abatement District's Service Area.

Although large uncertainty and high variation exist in the reported amounts of pesticide use within the District's Program Area counties, they vary according to particular needs, majority of habitat type, and seasonal vector outbreaks. The public is aware of these pesticide uses and, in general, is pressuring agencies within these counties to use less pesticide whenever possible. The District uses very strict and thorough BMPs in their pesticide applications for mosquito control and is attempting to reduce total pesticide use where possible consistent with IPM practices.

The District's incremental contributions to overall pesticide use within its Program Area do not trigger a cumulatively considerable impact. While overall use of pesticides throughout the Program Area may be considered cumulatively significant, the District's small incremental contributions to this impact are not cumulatively significant. Therefore, the Program's long-term activities including chemical applications would not contribute considerably to nontarget ecological receptor impacts. The Program alternatives would not result in significant cumulative impacts to the ecological health of the region.

6.2.9 Environmental Impacts Summary

Table 6-9 presents a summary of impacts to ecological health associated with the five alternatives compared to existing conditions.

Table 6-9 Summary of Ecological Health Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Effects on Ecological Health					
Impact ECO-1: The Surveillance Alternative would have a **less-than-significant** impact on nontarget ecological receptors, including native or special-status plants and animals and mitigation is not required.	LS	na	na	na	na
Impact ECO-2: The Physical Control Alternative would have a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	LS	na	na	na
Impact ECO-3: The employment of a nonherbicide Vegetation Management Alternative in the form of physical removal would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	na	LS	na	na
Impact ECO-4: The use of herbicides would be result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	na	LS	na	na
Impact ECO-5: The use of glyphosate would result in a **less-than-significant impact** to nontarget ecological receptors and mitigation is not required.	na	na	LS	na	na
Impact ECO-6: The use of adjuvants would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required	na	na	LS	na	na
Impact ECO-7: Planting mosquitofish in artificial environments that do not connect to natural water bodies would have **no impact** on aquatic habitats, native fish or aquatic invertebrates, special-status fish species, or HCP/NCCPs. No mitigation is required.	na	na	N	na	na
Impact ECO-8: Planting of mosquitofish in natural waterways or artificial environments that drain to natural waterways would have a **potentially significant** impact on native fish or aquatic invertebrates, special-status fish species, and applicable HCP/NCCPs. The mitigation measures for this action would reduce the ecological risks associated with planting of mosquitofish in natural waters, but these risks would not be eliminated. Because of this, the residual impact of this action would be **significant and unavoidable**.	na	na	na	SU	na

Table 6-9 Summary of Ecological Health Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact ECO-9: The use of the organophosphate temephos would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	na	na	na	LS
Impact ECO-10: The use of bacterial larvicides would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	na	na	na	LS
Impact ECO-11: The use of methoprene for mosquito larvae would result **in** a **less-than-significant** impact to nontarget ecological receptors and mitigation is **not required.**	na	na	na	na	LS
Impact ECO-12: The use of surfactants for the control of mosquito larvae would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	na	na	na	LS
Impact ECO-13: The use of pyrethrins for adult mosquitoes would result in a **less-than-significant** impact to nontarget ecological receptors including aquatic organisms and mitigation is not required.	na	na	na	na	LS
Impact ECO-14: The use of pyrethroids and pyrethroid-like compounds (e.g., resmethrin, permethrin, and etofenprox**)** for mosquitoes would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	na	na	na	LS
Impact ECO-15: The use of synergists (PBO) for mosquitoes would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	na	na	na	LS
Impact ECO-16: The use of the organophosphate naled would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	na	na	na	LS

LS = Less-than-significant impact

N = No impact

na = Not applicable

SM = Potentially significant but mitigable impact

SU = Significant and unavoidable impact

6.2.10 Mitigation and Monitoring

Although application scenarios are conducted using rigorous, strict BMP and treatment schedules that avoid periods when the nontarget receptors may be more sensitive to stresses (nesting, breeding, migration, known movements between habitats [small mammals and reptiles]), the District also conducts surveillance and monitoring of results on a routine basis. Receipt of information about mosquito outbreaks or unwanted population expansion of this vector is dealt with on a case-by-case basis. Pesticide use is conducted according to the verified requirements and guidance in the product labels (mandated by the USEPA) for the safe use of labeled products and the ultimate protection of humans and ecological receptors.

6.2.10.1 Planting Mosquitofish in Natural Waterways (ECO-10)

To minimize the potential impacts of planting mosquitofish in natural waterways, the District will implement a policy incorporating the following elements:

1. Limiting such plantings to areas where the District's historic and ongoing Surveillance Program indicates that mosquito breeding is likely to occur.
2. Consulting appropriate federal and state fish and wildlife department websites, including the USFWS website, CDFW website, and CalFish.org to determine if the area under consideration for treatment, including a 1 mile radius around the site, is a known habitat for threatened and/or endangered species.
3. Not planting in streams until flows have become discontinuous, and stream habitat consists of isolated pools to minimize the potential for the movement of mosquitofish to areas where treatment was not intended.
4. Not planting mosquitofish if there have been reported sightings of threatened and/or endangered species within this area without further surveys by a biologist qualified to perform such surveys, or consultation with agency biologists.
5. District staff conducting a site survey and preparing a written report relating to the occurrence of sensitive species and not planting mosquitofish if the survey identifies the potential presence of sensitive species.

   Unless prohibited by the guidelines above, the site will be planted with mosquitofish. The District will keep records of all plantings made by watershed and location, as well as records of any plantings that were planned and discontinued for any of the reasons provided above.

- Location: All natural waters to be treated with mosquitofish.
- Monitoring/Reporting Action: Consult appropriate websites for locations of species of concern or designated critical habitat for listed species. Have surveys performed by a biologist qualified to perform surveys for any sensitive species that might occur based on the above or consult with resource agency biologists prior to planting. In treatment areas more than one mile from locations where sensitive species are thought to occur, District staff will perform a site assessment and complete a site assessment report, to be kept on file at the District offices. If sensitive species are observed, mosquitofish will not be planted without consulting the regulatory agencies.
- Effectiveness Criteria: Mitigation will be considered effective if treatment of areas with potential presence of sensitive species is avoided.
- Responsible Agency: the District
- Timing: Dependent on need for treatment activities

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7 Human Health

Chapter 7 evaluates potential impacts of the Program on human health. Results of the evaluation are provided at the programmatic level. Section 7.1, Environmental Setting, presents an overview of the District's human population and growth estimates and the federal and state regulations that are applicable to the Program. Section 7.2, Environmental Impacts and Mitigation Measures, presents the following:

> Environmental concerns and evaluation criteria: A discussion of whether the Program alternatives would cause any potentially significant impacts to human health and addressing concerns from the public scoping

> Discussion of methods and assumptions

> Discussion of potential impacts of the Program alternatives, and mitigation measures, if necessary, for those impacts

> Cumulative impacts summary

> A summary of estimated impacts to human health

> Potential ecological impacts are addressed in Chapter 6.

7.1 Environmental Setting

The Program Area is defined as the Solano County Mosquito Abatement District and adjacent counties in California that are impacted by mosquitoes that must be controlled to minimize adverse effects associated with exposures to pest such as disease and discomfort to humans and animals. See Figure 2-1. The following section provides the population characteristics of the Program Area, background information on the environmental fate and toxicity of pesticides, and an overview of the regulatory setting with respect to chemical and biological pesticides.

7.1.1 Population Characteristics of the Program Area

The size of the population in the District's Service Area (Solano County) and the larger Program Area (adjacent 5 counties) are shown in the following two tables. In 2010, the population of California was estimated at 37.3 million (US Census Bureau, (http://www.bayareacensus.ca.gov/counties/counties.htm). The population of the District's Solano County Service Area is approximately 413,000, which represents 1 percent of the statewide total (see Table 7-1a).

Table 7-1a Population and Growth in Solano County (1990–2010)

County / Area	Population			Population Growth (Compound Annual Average)	
	1990	2000	2010	1990–2000	2000–2010
Solano	340,421	394,542	413,344	1.49%	0.47%
Statewide Area	**29,760,021**	**33,871,648**	**37,253,956**	**1.30%**	**0.96%**

Table 7-1b provides the population counts and projected growth in the five counties adjacent to the District's Service Area that are included in the District's Program Area.

Table 7-1b Population and Growth in the Five Counties Adjacent to the District (1990–2010)

	Population			Population Growth (Compound Annual Average)	
County / Area	**1990**	**2000**	**2010**	**1990–2000**	**2000–2010**
Contra Costa	803,732	948,816	1,049,025	1.67%	1.01%
Napa	110,765	124,279	136,484	1.16%	0.94%
Sonoma	388,222	458,614	483,878	1.68%	0.54%
Sacramento	1,066,789	1,229,940	1,418,788	1.43%	1.44%
Yolo	141,212	169,835	200,849	1.86%	1.69%
Adjacent County Total	2,510,720	2,931,484	3,289,024	1.56%	1,16%
Statewide Total	**29,760,021**	**33,871,648**	**37,253,956**	**1.30%**	**0.96%**

The California Department of Finance projects steady population growth in the future, with total state population reaching over 44 million by 2030.

7.1.2 Hazards, Toxicity, and Exposure in the Environmental Setting

A “hazardous material” is defined in California Health and Safety Code Section 25501 (p): as “any material that, because of its quantity, concentration, or physical or chemical characteristics, poses a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment. "Hazardous materials" include, but are not limited to, “hazardous substances, hazardous waste, and any material that a handler or the administering agency has a reasonable basis for believing that it would be injurious to the health and safety of persons or harmful to the environment if released into the workplace or the environment.” Any liquid, solid, gas, sludge, synthetic product, or commodity that exhibits characteristics of toxicity, ignitability, corrosiveness, or reactivity has the potential to be considered a “hazardous material.”

7.1.2.1 Toxicity and Exposure

Toxicology is the study of a compound’s potential to elicit an adverse effect in an organism. The toxicity of a compound is dependent upon exposure, including the specific amount of the compound that reaches an organism’s tissues (i.e., the dose), the duration of time over which a dose is received, the potency of the chemical for eliciting a toxic effect (i.e., the response), and the sensitivity of the organism receiving the dose of the chemical. Toxicity effects are measured in controlled laboratory tests on a dose/response scale, whereby the probability of a toxic response increases as dose increases. Exposure to a compound is necessary for potential toxic effects to occur. However, exposure does not, in itself, imply that toxicity will occur. Thus, toxic hazards can be mitigated by limiting potential exposure to ensure that doses are less than the amount that may result in adverse health effects.

The toxicity data included in the numerous tables and charts in this document are generally derived from rigidly controlled laboratory animal studies designed to determine the potential adverse effects of the chemical under several possible routes of exposure. In these studies, the species of interest is exposed to 100 percent chemical at several doses to determine useful information such as the lowest concentration resulting in a predetermined adverse effect (LOAEL) on numerous selected physiological and behavioral systems. The second component of these tests is to determine the highest concentration of chemical that results in no measurable adverse effect (NOAEL).

However, these, and other, coordinated and focused laboratory tests are designed to document the effects of the chemical when a continuous, controlled, exposure exists and do not realistically reflect the likely exposures or toxicity in the District field application scenarios. As such, the toxicity information is intended as an overview of potential issues and guidance for understanding the completely “safe” maximum exposure levels of applications that would not adversely impact humans or nontarget plant and animal species.

Although the regulatory community uses this basic information to provide a relative comparison of the potential for a chemical to result in unwanted adverse effects and this information is reflected in the approved usage labels and MSDSs, in actual practice, the amounts applied in the District’s Program Area are often substantially less than the amounts used in the laboratory toxicity studies. Because of these large safety factors used to develop recommended product label application rates, the amount of chemical resulting in demonstrated toxicity in the laboratory is much higher than the low exposure levels associated with an actual application. The application concentrations consistent with the labels or MSDSs are designed to be protective of the health of humans and other nontarget species (i.e., low enough to not kill them, weaken them, or cause them to fail to reproduce). However, adverse effects may still occur to some nontarget organisms.

7.1.3 Pesticides and the Environment

The pesticide and herbicide formulations included in the Proposed Program are listed in Table 7-2 and Table 7-3, respectively. Appendix B provides the results of review and evaluation of the active ingredients the District currently uses or proposes to use.

Table 7-2 Pesticide Active Ingredients

Active Ingredient	**Vector**
Biodegradable Alcohol Ethoxylated Surfactant	Mosquito
Petroleum Distillate-Mineral Oil Liquid	Mosquito
Bacillus sphaericus (Bs)	Mosquito
Bacillus thuringiensis israelensis (Bti)	Mosquito
Spinosad*	Mosquito
Methoprene	Mosquito
Permethrin	Mosquito
Prallethrin*	Mosquito
Pyrethrins	Mosquito
Resmethrin	Mosquito
Phenothrin (Sumithrin)*	Mosquito
Etofenprox*	Mosquito
PBO	Mosquito
Naled*	Mosquito
Temephos*	Mosquito

**Not currently used, but may be in the future.*

Table 7-3 Herbicide Active Ingredients and Adjuvants

Active Ingredient	Vector
Glyphosate*	Weed
Imazapyr*	Weed
Alkylphenol ethoxylates (APEs)*	Weed
Polydimethylsiloxane*	Weed

** Not currently used, but may be in the future.*

7.1.4 Regulatory Environment

Formulations proposed for each Program alternative for mosquito control are and would be used according to federal and state regulatory requirements for the registration, transportation, and use of pesticides. The regulatory framework pertaining to the use of pesticides is discussed below.

7.1.4.1 Federal

The USEPA regulates pesticides under two major statutes: the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Federal Food, Drug, and Cosmetic Act (FFDCA). Under these acts, the USEPA mandates extensive scientific research to assess risks to humans, domestic animals, wildlife, plants, groundwater, and beneficial insects before granting registration for a pesticide. These studies allow the USEPA to assess the potential for human and ecological health effects. When new data raise concern about a registered pesticide's safety, the USEPA may take action to suspend or cancel its registration. The USEPA may also perform an extensive special review of a pesticide's risks and benefits and/or work with manufacturers and users to implement changes in a pesticide's approved use (e.g., reducing application rates).

7.1.4.1.1 Federal Insecticide, Fungicide, and Rodenticide Act

FIFRA defines a pesticide as "any substance intended for preventing, destroying, repelling, or mitigating any pest." The act requires USEPA registration of pesticides prior to their distribution for use in the US, sets registration criteria (testing guidelines), and mandates that pesticides perform their intended functions without causing unreasonable adverse effects on people and the environment when used according to USEPA-approved label directions. FIFRA defines an "unreasonable adverse effect on the environment" as "(1) any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of the pesticide, or (2) a human dietary risk from residues that result from a use of a pesticide in or on any food inconsistent with the standard under Section 408 of the Federal Food, Drug, and Cosmetic Act (21 USC 346a)."

FIFRA regulates only the active ingredients of pesticides, not inert ingredients, which manufacturers are not required to reveal. However, toxicity studies conducted under FIFRA are required to evaluate the active ingredient and the entire product formulation, through which any potential additive or synergistic effects of inert ingredients are established.

7.1.4.1.2 Federal Food, Drug, and Cosmetic Act

The FFDCA authorizes the USEPA to set tolerances (i.e., maximum allowable amounts) for pesticide residues in/on food. Thus, the FFDCA does not expressly regulate pesticide use, but exceedance of tolerances may result in prosecution or changes in the approved use of a pesticide regulated under FIFRA.

7.1.4.1.3 Clean Water Act and National Pollutant Discharge Elimination System

The CWA establishes the principal federal statutes for water quality protection "to restore and maintain the chemical, physical, and biological integrity of the nation's water, to achieve a level of water quality which provides for recreation in and on the water, and for the propagation of fish and wildlife."

> Section 303(d) requires each state to provide a list of impaired waters that do not meet or are expected not to meet state water quality standards as defined by that section. The CWA regulates potentially toxic discharges through the NPDES and ambient water quality through numeric and narrative water quality standards. The release of aquatic pesticides into waters of any state may require an NPDES permit, depending on the pesticide considered, and the conditions proposed for application.

> Section 402, the NPDES, requires permits for pollution discharges (except dredge or fill material) into US waters, such that the permitted discharge does not cause a violation of federal and state water quality standards. Biological and residual pesticides discharged into surface waters constitute pollutants and require coverage under an NPDES permit. In California, NPDES permits are issued by the SWRCB or the RWQCBs.

7.1.4.1.4 Safe Drinking Water Act of 1974

Under the Safe Drinking Water Act of 1974, the USEPA establishes Maximum Contaminant Levels (MCLs), which are specific concentrations that cannot be exceeded for a given contaminant in surface water or groundwater. USEPA has the ability to enforce these nationwide standards or delegate administration and enforcement duties to state agencies. The CDPH administers the federal Safe Drinking Water Act in California.

7.1.4.1.5 California Toxics Rule

In 2000, the USEPA developed water quality criteria for priority toxic pollutants to protect human health and the environment when a gap in California's water quality standards was created when the state's water quality control plans containing water quality criteria for priority toxic pollutants were overturned in 1994 (thus causing California to be out of compliance with the CWA). These established criteria are to be applied to inland surface waters, enclosed bays, and estuaries in California. The rule includes aquatic life criteria for 23 priority toxic pollutants, human health criteria for 57 priority toxics, and a compliance schedule.

7.1.4.2 State of California

California's programs for the registration of pesticides and commercial chemicals parallel federal programs, but many of California's requirements are stricter than federal requirements. The Cal/EPA regulates registration of pesticides and commercial chemicals in California. Within Cal/EPA, the CDPR oversees pesticide evaluation and registration through use enforcement, environmental monitoring, residue testing, and reevaluation. The CDPR works with County Agricultural Commissioners, who evaluate, develop conditions of use, approve, or deny permits for restricted-use pesticides; certify private applicators; conduct compliance inspections; and take formal compliance or enforcement actions. The Secretary of Resources has certified California's pesticide regulatory program as meeting CEQA requirements (CDPR 2006).

California also requires commercial growers and pesticide applicators to report commercial pesticide applications to local county agricultural commissioners. The CDPR compiles this information in annual pesticide use reports. The CDPR's Environmental Hazards Assessment Program collects and analyzes environmental pesticide residue data, characterizes drift and other off-site pesticide movement, and evaluates the effect of application methods on movement of pesticides in air. If a pesticide is determined to be a toxic air contaminant, appropriate control measures are developed with the California Air Resources Board to reduce emissions to levels that adequately protect public health. Control measures may include product label amendments, applicator training, restrictions on use patterns or locations, and product cancellations.

7.1.4.2.1 Porter-Cologne Act and State NPDES Permitting

Under the Porter-Cologne Act (California Water Code Section 13000) the SWRCB, and the state's nine RWQCBs that it oversees, are responsible for administering federal and state water quality regulation and permitting duties.

The SWRCB oversees pesticide NPDES permitting in California. Users of specific larvicide and adulticide registered products are required to obtain coverage under the Statewide NPDES Permit for Biological and Residual Pesticide Discharges to Waters of the US from Vector Control Applications (SWRCB Water Quality Order No. 2012-0003-DWQ; NPDES No. CAG 990004; Vector Control Permit).Users of certain aquatic herbicides are required to obtain coverage under the Statewide General NPDES Permit for the Discharge of Aquatic Pesticides for Aquatic Weed Control in Waters of the US (SWRCB Water Quality Order No. 2004-0009-DWQ; NPDES No. CAG 990005; Aquatic Weed Control Permit).Pesticides and herbicides that require state NPDES permitting include *Bti*, *Bs*, methoprene, spinosad temephos, petroleum distillates, naled, pyrethrin, permethrin, resmethrin, prallethrin, PBO, etofenprox, 2,4-D, glyphosate, imazapyr, and triclopyr. Both permits are discussed in detail in Chapter 9, Section 9.1.2.2.9.

7.1.4.2.2 Safe Drinking Water Act 1976

The CDPH administers the federal Safe Drinking Water Act in California. In addition to enforcing the primary MCLs (discussed above in Section 7.1.4.1), CDPH uses as guidelines Secondary MCLs that regulate constituents that affect water quality aesthetics (such as taste, odor, or color).

Additionally, under the California Safe Drinking Water Act, Cal/EPA's Office of Environmental Health Hazard Assessment develops Public Health Goals (PHGs) for contaminants in California's publicly supplied drinking water. PHGs are concentrations of drinking water contaminants that pose no significant health risk if consumed for a lifetime, based on current risk assessment principles, practices, and methods. Public water systems use PHGs to provide information about drinking water contaminants in their annual Consumer Confidence Reports.

7.1.4.2.3 The Safe Drinking Water and Toxic Enforcement Act (Proposition 65)

This act, passed as a ballot initiative in 1986, requires the state to annually publish a list of chemicals known to the state to cause cancer or reproductive toxicity so that the public and workers are informed about exposures to potentially harmful compounds. Cal/EPA's Office of Environmental Health Hazard Assessment administers the act and evaluates additions of new substances to the list. Proposition 65 requires companies to notify the public about chemicals in the products they sell or release into the environment, such as through warning labels on products or signs in affected areas, and prohibits them from knowingly releasing significant amounts of listed chemicals into drinking water sources.

7.1.4.2.4 California Pesticide Regulatory Program

CDPR regulates the sale and use of pesticides in California. CDPR is responsible for reviewing the toxic effects of pesticide formulations and determining whether a pesticide is suitable for use in California through a registration process. Although CDPR cannot require manufacturers to make changes in labels, it can refuse to register products in California unless manufacturers address unmitigated hazards by amending the pesticide label. Consequently, many pesticide labels that are already approved by the United States Environmental Protection Agency (USEPA) also contain California-specific requirements. Pesticide labels defining the registered applications and uses of a chemical are mandated by USEPA as a condition of registration. The label includes instructions telling users how to make sure the product is applied only to intended target pests, and includes precautions the applicator should take to protect human health and the environment. For example, product labels may contain such measures as restrictions in certain land uses and weather (i.e., wind speed) parameters.

7.2 Environmental Impacts and Mitigation Measures

This section evaluates the potential impacts from the Program alternatives, focusing on the human health impacts specific to the use of selected chemical and biological pesticides.

7.2.1 Evaluation Concerns and Criteria

The public has indicated concerns about some of the following issues. While not required, the responses to the concerns help to direct the reader to the appropriate section or Appendix B, *Ecological and Human Health Assessment Report*, or they provide explanatory information in concise form.

> The PEIR should address Program impacts on people and pets through ingestion and absorption pathways and proposed mitigation. Address impacts on chemically sensitive people and sensitive populations such as children, the elderly, pregnant women. Exposure to pesticides can result in compromised immune system, which would allow for development of allergies or autoimmune disorders.

- Potential Chemical Control Alternative impacts are discussed in Section 7.2.7, and toxicity of individual active ingredients is evaluated in greater detail in Appendix B, Human and Ecological Health Assessment Report.

> The PEIR must list any and all biological or chemical agents proposed for use.

- The biological and chemical pesticide formulations included in the Program are listed in Table 7-2, Pesticide Products Containing Reported Active Ingredients and Table 7-3, Herbicide Products Containing Reported Active Ingredients.

> CDPH should be consulted to ensure all potential risks are identified, characterized, and evaluated.

- The PEIR document and information will be made publicly available and will be reviewed by the appropriate regulatory bodies.

> Concern expressed over public safety and health with regard to existing vegetable gardens and fruit trees within the project area. Local swimming holes could be a potential habitat for breeding mosquitoes, and chemical treatment could impact humans.

- BMPs to reduce exposure to nontarget species and areas are discussed in Chapter 2, discussed in Section 7.2.7, summarized in several other relevant chapters, and evaluated in greater detail in Appendix B.

> Concerned with use of Zenivex®; it mimes chrysanthemums but is a harmful neurotoxin.

- Etofenprox, the active ingredient in Zenivex®, is discussed in Section 7.2.7.2.2 and evaluated in greater detail in Appendix B. It does not require concomitant use of a synergist, such as PBO. Therefore, it likely exhibits less toxicity than others that require co-application with other chemicals. Based on toxicity, environmental fate, and usage patterns, etofenprox is not likely to result in unwanted adverse impacts to humans when BMPs are used.

> Adulticides present greater danger to humans than the threat of WNV, as many are known carcinogens and endocrine disruptors.

- The District's BMPs provide that adulticides are generally applied as aerosols using ULV techniques to minimize exposure to nontarget species. Aerial and ground application techniques are used to distribute the insecticides. The potential toxicity of the various adulticides included in the Program are discussed in Section 7.2.7 and evaluated in greater detail in Appendix B.

> Pyrethrins disrupt the normal functioning of sex hormones while PBO affects the functioning of hormone-related organs.
  - The District generally uses pyrethrins in ULV applications, which are designed to prevent environmental persistence and potential impacts to nontarget species.
  - As a synergist for pyrethrins and pyrethroids, PBO is also generally applied in ULV, and it degrades rapidly in soil and water. Its potential toxicity is discussed in Appendix B.

> How long are pesticides retained in humans (young infant through elderly), pets, home garden vegetables and fruit, etc.?
  - The half-lives of the 42 active ingredients and 4 adjuvants/surfactants included in the Program alternatives are listed in Appendix B.

> In addition to short-term effects, what are the long-term effects of repeated exposure to these chemicals?
  - The chronic effects of the various pesticides are discussed in detail in Appendix B.

The CEQA Guidelines Appendix G, Environmental Checklist Form, does not contain criteria for determining significance of impacts to human health from the use of pesticides and herbicides. The criteria for hazards and hazardous materials (Checklist Section VIII) are primarily addressed in Chapter 8. However, the first criterion is partly applicable and asks would the project:

a. Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?

The applicability is for the use of these chemicals. In short, the determination of significance is based on the potential to adversely affect human health based on existing data and application methods including label requirements and additional BMPs employed by the District (see Section 2.9). The specific concern is whether the activities used to control mosquitoes and vegetation could result in direct or indirect impacts to human populations in a treatment area in the short term (i.e., acute toxicity) or over the long term (i.e., chronic toxicity).

7.2.2 Evaluation Methods and Assumptions

Pesticides the District uses were investigated to provide a preliminary assessment of the potential impacts to humans (discussed in detail in Appendix B). A comprehensive literature review was conducted and the District supplied information to assess potential exposure and toxicity using the following:

> Pesticides the District uses

> Pesticide label recommendations

> Types of application sites (e.g., habitat types)

> Application procedures

> Number of treatments per application site

> Total amount used per treatment for each application site, based on yearly totals.

> Physicochemical properties of the pesticides/active ingredients

> Efficacy of the pesticide to eradicate the target mosquito species

> Reported adverse effects (e.g., reproductive, developmental, carcinogenic)

The pesticide application scenarios that result in reasonable efficacy with minimal unwanted estimated risk are preferred and are the basis of IPM approaches the District practices. Each of the pesticides identified as warranting further evaluation in Appendix B are known to exhibit at least one parameter that appears to drive potential or perceived risk. Toxicity levels (e.g., slight, low, moderate, high, etc.) are used prevalently in the published literature but are not standardized or representative of specific criteria. They qualitatively describe toxicity in relative terms in the evaluations of herbicides and pesticides in this PEIR and in Appendix B. Toxicity levels are helpful in making significance determinations.

This evaluation assumes that all pesticides are applied in accordance with label instructions and USEPA and Cal/EPA requirements. The USEPA requires mandatory statements to be included on pesticide product labels that include directions for use; precautions for avoiding certain dangerous actions; and where, when, and how the pesticide should be applied. This guidance is designed to ensure proper use of the pesticide and prevent unreasonable adverse effects to humans and the environment. All pesticide labels are required to include the name and percentage by weight of each active ingredient in the product/formulation. Toxicity categories for product hazards and appropriate first-aid measures must be properly and prominently displayed. Pesticide labels also outline proper use, storage, and disposal procedures, as well as precautions to protect applicators. The directions for use indicate target organism (pest), appropriate application sites, application rates or dosages, contact times, and required application equipment for the pesticide. Warnings regarding appropriate wind speeds, droplet sizes, or habitats to avoid during application are also prominently displayed

This evaluation does not include assumptions about which alternative treatment strategy(ies) would be applied in any given area. This evaluation assumes that important parameters, such as media half-life, are dependent on the specific conditions at the time of pesticide application, and values listed herein serve as references values.

7.2.3 Surveillance Alternative

Vector surveillance is critical to IPM strategies because it provides information that is used to determine when and where to institute other mosquito control measures. The District's mosquito surveillance activities are conducted in compliance with accepted federal and state guidelines (e.g., *California Mosquito-Borne Virus Surveillance & Response Plan* (CDPH et al. 2013) and *Best Management Practices for Mosquito Control in California* (CDPH and MVC 2012).These guidelines allow for flexibility in selection and specific application of control methods because local areas vary. Surveillance activities involve monitoring the abundance of adult and larval mosquitoes, field inspection of known or suspected mosquito habitat, monitoring and trapping of adult mosquitoes, testing for the presence of encephalitis virus-specific antibodies in sentinel chickens or wild birds, and/or response to public service requests regarding mosquitoes. Surveillance of potential areas of concern is a critical element for directing and responding to potential outbreaks of mosquitoes and the potential for conveying mosquito-borne diseases.

> **Impact HH-1: No impact** would occur to human health from the use of the Surveillance Alternative.

7.2.4 Physical Control Alternative

Physical Control for mosquitoes consists of the management of mosquito-producing habitat (including freshwater marshes and lakes, saltwater marshes, temporary standing water, and wastewater treatment facilities) especially through water control and maintenance or improvement of channels, tide gates, levees, and other water control facilities. Physical control is usually the most effective mosquito control technique because it provides a long-term solution by reducing or eliminating mosquito developmental sites and ultimately reduces the need for chemical applications. The physical control practices may be categorized into three groups: maintenance, new construction, and cultural practices. The District does not currently undertake these physical control activities but may choose to use this tool in the future. Should these activities be undertaken, they would be performed in accordance with all appropriate environmental regulations (wetland fill and dredge permits, endangered species review, water quality review, streambed alteration permits, etc.), and in a manner that generally maintains or improves habitat values for desirable species. Physical control techniques have minimal impact on humans due to prior identification and avoidance of potential problem areas and wildlife habitats by publishing schedules of the times and locations where such control practices are to be implemented.

Impact HH-2: Impacts to human health from use of the Physical Control Alternative would be **less than significant** and mitigation is not required.

7.2.5 Vegetation Management Alternative

Although rarely done in recent years, the District may choose to do any of the following activities in the future if feasible. For vegetation management, the District may use hand tools (e.g., shovels, pruners, chain saws, and weed-whackers) and heavy equipment where necessary for vegetation removal or thinning or apply herbicides to improve surveillance or reduce mosquito habitats. Vegetation removal or thinning would primarily occur in aquatic habitats to assist with the control of mosquitoes. To reduce the potential for mosquito breeding associated with water retention and infiltration structures, District staff may request the owners of the structures' to clear weeds and other obstructing vegetation in wetlands and retention basins). Vegetation management may be performed (under special circumstances) to assist other agencies and landowners with the management of invasive/nonnative weeds. These actions are typically performed under the direction of the concerned agency, which also maintains any required permits. These activities are conducted during predetermined times of recreational inactivity to provide an additional measure of safety to the public.

Impact HH-3: No impact would occur to human health from the nonherbicide Vegetation Management Alternative.

7.2.5.1 Herbicides

The District may use herbicides in the future to control vegetation in and around mosquito habitats to improve access needed for surveillance and to reduce potential habitat for mosquitoes. The herbicides the District may consider for future use are listed in Table 7-4 and are discussed in detail in Appendix B. The herbicides would be applied in strict conformance with label requirements.

Table 7-4 Herbicides the District May Use for Mosquito/Vegetation Management in the Future

Active Ingredient	Appendix B
Imazapyr*	Section 4.6.1
Glyphosate*	Section 4.6.2

**Not currently used, but may be in the future.*

The herbicides under consideration for the Program are nonselective and broad-spectrum (e.g., imazapyr and glyphosate) Imazapyr, is a systematic, nonselective, pre- and post-emergent herbicide used for a broad range of terrestrial and aquatic weeds. Glyphosate represents a commonly used herbicide for the control and elimination of grass weeds and sedges. Most of the herbicides are moderately persistent in soil and water. For each herbicide's half-life in soil and water, please refer to Appendix B.

Imazapyr is among the herbicides that have been shown to exhibit no/low toxicity to humans (USEPA 2006b). The District would take action to minimize drift of sprays, which is accomplished by carefully considering weather variables such as wind velocity and direction and chance of precipitation.

Impact HH-4: Impacts to human health from herbicides would be **less than significant** because the actual use and human exposure in the field is far less than tested in the laboratory and much higher volumes (exposure) would be needed to result in toxicity. Mitigation is not required.

The herbicides that were identified for further evaluation in Appendix B are discussed in further detail below.

7.2.5.1.1 Glyphosate

Glyphosate is a nonselective, post-emergent, and systemic herbicide that is the active ingredient (as an acid or salt) in Alligare, Aquamaster, Buccaneer, and Roundup© products. It is designed to target the shikimic acid pathway, which is specific to plants and some microorganisms; therefore, glyphosate is thought to have very low toxicity to mammals (USEPA 1993). The District would employ an adequate buffer to water sources should it choose to apply glyphosate.

The USEPA classifies glyphosate as Category III for oral and dermal toxicity (USEPA 1993), and the isopropylamine and ammonium salts exhibit low toxicity to mammals via the oral and dermal routes. No scientific evidence indicates that glyphosate is carcinogenic or mutagenic (USEPA 1993). It is poorly biotransformed in rats and is excreted via feces and urine; neither the parent compound nor its major breakdown product bioaccumulates in animal tissue (Williams et al. 2000).

Despite the apparent lack of toxicity to mammals, concerns have been raised about glyphosate's long-term developmental and reproductive effects. Although still in review, glyphosate is included in the final list of chemicals for screening under USEPA's Endocrine Disruptor Screening Program (USEPA 2009). The issue of endocrine-disrupting compounds is a topic of current scientific concern and inquiry but insufficient information is available to reach any conclusion about significance or potential adverse impacts. This situation is true of all "potential" endocrine-disrupting compounds.

It is likely that USEPA will provide an updated review of its potential risks in 2015; however, current data indicate that glyphosate is nontoxic to humans.

> **Impact HH-5:** Impacts to human health from the use of glyphosate would be **less than significant** and mitigation is not required.

7.2.5.2 Adjuvants

An adjuvant is any compound that is added to an herbicide formulation or tank mix to facilitate the mixing, application, or effectiveness of that herbicide. FIFRA does not require testing and registration of adjuvants. As such, little information on their fate, transport, and toxicity exists, other than that provided by the manufacturer or published by the scientific community (Bakke 2007; Tu et al. 2001). CDPR does require the registration of adjuvants that are considered to increase the action of the pesticides with which they are used (Bakke 2007). The adjuvants the District may employ in the future are listed in Table 7-5 and are discussed in detail in Appendix B.

Table 7-5 Adjuvants the District May Use for Mosquito Abatement/Vegetation Management in the Future

Active Ingredient	Appendix B
APEs*	Section 4.7.1
Polydimethylsiloxane Fluids*	Section 4.7.2

**Not currently used, but may be in the future.*

APEs are used as detergents, dispersants, emulsifiers, solubilizers, and foaming and wetting agents. Primary degradation of APEs in the environment generates more persistent shorter chain compounds, some of which may mimic natural hormones and disrupt endocrine function in humans (Ying et al. 2002). Nonylphenol and nonylphenol ethoxylate, which are produced in large volumes and widely used, exhibit low acute oral and dermal toxicity but are highly irritating and corrosive to the skin and eyes (USEPA 2010). The acute toxicity of APEs to mammals is low; however, concern exists regarding the estrogen-mimicking behaviors of these compounds, particularly nonylphenol and nonylphenol ethoxylate(USEPA 2010). The USEPA (2010)has recently recommended that this suite of chemicals be evaluated further due to their widespread use, persistence, and possible estrogen-mimicking behavior.

Polydimethylsiloxanes are insoluble in water and typically sorb to particulates. Degradation time varies depending on moisture in soils. These chemicals appear to be relatively nontoxic to most organisms, but information is scarce regarding the toxicity and environmental fate of polydimethylsiloxanes. Similarly, little is known about the toxicity or environmental fate of lecithins, which are a commonly used amphoteric surfactant derived from soybeans.

> **Impact HH-6:** Impacts to human health from the use of pesticide adjuvants would be **less than significant** and mitigation is not required.

7.2.6 Biological Control Alternative

Biological control of mosquitoes involves the intentional use of pathogens (diseases), parasites, and/or predators to reduce the population size of target mosquitoes. Biological control is used as a method of protecting the public from mosquitoes and the diseases they carry using mosquito parasites, pathogens, and predators. At present, mosquito parasites are not commercially available for mosquito control.

7.2.6.1 Mosquito Larvae Pathogens

As part of their Biological Control Alternative, the District employs bacterial larvicides that are highly specific to mosquitoes. These biological controls currently include *Bs*, and *Bti.* Spinosad is being considered for future use. Because the potential environmental impacts of *Bs* or *Bti* application are generally similar to those of chemical pesticide applications, these materials and spinosad are evaluated below under Section 7.2.7, Chemical Control Alternative. The environmental fate and toxicity of these control agents is discussed in Appendix B.

7.2.6.2 Mosquito Predators

Mosquitofish (*Gambusia affinis*) are presently the only commercially available mosquito predators. The District's rearing and stocking of these fish in mosquito habitats is the most commonly used biological control agent for mosquitoes in the world. Used correctly, this fish can provide safe, effective, and persistent suppression in various mosquito sources.

However, there has been increasing recognition in recent years that mosquitofish may adversely affect native amphibians, fish, invertebrates, and aquatic foodwebs (CDFG 2012), as described in Section 4.2.6. The District limits the use of mosquitofish by the public to ornamental fish ponds, water troughs, water gardens, fountains, and unused swimming pools. The District also uses mosquitofish in natural waters within their Service Area, where the District judges that mosquitofish are the best method for controlling larval mosquitoes. Such plantings have the potential to affect sensitive species and aquatic ecosystems, as described in Section 4.2.6.

Human interaction with mosquitofish is not hazardous to human health.

> **Impact HH-7: No impact** would occur to human health from the use of mosquitofish.

7.2.7 Chemical Control Alternative

Chemical control involves the application of nonpersistent selective insecticides to directly reduce populations of mosquitoes and other invertebrate threats to public health. If and when inspections reveal that mosquitoes are present at levels that trigger the District's criteria for chemical control – based on the mosquitoes' abundance/density, species composition, proximity to human settlements, water temperature, and presence of predators – the District applies pesticides to the site in strict accordance with label instructions and federal and state guidelines.

All of the chemical controls the Program uses are for mosquito abatement and are classified as larvicides or adulticides. Below is a discussion of the larvicides and adulticides the District uses. The active ingredients that were identified as warranting further evaluation in Appendix B due to their potential toxicity and/or prevalent use/public concern are listed in Table 7-6 (including herbicides discussed previously in Section 7.2.5).

Table 7-6 Active Ingredients Identified for Further Evaluation in Appendix B

Active Ingredient	Vector	Potential Issue
Methoprene		Prevalent use; toxicity to aquatics and insects
Etofenprox		Toxicity to aquatic organisms; no synergist required
Bti		Prevalent use; public concerns
Pyrethrins		Prevalent use; requires synergist (PBO)
Resmethrin		Requires synergist (e.g., PBO); potential endocrine disruptor
Permethrin	Mosquitoes	Toxicity to aquatic organisms; potential endocrine disruptor
APEs*		Toxicity to aquatic organisms; moderately bioaccumulative
Glyphosate*		Prevalent use; possible endocrine disruptor

**Not currently used, but may be in the future.*

7.2.7.1 *Mosquito Larvicides*

Larvicides are used to manage immature life stages of mosquitoes including larvae and pupae in aquatic habitats. Temporary aquatic habitats are usually targeted because permanent water bodies generally support natural mosquito predators such as fish. The larvicides are applied using ground application equipment, fixed wing aircraft, and rotary aircraft. The mosquito larvicides the District uses (or may choose to use in the future) are listed in Table 7-7 and are discussed in detail in Appendix B.

Table 7-7 Chemicals Employed for Larval Mosquito Abatement

Chemical Classification	Active Ingredient	Appendix B
Organophosphate	Temephos*	Section 4.2.2
Bacterial larvicide	*Bs*	Section 4.3.1
Bacterial larvicide	*Bti*	Section 4.3.2
Bacterial larvicide	Spinosad*	Section 4.3.3
Hydrocarbon ester	Methoprene	Section 4.3.4
Surfactants	Alcohol Ethoxylated Surfactant (monomolecular film) and Aliphatic Solvents	Section 4.3.5 Section 4.3.6

**Not currently used, but may be in the future.*

7.2.7.1.1 Bacterial Larvicides (*Bs*, *Bti*, and spinosad)

These bacterial larvicides are highly mosquito-specific bacteria that usually infect mosquito larvae when they are ingested. These pathogens multiply rapidly in the host, destroying internal organs and consuming nutrients. The pathogen can be spread to other mosquito larvae in some cases when larval tissue disintegrates and the pathogens are released into the water and are ingested by uninfected larvae. *Bs* and *Bti*, produce proteins that are toxic to most mosquito larvae, while the fermentation of *S. spinosa* produces spinosysns, which are highly effective mosquito neurotoxicants. All three bacteria are naturally occurring soil organisms and are commercially produced as mosquito larvicides. *Bs* can reproduce in natural settings for some time following release. *Bs* and *Bti* are applied on a variety of crops and standing and moving water bodies, *Bti* materials the District applies do not contain live organisms, only spores. The spores of *Bs* and *Bti* can persist in the environment for months, but the endotoxins are readily degraded by UV light and persist only for days. Bacterial spores of *Bti* are uniquely toxic to nematoceran Diptera (mosquitoes, midges, blackflies, psychodids, and ceratopogonids) (Lacey and Mulla 1990) and do not exhibit any human toxicity.

Spinosad alters nicotine acetylcholine receptors in insects, causing constant involuntary nervous system impacts ultimately leading to paralysis and death. It is used on various crops, animal husbandry premises, recreation areas, rights-of-way, and local residences. The USEPA has classified spinosad as a “reduced risk” compound because it is an alternative to more toxic, OP insecticides (CDPR 2002).It exhibits very acute toxicity by all exposure routes and has not been shown to elicit chronic toxicity in humans. The District does not currently use spinosad, but may choose to do so in the future.

Impact HH-8: No impact would occur to human health from the use of bacterial larvicides.

7.2.7.1.2 Hydrocarbon Ester - Methoprene

Methoprene is an insect growth regulator and selective larvicide. It is available in both liquid and solid formulations, and it is used in a variety of settings, including residential (ornamental ponds and abandoned swimming pools), agricultural (water troughs, over-irrigated fields) and industrial sites (oxidation ponds). It is applied either in response to observed high populations of mosquito larvae at a site, or as a sustained-release product that can persist for 4 months or longer if a site has limited accessibility and has regularly produced immature mosquitoes in the past. It is applied using hand held equipment (“belly grinders” for pellets), ATV mounted equipment (backpack sprayer, or Herd Seeder pellets/granules, or by suitably equipped aircraft (either fixed-wing or low-flying helicopters, particularly for marshes and other highly vegetated areas) but never when winds exceed 10 mph to prevent drift. Methoprene has very low acute toxicity to humans and mammals by all routes (USEPA 1991a). It is of public concern due to its potential ecological effects and widespread use (discussed in Chapter 6, Section 6.2.7.1.2).

Impact HH-9: No impact would occur to human health from the use of the mosquito larvicide methoprene.

7.2.7.1.3 Alcohol Ethoxylated and Aliphatic Solvent Surfactants

The monomolecular film formulation used in California for mosquito larvae control is Agnique. Monomolecular films and aliphatic solvents spread a thin film on the water surface that makes it difficult for mosquito larvae, pupae, and emerging adults to attach to the water’s surface, causing them to drown (USEPA 2007). The films also disrupt larval respiration of some other classes of air-breathing aquatic insects. They are used on an assortment of water bodies including ornamental ponds, pastures, irrigation systems, drainage systems, and drinking water systems (CDPR 2010). No evidence supports that these surfactants are toxic to humans.

Impact HH-10: No impact would occur to human health from the use of surfactant larvicide.

7.2.7.1.4 Temephos

Temephos is the only OP with larvicidal use and is used to help prevent mosquitoes from developing resistance to the bacterial larvicides. It was used prevalently in California for mosquito abatement from 1965 into the mid-1980s; however, microbial pesticides (e.g., *Bs*, *Bti,* spinosad), methoprene, and surface oils are used much more frequently now. It is used in various water bodies including lakes, marshes, drainage systems, irrigation systems, and polluted and stagnant water; it is not used on agricultural lands (CDPR 2010a). The District does not currently use temephos, but may choose to use it in the future. Application sites would primarily include man-made sources such as tire piles, utility vaults, and cemetery urns. Temephos has extremely low water solubility and binds strongly to soils. It has low toxicity for vertebrates at the levels used for mosquito control (USEPA 2000). The USEPA (2000) states that people are likely not exposed to temephos in drinking water or from residential use.

> **Impact HH-11:** Impacts to human health from the use of temephos would be **less than significant** and mitigation is not required.

7.2.7.2 Mosquito Adulticides

The District may use pesticides to control adult mosquitoes when no other tools are available and if specific criteria are met, including species composition, population density, proximity to human populations, and/or human disease risk. Adulticide materials are used infrequently and only when necessary to control mosquito populations. The adulticides the District uses (or may use in the future) to control mosquitoes are listed in Table 7-8 and discussed in detail in Appendix B.

> **Impact HH-12:** Impacts to human health from the use of naled would be **less than significant** and mitigation is not required.

Table 7-8 Chemicals Employed for Adult Mosquito Abatement

Chemical Classification	Active Ingredient		Appendix B
Pyrethrin	Pyrethrins	Mosquito	Section 4.1.1
Pyrethroid	Phenothrin (sumithrin or d-phenothrin)*	Mosquito	Section 4.1.3
Pyrethroid	Prallethrin*	Mosquito	Section 4.1.4
Pyrethroid	Resmethrin	Mosquito	Section 4.1.8
Pyrethroid	Permethrin	Mosquito	Section 4.1.10
Pyrethroid	Etofenprox*	Mosquito	Section 4.1.11
Synergist	PBO	Mosquito	Section 4.1.12
Organophosphate	Naled*	Mosquito	Section 4.2.1

**Not currently used, but may be in the future.*

7.2.7.2.1 Pyrethrins

Pyrethrins are naturally occurring compounds the flowers of the Chrysanthemum species produce. They effectively induce temporary paralysis in insects but are not acutely lethal by themselves; thus, they are used concomitantly with the synergist PBO, which inhibits metabolism of the pyrethrins so that a lethal dose is assured (USEPA 2006a). The District uses pyrethrins on crops, animal husbandry premises and pastures, outdoor household areas, and for wide-area mosquito abatement in areas that include aquatic habitats.

Pyrethrins have low to moderate acute mammalian toxicity via the oral, dermal, and inhalation routes (Categories III and IV). They are a moderate eye irritant (Category III), a mild dermal irritant (Category IV), and not a skin sensitizer. The effects of pyrethrins are (1) neurobehavioral effects following acute, short-term, and chronic exposure, with nervous system lesions observed in the rat and mouse following acute exposure; (2) thyroid effects, following chronic exposure in rats and dogs; and (3) liver effects, following short- and long-term exposure in rats, dogs, and mice. The neurobehavioral effects are considered relevant to humans because the effects are observed in both rats and mice, and the mode of action affects a basic function of the nervous system that is common to all animals (USEPA 2006a).

They are of concern because they are used prevalently and require the use of the synergist PBO, a potential endocrine disruptor (USEPA 2009). However, the District uses pyrethrins only when absolutely necessary in ULV applications that are designed to break down rapidly, resulting in very low potential exposure to humans.

> **Impact HH-13:** Impacts to human health from the use of pyrethrins would be **less than significant** and mitigation is not required.

7.2.7.2.2 Pyrethroids, Pyrethroid-Like Compounds, and Synergists

Pyrethroids are synthetic compounds that are chemically similar to the pyrethrins but have been modified to increase stability and activity against insects. Pyrethroids bind to neuronal voltage-gated sodium channels, preventing them from closing; this persistent activation of the channels then leads to paralysis.

First generation or “Type I” pyrethroids include phenothrin (sumithrin), prallethrin, and resmethrin. These pyrethroids are used to control flying and crawling insects in a number of commercial and horticultural applications and are sold for residential use and application on pets to control fleas and ticks. They have effective insect knock-down capabilities but are unstable as they are highly photosensitive (i.e., easily degraded by light). The newer second-generation/“Type II” pyrethroids (permethrin) contain an α-cyano group, which reduces their photosensitivity, thereby increasing their persistence and toxicity.

Some synthetic insecticides are similar to pyrethroids, such as etofenprox, but have a slightly different chemical composition. The pyrethroids that were identified for further evaluation in Appendix B are discussed below.

7.2.7.2.3 Resmethrin

Resmethrin is the active ingredient in Scourge®. It is a restricted-use pesticide due to its toxicity to fish and is available for use only by certified pesticide applicators or persons under their direct supervision.

Resmethrin has low acute toxicity via the oral (Category III), dermal (Category III), and inhalation (Category IV) routes of exposure. Resmethrin is included in the final list of chemicals for screening under USEPA's Endocrine Disruptor Screening Program (USEPA 2009).

Public concern regarding resmethrin exists because of its potential endocrine-disrupting properties and concomitant use of PBO, Scourge® is rarely used and is being phased out of the District's program and replaced with a non-resmethrin alternative.

7.2.7.2.4 Permethrin

Permethrin is also a pyrethroid. Dermal exposure in humans can cause tingling and pruritus with blotchy erythema on exposed skin (ATSDR 2003). In humans, acute effects observed subsequent to ingestion of permethrin included nausea, vomiting, abdominal pain, headache, dizziness, anorexia, and hypersalivation. Reports of severe poisoning are rare and usually follow ingestion of substantial, but poorly described, amounts of permethrin. Symptoms of severe poisoning include impaired consciousness, muscle fasciculation, convulsions, and noncardiogenic pulmonary edema (ATSDR 2003). Systemic effects are similar to those seen in acute and chronic ingestion with prolonged contact or contact with high concentrations of permethrin. Acute toxicity to permethrin via inhalation has been shown to be very small. The USEPA (2006c) has classified permethrin as Category III for acute oral and acute dermal toxicity, Category III for eye irritation potential, and Category IV for dermal irritation potential.

Because permethrin is included in the final list of chemicals for screening under USEPA's Endocrine Disruptor Screening Program (USEPA 2009), it is of concern to the public. However, the District rarely uses it, applies it through ULV application with either a hand-held ULV or ATV mounted small ULV unit or pick-up truck, and does not apply during high winds.

7.2.7.2.5 Etofenprox

Etofenprox is a pyrethroid-like insecticide that is the active ingredient in Zenivex®. It differs in structure from pyrethroids in that it lacks a carbonyl group and has an ether moiety, whereas pyrethroids contain ester moieties. It is used indoors, as a spot treatment for pets, and as an outdoor fogger to control flying and crawling insect pests. It is frequently applied to backyards and patios and sometimes directly to domestic pets by homeowners. It has low acute toxicity to humans and mammals. The public's concerns regarding the ecological impacts of etofenprox are discussed in Chapter 6, Section 6.2.7.2.5.

> **Impact HH-14:** Impacts to human health from the use of pyrethroids and pyrethroid-like compounds as mosquito adulticides would be **less than significant** and mitigation is not required.

7.2.7.2.6 Piperonyl Butoxide

PBO is a pesticide synergist that enhances the effectiveness of pesticide active ingredients, such as pyrethrins and pyrethroids, by inhibiting microsomal enzymes and, thus, the breakdown of the other active ingredient(s) (USEPA 2006a). It is a registered active ingredient in products used to control flying and crawling insects and arthropods in agricultural, residential, commercial, industrial, and public health settings. No products contain only PBO. It degrades quickly in soil and water. PBO has a low acute toxicity by oral, inhalation, and dermal routes, but it is included in the final list of chemicals for screening under USEPA's Endocrine Disruptor Screening Program (USEPA 2009). As a synergist, PBO is applied using the same guidelines as those for pyrethroids and pyrethrins: ULV application with a backpack mister or hand can/duster, and it is not applied during high winds.

> **Impact HH-15:** Impacts to human health from the use of the synergist PBO in mosquito adulticides would be **less than significant** and mitigation is not required.

7.2.7.2.7 Organophosphates

OP insecticides irreversibly block acetylcholinestarase activity, which causes accumulation of the neurotransmitter acetylcholine in the central nervous system, leading to excessive neuronal stimulation and then depression. Ops are quickly degraded and exhibit very low environmental persistence. The District may choose to use OPs in rotation with other active ingredients in the future to avoid the development of resistance.

Naled

Naled is an indoor and outdoor general use pesticide, used on food and feed crops, farms, dairies, pastureland, and in greenhouses and over standing water (CDPR 2010a). It is used in rotation with pyrethrins or pyrethroids to avoid the development of resistance. It is moderately toxic to mammals; however, the District does not currently use this chemical but may choose to in the future in the event of a threat of a disease outbreak. If used, the District would strictly adhere to BMPs and product label requirements, including the restriction of naled application to targets outside adequate buffer zones around permanent water bodies to reduce runoff. It would be applied aerially using ULV, and potential drift is prevented because it is not applied during moderate/high winds. In addition, spray setbacks are established to reduce spray drift for agricultural uses.

Impact HH-16: Impacts to human health from the use of naled would be **less than significant** and mitigation is not required.

7.2.8 Cumulative Impacts

“Cumulative impacts” are defined as “two or more individual effects which, when considered together, are considerable or compound or increase other environmental impacts (CEQA Guidelines, Section 15355). Cumulative impacts, as they relate to human health, include past, present, and reasonably foreseeable actions that potentially impact humans. Cumulative impacts can result from individually minor, but collectively significant, projects taking place over a period of time. The cumulative impact analysis is contained in Section 13.5 and focuses on the potential for the use of pesticides for mosquito control to contribute to regional pesticide use, which is of concern for its potential impacts to the health of human populations. It includes Table 13-1, Historical Pesticide Use within the SCMAD Program Area for 2006-2010 and Table 13-2, Pesticide Use within the SCMAD Service Area.

Although large uncertainty and high variation exist in the reported amounts of pesticide use within the District’s Program Area counties, they vary according to particular needs, majority of habitat type, and seasonal outbreaks. The public is aware of these pesticide uses and, in general, is pressuring agencies within these counties to use less pesticide whenever possible. The District uses very strict and thorough BMPs in their pesticide applications for mosquito control and is attempting to reduce total pesticide use where possible consistent with IPM practices.

The District’s incremental contributions to overall pesticide use within its Program Area do not trigger a cumulatively considerable impact on pesticide use. While overall use of pesticides throughout the Program Area may be considered cumulatively significant, the District’s small incremental contributions to this impact are not cumulatively significant. Therefore, the **Program’s long-term activities including chemical applications would not contribute considerably to human health impacts.** The Program alternatives would not result in significant cumulative impacts to the human health condition of the region.

7.2.9 Environmental Impacts Summary

Table 7-9 presents a summary of human health impacts associated with the five alternatives. The human health impacts correspond to those in Sections 7.2.3 through 7.2.8. All of the impacts were determined to be either “no impact” or a “less-than-significant impact.”

Table 7-9 Summary of Human Health Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Effects on Human Health					
Impact HH-1: No impact would occur to human health from the use of the Surveillance Alternative.	N	na	na	na	na
Impact HH-2: Impacts to human health from use of the Physical Control Alternative would be **less than significant** and mitigation is not required.	na	LS	na	na	na
Impact HH-3: No impact would occur to human health from the nonherbicide Vegetation Management Alternative.	na	na	N	na	na
Impact HH-4: Impacts to human health from herbicides would be **less than significant** because the actual use and human exposure in the field is far less than tested in the laboratory and much higher volumes (exposure) would be needed to result in toxicity. Mitigation is not required.	na	na	LS	na	na
Impact HH-5: Impacts to human health from the use of glyphosate would be **less than significant** and mitigation is not required.	na	na	LS	na	na
Impact HH-6: Impacts to human health from the use of pesticide adjuvants would be **less than significant** and mitigation is not required.	na	na	LS	na	na
Impact HH-7: No impact would occur to human health from the use of mosquitofish.	na	na	na	N	na
Impact HH-8: No impact would occur to human health from the use of bacterial larvicides**.**	na	na	na	na	N
Impact HH-9: No impact would occur to human health from the use of the mosquito larvicide methoprene.	na	na	na	na	N
Impact HH-10: No impact would occur to human health from the use of surfactant larvicide.	na	na	na	na	N
Impact HH-11: Impacts to human health from the use of temephos would be **less than significant** and mitigation is not required.	na	na	na	na	LS
Impact HH-12: Impacts to human health from the use of naled would be **less than significant** and mitigation is not required.	na	na	na	na	LS

Table 7-9 Summary of Human Health Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact HH-13: Impacts to human health from the use of pyrethrins would be **less than significant** and mitigation is not required.	na	na	na	na	LS
Impact HH-14: Impacts to human health from the use of pyrethroids and pyrethroid-like compounds as mosquito adulticides would be **less than significant** and mitigation is not required.	na	na	na	na	LS
Impact HH-15: Impacts to human health from the use of the synergist PBO in mosquito adulticides would be **less than significant** and mitigation is not required.	na	na	na	na	LS
Impact HH-16: Impacts to human health from the use of naled would be **less than significant** and mitigation is not required.	na	na	na	na	LS

LS = Less-than-significant impact
N = No impact
na = Not applicable
SM = Potentially significant but mitigable impact
SU = Significant and unavoidable impact

7.2.10 Mitigation and Monitoring

All impacts to human health are identified as either “no impact” or a “less-than-significant impact.” Therefore, mitigation measures are not applicable to the insignificant impacts identified for all of the Program alternatives described.

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8 Public Services and Hazard Response

Chapter 8 evaluates potential impacts to public services and hazard response from the Program implementation. Results of the evaluation are provided at the programmatic level. Section 8.1, Environmental Setting, presents an overview of the public services and hazard response in the Program Area, and contains state and local ordinances and regulations that are applicable to the Program. Section 8.2, Environmental Impacts and Mitigation Measures, presents the following:

> Environmental concerns and evaluation criteria: A determination of whether the Program alternatives would cause significant impacts to public services and hazard response

> Evaluation methods and assumptions

> Discussion of the impacts from the Program alternatives, and recommendations for mitigation, if required, for those impacts

> Cumulative impacts summary

> A summary of environmental impacts to public services and hazard response

8.1 Environmental Setting

8.1.1 Overview of Public Services and Hazard Response

The District conducts its operations in conformance with its Emergency Response Plan (SCMAD 2013) which consists of four elements: 1) Emergency Response Plan Guidelines; 2) Employee Training Plan; 3) Emergency Response Plan-Spill Control and Clean Up Procedures; and 4) Pesticide Safety Training Program. The component plans provide BMPs for minimizing the impact of small spills of hazardous materials, storage of hazardous materials, and worker safety in the field conducting surveillance, physical control, vegetation management, and pesticide/herbicide application protocols. For the years 2012 and 2013, the District had no incidents requiring spills management, no incidents involving worker safety, and no fire incidents. The Proposed Program would continue activities subject to these plans and BMPs in the future, similar to the existing Program.

A combination of county sheriffs' departments and municipal police departments provides law enforcement services in the Program Area. Sheriffs' departments typically provide law enforcement and jail services within their respective counties. In addition to law enforcement jurisdiction over unincorporated county areas, some sheriffs' departments also provide law enforcement services to certain cities within the county on a contract basis.

Additionally, the California Highway Patrol is the state police force for California. They have specific jurisdiction over all California state routes, US highways, interstate highways, and freeways in the state, and over all public roads in unincorporated parts of a county.

Fire protection services in the Program Area are provided by a number of agencies, including county fire departments, city fire departments, and fire districts. A number of counties also have volunteer fire departments.

California Department of Forestry and Fire Protection (CAL FIRE) oversees the fire protection and stewardship of over 31 million acres of California's privately owned wildlands. CAL FIRE's firefighters, fire engines, and aircraft respond to an average of more than 5,600 wildland fires each year. CAL FIRE also responds in other emergency situations such as medical aid, hazardous material spills, swiftwater rescues, search and rescue missions, civil disturbances, train wrecks, floods, earthquakes, and more. CAL FIRE provides varied emergency services in 36 of California's 58 counties via contracts with local governments.

8.1.2 Regulatory Setting

California state law and local ordinances and regulations pertaining to public services and hazard response are cited in this section. No federal regulations pertain to public services or hazard response. Regulations governing human health are discussed in Chapter 7, Human Health.

8.1.2.1 State

8.1.2.1.1 California Code of Regulations (CCR)

CCR Title 3 Division 6, Pesticides and Pest Control Operations, directs the safe use and transport of pesticides within the state. The following are some of the sections of particular relevance to the Proposed Program:

> ***6670. Container Control***
>
> *Pesticides, emptied containers or parts thereof, or equipment that holds or has held a pesticide, shall not be stored, handled, emptied, disposed of, or left unattended in such a manner or at any place where they may present a hazard to persons, animals (including bees), food, feed, crops or property. The [Agricultural] commissioner may take possession of such unattended pesticides or emptied containers to abate such hazard.*
>
> ***6672. Delivery of Pesticide Containers***
>
> *(a) No person shall deliver a container that holds, or has held, a pesticide to a property unless he stores it in an enclosure or closure complying with the requirements of this Section or delivers it to a person in charge of the property or his agent, or a pest control operator or his employee. The person receiving the container shall control access to it in accordance with this Section.*
>
> *(b) Each person who controls the use of any property or premises is responsible for all containers or equipment on the property that hold, or have held, a pesticide. Unless all such containers are under his personal control so as to avoid contact by unauthorized persons, he shall:*
>
> *(1) Provide a person responsible to him to maintain such control over the containers at all times; or*
>
> *(2) Store all such containers in a locked enclosure, or in the case of liquid pesticides in a container larger than 55 gallons in capacity, the container shall have a locked closure. Either shall be adequate to prevent unauthorized persons from gaining access to any of the material.*
>
> ***6682. Transportation***
>
> *(a) Pesticides shall not be transported in the same compartment with persons, food or feed.*
>
> *(b) Pesticide containers shall be secured to vehicles during transportation in a manner that will prevent spillage onto the vehicle or off the vehicle. Paper, cardboard, and similar containers shall be covered when necessary to protect them from moisture.*

8.1.2.1.2 California Department of Forestry and Fire Protection

Public Resources Code 4201-4204 directs CAL FIRE to map fire hazards within State Responsibility Areas based on relevant factors such as fuels, terrain, and weather. These statutes were passed after significant wildland-urban interface fires occurred; consequently, these hazards are described according to their potential for causing ignitions to buildings. These zones, referred to as Fire Hazard Severity Zones (FHSZs), provide the basis for application of various mitigation strategies to reduce risks to buildings associated with wildland fires (CAL FIRE 2007).

Additionally, the Public Resources Code, beginning with Section 4427, includes fire safety regulations that restrict the use of equipment that may produce a spark, flame, or fire; require the use of spark arrestors on construction equipment with internal combustion engines; specify requirements for the safe use of gasoline-powered tools in fire hazard areas; and specify fire suppression equipment that must be provided on site for various types of work in fire-prone areas. These requirements would apply to Program activities within a "Very High Fire Hazard Severity Zone."

8.1.2.2 Local

Local ordinances and regulations are usually contained within the general plans of cities and counties in the Program Area, and focus on providing adequate public services and hazard response with a reasonably brief response time throughout the Service Area. Municipal and county ordinances establish police and fire departments and districts, and some establish emergency preparedness councils or committees.

8.2 Environmental Impacts and Mitigation Measures

The impacts evaluation for public services and hazard response is provided below. The evaluation analyzes the Program's impacts relative to the impact significance criteria presented in Section 8.2.1.

8.2.1 Evaluation Concerns and Criteria

The following concerns were associated with public services and hazard response and are addressed in this section:

- Risk of spill of hazardous materials from equipment or applications of pesticides and/or herbicides
- Risk of aerial equipment failure during applications of pesticides.
- Safe storage and disposal of chemical-related materials including pesticide containers.

For this evaluation, Program impacts would be considered potentially significant according to the CEQA environmental checklists for Public Services (XIV), and Hazards and Hazardous Materials (VIII), if any of the Program alternatives would:

- Result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts in order to maintain acceptable service ratios, response time or other performance objectives for any of the public services:
  - Fire protection
  - Police protection
  - Schools
  - Parks
  - Other public facilities

> Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment;

> Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school;

> Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5, and, as a result, would it create a significant hazard to the public or the environment; or

> Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands.

The other criteria contained in the Checklist are not listed because they are not relevant to the impact analysis in this chapter for the Proposed Program for the following reasons. The Program could result in the application of certain pesticide treatments within 0.25 mile of an existing or proposed school; potential hazardous effects of the Program alternatives on sensitive populations are discussed in Chapter 7, Human Health. Public services and hazard response to impacts at or near schools would be the same as described under the first criterion listed above.

Although activities proposed under the Program alternatives could occur on or near sites included on a list of hazardous materials sites (e.g., landfills and manufacturing sites) compiled pursuant to Government Code Section 65962.5 (Cal/EPA 2013), most of these activities, with the exception of constructing new shallow ditches or minor water control features, would not involve excavation or other ground disturbance that could result in impacts related to the release of materials at these hazardous materials sites. However, the District maintains a list of these existing hazardous materials sites within their Service Area.

One of the Program alternatives involves aerial application of chemical treatments and would, therefore, occur partially within areas covered by airport land use plans, within 2 miles of public airports or public use airports, or within the vicinity of private airstrips. However, no construction or other activities would occur that would conflict with airport land use plans or result in a safety hazard for people residing or working in proximity to these facilities. Therefore, this criterion is not applicable to the Program and is not discussed further.

None of the Program alternatives would result in any road or lane closures or detours. The Program would not involve activities that could impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan. Therefore, this criterion is not applicable to the Program and is not discussed further.

Under some of the Program alternatives, the District and its registered contractors would practice safe disposal of pesticide products. Properly rinsed empty containers can be safely and legally disposed of at landfills. Any unused portions of Program chemicals would be disposed of at permitted hazardous waste collection locations. Adequate landfill and hazardous waste collection capacity exists in locations throughout the Program Area. The Program would not exceed the existing capacity to safely dispose of these materials. Therefore, this criterion is not applicable to the Program and is not discussed further.

Based on public concerns and the relevant CEQA criteria above, the environmental impact topics addressed in the impact analyses are:

(a) Increase Demand for Police, Fire, or Health-Care Services

(b) Create a Significant Hazard to the Public or Environment

(c) Expose People or Structures to Wildfire Risk

8.2.2 Evaluation Methods and Assumptions

The methodology and assumptions for this impact evaluation for the Program alternatives are provided below.

8.2.2.1 Methodology

The methodology used to prepare this public services and hazard response impact section is as follows:

> Reviewed transcripts from public scoping meetings on the nine-district PEIRs in May and June 2011.

> Summarized federal, state, county, and select municipal regulations, ordinances, and guidelines for general public services and hazard response issues and as they related to the Program.

> Evaluated potential hazards requiring response and potential interference with public services and hazard response at the programmatic level.

> Determined probable impacts and mitigation measures associated with the alternatives proposed in Chapter 2, Program Description.

8.2.2.2 Assumptions

For the analysis of potential impacts to public services and hazard response, no assumptions were made beyond those explained in Chapter 2, Program Description, for the Program alternatives. Under CEQA, the term “impact” is used to mean an adverse or negative effect from a physical change in the environment compared to existing conditions.

8.2.3 Surveillance Alternative

The Surveillance Alternative involves both ground surveillance and water surveillance. Surveillance activities include field investigations, trapping, sampling, and responding to public service requests. Ground surveillance requires the periodic use of light trucks, such as pickup trucks and jeeps, and low ground pressure ATVs, and would take place in all land use types. Water surveillance would require the use of ATVs and, occasionally, boats and most frequently would occur in agricultural and open-space areas. Most equipment would only be operated a few hours per day for varying periods of time throughout the year.

Pesticide use is limited; only a small amount of chemical is used in the collection jar of each New Jersey adult mosquito traps (i.e., piece approx. 1 “ x 2.75 of pest strip infused with dichlorvos). The jar is secured by a metal cage having a hinged, padlocked door.

8.2.3.1 Increase Demand for Police, Fire, or Health-Care Services

It is unlikely that the Surveillance Alternative would result in a substantial increase in requests for services from emergency dispatchers, and the Program would not adversely affect the ability of 911 dispatchers to handle calls.

> **Impact PSH-1**: Surveillance activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.

8.2.3.1.1 Create a Significant Hazard to the Public or Environment

Surveillance activities, including the use of vehicles and small amounts of pesticides in containers, would not create a significant hazard to the public or the environment. District staff would adhere to all applicable CCR requirements regarding pesticides and to trap label instructions. The District’s Employee Training Plan, Pesticide Safety Training Program, Emergency Response Plan Spill Control and Clean Up Procedures, and Emergency Response Plan Guidelines provide safety training for all employees who may be affected by any substance, process, procedure, or equipment that represents a potential hazard. Training programs are conducted for the safe use of equipment, machinery, or tools and the safe use and disposal of pesticides. Employees also receive periodic training materials at staff meetings (monthly or bi-monthly) from the District's insurance carrier on various health and safety issues that include quizzes. This is mandated by the District's insurance carrier.

Employment as a Mosquito Control Technician requires certification by the California Department of Public Health Vector Borne Disease Section (VBDS). Certification requires the passage of two exams. The first exam is referred to as Category A or the "Core Exam" and it includes questions on pesticide classification, formulations, application equipment, calibration, safety equipment, protective clothing, pertinent laws and regulations and first aid. In order to maintain active certification in mosquito control, the individual is required to attend 20 hours of continuing education in a 2-year period and view an additional 16 hours on video. Additional safety information quizzes are required by the District's insurance carrier, Department of Pesticide Regulation, and Solano County Department of Resource Management – Hazardous Materials Division.

Adherence to CCR requirements and the District's employee training programs reduce the potential for accident conditions; therefore, the Surveillance Alternative would not result in significant hazards to the public or environment.

> **Impact PSH-2:** Surveillance activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.

8.2.3.1.2 Expose People or Structures to Wildfire Risk

Surveillance vehicles could be used in moderate to very high FHSZs. Ground surveillance requires the periodic use of light trucks, such as pickup trucks and jeeps, and ATVs, but does not require the use of large-scale, offroad equipment. In addition, surveillance is conducted via existing roads and access routes except when existing routes are unavailable and offroad access is required. All vehicles used in wildland areas are equipped with a shovel and a fire extinguisher during the dry season. The District's Employee Training Plan and Emergency Response Plan Guidelines provide training for all employees on the safe use of equipment and machinery, including vehicle operation. Employees also receive periodic training materials at staff meetings (monthly or bi-monthly) from the District's insurance carrier on various health and safety issues that include quizzes. This is mandated by the District's insurance carrier. These measures will reduce potential fire hazards; therefore, the Surveillance Alternative is not likely to increase wildfire hazards through the use of equipment that may produce a spark, flame, or fire and would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires.

> **Impact PSH-3:** Surveillance activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.

8.2.4 Physical Control Alternative

The Physical Control Alternative involves managing mosquito habitat to reduce mosquito production or migration and typically reduces the need for pesticides. Mosquito control is accomplished primarily through direct habitat management and public education. Physical control for mosquitoes consists of managing wetlands and water bodies through maintenance, new construction, and cultural practices such as the installation and maintenance of water control facilities, sediment and debris removal, vegetation maintenance and removal, and the construction of ditches or installation of culverts that eliminate mosquito-breeding habitat. The District is rarely directly involved in physical control activities at this time, but instead participates in an advisory capacity only. The District also requires some landowners to conduct similar maintenance activities for mosquito abatement. Terrestrial activities would require the periodic use of light trucks, such as pickup trucks and jeeps, and ATVs. Wetland and aquatic activities would require the use of ATVs and, occasionally, boats and sprayers.

8.2.4.1.1 Increase Demand for Police, Fire, or Health-Care Services

The level of activity in the future is similar to existing conditions. It is unlikely that the Physical Control Alternative would result in a substantial increase in requests for services from emergency dispatchers, and the Program would not adversely affect the ability of 911 dispatchers to handle calls.

> **Impact PSH-4:** Physical control activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.

8.2.4.1.2 Create a Significant Hazard to the Public or Environment

Physical control activities do not include the use of pesticides and herbicides and are intended to reduce the need to use chemical control measures for mosquito control; therefore, the Physical Control Alternative would not create a significant hazard to the public or the environment.

> **Impact PSH-5:** Physical control activities do not include the use of pesticides or herbicides; therefore, these activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.

8.2.4.1.3 Expose People or Structures to Wildfire Risk

Physical control requires the use of vehicles and equipment that could be used in moderate to very high FHSZs. Access to work sites requires the periodic use of light trucks, such as pickup trucks and jeeps, and ATVs. Physical control activities are conducted via existing roads and access routes except when existing routes are unavailable and offroad access is required. Construction of ditches, levees, or other features could also require the use of large-scale, offroad equipment. Power tools may also be used for vegetation management. The District's Employee Training Plan and Emergency Response Plan Guidelines provide training for all employees on the safe use of pesticides, equipment, tools, and machinery, including vehicle operation. Employees also receive periodic training materials at staff meetings (monthly or bi-monthly) from the District's insurance carrier on various health and safety issues that include quizzes. This is mandated by the District's insurance carrier. All vehicles are equipped with a shovel and a fire extinguisher during the dry season. These measures will reduce fire hazards; therefore, the Physical Control Alternative is not likely to increase wildfire hazards through the use of equipment that may produce a spark, flame, or fire and would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires.

> **Impact PSH-6:** Physical control activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.

8.2.5 Vegetation Management Alternative

Vegetation management activities are conducted to reduce the value of mosquito habitat and to allow District access for inspections and treatment. Access to vegetation management areas would require the periodic use of light trucks, such as pickup trucks and jeeps, and ATVs. Access and herbicide application at or near aquatic areas requires the use of ATVs and, occasionally, boats and sprayers. Vegetation management activities require the use of hand tools or other mechanical means (i.e., heavy equipment) for vegetation removal or thinning. The District does not currently use herbicides for vegetation management, but may choose to do so in the future. Herbicide applications may be used at waste ponds and in natural habitats. Vegetation removal or thinning primarily occurs in aquatic habitats to control mosquitoes. To reduce the potential for mosquito breeding associated with water retention and infiltration structures, District staff may systematically clear weeds and other obstructing vegetation in wetlands and retention basins (or request the structures' owners to perform this task). Tools ranging from shovels and pruners to chain saws and weed eaters up to heavy equipment can all be used at times to clear plant matter that either prevent access to mosquito-breeding sites or that prevent good water management practices, which would minimize mosquito populations. Generally, however, District brushing activities rely almost entirely on hand tools. Trimmed vegetation is either removed and disposed of properly from the site or broadcast in such a way as to minimize visual degradation of the habitat. Trimming is also kept to a minimum to reduce the possibility of the invasion of exotic plant and animal species. Water control structures are also used to manage vegetation by manipulating hydroperiods.

8.2.5.1.1 Increase Demand for Police, Fire, or Health-Care Services

The level of activity in the future is similar to existing conditions but may include herbicide applications in the future. It is unlikely that the Vegetation Management Alternative would result in a substantial increase in requests for services from emergency dispatchers, and the Program would not adversely affect the ability of 911 dispatchers to handle calls.

> **Impact PSH-7:** Vegetation management activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.

8.2.5.1.2 Create a Significant Hazard to the Public or Environment

The routine transport, use, or disposal of herbicides for vegetation management activities would not create a significant hazard to the public or the environment. Applicators would adhere to all applicable CCR requirements regarding pesticides to ensure safety. The District's Employee Training Plan, Pesticide Safety Training Program, Emergency Response Plan Spill Control and Clean Up Procedures, and the Emergency Response Plan Guidelines provide safety training for all employees who may be affected by any substance, process, procedure or equipment that represents a potential hazard. Training programs are conducted for the safe use of equipment, machinery, or tools and the safe use and disposal of pesticides and herbicides. Employees receive periodic training materials at staff meetings (monthly or bi-monthly) from the District's insurance carrier on various health and safety issues that include quizzes. This is mandated by the District's insurance carrier.

All small spills would be handled according to the District's procedures for cleanup as described in their Emergency Response Plan – Spill Control and Clean Up Procedures as follows:

- Adequate caution shall be exercised to prevent spillage of pesticides during storage, transportation, mixing or application of pesticides. All pesticide spills and cleanups (excepting cases where dry materials may be returned to the container or application equipment) shall be reported by phone to the appropriate agencies according to the protocols listed in the District's Emergency Response Plan – Spill Control and Clean Up Procedures. A pesticide spill cleanup kit and proper protective equipment will be maintained at the District's Shop and in each vehicle used for pesticide application or transport.
- The spill site should be managed to prevent entry by unauthorized personnel. The spill will be contained and controlled by stopping it from leaking or spreading to surrounding areas, and dry spills will be covered with polyethylene or plastic tarpaulin and liquid spills will be absorbed with appropriate absorbent materials.
- The spilled material will be properly secured and the bags will be labeled with service container labels identifying the pesticide and delivered to the Field Supervisor for disposal.

Adherence to CCR requirements and the District's training programs and cleanup procedure reduces the potential for accident conditions; therefore, the Vegetation Management Alternative would not result in significant hazards to the public or environment.

> **Impact PSH-8:** Vegetation management activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous

materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.

8.2.5.1.3 Expose People or Structures to Wildfire Risk

Vehicles and power tools could be used in moderate to very high FHSZs during vegetation management activities. Power tools include leaf blowers, mowers, chain saws, and weed eaters. Access to sites and vegetation management requires the periodic use of light trucks, such as pickup trucks and jeeps, and ATVs, and could require the use of large-scale, offroad equipment such as tractors. Access will be via existing roads and access routes except when existing routes are unavailable and offroad access is required. The District's Employee Training Plan and the Emergency Response Plan Guidelines provide training for all employees on the safe use of tools, equipment, and machinery, including vehicle operation. Employees also receive periodic training materials at staff meetings (monthly or bi-monthly) from the District's insurance carrier on various health and safety issues that include quizzes. This is mandated by the District's insurance carrier. All vehicles are equipped with a shovel and a fire extinguisher during the dry season. These measures will reduce fire hazards; therefore, the Vegetation Management Alternative is not likely to increase wildfire hazards through the use of equipment that may produce a spark, flame, or fire and would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires.

> **Impact PSH-9:** Vegetation management activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.

8.2.6 Biological Control Alternative

The Biological Control Alternative involves the use of pathogens and predators to reduce mosquito populations. Mosquito pathogens include bacteria and viruses specifically targeted to mosquitoes, which do not pose a risk to public health. Insects, fish, birds, and bats are naturally occurring predators of mosquitoes. Mosquitofish (*Gambusia affinis*) are the most commonly used biological control agent throughout the world and the primary means of control used by the District. Biological control requires the periodic use of light trucks, and occasionally, ATVs, boats, tractors, helicopters, and sprayers.

The use of biological control reduces the need to use pesticides, but the use of pathogens involves chemical treatment. Examples of bacteria pathogenic to mosquitoes are *Bs*, the several strains of *Bti*, and *Saacharopolyspora spinosa (*spinosad*)*. Because the potential environmental impacts of *Bs* or *Bti* application are generally similar to those of chemical pesticide applications, these materials and spinosad are evaluated below under the Chemical Control Alternative.

8.2.6.1.1 Increase Demand for Police, Fire, or Health-Care Services

The level of activity in the future is similar to existing conditions. It is unlikely that the Biological Control Alternative would result in a substantial increase in requests for services from emergency dispatchers, and the Program would not adversely affect the ability of 911 dispatchers to handle calls.

> **Impact PSH-10:** Biological control activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.

8.2.6.1.2 Create a Significant Hazard to the Public or Environment

Biological control activities do not include the use of pesticides and herbicides or other hazardous materials, but rely on mosquitofish, and are intended to reduce the need to use chemical control measures. Mosquitofish are used in controlled environments to avoid their migration into habitats used by sensitive species. District policy is to limit their use to ornamental fishponds, water troughs, water gardens, fountains, and unused swimming pools. Therefore, the Biological Control Alternative would not create a significant hazard to the public or the environment.

Impact PSH-11: Biological control activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.

8.2.6.1.3 Expose People or Structures to Wildfire Risk

Vehicles could be used to access areas or to release or apply mosquitofish in areas that are moderate to very high FHSZs. Access requires the periodic use of light trucks, such as pickup trucks and jeeps, and ATVs, but does not require the use of large-scale, off-road equipment. The application of *Bs*, *Bti*, and potentially spinosad is performed by hand, from an ATV, or from aircraft, either helicopter or fixed-wing. Access for biological control will be via existing roads and access routes except when existing routes are unavailable and offroad access is required. The District's Employee Training Plan and the Emergency Response Plan Guidelines provide training for all employees on the safe use of equipment and machinery, including vehicle operation. Employees also receive periodic training materials at staff meetings (monthly or bi-monthly) from the District's insurance carrier on various health and safety issues that include quizzes. This is mandated by the District's insurance carrier. All vehicles are equipped with a shovel and a fire extinguisher during the dry season. These measures will reduce fire hazards; therefore, the Biological Control Alternative is not likely to increase wildfire hazards through the use of equipment that may produce a spark, flame, or fire and would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires.

Impact PSH-12: Biological control activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.

8.2.7 <u>Chemical Control Alternative</u>

Chemical control is a Program tool that consists of the application of non-persistent selective insecticides to directly reduce populations of larval or adult mosquitoes. Chemical control is implemented when inspections reveal that mosquitoes are present at levels that trigger the District's criteria for chemical control based on the mosquito abundance, density, species composition, proximity to human settlements, water temperature, presence of predators and other factors.

Chemical control tools used for mosquito abatement consist of larvicides and adulticides. This District is presently using the following larvicides: *Bti, Bs* methoprene (Altosid®), BVA2 and Agnique®. In the future, *Saacharopolyspora spinosa* (spinosad) (Natular™) CoCoBear™ Oil and Masterline Mosquito Larvicide may also be incorporated into the larvicide program.

Adulticides presently used by the District include the pyrethrin known as Pyrocide®), and the synthetic pyrethroid permethrin (Biomist®). In the future, the pyrethrins known as Pyrenone 25-5® and Pyrenone Crop Spray® as well as the synthetic pyrethroid permethrin known as Kontrol 4-4 may also be incorporated into the adulticide program. Mosquito adulticide materials are used infrequently only when necessary to control adult mosquito populations.

8.2.7.1 Mosquito Ground Application

For ground larviciding, the District uses a variety of techniques and equipment to apply larvicides, including hand held sprayers, backpack sprayers, and blowers, and truck- or ATV-mounted spray rigs. The District uses conventional pickup trucks, and ARGO and Polaris ATVs as ground larvicide vehicles. ATV safety and handling is provided to employees before operating these machines. Ground larviciding allows applications while in close proximity to the actual treatment area, and consequently treatments occur to only those micro habitats where larvae are actually present, reducing the pesticide load on the environment compared to aerial application. However, risk of chemical exposure is also greater for the applicators during ground larviciding than during aerial larviciding.

Adulticiding is the only known effective measure of reducing an adult mosquito population in a timely manner. The most common form of adulticide application is ground aduticiding via insecticide aerosols at very low dosages, which is referred to as the ultra-low volume or ULV method. This method employs specially designed ULV equipment mounted on trucks, ATVs, golf carts, and boats or hand-held for ground applications. Cold aerosol generators, cold foggers, and ULV aerosol machines are constructed by mounting a vortex nozzle on the forced air blower of a thermal fogger. Insecticide is applied as technical material or at moderately high concentrations (as is common with the pyrethroids) which translates to very small quantities per acre. In agriculture, this rate is assumed less than 36 ounces per acre, but mosquito control ground adulticiding operations rarely exceed 1 ounce per acre. The optimum sized droplet for mosquito control with cold aerosols applied at ground level has been determined to be in the range of 5 to 20 microns.

8.2.7.1.1 Increase Demand for Police, Fire, or Health-Care Services

The level of activity in the future is similar to existing conditions. Occasional calls to the District or to emergency personnel could occur from the public in the treatment area due to concerns about the potential for impacts and need to stay indoors (or not), especially when a large-scale application is planned for an imminent and severe threat to public health. For the years 2012 and 2013, the District received no calls of this type. (Most calls are for information on dealing with mosquito pest problems and requests for service.) However, it is unlikely that the Chemical Control Alternative would result in a substantial increase in requests for actual services from emergency dispatchers, and the Program would not adversely affect the ability of 911 dispatchers to handle calls.

> **Impact PSH-13:** Chemical control activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.

8.2.7.1.2 Create a Significant Hazard to the Public or Environment

The use, transport, and disposal of the pesticides would not create a significant hazard to the public or the environment. The District uses the Chemical Control method only when other alternatives are ruled out after certain criteria are met that require implementing Chemical Control Alternative (ground larviciding and adulticiding). Ground larviciding allows applications while in close proximity to the actual treatment area and, consequently, treatments occur to only those microhabitats where larvae are actually present, reducing the pesticide load on the environment compared to aerial application. Ground adulticiding employs specialized equipment that provides targeted control and applications at small quantities per acre and ULVs, reducing potential drift and nontarget exposure.

Applicators would adhere to all applicable CCR requirements regarding pesticides to ensure safety and strictly adhere to the specific label instructions for each pesticide (see Section 2.9.1 and Appendix B). The District's Employee Training Plan, Pesticide Safety Training Program, Emergency Response Plan Spill Control and Clean Up Procedures, and the Emergency Response Plan provide safety training for all employees who may be affected by any substance, process, procedure or equipment that represents a potential hazard. Training programs are conducted for the safe use of equipment, machinery, or tools and the safe use and disposal of pesticides. Employees also receive periodic training materials at staff meetings (monthly or bi-monthly) from the District's insurance carrier on various health and safety issues that include quizzes. This is mandated by the District's insurance carrier.

Employment as a Mosquito Control Technician requires certification by the California Department of Public Health Vector Borne Disease Section (VBDS). Certification requires the passage of two exams. The first exam is referred to as Category A or the “Core Exam” and it includes questions on pesticide classification, formulations, application equipment, calibration, safety equipment, protective clothing, pertinent laws and regulations and first aid. In order to maintain active certification in mosquito control, the individual is required to attend 20 hours of continuing education in a 2-year period and view an additional 16 hours on video. Additional safety information quizzes are required by the District's insurance carrier, Department of Pesticide Regulation, and Solano County Department of Resource Management – Hazardous Materials Division.

All small pesticide spills would be handled according to the District's procedures for cleanup as described in their Emergency Response Plan – Spill Control and Clean Up Procedures as follows:

> Adequate caution shall be exercised to prevent spillage of pesticides during storage, transportation, mixing or application of pesticides. All pesticide spills and cleanups (excepting cases where dry materials may be returned to the container or application equipment) shall be reported by phone to the appropriate agencies according to the protocols listed in the District's Emergency Response Plan – Spill Control and Clean Up Procedures. A pesticide spill cleanup kit and proper protective equipment will be maintained at the District's Shop and in each vehicle used for pesticide application or transport.

> The spill site should be managed to prevent entry by unauthorized personnel. The spill will be contained and controlled by stopping it from leaking or spreading to surrounding areas, and dry spills will be covered with polyethylene or plastic tarpaulin and liquid spills will be absorbed with appropriate absorbent materials.

> The spilled material will be properly secured and the bags will be labeled with service container labels identifying the pesticide and delivered to the Field Supervisor for disposal.

> Applicators must wear a P-95 disposable filtering face piece respirator for spill of Bs and Bti dry formulations.

Adherence to pesticide label instructions and the District's spill cleanup procedure reduces the potential for accident conditions to affect the public or the environment; therefore, ground larviciding and adulticiding under the Chemical Control Alternative would not result in significant hazards to the public or environment. See also Sections 6.2.7 and 7.2.7.

Impact PSH-14: Chemical control ground larviciding and adulticiding activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.

8.2.7.1.3 Expose People or Structures to Wildfire Risk

Chemical control vehicles and equipment used for ground larviciding and adulticiding could be used in moderate to very high FHSZs. The Districts would use a variety of vehicles and equipment for access to sites and to apply ground larvicides and adulticides, including conventional pickup trucks and ATVs, blowers, and truck- or ATV-mounted spray rigs. Access to sites is via existing roads and access routes except when existing routes are unavailable and offroad access is required. The District's Employee Training Plan and the Emergency Response Plan Guidelines provide training for all employees on the safe use of tools, equipment, and machinery, including vehicle operation. All vehicles are equipped with a shovel and a fire extinguisher during the dry season. These measures will reduce fire hazards; therefore, the Chemical Control Alternative is not likely to increase wildfire hazards through the use of equipment that may produce a spark, flame, or fire and would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires.

Impact PSH-15: Chemical control ground larviciding and adulticiding activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.

8.2.7.2 Mosquito Aerial Application

When large areas are simultaneously producing mosquito larvae at densities exceeding District treatment thresholds, then the District may use helicopters or other aircraft to apply any of the larvicides. Aerial application of larvicides is a relatively infrequent activity for the District with the exception of annual fall flooding of seasonal wetlands managed as waterfowl habitat. The 5-year average (2008–2012) for the number of applications made to non-seasonal waterfowl habitat areas was 9 with the average number of acres treated per application being 289.5 acres. The 5-year average for the number of applications made to seasonal waterfowl habitat was 27. The average number of acres treated per application during this period was 197 acres. Aerial application can be more practical for remote or inaccessible areas than ground larviciding. However, risk of drift is greater with aerial applications, especially with liquid or ULV aerial larviciding and, consequently, potential risk of nontarget exposure is greater.

The aerial larvicides, excluding granular and pellet formulations, are typically combined with water and applied as a low volume wet spray mix at 2 gallons per acre and sometimes at 5 gallons per acre. Aerial application of liquid larvicides typically occurs during daylight hours and at an altitude above the treatment site of less than 40 feet. Granular and pellet formulations of larvicides are applied using a large mechanical spreader with a bucket (or hopper for fixed-wing aircraft) that can hold several hundred pounds of granules/material beneath the aircraft. Granular applications occur during daylight hours and are at a less-than-50-foot altitude.

Aerial adulticiding is often the only means available to cover a very large area quickly in case of severe mosquito outbreaks or mosquito borne disease epidemics, and aerial applications may be the only reliable means of gaining effective control in some areas. Two aerial adulticiding techniques are used in California: low volume spraying and ULV aerosols. Low volume (<2 gallons per acre) sprays are applied with the pesticide diluted in light petroleum oils or water and as a rather wet spray. The size of the droplets reduces drift, thus limiting swath widths, and may not be ideal under certain circumstances for impinging on mosquitoes. The technique is compatible with equipment commonly used for aerial liquid larviciding.

A common aerial adulticiding technique applies the insecticide in a technical concentrate or in a very high concentration formulation as an ULV cold aerosol. Lighter aircraft, including helicopters, can be used because the insecticide load is a fraction of the other techniques. If the aircraft is capable of >120 knots, fine droplets can be created by the high-speed air stream impacting the flow from hydraulic nozzles. Slower aircraft and most helicopters typically use some variety of rotary atomizers to create the required droplet spectrum. ULV applications can be difficult to accurately place with any regularity. Without the visual cues, drift and settling characteristics can be difficult to access.

The flight parameters for aerial adulticiding differ by program and technique. Some operations fly during hours of daylight. At these times, the pilots should be able to see towers and other obstructions as well as keep track of the spray plume. The aircraft can be flown at a less-than-200-foot altitude, which may make it easier to hit the target area. Other operations may be conducted in the dark of the night. The aircraft typically are flown between a 200- and 300-foot altitude. Swath widths vary from operation to operation but are normally set somewhere between 400 and 1,200 feet. Swaths are flown as close to perpendicular with the wind as is possible. A number of factors affect the spray-drift offset and settling such as wind speed, droplet size, aircraft wake turbulence, altitude, and even characteristics of the individual aircraft. Pilots rely somewhat on experience for determining this offset, and some use telltale smoke or paper markers for swath alignment.

One of the public concerns was regarding potential hazards from fuel dumping, which is a procedure used to lighten an aircraft's weight in certain emergency situations. For instance, if a flight takes off at a maximum takeoff weight and then faces a situation where it must return to the departure airport (due to certain mechanical problems or a passenger medical issue), not enough time is available to consume the fuel meant for getting to the original destination, and the aircraft may be over the maximum landing weight to land back at the departure point. Fuel would be released before landing. Once released, fuel would trail behind the aircraft. Most aviation fuel is a derivative of kerosene, which evaporates rapidly in the atmosphere and rarely survives in liquid form to reach the earth's surface.

This issue does not apply to the District's use of helicopter or fixed-wing aircraft. These aircraft are not equipped to dump fuel. Only very large aircraft such as 727s and 747s are equipped to dump fuel prior to an emergency landing.

8.2.7.2.1 Increase Demand for Police, Fire, or Health-Care Services

The level of activity in the future is similar to existing conditions. Occasional calls to the District or to emergency personnel could occur from the public in the treatment area. However, it is unlikely that aerial application under the Chemical Control Alternative would result in a substantial increase in requests for services from emergency dispatchers, and the Program would not adversely affect the ability of 911 dispatchers to handle calls.

> **Impact PSH-16:** Chemical control (aerial application) activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.

8.2.7.2.2 Create a Significant Hazard to the Public or Environment

The use, transport, and disposal of the pesticides would not create a significant hazard to the public or the environment. The District uses the Chemical Control method only when other alternatives are ruled out after certain criteria are met that require implementing the Chemical Control Alternative. Aerial application of larvicides and adulticides is a relatively infrequent activity for the District. Applicators would adhere to all applicable CCR requirements regarding pesticides to ensure safety and strictly adhere to the specific label instructions for each pesticide (see Section 2.9.1 and Appendix B). The District's Employee Training Plan, Pesticide Safety Training Program, Emergency Response Plan Spill Control and Clean Up Procedures, and the Emergency Response Plan Guidelines provide safety training for all employees who may be affected by any substance, process, procedure or equipment that represents a potential hazard. Training programs are conducted for the safe use of equipment, machinery or tools, and use and disposal of pesticides. Employees also receive periodic training materials at staff meetings (monthly or bi-monthly) from the District's insurance carrier on various health and safety issues that include quizzes. This is mandated by the District's insurance carrier.

All small pesticide spills would be handled according to the District's procedures for cleanup as described in their Emergency Response Plan – Spill Control and Clean Up Procedures as follows:

- Adequate caution shall be exercised to prevent spillage of pesticides during storage, transportation, mixing or application of pesticides. All pesticide spills and cleanups (excepting cases where dry materials may be returned to the container or application equipment) shall be reported by phone to the appropriate agencies according to the protocols listed in the District's Emergency Response Plan – Spill Control and Clean Up Procedures. A pesticide spill cleanup kit and proper protective equipment will be maintained at the District's Shop and in each vehicle used for pesticide application or transport.
- The spill site should be managed to prevent entry by unauthorized personnel. The spill will be contained and controlled by stopping it from leaking or spreading to surrounding areas, and dry spills will be covered with polyethylene or plastic tarpaulin and liquid spills will be absorbed with appropriate absorbent materials.
- The spilled material will be properly secured and the bags will be labeled with service container labels identifying the pesticide and delivered to the Field Supervisor for disposal.
- Applicators must wear a P-95 disposable filtering facepiece respirator for spill of Bs and Bti dry formulations.

Adherence to pesticide label instructions and the District's small spill cleanup procedure reduces the potential for accident conditions to affect the public or the environment; therefore, the Chemical Control Alternative would not result in significant hazards to the public or environment.

Impact PSH-17: Chemical control (aerial application) activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.

8.2.7.2.3 Expose People or Structures to Wildfire Risk

Helicopters or other aircraft could be used in moderate to very high FHSZs for aerial application similar to existing conditions. However, continued flight operations would not pose increased fire risk in those zones, and the Program would not substantially increase the risk of wildfire from accidents; therefore, the Chemical Control (aerial application) Alternative is not likely to increase wildfire hazards through the use of equipment that may produce a spark, flame, or fire and would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires.

Impact PSH-18: Chemical control (aerial application) activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.

8.2.8 Cumulative Impacts

The District's Program would not incrementally increase demand for police, fire, or health-care services, nor would it create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials, through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment, or through the operation of aircraft. In addition, the Program would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. In short, the Program does not have incremental impacts on public services, and **implementation of any of the Program alternatives (individually or in combination) would not result in a significant contribution to any cumulative public services and hazard response impacts** that could result from other projects in the vicinity of the treatment areas.

8.2.9 Environmental Impacts Summary

Table 8-1 is a summary of all of the potential public services and hazard response impacts associated with the Program alternatives. The number of each statement correlates to its number in the text, and the significance determination symbols are provided at the end. All of the impact determinations are "no impact"; therefore, no mitigation is required.

Table 8-1 Summary of Public Services and Hazard Response Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Effects on Public Services and Hazard Response					
Impact PSH-1: Surveillance activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.	N	na	na	na	na
Impact PSH-2: Surveillance activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.	N	na	na	na	na
Impact PSH-3: Surveillance activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.	N	na	na	na	na
Impact PSH-4: Physical control activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.	na	N	na	na	na
Impact PSH-5: Physical control activities do not include the use of pesticides or herbicides; therefore, these activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.	na	N	na	na	na
Impact PSH-6: Physical control activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.	na	N	na	na	na
Impact PSH-7: Vegetation management activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.	na	na	N	na	na

Table 8-1 Summary of Public Services and Hazard Response Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact PSH-8: Vegetation management activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.	na	na	N	na	na
Impact PSH-9: Vegetation management activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.	na	na	N	na	na
Impact PSH-10: Biological control activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.	na	na	na	N	na
Impact PSH-11: Biological control activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.	na	na	na	N	na
Impact PSH-12: Biological control activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.	na	na	na	N	na
Impact PSH-13: Chemical control activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.	na	na	na	na	N
Impact PSH-14: Chemical control ground larviciding and adulticiding activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.	na	na	na	na	N
Impact PSH-15: Chemical control ground larviciding and adulticiding activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.	na	na	na	na	N

Table 8-1 Summary of Public Services and Hazard Response Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact PSH-16: Chemical control (aerial application) activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.	na	na	na	na	N
Impact PSH-17: Chemical control (aerial application) activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.	na	na	na	na	N
Impact PSH-18: Chemical control (aerial application) activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.	na	na	na	na	N

LS = Less-than-significant impact

N = No impact

na = Not applicable

SM = Potentially significant but mitigable impact

SU = Significant and unavoidable impact

8.2.10 Mitigation and Monitoring

No impacts would occur as a result of any of the Program alternatives, and no mitigation is required for ensuring an adequate public services and hazard response. Therefore, no monitoring of mitigation measures is needed.

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9 Water Resources

Chapter 9 evaluates potential impacts of the District's IMMP implementation on water resources. Results of the evaluation are provided at the programmatic level. Section 9.1, Environmental Setting, presents an overview of the physical properties and environmental settings; and contains federal regulations, state regulations, and local ordinances and regulations that are applicable to the Program. Section 9.2, Environmental Impacts and Mitigation Measures, presents the following:

- Environmental concerns and evaluation criteria: A determination of whether the Program alternatives would cause any potentially significant impacts to regional hydrologic resources
- Discussion of methods and assumptions, including findings from the Ecological and Human Health Risk Assessment, which is included as Appendix B
- Discussion of potential impacts of the Program alternatives, and recommendations for mitigation, if required, for those impacts
- Cumulative impacts summary
- A summary of estimated environmental impacts to hydrologic resources
- Monitoring of recommended mitigation measures

9.1 Environmental Setting

9.1.1 California's Hydrologic and Geomorphic Regions

The hydrologic resources of California can be divided into regions based on several hydrologic characteristics. The California Water Plan divides California into 10 hydrologic regions. These regions are delineated based upon the state's major drainage basins. Each region has distinct precipitation characteristics and water bodies.

Hydrologic regions over the District Program Area include portions of the North Coast, Sacramento River, San Francisco Bay, and San Joaquin River hydrologic regions. The District's Service Area and lands in adjacent counties comprise the District's Program Area, and the hydrologic regions with important water features for the District are shown on Figure 9-1. Description of surface water and groundwater characteristics for the differing hydrologic regions relied on *California Water Plan, Update 2009* and *California Water Plan, Update 2013, Advisory Committee Review Draft* (CDWR 2009a-c, 2013a-d

9.1.1.1 San Francisco Bay Hydrologic Region

The San Francisco Bay Hydrologic Region (Bay Region) occupies approximately 4,500 square miles, from Tomales Bay in Marin County to southern Santa Clara County, and inland to the confluence of the Sacramento and San Joaquin Rivers near Collinsville. The eastern boundary follows the crest of the Coast Range where the highest peaks are more than 4,000 feet above mean sea level (CDWR 2013b). This region includes portions of Sonoma, Napa, Solano, and Contra Costa counties within the District Program Area; portions of Alameda, Marin, San Mateo, and Santa Clara counties also lie within this region.

Principle watersheds in the Bay Region include Tomales Bay, Corte Madera Creek, Novato Creek, Petaluma River, Sonoma Creek, Napa River, Wildcat Creek, San Pablo Creek, Green Valley Creek, Suisun Creek, Walnut Creek, San Mateo Creek, San Francisquito Creek, Guadalupe River, Coyote Creek, Alameda Creek, San Lorenzo Creek, and San Leandro Creek watersheds. These watersheds drain into Suisun, San Pablo, North San Francisco, and South San Francisco bays, or directly into the Pacific Ocean. For example, the Guadalupe River and Coyote and Alameda creeks drain from the Coast

Range and flow northwest into San Francisco Bay. The Napa River originates in the Mayacamas Mountains at the northern end of Napa Valley and flows south into San Pablo Bay. Sonoma Creek begins in mountains within Sugarloaf State Park and flows south through Sonoma Valley into San Pablo Bay.

A large proportion of the nine counties that surround the San Francisco Bay is urbanized. As a result, many creeks have been confined to underground culverts beneath the developed regions. While many larger creeks remain open, they often have been heavily modified to run in concrete channels to optimize flood conveyance and provide flood protection. Ownership of Bay Area streams is a patchwork of public title, public easements, and private ownership that complicates policies and jurisdiction over, or maintenance responsibility for, urban streams. Many Bay Area stream reaches have, in fact, no established public jurisdiction or maintenance responsibility (RMC 2006).

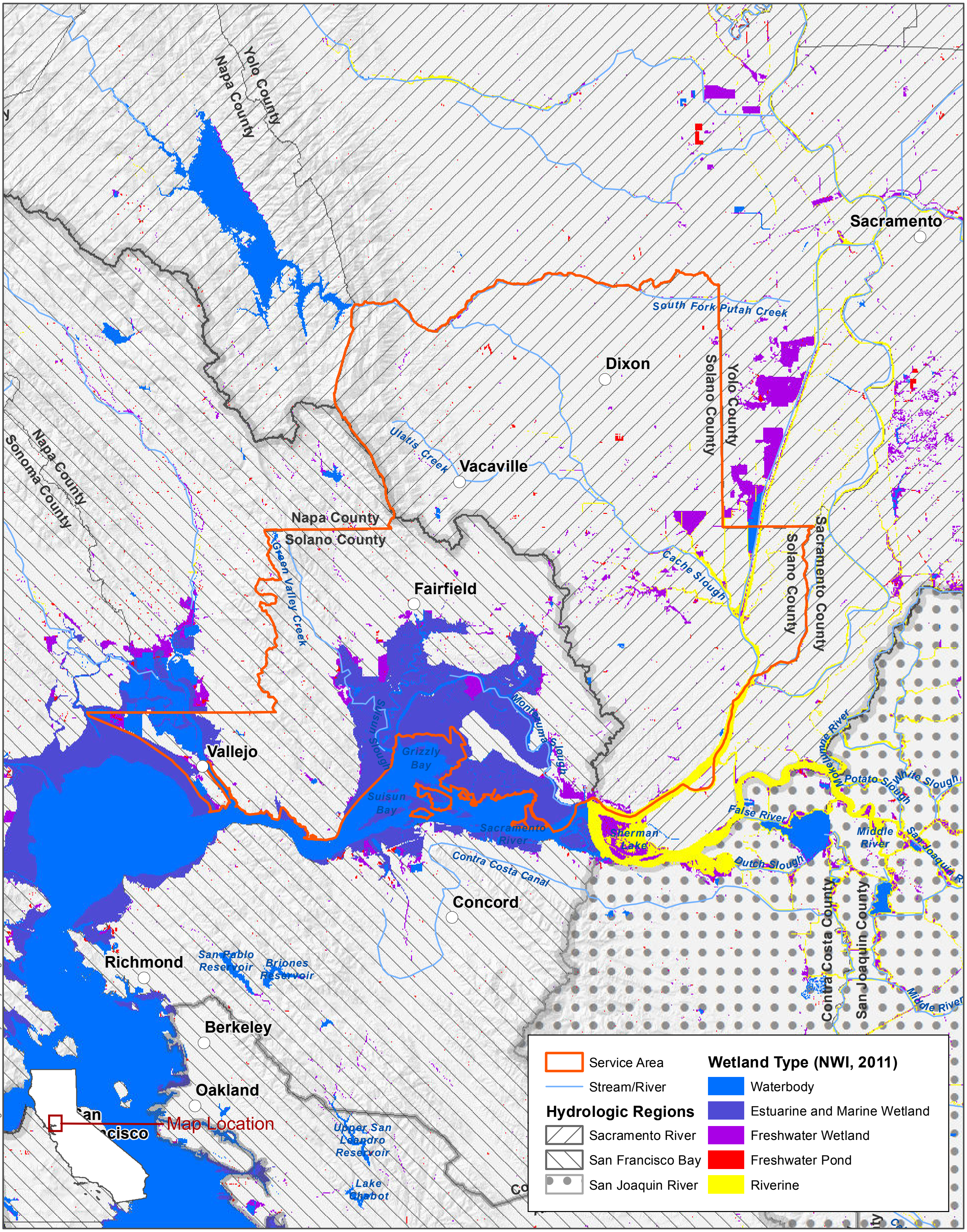
Tidal marshes occur throughout much of the fringe of the San Francisco Bay, from the lowest extent of vascular vegetation to the top of the intertidal zone (at the maximum height of the tides). Tidal marsh also exists in the tidal reaches of local rivers and streams. Tidal marshland was once more extensive and was estimated to be 190,000 acres; however, development in the region has decreased the amount of tidal marshland to approximately 40,000 acres. A large effort has recently been undertaken to restore these ecosystems as high-quality wetlands have been shown to moderate the effect of floods, improve water quality, help maintain shipping channels, and provide habitat to numerous species (USEPA 1999).

Like most of Northern California, the climate in the Bay Region largely is governed by weather patterns originating in the Pacific Ocean. About 90 percent of the annual precipitation falls between November and April. The North Bay receives about 20 to 25 inches of precipitation annually. In the South Bay, east of the Santa Cruz Mountains, annual precipitation is only about 15 to 20 inches because of the rain shadow effect. Temperatures in the Bay Region generally are cool, and fog often resides along the coast. The inland valleys receive warmer, Mediterranean-like weather (average summer high temperatures are about 80 degrees Fahrenheit). The gap in the rolling hills at Carquinez Strait allows cool air to flow from the Pacific Ocean into the Sacramento Valley. Most of the interior North Bay and the northern parts of the South Bay are influenced by this marine effect. By contrast, the southern interior portions of the South Bay experience very little marine air movement (CDWR 2013b).

Land use in the Bay Region is diverse. Residents live in urban, suburban, and rural areas. Some of these areas are on natural floodplains, which historically were used for agriculture. Agriculture accounts for 21 percent of the Bay Region’s land area, much of which is in the North and Northeast Bay in Napa, Sonoma, and Solano counties (CDWR 2013b).

The region has many significant water management challenges: sustaining water supply, water quality, and the ecosystems in and around San Francisco Bay; reducing flood damages and adapting to impacts from climate change. Numerous government agencies and water districts deliver, treat, and regulate water in the Bay Region. Many planning organizations identify present and future challenges in the region such as land use, housing, environmental quality, economic development, wetlands, water quality, water reliability, stormwater management, flood protection, watershed management, groundwater management, fisheries, and ecosystem restoration (CDWR 2013b).

Groundwater basins underlie approximately 1,400 square miles or 30 percent of the Bay Region and account for about 15 percent of the region’s average annual water supply. The Bay Region has 25 identified groundwater basins, as shown on CDWR’s Figure SFB-3 (CDWR 2013b) The Santa Clara Valley, Livermore Valley, Westside, Niles Cone, Napa-Sonoma Valley, and Petaluma Valley are heavily used groundwater basins (CDWR 2013b).



33441001 MVCAC PEIR, Figure9-1, SolanoCountyMAD HydroRegions.04-17-13

Source: Cardno ENTRIX, 2013

N

0 5 10

Scale in Miles

INTEGRATED MOSQUITO MANAGEMENT PROGRAM PEIR

Solano County Mosquito Abatement District

Figure 9-1 - Program Area and California Hydrologic Regions with Major Water Bodies

Ongoing surface water quality issues exist in the Bay Region. Pollutants from urban and rural runoff include pathogens, nutrients, sediments, and toxic residues. Some toxic residues are from past human activities such as mining; industrial production; and the manufacture, distribution, and use of agricultural pesticides. These residues include mercury, PCBs, selenium, and chlorinated pesticides. Emerging pollutants in the region include flame retardants and pharmaceuticals.

San Francisco Bay and a number of the streams, lakes, and reservoirs in the Bay Region have elevated mercury levels, as indicated by elevated mercury levels in fish tissue. The major source of the mercury is historic mercury mining and mining activities in the Sierra Nevada and coastal mountains. Large amounts of contaminated sediments were discharged into the Bay from Central Valley streams and local mines in the Bay Area. Significantly impaired water bodies include the Bay which is located within the Program Area, and the Guadalupe River in Santa Clara County (from New Almaden Mine discharges), and Walker Creek in Marin County (from Gambonini Mine discharges), both of which are located outside the Program Area. The SFBRWQCB has adopted total maximum daily loads (TMDLs) for mercury in the Bay, Guadalupe River, and Walker Creek (CDWR 2013b).

Water agencies in the region have relied on importing water from the Sierra Nevada for nearly a century to supply their customers. Water from the Mokelumne and Tuolumne rivers accounts for about 38 percent of the region’s average annual water supply. Water from the Delta via the federal Central Valley Project and the State Water Project accounts for another 28 percent. Approximately 31 percent of the average annual water supply is from local groundwater and surface water, and 3 percent is from miscellaneous sources. Population growth and concerns over diminishing water quality have led to the development of local surface water supplies, recharge of groundwater basins, and incorporation of conservation guidelines (CDWR 2013b).

Drinking water in the Bay Region ranges from high-quality Mokelumne and Tuolumne river water to variable-quality Delta water, which constitutes about one-third of the domestic water supply. Purveyors that depend on the Delta for all or part of their domestic water supply can meet drinking water standards, but still need to be concerned about microbial contamination, salinity, and organic carbon.

The Bay Region generally receives very little snow, so floodwaters originate primarily from intense rainstorms. The northern portion of the region receives more precipitation and floods more often than the southern portion. Flooding occurs more frequently in winter and spring and can be intense with a short duration in small watersheds with steep terrain. Local flooding tends to occur when large, widespread storms fall on previously saturated watersheds that drain into local valleys. The greatest flood damages occur in the lower reaches of streams when floodwaters spill onto the floodplain and spread through urban neighborhoods (CDWR 2013b).

Drought, overdraft, and pollution have impaired portions of 28 groundwater basins in the Bay Region. The basins face a perpetual threat of contamination from spills, leaks, and discharges of solvents, fuels, and other pollutants. Contamination affects the supply of potable water and water for other beneficial uses. Some municipal, domestic, industrial, and agricultural supply wells have been removed from service due to the presence of pollution, mainly in shallow groundwater zones. Overdraft can result in land subsidence and saltwater intrusion, although active groundwater management has stopped or reversed the saltwater intrusion (CDWR 2013b).

A variety of historical and ongoing industrial, urban, and agricultural activities and their associated discharges have degraded groundwater quality, including industrial and agricultural chemical spills, underground and aboveground tank and sump leaks, landfill leachate, septic tank failures, and chemical seepage via shallow drainage wells and abandoned wells. The region has over 800 groundwater cleanup cases, about half of which are related fuel spills from leaking underground tanks. In many cases, the groundwater is treated and discharged to surface waters via storm drains (CDWR 2013b).

9.1.1.2 North Coast Hydrologic Region

The North Coast Hydrologic Region (North Coast region) encompasses all basins draining into the Pacific Ocean from the Oregon state line to Tomales Bay in Marin County. This region includes coastal areas, redwood forests, inland mountain valleys, and semi-desert-like areas. The southern tip of this region includes a portion of Sonoma and Marin counties. Watersheds within Sonoma and Marin counties include Gualala River, Russian River, and Bodega; characteristics of these watersheds are described at the end of this section.

In the North Coast region, topographic relief can be steep and precipitation is generally high relative to the rest of the state. Heavy rainfall over the mountainous portions of the North Coast region (up to 100 inches per year) makes it California's most water-abundant area. The western coastal portion of this region receives less rainfall (e.g., at Bodega Bay in Sonoma County, annual precipitation is about 37 inches). Average temperatures are moderated by the influence of the Pacific Ocean and range from highs in the mid-80s in the summer to lows in the mid-30s during the winter (CDWR 2013c).

The North Coast region is generally forest land with agricultural land concentrated in narrow river valleys. Land use issues in the region include activities causing soil erosion such as road construction, logging and hillside agriculture (vineyards), which can affect native fish spawning. Many of the region's watersheds support threatened and endangered species of plants and animals, and many North Coast streams and rivers support runs of salmon and steelhead trout. Forest management practices are also a significant issue impacting flood management.

The North Coast region contains water service providers of all types, from small, private facilities that provide water for just a few neighboring residences to large municipal suppliers and wastewater treatment facilities. Private water districts include those representing counties or portions of counties, municipalities, irrigation districts, or particular water bodies. Many of the smaller communities and rural areas in the North Coast region are generally supplied by small local surface water and groundwater systems. In general for the North Coast region, groundwater contamination from leaking underground tanks and health and safety issues from contaminated areas that are open to the public are identified by the California Department of Water Resources as priority issues related to groundwater quality (CDWR 2009c). Additionally, groundwater quality problems in the North Coast region include contamination from seawater intrusion, nitrates in some shallow coastal groundwater aquifers, and iron, boron, and manganese in some of the inland groundwater basins of Sonoma County (CDWR 2009c).

One of the largest water supply reservoirs in the North Coast region includes USACE's 380,000 acre-foot Lake Sonoma in the Russian River watershed. Lake Sonoma is operated to provide flood control and instream flows in the Lower Russian River in Sonoma County. This facility provides water for instream flows, recreation, hydropower, and water supply purposes (CDWR 2013c).

9.1.1.2.1 Southern Watersheds

The Gualala River watershed encompasses about 300 square miles; the Gualala River flows from Mendocino County to Sonoma County in a north-south direction, reaching the ocean at the town of Gualala. The watershed contains mostly mountainous terrain where tributaries flow through steep valleys with narrow floors that contain erodible soil. Most of the annual precipitation occurs between October and April, with the greatest amounts in January. Rainfall averages about 38 inches per year at the coast and up to 100 inches per year on the inland peaks. Timber companies own about one-third of the watershed. Orchards and ranching are on the decline while the watershed has seen an increase in hillside vineyard development. The watershed supports an anadromous fishery that includes Coho salmon. The Gualala River provides the primary source of drinking water for Sea Ranch and Gualala (CDWR 2013c).

The Russian River watershed encompasses 1,485 square miles in Mendocino and Sonoma counties. It is bounded by the Coast Ranges on both the east and west. The mainstream is about 110 miles long and flows from north of Ukiah southward through Redwood Valley (Mendocino County) to its confluence with

Mark West Creek, where it turns west, passes through the coast range, and empties into the Pacific Ocean. The summer climate is moist and cool near the coast with temperatures increasing in the valley areas, which are isolated from the cooling coastal influence. During winter, average rainfall ranges from 30 to 80 inches, depending on locale. The Russian River watershed is primarily an agricultural area with the greatest emphasis on vineyard and orchard crops. Besides agriculture, a growing trend toward light industry and commercial development and a significant telecommunications industry are noticeable within the region (CDWR 2013c).

The Bodega watershed contains streams with headwaters in the Coast Range entering the Pacific Ocean south of the Russian River. Salmon, Americano, and Stemple creeks and their associated estuaries are the main water bodies in this watershed. The terrain is relatively steep and erodible and is sensitive to disturbance. Cooler temperatures and relatively high winter rainfall due to coastal influences typify the climate of the Bodega watershed. Because of the Mediterranean climate, summertime flows are often nonexistent in Americano and Stemple creeks, while Salmon Creek flow is low but sustained. Each of these watersheds has estuary areas (CDWR 2013c).

9.1.1.3 Existing Water Quality

Statewide and regional surface water monitoring has identified pesticides in surface waters and sediments throughout the Program Area and vicinity. A query of water quality data available through the California Environmental Data Exchange Network (CEDEN) water quality database revealed detectable quantities of several chemicals that the District will use and several additional chemicals of the same class (i.e., pyrethroids). See Tables 2-1 through 2-6 for a list of all chemicals the District uses.

The following is a summary of CEDEN data from 1993 to 2012 regarding the concentrations of these chemical constituents when detected and the water bodies in which they were discovered (CEDEN 2013) but only for those active ingredients that are part of the District's Program. Some of the affected water bodies are not located in the District's Program Area. In addition to the CEDEN data, the list below includes Water Year 2012 Regional Monitoring Coalition pesticide results (BASMAA 2013). The Regional Monitoring Coalition was formed to implement the monitoring program required by the Municipal Regional Stormwater NPDES Permit (Order R2-2009-0074) issued by the SFBRWQCB. In consideration of their more frequent usage and potentially greater toxicity compared with other commonly applied pesticides used in this geographic region, monitoring of the class of pesticides known as pyrethroids was conducted by the Regional Monitoring Coalition to explore potential causes of toxicity to *Hyalella azteca* in sediments. Based on monitoring results, BASMAA (2013) concluded that it is likely that pyrethroids caused toxicity in water year 2012.

> The concentration of all permethrin isomers detected in the water column of the Hayward Industrial Storm Drain ranged from 1.57 to 285 ng/L. Sunnyvale East Channel, Guadalupe River, and Lower Marsh Creek sediments contained concentrations ranging from 3.81 to 20.9 µg/kg. Cis- and trans- permethrin isomers were detected in Central Bay, Grizzly Bay, Lower South Bay, San Pablo Bay (Pinole Point), South Bay, and Suisun Bay sediments in concentrations ranging from 0.10 to 1.32 µg/kg. Cis- and trans- isomers were also detected in Coyote Creek, Redwood Creek, San Leandro Creek, and Tembladero Slough sediments in concentrations 0.12 to 25.6 µg/kg. Only the cis- isomer of permethrin was detected in Guadalupe Creek, Laurel Creek, Salinas River, and San Mateo Creek sediments in concentrations ranging from 3.22 to 11.1 µg/kg. Trans-permethrin was the only isomer detected in Lagunitas Creek and the Pajaro River sediments in concentrations ranging from 4.06 to 4.52 µg/kg.

> Phenothrin was detected in Central Bay and San Francisco Bay (Yerba Buena Island) sediments in concentrations ranging from 0.988 to 4.81 µg/kg.

Additional queries were made to the USEPA's ECOTOX database to compare regional water quality data to available ecological toxicity data (See Table 9-1). The toxicology data is expressed in LC_{50}.[1] The LC_{50} value is used as a standard measure of toxicity for evaluation and comparison of chemicals. Chemicals with lower LC_{50} values are more toxic. The LC_{50} values in Table 9-1 are populated from the lowest available constituent concentrations in which a 50 percent die-off for the test species is observed (USEPA 2013a). LC_{50} values are not available for sediment. Freshwater and saltwater values are provided where available.

A 2010 study performed by the CDPR analyzed the presence of pyrethroid insecticides in California's surface waters from urban areas. The most frequently detected pyrethroids included permethrin, which is also found in many common household insecticides. The District is not using and is not proposing to use the other frequently detected pyrethroids (bifenthrin and cyfluthrin).

9.1.2 Regulatory Setting

The Program includes components under the jurisdiction of federal, state, and local agencies. Applicable regulations are summarized below and include aspects related to both surface water and groundwater. The primary focus of this regulatory summary is the water quality aspects related to the Program alternatives. Because the Program will not cause changes to natural precipitation patterns, runoff, or groundwater infiltration, changes to water quantity are not anticipated.

9.1.2.1 Federal

Federal Clean Water Act (33 United States Code Section 1251 et seq.)

The USEPA is the federal agency responsible for water quality management and administers the federal Water Pollution Control Act Amendments of 1972 and 1987, collectively known as the Clean Water Act (CWA). The CWA establishes the principal federal statutes for water quality protection. It was established with the intent "to restore and maintain the chemical, physical, and biological integrity of the nation's water, to achieve a level of water quality which provides for recreation in and on the water, and for the propagation of fish and wildlife." Several key CWA sections guide the regulation of water pollution in the US:

- Section 208, Water Quality Control Plans. This section requires the preparation of local water quality control plans throughout the nation. Each water quality control plan covers a defined drainage area. The primary goal of each water quality control plan is to attain water quality standards established by the CWA and the state governments within the defined area of coverage. Minimum content requirements, preparation procedures, time constraints, and federal grant funding criteria pertaining to the water quality control plans are established in Section 208. The USEPA has delegated preparation of the water quality control plans to the individual states. More information is provided below in the state regulatory setting section.
- Section 303(d) Water Quality Limited Surface Waters. This section requires each state to provide a list of impaired waters that do not meet or are expected not to meet state water quality standards as defined by that section. It also requires the state to develop TMDLs from the pollution sources for such impaired water bodies. Table 9-2 lists pesticide-impaired surface waters and TMDL status in the Program Area. Because pyrethroids have been implicated in sediment toxicity, those impairments are also included in Table 9-2. See the state regulatory setting section (Section 9.1.2.2) for description of the Diazinon and Pesticide-Related Toxicity in Urban Creeks TMDL.

[1] LC_{50} refers to the lethal concentration of a chemical (amount of chemical in a volume of food, water or air) that that would kill 50 percent of a group of test animals exposed to the chemical for a defined exposure time.

Table 9-1 Pesticide Concentrations in Surface Water and Sediment throughout the Program Area and Vicinity (1993 to 2012)

	Sediment		Water			
Pesticide	**Concentration (µg/kg)**	**LC_{50} (µg/kg)**	**Concentration (ng/L)**	**LC_{50} (ng/L)**	**Standard Test Species**	**Exposure Time**
Permethrin	3.81 - 20.9	*	1.57 - 285	0.007 (umol/L)	Channel Catfish (*Ictalurus punctatus*)	96-hour exposure in Freshwater Medium
				4	Amphipod (*Eohaustorius estuarius*)	48-hour exposure in Saltwater Medium
Cis- and Trans-Permethrin Isomers	0.10 - 25.6	*	*	465	Water Flea (*Ceriodaphnia dubia)*	96-hour exposure to Cis-Permethrin in Freshwater Medium
Phenothrin	0.988 - 4.81	*	*	140	Rainbow Trout (*Oncorhynchus mykiss*)	96-hour exposure in Freshwater Medium
				21	Opossum Shrimp (*Americamysis bahia)*	96-hour exposure in Saltwater Medium

*No Data Available

Table 9-2 Section 303(d) Pesticide and Sediment Toxicity Limited Surface Waters in SCMAD Program Area

Water Body	Pollutants	Primary Stressors	TMDL Completion Dates
Contra Costa County			
Kellogg Creek	Escherichia coli (E. coli), Dissolved Oxygen, Salinity, Sediment Toxicity, Unknown Toxicity	Unknown Source	2021
Kirker Creek	Pyrethroids, Toxicity, Trash	Channelization, Urban Runoff-Erosion and Sedimentation, Surface Runoff, Unknown Source, Illegal Dumping, Urban Runoff/Storm Sewers	2007–2021
Marsh Creek (Marsh Creek Reservoir to San Joaquin River)	Diazinon, Escherichia coli (E. coli), Mercury, Sediment Toxicity, Unknown Toxicity	Agriculture, Unknown Source, Urban Runoff/Storm Sewers, Resource Extraction	2007–2021

Source: SWRCB 2011b

> Section 401, Water Quality Certifications. This CWA section requires that, prior to the issuance of a federal license or permit for an activity or activities that may result in a discharge of pollutants into waters of the US (see Section 404 discussion, below), the permit applicant must obtain a certification from the state in which the discharge would originate. A state certification indicates that the proposed activity or activities would not result in a violation of applicable water quality standards established by federal or state law, or that no water quality standards apply to the proposed activity. The SWRCB and/or the nine RWQCBs administer the certification program in California.

> Section 402, NPDES. The NPDES requires permits for pollution discharges (except dredge or fill material) into waters of the US, such that the permitted discharge does not cause a violation of federal and state water quality standards. Biological and residual pesticides discharged into surface waters constitute pollutants within the meaning of the CWA and require coverage under an NPDES permit. NPDES permits define quantitative and/or qualitative pollution limitations for the permitted source and control measures that must be implemented to achieve the pollution limitations. Pollution control measures are often referred to as BMPs. In California, NPDES permits are issued by the SWRCB or the RWQCBs.

> Section 404, Discharge of Dredge and Fill Material. Section 404 assigns the USACE with permitting authority for proposed discharges of dredged and fill material into waters of the US, defined as "…waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide; territorial seas and tributaries to such waters." The USACE typically considers all natural drainages with defined beds and banks to be waters of the US. Section 404 establishes procedures by which the permitting agency is to review, condition, approve, and deny permit requests. Per the regulations, permitting agencies are responsible to conduct public noticing and provide the opportunity for public hearings during the review of each permit request. This responsibility includes informing the USFWS and/or NMFS of each permit request. Consultation with the USFWS and/or NMFS is required for proposed discharges that could affect species protected by the federal Endangered Species Act. Measures that are required by the USFWS and/or NMFS to minimize impacts to federally protected species must be included as conditions of the permit. The USACE also authorizes, with limited application requirements and associated delay, certain activities with minimal adverse effects on the environment, under nationwide permits. Currently, 50 nationwide permits exist, of which about half require preconstruction notification, which USACE reviews to verify the activity qualifies for the nationwide permit.

9.1.2.1.1 Federal Insecticide, Fungicide, and Rodenticide Act

The FIFRA was first passed in 1947 to establish labeling provisions and procedures for registering pesticides with the USDA. It was rewritten in 1972 and has since been amended several times. In its current form, FIFRA mandates that USEPA regulate the use and sale of pesticides to protect human health and preserve the environment. Registration with the USEPA assures that pesticides will be properly labeled and that, if used in accordance with specifications, they will not cause unreasonable harm to the environment. Pesticide use in California is also regulated by the CDPR and local County Agricultural Commissioners.

9.1.2.1.2 California Toxics Rule

The USEPA has developed water quality criteria for priority toxic pollutants and other provisions for water quality standards to be applied to inland surface waters, enclosed bays, and estuaries in California. This rule was developed to address a gap in California's water quality standards that was created when the state's water quality control plans containing water quality criteria for priority toxic pollutants were overturned in 1994. The established numerical standards were deemed necessary to protect human health and the environment. The rule includes ambient aquatic life criteria for 23 priority toxic pollutants, ambient human health criteria for 57 priority toxics, and a compliance schedule.

9.1.2.1.3 Safe Drinking Water Act of 1974

With the passage of the federal Safe Drinking Water Act of 1974, the USEPA established and enforced mandatory nationwide minimum standards. California adopted its own Safe Drinking Water Act in 1976 that gave California Department of Health Services (now CDPH) responsibility for the administration of the federal Safe Drinking Water Act in California. Under this program, the USEPA has delegated primary responsibility for setting and enforcing drinking water standards to the CDPH. CDPH has two approaches to standards for drinking water quality. The first approach is to safeguard public welfare by limiting the level of specific contaminants that can impact public health. These limits are identified as Primary MCLs and are specific concentrations that cannot be exceeded for a given constituent in surface water or groundwater.

9.1.2.1.4 Rivers and Harbors Act

The Rivers and Harbors Act (RHA) of 1899 prohibits the unauthorized alteration or obstruction of any navigable waters of the US. As defined by the RHA, navigable waters include all waters that are:

> Historically, presently, or potentially used for interstate or foreign commerce

> Subject to the ebb and flow of tides

Regulations implementing RHA Section 10 are coordinated with regulations implementing CWA Section 404. The RHA specifically regulates:

> Construction of structures in, under, or over navigable waters

> Deposition or excavation of material in navigable waters

> All work affecting the location, condition, course, or capacity of navigable waters

The USACE administers the RHA. If a proposed activity falls under the authority of RHA Section 10 and CWA Section 404, the USACE processes and issues a single permit. For activities regulated only under RHA Section 10, such as installation of a structure not requiring fill, permit conditions may be added to protect water quality during construction.

Program activities are not anticipated to affect any facilities that would be regulated under the RHA.

9.1.2.2 State

9.1.2.2.1 Porter-Cologne Act

The Porter-Cologne Act (California Water Code Section 13000) is the principal law governing water quality regulation in California. It establishes a comprehensive program to protect water quality and the beneficial uses of water. The Porter-Cologne Act applies to surface waters, wetlands, and groundwater, and to both point and nonpoint sources of pollution. Pursuant to the Porter-Cologne Act, it is the policy of the State of California that:

> The quality of all the waters of the state shall be protected.

> All activities and factors affecting the quality of water shall be regulated to attain the highest water quality within reason.

> The state must be prepared to exercise its full power and jurisdiction to protect the quality of water in the state from degradation.

Pursuant to the Porter-Cologne Act, the responsibility for protection of water quality in California rests with the SWRCB. The SWRCB administers federal and state water quality regulations for California's ocean waters and also oversees and funds the state's nine RWQCBs. The RWQCBs prepare water quality control plans, establish water quality objectives, and carry out federal and state water quality regulations and permitting duties for inland water bodies, enclosed bays, and estuaries within their respective regions. The Porter-Cologne Act gives the SWRCB and RWQCBs broad powers to protect water quality by regulating waste discharge to water and land and by requiring cleanup of hazardous wastes.

9.1.2.2.2 State Antidegradation Policy

The SWRCB adopted the Statement of Policy with Respect to Maintaining High Quality Water in California (Resolution No. 68-16) on October 28, 1968. This policy is generally referred to as the "Antidegradation Policy" and it protects surface water and groundwater where existing water quality is higher than the standards set by the Water Quality Control Plan (or Basin Plan) to protect beneficial use of the waters. Under the Antidegradation Policy, any action that can adversely affect water quality in surface water or groundwater:

> Must be consistent with the maximum benefit to the people of the state.

> Must not unreasonably affect present and anticipated beneficial use of such water.

> Must not result in water quality less than that prescribed in water quality plans and policies.

9.1.2.2.3 Safe Drinking Water Act 1976

California adopted its own Safe Drinking Water Act in 1976 that gave California Department of Health Services the responsibility for the administration of the federal Safe Drinking Water Act in California. This responsibility was then moved to the CDPH. The first approach is to safeguard public welfare by limiting the level of specific contaminants that can impact public health. These limits are identified as Primary MCLs and are specific concentrations that cannot be exceeded for a given constituent. The second approach is a treatment technique that is based on distribution system sampling in comparison to an action level. If the action level is exceeded in more than 10 percent of the samples, then additional treatment is required of the water supplier. Currently, treatment technique limits apply only to copper and lead. CDPH also has established Secondary MCLs that regulate constituents that affect water quality aesthetics (such as taste, odor, or color). Generally, CDPH uses the Secondary MCLs as guidelines.

Another component of the California Safe Drinking Water Act is the requirement of Cal-EPA's Office of Environmental Health Hazard Assessment to develop PHGs for contaminants in California's publicly supplied drinking water. PHGs are concentrations of drinking water contaminants that pose no significant health risk if consumed for a lifetime, based on current risk assessment principles, practices, and methods. This office establishes PHGs pursuant to Health & Safety Code Section 116365© for contaminants with MCLs and for those for which CDPH will be adopting MDLs. Public water systems use PHGs to provide information about drinking water contaminants in their annual Consumer Confidence Reports. Certain public water systems must provide a report to their customers about health risks from a contaminant that exceeds its PHG and about the cost of treatment to meet the PHG, and hold a public hearing on the report.

9.1.2.2.4 Section 401 Water Quality Certification

CWA Section 401 certification is required for any permit or license issued by a federal agency for any activity that may result in a discharge into waters of the state to ensure that a proposed project will not violate state water quality standards. This water quality certification is part of the 1974 CWA, which allows each state to have input into projects that may affect its waters (USEPA 2013b).

9.1.2.2.5 Water Quality Control Plan

The Water Quality Control Plans (or Basin Plans) of all nine of the RWQCBs and the California Ocean Plan (prepared and implemented by the SWRCB) collectively constitute the State Water Quality Control Plan. These plans are the RWQCB's master water quality control planning documents. They designate beneficial uses and water quality objectives for waters of the state, including surface waters and groundwater and also include programs of implementation to achieve water quality objectives. According to the requirements of the CWA and the California Porter-Cologne Act, each Basin Plan has been designed to support the intentions of the CWA and the Porter-Cologne Act by (1) characterizing the water resources within a region, (2) identifying beneficial uses that exist or have the potential to exist in each water body, (3) establishing water quality objectives for each water body to protect beneficial uses or allow their restoration, and (4) providing an implementation program that achieves water quality objectives. Implementation program measures include monitoring, permitting, and enforcement activities. The Basin Plans include numeric site-specific water quality objectives and narrative objectives for toxicity, chemical constituents, and tastes and odors. The narrative toxicity objective states: "*All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life*."

9.1.2.2.6 Diazinon and Pesticide-Related Toxicity in Urban Creeks TMDL

Resolution R2-2005-0063 amended the Basin Plan for the San Francisco Bay region to establish a Water Quality Attainment Strategy and TMDL for Diazinon and pesticide-related toxicity in the Bay Area region creeks. As Diazinon use was phased out in 2004, alternatives began to pose water quality concerns and pyrethroids in particular were identified as the likely cause of sediment toxicity in some Bay Area urban creeks. To account for pesticide use changes over time, the Basin Plan amendment includes generic pesticide-related toxicity targets to comply with the narrative toxicity objective. When pesticide-related toxicity occurs in urban creek water, creeks do not meet the narrative toxicity objective as stated above in *Water Quality Control Plan*. When pesticide-related toxicity occurs in sediment, the creeks also do not meet the narrative sediment objective, which states: "Controllable water quality factors shall not cause a detrimental increase in the concentrations of toxic pollutants in sediments or aquatic life." Management actions designed to reduce the impacts of pesticide-related toxicity are outlined within the TMDL and Water Quality Attainment Strategy and are currently underway via Provision C.9 of the Municipal Regional NPDES Permit (BASMAA 2013).

9.1.2.2.7 California Pesticide Regulatory Program

CDPR regulates the sale and use of pesticides in California. CDPR is responsible for reviewing the toxic effects of pesticide formulations and determining whether a pesticide is suitable for use in California through a registration process. Although CDPR cannot require manufacturers to make changes in labels, it can refuse to register products in California unless manufacturers address unmitigated hazards by amending the pesticide label. Consequently, many pesticide labels that are already approved by USEPA also contain California-specific requirements. Pesticide labels are application requirements and include instructions informing users how to make sure the product is applied only to target pests including precautions the applicator should take to protect human health and the environment. For example, product labels may contain such measures as restrictions in applications to certain land uses and weather (i.e., wind speed) parameters.

9.1.2.2.8 Cooperative Agreement between the California Department of Public Health and Local Vector Control Agencies

Due to their public health mission, CDPR's Pesticide Regulatory Program provides special procedures for vector control agencies that operate under a Cooperative Agreement with CDPH. The application of pesticides by vector control agencies is regulated by a special and unique arrangement among the CDPH, CDPR, and County Agricultural Commissioners. CDPR does not directly regulate vector control agencies. CDPH provides regulatory oversight for vector control agencies that are signatory to the Cooperative Agreement. Signatories to the agreement use only pesticides listed by CDPH, maintain pesticide use reports, and ensure that pesticide use does not result in harmful residues on agricultural products.

9.1.2.2.9 Pesticide Permits

In response to a Sixth Circuit Court decision in 2009 that the application of pesticides at, near, or over waters of the US that results in discharges of pollutants requires coverage under a NPDES permit, the SWRCB adopted four Pesticide Permits. The following two are applicable to the Program. The Spray Applications Permit is also relevant to the regulatory setting when the District performs pesticide applications for the CDFA and/or USFS.

> <u>Statewide NPDES Vector Control Permit</u>. Users of specific larvicide and adulticide registered products are required to obtain coverage under the Statewide NPDES Permit for Biological and Residual Pesticide Discharges to waters of the US from Vector Control Applications (SWRCB Water Quality Order No. 2012-0003-DWQ; NPDES No. CAG 990004; Vector Control Permit). Permitted larvicide active ingredients include monomolecular films, methoprene, *Bti*, *Bs,* spinosad, temephos and~~,~~ petroleum distillates**.** Permitted adulticide active ingredients include malathion, naled, pyrethrin, permethrin, resmethrin, sumithrin, prallethrin, the synergist PBO, etofenprox, and N-octyl bicycloheptene dicarboximide (MGK-264 synergist). The permit contains a receiving water limitation for malathion and receiving water monitoring triggers for the other active ingredients. Receiving water monitoring triggers are conservatively based on one-tenth of the LC50 from USEPA's Ecotoxicity Database (LC_{50} is defined in Section 9.1.1.4). To obtain coverage under the permit, each discharger (typically a vector control district) must submit a Notice of Intent, application fee, and PAP, which is subject to approval by the SWRCB following a 30-day public comment period.

The PAP serves as a comprehensive plan developed by the discharger that describes the project, the need for the project, what will be done to reduce water quality impacts, and how those impacts will be monitored. The PAP must include a description of application and target areas, evaluation of available BMPs, and description of BMPs to be implemented. The PAP must include a discussion of the factors influencing the decision to select pesticide applications for vector control, what pesticide products or types expected to be used and any known degradation byproducts. The PAP also includes the methodology used to determine how much pesticide is needed and how this amount was determined, the methods in which pesticides are to be applied, and any adjuvants or surfactants that will be used.

Permittees must comply with the Vector Control Permit Monitoring and Reporting Program (MRP), which encourages formation of monitoring coalitions. Monitoring requirements include background, event, and post-event sampling for visual, physical, and chemical constituents for each type of aquatic pesticide used. Visual observations were but presently are not required at 10 percent of all application sites. Physical measurements and chemical samples are required at six sites in each environmental setting (urban, agricultural/rural, and wetland). The District is a member of the MVCAC NPDES Permit Coalition, which is responsible for coordinating all physical measurements and conducting all chemical monitoring required under the Vector Control Permit MRP. Chemical monitoring results that exceed the receiving water limitation for malathion or the receiving water monitoring trigger for other active ingredients must be reported to the SWRCB and RWQCB within 24 hours of identification and again after 5 days. A description of actions to be taken to prevent recurrence of adverse incidents is included in those reports. Annual reports are required by the MVCAC NPDES Permit Coalition and each member district. Member district annual reports are typically limited to submittal of Pesticide Application Logs, which contain specific application details and review of their PAP. The MVCAC NPDES Permit Coalition annual report includes all physical and chemical monitoring data and makes recommendations for modifications to the MRP, if appropriate.

> <u>Statewide NPDES Aquatic Weed Control Permit</u>. The Statewide General NPDES Permit for the Discharge of Aquatic Pesticides for Aquatic Weed Control in waters of the US (SWRCB Water Quality Order No. 2004-0009-DWQ; NPDES No. CAG 990005; Aquatic Weed Control Permit) addresses the discharge of aquatic pesticides related to the application of 2,4-D, acrolein, copper, diquat, endothall, fluridone, glyphosate, imazapyr, sodium carbonate peroxyhydrate, and triclopyr-based aquatic pesticides to surface waters for the control of aquatic weeds. Covered discharges include over-applied

or misdirected pesticide products and pesticide residues but do not include stormwater discharges or return flows from irrigated agriculture. Aquatic pesticides that are applied to application areas within waters of the US in accordance with FIFRA label requirements and Use Permit restrictions are not considered pollutants. The permit contains receiving water limitations for 2,4-D, acrolein, copper, diquat, endothall, fluridone, glyphosate, and nonylphenol. To obtain coverage under the permit, a discharger must submit a Notice of Intent, application fee, and a vicinity map to the appropriate RWQCB. Effluent limitations contained in the Aquatic Weed Control Permit are narrative and include requirements to develop and implement an APAP.

The APAP must describe appropriate BMPs, including compliance with all pesticide label instructions, and a monitoring plan that meets the requirements of the permit MRP. Monitoring requirements include background, event, and post-event sampling for visual, physical, and chemical constituents at 10 percent of all application sites for each type of aquatic pesticide used for each type of site (flowing water and nonflowing water). Annual reports must summarize monitoring data and address the effectiveness of the APAP to reduce or prevent the discharge of pollutants associated with aquatic pesticide applications. Other specific requirements of the APAP include a description of the water body(ies) or water body systems being controlled and a description of what weed(s) are being controlled and why. The APAP also serves as a discussion of control tolerances (i.e., how much growth can occur before action is necessary) and of the factors influencing the decision to use aquatic pesticides in regards to those tolerances (pros and cons). The types of pesticides and adjuvants that are used and the methodology used to determine the amount of product to be applied are also detailed within an APAP. Finally, the APAP should have a description of application and treatment areas within the system and, if applicable, a list of gates or control structures and their inspection schedule to ensure they are not leaking.

The Aquatic Weed Control Permit was revised in 2013. SWRCB Order No. 2013-0002-DWQ adds imazamox and penoxsulam as active ingredients, requires a 30-day public comment period of the APAP, adds a dissolved oxygen receiving water limit, and adds receiving water monitoring triggers for imazamox, imazapyr, penoxsulam, sodium carbonate peroxyhydrate, and triclopyr. The permit also modifies the MRP, adds 24-hour and 5-day reporting requirements in the event of an exceedance of a receiving water limit or receiving water monitoring trigger, and clarifies other permit language. The updated permit was adopted by the SWRCB in June 2013 and became effective on December 1, 2013.

> Statewide NPDES Spray Applications Permit. The Statewide General NPDES Permit for Biological and Residual Pesticide Discharges to Waters of the US from Spray Applications (SWRCB Water Quality Order No. 2011-0004-DWQ; NPDES No. CAG 990007; Spray Applications Permit) addresses spray applications of insecticides and herbicides by CDFA and USFS. Under the permit, CDFA is covered for applications of acetamiprid, aminopyralid, *Bacillus thuringiensis*, subspecies *kurstaki* (*Btk*), carbaryl, chlorsulfuron, clopyralid, cyfluthrin, dinotefuran, glyphosate, imazapyr, imidacloprid, malathion, naled, nuclear polyhedrosis virus (NPV), pheromone, pyrethrins, Spinosad A and D, triclopyr butoxyethyl ester (BEE), and triclopyr triethylamine salt (TEA). USFS is covered for applications of biological control agents, which is a subset of the CDFA active ingredients.

The permit contains a receiving water limitation for malathion and receiving water monitoring triggers for many of the other active ingredients. To obtain coverage under the permit, the discharger must submit a Notice of Intent, application fee, and a project- or program-specific PAP to the SWRCB. The PAP must describe the application area, appropriate BMPs for each pesticide project, an evaluation of possible alternatives to pesticide use, and a monitoring plan. The PAP must also include an Off-Target Drift Management Plan. Monitoring requirements include background and event monitoring for visual, physical, and chemical parameters at frequencies similar to the Vector Control Permit. Annual reports must summarize sampling results and recommend improvements to the monitoring program, BMPs, and PAP.

9.1.2.3 Local

A compilation of local ordinances and regulations (or chapters within which they can be found) for the District Service Area is provided in Table 9-3.

Table 9-3 List of County General Plan Pesticide and Water Quality Policies

County	Name of Code/Plan	Element Title, Chapter and Section
Solano	Solano County General Plan	Health and Safety Element, HS.I-58

Sources: Solano County 2008

9.1.2.3.1 County Agricultural Commissioners

In addition to federal and state oversight, County Agricultural Commissioners in California also regulate the sale and use of pesticides and issue Use Permits for applications of pesticides that are deemed as restricted materials by CDPR. The Solano County Agricultural Commissioner collects pesticide use reports from the District and other users of pesticides, investigates incidents and illnesses, and conducts annual inspections.

9.2 Environmental Impacts and Mitigation Measures

The water resource impacts evaluation is provided below. The evaluation qualitatively and quantitatively compares the Program's potential water resource impacts to the significance criteria presented in Section 9.2.1, Evaluation Concerns and Criteria. Significant impacts are summarized for each alternative where one or more potential impacts were identified. Mitigation measures are identified for potentially significant but mitigable impacts following the statement of impact. Additional information on the mitigation measures is provided in Section 9.2.1.1.

9.2.1 Evaluation Concerns and Criteria

Impacts are considered significant if the Program actions cause concentrations of Program compounds in receiving water bodies (surface water or groundwater) to exceed established water quality objectives or other applicable water quality standards or promulgated regulations on the local, state, or federal level. Increased concentrations of potential pollutants associated with Program activities within the Program Area would be related to the application of Program materials or implementation of Program activities in the Program Area.

As discussed previously in this PEIR, the Program Area is distributed across the District (and adjacent counties) rather than in a single particular location. The effects on water resources are largely attributable to the post-application movement of those compounds identified for use under the Program alternatives to surface water and/or groundwater. Some Program activities that do not involve applications of compounds could also affect water resources.

Concerns related to water resources issues that were raised during public scoping included the following:

> Consideration of CDPH review and approval of mosquito abatement materials and practices proposed for use on watershed lands.

> Integration of “Source Reduction” strategies with Stream Maintenance Program approaches in Water Agency-owned flood control channels. (Sonoma CWA)

> Need for description and quantification of dredge or fill activities and evaluation of their impacts.

> Impacts of drift from aerial spray and ground applications on water bodies, watersheds, and drinking water supplies.

While the first two issues are related to Program implementation and coordination with other agencies (who will receive this PEIR), the last two are related to the Physical Control, Vegetation Management, and Chemical Control Alternatives and are addressed in the environmental impact analyses.

This water resource analysis addresses potential impacts to the quality of surface water and groundwater at a programmatic level and does not quantify dredge and fill activities (which could be addressed in the new USACE permit described in Section 2.8.1.3). Because no large-scale consumptive use of water supply is associated with implementation of the Program alternatives, the potential for an impact to water supply would be related to a physical impact to water quality. Additional discussion of the potential for the pesticides to result in exceedance of federal or state agency surface water quality standards or objectives is contained in Section 6.2, Ecological Health Environmental Impacts.

9.2.1.1 Thresholds of Significance

Applicable regulatory and planning standards discussed above can be used to determine appropriate thresholds of significance for this water resource analysis.

The Program activities are evaluated in accordance with the Hydrology and Water Quality Section IX of the CEQA Environmental Checklist Form, Appendix G. Several of the topic areas represented by the questions from the checklist are not affected by the Program activities, as follows:

Would the Program substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?	No, Program activities would not impact groundwater supplies or groundwater recharge.
Would the Program substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off site?	No, Program activities would not substantially change or alter drainage amount, timing, or patterns.
Would the Program substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner, which would result in flooding on- or off site?	No, Program activities would not substantially change or alter drainage amount, timing, or patterns.
Would the Program create or contribute runoff water, which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	No, Program activities would not create or contribute additional sources of clean or polluted runoff.
Would the Program place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	No, Program activities would not construct any housing.
Would the Program place within a 100-year flood hazard area structures, which would impede or redirect flood flows?	No, Program activities would not create any structures.
Would the Program expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?	No, Program activities would not expose people or structures to flooding.
Would the Program lead to inundation by seiche, tsunami, or mudflow?	No, Program activities would not cause inundation by seiche, tsunami, or mudflow.

Topic areas that may be impacted by the Proposed Program include the following:

> Would the Program violate any water quality standards or waste discharge requirements?

> Would the Program otherwise substantially degrade water quality?

For the evaluation of these topic areas, impacts from Program activities on the water quality of surface water or groundwater would be considered potentially significant if the Program implementation or activities could cause chemical concentrations to exceed the following criteria:

> Any discharge to the surface water or groundwater that exceeds NPDES permit receiving water limitations

> Any discharge to the surface water or groundwater that exceeds Basin Plan objectives with a focus on the toxicity objective

> Any discharge to the surface water or groundwater that exceeds the MCLs

> Any discharge to surface water or groundwater that exceeds the California Toxics Rule Criteria Maximum Concentrations for human health or for aquatic life

> Any discharge to surface water or groundwater that degrades the water quality either by affecting beneficial uses or by exceeding any prescribed concentration limits in state water quality plans and policies.

9.2.2 <u>Evaluation Methods and Assumptions</u>

The methodology and assumptions of this water resources impact evaluation for the Program alternatives are provided below.

9.2.2.1 Methodology

The methodology used to prepare this programmatic impact analysis section is as follows:

> Obtain source-specific data for Program-specific chemical constituents.

> Evaluate Ecological and Human Health Risk Assessment (Appendix B) sections related to the Program.

> Compare water quality conditions associated with Program alternatives against threshold criteria.

> Identify water resource impacts and mitigation measures for Program activities that exceed water quality thresholds.

The Human and Ecological Health Risk Assessment Report (Appendix B) reviews and evaluates 18 pesticide (insecticides and herbicides) active ingredients and two adjuvants currently used or proposed for use by the District. Application information, including the target organisms, number of treatments, total amount applied, and specific habitat types was obtained from the District. A comprehensive literature review was conducted to evaluate environmental fate and general toxicity characteristics for the active ingredients. The results of the assessment were used to rank the potential for adverse effects to human health and the environment. Chemical and application characteristics such as the likelihood for impact on nontarget species and habitats, the potential for drift, and the possible transport and fate of the chemical in various media (i.e., air, surface water/groundwater, soil) were considered in the assessment. Those active ingredients that appear to exhibit a higher level of risk than others or that are in prevalent use in the current Program (even though they had lower toxicity) include the following products:

> Methoprene for mosquito control (toxicity to aquatic organisms and insects)

> Etofenprox for mosquito control (toxicity to aquatic organisms)

> *Bti* for mosquito control (prevalent use; public concerns)

> Pyrethrins for mosquito control (prevalent use; includes PBO synergist)

> Resmethrin for mosquito control (prevalent use; includes PBO synergist)

> Permethrin for mosquito and wasp control (toxicity to aquatic organisms; potential endocrine disruptor)

> APEs for weed control (high toxicity to aquatic organisms; moderately bioaccumulative)

> Glyphosate for general weed control (prevalent use; possible endocrine disruptor);

9.2.2.2 Assumptions

The following assumptions were used in the assessment of potential water resource impacts from the Program alternatives:

> Site-specific evaluation of water quality impacts are not within the scope of this programmatic evaluation.

> The programmatic evaluation is based on the current proposed mosquito control methods and is subject to change.

> Existing baseline ambient water quality data related to Program chemicals are limited for most areas.

> Mitigation measures for specific locations within the Program Area are not provided.

Assumptions related to the analysis of hazards, toxicity, and exposure for chemical treatment methods are explained below, including the definition of key terms.

9.2.2.2.1 Hazardous Material

A “hazardous material” is defined in California Health and Safety Code Section 25501 (p): as “any material that, because of its quantity, concentration, or physical or chemical characteristics, poses a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment. "Hazardous materials" include, but are not limited to, “hazardous substances, hazardous waste, and any material that a handler or the administering agency has a reasonable basis for believing that it would be injurious to the health and safety of persons or harmful to the environment if released into the workplace or the environment.” Any liquid, solid, gas, sludge, synthetic product, or commodity that exhibits characteristics of toxicity, ignitability, corrosiveness, or reactivity has the potential to be considered a “hazardous material.”

9.2.2.3 Toxicity and Exposure

Toxicology is the study of a compound’s potential to elicit an adverse effect in an organism. The toxicity of a compound is dependent upon exposure, including the specific amount of the compound that reaches an organism’s tissues (i.e., the dose), the duration of time over which a dose is received, the potency of the chemical for eliciting a toxic effect (i.e., the response), and the sensitivity of the organism receiving the dose of the chemical. Toxicity effects are measured in controlled laboratory tests on a dose/response scale, whereby the probability of a toxic response increases as dose increases. Exposure to a compound is necessary for potential toxic effects to occur. However, exposure does not, in itself, imply that toxicity will occur. Thus, toxic hazards can be mitigated by limiting potential exposure to ensure that doses are less than the amount that may result in adverse health effects.

The toxicity data included in the numerous tables and charts in this document are generally derived from rigidly controlled laboratory animal studies designed to determine the potential adverse effects of the chemical under several possible routes of exposure. In these studies, the species of interest is exposed to 100 percent chemical at several doses to determine useful information such as the lowest concentration resulting in a predetermined adverse effect (LOAEL) on numerous selected physiological and behavioral systems. The second component of these tests is to determine the highest concentration of chemical that results in no measurable adverse effect (NOAEL).

However, these, and other, coordinated and focused laboratory tests are designed to document the effects of the chemical when a continuous, controlled, exposure exists and do not realistically reflect the likely exposures or toxicity in the District field application scenarios. As such, the toxicity information is intended as an overview of potential issues and guidance for understanding the completely “safe” maximum exposure levels of applications that would not adversely impact humans or nontarget plant and animal species.

Although the regulatory community uses this basic information to provide a relative comparison of the potential for a chemical to result in unwanted adverse effects and this information is reflected in the approved usage labels and MSDSs, in actual practice, the amounts applied in the District’s Program Area are substantially less than the amounts used in the toxicity studies. Because of the large safety factors used to develop recommended product label application rates, the amount of chemical resulting in demonstrated toxicity in the laboratory is much higher than the low exposure levels associated with an actual application. The application concentrations consistent with the labels or MSDSs are designed to be protective of the health of humans and other nontarget species (i.e., low enough to not kill them, weaken them, or cause them to fail to reproduce). However, adverse effects may still occur to some non-target organisms.

9.2.3 Surveillance Alternative

Surveillance activities involve monitoring the abundance of adult and larval mosquitoes, field inspection of mosquito habitat, testing for the presence of encephalitis virus-specific antibodies in sentinel chickens or wild birds, and/or response to public service requests regarding mosquitoes. Mosquito populations are monitored through the use of traps, inspections, and sampling in mosquito habitats. Known and suspected habitats are anywhere that water can collect, be stored, or remain standing for more than a few days, including, but not limited to, catch basins, stormwater detention systems, residential communities, parks, ornamental ponds, unmaintained swimming pools, seeps, seasonal wetlands, tidal and diked marshes, wastewater ponds, sewer plants, winery waste/agricultural ponds, managed waterfowl ponds, canals, creeks, tree holes, and flooded basements. If preexisting roads and trails are not available, low ground pressure ATVs may be used to access sites. Off-road access is minimized and used only when roads and trails are not available.

These activities do not involve chemical applications to water or soil and require very little interaction with water bodies to collect samples. With the exception of some adult mosquito traps, pesticides are not required for any of the surveillance techniques. Some adult mosquito traps use a Vapona strip infused with dichlorvos in the bottom of the collection jar; this chemical would be contained in the collection device and would not contact nor interact with the environment. Therefore, no impact would occur to surface water or groundwater.

Impact WR-1: The Surveillance Alternative collection devices would not contact nor interact with the environment. **No impact** would occur to surface water or groundwater.

9.2.4 Physical Control Alternative

Physical control for mosquitoes consists of the management of mosquito-producing habitat (including freshwater marshes and lakes, saltwater marshes, temporary standing water, and wastewater treatment facilities) especially through water control and maintenance or improvement of channels, tide gates, levees, and other water control facilities, etc. Physical controls reduce or eliminate mosquito development sites by improving the habitat value for mosquito predators (i.e., providing deepwater sanctuary for larvivorous fish) or by reducing the habitat value for mosquitoes. Most mosquito species require stagnant standing water to complete their life cycle. The District attempts to reduce these habitats primarily through educating land owners/stewards on techniques involving vegetation management, increased circulation, steepening banks, changes in water quality, or by reducing the duration that standing water is allowed to persist. The specific method employed is based on site- and project-specific considerations, including whether the activity is conducted to prevent mosquito-producing habitat from forming or in response to existing conditions. Characteristics of the site and water body are also considered in planning physical control activities. Vegetation management is based on an IMM approach and is discussed in Section 9.2.5. At present, the District rarely conduct physical control activities but rather requests/requires landowners and stewards to implement maintenance activities and advises landowners on source reduction techniques for mosquito habitat.

Three types of physical control practices may be implemented by the District in the future:

1. Maintenance activities include removal of sediments from existing water circulation ditches; repair of existing water control structures, removal of debris in natural channels, clearance of brush for access to streams tributary to wetland areas, and filling of existing, nonfunctional water circulation ditches to achieve required water circulation dynamics and restore ditched wetlands.
2. New construction typically involves the creation of new ditches to enhance tidal flow preventing stagnant water.
3. Cultural practices include vegetation and water management (i.e., irrigation practices), placement of culverts or other engineering works, and making other physical changes to the lands.

The District would perform these physical control activities in accordance with all appropriate environmental regulations and in a manner that generally maintains or improves habitat values for desirable species. Physical control activities can be relatively minor the average amount of ditch maintenance for the past 5-year period was 1,204 feet with 6,020 feet being done in 2008. No other maintenance work has been performed since that time, but may become necessary in the future. Projects consisting of up to 10,000 to 20,000 linear feet of ditch maintenance per year, have been covered in the past by the District's 5-year USACE and BCDC regional wetlands permits (Section 2.8.1.3). Filling or periodically draining artificially ponded areas such as ornamental ponds and irrigation ponds can be cost-effective and environmentally acceptable; however, these methods are not appropriate strategies in natural areas, large permanent water bodies, or in areas set aside for stormwater or wastewater retention. Consequently, the District does not usually undertake physical control projects in freshwater bodies including marshes and ponds. In saline and brackish marsh habitat, physical control measures are typically designed to reduce salt-marsh mosquito production through enhancement of the frequency and duration of tidal inundation or through other water management strategies.

Construction of water control facilities and changes in water management strategies could affect existing drainage patterns and water quality locally. However, physical control activities would be designed to increase water circulation, which can increase dissolved oxygen and reduce water temperatures, improving these water quality conditions locally. Changing water circulation patterns can also increase localized areas of scour due to increased water velocities, particularly near structures. Water control facilities (e.g., tide gates, levees) are designed to minimize scour near the structure for long-term stability. Potential increases in turbidity in the water body would be limited to during and immediately after the action and would not extend beyond the vicinity of the area being improved. Changes to groundwater conditions such as water quality or recharge would not occur.

Removal of sediments from existing water circulation ditches has the potential to temporarily approach or exceed turbidity water quality objectives in nearby downstream receiving waters. However, the physical control activities are short in duration (typically less than 1 day), are localized to site-specific areas, and are transitory in location. Therefore, this temporary and transitory potential impact to surface water or groundwater is less than significant.

Impact WR-2: The Physical Control Alternative's activities to modify water circulation, remove sediment, and maintain water control facilities to reduce habitat conditions for mosquito production would have a **less-than-significant** impact on water resources and no mitigation is required.

9.2.5 Vegetation Management Alternative

District staff may advise property owners/managers to undertake vegetation management activities on their property to reduce the mosquito habitat value of sites by improving water circulation or access by fish and other predators, or to allow District staff's access to standing water for inspections and treatment. District staff does not normally perform direct vegetation management itself.

Although rarely done in recent years, the District may choose to do any of the following activities in the future if feasible. For vegetation management, the District may use hand tools, other mechanical means (i.e. heavy equipment) for vegetation removal or thinning, or apply herbicides to thin or remove vegetation. These activities primarily occur in aquatic habitats to assist with the control of mosquitoes. To reduce the potential for mosquito production associated with water retention and infiltration structures, District staff may request the owners of the structures to clear weeds and other obstructing vegetation in wetlands and retention basins.

Herbicides the District may consider for future use are listed in Table 2-1 along with information regarding the timing/season of application, method of application, and types of sites where they would be applied. Section 4.6 of the Appendix B includes descriptions of each herbicide and information on their environmental fate and toxicity. All herbicides are applied in strict conformance with label requirements, which have been approved by CDPR for use in California. Pesticide labels are legal requirements and include instructions telling users how to apply the product and precautions the applicator should take to protect human health and the environment. In addition, aquatic herbicides are applied in conformance with the APAP as required by the NPDES Aquatic Weed Control Permit.

In some instances, the water quality objective that establishes a minimum concentration for dissolved oxygen may not be met, such as when aquatic weeds killed by herbicides decompose rapidly and consume dissolved oxygen in the process.

Some herbicide applications also have the potential to approach or exceed the narrative toxicity water quality objective or the numeric water quality objective or receiving water monitoring trigger for the specific active ingredient. Herbicides that are not labeled for aquatic use and are subject to spray drift or surface water runoff may cause acute or chronic toxicity. Herbicides and adjuvants the District may consider are grouped below based on toxicity to fish and aquatic invertebrates. They are discussed in more detail in Appendix B.

9.2.5.1 Mechanical Removal of Vegetation

Mechanical and hand removal of vegetation from aquatic habitats has the potential to temporarily approach or exceed turbidity water quality objectives in downstream receiving waters. However, the vegetation control activities are short in duration (typically less than 1 day), are localized to site-specific areas, and are transitory in location. Therefore, this temporary and transitory potential impact to surface water is less than significant. No impact to groundwater is associated with these activities.

Impact WR-3: Mechanical removal of vegetation from aquatic habitats would have a **less-than-significant** impact to surface water and **no impact** to groundwater resources and no mitigation is required.

9.2.5.2 Registered Herbicides or Adjuvants with Relatively Low Toxicity to Fish and Aquatic Invertebrates

Imazapyr is a systemic, nonselective, pre- and post-emergent herbicide used for the control of a broad range of terrestrial and aquatic weeds, including terrestrial annual and perennial grasses, broadleaf herbs, woody species, and riparian and emergent aquatic species. Imazapyr is water-soluble, can run off to surface water bodies, and degrades in clear, open water. However, it is persistent in soil and leaches to groundwater. It has low toxicity to fish and aquatic invertebrates. Based upon imazapyr's toxicity and environmental fate, and using BMP application techniques, these products should not result in adverse effects.

Glyphosate is a nonselective, post-emergent, and systemic herbicide registered for use in agricultural and nonagricultural areas. It is used to control emergent foliage, but is not effective on submerged or mostly submerged foliage. Glyphosate is highly water-soluble, but binds tightly to soil and sediments. It has a low tendency to run off when applied to land because of strong adsorption to soil particles and it has a low potential to move to groundwater. Glyphosate degrades in soil in about a month. It has low toxicity to fish and aquatic invertebrates. Using BMP approaches, applications of glyphosate can be used safely when an adequate buffer to water sources is maintained.

The District would apply all herbicide formulations in strict conformance with their APAPs (if applicable) and label requirements, which have been approved by CDPR for use in California. Standard BMP application techniques, maintaining adequate buffer zones, and using care during herbicide applications would minimize adverse effects. If downstream water bodies are not already impacted by these chemical active ingredients (i.e., imazapyr and glyphosate), application of these herbicides would have a less-than-significant impact to surface water or groundwater resources when applied in accordance with label instructions.

> **Impact WR-4:** Application of the herbicides imazapyr and glyphosate would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.

9.2.5.3 Registered Herbicides or Adjuvants with High Toxicity to Fish or Aquatic Invertebrates

APEs are nonaquatic herbicides that were identified in Appendix B as having high toxicity to fish or other aquatic organisms.

APEs include a broad range of chemicals that act as adjuvants. APEs bind strongly to aquatic particles in river and coastal environments and are persistent in sediments. Nonylphenol and short-chain nonylphenol ethoxylates are moderately bioaccumulative and extremely toxic to aquatic organisms. The USEPA has recently recommended that nonylphenol and short-chain ethoxylates be evaluated further due to their widespread use (past and present), persistence, and possible estrogen-mimicking behavior.

The District would apply all herbicide formulations in strict conformance with their APAPs (if applicable) and label requirements, which have been approved by CDPR for use in California. Standard BMP application techniques, maintaining adequate buffer zones, and using care during herbicide applications would minimize adverse effects. However, potential contamination of surface water runoff and groundwater is particularly high for highly soluble or highly mobile chemicals.

If downstream water bodies are not already impacted by these chemical active ingredients, application of APEs would have a less-than-significant impact to surface water and groundwater resources when applied in accordance with label instructions.

> **Impact WR-5:** Application of APEs would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.

9.2.5.4 Registered Herbicides or Adjuvants with Unknown Toxicity to Fish or Aquatic Invertebrates

Polydimethylsiloxane fluids are insoluble in water. High molecular weight polydimethylsiloxanes typically sorb to particulate matter when in water and become associated with soil and sediments. Degradation is slow on moist soils but rapid on dry soil. These chemicals appear to be relatively nontoxic to most organisms, but data are lacking. Although some information is lacking regarding polydimethylsiloxanes' toxicity and environmental fate, these products should not result in adverse effects when used in accordance with recommended BMP application techniques.

The District would apply all herbicide formulations in strict conformance with their APAPs (if applicable) and label requirements, which have been approved by CDPR for use in California. Due to the lack of reported, documented effects of these herbicides and adjuvants, proper application of methods using BMP application techniques should not result in adverse effects. If downstream water bodies are not already impacted, application of polydimethylsiloxanes would have a less-than-significant impact to surface water and groundwater resources when applied following label instructions.

> **Impact WR-6:** Application of polydimethylsiloxanes would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.

9.2.6 Biological Control Alternative

Biological control of mosquitoes involves the intentional use of vector pathogens, parasites, and predators to reduce the mosquito population. It is one of the principal components of the IMM approach followed by MVCAC member agencies, in which the emphasis is on source reduction and control of mosquitoes in their immature stages. Mosquito pathogens include an assortment of viruses and bacteria. Mosquito parasites are not generally available commercially for mosquito control at present. Mosquito predators are represented by insects, fish, birds, and bats that consume larval or adult mosquitoes as prey. Although the District supports the presence of a variety of species, only mosquitofish (*Gambusia affinis*) are commercially available to use at present.

Because the potential environmental impacts of mosquito pathogens the District applies are generally similar to those of chemical pesticide applications, these chemicals are evaluated under the Chemical Control Alternative (Section 9.2.7). Mosquitofish are reared at the District hatchery where wastewater discharge has the potential to convey nutrients, sediments, and other potential pollutants to storm drains, downstream receiving waters, and groundwater. The wastewater is discharged to land as irrigation water; therefore, natural degradation would provide some treatment via chemical, biological, and physical processes that occur as the wastewater flows over and percolates through the soil. Because the volume and frequency of discharges are relatively minor (180 gallons per week, the impact of this alternative to surface water and groundwater is less than significant.

> **Impact WR-7:** The Biological Control Alternative's production of mosquitofish limits wastewater discharges to upland areas. Therefore, the production of mosquitofish would have a **less-than-significant** impact on surface water and groundwater resources and no mitigation is required.

High populations of mosquitofish in a water body could increase nutrient concentrations, causing algal blooms and a subsequent drop in dissolved oxygen. However, because mosquitofish use most often occurs in man-made water features that are hydrologically isolated from receiving waters, their impact to surface water is less than significant. Because the connection between these man-made water bodies and natural surface waters or groundwater is limited or nonexistent, the impact of this alternative is less than significant.

> **Impact WR-8:** The Biological Control Alternative's use of mosquitofish in man-made water features that are hydrologically-isolated from receiving waters would have a **less-than-significant** impact on surface water and groundwater resources and no mitigation is required.

The District also uses mosquitofish in natural waters within their Service Area (up to 100 pounds annually), where the District judges that mosquitofish are the best method for controlling larval mosquitoes. Such plantings have the potential to affect sensitive species and aquatic ecosystems, as described in Section 4.6.2, and to affect surface water quality. However, the quantities used at any location are not large enough to adversely affect dissolved oxygen and cause algal blooms. For example, in 2013, 72 pounds of mosquitofish were distributed in 101 applications. They are most commonly distributed in the Vacaville/Dixon area in areas covering 187.59 acres.

> **Impact WR-9** Planting of mosquitofish in natural waterways or artificial environments that drain to natural waterways would have a **less than significant** impact on surface water resources and no mitigation is required.

9.2.7 Chemical Control Alternative

Chemical control consists of the application of chemicals to directly reduce mosquito populations that pose a risk to public health (herbicides are discussed in Section 9.2.5, Vegetation Management Alternative.). As part of their IMM program, the District prioritizes the least toxic materials available for control of the larval stages, focusing on bacterial larvicides, growth regulators, and surface films rather than organophosphates (OPs) or pyrethroids. Control of adult mosquitoes may become necessary under some circumstances, such as in the event of a disease outbreak (documented presence of infectious virus in active host-seeking adult mosquitoes), or lack of access to larval sources and habitats leading to the emergence of large numbers of biting adult mosquitoes. OP insecticides may be used in rotation with pyrethrins or pyrethroids to avoid the development of resistance. The active ingredients currently used for control of adult mosquitoes have been deliberately selected for lack of persistence and minimal effects on nontarget organisms when applied in accordance with label guidelines for ultra-low volume (ULV) mosquito control.

All chemicals are applied in strict conformance with label requirements, which have been approved by CDPR for use in California. Pesticide labels are application requirements and include instructions informing users how to apply the product and precautions the applicator should employ to protect human health and the environment. In addition, chemicals are applied in conformance with the PAP as required by the NPDES Vector Control Permit. All BMPs included in the PAP and product labels are followed and include such measures as restrictions in applications to certain land uses and weather (i.e., wind speed) parameters.

All chemical active ingredients and adjuvants the District currently uses are reviewed and evaluated in Appendix B. The following sections evaluate groups of chemicals based on their target organism or life stage.

9.2.7.1 Mosquito Larvicides

Larvicides are used to manage immature life stages of mosquitoes including larvae and pupae in aquatic habitats. Temporary aquatic habitats are usually targeted because permanent water bodies generally support natural mosquito predators such as fish. The larvicides are applied using ground application equipment and aircraft (both rotary and fixed-wing). Applications may be repeated at any site at recurrence intervals ranging from annually to weekly.

9.2.7.1.1 Biological Agents

Bs is a bacterial larvicide that is applied to irrigation ditches, floodwater, standing ponds, woodland pools, pastures, tidal water, fresh or saltwater marshes, and stormwater retention areas. It damages and paralyzes the gut of mosquito larvae that ingest the spores. Although dormant *Bs* spores may persist in the environment for several weeks to months and the endotoxins generally persist for 2 to 4 weeks following application, the endotoxins degrade rapidly in sunlight and are degraded by soil microorganisms. *Bs* does not percolate through the soil and readily binds to sediments. It is highly selective for mosquitoes and is not toxic to nontarget species, including birds, mammals, fish, and invertebrates in amounts that effectively control mosquito larvae. For these reasons, *Bs* should not result in adverse effects to surface water or groundwater.

Bti is applied in a similar manner and often in combination with *Bs*. *Bti* toxins may persist in soil for several months, yet a half-life for typical *Bti* products on foliage is approximately 1 to 4 days due to rapid degradation in sunlight. Toxicity is minimal to nonexistent to nontarget avian, freshwater fish, freshwater aquatic invertebrates, estuarine and marine animals, arthropod predators/parasites, honeybees, annelids, and mammalian wildlife at the label use rates of registered *Bti* active ingredients. For these reasons, *Bti* should not result in adverse effects to surface water or groundwater.

Spinosad is a biologically derived insecticide produced from the fermentation of *Saacharopolyspora spinosa*, a naturally occurring soil organism. It activates the central nervous system of insects through interaction with neuroreceptors and causes mortality through continuous stimulation of the insect nervous system. Spinosad degrades quickly in sunlight in both aqueous and soil environments. It adsorbs strongly to soil particles where it is quickly metabolized by soil microorganisms under aerobic conditions and is therefore unlikely to leach into groundwater. Spinosad is practically nontoxic to birds and mammals but is slightly to moderately toxic to fish and most aquatic invertebrates. However, low amounts typically used for mosquito control would not likely pose a significant risk to potential ecological receptors. For these reasons, spinosad should not result in adverse effects to surface water or groundwater. The District would apply all biological pathogen larvicides in strict conformance with their PAP and the label requirements, which have been approved by CDPR for use in California.

Proper application of methods using BMPs should not result in adverse effects and use of these larvicides would have a less-than-significant impact to surface water and groundwater resources.

> **Impact WR-10:** Application of the biological agents *Bs*, *Bti,* and spinosad would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.

9.2.7.1.2 Hydrocarbon Esters

Methoprene is an insect growth regulator that is applied at very low concentrations for mosquito control in the form of briquettes, pellets, sand granules, and liquid. It consists of two enantiomers: S-methoprene and R-methoprene, with S-methoprene being the biologically active enantiomer. Fate and transport characteristics of the s-enantiomer and the mixture are similar, but toxicity differs. Methoprene readily binds to suspended solids in the water column and soils. It rapidly degrades by photolysis and is metabolized in soil under both aerobic and anaerobic conditions. Although it may exhibit toxicity to fish and aquatic invertebrates, as well as nontarget insects including moths, butterflies, and beetles, methoprene is considered the least toxic of all larvicide alternatives.

These products would have a less-than-significant impact to surface water or groundwater resources when applied in accordance with the recommended BMP application techniques described in their PAP and product label requirements.

> **Impact WR-11:** Application of methoprene would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.

9.2.7.1.3 Surfactants

The monomolecular film used in California for the control of mosquito larvae is alpha-isooctadecyl-omega-hydroxypoly (oxyethylene). Monomolecular films spread a thin film on the surface of the water that makes it difficult for mosquito larvae, pupae, and emerging adults to attach to the water's surface, causing them to drown. It also disrupts larval respiration. Reported half-lives of monomolecular films in water range from 5 to 22 days. It may temporarily impact nontarget surface-breathing insects but has no observable effects to amphibians, fish, or other aquatic organisms. These products should not result in adverse water quality conditions in surface water or groundwater when used in accordance with approved BMP application requirements and techniques.

Specially derived aliphatic solvents (e.g., mineral oils and aliphatic petroleum hydrocarbons) are used to form a coating on top of water to drown larvae, pupae, and emerging adult mosquitoes. Petroleum distillates can be more effective than monomolecular films but break down much more rapidly (2 to 3 days). They have low water solubility and high sorption to organic matter. They are practically nontoxic to most nontarget organisms. Using BMP application techniques, these products should not result in adverse effects to water quality conditions in surface water or groundwater.

The District would apply all surfactant larvicides in strict conformance with their PAP and the label requirements, which have been approved by CDPR for use in California. Proper application using BMPs should not result in adverse effects and use of these chemicals would have a less-than-significant impact to surface water or groundwater resources.

> **Impact WR-12:** Application of the surfactant larvicides alpha-isooctadecyl-omega-hydroxypoly (oxyethylene), mineral oils, and aliphatic petroleum hydrocarbons would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.

9.2.7.1.4 Temephos

Temephos is the only OP larvicide used and is sometimes used in rotation with bacterial pathogens to prevent resistance. Temephos is not labeled for use in agricultural lands or pasture. Temephos is not currently used but should it be used, the District would limit its use to man-made sources such as tire piles, utility vaults, and cemetery urns. It provides effective control in water with high levels of decaying organic matter. Temephos is extremely hydrophobic with low solubility and, therefore, is unlikely to leach to groundwater. It adsorbs rapidly to organic material in water and binds strongly to soils where it breaks down via photolysis and microbial degradation. It is slightly to moderately toxic to mammals and fish, but only when applied at rates much higher than needed for mosquito larval control.

However, it is highly toxic to nontarget aquatic invertebrates and therefore is rarely used. When applied in strict conformance with label requirements and the District's PAP, use of temephos would have a less-than-significant impact on surface water or groundwater resources.

> **Impact WR-13:** Application of temephos would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.

9.2.7.2 Mosquito Adulticides

The use of adulticides to control mosquitoes is the method of control of last resort in the District's IMM program. Adulticides are only applied when other tools are not available and when specific criteria are met, including species composition, population density, proximity to human populations, and/or human disease risk. The active ingredients currently in use have been deliberately selected for lack of persistence and minimal effects on non-target organisms when applied in strict conformance to label instructions for ULV mosquito control. Adulticides are applied using ground application equipment or aircraft (both rotary and fixed-wing) and following strict conformance with label requirements and BMPs described in the District's PAP.

9.2.7.2.1 Pyrethrins and Pyrethroids

The District uses pyrethrins and pyrethroids to control adult mosquitoes. Pyrethrins are naturally occurring products distilled from the flowers of Chrysanthemum species. Pyrethroids are synthetic compounds that are chemically similar to the pyrethrins, but have been modified to increase their stability and activity against insects, while minimizing their effect on nontarget organisms. First generation or "Type I" photosensitive pyrethroids include d-allethrin, phenothrin (sumithrin), prallethrin, resmethrin, and tetramethrin. Typically, these pyrethroids are used indoors and around residential areas. The newer second-generation pyrethroids are mostly "Type II" pyrethroids (e.g., permethrin). Type II pyrethroids are more toxic than Type I pyrethroids because they are less photosensitive and persist longer in the environment. Etofenprox is a synthetic pyrethroid-like chemical, differing in structure from pyrethroids in that it lacks a carbonyl group and has an ether moiety, whereas pyrethroids contain ester moieties. Pyrethrins and pyrethroids act by causing a persistent activation of the sodium channels on insect neurons.

Pyrethrins and pyrethroids quickly adsorb to suspended solids in the water column and partition into the sediment. They adsorb strongly to soil surfaces, and are generally considered immobile in soils and, therefore, are unlikely to leach to groundwater (USEPA 2006b). These materials are relatively nontoxic to mammals and birds, but are highly toxic to fish and invertebrates. The major route of degradation is through photolysis in both water and soil. Pyrethrins and pyrethroids may be persistent in environments free of light, and pyrethroids as a class have been implicated in 303(d) listings of sediment toxicity in urban creeks (BASMAA 2013). However, the ULV applications common to mosquito control encourage dissipation rather than persistence in the environment.

Insecticides containing pyrethrins and pyrethroids usually also contain PBO as a synergist. PBO interferes with the insect's ability to detoxify pyrethrins and pyrethroids, thus enhancing the product's effectiveness. PBO has low toxicity to mammals but is a possible endocrine disruptor and is included in the final list of chemicals for screening under USEPA's Endocrine Disruptor Screening Program. It is moderately to highly toxic to fish and is highly toxic to aquatic invertebrates. PBO is moderately mobile in soil and water but degrades rapidly in the environment by photolysis and through metabolism by soil microbes. Although it degrades rapidly, release of PBO to the environment may "activate" persistent pyrethroids that are already present in the sediment. However, PBO would have a less-than-significant impact on surface water or groundwater when applied using ULV techniques, label requirements, and BMPs described in the District's PAP.

> **Impact WR-14:** Application of the synergist PBO would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.

The District applies pyrethrins in terrestrial and aquatic environments for wide-area mosquito abatement using ULV techniques. Pyrethrins quickly adsorb to suspended solids in the water column and adsorb strongly to soil surfaces making them immobile in soils and unlikely to leach into groundwater. They degrade via photolysis and are likely to persist under anaerobic conditions. Pyrethrins have low to moderate acute toxicity to mammals but are practically nontoxic to birds. They are very highly toxic to freshwater fish and invertebrates. Several studies have shown that pyrethrins applied using ULV techniques do not accumulate in water or sediment following repeated applications. These studies also determined that no toxicity is associated when exposure is limited to the amounts used when following ULV protocols for mosquito control (Lawler et al. 2008; Amweg et al. 2006). Pyrethrins would have a less-than-significant impact on surface water or groundwater when applied using ULV techniques, in accordance with label requirements, and using BMPs as described in the District's PAP.

> **Impact WR-15:** Application of pyrethrins would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.

Permethrin is a Type I synthetic pyrethroid that is usually combined with synergists such as PBO to control adult mosquitoes using ULV techniques. It is hydrophobic and tends to partition to soil and sediment. Its primary degradation pathways include photolysis and aerobic metabolism and it may be persistent in environments free of light. Permethrin is slightly toxic to humans and has been included in the final list of chemicals for screening under USEPA's Endocrine Disruptor Screening Program. It has low toxicity to mammals and is practically nontoxic to birds, but is very highly toxic to fish, aquatic invertebrates, and honeybees. Because of its high toxicity and potential persistence, the application of permethrin is potentially significant but mitigable.

> **Impact WR-16:** Because of its high toxicity and potential persistence, the application of permethrin is considered a **potentially significant but mitigable** impact to surface water resources. Mitigation is required. For groundwater, because of its strong tendency to adsorb to soil surfaces, permethrin is unlikely to leach to groundwater and, therefore, its application is considered a **less-than-significant** impact to groundwater resources and no mitigation is required.

> <u>Mitigation Measure WR-16a:</u> Application of permethrin would occur only when other IMM options have been exhausted. Alternative mosquito adulticides should be considered whenever possible.

> <u>Mitigation Measure WR-16b:</u> Application of these chemicals would not occur in locations where receiving waters are 303(d) listed for pyrethroids or sediment toxicity. Consistent with the District's current IMM plan, application of chemicals would occur only when other IMPM options have been exhausted. Because permethrin has relatively high toxicity and persistence in comparison to other pyrethroids, the District's current IMM plan will be updated to give lower priority to the use of permethrin than other pyrethroids in instances requiring chemical control. Permethrin use will be reserved for specific cases where alternative pesticides would not be as effective. Prior to chemical applications, the location of the application area will be reviewed with respect to proximity to impaired water bodies. Application of permethrin would not be conducted in locations where receiving waters are 303(d) listed for pyrethroids or sediment toxicity. With implementation of Mitigation Measure WR-18, the impact is reduced to **less than significant**.

Phenothrin (or sumithrin) is a Type I synthetic pyrethroid that is usually combined with synergists such as PBO to control adult mosquitoes. Phenothrin has low solubility and a relatively high affinity for binding to soil. It degrades through photolysis in water and aerobic metabolism in soil but is moderately persistent under aerobic conditions and persistent under anaerobic conditions. Phenothrin is not toxic to mammals or birds but is highly toxic to fish and freshwater invertebrates. When applied in ULV applications according to the District's PAP, phenothrin would not result in adverse effects to surface water or groundwater. Use of phenothrin would have a less-than-significant impact on surface water or groundwater.

> **Impact WR-17:** Application of phenothrin would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.

Prallethrin is a Type I synthetic pyrethroid. The only prallethrin-containing product registered for mosquito control in California is Duet, which also contains phenothrin and PBO. Prallethrin readily absorbs to soils and sediments and degrades quickly via photolysis in both water and soil. It is not toxic to mammals or birds but is highly toxic to fish and nontarget aquatic invertebrates. When applied in ULV applications according to the District's PAP, prallethrin would not result in adverse effects to surface water or groundwater. Use of prallethrin would have a less-than-significant impact on surface water or groundwater.

> **Impact WR-18:** Application of prallethrin would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.

Resmethrin is a Type I synthetic pyrethroid that is usually combined with synergists such as PBO to control adult mosquitoes that are associated with tree holes using ULV techniques. Resmethrin has a high affinity to bind to soils, sediments, and organic carbon and it degrades rapidly when exposed to light. When not subject to photolysis, it may be environmentally persistent. Resmethrin has low toxicity to mammals but has been included in the final list of chemicals for screening under USEPA's Endocrine Disruptor Screening Program. It is moderately toxic to birds and highly toxic to fish and aquatic invertebrates. Due to its high toxicity and potential persistence, the application of resmethrin is potentially significant but mitigable.

Impact WR-19: Due to its high toxicity and potential persistence, the application of resmethrin is considered a **potentially significant but mitigable** impact to surface water resources. Mitigation is required. For groundwater, because of its strong tendency to adsorb to soil surfaces, resmethrin is unlikely to leach to groundwater and therefore its application is considered a **less-than-significant** impact to groundwater resources and no mitigation is required.

Mitigation Measure WR-19a: Application of resmethrin would occur only when other IMM options have been exhausted. Alternative mosquito adulticides should be considered.

Mitigation Measure WR-19b: Application of these chemicals would not occur in locations where receiving waters are 303(d) listed for pyrethroids or sediment toxicity. Consistent with the District's current IMM plan, application of chemicals would occur only when other IMM options have been exhausted. Because resmethrin has relatively high toxicity and persistence in comparison to other pyrethroids, the District's current IMM plan will be updated to give lower priority to the use of resmethrin than other pyrethroids in areas requiring chemical control. Resmethrin use will be reserved for specific cases where alternative pesticides would not be as effective. Prior to chemical applications, the location of the application area will be reviewed with respect to proximity to impaired water bodies. Application of resmethrin would not occur in locations where receiving waters are 303(d) listed for pyrethroids or sediment toxicity. With implementation of Mitigation Measure WR-21, the impact is reduced to **less than significant**.

Etofenprox is a pyrethroid-like insecticide that is used as a mosquito adulticide and is available in formulations that do not contain PBO. It is virtually insoluble in water and stable to hydrolysis but is rapidly degraded by photolysis. Residues of etofenprox are not likely to persist in the environment. It has low toxicity to mammals but is highly toxic to fish and aquatic invertebrates. Based on toxicity and environmental fate, etofenprox would not result in adverse effects to surface water or groundwater when applied following label requirements and BMPs described in the District's PAP. Use of etofenprox would have a less-than-significant impact on surface water or groundwater.

Impact WR-20: Application of etofenprox would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.

9.2.7.2.2 Organophosphates

Naled is an OP insecticide and is used in rotation with pyrethrins or pyrethroids to avoid the development of resistance. Naled is the most commonly used material for this purpose. The District would only apply Naled on an infrequent basis in connection with potential disease outbreak. Naled has low water solubility but is mobile in soils with low organic matter content. It is moderately toxic to mammals, fish, and aquatic invertebrates but degrades readily in water, under sunlight, in soil under aerobic and anaerobic conditions, in air, and on plants. Dichlorvos, a breakdown product of naled, and itself a registered pesticide, may be present in toxic concentrations after naled is no longer detectable. Dichlorvos is very highly toxic to birds and freshwater fish and insects, including honeybees. It has high water solubility and degrades primarily through volatilization and aerobic soil metabolism. With a half-life of about 0.9 day, the degradation of dichlorvos is rapid but slower than that of its parent naled (USEPA 2006c). It does not persist in surface water and, because of breakdown by soil micro-organisms, is unlikely to leach to groundwater. Naled and other OPs are important chemicals that help control resistance of alternative products such as pyrethrins and pyrethroids. Due to the toxicity of its breakdown product dichlorvos, but its importance in the District's IMMP, use of naled is significant and unavoidable. There is no feasible mitigation.

> **Impact WR-21:** Due to the toxicity of its breakdown product but its importance in the District's IMMP, the application of naled is considered a **significant and unavoidable** impact to surface and groundwater resources.

9.2.8 Cumulative Impacts

Cumulative impacts to water resources are discussed in Section 13.7. In summary, Several receiving waters in the Program Area are already included on the CWA 303(d) list as impaired by pyrethroids or sediment toxicity, with the likely cause being the use of common household insecticides containing pyrethroids by members of the public, not vector control activities the District conducts. Where receiving waters have been designated as impaired by pyrethroids or sediment toxicity, an existing significant cumulative impact is associated with the combined applications of these pesticides. Mitigation measures WR-21a and WR-21b will ensure that the District minimizes use of more toxic and persistent pyrethroids (permethrin and resmethrin) and will not apply them in a manner that could affect 303(d) listed waters. Therefore, **the District's use of any pyrethroid is contributing in less-than-significant incremental amounts to an existing cumulatively considerable impact to water resources in the Program Area.** No additional impacts were identified in association with the chemical and nonchemical Program alternatives, and **no additional cumulative impacts are anticipated to occur** (i.e., the District's less-than-significant contributions are not triggering a new cumulative impact).

9.2.9 Environmental Impacts Summary

Table 9-4 provides a summary of the identified impacts for each subgroup of practices and chemicals included in the Program.

Two instances with potentially significant impacts could occur. Under the Chemical Control Alternative, the adulticides permethrin and resmethrin are potentially significant but mitigable. Concerning the OP naled, the impact is significant and unavoidable.

Table 9-4 Summary of Water Resources Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Effects on Water Resources					
Impact WR-1: The Surveillance Alternative collection devices would not contact nor interact with the environment. **No impact** would occur to surface water or groundwater.	N	na	na	na	na
Impact WR-2: The Physical Control Alternative's activities to modify water circulation, remove sediment, and maintain water control facilities to reduce habitat conditions for mosquito production would have a **less-than-significant** impact on water resources and no mitigation is required.	na	LS	na	na	na
Impact WR-3: Mechanical removal of vegetation from aquatic habitats would have a **less-than-significant** impact to surface water and **no impact** to groundwater resources and no mitigation is required.	na	na	LS, N	na	na
Impact WR-4: Application of the herbicides imazapyr and glyphosate would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	LS	na	na
Impact WR-5: Application of APEs would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required	na	na	LS	na	na
Impact WR-6: Application of polydimethylsiloxanes would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	LS	na	na
Impact WR-7: The Biological Control Alternative's production of mosquitofish limits wastewater discharges to upland areas. Therefore, the production of mosquitofish would have a **less-than-significant** impact on surface water and groundwater resources and no mitigation is required	na	na	na	LS	na
Impact WR-8: The Biological Control Alternative's use of mosquitofish in man-made water features that are hydrologically-isolated from receiving waters would have a **less-than-significant** impact on surface water and groundwater resources and no mitigation is required.	na	na	na	LS	na
Impact WR-9 Planting of mosquitofish in natural waterways or artificial environments that drain to natural waterways would have a **less than significant** impact on surface water resources and no mitigation is required.	na	na	na	LS	na

Table 9-4 Summary of Water Resources Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact WR-10: Application of the biological agents *Bs*, *Bti,* and spinosad would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	LS
Impact WR-11: Application of methoprene would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	LS
Impact WR-12: Application of the surfactant larvicides alpha-isooctadecyl-omega-hydroxypoly (oxyethylene), mineral oils, and aliphatic petroleum hydrocarbons would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	LS
Impact WR-13: Application of temephos would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	LS
Impact WR-14: Application of the synergist PBO would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	LS
Impact WR-15: Application of pyrethrins would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	LS
Impact WR-16: Because of its high toxicity and potential persistence, the application of permethrin is considered a **potentially significant but mitigable** impact to surface water resources. Mitigation is required. For groundwater, because of its strong tendency to adsorb to soil surfaces, permethrin is unlikely to leach to groundwater and, therefore, its application is considered a **less-than-significant** impact to groundwater resources and no mitigation is required.	na	na	na	na	SM, LS
Impact WR-17: Application of phenothrin would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	LS
Impact WR-18: Application of prallethrin would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	LS

Table 9-4 Summary of Water Resources Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact WR-19: Due to its high toxicity and potential persistence, the application of resmethrin is considered a **potentially significant but mitigable** impact to surface water resources. Mitigation is required. For groundwater, because of its strong tendency to adsorb to soil surfaces, resmethrin is unlikely to leach to groundwater and therefore its application is considered a **less-than-significant** impact to groundwater resources and no mitigation is required.	na	na	na	na	SM, LS
Impact WR-20: Application of etofenprox would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	LS
Impact WR-21: Due to the toxicity of its breakdown product but its importance in the District's IMMP, the application of naled is considered a **significant and unavoidable** impact to surface and groundwater resources.	na	na	na	na	SU

LS = Less-than-significant impact

N = No impact

na = Not applicable

SM = Potentially significant but mitigable impact

SU = Significant and unavoidable impact

9.2.10 Mitigation and Monitoring

Mitigation measures for Impacts WR-9, WR-16 and WR-19 are included in this section.

Mitigation Measure WR-9. The District has a policy of restricting its planting of mosquitofish to natural waters to situations where the potential environmental effects are likely to be low. Such plantings are subject to a series of measures to minimize environmental effects, including:

1. Limiting such plantings to areas where the District's historic and ongoing Surveillance Program indicates that mosquito breeding is likely to occur.
2. Consulting appropriate federal and state fish and wildlife department websites, including the USFWS website, CDFW website, and CalFish.org to determine if the area under consideration for treatment, including a 1 mile radius around the site, is a known habitat for threatened and/or endangered species.
3. Not planting in streams until flows have become discontinuous, and stream habitat consists of isolated pools to minimize the potential for the movement of mosquitofish to areas where treatment was not intended.
4. Not planting mosquitofish if there have been reported sightings of threatened and/or endangered species within this area without further surveys by a biologist qualified to perform such surveys, or consultation with agency biologists.
5. District staff conducting a site survey and preparing a written report relating to the occurrence of sensitive species and not planting mosquitofish if the survey identifies the potential presence of sensitive species.

With implementation of Mitigation Measure WR-9, the impact would have a **potentially significant but mitigable impact** on surface and groundwater resources.

Mitigation Measure WR-16a: Application of permethrin would occur only when other IMM options have been exhausted. Alternative mosquito adulticides should be considered whenever possible. With implementation of other chemicals, the impact is reduced to less than significant.

Mitigation Measure WR-16b: Application of these chemicals would not occur in locations where receiving waters are 303(d) listed for pyrethroids or sediment toxicity. Consistent with the District's current IMM plan, application of chemicals would occur only when other IMM options have been exhausted. Because permethrin has relatively high toxicity and persistence in comparison to other pyrethroids, the District's current IMM plan will be updated to give lower priority to the use of permethrin than other pyrethroids in instances requiring chemical control. Permethrin use will be reserved for specific cases where alternative pesticides would not be as effective. Prior to chemical applications, the location of the application area will be reviewed with respect to proximity to impaired water bodies. Application of permethrin would not be conducted in locations where receiving waters are 303(d) listed for pyrethroids or sediment toxicity.

> Location: Areas requiring chemical control at or near water bodies and locations where receiving waters are 303(d) listed for pyrethroids or sediment toxicity

> Monitoring/Reporting: District staff to Board of Trustees

> Effectiveness Criteria: Implementation of updated IMM plan

> Responsible Agency: District

> Timing: Prior to chemical control

With implementation of Mitigation Measure WR-16, the impact is reduced to **less than significant**.

Mitigation Measure WR-19a: Application of resmethrin would occur only when other IMM options have been exhausted. Alternative mosquito adulticides should be considered.

Mitigation Measure WR-19b: Application of these chemicals would not occur in locations where receiving waters are 303(d) listed for pyrethroids or sediment toxicity. Consistent with the District's current IMM plan, application of chemicals would occur only when other IMM options have been exhausted. Because resmethrin has relatively high toxicity and persistence in comparison to other pyrethroids, the District's current IMM plan will be updated to give lower priority to the use of resmethrin than other pyrethroids in areas requiring chemical control. Resmethrin use will be reserved for specific cases where alternative pesticides would not be as effective. Prior to chemical applications, the location of the application area will be reviewed with respect to proximity to impaired water bodies. Application of resmethrin would not occur in locations where receiving waters are 303(d) listed for pyrethroids or sediment toxicity.

> Location: Areas requiring chemical control at or near water bodies and locations where receiving waters are 303(d) listed for pyrethroids or sediment toxicity

> Monitoring/Reporting: District staff to Board of Trustees

> Effectiveness Criteria: Implementation of updated IMM plan

> Responsible Agency: District

> Timing: Prior to chemical control

With implementation of Mitigation Measure WR-19, the impact is reduced to **less than significant**.

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10 Air Quality

This chapter is based on Appendix C, Air Quality and Greenhouse Gas Emissions Technical Report. It presents the environmental setting for the District's Proposed Program and an analysis of environmental impacts to air quality in the District's Program Area. This chapter evaluates Program emissions to determine individual and combined effects in relation to established thresholds of significance. The Proposed Program is the continuation of strategies (alternatives) currently employed for mosquito and/or vector control.

10.1 Environmental Setting

State and federal law defines criteria emissions to include the following: reactive or volatile organic compounds (ROCs or VOCs), nitrogen oxides (nitric oxide [NO] and nitrogen dioxide [NO_2]), carbon monoxide (CO), sulfur dioxide (SO_2), respirable particulate matter (PM_{10}), and fine particulate matter ($PM_{2.5}$). Elimination of tetraethyl lead in motor gasoline has eliminated lead (Pb) emissions from vehicles and portable equipment, although tetraethyl lead is still used in some types of aviation gasoline.

During applicable mosquito and/or vector control activities, the Program would generate criteria emissions from the combustion of fossil fuels (i.e., gasoline, diesel, jet fuel) used to operate portable equipment, vehicles, and aircraft across the District's service area. (Control activities would also cause greenhouse gas emissions, which are addressed in Chapter 11.)

10.1.1 Program Location

The Program Area is defined as the Solano County Mosquito Abatement District (SCMAD) Service Area (Solano County) and the adjacent counties (which include Contra Costa, Napa, Sacramento, Sonoma, and Yolo counties) where control activities may be provided upon request. Solano, Napa, and Sonoma are predominantly in the San Francisco Bay Area Air Basin (SFBAAB), under the jurisdiction of the Bay Area Air Quality Management District (BAAQMD), along with the Northern Sonoma County Air Pollution Control District (NSCAPCD) and Yolo-Solano Air Quality Management District (YSAQMD) in adjacent areas. The bulk of criteria pollutant emissions resulting from Program activities would occur in the San Francisco Bay Area, and minor amounts would occur in northern Sonoma County, Yolo County, and the northeastern portion of Solano County.

Air districts in California are required to monitor air pollutant levels to assure that National Ambient Air Quality Standards (NAAQS) and California Ambient Air Quality Standards (CAAQS) are met and, in the event that they are not, to develop strategies to meet these standards. If the standards are met, the local air basin is classified as being in "attainment"; if the standards are exceeded, it is classified as "nonattainment." Where insufficient data exist to make a determination, an area is deemed "unclassified."

The SFBAAB is designated as nonattainment for the state 1-hour, state 8-hour, and federal 8-hour ozone (O_3) standards, and nonattainment for all state PM_{10} and $PM_{2.5}$ standards. The SFBAAB is also designated unclassified for the 24-hour federal PM_{10} standard, and nonattainment and attainment for the federal 24-hour and annual $PM_{2.5}$ standards, respectively. For all other pollutants and standards, the SFBAAB is designated as either attainment or unclassified status (BAAQMD 2012a; CARB 2012a; USEPA 2012a; see Table 10-2).

Northern Sonoma County is designated transitional/uncharacterized for the state 1-hour O_3 standard. Yolo-Solano AQMD counties are "Serious" nonattainment for the state 1-hour O_3 standard, nonattainment for the state and federal 8-hour O_3 standards, nonattainment for the state 24-hour and annual PM_{10} standards, and partial nonattainment for the federal 24-hour $PM_{2.5}$ standard. For all other pollutants and standards northern Sonoma, Yolo, and northeastern Solano counties are designated either attainment or unclassified status (CARB 2012a; USEPA 2012a; Yolo-Solano Air Quality Management District 2013).

10.1.2 Meteorology and Climate

The Program Area climate is characterized by moderately wet winters and dry summers. For the region including SCMAD Program Area, about 90 percent of the annual total rainfall is received in the November through April period. Between June and September, normal rainfall is typically less than 0.6 inch (1.5 centimeters). Temperatures in the Program Area average about 60 degrees Fahrenheit (°F) (15 degrees Celsius [°C]) annually, with average summer highs in the 70 to 80°F (21 to 27°C) range and average winter lows in the 40 to 50°F (4 to 10°C) range. Precipitation averages about 23 inches (58 centimeters) per year, although annual precipitation can vary significantly from year-to-year. Annual average wind speeds in the Program Area are about 8 miles per hour (3.6 meters per second). The predominant direction of air pollution transport in the Program Area is inland from the coastal areas (BAAQMD 2010a; World Climate 2012; NOAA 2008).

10.1.3 Criteria Air Pollutants and Potential Health Impacts

A criteria or regulated air pollutant is any air pollutant for which ambient air quality standards have been set by the USEPA or the California Air Resources Board (CARB). Primary air quality standards are established to protect human (public) health. Secondary air quality standards are designed to protect public welfare from effects such as diminished production and quality of agricultural crops, reduced visibility, degraded soils, materials and infrastructure damage, and damaged vegetation. Criteria pollutants include O_3, NO_2, CO, SO_2, PM_{10}, and $PM_{2.5}$. The six most prevalent criteria pollutants and their potential health effects are described below.

10.1.3.1 Ozone

Ground-level O_3 is a secondary pollutant formed in the atmosphere by a series of complex chemical reactions and transformations in the presence of sunlight above urban areas due to the mixing effects of temperature inversions. Nitrogen oxides (NO_X) and reactive organic gases (ROGs)[1] are the principal constituents in these reactions. NO_X and ROG emissions are predominantly attributed to mobile sources (on road motor vehicles and other mobile sources). Thus, regulation and control of NO_X and ROGs from these sources is essential to reduce the formation of ground-level O_3.

O_3 is a strong irritating gas that can chemically burn and cause narrowing of airways, forcing the lungs and heart to work harder to provide oxygen to the body. A powerful oxidant, O_3 is capable of destroying organic matter, including human lung and airway tissue; it essentially burns through cell walls. O_3 damages cells in the lungs, making the passages inflamed and swollen. O_3 also causes shortness of breath, nasal congestion, coughing, eye irritation, sore throat, headache, chest discomfort, breathing pain, throat dryness, wheezing, fatigue, and nausea. It can damage alveoli, the individual air sacs in the lungs where oxygen and carbon dioxide are exchanged. O_3 has been associated with a decrease in resistance to infections. People most likely to be affected by O_3 include the elderly, the young, and athletes. O_3 may pose its worst health threat to people who already suffer from respiratory diseases such as asthma, emphysema, and chronic bronchitis (VCAPCD 2003).

10.1.3.2 Nitrogen Dioxide

NO_2 is formed in the atmosphere primarily by the rapid reaction of the colorless gas NO with atmospheric oxygen. It is a reddish brown gas with an odor similar to that of bleach. NO_2 participates in the photochemical reactions that result in O_3. The greatest source of NO, and subsequently NO_2, is the high-temperature combustion of fossil fuels such as in motor vehicle engines and power plant boilers. NO_2 and NO are referred to collectively as NO_X. NO_2 can irritate and damage the lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections such as influenza. Researchers have identified

[1]Also referred to as ROCs or VOCs.

harmful effects, similar to those caused by O_3, with progressive changes over 4 hours of exposure causing impaired pulmonary function, increased incidence of acute respiratory disease, and difficult breathing for both bronchitis sufferers and healthy persons (VCAPCD 2003).

10.1.3.3 Carbon Monoxide

CO is a common, colorless, odorless, highly toxic gas. It is produced by natural and anthropogenic (caused by human activity) combustion processes. The major source of CO in urban areas is incomplete combustion of carbon-containing fuels (primarily gasoline, diesel fuel, and natural gas). However, it also results from combustion processes including forest fires and agricultural burning. Ambient CO concentrations are generally higher in the winter, usually on cold, clear days and nights with little or no wind. Low wind speeds inhibit horizontal dispersion, and surface inversions inhibit vertical mixing. Traffic-congested intersections have the potential to result in localized high CO levels.

When inhaled, CO does not directly harm the lungs. The impact from CO is on oxygenation of the entire body. CO combines chemically with hemoglobin, the oxygen-transporting component of blood, which diminishes the ability of blood to carry oxygen to the brain, heart, and other vital organs. Red blood cells have 220 times the attraction for CO as for oxygen. This affinity interferes with movement of oxygen to the body's tissues. Effects from CO exposure include headaches, nausea, and death. People with heart ailments are at risk from low-level exposure to CO. Also sensitive are people with chronic respiratory disease, the elderly, infants and fetuses, and people suffering from anemia and other conditions that affect the oxygen-carrying capacity of blood. High CO levels in a concentrated area can result in asphyxiation. Studies show a synergistic effect when CO and O_3 are combined (VCAPCD 2003).

10.1.3.4 Sulfur Dioxide

SO_2 is a colorless gas with a sharp, irritating odor. It can react in the atmosphere to produce sulfuric acid and sulfates, which contribute to acid deposition and atmospheric visibility reduction. It also contributes to the formation of PM_{10}. Most of the SO_2 emitted into the atmosphere is from burning sulfur-containing fossil fuels by mobile sources such as marine vessels and farm equipment and stationary fuel combustion. SO_2 irritates the mucous membranes of the eyes and nose and may also affect the mouth, trachea, and lungs. Healthy people may experience sore throats, coughing, and breathing difficulties when exposed to high concentrations. SO_2 causes constriction of the airways and poses a health hazard to asthmatics, which are very sensitive to SO_2. Children often experience more respiratory tract infections when they are exposed to SO_2 (VCAPCD 2003).

10.1.3.5 Respirable Particulate Matter, 10 Microns

PM_{10} consists of particulate matter, fine dusts and aerosols, 10 microns or smaller in diameter. When inhaled, particles larger than 10 microns generally are caught in the nose and throat and do not enter the lungs. PM_{10} can enter the large upper branches of the lungs just below the throat, where they are caught and removed (by coughing, spitting, or swallowing).

The primary sources of PM_{10} include dust from paved and unpaved roads and construction and demolition operations. Lesser sources of PM_{10} include wind erosion, agricultural operations, residential wood combustion, smoke, tailpipe emissions, and industrial sources. These sources have different constituents, and, therefore, varying effects on health. Road dust is composed of many particles other than soil dust. It also includes engine exhaust, tire rubber, oil, and truck load spills. Diesel particulate matter (DPM) contains many toxic particle and elemental carbon (soot), and is considered a toxic air contaminant in California. Airborne particles absorb and adsorb toxic substances and can be inhaled and lodge in the lungs. Once in the lungs, the toxic substances can be absorbed into the bloodstream and carried throughout the body. PM_{10} concentrations tend to be lower during the winter months because weather greatly affects PM_{10} concentrations. During rain, concentrations are relatively low, and on windy days, PM_{10} levels can be high. Photochemical aerosols, formed by chemical reactions with man-made emissions, may also influence PM_{10} concentrations.

Elevated ambient particulate levels are associated with premature death, an increased number of asthma attacks, reduced lung function, aggravation of bronchitis, respiratory disease, cancer, and other serious health effects. Short-term exposure to particulates can lead to coughing, minor throat irritation, and a reduction in lung function. Long-term exposure can be more harmful. USEPA estimates that 8 percent of urban nonsmoker lung cancer risk is due to PM_{10} in soot from diesel trucks, buses, and cars. Additional studies by USEPA and the Harvard School of Public Health estimate that 50,000 to 60,000 deaths per year in the US are caused by particulates. PM_{10} particles collect in the upper portion of the respiratory system, affecting the bronchial tubes, nose, and throat. They contribute to aggravation of asthma, premature death, increased number of asthma attacks, bronchitis, reduced lung function, respiratory disease, aggravation of respiratory and cardiovascular disease, alteration of lung tissue and structure, changes in respiratory defense mechanisms, and cancer (VCAPCD 2003).

10.1.3.6 Fine Particulate Matter, 2.5 Microns

$PM_{2.5}$ is a mixture of particulate matter, fine dusts, and aerosols 2.5 microns or smaller in aerodynamic diameter. $PM_{2.5}$ can enter the deepest portions of the lungs where gas exchange occurs between the air and the blood stream. They are the most dangerous particles because the lungs have no efficient mechanisms for removing them. If these particles are soluble in water, they pass directly into the blood stream within minutes. If they are not soluble in water, they are retained deep in the lungs and can remain there permanently. This tendency increases the risks of long-term disease including chronic respiratory disease, cancer, and increased and premature death. Other effects include increased respiratory stress and disease, decreased lung function, alterations in lung tissue and structure, and alterations in respiratory tract defense mechanisms.

$PM_{2.5}$ particles are emitted from activities such as industrial and residential combustion processes, wood burning, and from diesel- and gasoline-powered vehicles. They are also formed in the atmosphere from gases such as SO_2, NO_X, ammonia, and VOCs that are emitted from combustion activities and then become particles as a result of chemical transformations in the air (secondary particles) (VCAPCD 2003).

10.1.4 Relationship of Air Pollution to Asthma

10.1.4.1 Sensitive Receptors

Consistent with the health effects of air pollution described above, certain population groups are considered more sensitive to air pollution and odors than others; in particular, children, elderly, and acutely ill and chronically ill persons, especially those with cardio respiratory diseases such as asthma and bronchitis. Sensitive receptors (land uses) indicate locations where such individuals are typically found, namely schools, daycare centers, hospitals, convalescent homes, residences of sensitive persons, and parks with active recreational uses, such as youth sports.

Persons engaged in strenuous work or physical exercise also have increased sensitivity to poor air quality. Residential areas are considered more sensitive to air quality conditions than commercial and industrial areas, because people generally spend longer periods of time at their residences, resulting in greater exposure to ambient air quality conditions. Recreational uses such as parks are also considered sensitive, due to the greater exposure to ambient air quality conditions and because the presence of pollution detracts from the recreational experience.

Due to the wide geographic dispersion of District activities and their short-term temporary nature at any particular location, no quantifiable risk to sensitive receptors or the general public would be posed by Program-related engine exhaust.

10.1.5 Existing Air Quality

Air quality is affected by a variety of sources in the vicinity of the Program Area. Large stationary sources such as oil refineries and power plants emit substantial amounts of NO_X and ROCs, along with PM_{10} and $PM_{2.5}$. Light motor vehicles, diesel-powered construction equipment, and commercial trucks used in the Program Area are another source of these pollutants. Noncombustion sources of PM_{10} and $PM_{2.5}$ include fugitive dust from roads, construction, demolition, and earthmoving. Finally, commercial and general aviation aircraft generate emissions that affect air quality.

O_3 is a secondary pollutant that is not emitted directly by sources, but rather is formed by a reaction between NO_X and ROCs in the presence of sunlight. Reductions in O_3 concentrations are dependent upon reducing emissions of these precursors. The major sources of O_3 precursors in the Bay Area are motor vehicles and other mobile equipment (including agricultural equipment), solvent use, petroleum industry activities, nonelectric agricultural water pumping, and electric utilities operation.

BAAQMD and NSCAPCD operate extensive regional air monitoring networks comprised of monitoring stations (sites) that collectively measure the ambient concentrations of six criteria air pollutants: O_3, NO_2, SO_2, CO, PM_{10}, and $PM_{2.5}$. Not all monitoring stations are fully instrumented for these pollutants, while some sites have not been operating for adequate periods of time to provide representative data for characterization of attainment status.

10.1.5.1 Sources of Air Pollutants

The most significant regional sources of O_3, NO_2, and CO in ambient air are automobiles, trucks, and other onroad vehicles, along with trains, vessels, and aircraft. O_3 is not directly emitted; rather, photochemical O_3 is formed by the atmospheric reaction of VOCs and NO_X in sunlight. Gasoline and diesel engines emit VOCs and NO_X as combustion products, as does natural gas-fired equipment (stationary sources) such as pump engines, gas turbine generators, process heaters, and steam boilers.

Local PM_{10} emissions are primarily the result of fugitive dust from travel on unpaved roads, as well as construction and agricultural activities. Coarser particles also may be emitted from activities that disturb the topsoil. Other sources include wind-blown dust, pollen, salts, brake dust, and tire wear. Although $PM_{2.5}$ is a subset of PM_{10}, it differs from the rest of PM_{10}. While most of the ambient PM_{10} results from direct emissions of the pollutant, a significant amount of the ambient $PM_{2.5}$ results from transformation of precursors and condensing of gaseous pollutants in the atmosphere. Other than direct $PM_{2.5}$ emissions, the key pollutants contributing to $PM_{2.5}$ concentrations in the atmosphere are SO_2, NO_X, VOCs, and ammonia (CARB 2005).

Mobile sources used in mosquito and vector control activities include on road fleet vehicles (light- and medium-duty trucks, vans, passenger cars), off-road ATVs, watercraft (motorboats, airboats), aircraft (helicopters and fixed-wing), portable equipment (pumps, sprayers, generators), and small equipment (handheld sprayers, foggers, dusters). Except for 2-stroke engines used in small lightweight equipment (spark ignition, 50:1 gas/oil mix), engines are 4-stroke gasoline (spark ignition) or diesel fuel (compression ignition). The dominant fuel used for these mobile sources is motor gasoline along with some diesel fuel (larger trucks), aviation gasoline (fixed-wing aircraft), and jet fuel (turbine-powered helicopters). Light trucks, vans, and passenger cars are normally used for responding to public service requests and disease surveillance.

10.1.6 Regulatory Framework

The following paragraphs summarize the federal, state, and local agencies and the laws and regulations governing air quality that are provided in Appendix C. *It is the practice of the District to work with Service Area jurisdictions and agencies during Program planning to reasonably consider the local environmental protection policies and to conform to the extent required.*

10.1.6.1 Standards and Attainment Status

The Clean Air Act of 1970 (CAA, amended 1977 and 1990, 42 United States Code 7401 et seq.) established NAAQS, and individual states retained the option to adopt more stringent standards and to include other pollution sources. CAAQS tend to be at least as protective as national standards and are often more stringent.

The ambient air quality standards shown in Table 10-1 are intended to protect the public health and welfare and specify the concentration of pollutants (with an adequate margin of safety) to which the public may be exposed without adverse health effects. The standards are designed to protect those segments of the public most susceptible to respiratory distress (known as sensitive receptors), including asthmatics, the very young, the elderly, people weak from other illness or disease, or persons engaged in strenuous work or exercise. Healthy adults can tolerate occasional exposure to air pollution levels somewhat above the ambient air quality standards before adverse health effects are observed.

Table 10-1 Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards		Federal Standards	
		ppmv	µg/m^3	ppmv	µg/m^3
Ozone (O_3)	1-hour	0.09	177	—	—
	8-hour	0.07	137	0.075	147
Nitrogen Dioxide (NO_2)	1-hour	0.18	338	0.100	188
	Annual	0.03	56	0.053	100
Sulfur Dioxide (SO_2)	1-hour	0.25	655	0.075	196
	3-hour Secondary	—	—	0.50	1,309
	24-hour	0.04	105	—	—
Carbon Monoxide (CO)	1-hour	20	22,898	35	40,071
	8-hour	9	10,304	9	10,304
	Lake Tahoe (8-hr)	6	6,869	—	—
Particulates (as PM_{10})	24-hour	—	50	—	150
	Annual	—	20	—	—
Particulates (as $PM_{2.5}$)	24-hour	—	—	—	35
	Annual Primary	—	12	—	12
	Annual Secondary	—	—	—	15
Lead (Pb)	30-day	—	1.5	—	—
	3-month (rolling)	—	—	—	0.15
Sulfates (as SO_4)	24-hour	—	25	—	—
Hydrogen Sulfide (H_2S)	1-hour	0.03	42	—	—
Vinyl Chloride (C_2H_3Cl)	24-hour	0.01	26	—	—
Visibility Reducing Particles	8-hour	Extinction coefficient of 0.23 per kilometer; visibility of 10 miles or more (0.07 to 30 miles or more for Lake Tahoe) due to particles when relative humidity is less than 70 percent.		—	—

Sources: CARB 2012b; USEPA 2012b

ppmv = part(s) per million by volume
µg/m^3 = microgram(s) per cubic meter

The 1.5 µg/m^3 federal quarterly lead standard applied until 2008; 0.15 µg/m^3 rolling 3-month average thereafter For gases, µg /m^3 calculated from ppmv based on molecular weight and standard conditions. Standard Temperature 25°C. Standard Molar Volume 24.465 liter/g-mole

In general, the San Francisco Bay Area experiences low concentrations of most pollutants when compared to state and federal standards, except for O_3 and particulate matter, for which standards are periodically exceeded. Portions of Sonoma County also experience mildly elevated concentrations of O_3, resulting in state-level transitional and moderate nonattainment designations, respectively. The attainment status of the main Bay Area region is shown in Table 10-2.

Table 10-2 Attainment Status Summary - Bay Area Region

Criteria Pollutant	State Designation	Federal Designation
Ozone (O_3) (1-hour)	Nonattainment	—
Ozone (O_3) (8-hour)	Nonattainment	Nonattainment(1)
Nitrogen Dioxide (NO_2) (1-hour)	Attainment	Unclassified(2)
Nitrogen Dioxide (NO_2) (annual)	Attainment	Attainment
Sulfur Dioxide (SO_2)	Attainment	Attainment
Carbon Monoxide (CO)	Attainment	Attainment
Resp. Particulates (as PM_{10}) (24-hour)	Nonattainment	Unclassified(2)
Resp. Particulates (as PM_{10}) (annual)	Nonattainment	—
Fine Particulates (as $PM_{2.5}$) (24-hour)	—	Nonattainment
Fine Particulates (as $PM_{2.5}$) (annual)	Nonattainment	Attainment
Lead (Pb)	Attainment	Attainment
Sulfates (as SO_4)	Attainment	—
Hydrogen Sulfide (H_2S)	Unclassified(2)	—
Vinyl Chloride (C_2H_3Cl)	ND	—
Visibility	Unclassified(2)	—

Source: BAAQMD 2012a

ND = no data/information available

Notes:

(1) The 0.08 ppmv federal 8-hour O_3 standard applied until 2008; 0.075 ppmv thereafter

2) At the time of designation, if the available data do not support a designation of attainment or nonattainment, the area is designated as unclassified.

The YSAQMD is non-attainment for the State ozone standards (both one and eight hour), and is non-attainment for the federal 8-hour ozone standard. It is also non-attainment for the State 24-hour and annual average coarse particulate (PM_{10}) standard.

10.1.6.2 Federal Authority

The 1977 CAA amendments required that regional planning and air pollution control agencies prepare regional air quality plans to outline the measures by which both stationary and mobile sources of pollutants can be controlled to achieve all standards by the deadlines specified in the act.

For the SFBAAB, the Association of Bay Area Governments, the Metropolitan Transportation Commission, and BAAQMD jointly prepared the *2005 Bay Area Ozone Strategy,* which provided inputs to the most recent *2010 Clean Air Plan* issued by BAAQMD (2012a). These plans contain control strategies that demonstrate attainment with NAAQS by the deadlines established in the federal CAA and become part of the State Implementation Plan (SIP) administered by CARB and submitted to USEPA. Similarly, NSCAPCD is also required to prepare and submit tailored clean air implementation plans to state and federal regulators.

Under the 1990 CAA amendments, areas that did not meet the original federal 1-hour O_3 standard were classified according to the severity of each area's respective O_3 problem. The 1-hour classifications were Marginal, Moderate, Serious, Severe, and Extreme.

10.1.6.3 State Authority

In 1988, the California legislature passed the California CAA (California Health and Safety Code Section 39600 et seq.), which, like its federal counterpart, called for designations of areas as attainment or nonattainment based on state rather than federal standards.

Similar to the federal CAA, the California CAA also classifies areas according to pollution levels. Under the California CAA, the Bay Area is a "Serious" O_3 nonattainment area and state PM_{10} and $PM_{2.5}$ nonattainment areas. In addition, localized CO concentrations, also known as CO "hotspots," may occur at heavily traveled roadways, particularly at intersections or other locations where the traffic is congested and vehicles idle for prolonged periods. CO concentrations exceeding the existing standard may occur at intersections that operate at a Level of Service D or worse.

CARB is the state agency responsible for regulating air quality, and its responsibilities include establishing CAAQS, emissions standards, and regulations for mobile emissions sources (e.g., autos, trucks, etc.) as well as overseeing the efforts of countywide and multicounty air pollution control districts, which have primary responsibility over stationary sources. The emission standards most relevant to the Program are those related to automobiles, light- and medium-duty trucks, and California heavy-duty truck and construction equipment engines.

10.1.6.4 Local Authority

BAAQMD is the regional agency responsible for air quality regulation within the San Francisco Bay Area, along with NSCAPCD and YSAQMD in their respective jurisdictions. Air quality is regulated through planning, monitoring, rulemaking, permitting, and enforcement activities. Districts have permit authority over most types of stationary emission sources and can require stationary sources to obtain permits; they can also impose emission limits, set fuel or material specifications, or establish operational limits to reduce air emissions. BAAQMD also regulates new or expanding stationary sources of toxic air contaminants. For state air quality planning purposes, the Bay Area is classified by the California CAA as a nonattainment area for O_3. The "Serious" classification triggers various plan submittal requirements and transportation performance standards. One such requirement is that each district update its air quality attainment plan every 3 years (triennially) to reflect progress in meeting the air quality standards and to incorporate new information regarding the feasibility of control measures and new emission inventory data. Districts indirectly regulate construction projects that use mobile sources via the statewide Portable Equipment Registration Program (PERP) discussed below. Since the Program does not meet the definition of permanent stationary sources, no permits would be required from the BAAQMD, NSCAPCD, or YSAQMD.

10.1.6.5 Source-Specific Regulations

10.1.6.5.1 Non-road Engine Standards

CARB regulates mobile sources of air pollution in the State of California. Self-propelled non-road construction equipment is considered a vehicle, as defined by the California Vehicle Code. A vehicle may have an engine that both propels the vehicle and powers equipment mounted on the vehicle. As such, vehicles are generally exempt from regulation by the air districts. However, not included in exemption provisions is any equipment mounted on a vehicle that would otherwise require a permit under air district rules and regulations.

Federal Tier 1 standards for off-road diesel engines were adopted as part of the California requirements for 1995. Federal Tier 2 and Tier 3 standards were adopted in 2000 and selectively apply to the full range of diesel off-road engine power categories. Both Tier 2 and Tier 3 standards include durability requirements to ensure compliance with the standards throughout the useful life of the engine (40 CFR 89.112, 13 CCR 2423).

On May 11, 2004, the USEPA signed the final rule implementing Tier 4 emission standards, which are to be phased-in over the period of 2008 to 2015 (69 Federal Register 38957-39273, 29 June 2004). The Tier 4 standards require that PM and NO_X emissions be further reduced by about 90 percent. Such emission reductions can be achieved through the use of advanced control technologies – including advanced exhaust gas after treatment similar to those required by the 2007–2010 standards for highway diesel engines.

10.1.6.5.2 Portable Equipment Registration Program

The statewide PERP establishes a uniform program to regulate portable engines and portable engine-driven equipment units. Once registered in PERP, engines and equipment units may operate throughout the California without the need to obtain individual permits from local air districts such as BAAQMD and NSCAPCD. Owners or operators of portable engines and certain types of equipment can register their units under the PERP to operate their equipment anywhere in the state. (CARB 2012c)

BAAQMD operates stipulated enforcement programs for owners and operators of portable equipment, which does not comply with CARB's Portable Diesel Airborne Toxic Control Measure (ATCM) regulation. Under this rule, any portable diesel engine not registered in the PERP prior to January 1, 2006, is illegal, and may not be operated in California unless it meets the ATCM Tier requirements or has an operating permit issued by an air district.

BAAQMD Regulation 2, Sections 2-1-105 and 2-1-114 list types of portable equipment commonly used in construction as exempt from stationary source rule requirements provided that the equipment complies with all applicable requirements of the statewide PERP pursuant to 13 CCR, Division 3, Chapter 3, Article 5. The District's Proposed Program is not subject to BAAQMD permitting requirements because the Program would not involve any stationary air pollution sources that are subject to BAAQMD review, including engine-driven pumps, generators, and air compressors.

10.1.6.5.3 Air Toxics Control Measures

On July 26, 2007, CARB adopted a regulation to reduce DPM and NO_X emissions from in use (existing) off-road heavy-duty diesel vehicles in California. Such vehicles are used in construction, mining, and industrial operations. Not included in this category are locomotives, commercial marine vessels, and marine engines over 50 horsepower, or recreational vehicles. The ATCM regulation supplements existing tiered emission standards for nonroad diesel engines in California (CARB 2012d).

10.1.6.5.4 Senate Bill 656

Senate Bill 656 is a planning requirement that calls for a plan and strategy for reducing $PM_{2.5}$ and PM_{10}. This bill requires CARB to identify, develop, and adopt a list of control measures to reduce the $PM_{2.5}$ and PM_{10} emissions from new and existing stationary, mobile, and area sources. BAAQMD has developed particulate matter control measures and submitted plans to CARB that include lists of measures to reduce particulate matter. Under the plans, air districts are required to continue to assess $PM_{2.5}$ and PM_{10} emissions and their impacts.

For construction emissions of fugitive PM_{10}, California air districts have adopted a number of feasible control measures that can be reasonably implemented to significantly reduce fugitive PM_{10} emissions from construction. In general, most districts' approach to CEQA analyses of construction impacts is to emphasize implementation of effective and comprehensive control measures rather than detailed quantification of emissions.

10.1.6.5.5 Nuisance (Odors)

BAAQMD CEQA Air Quality Guidelines (BAAQMD 1999) require an assessment of a project's potential to cause a public nuisance by subjecting surrounding land uses (receptors) to objectionable odors. Due to proximity, NSCAPCD generally follows the BAAQMD guidelines (NSCAPCD 2012).

The YSAQMD handbook (YSAQMD 2007) addresses odors as follows:

> *"While offensive odors rarely cause any physical harm, they can be very unpleasant, leading to considerable distress among the public and often generating citizen complaints to local governments and the District. The general nuisance rule (H&SC §41700 and District Rule 2.5) is the basis for this threshold. A project may reasonably be expected to have a significant adverse odor impact where it "generates odorous emissions in such quantities as to cause detriment, nuisance, or annoyance to any considerable number of persons or to the public, or which may endanger the comfort, repose, health, or safety of any such person or the public, or which may cause, or have a natural tendency to cause, injury or damage to business or property."*

Based on the YSAQMD handbook (YSAQMD 2007) screening of potential odor impacts should be conducted for projects that would potentially generate odorous emissions near existing sensitive receptors or other land uses where people may congregate. If a project would locate receptors and known odor sources in proximity to each other (up to one mile) a full analysis should be undertaken.

Nuisance is a fundamental air pollution control rule across the state in all air districts, including NSCAPCD Rule 400 and typically contain the same language as BAAQMD Regulation 1, Rule 301 which states that "*No person shall discharge from any source whatsoever such quantities of air contaminants or other material which cause injury, detriment, nuisance or annoyance to any considerable number of persons or the public; or which endangers the comfort, repose, health or safety of any such persons or the public, or which causes, or has a natural tendency to cause, injury or damage to business or property*."

BAAQMD Regulation 7, Rule 102 defines an objectionable odor problem as when the Air Pollution Control Officer "receives odor complaints from ten or more complainants within a 90-day period, alleging that a person has caused odors perceived at or beyond the property line of such person and deemed to be objectionable by the complainants in the normal course of their work, travel, or residence." The assessment protocol includes projects that have the potential to cause odors or projects that may subject potential sensitive receptors to nearby existing or proposed land uses that emit objectionable odors.

10.1.6.5.6 Toxic Air Contaminants

A project with the potential to expose sensitive receptors (including residential areas) or the general public to substantial levels of toxic air contaminants, as designated by CARB under 17 CCR Section 93001, listed in BAAQMD's Toxic Air Contaminants Inventory (BAAQMD 2004), would be deemed to have a significant impact. Projects that would locate receptors near existing sources of toxic air contaminants are included, as well as projects that would place sources of toxic air contaminants near existing receptors.

Projects that have the potential to expose the public to toxic air contaminants in excess of the following thresholds would be considered to have a significant air quality impact for receptors within 1,000 feet of a source boundary. These thresholds, which are based on the 1999 BAAQMD CEQA Air Quality Guidelines, are as follows:

> Probability of contracting cancer for the Maximally Exposed Individual (MEI) that exceeds 10 in 1 million. The MEI is a hypothetical person exposed for 70 years continuously (24 hours per day, 365 days per year).

> Ground-level concentrations of chronic or acute noncarcinogenic toxic air contaminants that result in a Hazard Index greater than 1 for the MEI.

DPM is considered a toxic air contaminant in California (BAAQMD 2004). Due to the limited use of diesel-powered vehicles and equipment and the Program's wide geographic scope, DPM emissions would not be sufficient to pose a significant risk to sensitive receptors from mosquito and/or vector control equipment operations.

10.1.6.5.7 General Conformity

A General Conformity determination is required for federally sponsored, permitted, or funded actions in NAAQS nonattainment areas or in certain maintenance areas when the total direct and indirect net emissions of nonattainment pollutants (or their precursors) exceed specified thresholds (CAA Amendments of 1990 Section 176[c]). This regulation ensures that federal actions conform to SIPs and agency NAAQS attainment plans.

As discussed in Section 10.1.6 and shown in Table 10-2, the Bay Area region is in federal nonattainment for $PM_{2.5}$ and O_3. Thus, the emissions of nonattainment pollutants NO_X, VOCs, PM_{10}, and $PM_{2.5}$ would be subject to the Rule if the Program were a federal action. However, since the Program is a local action and not federally sponsored, permitted, or funded actions, General Conformity does not apply.

10.2 Environmental Impacts and Mitigation Measures

10.2.1 <u>Evaluation Concerns and Criteria</u>

The environmental concerns are those identified below from the CEQA Guidelines and from public scoping. The public identified the following issues:

> Address impacts of spraying/fogging on air quality for humans and pets alike.

> Address impacts of emissions of air pollutants from control and treatment methods and combustion of fuels.

The focus in this chapter is on the use of equipment to perform all Program activities and the resulting emissions impacts to air quality. Concerning the chemical treatment methods, the effects of applications (including spraying) of those specific chemicals is addressed in Section 6.2 for ecological health and Section 7.2 for human health. The CEQA Guidelines cover the issues from public scoping.

10.2.1.1 Standards of Significance

The PEIR addresses the following criteria/standards of significance for air resources as based on CEQA Guidelines Appendix G, Environmental Checklist Form, Section III. Would the project:

- Conflict with or obstruct implementation of the applicable Air Quality Attainment Plan or Congestion Management Plan?
- Violate any stationary source air quality standard or contribute to an existing or projected air quality violation?
- Result in a net increase of any criteria pollutant for which the project region is nonattainment under an applicable federal or state ambient air quality standard (including releasing emissions, which exceed quantitative thresholds for ozone precursors)?
- Expose sensitive receptors to substantial pollutant concentrations?
- Create objectionable odors affecting a substantial number of people?

For this Program, determinations made with respect to significance criteria are documented in Sections 10.2.3 through 10.2.8.

10.2.1.1.1 BAAQMD CEQA Guidelines

On June 2, 2010, the BAAQMD adopted new CEQA Air Quality Guidelines (BAAQMD 2012b) for consideration by lead agencies tasked with evaluating the air quality and climate change impacts of proposed new projects. The proposed guidelines superseded the December 1999 Guidelines. As guidelines, they did not comprise enforceable rules or regulations per se; nevertheless, the guidelines established new quantitative thresholds of significance for criteria and greenhouse gas emissions.

However, on March 5, 2012, the Alameda County Superior Court issued a judgment finding that the BAAQMD had failed to comply with CEQA when it adopted the thresholds of significance. The court did not determine whether the thresholds were valid on the merits, but found that the adoption of the thresholds was a project under CEQA. The court issued a writ of mandate ordering the BAAQMD to set aside the 2010 thresholds and cease dissemination of them until it had complied with CEQA. The BAAQMD is no longer recommending that the 2010 thresholds be used as a generally applicable measure of a project's significance. Lead agencies may continue to rely on the 1999 CEQA thresholds and may continue to make determinations regarding the significance of an individual project's air quality impacts based on the substantial evidence in the record for that project.

For the PEIR, air quality impacts will be quantitatively assessed using significance thresholds established by BAAQMD in its 1999 CEQA Guidelines for nonattainment pollutants and USEPA for attainment pollutants, which are listed in Table 10-3. Federal Prevention of Significant Deterioration thresholds contained in 40 CFR 51.166(b)(23)(i) applicable to NSCAPCD are also higher than BAAQMD thresholds.

Table 10-3 CEQA Significance Thresholds - BAAQMD (1999)

Applicability	**VOCs**	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**
Operation, tons/year	15	CAAQS(1)	15	40(2)	15	10(2)
Operation, pounds/year	30,000	CAAQS(1)	30,000	80,000	30,000	20,000
Operation, pounds/day	80	CAAQS(1)	80	—	80	—
Construction, pounds/day	80	CAAQS(1)	80	—	80(3)	—

Sources: BAAQMD 1999, 2012b, 40 CFR 51.166.

Notes:

(1) No violation of CAAQS for CO (9 ppmv for 1 hour, 20 ppmv for 8 hours)

(2) Prevention of Significant Deterioration, annual only

(3) For construction projects, applies to exhaust emissions only, not fugitive dusts

The YSAQMD has established project-level thresholds of significance for particulate matter less than 10 micrometers in diameter (PM_{10}), precursors to ozone, which are reactive organic gases (ROG) and nitrogen oxides (NOx), and carbon monoxide (CO). These thresholds apply to both construction and operational impacts and are presented in Table 10-4. Thus, the 1999 BAAQMD thresholds are the most stringent (lowest) quantitative criteria for assessing the potential for all Program impacts under CEQA.

Table 10-4 YSAQMD Thresholds of Significance for Criteria Pollutants of Concern

Pollutant	**Thresholds of Significance**
Reactive Organic Gases (ROG)	10 tons/year
NOx	10 tons/year
PM10	80 lbs/day
CO	Violation of State ambient air quality standard for CO

Source: YSAQMD 2007

10.2.2 Evaluation Methods and Assumptions

As described in Section 10.1.5, operation of onroad fleet vehicles, off-road all-terrain vehicles, watercraft, aircraft, portable equipment, and small equipment would result in emissions of criteria pollutants (NO_X, VOCs, CO, SO_X, PM_{10}, $PM_{2.5}$) in engine exhaust. Detailed lists of equipment, estimated usage, and emission calculations are provided in Appendix C, Attachment A. Equipment lists and annual activity schedules were provided by the District. Emission calculations were performed using the most recent and applicable emission factors published by CARB (2008a), Hare and Springer 1973, and USEPA (1991, 2011a, 2011b, 2012c).

Table 10-5 shows alternatives applicability by percentage as selected by the District: surveillance, physical control, vegetation management, biological control, chemical control, or other nonchemical control. Table 10-6 shows land uses associated with selected alternatives: residential, commercial, industrial, agricultural, and open space.

No annual thresholds (Table 10-3) would be exceeded by the Program based on existing activities. As shown in Table 10-14, the District would not exceed “worst-case” daily thresholds. As shown in Table 10-15, no “typical case” daily thresholds would likely be exceeded by the Program. No ambient air quality standards for any pollutant would be violated solely by mosquito and/or vector control activities. The annual or average daily emissions contribution of the District would not be significant. Furthermore, continuation of existing activities under the Proposed Program in comparison to existing conditions when the NOP was published, would be practically zero.

Table 10-5 Solano County Mosquito Abatement District’s (SCMAD) Selected Alternatives Applicability

Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control	Other Nonchemical
24%	—	—	0.03%	46%	30%

Sources: Appendix C, Solano County Mosquito Abatement District

Table 10-6 Land Uses Associated with Selected Alternatives in the SCMAD Program Area

Residential	Commercial	Industrial	Agricultural	Open Space
●	●	●	●	●

Sources: Appendix C, Solano County Mosquito Abatement District

Tables 10-7 through 10-12 show estimated ongoing annual criteria emissions by alternative for the District. Table 10-13 shows estimated peak daily criteria emissions for applicable alternatives assuming simultaneous operations of all alternatives as a hypothetical and highly unlikely “worst-case” scenario. Table 10-14 shows estimated highest quarterly and average daily criteria emissions for applicable alternatives assuming concurrent operations as “typical case,” which is a more likely and realistic scenario.

Table 10-7 Estimated Annual Criteria Emissions for SCMAD Surveillance Alternative

VOCs lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
73	1,710	225	2.6	9.0	5.9

Sources: CARB 2008a; Hare and Springer 1973; USEPA 1991b, 2011a, 2011b, 2012c

Table 10-8 Estimated Annual Criteria Emissions for SCMAD Physical Control Alternative

VOCs lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
0	0	0	0.0	0.0	0.0

Sources: CARB 2008a; Hare and Springer 1973; USEPA 1991b, 2011a, 2011b, 2012c

Table 10-9 Estimated Annual Criteria Emissions for SCMAD Vegetation Management Alternative

VOCs lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
0	0	0	0.0	0.0	0.0

Sources: CARB 2008a; Hare and Springer 1973; USEPA 1991b, 2011a, 2011b, 2012c

Table 10-10 Estimated Annual Criteria Emissions for SCMAD Biological Control Alternative

VOCs lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
0	2	0	0.0	0.0	0.0

Sources: CARB 2008a; Hare and Springer 1973; USEPA 1991b, 2011a, 2011b, 2012c

Table 10-11 Estimated Annual Criteria Emissions for SCMAD Chemical Control Alternative

VOCs lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
138	3,235	426	4.8	17.1	11.1

Sources: CARB 2008a; Hare and Springer 1973; USEPA 1991b, 2011a, 2011b, 2012c

Table 10-12 Estimated Annual Criteria Emissions for SCMAD Other Nonchemical Activities

VOCs lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
92	2,151	283	3.2	11.4	7.4

Sources: CARB 2008a; Hare and Springer 1973; USEPA 1991b, 2011a, 2011b, 2012c

Note:
Emissions referenced in the "Other Nonchemical" category emanate from vehicles and equipment used in connection with district activities not directly related to mosquito control, such as transportation to various meetings and facilities maintenance.

Table 10-13 Estimated Peak Daily Criteria Emissions for Applicable Alternatives - Simultaneous Operations

VOCs lbs/day	CO lbs/day	NO_X lbs/day	SO_X lbs/day	PM_{10} lbs/day	$PM_{2.5}$ lbs/day
9.2	283.7	43.8	0.4	1.2	0.8

Sources: CARB 2008a; Hare and Springer 1973; USEPA 1991b, 2011a, 2011b, 2012c

Table 10-14 Estimated Highest Quarterly Criteria Emissions for Applicable Alternatives

VOCs lbs/qtr	CO lbs/qtr	NO_X lbs/qtr	SO_X lbs/qtr	PM_{10} lbs/qtr	$PM_{2.5}$ lbs/qtr
136	3,702	413	5	15	10

Sources: CARB 2008a; Hare and Springer 1973; USEPA 1991b, 2011a, 2011b, 2012c

10.2.3 Surveillance Alternative

The Surveillance Alternative would be a continuation of existing activities the District currently practices using applicable techniques, equipment, vehicles, and watercraft. Surveillance involves monitoring mosquito and/or vector populations and habitat, their disease pathogens, and the human/vector interactions. Field counting/sampling and trapping are common mechanisms for surveillance. The environmental impact concerns are phrased as questions as follows for the Surveillance Alternative.

Conflict with or obstruct implementation of the applicable Air Quality Attainment Plan or Congestion Management Plan?

The emission source categories associated with the Surveillance Alternative include offroad vehicles, onroad vehicles, and watercraft, all of which are mobile sources of nonattainment pollutants NO_X, VOCs, PM_{10}, and $PM_{2.5}$. As discussed in Section 10.1.6, these types of emission sources are included in the SIP emission inventory and required to meet CARB and USEPA nonroad and onroad emission standards applicable on the date of manufacture. Taken together, these conditions establish that the Surveillance Alternative would not conflict with applicable air quality attainment plans.

> **Impact AQ-1:** Based on the general inclusion of Surveillance Alternative emissions in the SIP emission inventory and the compliance with applicable air regulations, the Surveillance Alternative would not conflict with applicable air quality plans. Impacts would be **less than significant** and no mitigation is required**.**

Violate any stationary source air quality standard or contribute to an existing or projected air quality violation?

The Surveillance Alternative has the potential to emit regulated criteria pollutants, including O_3 precursors NO_X and VOCs, CO, SO_2, PM_{10}, and $PM_{2.5}$. Estimated peak daily emissions of each of these pollutants from all alternatives combined in the District are shown in Table 10-13 and are less than the daily thresholds shown in Table 10-3. Annual thresholds do not apply to estimated emissions shown in Table 10-7 because mosquito and vector control activities do not comprise a stationary source of air contaminants. Since mosquito and vector control activities are widely dispersed across a broad geographic area, no violation of CAAQS for CO would occur. Based on estimated peak daily emissions for each criteria pollutant and geographic dispersion, the Surveillance Alternative would not be the sole cause of a violation of either NAAQS or CAAQS.

Impact AQ-2: Based on estimated daily emissions for each criteria pollutant, the Surveillance Alternative would not violate an ambient air quality standard. Impacts would be **less than significant** and no mitigation is required.

Result in a net increase of any criteria pollutant for which the project region is nonattainment under an applicable federal or state ambient air quality standard (including releasing emissions, which exceed quantitative thresholds for ozone precursors)?

As discussed in Section 10.1.6, the focus of this assessment is on regulated criteria pollutants for which the local air basin is in nonattainment. Nonattainment pollutants include O_3 precursors NO_X and VOCs, PM_{10}, and $PM_{2.5}$. Estimated peak daily emissions of each of these pollutants from all alternatives combined are shown in Table 10-13 and are less than the daily thresholds shown in Table 10-3. Annual thresholds do not apply to estimated emissions shown in Table 10-7 because mosquito and vector control activities do not comprise a stationary source of air contaminants. Based on estimated peak daily emissions for each criteria pollutant and geographic dispersion, the Surveillance Alternative would not result in a cumulatively considerable increase of nonattainment pollutants.

Impact AQ-3: Based on estimated daily emissions for each criteria pollutant, the Surveillance Alternative would not result in a cumulatively considerable increase of nonattainment pollutants. Impacts would be **less than significant** and no mitigation is required.

Expose sensitive receptors to substantial pollutant concentrations?

The Surveillance Alternative has the potential to emit regulated criteria pollutants, including O_3 precursors NO_X and VOCs, CO, SO_2, PM_{10}, and $PM_{2.5}$. Estimated peak daily emissions of each of these pollutants from all alternatives combined are shown in Table 10-13 and are less than the daily thresholds shown in Table 10-3. Annual thresholds do not apply to estimated emissions shown in Table 10-7 because mosquito and vector control activities do not comprise a stationary source of air contaminants. Since mosquito and vector control activities use relatively small amounts of diesel fuel (most equipment and vehicles are gasoline-powered), potential DPM emissions would be small, transient in nature, and dispersed over a wide geographic area. Thus, no significant risk to sensitive receptors would occur from DPM emissions (as PM_{10}). Based on estimated peak daily emissions for each criteria pollutant, the Surveillance Alternative would not be the sole cause of a violation of either NAAQS or CAAQS.

Impact AQ-4: Based on the estimated daily emissions for each criteria pollutant, the Surveillance Alternative would not expose sensitive receptors to substantial pollutant concentrations. Impacts would be **less than significant** and no mitigation is required.

Create objectionable odors affecting a substantial number of people?

Certain VOCs, sulfur compounds, and chlorine compounds found in some pesticides such as OPs and, fumigants emit characteristic odors when they evaporate (volatilize) into air, even at very low concentrations well within safety limits. The human sense of smell (olfactory system) is sensitive to these types of compounds as a warning mechanism, and some individuals are more sensitive than others. The Surveillance Alternative would not apply these types of odorous treatments, because it involves mostly field sampling and trapping activities. Thus, people would not be affected by objectionable odors.

Impact AQ-5: The Surveillance Alternative would not subject people to objectionable odors. **No impact** would occur**.**

10.2.4 Physical Control Alternative

The Physical Control Alternative would be a continuation of existing activities the District currently practices using applicable techniques, equipment, vehicles, and watercraft. This alternative involves managing vector habitat using source control and permanent control methods that do not use biological agents or chemical pesticides, such as ditch maintenance, debris removal in natural channels, and blockage of access points. The environmental impact concerns are phrased as questions as follows for the Physical Control Alternative.

Conflict with or obstruct implementation of the applicable Air Quality Attainment Plan or Congestion Management Plan?

The emission source categories associated with the Physical Control Alternative include small equipment, portable equipment, offroad vehicles, onroad vehicles, and watercraft, all of which are mobile sources of nonattainment pollutants NO_X, VOCs, PM_{10}, and $PM_{2.5}$. As discussed in Section 10.1.6, these types of emission sources are included in the SIP emission inventory, required to meet CARB and USEPA nonroad and onroad emission standards applicable on the date of manufacture, and subject to PERP and ATCM as applicable. Taken together, these conditions establish that the Physical Control Alternative would not conflict with applicable air quality attainment plans.

> **Impact AQ-6:** Based on the general inclusion of Physical Control Alternative emissions in the SIP emission inventory and the compliance with applicable air regulations, the Physical Control Alternative would not conflict with applicable air quality plans. Impacts would be **less than significant** and no mitigation is required.

Violate any stationary source air quality standard or contribute to an existing or projected air quality violation?

The Physical Control Alternative has the potential to emit regulated criteria pollutants, including O_3 precursors NO_X and VOCs, CO, SO_2, PM_{10}, and $PM_{2.5}$. Estimated peak daily emissions of each of these pollutants from all alternatives combined in the District are shown in Table 10-13 and are less than the daily thresholds shown in Table 10-3. Annual thresholds do not apply to estimated emissions shown in Table 10-8 because mosquito and vector control activities do not comprise a stationary source of air contaminants. Since mosquito and vector control activities are widely dispersed across a broad geographic area, no violation of CAAQS for CO would occur. Based on estimated peak daily emissions for each criteria pollutant and geographic dispersion, the Physical Control Alternative would not be the sole cause of a violation of either NAAQS or CAAQS.

> **Impact AQ-7:** Based on estimated daily emissions for each criteria pollutant, the Physical Control Alternative would not violate an ambient air quality standard. Impacts would be **less than significant** and no mitigation is required.

Result in a net increase of any criteria pollutant for which the project region is nonattainment under an applicable federal or state ambient air quality standard (including releasing emissions, which exceed quantitative thresholds for ozone precursors)?

As discussed in Section 10.1.6, the focus of this assessment is on regulated criteria pollutants for which the local air basin is in nonattainment. Nonattainment pollutants include O_3 precursors NO_X and VOCs, PM_{10}, and $PM_{2.5}$. Estimated peak daily emissions of each of these pollutants from all alternatives combined in the District are shown in Table 10-13 and are less than the daily thresholds shown in Table 10-3. Annual thresholds do not apply to estimated emissions shown in Table 10-8 because mosquito and vector control activities do not comprise a stationary source of air contaminants. Based on estimated peak daily emissions for each criteria pollutant and geographic dispersion, the Physical Control Alternative would not result in a cumulatively considerable increase of nonattainment pollutants.

Impact AQ-8: Based on estimated daily emissions for each criteria pollutant, the Physical Control Alternative would not result in a cumulatively considerable increase of nonattainment pollutants. Impacts would be **less than significant** and no mitigation is required.

Expose sensitive receptors to substantial pollutant concentrations?

The Physical Control Alternative has the potential to emit regulated criteria pollutants, including O_3 precursors NO_X and VOCs, CO, SO_2, PM_{10}, and $PM_{2.5}$. Estimated peak daily emissions of each of these pollutants from all alternatives in the District are shown in Table 10-13 and are less than the daily thresholds shown in Table 10-3. Annual thresholds do not apply to estimated emissions shown in Table 10-8 because mosquito and vector control activities do not comprise a stationary source of air contaminants. Since mosquito and vector control activities use relatively small amounts of diesel fuel (most equipment and vehicles are gasoline-powered), potential DPM emissions would be small, transient in nature, and dispersed over a wide geographic area. Thus, no significant risk to sensitive receptors would occur from DPM emissions (as PM_{10}). Based on estimated peak daily emissions for each criteria pollutant, the Physical Control Alternative would not be the sole cause of a violation of either NAAQS or CAAQS.

Impact AQ-9: Based on the estimated daily emissions for each criteria pollutant, the Physical Control Alternative would not expose sensitive receptors to substantial pollutant concentrations. Impacts would be **less than significant** and no mitigation is required.

Create objectionable odors affecting a substantial number of people?

Certain VOCs, sulfur compounds, and chlorine compounds found in some pesticides such as OPs and fumigants emit characteristic odors when they evaporate (volatilize) into air, even at very low concentrations well within safety limits. The human sense of smell (olfactory system) is sensitive to these types of compounds as a warning mechanism, and some individuals are more sensitive than others. The Physical Control Alternative would not apply these types of odorous chemical treatments. Thus, people would not be affected by objectionable odors.

Impact AQ-10: The Physical Control Alternative would not subject people to objectionable odors. **No impact** would occur.

10.2.5 Vegetation Management Alternative

The Vegetation Management Alternative would be a continuation of existing activities the District currently practices using applicable techniques, equipment, vehicles, and watercraft. Vegetation management is used to reduce the habitat value for mosquitoes. The District may use hand tools and may at times use heavy equipment to remove vegetation primarily in aquatic habitats. The District may also consider the application of herbicides to remove vegetation. The environmental impact concerns are phrased as questions as follows for the Vegetation Management Alternative:

Conflict with or obstruct implementation of the applicable Air Quality Attainment Plan or Congestion Management Plan?

The emission source categories associated with the Vegetation Management Alternative include small equipment, portable equipment, offroad vehicles, onroad vehicles, and watercraft, all of which are mobile sources of nonattainment pollutants NO_X, VOCs, PM_{10}, and $PM_{2.5}$. As discussed in Section 10.1.6, these types of emission sources are included in the SIP emission inventory, required to meet CARB and USEPA nonroad and onroad emission standards applicable on the date of manufacture, and subject to PERP and ATCM as applicable. Taken together, these conditions establish that the Vegetation Management Alternative would not conflict with applicable air quality attainment plans.

Impact AQ-11: Based on the general inclusion of Vegetation Management Alternative emissions in the SIP emission inventory and the compliance with applicable air regulations, the Vegetation Management would not conflict with applicable air quality plans. Impacts would be **less than significant** and no mitigation is required.

Violate any stationary source air quality standard or contribute to an existing or projected air quality violation?

The Vegetation Management Alternative has the potential to emit regulated criteria pollutants, including O_3 precursors NO_X and VOCs, CO, SO_2, PM_{10}, and $PM_{2.5}$. Estimated peak daily emissions of each of these pollutants from all alternatives combined in the District are shown in Table 10-13 and are less than the daily thresholds shown in Table 10-3. Annual thresholds do not apply to estimated emissions shown in Tables 10-9 and 10-13 because mosquito and vector control activities do not comprise a stationary source of air contaminants. Since mosquito and vector control activities are widely dispersed across a broad geographic area, no violation of CAAQS for CO would occur. Based on estimated peak daily emissions for each criteria pollutant and geographic dispersion, the Vegetation Management Alternative would not be the sole cause of a violation of either NAAQS or CAAQS.

Impact AQ-12: Based on estimated daily emissions for each criteria pollutant, the Vegetation Management Alternative would not violate an ambient air quality standard. Impacts would be **less than significant** and no mitigation is required.

Result in a net increase of any criteria pollutant for which the project region is nonattainment under an applicable federal or state ambient air quality standard (including releasing emissions, which exceed quantitative thresholds for ozone precursors)?

As discussed in Section 10.1.6, the focus of this assessment is on regulated criteria pollutants for which the local air basin is in nonattainment. Nonattainment pollutants include O_3 precursors NO_X and VOCs, PM_{10}, and $PM_{2.5}$. Estimated peak daily emissions of each of these pollutants from all alternatives combined in the District are shown in Table 10-13 and are less than the daily thresholds shown in Table 10-3. Annual thresholds do not apply to estimated emissions shown in Table 10-9 because mosquito and vector control activities do not comprise a stationary source of air contaminants. Based on estimated peak daily emissions for each criteria pollutant and geographic dispersion, the Vegetation Management Alternative would not result in a cumulatively considerable increase of nonattainment pollutants.

Impact AQ-13: Based on estimated daily emissions for each criteria pollutant, the Vegetation Management Alternative would not result in a cumulatively considerable increase of nonattainment pollutants. Impacts would be **less than significant** and no mitigation is required.

Expose sensitive receptors to substantial pollutant concentrations?

The Vegetation Management Alternative has the potential to emit regulated criteria pollutants, including O_3 precursors NO_X and VOCs, CO, SO_2, PM_{10}, and $PM_{2.5}$. Estimated peak daily emissions of each of these pollutants from all alternatives combined in the District are shown in Table 10-13 and are less than the daily thresholds shown in Table 10-3. Annual thresholds do not apply to estimated emissions shown in Table 10-8 because mosquito and vector control activities do not comprise a stationary source of air contaminants. Since mosquito and vector control activities use relatively small amounts of diesel fuel (most equipment and vehicles are gasoline-powered), potential DPM emissions would be small, transient in nature, and dispersed over a wide geographic area. Thus, no significant risk to sensitive receptors would occur from DPM emissions (as PM_{10}). Based on estimated peak daily emissions for each criteria pollutant, the Vegetation Management Alternative would not be the sole cause of a violation of either NAAQS or CAAQS.

Impact AQ-14: Based on the estimated daily emissions for each criteria pollutant, the Vegetation Management Alternative would not expose sensitive receptors to substantial pollutant concentrations. Impacts would be **less than significant** and no mitigation is required.

Create objectionable odors affecting a substantial number of people?

Certain VOCs, sulfur compounds, and chlorine compounds found in some pesticides such as OPs and fumigants emit characteristic odors when they evaporate (volatilize) into air, even at very low concentrations well within safety limits. The human sense of smell (olfactory system) is sensitive to these types of compounds as a warning mechanism, and some individuals are more sensitive than others. The Vegetation Management Alternative would not apply these types of odorous treatments; the herbicides used would not be odorous as well. Thus, people would not be affected by objectionable odors.

Impact AQ-15: The Vegetation Management Alternative would not subject people to objectionable odors. **No impact** would occur.

10.2.6 Biological Control Alternative

The Biological Control Alternative would be a continuation of existing activities the District currently practices using applicable techniques, equipment, vehicles, watercraft, and aircraft. It involves the use of mosquito predators, i.e., mosquitofish (*Gambusia affinis*). The environmental impact concerns are phrased as questions as follows for the Biological Control Alternative:

Conflict with or obstruct implementation of the applicable Air Quality Attainment Plan or Congestion Management Plan?

The emission source categories associated with the Biological Control Alternative include small equipment, portable equipment, offroad vehicles, onroad vehicles, watercraft, and aircraft, all of which are mobile sources of nonattainment pollutants NO_X, VOCs, PM_{10}, and $PM_{2.5}$. As discussed in Section 10.1.6, these types of emission sources are included in the SIP emission inventory, required to meet CARB and USEPA nonroad and onroad emission standards applicable on the date of manufacture, and subject to PERP and ATCM as applicable. Taken together, these conditions establish that the Biological Control Alternative would not conflict with applicable air quality attainment plans.

Impact AQ-16: Based on the general inclusion of Biological Control Alternative emissions in the SIP emission inventory and the compliance with applicable air regulations, the Biological Control Alternative would not conflict with applicable air quality plans. Impacts would be **less than significant** and no mitigation is required.

Violate any stationary source air quality standard or contribute to an existing or projected air quality violation?

The Biological Control Alternative has the potential to emit regulated criteria pollutants, including O_3 precursors NO_X and VOCs, CO, SO_2, PM_{10}, and $PM_{2.5}$. Estimated peak daily emissions of each of these pollutants from all alternatives combined in the District are shown in Table 10-13 and are less than the daily thresholds shown in Table 10-3. Annual thresholds do not apply to estimated emissions shown in Table 10-10 because mosquito and vector control activities do not comprise a stationary source of air contaminants. Since mosquito and vector control activities are widely dispersed across a broad geographic area, no violation of CAAQS for CO would occur. Based on estimated peak daily emissions for each criteria pollutant and geographic dispersion, the Biological Control Alternative would not be the sole cause of a violation of either NAAQS or CAAQS.

Impact AQ-17: Based on estimated daily emissions for each criteria pollutant, the Biological Control Alternative would not violate an ambient air quality standard. Impacts would be **less than significant** and no mitigation is required.

Result in a net increase of any criteria pollutant for which the project region is nonattainment under an applicable federal or state ambient air quality standard (including releasing emissions, which exceed quantitative thresholds for ozone precursors)?

As discussed in Section 10.1.6, the focus of this assessment is on regulated criteria pollutants for which the local air basin is in nonattainment. Nonattainment pollutants include O_3 precursors NO_X and VOCs, PM_{10}, and $PM_{2.5}$. Estimated peak daily emissions of each of these pollutants from all alternatives combined in the District are shown in Table 10-13 and are less than the daily thresholds shown in Table 10-3. Annual thresholds do not apply to estimated emissions shown in Table 10-10 because mosquito and vector control activities do not comprise a stationary source of air contaminants. Based on estimated peak daily emissions for each criteria pollutant and geographic dispersion, the Biological Control Alternative would not result in a cumulatively considerable increase of nonattainment pollutants.

> **Impact AQ-18:** Based on estimated daily emissions for each criteria pollutant, the Biological Control Alternative would not result in a cumulatively considerable increase of nonattainment pollutants. Impacts would be **less than significant** and no mitigation is required.

Expose sensitive receptors to substantial pollutant concentrations?

The Biological Control Alternative has the potential to emit regulated criteria pollutants, including O_3 precursors NO_X and VOCs, CO, SO_2, PM_{10}, and $PM_{2.5}$. Estimated peak daily emissions of each of these pollutants from all alternatives combined in the District are shown in Table 10-13 and are less than the daily thresholds shown in Table 10-3. Annual thresholds do not apply to estimated emissions shown in Table 10-10 because mosquito and vector control activities do not comprise a stationary source of air contaminants. Since mosquito and vector control activities use relatively small amounts of diesel fuel (most equipment and vehicles are gasoline-powered), potential DPM emissions would be small, transient in nature, and dispersed over a wide geographic area. Thus, no significant risk to sensitive receptors would occur from DPM emissions (as PM_{10}). Based on estimated peak daily emissions for each criteria pollutant, the Biological Control Alternative would not be the sole cause of a violation of either NAAQS or CAAQS.

> **Impact AQ-19:** Based on the estimated daily emissions for each criteria pollutant, the Biological Control Alternative would not expose sensitive receptors to substantial pollutant concentrations. Impacts would be **less than significant** and no mitigation is required.

Create objectionable odors affecting a substantial number of people?

Certain VOCs, sulfur compounds, and chlorine compounds found in some pesticides such as OPs, and fumigants emit characteristic odors when they evaporate (volatilize) into air, even at very low concentrations well within safety limits. The human sense of smell (olfactory system) is sensitive to these types of compounds as a warning mechanism, and some individuals are more sensitive than others. The Biological Control Alternative would not apply these types of odorous treatments. Thus, people would not be subjected to objectionable odors.

> **Impact AQ-20:** The Biological Control Alternative would not subject people to objectionable odors. **No impact** would occur.

10.2.7 <u>Chemical Control Alternative</u>

The Chemical Control Alternative would be a continuation of existing activities the District currently practices using applicable techniques, equipment, vehicles, watercraft, and aircraft. It involves the application of insecticides to reduce populations of mosquitoes. The environmental impact concerns are phrased as questions as follows for the Chemical Control Alternative:

Conflict with or obstruct implementation of the applicable Air Quality Attainment Plan or Congestion Management Plan?

The emission source categories associated with the Chemical Control Alternative include small equipment, portable equipment, offroad vehicles, onroad vehicles, watercraft, and aircraft all of which are mobile sources of nonattainment pollutants NO_X, VOCs, PM_{10}, and $PM_{2.5}$. As discussed in Section 10.1.6, these types of emission sources are included in the SIP emission inventory, required to meet CARB and USEPA nonroad and onroad emission standards applicable on the date of manufacture, and subject to PERP and ATCM as applicable. Taken together, these conditions establish that the Chemical Control Alternative would not conflict with applicable air quality attainment plans.

> **Impact AQ-21:** Based on the general inclusion of Chemical Control Alternative emissions in the SIP emission inventory and the compliance with applicable air regulations, the Chemical Control Alternative would not conflict with applicable air quality plans. Impacts would be **less than significant** and no mitigation is required.

Violate any stationary source air quality standard or contribute to an existing or projected air quality violation?

The Chemical Control Alternative has the potential to emit regulated criteria pollutants, including O_3 precursors NO_X and VOCs, CO, SO_2, PM_{10}, and $PM_{2.5}$. Estimated peak daily emissions of each of these pollutants from all alternatives combined in the District are shown in Table 10-13 and are less than the daily thresholds shown in Table 10-3. Annual thresholds do not apply to estimated emissions shown in Table 10-11 because mosquito and vector control activities do not comprise a stationary source of air contaminants. Since mosquito and vector control activities are widely dispersed across a broad geographic area, no violation of CAAQS for CO would occur. Based on estimated peak daily emissions for each criteria pollutant and geographic dispersion, the Chemical Control Alternative would not be the sole cause of a violation of either NAAQS or CAAQS.

> **Impact AQ-22:** Based on estimated daily emissions for each criteria pollutant, the Chemical Control Alternative would not violate an ambient air quality standard. Impacts would be **less than significant** and no mitigation is required.

Result in a net increase of any criteria pollutant for which the project region is nonattainment under an applicable NAAQS or CAAQS (including releasing emissions, which exceed quantitative thresholds for O_3 precursors)?

As discussed in Section 10.1.6, the focus of this assessment is on regulated criteria pollutants for which the local air basin is in nonattainment. Nonattainment pollutants include O_3 precursors NO_X and VOCs, PM_{10}, and $PM_{2.5}$. Estimated peak daily emissions of each of these pollutants from all alternatives combined in the District are shown in Table 10-13 and are less than the daily thresholds shown in Table 10-3. Annual thresholds do not apply to estimated emissions shown in Table 10-11 because mosquito and vector control activities do not comprise a stationary source of air contaminants. Based on estimated peak daily emissions for each criteria pollutant and geographic dispersion, the Chemical Control Alternative would not result in a cumulatively considerable increase of nonattainment pollutants.

> **Impact AQ-23:** Based on estimated daily emissions for each criteria pollutant, the Chemical Control Alternative would not result in a cumulatively considerable increase of nonattainment pollutants**.** Impacts would be **less than significant** and no mitigation is required.

Expose sensitive receptors to substantial pollutant concentrations?

The Chemical Control Alternative has the potential to emit regulated criteria pollutants, including O_3 precursors NO_X and VOCs, CO, SO_2, PM_{10}, and $PM_{2.5}$. Estimated peak daily emissions of each of these pollutants from all alternatives combined in the District are shown in Table 10-13 and are less than the daily thresholds shown in Table 10-3. Annual thresholds do not apply to estimated emissions shown in

Table 10-11 because mosquito and vector control activities do not comprise a stationary source of air contaminants. Since mosquito and vector control activities use relatively small amounts of diesel fuel (most equipment and vehicles are gasoline-powered), potential DPM emissions would be small, transient in nature, and dispersed over a wide geographic area. Thus, no significant risk to sensitive receptors would occur from DPM emissions (as PM_{10}). Based on estimated peak daily emissions for each criteria pollutant, the Chemical Control Alternative would not be the sole cause of a violation of either NAAQS or CAAQS.

Impact AQ-24: Based on the estimated daily emissions for each criteria pollutant, the Chemical Control Alternative would not expose sensitive receptors to substantial pollutant concentrations**.** Impacts would be **less than significant** and no mitigation is required.

Create objectionable odors affecting a substantial number of people?

Certain VOCs, sulfur compounds, and chlorine compounds found in some pesticides such as Ops and, fumigants emit characteristic odors when they evaporate (volatilize) into air, even at very low concentrations well within safety limits. Pesticides currently used or proposed for future use emit phenols (e.g., etofenprox, permethrin, or resmethrin). Due to limited applicability, small quantities of these types of substances are typically used.

The human sense of smell (olfactory system) is sensitive to these types of compounds as a warning mechanism, and some individuals are more sensitive than others. The Chemical Control Alternative would apply certain types of odorous treatments using hydraulic spraying and atomizing (fogging), which could result in drift of small droplets and gaseous vapors. Depending on atmospheric conditions (i.e., wind direction, wind speed, stability class), this drift could subject people to objectionable odors near a treatment area. Without site-specific information, it cannot be determined whether an objectionable odor may persist downwind of a particular treatment area; therefore, an application containing an odorous compound may impact an undefined number people for an undefined period of time. The materials have been used in the current Program, and people have not complained about odors. However, it is possible that complaints could occur in the future.

Impact AQ-25: The Chemical Control Alternative could subject people to objectionable odors. Impacts could be **potentially significant but mitigable.**

To mitigate Impact AQ-25, the District and its contractors may implement any of the following measures as applicable to the specific application situation to reduce drift towards human populations/residences from the ground and aerial applications of odorous treatment compounds:

<u>Mitigation Measure AQ-25a:</u> Maintain appropriate buffer zones between spray areas and sensitive receptor locations whenever possible and practicable for the application of the treatment compounds, especially true for aerial applications.

<u>Mitigation Measure AQ-25b:</u> Whenever possible and practicable, defer application of treatment compounds until such time that favorable wind conditions would reduce or avoid the risk of drift into populated areas.

<u>Mitigation Measure AQ-25c:</u> Use global positioning system (GPS) dataloggers that document site-specific compliance with all label requirements for drift mitigation.

Mitigation Measure AQ-25d: Use precision application technology to reduce drift and the total amount of material applied. This measure can include (1) Precision guidance systems that minimize ground or aerial spray overlap (e.g., GPS and Real Time Kinetics – GPS/RTK) and (2) Computer-guided application systems that integrate real-time meteorological data and computer model guidance to reduce drift from aerial application (e.g., trade names "AIMMS," "Wingman™ GX," and "NextStar™ Flow Control").

Use of any one of these measures would reduce the impact to **less than significant**.

10.2.8 Cumulative Impacts

Cumulative impacts to regional air quality are discussed in Section 13.8. The majority of air districts in California, including BAAQMD, YSAQMD, and NSCAPCD, assume that if project-level emissions do not exceed significance thresholds, and no closely related project exists, then a project would not have a cumulatively considerable impact on air quality. In the YSAQMD, a project that individually exceeds the significance thresholds (refer to Table 10-4 above) would also be considered to have a significant cumulative impact. In addition, CO impacts are cumulatively significant when modeling shows that the combined emissions from the project and other existing and planned projects (i.e., background concentration) will exceed air quality standards (YSAQMD 2007). All of the Program alternative emissions (separately and combined for the District's entire Program) would be below the significance thresholds for criteria pollutant emissions. In summary, **the incremental impacts on air quality from the Program alternatives are not individually significant nor are they cumulatively considerable.** Therefore, cumulative impacts to regional air quality are less than significant.

10.2.9 Environmental Impacts Summary

Table 10-14 presents a summary of air quality impacts associated with the five alternatives in comparison to existing emissions inventories and conditions. The air quality impact callouts correspond to those in Sections 10.2.3 through 10.2.7.

Table 10-15 Summary of Air Quality Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Effects on Air Quality					
Impact AQ-1: Based on the general inclusion of Surveillance Alternative emissions in the SIP emission inventory and the compliance with applicable air regulations, the Surveillance Alternative would not conflict with applicable air quality plans. Impacts would be **less than significant** and no mitigation is required**.**	LS	na	na	na	na
Impact AQ-2: Based on estimated daily emissions for each criteria pollutant, the Surveillance Alternative would not violate an ambient air quality standard. Impacts would be **less than significant** and no mitigation is required.	LS	na	na	na	na
Impact AQ-3: Based on estimated daily emissions for each criteria pollutant, the Surveillance Alternative would not result in a cumulatively considerable increase of nonattainment pollutants. Impacts would be **less than significant** and no mitigation is required.	LS	na	na	na	na
Impact AQ-4: Based on the estimated daily emissions for each criteria pollutant, the Surveillance Alternative would not expose sensitive receptors to substantial pollutant concentrations. Impacts would be **less than significant** and no mitigation is required.	LS	na	na	na	na
Impact AQ-5: The Surveillance Alternative would not subject people to objectionable odors. **No impact** would occur.	N	na	na	na	na
Impact AQ-6: Based on the general inclusion of Physical Control Alternative emissions in the SIP emission inventory and the compliance with applicable air regulations, the Physical Control Alternative would not conflict with applicable air quality plans. Impacts would be **less than significant** and no mitigation is required.	na	LS	na	na	na
Impact AQ-7: Based on estimated daily emissions for each criteria pollutant, the Physical Control Alternative would not violate an ambient air quality standard. Impacts would be **less than significant** and no mitigation is required.	na	LS	na	na	na

Table 10-15 Summary of Air Quality Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact AQ-8: Based on estimated daily emissions for each criteria pollutant, the Physical Control Alternative would not result in a cumulatively considerable increase of nonattainment pollutants. Impacts would be **less than significant** and no mitigation is required.	na	LS	na	na	na
Impact AQ-9: Based on the estimated daily emissions for each criteria pollutant, the Physical Control Alternative would not expose sensitive receptors to substantial pollutant concentrations. Impacts would be **less than significant** and no mitigation is required.	na	LS	na	na	na
Impact AQ-10: The Physical Control Alternative would not subject people to objectionable odors. **No impact** would occur.	na	N	na	na	na
Impact AQ-11: Based on the general inclusion of Vegetation Management Alternative emissions in the SIP emission inventory and the compliance with applicable air regulations, the Vegetation Management would not conflict with applicable air quality plans. Impacts would be **less than significant** and no mitigation is required.	na	na	LS	na	na
Impact AQ-12: Based on estimated daily emissions for each criteria pollutant, the Vegetation Management Alternative would not violate an ambient air quality standard. Impacts would be **less than significant** and no mitigation is required.	na	na	LS	na	na
Impact AQ-13: Based on estimated daily emissions for each criteria pollutant, the Vegetation Management Alternative would not result in a cumulatively considerable increase of nonattainment pollutants. Impacts would be **less than significant** and no mitigation is required.	na	na	LS	na	na
Impact AQ-14: Based on the estimated daily emissions for each criteria pollutant, the Vegetation Management Alternative would not expose sensitive receptors to substantial pollutant concentrations. Impacts would be **less than significant** and no mitigation is required.	na	na	LS	na	na
Impact AQ-15: The Vegetation Management Alternative would not subject people to objectionable odors. **No impact** would occur.	na	na	N	na	na

Table 10-15 Summary of Air Quality Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact AQ-16: Based on the general inclusion of Biological Control Alternative emissions in the SIP emission inventory and the compliance with applicable air regulations, the Biological Control Alternative would not conflict with applicable air quality plans. Impacts would be **less than significant** and no mitigation is required.	na	na	na	LS	na
Impact AQ-17: Based on estimated daily emissions for each criteria pollutant, the Biological Control Alternative would not violate an ambient air quality standard. Impacts would be **less than significant** and no mitigation is required.	na	na	na	LS	na
Impact AQ-18: Based on estimated daily emissions for each criteria pollutant, the Biological Control Alternative would not result in a cumulatively considerable increase of nonattainment pollutants**.** Impacts would be **less than significant** and no mitigation is required.	na	na	na	LS	na
Impact AQ-19: Based on the estimated daily emissions for each criteria pollutant, the Biological Control Alternative would not expose sensitive receptors to substantial pollutant concentrations. Impacts would be **less than significant** and no mitigation is required.	na	na	na	LS	na
Impact AQ-20: The Biological Control Alternative would not subject people to objectionable odors. **No impact** would occur.	na	na	na	N	na
Impact AQ-21: Based on the general inclusion of Chemical Control Alternative emissions in the SIP emission inventory and the compliance with applicable air regulations, the Chemical Control Alternative would not conflict with applicable air quality plans. Impacts would be **less than significant** and no mitigation is required.	na	na	na	na	LS
Impact AQ-22: Based on estimated daily emissions for each criteria pollutant, the Chemical Control Alternative would not violate an ambient air quality standard. Impacts would be **less than significant** and no mitigation is required.	na	na	na	na	LS

Table 10-15 Summary of Air Quality Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact AQ-23: Based on estimated daily emissions for each criteria pollutant, the Chemical Control Alternative would not result in a cumulatively considerable increase of nonattainment pollutants**.** Impacts would be **less than significant** and no mitigation is required.	na	na	na	na	LS
Impact AQ-24: Based on the estimated daily emissions for each criteria pollutant, the Chemical Control Alternative would not expose sensitive receptors to substantial pollutant concentrations**.** Impacts would be **less than significant** and no mitigation is required.	na	na	na	na	LS
Impact AQ-25: The Chemical Control Alternative could subject people to objectionable odors. Impacts could be **potentially significant but mitigable.**	na	na	na	na	SM

Sources: BAAQMD 1999; Hare and Springer 1973; CARB 2008a; USEPA 1991b, 2011a, 2011b, 2012c

LS = Less-than-significant impact

N = No impact

na = Not applicable

SM = Potentially significant but mitigable impact

SU = Significant and unavoidable impact

10.2.10 Mitigation and Monitoring

Except for potential odor impacts under the Chemical Control Alternative (Impact AQ-25), all other impacts are either less than significant (LS) or no impact (N) and require no mitigation.

To mitigate Impact AQ-25, the District and its contractors may implement any of the following measures as applicable to reduce drift from the ground and aerial application of treatment compounds:

Mitigation Measure AQ-25a: Maintain appropriate buffer zones between spray areas and sensitive receptor locations when possible for the application of the treatment compounds, especially true for aerial applications.

- Location: Areas to receive treatment with pesticides that are near residential and commercial land uses
- Monitoring/Reporting Action: District staff to check current land use maps or aerial photos prior to treatments
- Effectiveness Criteria: Document odor complaints from the public
- Responsible Agency: District
- Timing: Prior to chemical treatments

Mitigation Measure AQ-25b: When possible, defer application of treatment compounds until such time that favorable wind conditions would reduce or avoid the risk of drift into populated areas.

- Location: Areas to receive treatment with pesticides that are near residential and commercial land uses
- Monitoring/Reporting Action: District staff to check current land use maps or aerial photos prior to treatments
- Effectiveness Criteria: Document odor complaints from the public
- Responsible Agency: District
- Timing: Prior to chemical treatments

Mitigation Measure AQ-25c: Use GPS dataloggers that document site-specific compliance with all label requirements for drift mitigation.

- Location: Areas to receive treatment with pesticides that are near residential and commercial land uses
- Monitoring/Reporting Action: District staff to check current land use maps or aerial photos prior to treatments
- Effectiveness Criteria: Document odor complaints from the public
- Responsible Agency: District
- Timing: Prior to chemical treatments

Mitigation Measure AQ-25d: Use precision application technology to reduce drift and the total amount of material applied. This measure can include (1) precision guidance systems that minimize ground or aerial spray overlap (e.g., GPS and Real Time Kinetics – GPS/RTK), and (2) computer-guided application systems that integrate real-time meteorological data and computer model guidance to reduce drift from aerial application (e.g., trade names "AIMMS," "Wingman™ GX," and "NextStar™ Flow Control").

- Location: Areas to receive treatment with pesticides that are near residential and commercial land uses
- Monitoring/Reporting Action: District staff to check current land use maps or aerial photos prior to treatments
- Effectiveness Criteria: Document odor complaints from the public
- Responsible Agency: District
- Timing: Prior to chemical treatments

11 Greenhouse Gases and Climate Change

This chapter provides an overview of the environmental setting for greenhouse gases (GHGs) and climate change, based on Appendix C. The American Meteorological Society refers to climate change as any systematic change in the long-term statistics of climate elements (such as temperature, pressure, or winds) sustained over several decades or longer. The Society also indicates that climate change may be due to natural external forcings, such as changes in solar emission or slow changes in the Earth's orbital elements; natural internal processes of the climate system; or anthropogenic forcing (AMS 2012). The climate system can be influenced by changes in the concentration of various GHGs in the atmosphere that affect the Earth's absorption of radiation. This chapter concludes with an evaluation of the Proposed Program's contribution to GHG emissions.

11.1 Environmental Setting

11.1.1 Global Climate Change

Climate change refers to any measurable alteration of climate lasting for an extended period of time – several decades or longer – and includes recordable changes in temperature, precipitation, or wind patterns. The average temperature of the Earth has increased about 0.7 to 1.5°F (0.4 to 0.8°C) over the past century, and is projected to rise another 2 to 11.5°F (1.1 to 6.4°C) over the next 100 years (IPCC 2001; USEPA 2012d). Seemingly, small changes in the average temperature of the planet can translate to large and potentially hazardous shifts in climate and weather. Climate change is suspected as the cause of changes in rainfall amounts and distribution that can result in flooding, droughts, or more frequent and severe heat waves. Also, oceans are warming and becoming more acidic, polar ice caps are melting, glaciers are receding, and sea levels are rising due to thermal expansion and ice loss. Long-term studies indicate that ocean surface temperatures have been rising at an average rate of 0.13°F (0.07°C) per decade and since 1901, average sea level has increased by about 8 inches (20 centimeters) during the same period, and average pH has decreased (acidified) by about 0.05 pH units since the mid-1980s. Late summer Arctic Ocean sea ice coverage has decreased by half since 1979, and glaciers have receded and lost significant mass since the 1970s (USEPA 2012d). As climate change progresses in the coming decades, it will likely present challenges to society and the environment.

11.1.1.1 Local Climate

The Program Area climate is characterized by moderately wet winters and dry summers. For the region including SCMAD, about 90 percent of the annual total rainfall is received in the November through April period. Between June and September, normal rainfall is typically less than 0.6 inch (1.5 centimeters). Temperatures in the Program Area average about 60°F (15°C) annually, with average summer highs in the 70 to 80°F (21 to 27°C) range and average winter lows in the 40 to 50°F (4 to 10°C) range. Precipitation averages about 23 inches (58 centimeters) per year, although annual precipitation can vary significantly from year to year. Annual average wind speeds in the Program Area are about 8 miles per hour (3.6 meters per second). The predominant direction of air pollution transport in the Program Area is inland from the coastal areas (BAAQMD 2010a; World Climate 2012; NOAA 2008).

11.1.2 The Greenhouse Effect

Over the past century, human activities have released large amounts of carbon dioxide (CO_2) and other GHGs into the atmosphere. The majority of GHGs are the by-product of burning fossil fuels to release energy in the form of heat, although deforestation, industrial processes, and some agricultural practices also emit GHGs into the atmosphere. GHGs trap solar energy in the atmosphere and cause it to warm. This phenomenon is called the greenhouse effect and is necessary to support life on Earth; however, excessive buildup of GHGs can change Earth's climate and result in undesirable effects on ecosystems, which affect human health and welfare. (USEPA 2012d)

In its *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2011* (USEPA 2012e), the USEPA provides summary information on the work of the United Nations Framework Convention on Climate Change (UNFCCC 2009) and the Intergovernmental Panel on Climate Control (IPCC 1990-2007); key information from that report is summarized below – more details may be found in the cited source documents.

The UNFCCC defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (UNFCCC 2009). In its *Second Assessment Report* of the science of climate change, the IPCC concluded "human activities are changing the atmospheric concentrations and distributions of greenhouse gases and aerosols" (IPCC 1995). These changes can produce a radiative forcing by changing either the reflection or absorption of solar radiation, or the emission and absorption of terrestrial radiation." Building on this conclusion, the IPCC *Third Assessment Report* (IPCC 2001) asserted "concentrations of atmospheric greenhouse gases and their radiative forcing have continued to increase as a result of human activities."

The IPCC reports the global average surface temperature of the Earth has increased by 1.1 ± 0.4°F (0.6 ± 0.2°C) over the 20th century. This value is about 0.27°F (0.15°C) larger than that estimated by the Second Assessment Report, which reported for the period up to 1994, "owing to the relatively high temperatures of the additional years (1995 to 2000) and improved methods of processing the data."

While the *Second Assessment Report* concluded, "the balance of evidence suggests there is a discernible human influence on global climate," the *Third Assessment Report* more directly connects the influence of human activities on climate. IPCC concluded, "In light of new evidence and taking into account the remaining uncertainties, most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations."

In its most recent *Fourth Assessment Report*, IPCC stated warming of Earth's climate is unequivocal, and that warming is very likely attributable to increases in atmospheric GHGs caused by human activities (IPCC 2007). IPCC further stated changes in many physical and biological systems, such as increases in global temperatures, more frequent heat waves, rising sea levels, coastal flooding, loss of wildlife habitat, spread of infectious disease, and other potential environmental impacts, are linked to changes in the climate system, and some changes might be irreversible.

The mobile sources used in mosquito and vector control activities emit GHGs and, therefore, contribute incrementally to climate change; however, as described in Section 11.2.2, these emissions comprise a very small fraction of the Bay Area, California, and national GHG inventories. This fact precludes any meaningful analysis of quantitative effects that mosquito and vector control operations may specifically have on climate, although taken together with regional, national, and worldwide GHG emissions, global effects are as described above.

11.1.3 Greenhouse Gases and Their Emissions

11.1.3.1 The Atmosphere

Air is a mixture of constituent gases and its composition varies slightly with location and altitude. For 20th century scientific and engineering purposes, it became necessary to define a standard composition known as the US Standard Atmosphere. In addition to the common gases (nitrogen, oxygen, CO_2, methane [CH_4], hydrogen, nitrous oxide [N_2O]), the atmosphere contains noble or inert gases (argon, neon, helium, krypton, xenon). Radon is also present in low concentrations near ground level in limited geographic areas where it is naturally emitted from certain types of rock and soil. Table 11-1 shows the typical composition of dry standard air, which is over 99 percent nitrogen and oxygen (UIG 2008; USEPA 2012e). The apparent molecular weight of dry standard air is 28.966 grams per mole (Jennings 1970; du Pont 1971).

Table 11-1 Standard Composition of Dry Air

Principal Gas	Chemical Symbol	Gas MW g/mole	Concentration ppmv	Fraction Percent	Fraction MW g/mole
Nitrogen	N_2	28.014	780,805.00	78.080500	21.873471
Oxygen	O_2	31.998	209,440.00	20.944000	6.701661
Argon	Ar	39.948	9,340.00	0.934000	0.373114
Carbon Dioxide	CO_2	44.009	387.69	0.038769	0.017062
Neon	Ne	20.183	18.21	0.001821	0.000368
Helium	He	4.003	5.24	0.000524	0.000021
Methane	CH_4	16.043	1.81	0.000181	0.000029
Krypton	Kr	83.800	1.14	0.000114	0.000096
Hydrogen	H_2	2.016	0.50	0.000050	0.000001
Nitrous Oxide	N_2O	44.013	0.32	0.000032	0.000014
Xenon	Xe	31.300	0.09	0.000009	0.000003
Totals			**1,000,000.00**	**100.000**	**28.966**

Sources: UIG 2008 ; USEPA 2012e ; du Pont 1971 ; Jennings 1970

Notes:

MW = molecular weight, g/mole

ppmv = parts per million by volume (10^{-6})

The atmosphere consists of five basic altitude zones: troposphere (sea level to 8 miles), stratosphere (8 to 32 miles), mesosphere (32 to 50 miles), thermosphere (50 to 350 miles), and exosphere (350 to 500 miles). Within the stratosphere is the ozone layer (9 to 22 miles), which absorbs ultraviolet wavelengths; and within the mesosphere is the ionosphere (62 to 190 miles), which reflects shortwave radio signals and produces auroras. These approximate altitude ranges vary with latitude, season, solar activity, and turbulence. GHGs persist mainly in the troposphere and stratosphere – some in the mesosphere – for different lengths of time, ranging from less than 5 years to over 50,000 years, long enough to become well-mixed, meaning that atmospheric concentrations are about the same all over the world, regardless of source locations (USEPA 2012f). Thus, the homogeneous composition of the lower atmosphere is the global setting for climate change.

11.1.3.2 Greenhouse Gases

Gases that trap heat in the atmosphere are called GHGs. Principal GHGs include CO_2, CH_4, N_2O, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride (SF_6), and other fluorinated gases including nitrogen trifluoride and hydrofluorinated ethers. GHGs occur naturally because of volcanoes, forest fires, and biological processes such as enteric fermentation and aerobic decomposition. They are also produced by combustion of fuels, industrial processes, agricultural operations, waste management, and land use changes such as loss of farmland to urbanization. The most common GHG from human activity (fuel combustion) is CO_2, followed by CH_4 and N_2O. (USEPA 2012f)

Concentration, or abundance, is the amount of a particular gas in the air. Larger GHG emissions lead to higher concentrations in the atmosphere. GHG concentrations are measured in units of parts per million (ppm), parts per billion (ppb), and parts per trillion (ppt). One ppm is equivalent to 1 cubic centimeter (cc) of pure gas diluted in 1 cubic meter of air. Similarly, 1 ppb is 1 cc diluted in 1,000 cubic meters, and 1 ppt is 1 cc diluted in 1,000,000 cubic meters. (USEPA 2012f)

11.1.3.2.1 Carbon Dioxide

CO_2 enters the atmosphere through burning fossil fuels (coal, natural gas, and petroleum products), decomposition of solid waste, trees and wood products, fermentation, and also as a result of certain chemical reactions, such as manufacture of cement. CO_2 is removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biologic carbon cycle. In the carbon cycle, carbon in various molecular forms is cycled among atmospheric, oceanic, land biotic, marine biotic, and mineral reservoirs. Atmospheric CO_2 is part of this global carbon cycle. CO_2 concentrations in the atmosphere have increased from about 280 ppm in preindustrial times to about 390 ppm today, a 39 percent increase. The IPCC notes that “this concentration has not been exceeded during the past 420,000 years, and likely not during the past 20 million years. The rate of increase over the past century is unprecedented, at least during the past 20,000 years.” The IPCC definitively states that “the present atmospheric CO_2 increase is caused by anthropogenic emissions of CO_2.” (USEPA 2012f; IPCC 2007)

Global Warming Potential (GWP) is a quantified measure of the globally averaged relative radiative forcing impacts of a particular GHG. It is defined as the cumulative radiative forcing both direct and indirect effects integrated over a period of time from the emission of a unit mass of gas relative to a reference gas. CO_2 is the reference gas with a GWP of unity (1). Carbon dioxide equivalents (CO_2e) are calculated by summing the products of mass GHG emissions by species times their respective USEPA official GWP coefficients. The persistence of CO_2 in the atmosphere is estimated to be in the range of 50 to 200 years, depending on variations in the carbon cycle. (USEPA 2012e,f)

11.1.3.2.2 Methane

CH_4 is primarily produced through anaerobic decomposition of organic matter in biological systems. Agricultural processes such as wetland rice cultivation, enteric fermentation in ruminant animals (e.g., cows), and the decomposition of animal wastes emit CH_4, as does the decomposition of municipal solid wastes. CH_4 is also fugitively emitted during the production and distribution of natural gas and petroleum, and is released as a by-product of coal mining and incomplete fossil fuel combustion. Pipeline-quality natural gas is over 90 percent CH_4 by volume and is considered a “clean fuel” by industry with CO_2 and water vapor as its main combustion by-products. Atmospheric concentrations of CH_4 have increased by about 160 percent since preindustrial times, although the rate of increase has been declining. The IPCC has estimated that slightly more than half of the current CH_4 flux to the atmosphere is anthropogenic, from human activities such as agriculture, fossil fuel use, and waste disposal. The USEPA’s official GWP coefficient of CH_4 is 21, and its persistence in the atmosphere is estimated to be about 9 to 15 years. (USEPA 2012e,f)

11.1.3.2.3 Nitrous Oxide

N_2O is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste. Anthropogenic sources of N_2O emissions include agricultural soils, especially the use of synthetic and manure fertilizers; fossil fuel combustion, especially from mobile combustion; adipic (nylon) and nitric acid production; wastewater treatment and waste combustion; and biomass burning. The atmospheric concentration of N_2O has increased by about 19 percent since 1750, from a preindustrial value of about 270 to about 320 ppb today, a concentration that has not been exceeded during the last thousand years. The USEPA’s official GWP coefficient of N_2O is 310, and its persistence in the atmosphere is estimated to be about 110 to 120 years. (USEPA 2012e,f)

11.1.3.2.4 Fluorinated Gases

Hydrofluorocarbons, perfluorocarbons, and SF_6 are synthetic, powerful GHGs that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for ozone-depleting substances (e.g., chlorofluorocarbons, hydrochlorofluorocarbons, and halons). In the electric utility industry, SF_6 is used as a dielectric gas in high-voltage equipment, such as switchgear and circuit breakers. As man-made gas, SF_6 in the atmosphere has increased from 0 to about 7 ppt in modern times. Due to their expense, all of these fluorinated gases are typically emitted (lost) in small quantities relative to combustion by-products, but because they are potent GHGs, they are sometimes referred to as “High GWP gases” with estimated persistence in the atmosphere ranging from 1.5 to 50,000 years. Of these, SF_6 is the most potent, with an USEPA official GWP of 23,900 and an estimated persistence of about 3,200 years. (USEPA 2012e,f)

11.1.3.3 Emission Sources

The USEPA tracks GHG emissions in the US and publishes the *Inventory of U.S. Greenhouse Gas Emissions and Sinks*, which is updated annually (USEPA 2012e). This detailed report contains estimates of the total national GHG emissions and removals associated with human activities in all 50 states. From the current report, the main sources of GHG emissions in the US are identified below (USEPA 2012f):

- Electric power generation
- Transportation
- Industry
- Commercial and residential
- Agriculture

Land Use and Forestry offsets (absorbs or sequesters) about 15 percent of GHG emissions nationwide. Land areas can act as GHG sinks (absorbing CO_2 from the atmosphere) or GHG sources. Since 1990, well-managed forests and other lands have absorbed more CO_2 from the atmosphere than they emit.

11.1.3.4 Mobile Sources

While stationary sources such as power plants and oil refineries emit large quantities of GHGs, mobile sources, due to their sheer numbers nationwide, also emit significant amounts. Mobile sources include onroad vehicles (e.g., automobiles, trucks, motorcycles), offroad equipment (e.g., earthmovers, cranes, portable pumps, and generators), trains (e.g., freight, passenger, light rail), vessels (e.g., boats, ships, watercraft), and aircraft (e.g., general aviation, commercial, military). Mobile source fuels include gasoline, diesel, heavy fuel oil (large marine vessels), and jet fuel, all of which emit GHGs when combusted.

Mobile sources used in mosquito and/or vector control activities include onroad fleet vehicles (light- and medium-duty trucks, vans, passenger cars), offroad ATVs, watercraft (motorboats, airboats), aircraft (helicopters and fixed-wing), portable equipment (pumps, sprayers, generators), and small equipment (handheld sprayers, foggers, dusters). Except for 2-stroke engines used in small lightweight equipment (spark ignition, 50:1 gas/oil mix), engines are 4-stroke gasoline (spark ignition) or diesel fuel (compression ignition). The dominant fuel used for these mobile sources is motor gasoline along with some diesel fuel (larger trucks) , aviation gasoline (fixed-wing aircraft), and jet fuel (turbine-powered helicopters). Light trucks, vans, and passenger cars are normally used for responding to public service requests and disease surveillance. Typical GHG contents of common fuels are presented in Table 11-2.

Table 11-2 Typical GHG Contents of Common Fuels

Fuel	CO_2 kg/mmBTU	CH_4 kg/mmBTU	N_2O kg/mmBTU	CO_2e lb/mmBTU	Energy BTU/gal	CO_2e lb/gal
Diesel Fuel No. 2	73.96	0.0105	0.0006	163.97	138,300	22.68
Kerosene	73.19	0.0105	0.0006	162.27	138,700	22.51
Jet Fuel	72.23	0.0105	0.0006	160.17	135,000	21.62
Motor Gasoline	71.35	0.0105	0.0006	158.23	122,600	19.40
Aviation Gasoline	69.15	0.0105	0.0006	153.38	120,200	18.44
Propane	62.22	0.0053	0.0001	137.49	91,300	12.55
Pipeline Natural Gas	53.02	0.0053	0.0001	117.20	—	—

Sources: USEPA 2012e, 2011a

Notes:

kg/mmBTU = kilogram(s) per million British Thermal Units

lb/mmBTU = pound(s) per million British Thermal Units

BTU = the amount of energy (heat) required to raise 1 pound of liquid water 1 degree Fahrenheit from 39 to 40°F

11.1.3.5 Sensitive Receptors

Certain population groups are considered more sensitive to air pollution and odors than others; in particular, children, elderly, and acutely ill and chronically ill persons, especially those with cardiorespiratory diseases such as asthma and bronchitis. Sensitive receptors (land uses) indicate locations where such individuals are typically found, namely schools, daycare centers, hospitals, convalescent homes, residences of sensitive persons, and parks with active recreational uses, such as youth sports.

None of the GHGs described in Section 11.2.2 are considered toxic; however, all are classified as asphyxiants. Thus, in high enough concentrations in confined spaces they can displace the oxygen in air and present hazards to industrial workers, however, GHG concentrations in ambient air (see Table 11-1) are far below any danger levels. Therefore, no risk to sensitive receptors or the general public is posed by GHGs emitted to outdoor air, either from stationary or mobile sources.

11.1.4 California Climate Impacts

Climate change is already affecting California. Average temperatures have increased, leading to more extreme hot days and fewer cold nights. Shifts in the water cycle have been observed, with less winter precipitation falling as snow, and both snowmelt and rainwater running off earlier in the year. Sea levels have risen. Wildland fires are becoming more frequent and intense due to dry seasons that start earlier and end later. These climate-driven changes affect resources critical to the health and prosperity of California. (CEC 2010)

If the state takes no action to reduce or minimize expected impacts from future climate change, the costs could be severe. In November 2008, the Governor directed the California Natural Resources Agency to develop a climate adaptation strategy for California. The Natural Resources Agency coordinated with ten state agencies, multiple scientists, a consulting team, and stakeholders to develop the first statewide, multisector adaptation strategy in the country. The resulting report, *2009 California Climate Adaptation Strategy*, summarizes the best-known science to assess the vulnerability of the state to climate change impacts, and outlines possible solutions that can be implemented within and across state agencies to promote resiliency. This strategy is the first step in an evolving process to reduce California's vulnerability to climate change impacts. (CEC 2010)

11.1.4.1 State Policies

The Global Warming Solutions Act of 2006 (Assembly Bill [AB] 32) (see Appendix C) required CARB to prepare a Scoping Plan to achieve substantial GHG emissions reductions, both from within the state and from “exported” emissions, such as importing electric power generated at coal-fired power plants located in neighboring western states. The 2008 Scoping Plan outlines a wide range of strategies for reducing statewide GHG emissions to 1990 levels by 2020. This goal will be achieved by cutting about 30 percent from business-as-usual emission levels projected for 2020, or about 15 percent from 2008 levels. Allowing for population growth, the goal is to reduce annual per capita emissions from 14 metric tonnes (MT) CO_2e down to about 10 MT CO_2e per capita by 2020. (CARB 2008b)

11.1.5 Emissions Inventories

The bulk of mosquito and vector control activity emissions would occur in the Bay Area, and only minor amounts would occur in northern Sonoma County. Therefore, the comprehensive 2007 Bay Area GHG inventory is used as the regional benchmark for comparison purposes.

Table 11-3 shows aggregated national, state, and regional GHG emissions for all sources on a gross basis (i.e., CO_2e emissions only, not including CO_2 sinks such as forestry and agriculture). As shown, California accounts for about 7 percent of gross CO_2e emissions in the US annually, and the Bay Area accounts for about 20 percent of gross CO_2e emissions in California.

Table 11-3 Greenhouse Gas Emissions Inventories - Gross Basis

Summary Year	National MMT CO_2e	California MMT CO_2e	Bay Area MMT CO_2e
2005	7,204	482.5	—
2006	7,159	481.9	—
2007	7,253	488.8	95.8
2008	7,048	484.7	—
2009	6,608	456.8	—
5-Year Average	**7,054**	**478.9**	**—**
Average Annual Variation	**2.6%**	**1.8%**	**—**

Sources: USEPA 2012e; CARB 2011; BAAQMD 2010b

Notes:

MMT = million metric tonnes (annual)

1 metric tonne = 1,000 kilograms or 2,204.6 pounds

2009 is most recent CARB published data; Bay Area for 2007 only

Tables 11-4, 11-5, 11-6, and 11-7 present progressively focused Bay Area GHG emissions inventory data for 2007 broken down by sectors, counties, and applicable subsectors. The District’s Program Area counties within the BAAQMD are shown in bold. This information will be used as a basis for comparisons with estimated mosquito and vector control activity emissions presented in Section 11.2.2.

Table 11-4 Bay Area GHG Emissions by Sector

End-Use Sector	District Emissions Percent	District Emissions MMT CO_2e
Industrial / Commercial	36.4%	34.9
Residential Fuel Use	7.1%	6.8
Local Electric Power Generation	8.5%	8.1
Imported Electric Power Generation	7.4%	7.1
Offroad Equipment	3.0%	2.9
Transportation	36.4%	34.9
Agriculture / Farming	1.2%	1.1
Totals	**100.0%**	**95.8**

Source: BAAQMD 2010b

Notes:

MMT = million metric tonnes (annual)

1 metric tonne = 1,000 kilograms or 2,204.6 pounds

Table 11-5 Bay Area GHG Emissions by County

County	District Emissions Percent	District Emissions MMT CO_2e
Alameda	16.4%	15.7
Contra Costa	32.9%	31.5
Marin	2.8%	2.7
Napa	1.8%	1.7
San Francisco (within BAAQMD)	7.4%	7.1
San Mateo (within BAAQMD)	8.9%	8.5
Santa Clara (within BAAQMD)	19.6%	18.8
Solano (within BAAQMD)	5.9%	5.7
Sonoma (within BAAQMD)	4.3%	4.1
Totals	**100.0%**	**95.8**

Source: BAAQMD 2010b

Notes:

MMT = million metric tonnes (annual)

1 metric tonne = 1,000 kilograms or 2,204.6 pounds

Table 11-6 Mobile Sectors GHG Emissions by County

County	Offroad MT CO_2e	Transportation MT CO_2e
Alameda	569,000	8,351,000
Contra Costa	406,000	4,998,000
Marin	99,000	1,286,000
Napa	50,000	917,000
San Francisco (within BAAQMD)	415,000	2,673,000
San Mateo (within BAAQMD)	270,000	4,850,000
Santa Clara (within BAAQMD)	790,000	7,859,000
Solano (within BAAQMD)	147,000	1,834,000
Sonoma (within BAAQMD)	175,000	2,103,000
Totals	**2,921,000**	**34,871,000**

Source: BAAQMD 2010b

Notes:

MMT = million metric tonnes (annual)

1 metric tonne = 1,000 kilograms or 2,204.6 pounds

Values rounded to nearest 1,000 tonnes

"Offroad" is offroad equipment category

Table 11-7 Offroad Subsectors GHG Emissions by County

County	Utility MT CO_2e	Commercial MT CO_2e	Combined MT CO_2e
Alameda	29,800	49,900	79,700
Contra Costa	20,300	26,900	47,200
Marin	7,900	12,300	20,200
Napa	2,900	4,300	7,200
San Francisco (within BAAQMD)	**14,200**	**43,900**	**58,100**
San Mateo (within BAAQMD)	**14,200**	**27,200**	**41,400**
Santa Clara (within BAAQMD)	**32,900**	**56,500**	**89,400**
Solano (within BAAQMD)	**3,900**	**6,800**	**10,700**
Sonoma (within BAAQMD)	**7,800**	**13,500**	**21,300**
Totals	**133,900**	**241,300**	**375,200**

Source: BAAQMD 2010b

Notes:

MMT = million metric tonnes (annual)

1 metric tonne = 1,000 kilograms or 2,204.6 pounds

Values rounded to nearest 100 tonnes

"Utility" is small landscaping equipment selected for comparisons to Districts' activities

"Commercial" is light commercial equipment selected for comparisons to Districts' activities

11.1.6 Potential for Mitigation

With respect to mosquito and vector control activities, BMPs include fuel conservation, which minimizes GHG emissions by the Program. Mitigation Measures GHG-1, GHG-2, and GHG-3 apply, as described in Section 11.2.11.

11.1.7 Regulatory Setting

Currently, no local, state, or federal regulatory standards directly apply to GHG emissions from temporary or intermittent mobile sources such as mosquito and vector control activities. However, in the context of the Scoping Plan discussed in Section 11.1.4.1, implementation of Low Carbon Fuel Standard (Executive Order S-1-7, below) would indirectly apply to mosquito and vector control activities via fuel usage. Principal federal, state, and local GHG statutes, regulations, and programs that affect other types of sources are presented in Appendix C with total CEQA guidelines summarized below:

11.1.7.1 Federal

The following are presented in Appendix C:

> 40 CFR Part 98 – Greenhouse Gas Reporting

> General Conformity

11.1.7.2 State

> Global Warming Solutions Act

> Cap and Trade

> Assembly Bill 939

> Senate Bill 1368

> Senate Bill 97

> Senate Bill 375

> Senate Bills 1078 and 10

> Executive Order S-20-04

> Executive Order S-3-05

> Executive Order S-1-07

> Executive Order S-13-08

11.1.7.3 Local

Most of the District's Program Area is covered by the BAAQMD and the Yolo-Solano Air Quality Management District (YSAQMD). YSAQMD covers Yolo County and the northeastern part of Solano County.

11.1.7.3.1 BAAQMD CEQA Guidelines

On June 2, 2010, the BAAQMD adopted new CEQA Air Quality Guidelines (BAAQMD 2012b) for consideration by lead agencies tasked with evaluating the air quality and climate change impacts of proposed new projects. The proposed Guidelines superseded the December 1999 Guidelines. As guidelines, they did not comprise enforceable rules or regulations per se; nevertheless, the guidelines established the following quantitative thresholds of significance for GHG emissions:[1]

> Stationary Sources: 10,000 MT CO_2e per year

> Other than Stationary Sources: 1,100 MT CO_2e per year or 4.6 MT CO_2e per SP per year

> Plans: 6.6 MT CO_2e per SP per year

However, on March 5, 2012, Alameda County Superior Court issued a judgment finding that the BAAQMD had failed to comply with CEQA when it adopted the thresholds of significance. The court did not determine whether the thresholds were valid on the merits, but found that the adoption of the thresholds was a project under CEQA. The court issued a writ of mandate ordering the BAAQMD to set aside the 2010 thresholds and cease dissemination of them until it had complied with CEQA. The BAAQMD is no longer recommending that the 2010 thresholds be used as a generally applicable measure of a project's significance. Lead agencies may continue to rely on the 1999 CEQA thresholds and may continue to make determinations regarding the significance of an individual project's air quality impacts based on the substantial evidence in the record for that project.

YSAQMD does not have applicable CEQA thresholds for GHGs. Since the 1999 BAAQMD thresholds apply only to criteria pollutants, not GHGs, no GHG thresholds currently apply (BAAQMD 1999, 2012b). Notwithstanding the writ of mandate, Program status would have been as follows under the 2010 Bay Area CEQA Guidelines:

> Mosquito and vector control activities do not meet the regulatory definition of a stationary source of air contaminants; therefore, the 10,000 MT CO_2e per year stationary source GHG threshold would not apply.

> For nonstationary source land use development projects, BAAQMD's adopted "bright-line" threshold of significance differs from other proposed GHG thresholds currently under consideration in California. Under this threshold, to conclude that a project's GHG impacts are less than significant, a project would need to be in compliance with a "Qualified Greenhouse Gas Reduction Strategy," emit less than 1,100 MT CO_2e per year, or emit less than 4.6 MT CO_2e per year per capita SP (residents + employees). However, the Program does not qualify as a land use development project; therefore, these GHG thresholds would not apply.

> No GHG thresholds exist for temporary construction emissions from mobile and portable sources, neither daily nor annual, whether for stationary or nonstationary source projects. Since mosquito and vector control activities comprise mobile and portable sources similar to construction, no quantitative GHG significance thresholds would apply to the Program since activities such as mosquito and vector control are not specified, defined, or addressed in the guidelines.

[1] MT = metric tonne, 1,000 kilograms or 2,204.6 pounds; SP = Service Population, residents + employees

11.2 Environmental Impacts and Mitigations Measures

11.2.1 Evaluation Concerns and Criteria

The environmental concerns are those identified below from the CEQA Guidelines and from public scoping. The public identified the following issues:

> Address impacts of GHG emissions and climate change

The focus in this chapter is on the use of equipment to perform all Program activities and the resulting emissions impacts to generation of GHGs. The CEQA Guidelines cover the issues from public scoping.

As described in Section 11.1.7, no promulgated standards of significance exist for GHG impacts established under CEQA for mobile sources such as mosquito and vector control activities. The PEIR addresses the following qualitative criteria are used as standards of significance and are based on CEQA Guidelines Appendix G, Environmental Checklist Form, Section VII. Would the project:

> Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?

> Conflict with any applicable plan, policy, or regulation of an agency adopted for the purpose of reducing the greenhouse gas emissions?

Determinations made with respect to significance criteria are documented in Sections 11.2.3 through 11.2.8.

See Section 11.1.7.3.1 for a discussion of CEQA thresholds of significance for GHGs.

11.2.2 Evaluation Methods and Assumptions

As described in Section 11.1.3, operation of onroad fleet vehicles, offroad all-terrain vehicles, watercraft, aircraft, portable equipment, and small equipment would result in GHG emissions in engine exhaust. Detailed lists of equipment, estimated usage, and emission calculations are provided in Appendix C. Equipment lists and annual activity schedules were provided by the nine Districts. Emission calculations were performed using the most recent and applicable emission factors published by CARB (2008a) and USEPA (2011a, 2012e).

Table 11-8 shows Program alternatives applicability by percentage: surveillance, physical control, vegetation management, biological control, chemical control, or other nonchemical control. Table 11-9 shows land uses associated with selected alternatives: residential, commercial, industrial, agricultural, and open space.

As described in Section 11.1.7, no promulgated standards of significance exist for GHG impacts established under CEQA for mobile sources such as mosquito and vector control activities. Thus, Program emissions are compared against existing GHG inventories for context. The existing Program activities are the basis for the quantitative evaluation and if compared strictly to existing activities at the time the NOP was published, the impact would be no change. Future Program activities would be similar and not result in substantial emission changes.

Table 11-8 Solano County Mosquito Abatement District's (SCMAD's) Selected Alternatives Applicability

Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control	Other Nonchemical
24%	—	—	0.03%	46%	30%

Sources: Nine Districts

Table 11-9 Land Uses Associated with SCMAD's Selected Alternatives

Residential	Commercial	Industrial	Agricultural	Open Space
•	•	•	•	•

Sources: Nine Districts

Table 11-10 shows estimated ongoing annual GHG emissions as CO_2e by alternative. On the local level, the combined "grand total" of 2,600 MT CO_2e per year comprises only 0.7 percent of the 375,200 MT CO_2e per year in the utility and commercial offroad subsectors (see Table 11-7); this amount is within USEPA limits of precision of -2 to +5 percent for fossil fuel combustion (USEPA 2012e). On the regional level, this is less than 0.003 percent of aggregate GHG emissions from the Bay Area (see Table 11-4). At the state and national levels, these emissions are negligible: 0.0005 and 0.00004 percent, respectively (see Table 11-3).The incremental contribution of the District's emissions would not be cumulatively considerable.

Table 11-10 Estimated Annual GHG Emissions by Alternative for Solano County Mosquito Abatement District (SCMAD)

Alternatives and Activities	CO_2 MT/year	CH_4 MT/year	N_2O MT/year	CO_2e MT/year
Biological Control	0.0	0.0000	0.0000	0.0
Chemical Control	67.1	0.0031	0.0018	67.7
Physical Control	0.0	0.0000	0.0000	0.0
Vegetation Management	0.0	0.0000	0.0000	0.0
Surveillance	35.5	0.0016	0.0009	35.8
Other Nonchemical[1]	44.6	0.0020	0.0012	45.0
Totals	**147.2**	**0.0067**	**0.0039**	**148.5**

Sources: CARB 2008a; USEPA 2011a, 2012e

Note: Emissions referenced in the "Other Nonchemical" category emanate from vehicles and equipment used in connection with district activities not directly related to mosquito control, such as transportation to various meetings and facilities maintenance.

11.2.3 Surveillance Alternative

The Surveillance Alternative would be a continuation of existing activities currently practiced by the District using applicable techniques, equipment, vehicles, and watercraft. Surveillance involves monitoring mosquito and/or vector populations and habitat, their disease pathogens, and the human/vector interactions. Field counting/sampling and trapping are common mechanisms for surveillance. The environmental impact concerns are phrased as questions as follows for the Surveillance Alternative:

Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?

GHG emissions from the Surveillance Alternative would not be expected to exceed average emissions shown in Table 11-10. The Surveillance Alternative would emit approximately 36 MT CO_2e per year. Compared to national, statewide, and Bay Area GHG inventories shown in Table 11-3 (i.e., 7054 MMT/year, 479 MMT/year, 96 MMT/year, respectively), the Surveillance Alternative emissions would comprise about 0.000000005 percent, 0.00000008 percent, and 0.0000004 percent of these respective inventories on an annual basis. These GHG emissions are well within USEPA limits of precision of -2 to +5 percent for fossil fuel combustion (USEPA 2012e) and are, thus, negligible in context and similar to existing conditions. Due to its small scale and GHG mitigations, the Surveillance Alternative would not individually affect the environment or impede the state's ability to meet its 2020 GHG emission reduction goal because the incremental cumulative impact would not be considerable.

> **Impact GHG-1:** Based on estimated annual CO_2e emissions, the Surveillance Alternative would not result in a cumulatively considerable amount of GHGs, and neither would the incremental contribution of the District. Impacts would be **less than significant** and no mitigation is required.

Conflict with any applicable plan, policy, or regulation of an agency adopted for the purpose of reducing the greenhouse gas emissions?

On a statewide basis, agencies in California are in the process of implementing strategies to reduce GHG emissions pursuant to the Global Warming Solutions Act of 2006 (AB 32, Núñez, Chapter 488, Statutes of 2006), which requires that California reduce its statewide GHG emissions to 1990 levels by 2020. AB 32 required CARB to develop the Scoping Plan (2008b) in coordination with the California Energy Commission's (CEC's) Climate Action Team (2010). The Scoping Plan defines a comprehensive set of emission reduction measures such as energy efficiency, renewable energy, cap-and-trade, transportation measures, low-carbon fuels, and targeted GHG fees. Due to its small scale, the Surveillance Alternative would not conflict with state and local plans, policies, or regulations aimed at curbing GHG emissions.

> **Impact GHG-2:** Based on the general inclusion of Surveillance Alternative emissions in the local and statewide GHG emission inventories, the Surveillance Alternative would not conflict with applicable plans, policies, or regulations for reducing GHG emissions. Impacts would be **less than significant** and no mitigation is required.

11.2.4 Physical Control Alternative

The Physical Control Alternative would be a continuation of existing activities currently practiced by the District using applicable techniques, equipment, vehicles, and watercraft. This alternative involves managing mosquito habitat using source control and permanent control methods that do not use biological agents or chemical pesticides, such as ditch maintenance, debris removal in natural channels, and blockage of access points. The environmental impact concerns are phrased as questions as follows for the Physical Control Alternative:

Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?

GHG emissions are not expected from the Physical Control Alternative (Table 11-10). Due the lack of GHG mitigations, the Physical Control Alternative would not individually affect the environment or impede the state's ability to meet its 2020 GHG emission reduction goal because the incremental cumulative impact would not be considerable.

> **Impact GHG-3:** Due to the lack of projected annual CO_2e emissions, the Physical Control Alternative would not result in a cumulatively considerable amount of GHGs, and neither would the incremental contribution of the District. Impacts would be **less than significant** and no mitigation is required.

Conflict with any applicable plan, policy, or regulation of an agency adopted for the purpose of reducing the greenhouse gas emissions?

On a statewide basis, agencies in California are in the process of implementing strategies to reduce GHG emissions pursuant to the Global Warming Solutions Act of 2006 (AB 32, Núñez, Chapter 488, Statutes of 2006), which requires that California reduce its statewide GHG emissions to 1990 levels by 2020. AB 32 required CARB to develop the Scoping Plan (2008b) in coordination with the CEC's Climate Action Team (2010). The Scoping Plan defines a comprehensive set of emission reduction measures such as energy efficiency, renewable energy, cap-and-trade, transportation measures, low-carbon fuels, and targeted GHG fees. Due to its small scale, the Physical Control Alternative would not conflict with state and local plans, policies, or regulations aimed at curbing GHG emissions.

> **Impact GHG-4:** Based on the general inclusion of Physical Control Alternative emissions in the local and statewide GHG emission inventories, the Physical Control Alternative would not conflict with applicable plans, policies, or regulations for reducing GHG emissions. Impacts would be **less than significant** and no mitigation is required.

11.2.5 Vegetation Management Alternative

The Vegetation Management Alternative would be a continuation of existing activities currently practiced by the District using applicable techniques, equipment, vehicles, and watercraft. Vegetation management is used to reduce the habitat value for mosquitoes.. The District uses hand tools and may sometimes use heavy equipment to remove vegetation primarily in aquatic habitats. The District may also apply herbicides to remove vegetation. The environmental impact concerns are phrased as questions as follows for the Vegetation Management Alternative:

Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?

GHG emissions are not expected from the Vegetation Management Alternative (Table 11-10). Due to the lack of GHG emissions, the Vegetation Management Alternative would not individually affect the environment or impede the state’s ability to meet its 2020 GHG emission reduction goal because the incremental cumulative impact would not be considerable.

> **Impact GHG-5:** Due to the lack of projected annual CO_2e emissions, the Vegetation Management Alternative would not result in a cumulatively considerable amount of GHGs, and neither would the incremental contribution of each District. Impacts would be **less than significant** and no mitigation is required.

Conflict with any applicable plan, policy, or regulation of an agency adopted for the purpose of reducing the greenhouse gas emissions?

On a statewide basis, agencies in California are in the process of implementing strategies to reduce GHG emissions pursuant to the Global Warming Solutions Act of 2006 (AB 32, Núñez, Chapter 488, Statutes of 2006), which requires that California reduce its statewide GHG emissions to 1990 levels by 2020. AB 32 required CARB to develop the Scoping Plan (2008b) in coordination with the CEC’s Climate Action Team (2010). The Scoping Plan defines a comprehensive set of emission reduction measures such as energy efficiency, renewable energy, cap-and-trade, transportation measures, low-carbon fuels, and targeted GHG fees. Due to its small scale, the Vegetation Management Alternative would not conflict with state and local plans, policies, or regulations aimed at curbing GHG emissions.

> **Impact GHG-6:** Based on the general inclusion of Vegetation Management Alternative emissions in the local and statewide GHG emission inventories, the Vegetation Management Alternative would not conflict with applicable plans, policies, or regulations for reducing GHG emissions. Impacts would be **less than significant** and no mitigation is required.

11.2.6 Biological Control Alternative

The Biological Control Alternative would be a continuation of existing activities currently practiced by the District using applicable techniques, equipment, vehicles, watercraft, and aircraft. It involves the use of mosquito predators, i.e., mosquitofish (*Gambusia affinis*). The environmental impact concerns are phrased as questions as follows for the Biological Control Alternative:

Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?

GHG emissions are not expected from the Biological Control Alternative (Table 11-10). Due to and the lack of GHG emissions, the Biological Control Alternative would not individually affect the environment or impede the state's ability to meet its 2020 GHG emission reduction goal because the incremental cumulative impact would not be considerable.

> **Impact GHG-7:** Due to the lack of projected annual CO_2e emissions, the Biological Control Alternative would not result in a cumulatively considerable amount of GHGs, and neither would the incremental contribution of each District. Impacts would be **less than significant** and no mitigation is required.

Conflict with any applicable plan, policy, or regulation of an agency adopted for the purpose of reducing the greenhouse gas emissions?

On a statewide basis, agencies in California are in the process of implementing strategies to reduce GHG emissions pursuant to the Global Warming Solutions Act of 2006 (AB 32, Núñez, Chapter 488, Statutes of 2006), which requires that California reduce its statewide GHG emissions to 1990 levels by 2020. AB 32 required CARB to develop the Scoping Plan (2008b) in coordination with the CEC's Climate Action Team (2010). The Scoping Plan defines a comprehensive set of emission reduction measures such as energy efficiency, renewable energy, cap-and-trade, transportation measures, low-carbon fuels, and targeted GHG fees. Due to its small scale, the Biological Control Alternative would not conflict with state and local plans, policies, or regulations aimed at curbing GHG emissions.

> **Impact GHG-8:** Based on the general inclusion of Biological Control Alternative emissions in the local and statewide GHG emission inventories, the Biological Control Alternative would not conflict with applicable plans, policies, or regulations for reducing GHG emissions. Impacts would be **less than significant** and no mitigation is required.

11.2.7 Chemical Control Alternative

The Chemical Control Alternative would be a continuation of existing activities currently practiced by the District using applicable techniques, equipment, vehicles, watercraft, and aircraft. It involves the application of insecticides to reduce populations of mosquitoes. The environmental impact concerns are phrased as questions as follows for the Chemical Control Alternative:

Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?

GHG emissions from the Chemical Control Alternative would not be expected to exceed average emissions shown in Table 11-10. The Chemical Control Alternative would emit approximately 68 MT CO_2e per year. Compared to national, statewide, and Bay Area GHG inventories shown in Table 11-3 (i.e., 7054 MMT/year, 479 MMT/year, 96 MMT/year, respectively), the Chemical Control Alternative emissions would comprise about 0.0000000001 percent, 0.0000001 percent, and 0.0000007 percent of these respective inventories on an annual basis. These GHG emissions are well within USEPA limits of precision of -2 to +5 percent for fossil fuel combustion (USEPA 2012e) and are, thus, negligible in context. Due to its small scale and GHG mitigations, the Chemical Control Alternative would not individually affect the environment or impede the state's ability to meet its 2020 GHG emission reduction goal because the incremental cumulative impact would not be considerable.

> **Impact GHG-9:** Based on estimated annual CO_2e emissions, the Chemical Control Alternative would not result in a cumulatively considerable amount of GHGs, and neither would the incremental contribution of the District. Impacts would be **less than significant** and no mitigation is required.

Conflict with any applicable plan, policy, or regulation of an agency adopted for the purpose of reducing the greenhouse gas emissions?

On a statewide basis, agencies in California are in the process of implementing strategies to reduce GHG emissions pursuant to the Global Warming Solutions Act of 2006 (AB 32, Núñez, Chapter 488, Statutes of 2006), which requires that California reduce its statewide GHG emissions to 1990 levels by 2020. AB 32 required CARB to develop the Scoping Plan (2008b) in coordination with the CEC's Climate Action Team (2010). The Scoping Plan defines a comprehensive set of emission reduction measures such as energy efficiency, renewable energy, cap-and-trade, transportation measures, low-carbon fuels, and targeted GHG fees. Due to its small scale, the Chemical Control Alternative would not conflict with state and local plans, policies, or regulations aimed at curbing GHG emissions.

> **Impact GHG-10:** Based on the general inclusion of Chemical Control Alternative emissions in the local and statewide GHG emission inventories, the Chemical Control Alternative would not conflict with applicable plans, policies, or regulations for reducing GHG emissions. Impacts would be **less than significant** and no mitigation is required.

11.2.8 Cumulative Impacts

Cumulative impacts from Program GHG emissions are discussed in Section 13.9. Cumulative impacts were assessed in a qualitative manner by determining if the Program alternatives, in conjunction with other projects throughout the Program Area, would have the potential to contribute to a long-term cumulative impact on climate change. Given that GHG emissions and climate change are global issues, a statewide framework or cumulative approach for consideration of environmental impacts may be most appropriate. Virtually every project in the state of California, as well as those outside the state, would have GHG emissions.

In summary, only the Surveillance and Chemical Control Alternatives (and other activities not associated with mosquito control) would generate GHG emissions and incrementally contribute to climate change, however minor. When all Program emissions are viewed in combination with global emissions levels that are contributing to the existing cumulative impact on global climate change, the incremental contribution of these Program emissions would not be cumulatively considerable because they occur intermittently on a very small scale (i.e., not stationary sources). Therefore, **all Program alternatives (either individually or in combination) would not have a cumulatively considerable impact on global climate change**. If optional mitigation measures (BMPs) are implemented, the Program alternatives' incremental contribution would be reduced further.

11.2.9 Environmental Impacts Summary

Table 11-11 presents a summary of GHG impacts associated with the six alternatives in comparison to existing conditions defined as existing GHG inventories as well as existing conditions as of May-June 2012. The GHG impact callouts correspond to those in Sections 11.2.3 through 11.2.8.

Table 11-11 Summary of Greenhouse Gas Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Effects on GHG					
Impact GHG-1: Based on estimated annual CO2e emissions, the Surveillance Alternative would not result in a cumulatively considerable amount of GHGs, and neither would the incremental contribution of the District. Impacts would be **less than significant** and no mitigation is required.	LS	na	na	na	na
Impact GHG-2: Based on the general inclusion of Surveillance Alternative emissions in the local and statewide GHG emission inventories, the Surveillance Alternative would not conflict with applicable plans, policies, or regulations for reducing GHG emissions. Impacts would be **less than significant** and no mitigation is required.	LS	na	na	na	na
Impact GHG-3: Due to the lack of projected annual CO2e emissions, the Physical Control Alternative would not result in a cumulatively considerable amount of GHGs, and neither would the incremental contribution of the District. **Impacts would be** less than significant and no mitigation is required.	na	LS	na	na	na
Impact GHG-4: Based on the general inclusion of Physical Control Alternative emissions in the local and statewide GHG emission inventories, the Physical Control Alternative would not conflict with applicable plans, policies, or regulations for reducing GHG emissions. Impacts would be **less than significant** and no mitigation is required.	na	LS	na	na	na
Impact GHG-5: Due to the lack of projected annual CO2e emissions, the Vegetation Management Alternative would not result in a cumulatively considerable amount of GHGs, and neither would the incremental contribution of each District. **Impacts would be** less than significant and no mitigation is required.	na	na	LS	na	na
Impact GHG-6: Based on the general inclusion of Vegetation Management Alternative emissions in the local and statewide GHG emission inventories, the Vegetation Management Alternative would not conflict with applicable plans, policies, or regulations for reducing GHG emissions. Impacts would be **less than significant** and no mitigation is required.	na	na	LS	na	na

Table 11-11 Summary of Greenhouse Gas Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact GHG-7: Due to the lack of projected annual CO2e emissions, the Biological Control Alternative would not result in a cumulatively considerable amount of GHGs, and neither would the incremental contribution of each District. **Impacts would be** less than significant and no mitigation is required.	na	na	na	LS	na
Impact GHG-8: Based on the general inclusion of Biological Control Alternative emissions in the local and statewide GHG emission inventories, the Biological Control Alternative would not conflict with applicable plans, policies, or regulations for reducing GHG emissions. Impacts would be **less than significant** and no mitigation is required.	na	na	na	LS	na
Impact GHG-9: Based on estimated annual CO2e emissions, the Chemical Control Alternative would not result in a cumulatively considerable amount of GHGs, and neither would the incremental contribution of the District. Impacts would be **less than significant** and no mitigation is required.	na	na	na	na	LS
Impact GHG-10: Based on the general inclusion of Chemical Control Alternative emissions in the local and statewide GHG emission inventories, the Chemical Control Alternative would not conflict with applicable plans, policies, or regulations for reducing GHG emissions. Impacts would **be less than** significant and no mitigation is required**.**	na	na	na	na	LS

LS = Less-than-significant impact

N = No impact

na = Not applicable

SM = Potentially significant but mitigable impact

SU = Significant and unavoidable impact

11.2.10 Mitigation and Monitoring

All impacts are less than significant (LS) compared to existing conditions and require no mitigation. As an option, the District may choose to reduce small impacts even further (under Impacts GHG-1, GHG-3, GHG-5, GHG-7, GHG-9, and GHG-11). The District and its contractors may implement the following BMPs as applicable to minimize diesel and gasoline engine exhaust emissions:

Mitigation Measure GHG-1: Idling times will be minimized either by shutting engines off when not in use or reducing the maximum idling time to 5 minutes (as required by the California ATCM Title 13, Section 2485 of CCR). Clear signage will be provided for workers at all access points.

Mitigation Measure GHG-2: Correct tire inflation will be maintained in accordance with manufacturer's specifications on wheeled equipment and vehicles to prevent excessive rolling resistance.

Mitigation Measure GHG-3: All equipment and vehicles will be maintained and properly tuned in accordance with manufacturer's specifications.

12 Noise

Chapter 12 evaluates potential noise impacts from Program implementation at a programmatic level. Section 12.1, Environmental Setting, presents an overview of the physical properties and environmental noise; and contains federal, state, and local ordinances, plans, and regulations that are applicable to the Program. Section 12.2, Environmental Impacts and Mitigation Measures, presents the following:

> Environmental concerns and evaluation criteria used to determine whether the Program alternatives would cause significant impacts on noise levels throughout the region

> Evaluation methods and assumptions

> Discussion of noise impacts of the Program alternatives

> Cumulative impacts summary

> A summary of environmental impacts due to noise

Appendix D, Noise Analysis Technical Report includes additional detailed information regarding the physical properties of noise; federal, state, and local noise regulations; and equipment use noise generated by each of the Program alternatives.

12.1 Environmental Setting

12.1.1 Overview of Environmental Sound

Noise may be defined as unwanted sound. Noise is usually objectionable because it is disturbing or annoying. Several noise measurement scales are used to describe noise in a particular location. A decibel (dB) is a unit of measurement that indicates the relative amplitude of a sound. The zero on the decibel scale is based on the lowest sound level that the healthy, unimpaired human ear can detect. Sound levels in decibels are calculated on a logarithmic basis. An increase of 10 dB represents a 10-fold increase in acoustic energy, while 20 dB is 100 times more intense, 30 dB is 1,000 times more intense, etc. A relationship exists between the subjective noisiness or loudness of a sound and its intensity. Each 10-dB increase in sound level is perceived as approximately a doubling of loudness over a fairly wide range of intensities.

Several methods are used to characterize sound. The most common is the A-weighted sound level, or dBA. This scale gives greater weight to the frequencies of sound to which the human ear is most sensitive. Because sound levels can vary markedly over a short period of time, a method for describing either the average character of the sound or the statistical behavior of the variations must be utilized. Most commonly, sounds are described in terms of an average level that has the same acoustical energy as the summation of all the time-varying events. This energy-equivalent sound/noise descriptor is called L_{eq}. The most common averaging period is hourly, but L_{eq} can describe any series of noise events of arbitrary duration.

Because the sensitivity to noise increases during the evening and at night—excessive noise interferes with the ability to sleep—24-hour descriptors have been developed that incorporate artificial noise penalties added to quiet-time noise events. The Community Noise Equivalent Level (CNEL) is a measure of the cumulative noise exposure in a community, with a 5-dB penalty added to evening (7:00 pm to 10:00 pm) and a 10-dB addition to nocturnal (10:00 pm to 7:00 am) noise levels. The day/night average sound level (L_{dn}) is essentially the same as CNEL, with the exception that the evening time period is dropped and all occurrences during this 3-hour period are grouped into the daytime period.

Noise changes both in level and frequency spectrums as it travels from the source to the receiver. The most obvious is the decrease in noise as the distance from the source increases. The manner in which noise is reduced depends on a variety of factors, including the noise source type as well as the region over which the noise source propagates. Noise generated by a point source, such as equipment at a construction site, drops off at a rate of 6 dBA per doubling of distance. Traffic noise attenuates, or is reduced, at a different rate. The movement of vehicles makes the noise source appear to emanate from a line as opposed to a single point when viewed over a period of time. Noise levels drop-off at a rate of about 3 dBA per doubling of distance for this type of source near hard surfaces, such as paved areas or bodies of water. However, ground type also plays into how much of a drop off over distance will occur. Surfaces, such as plowed fields, crops, or grass, absorb some of the sound energy as the sound passes over; therefore, noise is reduced by 4.5 dBA for every doubling of the distance in such areas.

12.1.2 Community Noise Levels

Community noise levels depend on the intensity of nearby human activity. Noise levels are generally considered low when ambient levels are below 45 dBA, moderate in the 45- to 60-dBA range, and high above 60 dBA. In rural and undeveloped areas, L_{dn} can fall below 35 dBA. Levels above 75 to 80 dBA are more common near major freeways and airports. Although people often accept the higher levels associated with very noisy urban areas, they nevertheless are considered to be adverse to public health.

Typical noise levels from both mobile and stationary sources are included in Table 12-1.

Table 12-1 Typical Stationary and Mobile Noise Source Sound Levels in dBA

Noise Source	Sound Level in dBA
Sprayer, hand-held	**10-20**
Noise at ear level from rustling leaves	20
Room in a quiet dwelling at midnight	32
Soft whisper at 5 feet	34
Large department store	50 to 65
Room with window air conditioner	55
Leaf blower/vac	**55-105**
Conversational speech	60 to 75
Pump station equipment with noise abatement	62
Sprayer, powered, truck- or trailer-mounted	**65-105**
Passenger car at 50 feet	69
Vacuum cleaner in private home at 10 feet	69
Tractor, agricultural	**76-110**
Ringing alarm at 2 feet	80
Brush/weed cutter	**90-97**
Roof-top air conditioner	85
Small bulldozer (Cat D3) or excavator (Cat 320)	**74-80**
Heavy bulldozer at 50 feet	87
All-terrain vehicle (ATV)	87-109
Heavy city traffic	90
Lawn mower	**91-98**
Chain saw	**100-120**

Table 12-1 Typical Stationary and Mobile Noise Source Sound Levels in dBA

Noise Source	Sound Level in dBA
Jet aircraft at 500 feet overhead	115
Human pain threshold	120
Construction blast	120 to 145 at 50 feet

Sources: Equipment manufacturer specification sheets, Noise Control Reference Handbook, Industrial Acoustics Company
Note:
Bold indicates equipment used in the Program.

12.1.3 Noise Level Acceptance Criteria

The surrounding land uses dictate what noise levels would be considered acceptable or unacceptable. In rural and undeveloped areas away from roads and other human activity, the day-to-night difference is normally small. Because of diurnal activity, nighttime ambient levels in urban environments are about 7 dB lower than the corresponding daytime levels. Nighttime noise is a concern because of the likelihood of disrupting sleep. Noise levels above 45 dBA at night can result in the onset of sleep interference. At 70 dBA, sleep interference effects become considerable (USEPA 1974).

12.1.4 Sensitive Receptors

Some land uses are generally regarded as being more sensitive to noise than others due to the types of population groups or activities involved. The definition of sensitive receptors varies by jurisdiction, but in general sensitive population groups include children and the elderly and sensitive land uses include residential (single- and multifamily, mobile homes, dormitories, and similar uses), guest lodging, parks and outdoor recreation areas, hospitals, nursing homes and other long-term medical care facilities, and educational facilities, including schools, libraries, churches, and places of public assembly.

12.1.5 Regulatory Setting

Federal and state guidelines and local ordinances, plans, and regulations pertaining to environmental noise within the nine-county Program Area are cited in this section. In addition, a representative selection of counties and cities throughout California that may be potentially treated is cited.

12.1.5.1 Federal Regulations

The federal noise standards or guidelines discussed in this section are relevant to the implementation of Program alternatives. Noise regulations and standards are provided for the following agencies:

- USEPA
- Federal Aviation Administration (FAA)

12.1.5.1.1 US Environmental Protection Agency

The USEPA has developed guidelines on recommended maximum long-term noise levels to protect public health and welfare (USEPA 1974). The USEPA does not enforce these guidelines, but rather offers them as a planning tool for state and local agencies. Table 12-2 provides examples of protective noise levels recommended by the USEPA. They are applicable to noise generated on federal lands, such as national wildlife refuges.

Table 12-2 USEPA-Designated Long-Term Noise Safety Levels

Effects	Noise Level	Area
Hearing Loss	$L_{eq}(24) < 70$ dB	All areas
Outdoor Activity Interference and Annoyance	$L_{dn} < 55$ dB	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	L_{eq} (24) <55 dB	Outdoor areas where people spend limited amounts of time, such as schoolyards, playgrounds, etc.
Indoor Activity Interference and Annoyance	$L_{dn} < 45$ dB	Indoor residential areas
	$L_{eq}(24) < 45$ dB	Other indoor areas with human activities such as schools, etc.

Source: USEPA 1974

Notes:

L_{eq} (24) = sound energy averaged over a 24-hour period.

L_{dn} = L_{eq} with a 10-dB nighttime weighting.

12.1.5.1.2 Federal Aviation Administration

The major parts of CFR Title 14: Aeronautics and Space, Chapter I: Federal Aviation Administration, Department of Transportation, Subchapter C, for fixed-wing aircraft noise and Subchapter H for helicopter noise, were reviewed for applicability to Program flight operations, specifically:

Part 91: Flight Operations

Portions of Part 91 are provided to describe operational restrictions associated with different aircraft types. Altitude limitations governing agricultural operations are given in Part 137, Agricultural Operations. They are included because the FAA considers aerial spraying to be an agricultural use, even if it is not specifically used for agricultural purposes.

Fixed-wing aircraft not operating under Instrument Flight Rules, emergencies, during takeoff or landing, or Part 137 are required to maintain the altitudes listed in Section 91.119 - Minimum Safe Altitudes: General (a)-(d). Section 91.119 (a), (b), and (c) are provided below.

Except when necessary for takeoff or landing, no person may operate an aircraft below the following altitudes:

(a) *Anywhere*. An altitude allowing, if a power unit fails, an emergency landing without undue hazard to persons or property on the surface.

(b) *Over congested areas*. Over any congested area of a city, town, or settlement, or over any open air assembly of persons, an altitude of 1,000 feet above the highest obstacle within a horizontal radius of 2,000 feet of the aircraft.

(c) *Over other than congested areas*. An altitude of 500 feet above the surface, except over open water or sparsely populated areas. In those cases, the aircraft may not be operated closer than 500 feet to any person, vessel, vehicle, or structure.

Section 137.49 – Operations over other than Congested Areas

Notwithstanding Part 91 of this chapter, during the actual dispensing operation, including approaches, departures, and turnarounds reasonably necessary for the operation, an aircraft may be operated over other than congested areas below 500 feet above the surface and closer than 500 feet to persons, vessels, vehicles, and structures, if the operations are conducted without creating a hazard to persons or property on the surface.

Section 137.51 – Operation over Congested Areas: General

(a) Notwithstanding Part 91 of this chapter, an aircraft may be operated over a congested area at altitudes required for the proper accomplishment of the agricultural aircraft operation if the operation is conducted:

 (1) With the maximum safety to persons and property on the surface, consistent with the operation, and

 (2) In accordance with the requirements of paragraph (i) of this section

  (i) No person may operate an aircraft over a congested area except in accordance with the requirements of this paragraph.

 (3) Prior written approval must be obtained from the appropriate official or governing body of the political subdivision over which the operations are conducted.

 (4) Notice of the intended operation must be given to the public by some effective means, such as daily newspapers, radio, television, or door-to-door notice.

 (5) A plan for each complete operation must be submitted to, and approved by appropriate personnel of the FAA Flight Standards District Office having jurisdiction over the area where the operation is to be conducted. The plan must include consideration of obstructions to flight, the emergency landing capabilities of the aircraft to be used, and any necessary coordination with air traffic control.

 (6) Single engine aircraft must be operated as follows:

  (i) Except for helicopters, no person may take off a loaded aircraft, or make a turnaround over a congested area.

  (ii) No person may operate an aircraft over a congested area below the altitudes prescribed in Part 91 of this chapter except during the actual dispensing operation, including the approaches and departures necessary for that operation.

  (iii) No person may operate an aircraft over a congested area during the actual dispensing operation, including the approaches and departures for that operation, unless it is operated in a pattern and at such an altitude that the aircraft can land, in an emergency, without endangering persons or property on the surface.

 (7) Multiengine aircraft must be operated as follows:

  (i) No person may take off a multiengine airplane over a congested area except under conditions that will allow the airplane to be brought to a safe stop within the effective length of the runway from any point on takeoff up to the time of attaining, with all engines operating at normal takeoff power, 105 percent of the minimum control speed with the critical engine inoperative in the takeoff configuration or 115 percent of the power-off stall speed in the takeoff configuration, whichever is greater, as shown by the accelerate stop distance data. In applying this requirement, takeoff data is based upon still-air conditions, and no correction is made for any uphill gradient of 1 percent or less when the percentage is measured as the difference between elevations at the end points of the runway divided by the total length. For uphill gradients greater than 1 percent, the effective takeoff length of the runway is reduced 20 percent for each 1 percent grade.

(ii) No person may operate a multiengine airplane at a weight greater than the weight that, with the critical engine inoperative, would permit a rate of climb of at least 50 feet per minute at an altitude of at least 1,000 feet above the elevation of the highest ground or obstruction within the area to be worked or at an altitude of 5,000 feet, whichever is higher. For the purposes of this subdivision, it is assumed that the propeller of the inoperative engine is in the minimum drag position, that the wing flaps and landing gear are in the most favorable positions, and that the remaining engine or engines are operating at the maximum continuous power available.

(iii) No person may operate any multiengine aircraft over a congested area below the altitudes prescribed in Part 91 of this chapter except during the actual dispensing operation, including the approaches, departures, and turnarounds necessary for that operation.

Section 137.53 – Operation over Congested Areas: Pilots and Aircraft

(a) General. No person may operate an aircraft over a congested area except in accordance with the pilot and aircraft rules of this section.

(b) Pilots. Each pilot in command must have at least:

(1) 25 hours of pilot-in-command flight time in the make and basic model of the aircraft, at least 10 hours of which must have been acquired within the preceding 12 calendar months.

(2) 100 hours of flight experience as pilot in command in dispensing agricultural materials or chemicals.

(c) Aircraft

(1) Each aircraft must:

(i) If it is an aircraft not specified in paragraph (c)(1)(ii) of this section, have had within the preceding 100 hours of time in service a 100-hour or annual inspection by a person authorized by Part 65 or 145 of this chapter, or have been inspected under a progressive inspection system.

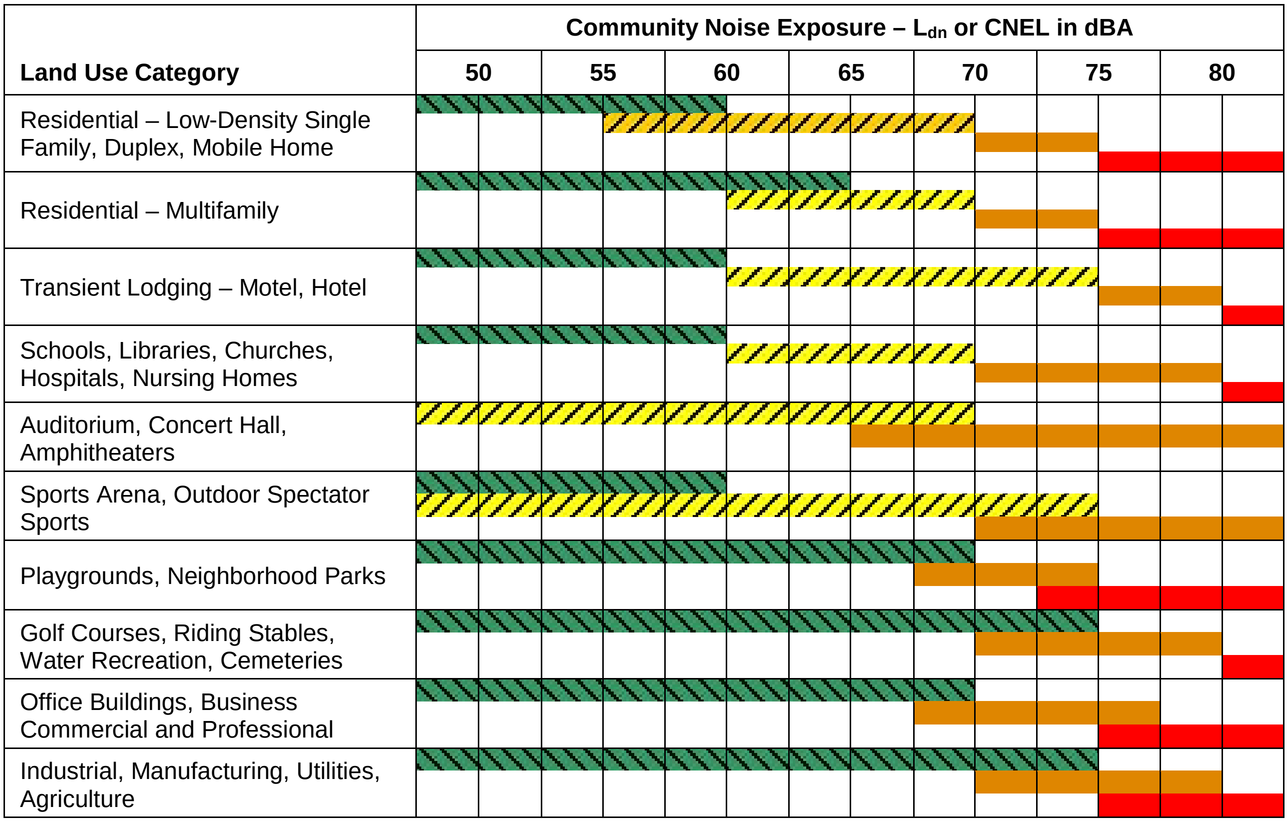
(ii) If it is a large or turbine-powered multiengine civil airplane of U.S. registry, have been inspected in accordance with the applicable inspection program requirements of Section 91.409 of this chapter.

(2) If other than a helicopter, it must be equipped with a device capable of jettisoning at least one-half of the aircraft's maximum authorized load of agricultural material within 45 seconds. If the aircraft is equipped with a device for releasing the tank or hopper as a unit, there must be a means to prevent inadvertent release by the pilot or other crewmember.

12.1.5.2 State Regulations

California Government Code Section 65302(f) encourages each local government entity to conduct noise studies and implement a noise element as part of its General Plans. In addition, the California Office of Planning and Research published guidelines for evaluating the compatibility of various land uses as a function of community exposure to permanent or long-term noise sources, and they are listed in Table 12-3. In general, noise levels less than 60-dBA L_{dn} are acceptable for all land uses, including residences, schools, and other noise-sensitive receptors.

Table 12-3 Land Use Compatibility for Community Noise Environment



Legend

(green hatched)	Normally Acceptable: Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.
(yellow hatched)	Conditionally Acceptable: New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features are included in the design.
(orange)	Normally Unacceptable: New construction or development should be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirement must be made and needed noise insulation features included in the design.
(red)	Clearly Unacceptable: New construction or development generally should not be undertaken.

Source: State of California 1998

CNEL = Community Noise Equivalent Level

dBA = A-weighted decibel(s)

L_{dn} = Day-Night Noise Level

12.1.5.3 Local Regulations

A listing of local plans and noise ordinances for selected localities within each of the nine mosquito and/or vector control districts including SCMAD is included in Appendix D. Cities and counties in California are required to include a noise element in their general plans, which include policies intended to achieve noise compatibility between land uses. These policies typically establish average noise levels that are acceptable at different land uses and are usually the same as or similar to those recommended by the state (Table 12-3). Some may specify noise levels that cannot be exceeded for certain periods of time or may specify allowable hours for construction but, generally, the standards established in noise elements are intended to establish land use compatibility for planning purposes and are not intended to address temporary and sporadic sources of noise such as would be generated by the proposed alternatives addressed in this PEIR. Many jurisdictions have noise ordinances that provide additional detail regarding allowable noise levels resulting from different types of activities, such as construction and emergency actions, although others may handle noise complaints through nuisance laws. Many ordinances allow for very loud noise emissions on a short-term basis, allowing the loudest noise levels to occur for the briefest period of time. Some jurisdictions, including Napa County specifically exempt emergency actions that are intended to protect, maintain, or restore public health and safety; and some specifically exempt noise from government-operated helicopters. Other communities do not address short-term, sporadic noise increases.

12.2 Environmental Impacts and Mitigation Measures

The noise impacts evaluation is provided below. The evaluation qualitatively and quantitatively compares probable noise levels against the impact significance criteria presented in Section 12.2.1.

12.2.1 <u>Evaluation Concerns and Criteria</u>

Temporary noise increases within the Program Area would be associated with the use of vehicles, backpack sprayers and ancillary equipment, sprayers, boats, heavy equipment, and aerial applications similar to current use of this equipment.

For this evaluation, impacts from Program noise sources would be considered significant if noise levels would:

> Expose people to or generate noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies. Because of the large number of local jurisdictions involved, the state’s long-term land use compatibility guidelines, shown in Table 12-3, are used as a surrogate for land use compatibility standards in local general plans.

> Result in a substantial temporary increase in ambient noise levels above levels existing without the Program.

The CEQA Guidelines, and most cities and counties, do not provide a definition of what constitutes a substantial noise increase for the second bullet point above. A common practice has been to assume that minimally perceptible to clearly noticeable increases of 3 to 5 dBA represent a significant increase in ambient noise levels. A sliding scale is commonly used to identify the significance of noise increases, allowing greater increases at lower absolute sound levels than at higher sound levels. This approach is based on research that relates changes in noise to the percentage of individuals that would be highly annoyed by the change (Federal Interagency Committee on Noise 1992). The significance criteria for changes in noise from Program operations would be a 3-dBA CNEL increase in noise levels if the existing noise level already exceeds the acceptable range for the land use, or a 5-dBA CNEL increase in noise if the existing noise level is in the acceptable range and the resulting level remains within the acceptable range for the land use.

Other CEQA Guidelines Appendix G criteria for noise impacts include impacts from permanent increases in noise levels, ground-borne vibration, and impacts from nearby airports and airstrips. With regard to vibration, Program equipment with the highest vibratory potential would include light trucks. While these vehicles may produce vibration, the levels would not be expected to be perceptible over existing vibration from delivery or highway truck traffic, and vibration levels would not reach thresholds for human annoyance or structural damage. With regard to permanent increases in noise levels, noise from the Program would be temporary and would last only for the duration of each activity. No potential exists to produce permanent increases in noise as a result of the Program. Finally, with regard to airports and airstrips, the Program would not result in the location of any new receptors near airports or airstrips. Therefore, these three criteria have been dismissed from the analysis and are not discussed further.

Concerns raised during scoping include:

> Noise-related impacts on humans, in particular consistency with local noise regulations

> Noise-related impacts on wildlife

The potential to exceed noise standards and result in substantial temporary noise levels above those existing (and without the Program equipment in use) within the Program Area are evaluated for each Program alternative. Impacts of Program noise on wildlife are addressed in Chapter 5, Biological Resources—Terrestrial.

12.2.2 Evaluation Methods and Assumptions

The methodology and assumptions of this noise impact evaluation for Program alternatives are provided below.

12.2.2.1 Methodology

The methodology used to prepare this programmatic noise impact section is as follows:

> Reviewed transcripts from public scoping meetings on the PEIR held in 2012.

> Reviewed federal, state, and selected county and municipal noise regulations, plans, ordinances, and/or guidelines for general noise issues and issues related to Program-specific noise sources.

> Obtained source-specific noise data for Program-specific noise sources where available.

> Estimated noise levels for specific and categorical equipment types proposed for Program operations where specific noise data were not available at 50 feet and 400 feet from point of measure.

> Compared Proposed Program activities with those that currently occur under existing vector control programs (existing conditions).

> Considered the implementation of the following BMPs used by the Districts for operations that generate noise expected to be of concern to the public.

  - <u>Measure 1: Provide Advance Notices.</u> A variety of measures are implemented depending on the nature/magnitude of the activities and the District involved, including press releases, social media, District websites, hand-delivered flyers, posted signs, emails, and phone alerts. Public agencies and elected officials also may be notified of the nature and duration of the activities, including the local Board of Supervisors or City Council, environmental health and agricultural agencies, emergency service providers, and airports.

  - <u>Measure 2: Provide Mechanism to Address Complaints.</u> The District staff is available during regular business hours to respond to service calls and may staff phone lines to address concerns during nighttime operations.

- Measure 3: Follow Established Procedures for Airboat Operations. Airboat operators are limited to certain areas and follow the guidelines established for those areas.

> Determined probable noise impacts associated with the alternatives proposed in Chapter 2 based on the above significance thresholds. The impact analysis is based on detailed information regarding equipment and vehicle types and usage, and land uses where they would be used provided by each of the Districts. Detailed information regarding the noise generated by each type of equipment and vehicles that would be used is shown in Appendix D, Tables 4-1 through 4-7.

12.2.2.2 Assumptions

The following assumptions were used in the assessment of potential noise impacts from the Program alternatives:

> Impacts are addressed at a programmatic level based on categories of land use types. Site-specific evaluation of noise sources and potential impacts is beyond the scope of this programmatic evaluation.

12.2.3 Surveillance Alternative

The Surveillance Alternative would involve both ground surveillance and water surveillance. The number and type of vehicles and equipment required, are shown in Table 12-4, but typically, ground surveillance would require the periodic use of light trucks, such as pickup trucks and jeeps, and ATVs and would take place in all land use types. Water surveillance would require the use of ATVs and, occasionally, boats and most frequently would occur in agricultural and open-space areas including wildlife refuges, where noise-sensitive human receptors are typically not located. Table 12-4 also shows the range of noise levels that vehicles and equipment typically would generate at 50- and 400-foot distances from the source. As indicated, noise attenuates, or is reduced, rapidly as the distance from the noise source increases. Detailed information regarding the average number of hours per day and the number of days in a quarter that equipment and vehicles would be used is included in Appendix D. Most equipment would only be operated a few hours per day for varying periods of time throughout the year.

Table 12-4 Surveillance Alternative for SCMAD–Primary Equipment Use, Noise Levels, and Land Use Types

		Predicted Noise Level (dBA)[a]		Land Use Types				
Activity	**Equipment**	**50 feet**	**400 feet**	**Residential**	**Commercial**	**Industrial**	**Agricultural**	**Open Space**
Ground Surveillance Application+/Mgt	Light trucks	83	65	●			●	●
Water Surveillance Applications/Mgt	Boat	75-85	57-67					●
	ATVs	87	69				●	●

Notes:
[a] Noise from aircraft used for agricultural operations, such as those expected to be used for aerial applications, is not regulated by the FAA and, therefore, no noise information is available. Noise likely would be comparable to that of helicopters.

12.2.3.1 Exceedance of Noise Standards

As discussed in Section 12.1.5.3, many jurisdictions specifically exempt activities intended to protect public health and safety, such as those implemented under the Proposed Program, from their noise standards. Other noise standards address either temporary construction noise or long-term or permanent noise sources, which are not relevant to the types of activities implemented as part of this Program. Some jurisdictions include provisions for brief periods of noise that exceed their land use compatibility standards, which are based on average daily noise levels, such as L_{dn} or CNEL. Noise from this alternative would be periodic, limited to brief periods of time spread out over multiple days in multiple locations, minimizing the amount of time any sensitive receptor was exposed to increased noise. The noise levels shown in Table 12-4 represent those that would be generated while the equipment or vehicles were operating, and they would not operate constantly; thus, daily average noise levels would be considerably lower. Noise from light trucks would not exceed the long-term land use compatibility guidelines at nearby sensitive receptors because a limited number of vehicles would be used; any change to the average noise level would not be perceptible because it takes a doubling of trips to increase noise levels by only 3 dBA. ATVs and other equipment would be used primarily in agricultural and open-space areas, as well as industrial areas. Such areas are not typically considered noise-sensitive. Although certain types of open-space areas may have increased sensitivity to noise, such as those used by recreational users seeking quiet, given the temporary, sporadic increase in noise at any given location, noise from the Surveillance Alternative would not exceed regulatory standards.

> **Impact N-1:** Use of equipment and vehicles would increase noise levels during operations, but this increase would not exceed regulatory thresholds. This impact is **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.

12.2.3.2 Substantial Temporary Increase in Noise Levels

Noise from the use of light trucks generally would not be distinguishable from ambient noise levels because it takes a doubling of traffic to increase noise levels by only 3 dB. The types of light trucks that would be used (e.g., pickup trucks and jeeps) are common, and a limited number of vehicles would be used and would be dispersed over a large area. Water surveillance activities would occur in agricultural and open-space areas, not in proximity to noise sensitive receptors; moreover, limited numbers of equipment and vehicles would be used for brief periods of time over a large area. Given the sporadic use of vehicles and equipment and the limited duration that they would be used in any given location, noise levels would not increase by 3- to 5-dBA CNEL in proximity to noise-sensitive receptors. The District also is already implementing the types of activities that are part of this alternative; thus, this alternative represents a continuation of existing conditions, and noise levels from Program activities would not increase beyond those that already occur. In addition, BMPs would be implemented as appropriate by providing advance notification of noise-generating activities expected to be of concern to the public and providing a means for registering public complaints about noise, thus further minimizing the potential for public annoyance. Airboats also would be required to operate only in certain areas, as allowed by the land management agencies, minimizing the potential for impacts in other areas.

> **Impact N-2:** Use of equipment and vehicles would cause a temporary increase in noise levels during operations. This increase would not be substantial and, therefore, is **less than significant** based on the frequency and duration of the activity, resulting noise levels, comparability to noise resulting from existing activities, and implementation of BMPs. No mitigation is required.

12.2.4 Physical Control Alternative

The Physical Control Alternative involves a variety of actions, some of which would not directly result in noise generated by the District; they include educating and advising landowners regarding appropriate methods to prevent or reduce control mosquito production by eliminating or reducing the habitat value of an area. Other activities may require the implementation of maintenance activities within marshes and wetlands, which typically are in undeveloped areas and not in proximity to noise-sensitive receptors. Some activities may take place in more urban areas, such as those including localized vegetation management associated with wastewater treatment facilities.

The number and type of vehicles and equipment required are shown in Table 12-5, but typically, ground based non-chemical control activities would require the periodic use of light trucks, such as pickup trucks. and perhaps jeeps. In addition to the primary vehicles and equipment that would be used by each District, Table 12-5 also shows the range of noise levels that they typically would generate at 50- and 400-foot distances from the source. This table also shows the land use types where activities would occur.

Table 12-5 Physical Control Alternative for SCMAD–Primary Equipment Use, Noise Levels, and Land Use Types

		Predicted Noise Level (dBA)[a]		Land Use Types				
Activity	**Equipment**	**50 feet**	**400 feet**	**Residential**	**Commercial**	**Industrial**	**Agricultural**	**Open Space**
Ground Surveillance & Application/Mgt	Light trucks	83	65	●			●	●

12.2.4.1 Exceedance of Noise Standards

The discussion under the Surveillance Alternative is generally applicable to the Physical Control Alternative because similar types of vehicles and equipment would be used, or they would generate similar amounts of noise and be used for a similar length of time. Noise generated by the Physical Control Alternative would not exceed noise standards due to the sporadic, temporary nature of the impact.

> **Impact N-3:** Use of equipment and vehicles would increase noise levels during operations, but this increase would not exceed regulatory thresholds. This impact is **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.

12.2.4.2 Substantial Temporary Increase in Noise Levels

The discussion under the Surveillance Alternative is generally applicable to the Physical Control Alternative because similar types of vehicles and equipment would be used, or they would generate similar amounts of noise and be used for a similar length of time. The types of activities that would occur under this alternative already are being implemented by the District and noise impacts, therefore, would be comparable to those that already occur. In addition, BMPs would be implemented as appropriate by providing advance notification of noise-generating activities expected to be of concern to the public based on past complaints and providing a means for registering public complaints about noise, thus further minimizing the potential for public annoyance.

Impact N-4: Use of equipment and vehicles would cause a temporary increase in noise levels during operations. This increase would not be substantial, and therefore is **less than significant** based on the frequency and duration of the activity, resulting noise levels, comparability to noise resulting from existing activities, and implementation of BMPs. No mitigation is required.

12.2.5 Vegetation Management Alternative

Certain elements of the Vegetation Management Alternative would not directly generate noise, such as advising property owners/managers to undertake vegetation management activities on their property as a tool to reduce the habitat value of sites for mosquitoes or to aid production or dispersal of mosquito predators, as well as to allow District staff's access to mosquito habitat for surveillance and other control activities. Additional expertise is obtained from appropriate agencies that can also assist in teaching landowners how to perform vegetation management on their property.

Although rarely done in recent years, the District may choose to do any of the following activities in the future if feasible. For vegetation management, District staff may use hand tools or other mechanical means (i.e., heavy equipment) for vegetation removal or thinning and may sometimes apply herbicides (chemical pesticides with specific toxicity to plants) to improve surveillance or reduce mosquito vector habitats. Vegetation removal or thinning would primarily occur in aquatic habitats to assist with the control of mosquitoes. To reduce the potential for mosquito breeding associated with water retention and infiltration structures, District staff may request the owners of the structures to clear weeds and other obstructing vegetation in wetlands and retention basins. Tools ranging from shovels and pruners to chain saws and "weed whackers" up to heavy equipment can all be used at times to clear plant matter that either prevents access to mosquito breeding sites or that prevents good water management practices that would minimize mosquito populations. The District does not currently perform any brushing activities; however, should it decide to, District "brushing" activities would rely almost entirely on hand tools.

The number and type of vehicles and equipment required, are shown in Table 12-6, but typically, vegetation management would require the periodic use of light trucks, such as pickup trucks and perhaps jeeps. Water surveillance would require the use of ATVs and, occasionally, boats. and sprayers In addition to the vehicles and equipment that would be used by the District, Table 12-6 shows the range of noise levels that they typically would generate at 50- and 400-foot distances from the source and the land uses that would be affected. Shovels and other hand tools that generate no noise or minimal noise are not included in this table.

Table 12-6 Vegetation Management Alternative for SCMAD–Primary Equipment Use, Noise Levels, and Land Use Types

		Predicted Noise Level (dBA)		Land Use Types				
Activity	**Application Equipment**	**50 feet**	**400 feet**	**Residential**	**Commercial**	**Industrial**	**Agricultural**	**Open Space**
Ground Surveillance & Application/Mgt	Light trucks	83	65			●	●	●
	ATVs	87	69			●	●	●
	Weed eater, chain saw	67-72	49-54					●
	Airboat, other boats	75-95	57-77					●
	Sprayer	75	57					●

12.2.5.1 Exceedance of Noise Standards

The discussion under the Surveillance Alternative is generally applicable to the Vegetation Management Alternative because similar types of vehicles and equipment would be used, or they would have comparable noise levels and also would be used for brief periods of time over multiple locations. Noise generated would be similar to that which already occurs and would not exceed noise standards.

> **Impact N-5:** Use of equipment and vehicles would increase noise levels during operations, but this increase would not exceed regulatory thresholds. This impact is **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.

12.2.5.2 Substantial Temporary Increase in Noise Levels

The discussion under the Surveillance Alternative generally is applicable to the Vegetation Management Alternative because similar types of vehicles and equipment would be used, or they would have comparable noise levels and also would be used for brief periods of time over multiple locations. Noise generated would be similar to that which already occurs and would not result in a substantial temporary increase in noise levels. In addition, BMPs would be implemented as appropriate by providing advance notification of noise-generating activities expected to be of concern to the public and providing a means for registering public complaints about noise, thus further minimizing the potential for public annoyance. Airboats also would be required to operate only in certain permitted areas, minimizing the potential for impacts in other areas.

> **Impact N-6:** Use of equipment and vehicles would cause a temporary increase in noise levels during operations. This increase would not be substantial, and therefore is **less than significant** based on the frequency and duration of the activity, resulting noise levels, comparability to noise resulting from existing activities, and implementation of BMPs. No mitigation is required.

12.2.6 Biological Control Alternative

The Biological Control Alternative involves the use of mosquito pathogens, parasites, and predators (i.e., mosquitofish). The parasites are not commercially available at present. The other options would generate noise, from the periodic use of light trucks for distribution of mosquitofish at artificial water bodies and natural waterways according to District Policies listed under 2.3.4.3.2., and occasionally, ATVs, boats, and sprayers (for the pathogens which are discussed under the Chemical Control Alternative for most resources). Examples of bacteria pathogenic to mosquitoes are *Bs*, the several strains of *Bti,* and *Saacharopolyspora spinosa* (or spinosad).

The number and type of vehicles and equipment required, are shown in Table 12-7, which also shows the range of noise levels that they typically would generate at 50- and 400-foot distances from the source and the land uses that would be affected.

Table 12-7 Biological Control for SCMAD–Primary Equipment Use, Noise Levels, and Land Use Types

		Predicted Noise Level (dBA)			Land Use Types				
Activity	**Equipment**	**50 feet**	**400 feet**	**500 feet**	**Residential**	**Commercial**	**Industrial**	**Agricultural**	**Open Space**
Ground Surveillance & Application/Mgt	Light trucks	83	65	—	•	•	•	•	•

12.2.6.1 Exceedance of Noise Standards

The discussion under the Surveillance Alternative is generally applicable to the Biological Control Alternative because similar types of vehicles and equipment would be used, or they would have similar noise levels and also would be used for brief periods of time over multiple locations. Additionally, helicopters or fixed-wing aircraft would be used under this alternative, but they, too, would operate only briefly in any given area. The brief increase in noise from the periodic use of helicopters and fixed-wing aircraft and other vehicles and equipment would not exceed noise standards.

> **Impact N-7:** Use of equipment and vehicles would increase noise levels during operations, but this increase would not exceed regulatory thresholds. This impact is **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.

12.2.6.2 fixed-wing Substantial Temporary Increase in Noise Levels

The discussion under the Surveillance Alternative generally is applicable to the Biological Control Alternative because similar types of vehicles and equipment would be used, or they would have similar noise levels and also would be used for brief periods of time over multiple locations.

> **Impact N-8:** Use of equipment and vehicles would cause a temporary increase in noise levels during operations. This increase would not be substantial and, therefore, is **less than significant** based on the frequency and duration of the activity and resulting noise levels, and implementation of BMPs. No mitigation is required.

12.2.7 Chemical Control Alternative

A variety of activities would be implemented under the Chemical Control Alternative. Some activities, such as the application of larvicides to unmaintained swimming pools, either by hand or with hand-held non-motorized equipment, would not result in noise impacts, other than from the use of vehicles to access the swimming pool treatment sites. Others would require more extensive use of vehicles and equipment.

The District would use a variety of techniques and equipment to apply mosquito larvicides, including hand-held sprayers, backpack sprayers and blowers, truck- or ATV-mounted spray rigs, and helicopters or fixed-wing aircraft. The District uses conventional pickup trucks and ATVs as larvicide vehicles. Equipment used in ground applications of liquid formulations include hand-held sprayers (handcans or spray bottles), and backpack sprayers and blowers. Hand-held sprayers (handcans) are standard 1- or 2- or 3-gallon garden style pump-up sprayers used to treat very small isolated areas. Backpack sprayers are either hand pump-up for liquid applications and have a 2.5/3 to 5-gallon tank. or are gas powered. When large areas are simultaneously producing mosquito larvae at densities exceeding District treatment thresholds, then the

District may use helicopters or fixed wing aircraft to apply larvicides. Aerial application of larvicides is a relatively infrequent activity for the District with the exception of the annual fall flooding of seasonal wetlands managed as waterfowl habitat. The 5-year average (2008-2012) for the number of applications made to non-seasonal waterfowl habitat areas was 9 with the average number of acres treated per application being 289.5 acres. The 5-year average (2008-2012) for the number of applications made to seasonal waterfowl habitat was 27. The average number of acres treated per application during this period was 197.0 acres. However, larval production can vary substantially, and the District is capable of undertaking more frequent or extensive operations if necessary. Aerial application of liquid larvicides typically occurs during daylight hours and at an altitude above the treatment site of less than 40 feet. Granular and pellet applications would occur during daylight hours at a less-than-50-foot altitude.

The most common form of adulticide application is via insecticide aerosols at very low dosages using ULV- equipment mounted on trucks, ATVs, golf carts, and watercraft or hand-held sprayers for ground applications. Residual treatments for adult mosquitoes consist of an application using a material generally applied with a compressed air sprayer to the preferred foliage, buildings, or resting areas of the mosquito species Although this is not a technique currently used by the District, it may become a necessary “tool” in the future if WNV outbreaks occur.

Aerial applications using helicopters and fixed-wing aircraft are used to obtain effective control in areas bordered by extensive mosquito production sites or with small, narrow, or inaccessible network of roads. The flight parameters differ by program and technique. Some operations fly during daylight hours so their applications begin either at dawn or before sunset and work into twilight. The aircraft can be flown at a less than 200-foot altitude, which may make it easier to hit the target area. Adulticiding operations may be conducted in darkness, typically after twilight or during pre-dawn hours before dawn. The aircraft typically are flown between 200- and 300-foot altitudes. Swath widths vary from operation to operation but are normally set somewhere between 400 and 1,200 feet. Aerial applications may be conducted over, but are not limited to, the following land uses within the Program Area: salt marsh, diked marsh, seasonal wetlands; evaporation ponds and wastewater ponds; and agricultural, residential, commercial, industrial, and recreational areas.

The number and type of vehicles and equipment required, are shown in Table 12-8, which also shows the range of noise levels that they typically would generate at 50- and 400-foot distances from the source and the land uses that would be affected. Noise from helicopters also is shown at a 500-foot distance. All land use types potentially could be treated through aerial applications, although those shown are the most likely to be affected.

Table 12-8 Chemical Control Alternative for SCMAD–Primary Equipment Use, Noise Levels, and Land Use Types

		Predicted Noise Level (dBA)[a]			Land Use Types				
Activity	Equipment	50 feet	400 feet	500 feet	Residential	Commercial	Industrial	Agricultural	Open Space
Ground Surveillance & Application/Mgt	Light trucks	83	65	—	•			•	•
Water Surveillance & Applications/Mgt	ATVs	87	69	—					•
Aerial Application*	Helicopters/fixed wing aircraft			84-87					•

[a] Noise from aircraft used for agricultural operations, such as those expected to be used for aerial applications, is not regulated by the FAA and, therefore, no noise information is available. Noise likely would be comparable to that of helicopters.

12.2.7.1 Exceedance of Noise Standards

The discussions under the Surveillance Alternative and Biological Control Alternative are generally applicable to the Chemical Control Alternative because similar types of vehicles and equipment would be used, or they would have comparable noise levels and also would be used for brief periods of time over multiple locations. Helicopters or fixed-wing aircraft would be used under this alternative; they would be used only briefly in any given area and generally would operate in open-space or agricultural areas, although other land use types could be affected as well.

> **Impact N-9:** Use of equipment and vehicles would increase noise levels during operations, but this increase would not exceed regulatory thresholds. This impact is **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.

> **Impact N-10:** Helicopter/fixed wing aircraft use would temporarily increase noise levels during operations, but would not exceed regulatory thresholds. This impact is **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.

12.2.7.2 Substantial Temporary Increase in Noise Levels

The discussions under the Surveillance Alternative and Biological Control Alternative are generally applicable to the Chemical Control Alternative because similar types of vehicles and equipment would be used, or they would have similar noise levels and also would be used for brief periods of time over multiple locations. As discussed in the preceding section, helicopters/fixed-wing aircraft also would be used, but only for brief periods up to several times a year, and they would affect any given area only briefly. In addition, BMPs would be implemented as appropriate by providing advance notification of noise-generating activities expected to be of concern to the public and providing a means for registering public complaints about noise, thus further minimizing the potential for public annoyance. Airboats also would be required to operate only in certain permitted areas, minimizing the potential for impacts in other areas.

> **Impact N-11:** Use of equipment and vehicles would cause a temporary increase in noise levels during operations. This increase would not be substantial and, therefore, is **less than significant** based on the frequency and duration of the activity, resulting noise levels, comparability to noise resulting from existing activities, and implementation of BMPs. No mitigation is required.

> **Impact N-12:** Helicopter/fixed-wing aircraft/airboat use would temporarily increase noise levels during operations, but this increase would not be substantial. This impact is **less than significant** based on the frequency and duration of the activity, resulting noise levels, and implementation of BMPs. No mitigation is required.

12.2.8 <u>Other Activities</u>

The District uses light trucks for activities not associated with Program implementation. Consequently, these non-mosquito control activities such as employee travel to meetings and facilities maintenance are not evaluated further under CEQA.

12.2.9 Cumulative Impacts

Cumulative noise impacts are discussed in Section 13.10. In summary, the potential for cumulative impacts is low, and any impacts that did occur would be of short duration and less than significant. **The incremental noise impacts from any of the Program alternatives, individually or in combination for the entire Program, would not be cumulatively considerable and would not trigger cumulative noise impacts in a given area**.

12.2.10 Environmental Impacts Summary

Table 12-9 is a summary of all of the potential noise impacts associated with the Program alternatives in comparison to existing conditions. The number of each statement correlates to its number in the text.

Table 12-9 Summary of Noise Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Effects on Noise					
Impact N-1: Use of equipment and vehicles would increase noise levels during operations, but this increase would not exceed regulatory thresholds. This impact is **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.	LS	na	na	na	na
Impact N-2: Use of equipment and vehicles would cause a temporary increase in noise levels during operations. This increase would not be substantial and, therefore, is **less than significant** based on the frequency and duration of the activity, resulting noise levels, comparability to noise resulting from existing activities, and implementation of BMPs. No mitigation is required.	LS	na	na	na	na
Impact N-3: Use of equipment and vehicles would increase noise levels during operations, but this increase would not exceed regulatory thresholds. This impact **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.	na	LS	na	na	na
Impact N-4: Use of equipment and vehicles would cause a temporary increase in noise levels during operations. This increase would not be substantial**,** and therefore is **less than significant** based on the frequency and duration of the activity, resulting noise levels, comparability to noise resulting from existing activities, and implementation of BMPs. No mitigation is required.	na	LS	na	na	na
Impact N-5: Use of equipment and vehicles would increase noise levels during operations, but this increase would not exceed regulatory thresholds. This impact is **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.	na		LS	na	na

Table 12-9 Summary of Noise Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact N-6: Use of equipment and vehicles would cause a temporary increase in noise levels during operations. This increase would not be substantial, and therefore is **less than significant** based on the frequency and duration of the activity, resulting noise levels, comparability to noise resulting from existing activities, and implementation of BMPs. No mitigation is required.	na	na	LS	na	na
Impact N-7: Use of equipment and vehicles would increase noise levels during operations, but this increase would not exceed regulatory thresholds. This impact is **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.	na	na	na	LS	na
Impact N-8: Use of equipment and vehicles would cause a temporary increase in noise levels during operations. This increase would not be substantial and, therefore, is **less than significant** based on the frequency and duration of the activity and resulting noise levels, and implementation of BMPs. No mitigation is required.	na	na	na	LS	na
Impact N-9: Use of equipment and vehicles would increase noise levels during operations, but this increase would not exceed regulatory thresholds. This impact is **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.	na	na	na	na	LS
Impact N-10: Helicopter/fixed wing aircraft use would temporarily increase noise levels during operations, but would not exceed regulatory thresholds. This impact is **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.	na	na	na	na	LS
Impact N-11: Use of equipment and vehicles would cause a temporary increase in noise levels during operations. This increase would not be substantial and, therefore, is **less than significant** based on the frequency and duration of the activity, resulting noise levels, comparability to noise resulting from existing activities, and implementation of BMPs. No mitigation is required.	na	na	na	na	LS

Table 12-9 Summary of Noise Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact N-12: Helicopter/fixed-wing aircraft/airboat use would temporarily increase noise levels during operations, but this increase would not be substantial. This impact is **less than significant** based on the frequency and duration of the activity, resulting noise levels, and implementation of BMPs. No mitigation is required.	na	na	na	na	LS

LS = Less-than-significant impact

N = No impact

na = Not applicable

SM = Potentially significant but mitigable impact

SU = Significant and unavoidable impact

12.2.11 Mitigation and Monitoring

No mitigation measures or monitoring are required because no significant impacts were identified.

13 Cumulative Impacts

"Cumulative impacts" are defined as "two or more individual effects which, when considered together, are considerable or compound or increase other environmental impacts (CEQA Guidelines Section 15355). Previously approved projects will be part of the baseline, and future projects that are not now known are speculative and need not be considered in the analysis. However, the analysis does need to consider the impacts of the proposed project in combination with any other reasonably foreseeable projects, and all of those impacts must be considered against the environmental baseline.

The cumulative impact from several projects is the change in the environment that results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time. The question is whether the project's incremental effect is cumulatively considerable. For a project to have a cumulative impact, it must have some incremental impact in the category being studied. For example, if the cumulative projects will all have impacts on Swainson's hawk, but the proposed project will not have any incremental impact on Swainson's hawk, the project has no cumulative impacts on Swainson's hawk. Conversely, if the project will have a large enough significant impact, such that it may affect an entire watershed or air basin, it may be considered to have significant cumulative impacts even if no other projects will contribute impacts. The determination is whether the proposed project's incremental contribution to a cumulative impact results in a potentially "considerable" (i.e., significant) cumulative impact, and, if so, whether the project's incremental contribution can be mitigated to a less-than-significant level.

The concern then is to assess the incremental environmental impact that can occur from a variety of sources, a summation of multiple insignificant impacts that, when taken together, result in a significant impact. If so, then the project's incremental contribution to the combined significant cumulative impact may be "cumulatively considerable." In summary, only the less-than-significant and potentially significant impacts of the District's Program alternatives have the potential to add an incremental effect to a cumulatively significant impact.

CEQA Guidelines Section 15130 requires that an EIR discuss cumulative impacts of a project and determines whether the project's incremental effect is "cumulatively considerable." The definition of cumulatively considerable is provided in Section 15065(a)(3):

> *"Cumulatively considerable" means that the incremental effects of an individual project are significant when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.*

According to CEQA Guidelines Section 15130(b),

> *The discussion of cumulative impacts shall reflect the severity of the impacts and their likelihood of occurrence, but the discussion need not provide as great detail as is provided for the project alone. The discussion should be guided by standards of practicality and reasonableness, and should focus on the cumulative impact to which the identified other projects contribute rather than the attributes of other projects which do not contribute to the cumulative impact.*

For purposes of this PEIR, the District's Program would have a significant cumulative effect if:

(1) The cumulative effect of related projects (past, current, and probable future projects) without the project are not significant and the project's incremental

impact is substantial enough, when added to the cumulative effects, to result in a significant impact; or

(2) The cumulative effects of related projects (past, current, and probable future projects) without the project are already significant and the project contributes considerably to the effect. The standards used herein to determine considerability are either that the impact must be substantial or must exceed an established threshold of significance.

Mitigation measures are to be developed, where feasible, that reduce the project's contribution to significant cumulative effects to a less-than-significant level.

To clarify, CEQA Guidelines Section 15064 (h) (4) states that the mere existence of significant cumulative impacts caused by other projects alone shall not constitute substantial evidence that the proposed project's incremental effects are cumulatively considerable. Where cumulative impacts are significant, any level of incremental contribution to that impact by the proposed project does not have to be called out as cumulatively considerable. Furthermore, when the District's IMMP makes no incremental contribution at all to a significant cumulative impact caused by other plans, programs, and projects, i.e., the "no impact" determination for a Program alternative, it cannot be called cumulatively considerable.

Two methods exist for analyzing the cumulative impacts of past, present, and reasonably foreseeable future projects: the "list method" and the "summary of projections method" (CEQA Guidelines Section 15130). Both of these methods are most appropriate to the evaluation of land development or projects involving changes in land use and related activities.

> The list method requires a discussion of related past, present, and future projects; and in the case of human health, it would require discovering and disclosing impacts to public health from all of these projects. This approach is not practical given the Program's extent to its Service Area and adjacent counties for a multi-county Program Area, which makes the development of a list of projects most difficult and would then require a human health impact assessment for a very long list and variety of projects potentially creating a physical change in the environment.

> The summary of projections method relies on projections contained in approved land use documents such as general plans, specific plans, and local coastal plans to serve as the foundation for the cumulative analysis. The issue is whether the project under evaluation is consistent with the forecasts of economic and population growth contained in the planning documents and, therefore, already addressed in the certified EIRs on these plans and projects. Can the agency rely on the cumulative analyses addressed in a prior EIR to say that no further analysis is needed?

The listing of all of the projects occurring in an area is not practical for this evaluation of a Program that could occur over multiple counties in California. The District's IMMP would not result in additional housing or commercial/industrial development in a treatment area. The alternative "summary of projections" method is also not practical because it is based on summaries of growth in city and county plans, which are not relevant for the Program as it does not induce growth or develop land. Because the Program Area is large, the impacts are explained in the context of a regional environmental concern, and the analysis includes consideration of regional trends in pesticide use from 2006 through 2010 (Section 13.4), where appropriate, as an alternative to the growth projections contained in local general plans.

The following discussion of cumulative impacts is for resources and environmental concerns with less-than-significant or potentially significant impacts and the geographic scope of the analysis is the District's Program Area (i.e., Service Area and adjacent counties where service could be provided upon request). A summary of the cumulative impact determinations by affected resources is presented at the end of the chapter.

13.1 Urban and Rural Land Uses

None of the Program alternatives would have any potentially significant impacts on the quantity and/or quality of recreational opportunities within the District's Program Area; however, all of the alternatives except for Biological Control could have less-than-significant impacts. Concerning land use regulations and policies in the Program Area, none of the Program alternatives would have impacts (i.e., determinations of no impact). However, the Chemical Control Alternative may limit recreational access and diminish recreational quality on a short-term basis during application events, a less-than-significant incremental impact. Due to the isolated nature of these events and the extensive recreational opportunities on public lands within the Program Area (i.e., no existing significant cumulative impact within the Program Area), the small incremental potential impacts on recreational opportunities from five of the Proposed Program alternatives when combined would not likely cumulatively contribute to recreational impacts in the region. No cumulative significant impacts to urban and rural land uses are anticipated when all of the Program's incremental impacts and the impacts of other activities in the region are considered together.

13.2 Biological Resources – Aquatic

Cumulative impacts, as they relate to aquatic resources, includes past, present, and reasonably foreseeable actions that potentially impact aquatic organisms, including fish and nontarget invertebrates. Cumulative impacts can result from individually minor, but collectively significant, projects taking place over a period of time. The determination is whether a proposed project's incremental contribution to a cumulative impact results in a potentially "considerable" (i.e., significant) cumulative impact, and, if so, whether that project's incremental contribution can be mitigated to a less-than-significant level.

The following is a discussion of how the Program impacts could become cumulatively considerable with other impacts in the region. To make this determination, consideration is given to the combined contribution of Program impacts considered together with impacts that exist outside of the Program Area. The issue is whether the Program's incremental contribution to the combined significant cumulative impact is "cumulatively considerable."

The cumulative impact issues addressed first are regional fisheries trends, loss of shallow-water habitats, loss of wetlands, weed control, and trends in pesticide use (Section 13.2.1). Then the impacts by alternative are evaluated (Section 13.2.2).

13.2.1 Regional Fisheries Trends

13.2.1.1 Pelagic Organism Decline (POD)

POD refers to the recent (2002–present) steep decline of pelagic fishes (i.e., fish that occupy open-water habitats) within the Bay-Delta estuary (Armor et al. 2005; CDWR and CDFG 2007; Sommer 2007; Baxter et al. 2010). This environmental issue has emerged as one of overwhelming concern in the Delta.

The issues surrounding POD were announced in early 2005 as a possible change in the estuary's ability to support pelagic species and appeared to be a "step-change" from the preceding long-term decline. Four fish species are of primary concern: delta smelt, longfin smelt, young-of-year striped bass, and threadfin shad. From 2002 to 2007, despite moderate hydrologic conditions in the estuary, which would have been expected to result in moderate increases in population sizes, the populations of these species experienced sharp declines. Populations of each of the four species have been at or near all-time record lows since 2002. The numbers of many pelagic species increased substantially in 2011, but declined again to values near historic lows in 2012, based on the fall mid-water trawl index (CDFW 2013). This change has persisted for a sufficiently long period to conclude that it is the result of something other than the pattern of widely variable population levels observed historically or as part of the long-term decline previously observed.

The factors considered most likely to be responsible for POD are previous abundance of these species; changes in habitat, particularly changes in turbidity and the salinity field in the Delta, invasive weeds and blue green algae blooms, and ammonia and pyrethroid toxicity; predation, particularly from introduced species such as striped bass, largemouth bass, and Mississippi silversides, and entrainment at the Central Valley Project and State Water Project Diversions; food-web effects from invasive clams; and changes in the phytoplankton and zooplankton community (CDWR and CDFG 2007; Sommer 2007; Baxter et al. 2010). These factors result in an existing significant cumulative impact.

Many of the Interagency Ecological Program studies to evaluate POD's causes have focused on these factors. To date, research has failed to identify a single factor responsible for the decline of all species or even that of a single species (CDWR and CDFG 2007; Sommer 2007; Baxter et al. 2010). POD researchers currently believe that important factors responsible for the decline may be different for each species and that even for a single species these factors may differ between seasons and by hydrologic condition (Wet and Dry years). These factors may operate cumulatively to cause the observed population declines.

The POD Management Team has hypothesized that a number of drivers have combined over time to decrease ecosystem resilience and result in a "regime shift" for the Delta and Suisun Bay region (Baxter et al. 2010). The drivers of the hypothesized regime shift include outflow, salinity, landscape, temperature, turbidity, nutrients, contaminants, and harvest. This hypothesis is currently under investigation.

The District borders on San Pablo and Suisun Bays, downstream from the Delta where the Physical Control and Vegetation Management alternatives would contribute to landscape habitat modifications, while the Chemical Control Alternative would contribute to contaminants. The BMPs associated with the implementation of these alternatives substantially reduce these potential effects to be less than significant at the Program level. However, these less-than-significant Program effects, in combination with the regional context of impacts, would be cumulatively considerable.

> The District's Physical Control and Vegetation Management alternatives are limited to small areas of highly modified habitat. These areas are not primary habitat for POD species. Because the areas where these activities occur are very small relative to the overall area of wetlands in the region, these activities are not expected to have any substantive effect on food production for POD species. Therefore, these two alternatives do not contribute substantially to POD.

> The Chemical Control Alternative includes the use of pyrethroid pesticides, which have been linked to POD. The District uses pyrethroid pesticides as part of an IPM or IMM approach, where application of pyrethroids is several levels down in the selection of control measures, so the use of pyrethroids is limited. When pyrethroids are used, the District preferentially uses pyrethroids with limited persistence in the environment. The District uses the minimal effective amounts of these chemicals over terrestrial and aquatic habitats and employs BMPs that minimize or avoid impacts to habitat supporting pelagic fish (see Section 2.9.1). Thus, the Chemical Control Alternative does not contribute substantially to the concentrations of pyrethroids in the environment or to the POD.

The Surveillance and Biological Control Alternatives involve access, monitoring, and control activities with very limited potential to impact POD. Therefore, all of the Program alternatives have a less-than-significant cumulative impact on POD.

13.2.1.2 Salmonid Population Trends

Salmonid population trends were evaluated in a number of 5-year status reviews completed by NOAA Fisheries in 2011 (NOAA Fisheries 2011 a-f). These reviews indicated that most populations of salmonids showed some evidence of decline, although data are very sparse for some distinct population segments (steelhead) or evolutionarily significant units (Chinook and Coho salmon) (also see NOAA 2011g). The declines in the 5-year period of review were largely due in part to poor ocean conditions in 2004 and 2005, which resulted in poor adult returns in 2007 through 2009 and drought (Lindley et al. 2009). However, based on the status reviews for these species, the principal factors resulting in their listing include:

> Loss, degradation, simplification, and fragmentation of habitat caused by a variety of activities including logging, road construction, urban development, mining activities, agriculture, ranching, and recreation

> Reduction or elimination of habitat or blocked access to habitat caused by water storage, withdrawal, conveyance and diversion facilities for agriculture, flood control, and domestic and hydropower purposes

> Point and nonpoint sources of pollution

> Loss of riparian habitats

The Physical Control and Vegetation Management Alternatives would contribute to the first and last factors, while the Chemical Control Alternative would contribute to the third factor. These activities generally occur over small areas and have little impact on primary salmonid habitat. The BMPs associated with the implementation of these alternatives substantially reduce these potential impacts to be less than significant at the Program level, and these alternatives do not contribute substantially to the total amount of habitat loss for salmonids in the region.

The Chemical Control Alternative applies chemicals in aquatic environments at levels that have minimal impacts to fisheries resources or their food supply. BMPs restrict the application of chemicals with higher potential to harm fish from being used in water, and these chemicals are used in very small amounts and with low frequency relative to other sources in the region. The District also preferentially uses chemicals that degrade quickly in the environment, further reducing the risk associated with this alternative. Thus, the Chemical Control Alternative does not contribute substantively to chemical loads in salmonid habitats.

The Surveillance and Biological Control Alternatives involve access, monitoring, and control activities with very limited potential to impact salmonids. Therefore, all of the Program alternatives have a less-than-significant cumulative impact on salmonid population trends.

13.2.2 <u>Program Alternatives</u>

The Surveillance Alternative's maintenance of access routes and the sampling/ monitoring of mosquito populations have less-than-significant impacts on aquatic habitats, native fish or aquatic invertebrates, special status species, or HCPs and NCCPs along with the Biological Control Alternative's use of mosquitofish in artificial/man-made water bodies and in selected natural waters (with restrictions contained in Mitigation Measure AR-18) are not cumulatively considerable given their limited disruption to natural habitats. Consequently, the focus of the analysis below is on the Physical Control, Vegetation Management, and Chemical Control Alternatives.

13.2.2.1 Physical Control Alternative

The draining or filling of shallow-water habitats in natural areas under the Physical Control Alternative would be cumulative with historic and ongoing impacts to these habitats from other land management practices including flood control, urbanization, and channelization. The majority of such activities occurring as part of the action would occur in artificial environments such as drainage ditches, retention ponds, etc. As described in Section 4.2.4.1, shallow-water habitats can be important habitats for young fish and other sensitive aquatic organisms. Floodplains, off-channel pools and backwaters, and wetlands provide high quality habitat for fry and tadpoles that are subject to predation in deeper, connected habitats. However, where fry are present, they would prey on mosquito larvae and, thus, these areas would likely not need treatment. However, conditions in these habitats may change from seasonally or annually, depending on tides, flows, and precipitation patterns, so that a pool that supports fish or amphibians in one year may not have sufficient water to do so in other years.

This Program's Physical Control Alternative occurs in the context of an environment that is highly modified by human use, for agriculture, urbanization, and flood control. It is estimated that more than 90 percent of wetland and riparian habitats in California have been lost to human development (California Natural Resources Agency 2010). Today, recognition of the importance of wetlands is much greater and many wetland protection and restoration projects are underway throughout the state, including, but not limited to, the HCP/NCCPs described in Section 4.1.4. Activities affecting wetlands are subject to permitting requirements from a variety of agencies including the USACE, SWRCB or RWQCBs, CDFW, and others. However, wetlands continue to be affected by urban and agricultural development, roadwork, and other activities (California Natural Resources Agency 2010), an existing significant cumulative impact. The District's activities within this context do not contribute substantially to the cumulative effects of other activities within the region in part due to the constraints of required permits. Therefore, the Program would have a less-than-significant cumulative impact on the amount or quality of aquatic habitat.

13.2.2.2 Vegetation Management Alternative

The vegetation within and around aquatic habitats is an important component of the aquatic ecosystem, as described in Section 4.2.5. As described above, historic development has adversely affected wetland communities to a great extent, in spite of their ecological importance. While these communities enjoy much more protection now than they have historically, impacts continue to occur because of human development.

The Vegetation Management Alternative includes measures to remove and maintain vegetation through manual, mechanical, and chemical treatments. Most of this activity would occur in artificial environments, where special-status species would not be impacted, but some activity in natural environments could occur. Similar activities may be undertaken by flood control or water supply agencies, and private and public landowners.

The District does not currently, but may choose to perform weed abatement activities in the future under special circumstances. These weed abatement activities may involve the use of manual, mechanical, and chemical controls to reduce or eliminate noxious weeds. California Food and Agriculture Code 5261 defines a noxious weed as "any species of plant that is, or is liable to be, troublesome, aggressive, intrusive, detrimental, or destructive to agriculture, silviculture, or important native species, and difficult to control or eradicate, which the Secretary, by regulation, designates to be a noxious weed."

Numerous entities throughout the Program Area have weed control programs that they implement. These entities include California Department of Transportation and local roads departments, local utilities, service districts, government, agricultural districts, and public and private landowners. Information about the coordination of such efforts can be obtained from the CDFA's Noxious Weed Information Project (http://www.cdfa.ca.gov/plant/ipc/noxweedinfo/noxweedinfo_hp.htm). Fourteen federal, state, and county agencies founded the California Interagency Noxious Weed Coordinating Committee in 1995 to coordinate the management of noxious weeds. This group has assembled a variety of tools for those involved in weed control activities (http://www.cdfa.ca.gov/plant/ipc/CINWCC/cinwcc_hp.htm). These tools are designed to minimize disruption of native plants and to improve habitat for them. The District's activities would be compliant with these tools.

Invasive weeds can disrupt native habitats. They compete with and may displace native plants, which may interfere with ecosystem functions, by altering and reducing the food resources available to primary and secondary consumers. Weed control activities the District may perform would be cumulative with those other entities perform. These activities would focus on areas with dense concentrations of weeds and not on individual weed plants distributed broadly in otherwise natural habitats. Thus, weed control activities may affect native plants, as these species may lie within treatment areas, but the effects on individuals of native species are minimized, and the overall effect is likely beneficial, as native species will have less competition in treated areas and, thus, would be expected to be more successful. The District does not use chemicals for vegetation management and, therefore does not contribute to herbicide loads in the aquatic environment. The District may use herbicides in the future, but these incremental effects would not be cumulatively considerable due to the beneficial effect noted above and BMPs employed to mitigate impacts. Therefore, there is not an existing significant cumulative impact to native habitats. The District's incremental activities associated with the control of invasive weeds would not be cumulatively considerable; i.e., less than significant.

13.2.2.3 Chemical Control Alternative

As described in Section 13.4 (Ecological Health) and 13.5 (Human Health), historic trends in pesticide use vary from county to county based on information available from CDPR. Within the District's Program Area as a whole, pesticide use increased by approximately 277 tons (554,462 pounds) in 2010 relative to 2006. However, the use of pesticides and herbicides will continue to be necessary. Many of these chemicals exhibit some environmental persistence and a number of water bodies have been listed as impaired for sediment toxicity, pesticides, or unknown toxicity (see Table 9-1). The uses of pesticides under the Chemical Control Alternative would be cumulative with uses of pesticides by agricultural, industrial, governmental, and residential users, an existing significant cumulative impact. Contaminants and pesticides have been hypothesized to contribute to declines in fish populations. The District's relative contribution to the loads of such concentrations is small compared with other users for the widely used pesticides. The District preferentially uses nonchemical alternatives and when using chemical alternatives, uses chemicals that are not persistent in the environment when chemicals are applied. As such, the District's Chemical Control Alternative does not contribute substantially to pesticide loads in the aquatic environment. The Chemical Control Alternative has a less-than-significant cumulative impact on pesticide loads.

13.3 Biological Resources – Terrestrial

Cumulative impacts, as they relate to terrestrial resources, include past, present, and reasonably foreseeable actions that potentially impact terrestrial mammalian and avian wildlife, herptiles, aquatic organisms, nontarget invertebrates which include beneficial insects that are pollinators, and botanical resources. Cumulative impacts can result from individually minor, but collectively significant, projects taking place over a period of time. The determination is whether a proposed project's incremental contribution to a cumulative impact results in a potentially "considerable" (i.e., significant) cumulative impact, and, if so, whether that project's incremental contribution can be mitigated to a less-than-significant level.

The following is a discussion of how the Program impacts could become cumulatively considerable with other impacts in the region. To make this determination, consideration is given to the combined contribution of Program impacts considered together with impacts that exist outside of the Program Area. The issue is whether the Program's incremental contribution to the combined significant cumulative impact is "cumulatively considerable."

In summary, only the Program alternatives' less-than-significant and potentially significant impacts have the potential to add an incremental effect to a cumulatively significant impact. In Section 5.2, the Surveillance, Physical Control, Vegetation Management, Chemical Control, and Other Nonchemical Control Alternatives" impacts to terrestrial resources were determined to be less than significant. (The Biological Control Alternative's use of mosquitofish had no impact to terrestrial resources.) The key issues for consideration herein are potential effects on beneficial insect pollinators from chemical applications and the potential cumulative impacts associated with Vegetation Management and Chemical Control Alternatives.

Program alternative impacts to terrestrial resources were identified as "less than significant" (LS) if the likely exposure to terrestrial habitats, to native terrestrial plant or animal populations, or to special-status species was either very short or the application medium (spray or liquid) was typically highly dilute (ULV techniques). Additionally, the LS determination was applied if it was indicated that exposure could be considered likely incomplete due to little or no overlap of application areas and typical habitat associated with nontarget special-status or sensitive terrestrial species.

13.3.1 Effects on Pollinators

Some of the currently available insecticides used to control mosquitoes may also exhibit toxicity to selected beneficial insects. The District employs a number of strict BMPs specifically designed to minimize or eliminate the impact of chemical treatments on nontarget insects such as honeybees. Of particular concern recently is a group of insecticides known as neonicotinoids, which target the nervous system of target insects, resulting in paralysis and death (Harmon 2012). However, reports implicate this group of pesticides as one of the possible contributors to reported decreases in bee colonies, known as colony collapse disorder (CCD). This disorder and the resulting decline in bee populations is an existing significant cumulative impact in the region. As reported, CCD has been used to correlate some reports of the apparent disappearance of honeybees from hives. A recent in situ study attempted to replicate CCD wherein the authors claimed that the only variable that contributed significantly to hive death was exposure to sublethal levels of imidacloprid (a commonly use neonicotinoid insecticide), although the authors reported mortalities in bees that were fed only contaminated fructose (large doses of the insecticide) (Lu et al. 2012). After this report was published, peer reviews of the article indicated that the methodology was substantially flawed by the use of extremely high levels of pesticides in the tests that are actually already known to be very toxic to bees (400 ppb) when fed directly with no opportunity to obtain alternate, uncontaminated sources of food (fructose).

In addition to the potential impacts of some pesticides on bees, it is clear that many other factors can impact bee colonies in their hives. Activities such as housing development and expansion of public projects decrease the number and proximity of orchards, and in many urban or semi-urban areas the restrictions on keeping bees severely limit the number of hives. These activities, in conjunction with mosquito control activities, can be considered cumulatively considerable, without precisely accounting for relative impacts to bee colonies. The claims that the problems with bee colonies are purely due to pesticide applications are not supported.

As an example of the conservative nature of pesticide applications the District practices, the District does not use neonicotinoid insecticides (e.g., imidacloprid and other pesticides recently claimed to be associated with CCD) and is not considering them for future use. As a result, the mosquito control and maintenance programs the District uses have not been associated with CCD. Mosquito control activities the District performs would be cumulative with vector control programs and habitat maintenance activities other, sometimes nearby, private and/or public groups perform that are within the range of influence of the beehives of interest. In general, while it is true that insect abatement activities may affect native pollinators near or adjacent to treatment areas, the careful use of BMPs greatly reduces the potential cumulative impacts to nontarget pollinators. Based on these conclusions, the Program's less-than-significant impacts on insect pollinators related to mosquito abatement activities would not be cumulatively considerable or significant.

13.3.2 Vegetation Management

The District does not currently, but may choose to perform weed abatement activities in the future under special circumstances. These vegetation management activities may involve the use of manual and mechanical controls to reduce or eliminate noxious weeds. California Food and Agriculture Code 5261 defines a noxious weed as "any species of plant that is, or is liable to be, troublesome, aggressive, intrusive, detrimental, or destructive to agriculture, silviculture, or important native species, and difficult to control or eradicate, which the Secretary, by regulation, designates to be a noxious weed."

Numerous entities throughout the Program Area have weed control programs that they implement. These entities include the California Department of Transportation and local roads departments, local utilities, service districts, government, agricultural districts, and public and private landowners. Information about the coordination of such efforts can be obtained from the CDFA's Noxious Week Information Project (http://www.cdfa.ca.gov/plant/ipc/noxweedinfo/noxweedinfo_hp.htm). Fourteen federal, state, and county agencies founded the California Interagency Noxious Week Coordinating Committee in 1995 to coordinate the management of noxious vegetation. This group has assembled a variety of tools for those involved in weed control activities (http://www.cdfa.ca.gov/plant/ipc/CINWCC/cinwcc_hp.htm).

Invasive vegetation can disrupt native habitats. It competes with and may displace native plants. This tendency may interfere with ecosystem functions, by altering and reducing the food resources available to primary and secondary consumers. Weed control activities the District may perform would be cumulative with those other entities perform. Weed control activities may affect native plants, as these species may lie within treatment areas, but the effects on individuals of native species are minimized, and the overall effect is likely beneficial, as native species will have less competition in treated areas and, thus, would be expected to be more successful. The District does not currently use chemicals for vegetation management and, therefore does not contribute to herbicide loads in the aquatic environment. The District may use herbicides in the future, but these incremental effects would not be cumulatively considerable due to the beneficial effect noted above and BMPs employed to mitigate impacts. Based on this conclusion, the Program's incremental less-than-significant effects relating to weed abatement activities would not, when considered with other weed abatement activities in the Program Area, be cumulatively considerable or significant.

13.3.3 Chemical Control Alternative

As described in Section 13.4 (Ecological Health), historic trends in pesticide use vary from county to county based on information available from CDPR. Within the District's Program Area as a whole, pesticide use varies by county in 2010 relative to 2006 including reductions in Contra Costa and Napa counties' pesticide use. However, the use of pesticides and herbicides will continue to be necessary. Many of these chemicals exhibit some environmental persistence. The uses of pesticides under the Chemical Control Alternative would be cumulative with uses of pesticides by agricultural, industrial, governmental, and residential users, an existing significant cumulative impact. The District's relative contribution to the loads of such concentrations for overall pesticide use is small compared with use by all other users combined. The District preferentially uses nonchemical alternatives and when using chemical alternatives, uses chemicals that are not persistent in the environment when chemicals are applied. Furthermore, the District employs BMPs to mitigate for potential adverse effects (see Section 2.9). As such, the District's Chemical Control Alternative does not contribute substantially to pesticide and herbicide exposures in the terrestrial environment. The Chemical Control Alternative has a less-than-significant cumulative impact on terrestrial resource exposures to herbicides and pesticides.

13.4 Ecological Health

Cumulative impacts, as they relate to ecological health include past, present, and reasonably foreseeable actions that potentially impact aquatic/terrestrial mammalian and avian wildlife, herptiles, aquatic organisms, nontarget invertebrates which include beneficial insects that are pollinators, and botanical resources. See also Sections 13.2 Aquatic Resources and 13.3 Terrestrial Resources for additional discussion of cumulative impacts. To make a determination of a cumulatively considerable impact, consideration is given to the combined contribution of Program impacts (mostly less than significant) considered together with impacts that exist outside of the Program from the activities of agencies and individuals. If those impacts, taken all together result in a significant impact, then the Program's incremental contribution to the combined significant cumulative impact is "cumulatively considerable" if it triggers the significant cumulative impact or if it has a substantial contribution to the existing significant cumulative impact

The Proposed Program does result in the use of pesticides and a potential increase in pesticide use over existing conditions for certain formulations. Local planning agencies, County Agricultural Commissioners, and CDPR do not forecast future pesticide use. However, the cumulative analysis for ecological health concerns can address the question of increases in pesticide use as a result of the Proposed Program as a variation of the "summary of projections method" to address regional cumulative impacts of pesticide use and whether the incremental contributions of the Program's chemical treatment methods contribute to cumulative significant ecological health-related impacts. The estimates of pesticide use in the District's Program Area are not based on population or housing units or employees in the state but rather on past trends in pesticide use from available data on pesticide sales of products, as active ingredients, reported to the CDPR for 2006-2010. The analysis seeks to provide the regional context needed for a reasonable discussion of cumulative impacts. Just as local and regional plans project growth based on past trends, the analysis below relies on past trends to address changes in pesticide use and potential cumulative ecological health impacts.

This analysis considers whether potential exists for any incremental contribution of chemical use from the Program, when combined with other reasonably foreseeable uses of the specific pesticides considered in this PEIR (and Appendix B), which would result in cumulative impacts that could be considered "cumulatively considerable" to ecological health. The District's activities would involve the application of low concentrations of selected pesticide active ingredients. Herbicide active ingredients may also be included in the future. Further, the District's practices including avoidance of some habitat types and strict adherence to stay within product label maximum application amounts, which typically require concentrations well below known toxicity values, would result in very short exposures. Program alternative impacts were identified as "less than significant" if the likely exposure to nontarget species was either very short or the application medium (spray or liquid) was typically highly dilute (ULV techniques). Additionally, the less-than-significant determination was applied if it was indicated that exposure could be considered likely incomplete due to little or no overlap of application areas and typical species habitat.

13.4.1 Trends in Pesticide Use 2006–2010

Trends in pesticide use help to determine whether there is an existing cumulatively considerable impact in the region from the uses of pesticides by all agricultural, industrial, governmental, and residential users. In general, there is an existing significant cumulative impact from the quantities of materials applied overall with some reductions in use of selected materials. Table 13-1 Historical Pesticide Use in the SCMAD's Program Area illustrates the changes in relative pesticide use by all users (as pounds per year of active ingredients) for the 46 chemicals in the counties represented in the District's Program Area (Service Area plus adjacent counties) which is the focus of this PEIR. After inspection of the yearly data reported by the CDPR, it is difficult to determine any repeatable or linear trends in use patterns. The potential cumulative impact of the use of similar pesticides by numerous agencies, organizations, and individuals in the counties suggests that many potential interactions could lead to cumulative pesticide impacts without definitive determination of the relative volume of each of the sources. However, pesticide use in the Program Area overall has increased since 2006. The amount of active ingredients used in the Program Area in 2006 was approximately 7,353,864 pounds (3,677 tons), whereas it increased to 7,908,326 pounds (3,954 tons) in 2010 (CDPR).

Although the reported cumulative pesticide product used has a very wide range for each county in the table, some generalities can be made for each county although the data are limited to 2006 to 2010:

- Contra Costa County reported 49 tons fewer pesticides used in 2010 than in 2006
- Sonoma County reported 21 tons more pesticides used in 2010 than in 2006
- Napa County reported more than 140 tons fewer pesticides use in 2010 than in 2006
- Solano County reported slightly more than 131 tons of pesticides used in 2010 than in 2006
- Sacramento County reported an increase of 245 tons of pesticide used in 2010 than in 2006
- Yolo County reported an increase of 70 tons of pesticides used in 2010 than in 2006.

Pesticide use by all users in the District's Service Area (i.e., only Solano County) was 394,468 pounds (197 tons) in 2006, which increased by almost 67 percent to 656,976 pounds (328 tons) in 2010.

Table 13-1 Historical Pesticide Use within the SCMAD Program Area

		Service Area Solano County			Adjacent Counties															
					Contra Costa			Sonoma			Napa			Sacramento			Yolo		
Active Ingredient	Vector	2006	2008	2010	2006	2008	2010	2006	2008	2010	2006	2008	2010	2006	2008	2010	2006	2008	2010
2,4-D	Herbicide	27481	33478	25791	5950	1611	1808	3215	33478	2788	509	595	354	9132	13706	12270	20875	18313	18543
Alcohol Ethoxylated Surfactant	Mosquito																		
Aliphatic Solvents	Mosquito																		
APEs	Herbicide																		
Allethrins	Mosquito, Yellow Jacket / Wasp	0.3	0.3	0.2	6.7	0.9	12.6	0.5	0.3	6.3	0.1	0.2	0.1	135	1.7	0.4	0.7	0.3	0.1
Bs	Mosquito	9.8	0.9	0.4	18964	211.3	451.5	435.9	0.9	1026.7	0.5	9.7	2.1	1055	365	181	394	524	561
Bti	Mosquito	9.1	3.9	2.3	7305	119	570	762	3.9	994	50.6	48.9	44.7	858	962	1148	8964	12424	11969
Benfluralin (Benefin)	Herbicide	60.2	90.9	2.8	0.3	100.2	190.5	43.3	90.9	72.7				45	146	7	5	3	
Bentazon	Herbicide																		
Brodifacoum	Rodents	0.02	0.02	0.03	0.08	0.06	0.04	0.05	0.02	0.03	0.02	0.02	0.01	0.2	0.1	0.2	0.04	0.02	0.03
Bromadiolone	Rodents	0.3	0.2	0.3	0.5	0.4	0.4	0.3	0.2	0.3	0.2	0.2	0.2	0.6	0.6	0.8	0.3	0.25	0.25
Chlorophacinone	Rodents	0.01	0.01		0.4	0.2	0.2	0.05	0.01		0.06	0.04	0.04	0.2	2.2	0.2	0.03	0.02	0.01
Cholecalciferol	Rodents	0.6	0.08	0.03	0.01	0.8	1	0.05	0.08	0.3	0.03	0.03	0.1	0.02	0.02	0.02	0.05	0.01	0.07
DCPA	Herbicide																		
Deltamethrin	Mosquito, Yellow Jacket / Wasp	75.4	55.8	45.3	532		109.8	40.3	55.8	108.4	5.9	4	4.6	1550	146	257	559	12	9
Difethialone	Rodents			0.1	0.2	0.1	6			0.04			0.01	0.02	0.02	0.07	0.01	0.01	0.1
Diphacinone	Rodents	0.6	4	0.3	2.6	3.7	4.3	0.2	4	0.2	0.07	0.2	0.5	1.1	0.3	0.4	0.01	0.3	0.3
Dithiopyr	Herbicide	34.1	270	780.5	458.8	692.3	889.9	119.6	270	81.3	58.6	33.9	24.9	733	1317	2634	59	675	383
Diuron	Herbicide	21737	17130.4	4813.3	26914	32567	14772	1847	17130	576.4	4976	5524.5	4152.9	11179	7377	7576	32413	12426	5716
Esfenvalerate	Yellow Jacket / Wasp	251.3	1034.6	264.7	10.2	14.9	51.6	0.4	1034.6	3.6		0.4	0.3	464	421	435	605	931	349
Etofenprox	Mosquito, Yellow Jacket / Wasp									1.3									
Glyphosate	Herbicide	80536	77951	112532	80522	50778	68934	79879	77952	94726	44422	32514	39832	143959	126078	155084	172553	121048	152542
Imazapyr	Herbicide		5.5	18.3	123.2	57.2	103.9	163.5	5.5	148.3		24.8	20.9	19	23	65	468	203	207
Lambda-cyhalothrin	Mosquito, Yellow Jacket / Wasp	519.6	1042.6	889.4	442	335.7	210.2	62.8	1043	12	16.8	18.4	5.4	480	611	566	1393	1943	1522
Lecithin	Herbicide	476.3	310.6	521.8	43.4	9.9	8.6	547	310.6	581.2	184.9	303.3	1022.7	216	208	1553	2438	3105	1131
Methoprene	Mosquito	231	298	277	2555	168	152.7	236	299	256.4	69	49	29.5	542	561	545	58	554	430
Metolachlor	Herbicide	12771	13434	17020			3050		13444					4756	3973	3500	38568	37158	40852
Modified Vegetable Oil	Herbicide																		
Naled	Mosquito	195.8								0.2			0.1	542	767	321	4145	2442	1133
Oryzalin	Herbicide	6610	17648.4	4618.1	2187.4	3559.2	5168.4	3047	17648	1788.6	5606	2726.2	1867.4	15142	16938	3933	8416	7014	11497
Pendimethalin	Herbicide	8666	15030.9	20641.3	12489	7600	5711.1	2879	15031	12021.3	402.5	138	2641.4	6209	7290	20001	9350	31685	34602
Permethrin	Mosquito, Yellow Jacket / Wasp	458.3	446.8	1360	4387	1438	923.2	974	446.8	842.1	336	246.3	141.9	2310	2822	2583	1763	632	314
Phenothrin	Yellow Jacket / Wasp	0.2	0.2	0.3	2.1	1	13.1	0.2	0.2	0.4		0.1	0.1	0.7	1	80	0.2	0.2	716
PBO	Mosquito	212	338.4	425.3	3971	443.8	947	153	338.4	469	191	220	210	3777	3610	4967	10853	7012	915
Polydimethylsiloxane Fluids	Herbicide																		

Table 13-1 Historical Pesticide Use within the SCMAD Program Area

Active Ingredient	Vector	Service Area Solano County			Adjacent Counties															
					Contra Costa			Sonoma			Napa			Sacramento			Yolo		
		2006	2008	2010	2006	2008	2010	2006	2008	2010	2006	2008	2010	2006	2008	2010	2006	2008	2010
Potassium Salts	All	11399	3592	5457	207	609	1450	12346	3583	21940	7118	6834	16682	20376	16865	5830	40056	21718	33343
Prallethrin	Mosquito			1.2			5.6			0.1			1			0.9			0.1
Pyrethrins	Mosquito, Yellow Jacket / Wasp	42.2	87.8	108.6	613.6	185.1	184.3	45	87.8	92.9	78.6	147.9	67.1	499	460	575	1120	849	56
Resmethrin	Mosquito, Yellow Jacket / Wasp				174.2	3.3	2.1							0.4	0.01		0.01	0.01	
Sodium Nitrate	Fumigant		1.8	0.2	46500	18.2	34.2	0.8	1.8					16	12	61	13	5	
Spinosad	Mosquito	3	1.2	28.3	17	5.3	13.4	55.7	1.2	42.5	4.5	1.1	210.9	41	34	167	126	197	91
Sulfometuron methyl	Herbicide	113.2	197.2	134.8	2344.7	955.7	800.6	31	197.2	79.9	89.7	134	119.3	712	433	683	126	49	122
Sulfur	Fumigant	220538	232318	458364.1	69349	80688	81823	1801508	232318	1811461	1127323	709824	843504.8	1768474	1976755	2257414	1208428	1135814	1383516
Temephos	Mosquito										0.1		0.3						
Tetramethrin	Yellow Jacket / Wasp		0.01					0.03	0.01					0.02	0.02	0.04	0.04		
Triclopyr	Herbicide	2037	3604	2877	8019	4875	7614	1235	3604	1535	132	125	97	3198	3545	3298	3930	8515	6381
Total		**394468.33**	**418377.52**	**656975.96**	**294091.39**	**187052.26**	**196017.24**	**1909627.68**	**418380.22**	**1951656.47**	**1191575.18**	**759523.19**	**911038.26**	**1996422**	**2185431**	**2485737**	**1567679**	**1425252**	**1706901**

Note:

Blank cells mean that there was either no use reported for that chemical in that county in that year or the reported data was less than 0.005 lbs.

*All values are reported in weight (lbs) of Active Ingredient used in a county over the given year.

*From the California Department of Pesticide Regulation, Pesticide Use Reporting database.

Although large uncertainty and high variation exist in the reported amounts of pesticide use by all users within these counties, they vary according to their particular needs, majority of habitat type, and seasonal vector outbreaks. The public is aware of these pesticide uses and, in general, is pressuring agencies within these counties to use less pesticide whenever possible.

The District uses very strict and thorough BMPs in its pesticide applications for mosquito control and is attempting to reduce its total pesticide use where possible consistent with IPM or IMM practices. The District's annual use of pesticides is reported to the Solano County Agricultural Commissioner and provided here in Table 13-2, Pesticide Usage within the SCMAD Service Area, 2010.

Table 13-2 Pesticide Usage within the SCMAD Service Area, 2010

Pesticide (units)	**Active ingredient**	**Amount Used 2010**
Larvicides		
Agnique MMF (gal)	Biodegradable, alcohol ethoxylated surfactant	0.39
Golden Bear (GB) 1111 (gal)	Petroleum distillate (mineral oil)	240.56
VectoMax CG (lbs)	Bs and Bti	0.00
VectoLex WSP (lbs)	Bs and Bti	5.90
Altosid Liquid Larvicide (ALL) (gal)	Methoprene	218.47
Altosid Pellets (lbs)	Methoprene	2,465.37
Altosid XR Briq. (lbs)	Methoprene	281.45
Altosid SBG Gran. (lbs)	Methoprene	1,470.00
Altosid XRG Gran. (lbs)	Methoprene	0.00
Adulticides		
Pyrenone 5%/25% (gal)	Pyrethrins and piperonyl butoxide (PBO)	1.46
MGK Pyrocide 5%/25% (gal)	Pyrethrins and piperonyl butoxide (PBO)	115.41
Aquahalt 5%/25% (gal)	Pyrethrins and piperonyl butoxide (PBO)	1.09
Biomist 4%/12% (gal)	Permethrin and piperonyl butoxide (PBO)	0.05
Total Product Use (lbs)		4,222.7
Total Product Use (gal)		577.4

Source: SCMAD 2010, Chemical Usage 2010

In 2010, the District's greatest use of pesticide involved formulations containing the active ingredient methoprene. In particular, 2,465 pounds of Altosid Pellets (4.25% methoprene) were used, and the amount of methoprene active ingredient was 104.8 pounds. Other products containing methoprene, Altosid XR Briquets at 281.5 pounds (5.9 pounds of methoprene), Altosid SBG Granules at 1,470 pounds (2.9 pounds methoprene), and Altosid Liquid Larvicide at 218.5 gallons (10.9 pounds methoprene), represent additional amounts of methoprene use. With total methoprene of about 125 pounds, the District's use represents 7 percent of the methoprene used (1,691 pounds) in the Program Area (from Table 13-1). This use plus the active ingredients in the other products used together represents a small portion of the overall pesticide use of 656,976 pounds (328 tons) in Solano County in 2010.

The District's incremental contributions to overall pesticide use within its Program Area do not trigger a cumulatively considerable impact. While the overall use of pesticides throughout the Program Area may be considered cumulatively significant, the District's small incremental contributions to this impact are not cumulatively considerable because the District's BMPs described in Section 2.9 substantially mitigate the impacts of these incremental contributions to overall pesticide use. Therefore, the Program's long-term activities including chemical applications would not contribute considerably to nontarget ecological receptor impacts. The Program alternatives would not result in significant cumulative impacts to the ecological health condition of the region.

13.5 Human Health

Cumulative impacts, as they relate to human health, include past, present, and reasonably foreseeable actions that potentially impact humans. Cumulative impacts can result from individually minor, but collectively significant, projects taking place over a period of time. To make a determination of a cumulatively considerable impact, consideration is given to the combined contribution of Program impacts (mostly less than significant) considered together with impacts that exist outside of the Program from the activities of agencies and individuals. If those impacts, taken all together result in a significant impact, then the Program's incremental contribution to the combined significant cumulative impact is "cumulatively considerable" if it triggers the significant cumulative impact or if it has a substantial contribution to the existing significant cumulative impact.

The Proposed Program does result in the use of pesticides and a potential increase in pesticide use over existing conditions for certain formulations. Local planning agencies, County Agricultural Commissioners, and CDPR do not forecast future pesticide use. However, the cumulative analysis for human health concerns can address the question of increases in pesticide use as a result of the Proposed Program as a variation of the summary of projections method to address regional cumulative impacts of pesticide use and whether the incremental contributions of the Program's chemical treatment methods contribute to cumulative significant human health-related impacts. The estimates of pesticide use in the District's Program Area provided in the preceding analysis in Section 13.4 (Table 13-1) are not based on population or housing units or employees in the state but rather on past trends in pesticide use from available data on pesticide sales of products, as active ingredients, reported to the CDPR. The analysis seeks to provide the regional context needed for a reasonable discussion of cumulative impacts. Just as local and regional plans project growth based on past trends, the analysis below relies on past trends to address changes in pesticide use and potential cumulative human health impacts.

This analysis considers whether potential exists for any incremental contribution of chemical use from the Program, when combined with other reasonably foreseeable uses of the specific pesticides considered in this PEIR (and Appendix B), which would result in cumulative impacts that could be considered "cumulatively considerable" to human health. The District's activities would involve the application of low concentrations of selected pesticide active ingredients. Further, the District's practices including avoidance of some habitat types and strict adherence to product labels, which typically require concentrations well below known toxicity values, would result in very short exposures. Program alternative impacts were identified as "less than significant" if the likely exposure to humans was either very short or the application medium (spray or liquid) was typically highly dilute (ULV techniques). Additionally, the less-than-significant determination was applied if an indication existed that exposure could be considered likely incomplete due to little or no overlap of application areas.

The District's incremental contributions to overall pesticide use within its Program Area do not trigger a cumulatively considerable impact. While the overall use of pesticides throughout the Program Area may be considered cumulatively significant based on the usage of a long list of active ingredients and quantities reported by all users, the District's incremental contributions to this overall impact are not cumulatively considerable because the District's BMPs described in Section 2.9 substantially mitigate the impacts of these incremental contributions to overall pesticide use. Therefore, the Program's long-term activities including chemical applications would not contribute considerably to human health impacts. The Program alternatives would not result in significant cumulative impacts to the human health condition of the region.

13.6 Public Services and Hazard Response

The District's Program would not incrementally increase demand for police, fire, or health-care services, nor would it create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials, through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment, or through the operation of aircraft. In addition, the Program would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. In short, the Proposed Program does not have incremental impacts on public services, and implementation of any of the Program alternatives (individually or in combination) would not result in a significant contribution to any cumulative public services and hazard response impacts that could result from other projects in the vicinity of the treatment areas.

13.7 Water Resources

Less-than-significant impacts to water resources are identified for all Program activities, except for use of selected herbicides under the Vegetation Management Alternative and use of selected pesticides under the Chemical Control Alternative. Because the use of chemicals that could cause impacts are associated with site-specific treatment needs that are not linked temporally or spatially and because the activities are only used as a last resort and are, therefore, only occasionally conducted, application of Program chemicals and biological agents (with use of identified mitigations) would not adversely affect water resources nor would these alternatives exceed any thresholds or water quality regulations.

In addition to the possible use of naled, which was identified to cause significant and unavoidable impacts, the District's use now or in the future of some of the more toxic and persistent pyrethroids (permethrin and resmethrin) could contribute to impairments of receiving water identified on the CWA 303(d) list as caused by pyrethroids and sediment toxicity. Where receiving waters have been designated as impaired for pesticides used under the District's IMMP, a cumulatively considerable impact results from all uses of these pesticides or the receiving waters would not be designated as impaired. The District's use of these "impairment chemicals" is contributing in less-than-significant amounts to an existing cumulatively considerable impact in the Program Area and is not cumulatively considerable because the District employs BMPs to mitigate for the potential for naled and the pyrethroids to impact surface and groundwater resources (see Section 2.9). No additional impacts were identified in association with the chemical and nonchemical Program alternatives, and no additional cumulative impacts are anticipated to occur (i.e., the District's less-than-significant impacts are not triggering a new cumulative impact).

13.8 Air Quality

Impacts to regional ambient air quality by all Program alternatives would be less than significant for criteria pollutant emissions. The majority of air districts in California, including BAAQMD, YSAQMD, and NSCAPCD, assume that if project-level emissions do not exceed significance thresholds, and no closely related project exists, then a project would not have a cumulatively considerable impact on air quality. In most of the areas the District is likely to target for Program activities, related projects would be similar programs other Districts conduct in their respective jurisdictions and CDFA's special campaigns to control specific threats such as gypsy moths, light brown apple moths, and Mediterranean fruit flies. These projects would not occur at the same times (days) and same locations. All of the Program alternative emissions (separately and combined for the District's entire Program) would be below the significance thresholds for criteria pollutant emissions. The incremental impacts on air quality from the Program alternatives are not individually significant nor are they cumulatively considerable. Therefore, cumulative impacts to regional air quality are less than significant.

13.9 Greenhouse Gases and Climate Change

Scientific consensus concurs that global climate change will increase the frequency of heat extremes, heat waves, and heavy precipitation events. Currently accepted models predict that continued GHG emissions at or above current rates will induce more extreme climate changes during the 21st century than were observed during the 20th century. A warming of about 0.2°C per decade is projected. Even if the concentrations of all GHGs and aerosols are kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected. A faster temperature increase will lead to more dramatic, and more unpredictable, localized climate extremes. Other likely direct effects of global warming include an increase in the areas affected by drought, an increase in tropical cyclone activity and higher sea level, and the continued recession of polar ice caps. Already some identifiable signs exist that global warming is taking place. In addition to substantial ice loss in the Arctic, the top seven warmest years since the 1890s have been after 1997. (IPCC 2007)

The overall global climate change will be comprised of social and economic losses. These negative effects will likely be disproportionately shouldered by the poor who do not have the resources to adapt to a change in climate. Some of the main ecosystem changes anticipated are that biodiversity of terrestrial and freshwater ecosystems could be reduced and that the ranges of infectious diseases would likely increase.

Cumulative impacts were assessed in a qualitative manner by determining if the Program alternatives, in conjunction with other projects throughout the Program Area, would have the potential to contribute to a long-term cumulative impact on climate change. Given that GHG emissions and climate change are global issues, a statewide framework or cumulative approach for consideration of environmental impacts may be most appropriate. Virtually every project California, as well as those outside the state, would have GHG emissions.

All Program alternatives would generate some GHG emissions individually but would not conflict with current plans, policies, and regulations. No potentially significant impact would occur as a result of any of the Program alternatives (individually or when combined for the entire Program), and no mitigation is required for GHGs and climate change. However, optional mitigation measures (BMPs) for all alternatives are listed in Section 11.2.11. Even with mitigation, the alternatives would generate GHG emissions and incrementally contribute to climate change, however minor.

When all Program emissions are viewed in combination with global emission levels that are contributing to the existing cumulative impact on global climate change, the incremental contribution of these Program emissions would not be cumulatively considerable because they occur intermittently and on a very small scale (i.e., not stationary sources). Therefore, all Program alternatives (either individually or in combination) would not have a cumulatively considerable impact on global climate change. If optional mitigation measures (BMPs) are implemented, the Program alternatives' incremental contribution would be reduced further.

13.10 Noise

Program activities would result in temporary, sporadic noise impacts from equipment use, and any given surveillance or treatment area would be affected only for a brief period. Cumulative impacts would result from the implementation of Program activities in combination with those of other reasonably foreseeable projects and actions occurring at the same time and in the same place. The likelihood of this happening and resulting in noise levels that would exceed thresholds or cause a substantial temporary increase in noise levels is remote; moreover, noise impacts from the Program would be temporary, lasting only a brief period of time at any given location, after which time the noise would cease. Thus, the potential for cumulative impacts is low, and any impacts that could occur would be of short duration and less than significant. The incremental noise impacts from any of the Program alternatives, individually or in combination for the entire Program, would not be cumulatively considerable and would not trigger cumulative noise impacts in a given area.

13.11 Summary of Cumulative Impacts

None of the Program alternatives would have incremental impacts that would be cumulatively considerable. The cumulative impacts by resource or environmental topic are summarized as follows:

> **Urban and Rural Land Uses:** No cumulative significant impacts to urban and rural land uses are anticipated when all of the Program's incremental impacts and the impacts of other activities in the region are considered together.

> **Biological Resources- Aquatic:** All of the Program alternatives have a less-than-significant cumulative impact on POD. All of the Program alternatives have a less-than-significant cumulative impact on salmonid population trends. The Program would have a less-than-significant cumulative impact on the amount or quality of aquatic habitat from the Physical Control and Biological Control Alternatives. The District's incremental activities associated with the control of invasive weeds under the Vegetation Management Alternative would not be cumulatively considerable.

> **Biological Resources-Terrestrial:** The District's Proposed Program does not contribute substantially to pesticide and herbicide exposures in the terrestrial environment. The Chemical Control and Vegetation Management Alternatives have a less-than-significant cumulative impact on terrestrial resource exposures to herbicides and pesticides. The Program's incremental less-than-significant effects relating to weed abatement activities would not, when considered with other weed abatement activities in the Program Area, be cumulatively considerable or significant.

> **Ecological Health:** While the overall use of pesticides throughout the Program Area may be considered cumulatively significant for nontarget ecological receptors including honeybees, the District's incremental contributions to this impact are not cumulatively considerable or significant. Therefore, the Program's long-term activities including chemical applications would not contribute considerably to ecological health impacts.

> **Human Health:** While the overall use of pesticides throughout the Program Area may be considered cumulatively significant, the District's incremental contributions to this impact are not cumulatively considerable or significant. Therefore, the Program's long-term activities including chemical applications would not contribute considerably to human health impacts.

> **Public Services and Hazard Response:** The Proposed Program does not have incremental impacts on public services, and implementation of any of the Program alternatives (individually or in combination) would not result in a significant contribution to any cumulative public services and hazard response impacts that could result from other projects in the vicinity of the treatment areas

> **Water Resources:** Where receiving waters have been designated as impaired for pesticides used under the District's IMMP, a cumulatively considerable impact results from all uses of these pesticides or the receiving waters would not be designated as impaired. The District's use of these "impairment chemicals" is contributing in less-than-significant amounts to an existing cumulatively considerable impact in the Program Area and are not cumulatively considerable.

> **Air Quality:** All of the Program alternative emissions (separately and combined for the District's entire Program) would be below the significance thresholds for criteria pollutant emissions. The incremental impacts on air quality from the Program alternatives are not individually significant nor are they cumulatively considerable.

- **Climate Change:** When all Program emissions are viewed in combination with global emission levels that are contributing to the existing cumulative impact on global climate change, the incremental contribution of these Program emissions would not be cumulatively considerable because they occur intermittently on a very small scale (i.e., not stationary sources).
- **Noise:** Any impacts that could occur would be of short duration and less than significant. The incremental noise impacts from any of the Program alternatives would not be cumulatively considerable and would not trigger cumulative noise impacts.

14 Other Required Disclosures

This section addresses other potential impacts as required by CEQA: significant environmental impacts that cannot be avoided if the Proposed Program is implemented, significant irreversible environmental changes that would be caused by the Proposed Program should it be implemented, and growth-inducing impacts of the Proposed Program (see CEQA Guidelines Section 15126.2).

14.1 Significant Unavoidable Impacts

Unavoidable impacts are those adverse environmental consequences of an action that cannot be avoided, either by changing the nature of the action or through mitigation if the action is undertaken. Significant impacts from No Program are assumed to be not mitigable in most cases, because an action that is currently unplanned and/or unfunded would be required to resolve the impact. Furthermore, the No Program actions to manage mosquitoes and other vectors would be undertaken primarily by private businesses and landowners, with limited assistance from CDPH if any.

14.1.1 No Program

Potential exists for substantial adverse effects throughout the Program Area if mosquitoes as a vector of disease and discomfort are allowed to spread and establish populations throughout urban, rural, and open-space areas. Impacts under the No Program Alternative have the potential to be significant and unavoidable for the following resource topics: urban and rural land uses, ecological health, human health, and public services and hazard response as discussed in Section 15.2.1. Furthermore, increases in mosquito populations could lead to reductions in local and state revenues for parks, marinas, campgrounds, and other recreational activities.

14.1.2 Proposed Program Alternatives

One of the Program alternatives would result in potentially significant impacts to surface and groundwater resources that could not be reduced to less than significant with the implementation of mitigation measures. Under the Chemical Control Alternative, the option to use the mosquito adulticide naled is determined to be a significant and unavoidable impact to water resources. Naled is an OP insecticide and is used in rotation with pyrethrins or pyrethroids to avoid the development of resistance. Naled is the most commonly used material for this purpose. The District does not currently use Naled and its use would be infrequent and under emergency conditions to suppress a disease outbreak when other adulticides are not available or have shown to be ineffective against the target species of mosquito. Naled has low water solubility but is mobile in soils with low organic matter content. It is moderately toxic to mammals, fish, and aquatic invertebrates but degrades readily in water, under sunlight, in soil under aerobic and anaerobic conditions, in air, and on plants. Dichlorvos, a breakdown product of naled, and itself a registered pesticide, may be present in toxic concentrations after naled is no longer detectable and is the reason for the determination of significant impact. However, naled and other OPs are important chemicals that help control resistance of mosquitoes to alternative pesticide products such as pyrethrins and pyrethroids (should significant resistance be detected within the District's Program Area). Due to the toxicity of its breakdown product dichlorvos but its importance in the District's IMMP, the potential use of naled is significant and unavoidable.

Under the Biological Control Alternative, the District also uses mosquitofish in natural waters within their Service Area, where the District judges that mosquitofish are the best method for controlling larval mosquitos. Such plantings have the potential to adversely native fish or aquatic invertebrates, special-status fish species, and applicable HCP/NCCPs, The District has a policy of restricting its planting of mosquitofish to natural waters to situations where the potential environmental effects are likely to be low.

Such plantings are subject to a series of measures to minimize environmental effects. However, this mitigation (see mitigation measure AR-18) does not fully resolve the potentially significant impact such that there could be a residual impact that is significant and unavoidable.

14.2 Irreversible and Irretrievable Commitments of Resources

Irreversible commitments are those that cause either directly or indirectly the use of natural resources to the extent that they cannot be restored or returned to their original condition, including nonrenewable resources. Irreversible decisions can also affect renewable resources such as soils, wetlands, and waterfowl habitats. They are considered irreversible because their implementation would affect a resource that has deteriorated such that renewal takes extensive time or financial resources or because they would destroy a resource.

Irretrievable commitments of natural resources mean the decision would result in loss of production or use of the resources. They represent opportunities foregone for a substantial period of time that the resources cannot be used. Also, irreversible damage can result from environmental accidents associated with a project.

No irreversible or irretrievable commitments of land resources are associated with any of the Program alternatives. For the Program alternatives, potential irreversible and irretrievable impacts are associated with the consumption of energy resources by equipment and vehicles including ATVs and helicopters/airplanes, and the potential for environmental accidents associated with the application equipment and vehicles/aircraft.

14.2.1 Energy Resources

Energy resources necessary for this Program would include gasoline and diesel fuel to power the vehicles and equipment at present and proposed for use in the District's mosquito and/or vector control activities. Equipment use for each of the five Program alternatives is shown in Table 2-4. The No Program Alternative would result in lower use of energy resources (than the Program alternatives), because the fuel currently used in District vehicles for measures such as surveillance and inspection activities, physical control of habitat, vegetation management, and application of registered chemical treatments would not be used.

14.2.2 Environmental Accidents

The following environmental accidents could occur as a result of the implementation of Program surveillance, control, and pesticide/herbicide applications:

- Aircraft crash
- Vehicle crash including fuel spill
- Misdirected spray from backpacks and truck-mounted equipment
- Leakage of chemical pesticides from containers/improper disposal of containers

Chapter 8, Public Services and Hazard Response, addresses fixed-wing aircraft/helicopter crashes, and determines that none of the Program alternatives would increase the risk of aircraft crashes. Chapter 8 also analyzes whether the Program would create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment, and determines that no increased risk of fuel spill would occur. Finally, Chapter 8 indicates that under each of the Program alternatives, the District and its registered contractors would practice safe disposal of pesticide products and that properly rinsed empty containers would safely and legally be disposed of at landfills and any unused portions of Program chemicals would be disposed of at permitted hazardous waste collection locations. Adequate landfill and hazardous waste collection capacity exists in locations throughout the Program Area and, therefore, the Program would not exceed the existing capacity to safely dispose of these materials.

14.3 Growth-Inducing Impacts

CEQA Section 21100(b)(5) requires that an EIR discuss the growth-inducing impacts of a proposed project. This requirement is further explained in CEQA Guidelines Section 15126.2 (g), which states that an EIR must address “the ways in which the proposed project could foster economic or population growth, or the construction of additional housing, either directly or indirectly in the surrounding environment.”

The Program alternatives do not foster economic or population growth. Rather, they allow for communities within the Program Area to grow according to local general plans without local residents, workers, and visitors suffering from a variety of illnesses or discomfort from mosquito-borne diseases. Of concern are areas where human habitations are in close proximity to natural habitats providing ample opportunity for breeding populations of mosquitoes or where home or business maintenance practices encourage mosquitoes to breed. The District would continue its IMMP, and no change in economic activity would occur. Therefore, the Program would not directly or indirectly stimulate economic or population growth and would not induce additional jobs or population in the Program Area.

14.4 Energy Requirements and Conservation Measures

Energy resources necessary for this Program would include gasoline and diesel fuel to power the vehicles, aircraft, and equipment proposed for use in the Program activities. No additional electrical power would be required. All equipment used in Program implementation would be kept up to date with maintenance requirements and would be used as efficiently as possible (i.e., minimize idling).

With regard to vehicles associated with Program surveillance, control, and treatment activities, the District is encouraged to (1) maintain vehicle tire pressure to manufacturer specifications; (2) inspect and reinflate tires at regular intervals; (3) use lower-carbon fuels such as biodiesel blends where feasible; (4) encourage ride sharing when transporting work crews from the base operations to the job site; (5) limit idling time of all vehicles and equipment; (6) service and maintain all equipment according to manufacturer’s instructions to remain in good working order; and (7) use engine retrofits such as diesel particulate matter filters with diesel oxidation catalysts where feasible.

With regard to portable offroad sources, the District is encouraged to utilize electrically or manually powered hydraulic spray equipment rather that gas- or diesel-powered equipment. This is done when feasible.

These energy conservation measures would have the benefit of reducing GHG emissions the Program generates. All impacts to climate change from GHG emissions are less than significant (LS) compared to existing conditions and require no mitigation. As an option, the District may choose to reduce small impacts even further (under Impacts GHG-1, GHG-3, GHG-5, GHG-7, GHG-9, and GHG-11) The District and its contractors may implement the BMPs identified above as applicable to minimize diesel and gasoline engine exhaust emissions.

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15 Alternatives

CEQA Guidelines Section 15126.6(a) requires that a draft EIR must describe a reasonable range of alternatives to the project or project location that could feasibly attain most of the basic project objectives and would avoid or substantially lessen any of the significant environmental impacts of the proposed project. This chapter summarizes the analysis of alternatives for the Solano County Mosquito Abatement District's IMMP. It is based on Appendix E, Alternatives Analysis Report.

15.1 Alternatives Analysis and Screening Process

The District undertakes mosquito control activities through its Program to control the mosquitoes that are vectors of disease and/ or discomfort in the Program Area.

The Proposed Program's specific objectives are as follows:

> Reduce the potential for human and animal disease caused by mosquitoes

> Reduce the potential for human and animal discomfort or injury from mosquitoes

> Accomplish effective and environmentally sound mosquito management by means of:

- Surveying for mosquito abundance/human contact
- Establishing treatment criteria
- Appropriately selecting from a wide range of Program tools or components

The District has a well-defined process for selecting tools to be used in mosquito control. The District has evaluated a variety of tools for their effectiveness in meeting the objectives listed above. The criteria used for determining the feasibility or viability and ranking of reasonable tools are listed below:

> **Criterion 1.** The District uses known effective tools to manage mosquito species that have developed breeding populations in the state.

> **Criterion 2.** The District does not use experimental or hypothetically effective tools except on an experimental basis to compare with existing tools and to look for feasible tools with less impact or greater effectiveness than current Program alternatives.

> **Criterion 3.** Given equal efficacy and operational constraints, the District will use the least environmentally disruptive tool in its IMMP.

15.2 Alternatives Considered but Eliminated

CEQA Guidelines Section 15126.6(c) requires that the draft EIR explain briefly why other alternatives were rejected. The District determined that of the 18 potential tools, the following were not ready to include in the Proposed Program at this time: Biological Control Pathogens (Viruses), Biological Control (Parasites), Mass Trapping, Attract and Kill, Inundative Releases (Parasites), Inundative Releases (Predators), Regulatory Controls, and Repellents.

Appendix E describes these eight tools that were eliminated from further consideration for inclusion in the Proposed Program. The rationale for eliminating these tools from further consideration is summarized here.

> **Biological Control (Viruses).** None of the mosquito viruses listed (in Appendix E, Section 2.5) are generally commercially available for mosquito control at present.

> **Biological Control (Parasites).** None of the mosquito parasites listed (in Appendix E, Section 2.7) are generally available commercially for mosquito control at present.

> **Mass Trapping.** This tool is not an economically feasible tool due to extensive labor involved in trap placement and retrieval.

> **Attract and Kill.** This has not been proven to be an effective control tool to date. This tool is too labor intensive for District use.

> **Inundative Releases (Parasites).** No parasites for mosquitoes are available for commercial use at present.

> **Inundative Releases (Predators).** With the exception of mosquitofish, there are no other proven, commercially available predators for mosquito control at present.

> **Regulatory Control.** These actions only prevent the human-aided movement of unwanted pests. They do not reduce existing pest numbers or the ability of the pest to spread on its own.

> **Repellents.** Have no value as a control tool; they are strictly a personal protective measure.

15.3 No Program

CEQA Guidelines Section 15126.6(a) requires analysis of a no project alternative in the draft EIR. No Project is defined as what would reasonably be expected to occur in the foreseeable future, based on current plans and consistent with available infrastructure and community services, if the project was not approved and implemented. For the District, the Proposed Program is to continue current nonchemical and chemical treatment activities and to introduce similar pesticides to those currently in use if needed. The No Project/No Program condition assumes that the current activities would cease and result in a "do nothing" alternative going forward. Key assumptions for the future No Project Alternative are:

> Current regulatory controls would continue and expand as needed; however, the District would not engage in implementing any of these regulations concerning public health and management of mosquitoes carrying potential diseases. For all practical purposes, the District's office would close. Public education and other outreach activities would cease along with the control activities.

> Private landowners would manage mosquito problems on private land without any state or federal oversight with pesticides approved for use. Households would use pesticides commonly available from retail outlets where permethrin and pyrethroids are common ingredients.

> In the absence of the District's IMMP, CDPH would not provide mosquito "oversight" to local jurisdictions given lack of personnel, equipment, or funding.

The District would perform no surveillance, physical control, vegetation management, biological control, chemical control or other nonchemical control activities within its Service Area or in adjacent jurisdictions. "Do nothing" means the District would cease to exist and not provide the services funded by local property taxes. It is assumed that CDPH would not be able to provide even limited mosquito management services at the local level. As a result, the mosquitoes that are vectors of human and animal disease and discomfort would be more numerous than under existing conditions, and proliferate such that outbreaks of disease and illness would occur more frequently. In comparison to existing conditions with the current Program fully implemented, the No Program Alternative would have the following environmental impacts:

> **Urban and Rural Land Uses:** No conflicts with local land regulations and no disruption to recreationists from temporary closures of trails or other park features would occur during chemical treatments. However, the increase in mosquitoes would impact the quality of the recreational experience and homeowners due to an increase in discomfort from biting mosquitoes. Without control of saltmarsh mosquitoes, all land uses could be affected in nearby areas. These impacts are **potentially significant**.

- **Biological Resources – Aquatic:** In the absence of physical controls, including the draining of aquatic habitats, no impact would occur to aquatic special-status species using those habitats if present. No conflicts with existing provisions of an HCP/NCCP would occur. It is assumed CDPH would not be able to employ chemical treatments to the same extent as the District. The mosquito adulticide naled would not be used for mosquito control. However, Lack of IPM-based larval surveillance and control may lead to increased, non-IPM based use of adulticides by individuals and private contractors that could affect aquatic habitats. Ad-hoc larviciding by individuals using unregistered materials (e.g., bleach, oil) would cause substantial harm to biological resources including aquatic habitats. In short, **potentially significant** impacts to aquatic resources would occur under No Program.
- **Biological Resources – Terrestrial:** Under No Program, terrestrial resources in general would not be impacted significantly. The draining of aquatic habitats would not occur, resulting in creation of less terrestrial habitat. However, in the absence of organized mosquito control, unlicensed individuals may apply over-the-counter pesticides on their own, without training and potentially without adhering to label requirements. Furthermore, wildlife including birds would be subject to greater incidence of disease including WNV. The overall impact is **potentially significant** especially if sensitive species are affected.
- **Ecological Health:** Fewer herbicide and pesticide treatments by organized mosquito control agencies would be used to control mosquitoes under No Program. Indiscriminant use of aerosol foggers by the public may lead to increased pesticide resistance issues. In the absence of physical controls and nonchemical vegetation management, it is possible that the habitat conditions would result in greater rates of infection of species involved in the transmission of the disease. Domesticated animals would suffer greater incidence of disease and discomfort. Greater incidence of diseases and possible pesticide resistance would be **potentially significant** impacts.
- **Human Health:** In the absence of the District's IMMP, greater incidence of mosquito-borne disease and discomfort to people would occur in the Program Area. CDPH would not be able to replace all of the services the District currently provides or would provide under the Proposed Program. Lack of coordinated surveillance increases risk of emerging mosquito-borne diseases or their associated vectors going undetected until already established in an area; it reduces disease risk assessments an outbreak predictions at the local level. Lack of public outreach leads to increased mosquito production on private property and less information being available to people about mosquito-borne disease reduction. Homeowners would resort to use of pesticides available to them, many of which are more toxic than the ones used by the District. This impact on human health is **potentially significant**.
- **Public Services and Hazard Response:** The greater use of over-the-counter pesticides could lead to greater improper disposal of the containers. A greater incidence of disease and discomfort would potentially increase the demand for emergency services in the Program Area, a **potentially significant** impact.
- **Water Resources:** Under No Program, use of chemical treatments, including the use of naled, would be reduced compared to existing conditions. **No impact** on surface and groundwater resources would occur.
- **Air Quality:** The District would cease mosquito control activities, resulting in no use of vehicles, equipment, or pesticides and herbicides. **No impact** on air quality would occur.
- **Greenhouse Gases and Climate Change:** The District would cease mosquito control activities, resulting in no use of vehicles, equipment, or pesticides and herbicides. However, increased mosquito populations may lead to reduced outdoor recreation, especially non-motorized recreation such as hiking and bicycling, and increased indoor recreation involving greater electricity usage for air conditioning and entertainment. A **less-than-significant** impact on GHG emissions would occur.

> **Noise:** The District would cease mosquito control activities, resulting in no use of vehicles, equipment, or pesticides and herbicides. **No impact** on noise would occur.

15.4 Alternatives to Reduce Significant Impacts

CEQA Guidelines Section 15126.6(b) also requires that a draft EIR identify alternatives that are capable of avoiding or substantially lessening the significant environmental effects of the proposed project, even if the alternative would impede to some degree the attainment of all of the project objectives or would be more costly.

Modifications to the Proposed Program could include the following "Reduced Program Alternatives" which would avoid some or most of the potentially significant impacts associated with the Proposed Program, depending on how reliance on the other alternatives (i.e., exclusion of some options) to achieve a similar level of control would be implemented.

15.4.1 Reduced Physical Control Alternative

This alternative would reduce or eliminate the draining of or making drainage improvements in areas of shallow freshwater habitats, seasonal wetlands, freshwater marshes and duck clubs, and saline and brackish habitats if special-status species are present at the time the improvements occur. Furthermore, any of the physical control measures determined to be in conflict with the provisions of an HCP or NCCP would be suspended as well. These modifications to the Physical Control Alternative would result in less-than-significant impacts to these specific aquatic habitats and special status species if present. It would mean greater reliance on the Chemical Control Alternative options (except for use of permethrin, resmethrin, and/or naled as adulticides) to offset the reduction in effectiveness in controlling mosquito populations from avoiding or minimizing use of the drainage control measures.

15.4.2 Reduced Biological Control Alternative

The use of up to 100 pounds of mosquitofish in natural waterways is an integral component of the District's IMMP to control mosquito larvae. To avoid the potential for any mosquitofish to escape into areas used by other aquatic species, the Biological Control Alternative would need to be modified to substantially reduce the planting of mosquitofish in natural waterways by the District.

15.4.3 Reduced Chemical Control Alternative

This alternative would eliminate the options of using permethrin, resmethrin, and/or naled as mosquito adulticides. It could result in greater use of other, less hazardous chemicals and in greater reliance on the Physical Control and Vegetation Management Alternatives which would have impacts unless the options identified above are excluded.

15.5 Comparison of Alternatives

Table 15-1 presents a summary of all of the impacts associated with each Program Alternative and, therefore, the overall Program of all of the alternatives combined. Clearly there are tradeoffs between biological and water resources and the potential for objectionable odors to people where potentially significant impacts could occur.

> The Physical Control Alternative has the potential for greater impacts to biological resources/aquatic habitats if sensitive species are present when the drainage control measures are implemented. It also has the potential to impact aquatic habitats if there are conflicts with any HCP/NCCPs adopted within the District's Program Area.

> The Vegetation Management Alternative has the potential for significant impacts to aquatic biological resources from conflicts with the provisions of adopted HCP and NCCPs.

> The Biological Control Alternative does not completely eliminate the ecological risks associated with the planting of mosquitofish in natural waterways, and the residual impact after mitigation is significant and unavoidable.

> The Chemical Control Alternative has potentially significant impacts to surface water resources from the application of permethrin, resmethrin, and/or naled as adulticides. Use of naled to combat potential pesticide resistance of adult mosquitoes to other adulticides, even under infrequent or limited conditions, is significant and unavoidable. Furthermore, there is the potential for subjecting people to objectionable odors depending on the formulation used and proximity of treatment locations to human activities.

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
3. Urban and Rural Land Uses					
Impact LU-1: Surveillance of mosquitoes would not appreciably impact the quantity and/or quality of recreational opportunities in the Program Area. This impact is **less than significant** and no mitigation is required.	**LS**	na	na	na	na
Impact LU-2: Surveillance of mosquitoes would not conflict with applicable land use regulations. **No impact** would occur.	**N**	na	na	na	na
Impact LU-3: Physical control of mosquito habitat would not appreciably impact the quantity and/or quality of recreational opportunities in the Program Area. This impact is **less than significant** and no mitigation is required.	na	**LS**	na	na	na
Impact LU-4: Physical control of mosquitoes would not conflict with applicable land use regulations. **No impact** would occur.	na	**N**	na	na	na
Impact LU-5: Vegetation management would not appreciably impact the quantity and/or quality of recreational opportunities in the Program Area. This impact is **less than significant** and no mitigation is required.	na	na	**LS**	na	na
Impact LU-6: Vegetation management would not conflict with applicable land use regulations because state law preempts local ordinances. **No impact** would occur.	na	na	**N**	na	na
Impact LU-7: Biological control of mosquitoes would not appreciably impact the quantity and/or quality of recreational opportunities in the Program Area. **No impact** would occur**.**	na	na	na	**N**	na
Impact LU-8: Biological control of mosquitoes would not conflict with applicable land use regulations. **No impact** would occur.	na	na	na	**N**	na
Impact LU-9: Chemical application to control mosquitoes would impact recreational access and the quality of recreational opportunities in the Program Area. However, because these impacts would be isolated and short term, they are considered **less than significant** and no mitigation is required.	na	na	na	na	**LS**
Impact LU-10: The Chemical Control Alternative would not conflict with applicable land use regulations because state law preempts local ordinances. **No impact** would occur.	na	na	na	na	**N**

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
4. Biological Resources – Aquatic					
Impact AR-1. The Surveillance Alternative would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, special-status species, or HCP/NCCPs. These effects would result through maintenance of access routes to sampling locations in and adjacent to surveillance monitoring sites. No mitigation is required.	**LS**	na	na	na	na
Impact AR-2. Increasing circulation in shallow areas would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status species. No mitigation is required.	na	**LS**	na	na	na
Impact AR-3. Draining areas of shallow freshwater habitats would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, as only a small proportion of such habitat would be drained. No mitigation is required.	na	**LS**	na	na	na
Impact AR-4. Draining areas of shallow freshwater habitats would have a **potentially significant but mitigable** impact on special-status species, if these species are present when the habitat is drained.	na	**SM**	na	na	na
Impact AR-5. Draining seasonal wetlands in areas supporting sensitive fish species would have a **potentially significant but mitigable** impact on aquatic habitats, native fish or aquatic invertebrates, and special-status species.	na	**SM**	na	na	na
Impact AR-6. Improving drainage in freshwater marshes and seasonal wetlands managed as waterfowl habitat would have a **less-than-significant** impact on aquatic habitats, and native fish or aquatic invertebrates. No mitigation is required.	na	**LS**	na	na	na
Impact AR-7. Improving drainage in freshwater marshes and seasonal wetlands managed as waterfowl habitat would have a **potentially significant but mitigable** impact on special-status species if such species are present.	na	**SM**	na	na	na
Impact AR-8. Improving drainage in saline and brackish habitats would have a **less-than-significant** impact on aquatic habitats, and native fish or aquatic invertebrates. No mitigation is required.	na	**LS**	na	na	na
Impact AR-9. Improving drainage in saline and brackish habitats would have a **potentially significant but mitigable** impact on special-status species if such species are present.	na	**SM**	na	na	na

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact AR-10. Physical control of temporary standing waters and artificial ponds would have **no impact** on native or special-status fish species, as these areas do not provide habitat for or support these species.	na	**N**	na	na	na
Impact AR-11. Physical control of mosquito habitat in tree holes would have **no impact** on native or special-status fish species, as tree holes do not provide habitat for fish.	na	**N**	na	na	na
Impact AR-12. Physical control measures in wastewater treatment facilities and septic systems would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.	na	**LS**	na	na	na
Impact AR-13. Physical control of mosquito habitat in an artificial container habitat would have **no impact** on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species, as these containers do not provide habitat for these fish species.	na	**N**	na	na	na
Impact AR-14. Physical control measures could have a **potentially significant but mitigable** impact by conflicting with the provisions of an HCP/NCCP.	na	**SM**	na	na	na
Impact AR-15. The Vegetation Management Alternative would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species, when applied in compliance with the BMPs above. No mitigation is required.	na	na	**LS**	na	na
Impact AR-16. Vegetation management measures could have a **potentially significant but mitigable** impact by conflicting with the provisions of an HCP/NCCP.	na	na	**SM**	na	na
Impact AR-17. Planting mosquitofish in artificial environments that do not connect to natural waterbodies would have **no impact** on aquatic habitats, native fish or aquatic invertebrates, special-status fish species, or HCP/NCCPs. No mitigation is required.	na	na	na	**N**	na

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact AR-18. Planting of mosquitofish in natural waterways or artificial environments that drain to natural waterways would have a **potentially significant** impact on native fish or aquatic invertebrates, special-status fish species, and applicable HCP/NCCPs. The mitigation measures for this action would reduce the ecological risks associated with planting of mosquitofish in natural waters, but these risks would not be eliminated. Because of this, the residual impact of this action would be **significant and unavoidable**.	na	na	na	**SU**	na
Impact AR-19. The use of methoprene at the label concentrations listed for control of mosquito larvae in natural and man-made aquatic habitats would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.	na	na	na	na	**LS**
Impact AR-20. The use of surfactants at the label concentrations listed for control of mosquito larva in natural and man-made aquatic habitats would have a **less-than-significant** impact **on** aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.	na	na	na	na	**LS**
Impact AR-21. The use of temphos in isolated, man-made habitats would have **no impact** on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species.	na	na	na	na	**N**
Impact AR-22. The use of pyrethrin or pyrethroid pesticides in or near aquatic habitats would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.	na	na	na	na	**LS**
Impact AR-23. The use of PBO over, in or near aquatic habitats would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.	na	na	na	na	**LS**
Impact AR-24. The use of naled over, in, or near aquatic habitats would have a **less-than-significant** impact on aquatic habitats, native fish or aquatic invertebrates, or special-status fish species. No mitigation is required.	na	na	na	na	**LS**
Impact AR-25. The Chemical Control Alternative could have a **potentially significant but mitigable** impact by conflicting with the provisions of an HCP/NCCP.	na	na	na	na	**SM**

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
5. Biological Resources – Terrestrial					
Impact TR-1: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from the Surveillance Alternative would be **less than significant** and mitigation is not required.	**LS**	na	na	na	na
Impact TR-2: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from the Physical Control Alternative would be **less than significant** and mitigation is not required.	na	**LS**	na	na	na
Impact TR-3: The impact to terrestrial habitats through the selected reduction of a portion of the habitat, to native terrestrial plants or animals (including special-status species) or to HCP, NCCPs from the targeted use of the non-herbicide physical component of the Vegetation Management Alternative, would impact only a small fraction of the available habitat, would not substantially change the quality or functionality of the habitat for non-target species, and would thus be **less than significant** and mitigation is not required.	na	na	**LS**	na	na
Impact TR-4: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from herbicide use for the Vegetation Management Alternative would be **less than significant** and mitigation is not required.	na	na	**LS**	na	na
Impact TR-5: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from adjuvants used for herbicide applications under the Vegetation Management Alternative would be **less than significant** and mitigation is not required.	na	na	**LS**	na	na
Impact TR-6: No impact would occur to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCPs/NCCPs from the use of mosquitofish for the Biological Control Alternative.	na	na	na	**N**	na

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact TR-7: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from bacterial larvicides used for the Chemical Control Alternative would be **less than significant** and mitigation is not required.	na	na	na	na	**LS**
Impact TR-8: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from the use of methoprene for the Chemical Control Alternative would be **less than significant** and mitigation is not required.	na	na	na	na	**LS**
Impact TR-9: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from the use of temephos for the Chemical Control Alternative would be **less than significant** and mitigation is not required.	na	na	na	na	**LS**
Impact TR-10: No impact would occur to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCPs/NCCPs from the use of surfactants for the Chemical Control Alternative.	na	na	na	na	**N**
Impact TR-11: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from the use of pyrethrins for the Chemical Control Alternative would be **less than significant** and mitigation is not required.	na	na	na	na	**LS**
Impact TR-12: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from use of pyrethroids and pyrethroid-like compounds for the Chemical Control Alternative would be **less than significant** and mitigation is not required.	na	na	na	na	**LS**
Impact TR-13: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to HCP/NCCPs from use of the synergist PBO for the Chemical Control Alternative would be **less than significant** and mitigation is not required.	na	na	na	na	**LS**

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact TR-14: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to HCP/NCCPs from naled use for the Chemical Control Alternative would be **less than significant** and mitigation is not required.	na	na	na	na	**LS**
Impact TR-15: The impact to terrestrial habitats through reduction of the amount or quality of habitat available, to native terrestrial plant or animal populations through direct mortality, to special-status species, or to appropriate HCP/NCCPs from pyrethroids use for the Chemical Control Alternative would be **less than significant** and mitigation is not required.	na	na	na	na	**LS**

6. Ecological Health

Impact ECO-1: The Surveillance Alternative would have a **less-than-significant** impact on nontarget ecological receptors, including native or special-status plants and animals and mitigation is not required.	**LS**	na	na	na	na
Impact ECO-2: The Physical Control Alternative would have a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	**LS**	na	na	na
Impact ECO-3: The employment of a nonherbicide Vegetation Management Alternative in the form of physical removal would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	na	**LS**	na	na
Impact ECO-4: The use of herbicides would be result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	na	**LS**	na	na
Impact ECO-5: The use of glyphosate would result in a **less-than-significant impact** to nontarget ecological receptors and mitigation is not required.	na	na	**LS**	na	na
Impact ECO-6: The use of adjuvants would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required	na	na	**LS**	na	na
Impact ECO-7: Planting mosquitofish in artificial environments that do not connect to natural water bodies would have **no impact** on aquatic habitats, native fish or aquatic invertebrates, special-status fish species, or HCP/NCCPs. No mitigation is required.	na	na	**N**	na	na

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact ECO-8: Planting of mosquitofish in natural waterways or artificial environments that drain to natural waterways would have a **potentially significant** impact on native fish or aquatic invertebrates, special-status fish species, and applicable HCP/NCCPs. The mitigation measures for this action would reduce the ecological risks associated with planting of mosquitofish in natural waters, but these risks would not be eliminated. Because of this, the residual impact of this action would be **significant and unavoidable**.	na	na	na	**SU**	na
Impact ECO-9: The use of the organophosphate temephos would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	na	na	na	**LS**
Impact ECO-10: The use of bacterial larvicides would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	na	na	na	**LS**
Impact ECO-11: The use of methoprene for mosquito larvae would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	na	na	na	**LS**
Impact ECO-12: The use of surfactants for the control of mosquito larvae would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	na	na	na	**LS**
Impact ECO-13: The use of pyrethrins for adult mosquitoes would result in a **less-than-significant** impact to nontarget ecological receptors including aquatic organisms and mitigation is not required.	na	na	na	na	**LS**
Impact ECO-14: The use of pyrethroids and pyrethroid-like compounds (e.g., resmethrin, permethrin, and etofenprox**)** for mosquitoes would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	na	na	na	**LS**
Impact ECO-15: The use of synergists (PBO) for mosquitoes would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	na	na	na	**LS**
Impact ECO-16: The use of the organophosphate naled would result in a **less-than-significant** impact to nontarget ecological receptors and mitigation is not required.	na	na	na	na	**LS**

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
7. Human Health					
Impact HH-1: No impact would occur to human health from the use of the Surveillance Alternative.	**N**	na	na	na	na
Impact HH-2: Impacts to human health from use of the Physical Control Alternative would be **less than significant** and mitigation is not required.	na	**LS**	na	na	na
Impact HH-3: No impact would occur to human health from the nonherbicide Vegetation Management Alternative.	na	na	**N**	na	na
Impact HH-4: Impacts to human health from herbicides would be **less than significant** because the actual use and human exposure in the field is far less than tested in the laboratory and much higher volumes (exposure) would be needed to result in toxicity. Mitigation is not required.	na	na	**LS**	na	na
Impact HH-5: Impacts to human health from the use of glyphosate would be **less than significant** and mitigation is not required.	na	na	**LS**	na	na
Impact HH-6: Impacts to human health from the use of pesticide adjuvants would be **less than significant** and mitigation is not required.	na	na	**LS**	na	na
Impact HH-7: No impact would occur to human health from the use of mosquitofish.	na	na	na	**N**	na
Impact HH-8: No impact would occur to human health from the use of bacterial larvicides**.**	na	na	Na	na	**N**
Impact HH-9: No impact would occur to human health from the use of the mosquito larvicide methoprene.	na	na	na	na	**N**
Impact HH-10: No impact would occur to human health from the use of surfactant larvicide.	na	na	na	na	**N**
Impact HH-11: Impacts to human health from the use of temephos would be **less than significant** and mitigation is not required.	na	na	na	na	**LS**
Impact HH-12: Impacts to human health from the use of naled would be **less than significant** and mitigation is not required.	na	na	na	na	**LS**
Impact HH-13: Impacts to human health from the use of pyrethrins would be **less than significant** and mitigation is not required.	na	na	na	na	**LS**

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact HH-14: Impacts to human health from the use of pyrethroids and pyrethroid-like compounds as mosquito adulticides would be **less than significant** and mitigation is not required.	na	na	na	na	**LS**
Impact HH-15: Impacts to human health from the use of the synergist PBO in mosquito adulticides would be **less than significant** and mitigation is not required.	na	na	na	na	**LS**
Impact HH-16: Impacts to human health from the use of naled would be **less than significant** and mitigation is not required.	na	na	na	na	**LS**
8. Public Services and Hazard Response					
Impact PSH-1: Surveillance activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.	**N**	na	na	na	na
Impact PSH-2: Surveillance activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.	**N**	na	na	na	na
Impact PSH-3: Surveillance activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.	**N**	na	na	na	na
Impact PSH-4: Physical control activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.	na	**N**	na	na	na
Impact PSH-5: Physical control activities do not include the use of pesticides or herbicides; therefore, these activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.	na	**N**	na	na	na
Impact PSH-6: Physical control activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.	na	**N**	na	na	na
Impact PSH-7: Vegetation management activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.	na	na	**N**	na	na

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact PSH-8: Vegetation management activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.	na	na	**N**	na	na
Impact PSH-9: Vegetation management activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.	na	na	**N**	na	na
Impact PSH-10: Biological control activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.	na	na	na	**N**	na
Impact PSH-11: Biological control activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.	na	na	na	**N**	na
Impact PSH-12: Biological control activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.	na	na	na	**N**	na
Impact PSH-13: Chemical control activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.	na	na	na	na	**N**
Impact PSH-14: Chemical control ground larviciding and adulticiding activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.	na	na	na	na	**N**
Impact PSH-15: Chemical control ground larviciding and adulticiding activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.	na	na	na	na	**N**
Impact PSH-16: Chemical control (aerial application) activities would not increase demand for police, fire, or health-care services. Therefore, **no impact** would occur.	na	na	na	na	**N**

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact PSH-17: Chemical control (aerial application) activities would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. Therefore, **no impact** would occur.	na	na	na	na	**N**
Impact PSH-18: Chemical control (aerial application) activities would not expose people or structures to a significant risk of loss, injury, or death involving wildland fires. Therefore, **no impact** would occur.	na	na	na	na	**N**

9. Water Resources

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact WR-1: The Surveillance Alternative collection devices would not contact nor interact with the environment. **No impact** would occur to surface water or groundwater.	**N**	na	na	na	na
Impact WR-2: The Physical Control Alternative's activities to modify water circulation, remove sediment, and maintain water control facilities to reduce habitat conditions for mosquito production would have a **less-than-significant** impact on water resources and no mitigation is required.	na	**LS**	na	na	na
Impact WR-3: Mechanical removal of vegetation from aquatic habitats would have a **less-than-significant** impact to surface water and **no impact** to groundwater resources and no mitigation is required.	na	na	**LS, N**	na	na
Impact WR-4: Application of the herbicides imazapyr and glyphosate would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	**LS**	na	na
Impact WR-5: Application of APEs would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required	na	na	**LS**	na	na
Impact WR-6: Application of polydimethylsiloxanes would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	**LS**	na	na
Impact WR-7: The Biological Control Alternative's production of mosquitofish limits wastewater discharges to upland areas. Therefore, the production of mosquitofish would have a **less-than-significant** impact on surface water and groundwater resources and no mitigation is required	na	na	na	**LS**	na

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact WR-8: The Biological Control Alternative's use of mosquitofish in man-made water features that are hydrologically-isolated from receiving waters would have a **less-than-significant** impact on surface water and groundwater resources and no mitigation is required.	na	na	na	**LS**	na
Impact WR-9 Planting of mosquitofish in natural waterways or artificial environments that drain to natural waterways would have a **less than significant** impact on surface water resources and no mitigation is required.	na	na	na	**LS**	na
Impact WR-10: Application of the biological agents *Bs*, *Bti,* and spinosad would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	**LS**
Impact WR-11: Application of methoprene would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	**LS**
Impact WR-12: Application of the surfactant larvicides alpha-isooctadecyl-omega-hydroxypoly (oxyethylene), mineral oils, and aliphatic petroleum hydrocarbons would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	**LS**
Impact WR-13: Application of temephos would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	**LS**
Impact WR-14: Application of the synergist PBO would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	**LS**
Impact WR-15: Application of pyrethrins would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	**LS**
Impact WR-16: Because of its high toxicity and potential persistence, the application of permethrin is considered a **potentially significant but mitigable** impact to surface water resources. Mitigation is required. For groundwater, because of its strong tendency to adsorb to soil surfaces, permethrin is unlikely to leach to groundwater and, therefore, its application is considered a **less-than-significant** impact to groundwater resources and no mitigation is required.	na	na	na	na	**SM, LS**
Impact WR-17: Application of phenothrin would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	**LS**
Impact WR-18: Application of prallethrin would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	**LS**

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact WR-19: Due to its high toxicity and potential persistence, the application of resmethrin is considered a **potentially significant but mitigable** impact to surface water resources. Mitigation is required. For groundwater, because of its strong tendency to adsorb to soil surfaces, resmethrin is unlikely to leach to groundwater and therefore its application is considered a **less-than-significant** impact to groundwater resources and no mitigation is required.	na	na	na	na	**SM, LS**
Impact WR-20: Application of etofenprox would have a **less-than-significant** impact to surface water and groundwater resources and no mitigation is required.	na	na	na	na	**LS**
Impact WR-21: Due to the toxicity of its breakdown product but its importance in the District's IMMP, the application of naled is considered a **significant and unavoidable** impact to surface and groundwater resources.	na	na	na	na	**SU**
10. Effects on Air Quality					
Impact AQ-1: Based on the general inclusion of Surveillance Alternative emissions in the SIP emission inventory and the compliance with applicable air regulations, the Surveillance Alternative would not conflict with applicable air quality plans. Impacts would be **less than significant** and no mitigation is required**.**	**LS**	na	na	na	na
Impact AQ-2: Based on estimated daily emissions for each criteria pollutant, the Surveillance Alternative would not violate an ambient air quality standard. Impacts would be **less than significant** and no mitigation is required.	**LS**	na	na	na	na
Impact AQ-3: Based on estimated daily emissions for each criteria pollutant, the Surveillance Alternative would not result in a cumulatively considerable increase of nonattainment pollutants. Impacts would be **less than significant** and no mitigation is required.	**LS**	na	na	na	na
Impact AQ-4: Based on the estimated daily emissions for each criteria pollutant, the Surveillance Alternative would not expose sensitive receptors to substantial pollutant concentrations. Impacts would be **less than significant** and no mitigation is required.	**LS**	na	na	na	na
Impact AQ-5: The Surveillance Alternative would not subject people to objectionable odors. **No impact** would occur.	**N**	na	na	na	na
Impact AQ-6: Based on the general inclusion of Physical Control Alternative emissions in the SIP emission inventory and the compliance with applicable air regulations, the Physical Control Alternative would not conflict with applicable air quality plans. Impacts would be **less than significant** and no mitigation is required.	na	**LS**	na	na	na

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact AQ-7: Based on estimated daily emissions for each criteria pollutant, the Physical Control Alternative would not violate an ambient air quality standard. Impacts would be **less than significant** and no mitigation is required.	na	**LS**	na	na	na
Impact AQ-8: Based on estimated daily emissions for each criteria pollutant, the Physical Control Alternative would not result in a cumulatively considerable increase of nonattainment pollutants. Impacts would be **less than significant** and no mitigation is required.	na	**LS**	na	na	na
Impact AQ-9: Based on the estimated daily emissions for each criteria pollutant, the Physical Control Alternative would not expose sensitive receptors to substantial pollutant concentrations. Impacts would be **less than significant** and no mitigation is required.	na	**LS**	na	na	na
Impact AQ-10: The Physical Control Alternative would not subject people to objectionable odors. **No impact** would occur.	na	**N**	na	na	na
Impact AQ-11: Based on the general inclusion of Vegetation Management Alternative emissions in the SIP emission inventory and the compliance with applicable air regulations, the Vegetation Management would not conflict with applicable air quality plans. Impacts would be **less than significant** and no mitigation is required.	na	na	**LS**	na	na
Impact AQ-12: Based on estimated daily emissions for each criteria pollutant, the Vegetation Management Alternative would not violate an ambient air quality standard. Impacts would be **less than significant** and no mitigation is required.	na	na	**LS**	na	na
Impact AQ-13: Based on estimated daily emissions for each criteria pollutant, the Vegetation Management Alternative would not result in a cumulatively considerable increase of nonattainment pollutants. Impacts would be **less than significant** and no mitigation is required.	na	na	**LS**	na	na
Impact AQ-14: Based on the estimated daily emissions for each criteria pollutant, the Vegetation Management Alternative would not expose sensitive receptors to substantial pollutant concentrations. Impacts would be **less than significant** and no mitigation is required.	na	na	**LS**	na	na
Impact AQ-15: The Vegetation Management Alternative would not subject people to objectionable odors. **No impact** would occur.	na	na	**N**	na	na

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact AQ-16: Based on the general inclusion of Biological Control Alternative emissions in the SIP emission inventory and the compliance with applicable air regulations, the Biological Control Alternative would not conflict with applicable air quality plans. Impacts would be **less than significant** and no mitigation is required.	na	na	na	**LS**	na
Impact AQ-17: Based on estimated daily emissions for each criteria pollutant, the Biological Control Alternative would not violate an ambient air quality standard. Impacts would be **less than significant** and no mitigation is required.	na	na	na	**LS**	na
Impact AQ-18: Based on estimated daily emissions for each criteria pollutant, the Biological Control Alternative would not result in a cumulatively considerable increase of nonattainment pollutants**.** Impacts would be **less than significant** and no mitigation is required.	na	na	na	**LS**	na
Impact AQ-19: Based on the estimated daily emissions for each criteria pollutant, the Biological Control Alternative would not expose sensitive receptors to substantial pollutant concentrations. Impacts would be **less than significant** and no mitigation is required.	na	na	na	**LS**	na
Impact AQ-20: The Biological Control Alternative would not subject people to objectionable odors. **No impact** would occur.	na	na	na	**N**	na
Impact AQ-21: Based on the general inclusion of Chemical Control Alternative emissions in the SIP emission inventory and the compliance with applicable air regulations, the Chemical Control Alternative would not conflict with applicable air quality plans. Impacts would be **less than significant** and no mitigation is required.	na	na	na	na	**LS**
Impact AQ-22: Based on estimated daily emissions for each criteria pollutant, the Chemical Control Alternative would not violate an ambient air quality standard. Impacts would be **less than significant** and no mitigation is required.	na	na	na	na	**LS**
Impact AQ-23: Based on estimated daily emissions for each criteria pollutant, the Chemical Control Alternative would not result in a cumulatively considerable increase of nonattainment pollutants**.** Impacts would be **less than significant** and no mitigation is required.	na	na	na	na	**LS**
Impact AQ-24: Based on the estimated daily emissions for each criteria pollutant, the Chemical Control Alternative would not expose sensitive receptors to substantial pollutant concentrations**.** Impacts would be **less than significant** and no mitigation is required.	na	na	na	na	**LS**

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact AQ-25: The Chemical Control Alternative could subject people to objectionable odors. Impacts could be **potentially significant but mitigable.**	na	na	na	na	**SM**
11. Effects on GHG					
Impact GHG-1: Based on estimated annual CO2e emissions, the Surveillance Alternative would not result in a cumulatively considerable amount of GHGs, and neither would the incremental contribution of the District. Impacts would be **less than significant** and no mitigation is required.	**LS**	na	na	na	na
Impact GHG-2: Based on the general inclusion of Surveillance Alternative emissions in the local and statewide GHG emission inventories, the Surveillance Alternative would not conflict with applicable plans, policies, or regulations for reducing GHG emissions. Impacts would be **less than significant** and no mitigation is required.	**LS**	na	na	na	na
Impact GHG-3: Due to the lack of projected annual CO2e emissions, the Physical Control Alternative would not result in a cumulatively considerable amount of GHGs, and neither would the incremental contribution of the District. Impacts would be **less than significant** and no mitigation is required.	na	**LS**	na	na	na
Impact GHG-4: Based on the general inclusion of Physical Control Alternative emissions in the local and statewide GHG emission inventories, the Physical Control Alternative would not conflict with applicable plans, policies, or regulations for reducing GHG emissions. Impacts would be **less than significant** and no mitigation is required.	na	**LS**	na	na	na
Impact GHG-5: Due to the lack of projected annual CO2e emissions, the Vegetation Management Alternative would not result in a cumulatively considerable amount of GHGs, and neither would the incremental contribution of each District. Impacts would be **less than significant** and no mitigation is required.	na	na	**LS**	na	na
Impact GHG-6: Based on the general inclusion of Vegetation Management Alternative emissions in the local and statewide GHG emission inventories, the Vegetation Management Alternative would not conflict with applicable plans, policies, or regulations for reducing GHG emissions. Impacts would be **less than significant** and no mitigation is required.	na	na	**LS**	na	na
Impact GHG-7: Due to the lack of projected annual CO2e emissions, the Biological Control Alternative would not result in a cumulatively considerable amount of GHGs, and neither would the incremental contribution of each District. Impacts would be **less than significant** and no mitigation is required.	na	na	na	**LS**	na

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact GHG-8: Based on the general inclusion of Biological Control Alternative emissions in the local and statewide GHG emission inventories, the Biological Control Alternative would not conflict with applicable plans, policies, or regulations for reducing GHG emissions. Impacts would be **less than significant** and no mitigation is required.	na	na	na	**LS**	na
Impact GHG-9: Based on estimated annual CO2e emissions, the Chemical Control Alternative would not result in a cumulatively considerable amount of GHGs, and neither would the incremental contribution of the District. Impacts would be **less than significant** and no mitigation is required.	na	na	na	na	**LS**
Impact GHG-10: Based on the general inclusion of Chemical Control Alternative emissions in the local and statewide GHG emission inventories, the Chemical Control Alternative would not conflict with applicable plans, policies, or regulations for reducing GHG emissions. Impacts would **be less than** significant and no mitigation is required**.**	na	na	na	na	**LS**
12. Effects on Noise					
Impact N-1: Use of equipment and vehicles would increase noise levels during operations, but this increase would not exceed regulatory thresholds. This impact is **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.	**LS**	na	na	na	na
Impact N-2: Use of equipment and vehicles would cause a temporary increase in noise levels during operations. This increase would not be substantial and, therefore, is **less than significant** based on the frequency and duration of the activity, resulting noise levels, comparability to noise resulting from existing activities, and implementation of BMPs. No mitigation is required.	**LS**	na	na	na	na
Impact N-3: Use of equipment and vehicles would increase noise levels during operations, but this increase would not exceed regulatory thresholds. This impact is **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.	na	**LS**	na	na	na
Impact N-4: Use of equipment and vehicles would cause a temporary increase in noise levels during operations. This increase would not be substantial**,** and therefore is **less than significant** based on the frequency and duration of the activity, resulting noise levels, comparability to noise resulting from existing activities, and implementation of BMPs. No mitigation is required.	na	**LS**	na	na	na

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact N-5: Use of equipment and vehicles would increase noise levels during operations, but this increase would not exceed regulatory thresholds. This impact is **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.	na		**LS**	na	na
Impact N-6: Use of equipment and vehicles would cause a temporary increase in noise levels during operations. This increase would not be substantial, and therefore is **less than significant** based on the frequency and duration of the activity, resulting noise levels, comparability to noise resulting from existing activities, and implementation of BMPs. No mitigation is required.	na	na	**LS**	na	na
Impact N-7: Use of equipment and vehicles would increase noise levels during operations, but this increase would not exceed regulatory thresholds. This impact is **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.	na	na	na	**LS**	na
Impact N-8: Use of equipment and vehicles would cause a temporary increase in noise levels during operations. This increase would not be substantial and, therefore, is **less than significant** based on the frequency and duration of the activity and resulting noise levels, and implementation of BMPs. No mitigation is required.	na	na	na	**LS**	na
Impact N-9: Use of equipment and vehicles would increase noise levels during operations, but this increase would not exceed regulatory thresholds. This impact is **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.	na	na	na	na	**LS**
Impact N-10: Helicopter/fixed wing aircraft use would temporarily increase noise levels during operations, but would not exceed regulatory thresholds. This impact is **less than significant** based on the frequency and duration of the activity and resulting noise levels. No mitigation is required.	na	na	na	na	**LS**
Impact N-11: Use of equipment and vehicles would cause a temporary increase in noise levels during operations. This increase would not be substantial and, therefore, is **less than significant** based on the frequency and duration of the activity, resulting noise levels, comparability to noise resulting from existing activities, and implementation of BMPs. No mitigation is required.	na	na	na	na	**LS**

Table 15-1 Summary of Program Alternative Impacts by Alternative

Impact Statement	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control
Impact N-12: Helicopter/fixed-wing aircraft/airboat use would temporarily increase noise levels during operations, but this increase would not be substantial. This impact is **less than significant** based on the frequency and duration of the activity, resulting noise levels, and implementation of BMPs. No mitigation is required.	na	na	na	na	**LS**

LS = Less-than-significant impact

N = No impact

na = Not applicable

SM = Potentially significant but mitigable impact

SU = Significant and unavoidable impact

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16 List of Preparers

The following personnel were directly involved in preparation of the PEIR:

Solano County Mosquito Abatement District

Jon Blegen .... District Manager/CEQA Project Manager

Carol Evkhanian .... Biologist

16.1 Consultant Team

Technical and support personnel from Cardno ENTRIX and the entire consultant team that were involved in technical analyses and document preparation are listed in Table 16-1.

Table 16-1 Technical and Support Personnel

Preparers	Degree(s) Years of Experience	Role in Preparation	Experience and Expertise
Cardno ENTRIX			
Hootkins, Susan	MUP, Urban and Regional Planning BA, Human Biology 39 years	Project Manager	> Environmental Planning > CEQA/NEPA Compliance > Socioeconomics
Bonin, Adam	PhD, Environmental Science & Resources BS, Environmental Management 18 years	Ecological Hazard Assessment; Human Health Hazard Assessment	> Environmental Microbiology > Ecological Risk Assessment > Environmental Chemistry > Quality Assurance/Quality Control Chemistry
Boyes, Brad	MBA, Project Management BS, Environmental Engineering 33 years	Air Quality Climate Change	> Air Quality > Climate Change / GHGs > Health Risk Assessments > Risk Management Plans > Environmental Site Assessment
Brice, Doug	BS, Geography: Emphasis on GIS and Environmental Planning 20 years	GIS Coordinator	> GIS Systems > Field/Data Collection > Geospatial Application Development > Environmental Planning

Preparers	Degree(s) Years of Experience	Role in Preparation	Experience and Expertise
Butler, Karen	27 years	Production Specialist	> Production Support
Clare, Anna	MA, Geography BS, Geographic Information System 6 years	GIS Analyst	> GIS System > Environmental Analysis > Physical Geography > Cartographic Research
Dillon, Reinhold	BA, History MA, Medieval History and Literature 30 years	Technical Editing Style Guide	> Technical Editing > Language Control
Eschen, Iris	35 years	Production Manager	> Production management and coordination, word processing, desktop publishing
Floyd, Emily	PhD, Ecology BA, Marine Science 11 years	Aquatic Ecology	> Aquatic Ecology > Fish Physiology > Ecotoxicology > Habitat Alteration
Knaapen, Anthony	BA, General Biology 2 years	Staff Scientist	> Public Scoping > Technical Support
Koppel, Emily	MS, Biology BS, Fisheries & Wildlife 8 years	Toxicity Assessment Aquatic Ecology	> Parasite and Disease Ecology > Marine Biology > Terrestrial Ecology > Environmental Toxicology
Lebednik, Gretchen	MS, Botany BA, Environmental Biology 25 years	Terrestrial Ecology	> Vegetation Ecology > Habitat Restoration > Rare plant Surveys > Wetland Delineation > Riparian Vegetation assessment
Lee, Michele	MS, Wildland Resource Science BA, Psychology 15 years	Terrestrial Ecology	> Vegetation Ecology > Habitat Restoration > Rare plant Surveys > Wetland Delineation > Riparian Vegetation assessment > Public Services and Hazards
Pavich, Steve	MS, Agricultural and Resource Economics BA, Economics 11 Years	Urban and Rural Land Use	> Socioeconomics > Resource Economics > Recreation > Land use planning

Preparers	Degree(s) Years of Experience	Role in Preparation	Experience and Expertise
Thompson, Tim	MS, Geological Sciences BS, Geological Sciences 27 years	Water Resources	> Water Resource Science > Regulatory Issues
Williams, Bill	PhD, Physiology and Biophysics MS, Physiology and Biophysics BA, Physiology and Biophysics 33 years	Ecological Hazard Assessment Task Leader; Human Health Hazard Assessment Task Leader; Terrestrial Biology	> Ecological and Human Health Risk Assessments > Natural Resource Damage Assessments > Pesticide Regulation > Toxicology
Wise, Larry	MA, Marine Biology BS, Marine Biology and Limnology 23 years	Aquatic Biology Aquatic Ecology	> Ecology of Freshwater, Estuarine, and Marine Systems > CEQA/NEPA Compliance
Woodman, Lorraine	PhD, Anthropology MA, Anthropology BA, Anthropology 29 years	Noise Analysis	> CEQA/NEPA Compliance > Habitat Conservation
URS Corporation			
Cooke, Terry	MS, Marine Sciences BA, Chemistry 32 years	Water Resources	> TMDLs / Water Quality > Stormwater Management > NPDES Permitting
de Berry, Bonnie	MFS, Aquatic Chemistry BS, Natural Resources and Environmental Sciences 15 years	Water Resources	> Water Quality > Hydrology > Stormwater Management > Wetland Mitigation > NPDES Permitting
Nielsen, Elizabeth	MS, Environmental Engineering BS, Biology 12 years	Water Resources	> Water Quality > Ecological Risk Assessment > NPDES Permitting
Grant Visual Technology			
Grant, Douglas	BS, Geological Sciences 22 years	Noise	> Geology > Engineering Design > Acoustical Modeling
Somach Simmons and Dunn			
Taber, Kelley	JD Major AB, East Asian Studies State Bar of CA, 1996 18 years	CEQA Compliance	> Legal Support > CEQA and water quality focus > CDFA consultant team

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Integrated Mosquito and Vector Management Programs

APPENDIX A

BIOLOGICAL RESOURCES TECHNICAL REPORT

Biological Resources Technical Report

Project Name	Integrated Mosquito and Vector Management Programs for Nine Districts
Date	June 2013

Prepared for:

Alameda County Mosquito Abatement District

Alameda County Vector Control Services District

Contra Costa Mosquito and Vector Control District

Marin/Sonoma Mosquito and Vector Control District

Napa County Mosquito Abatement District

Northern Salinas Valley Mosquito Abatement District

San Mateo County Mosquito and Vector Control District

Santa Clara County Vector Control District

Solano County Mosquito Abatement District

Prepared by:

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Table of Contents

Attachments

Tables

Figures

Acronyms

ACMAD	Alameda County Mosquito Abatement District
ACVCSD	Alameda County Vector Control Services District
CCMVCD	Contra Costa Mosquito and Vector Control District
CDFA	California Department of Food and Agriculture
CDFW	California Department of Fish and Wildlife
CDPH	California Department of Public Health
CDPR	California Department of Pesticide Regulation
MSMVCD	Marin/Sonoma Mosquito Vector Control District
NCMAD	Napa County Mosquito Abatement District
NMFS	National Marine Fisheries Service
NSVMAD	Northern Salinas Valley Mosquito and Vector Control District
RWQCB	Regional Water Quality Control Board
SCCVCD	Santa Clara County Vector Control District
SCMAD	Solano County Mosquito Abatement District
SMCMVCD	San Mateo County Mosquito and Vector Control District
SWRCB	State Water Resources Control Board
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

1 Introduction

This report provides a description of the environmental setting for biological resources for the Integrated Mosquito and Vector Management Programs (Programs) for nine mosquito abatement and/or vector control districts in northern California. The Programs provide for mosquito and/or vector control activities within each District's Program Area. The nine District Program Areas include both the areas within the districts and the surrounding counties where the districts may provide mosquito and/or other vector management services when requested. The nine districts are: Alameda County Mosquito Abatement District (ACMAD), Alameda County Vector Control Services District (ACVCSD), Contra Costa Mosquito and Vector Control District (CCMVCD), Marin/Sonoma Mosquito Vector Control District (MSMVCD), Napa County Mosquito Abatement District (NCMAD), Northern Salinas Valley Mosquito Abatement District (NSVMAD), San Mateo County Mosquito and Vector Control District (SMCMVCD), Santa Clara County Vector Control District (SCCVCD), and the Solano County Mosquito Abatement District (SCMAD).

The immediate nine District Service Areas are located in the following nine counties of the state: Alameda, Contra Costa, Marin, Monterey (NSVMD), Napa, Sonoma, Solano, San Mateo, and Santa Clara. The nine District Program Areas addressed in this report also include the ten surrounding counties: Mendocino, Merced, Lake, Sacramento, San Benito, San Francisco, San Joaquin, Santa Cruz, Stanislaus, Yolo, and the portion of Monterey County south of the NSVMAD. Control activities may also be provided in areas adjacent to the District Service Areas upon request of the adjacent jurisdictions to protect the health and safety of residents in adjacent jurisdictions. Actions that would be taken outside of the nine Districts' Service Areas are the same types of actions undertaken within the Districts' Service Areas and in similar types of habitats or sites.

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2 Environmental Setting

2.1 Aquatic Habitat

Due to the extent of the nine Program Areas, hydrologic provinces and fish species assemblages presented in Moyle (2002) have been used to describe the areas where treatments would be implemented (Figure 2-1).The hydrologic provinces (as described in Moyle 2002) potentially affected by the Programs are described below. The provinces for each district and its boundary counties are provided in Table 2-1.

Table 2-1 Hydrologic Provinces by District and Adjacent Counties

District	Sacramento – San Joaquin Province			North Coast Province	South Coast Province
	Central Valley Subprovince	Clear Lake Subprovince	Monterey Bay Subprovince		
ACMAD	yes	--	--	--	--
ACMAD adjacent	yes	--	yes	--	--
ACVCSD	yes	--	--	--	--
ACVCSD adjacent	yes	--	yes	--	--
CCMVCD	yes	--	--	--	--
CCMVCD adjacent	yes	--	--	--	--
MSMVCD	yes	--	--	yes	--
MSMVCD adjacent	yes	yes	--	yes	--
NCMAD	yes	--	--	yes	--
NCMAD adjacent	yes	yes	--	yes	--
NSVMAD	--	--	yes	--	--
NSVMAD adjacent	yes	--	yes	--	--
SMCMVCD	yes	--	yes	--	--
SMCMVCD adjacent	yes	--	yes	--	--
SCCVCD	yes	--	yes	--	--
SCCVCD adjacent	yes	--	yes	--	--
SCMAD	yes	--	--	--	yes
SCMAD adjacent	yes	--	--	yes	yes

2.1.1 Sacramento-San Joaquin Province

2.1.1.1 Central Valley Subprovince

The Central Valley Subprovince is drained by the Sacramento and San Joaquin rivers. Species native to this region are distinct with respect to morphology, physiology, and life-history patterns, reflecting an evolutionary history of adaptation to a unique climate characterized by extended droughts as well as massive floods (Moyle 2002). The hot Mediterranean climate of the Central Valley is characterized by hot, dry summers and cool, damp winters. The rainy season occurs from mid-Autumn through spring, with the northern half of the Central Valley receiving greater precipitation than the semidesert southern half. The four main fish assemblages that occur in the Central Valley Subprovince are (1) the rainbow trout assemblage, (2) the California roach assemblage, (3) the pikeminnow-hardhead-sucker assemblage, and (4) the deep-bodied assemblage.

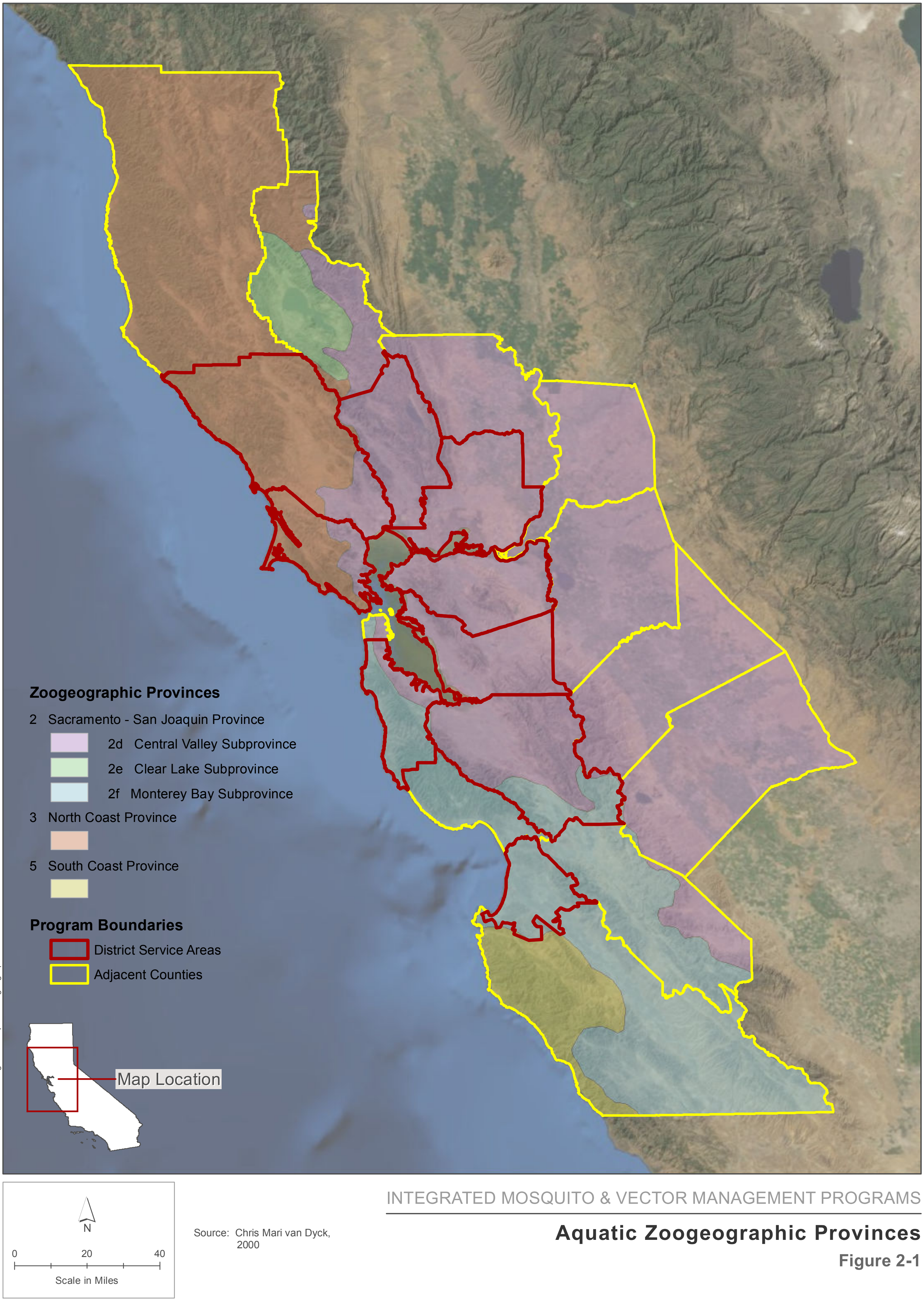
2.1.1.1.1 San Francisco Estuary

The Sacramento-San Joaquin River Delta lies near the confluence of the Sacramento and San Joaquin rivers between the towns of Hood, Vernalis, and Martinez. The Delta is the transition zone between freshwater river habitats of the Central Valley rivers and the successively more saline habitats of Suisun, San Pablo, and San Francisco bays. These habitats are affected by the tides, which cause diurnal changes in flow patterns and water quality, as well as river outflow, which cause more seasonal changes in habitat. The Delta has been substantially modified from its historic condition by levees, agriculture, toxic contaminants from municipal, industrial, and agricultural sources, and water diversions. The estuary is home to a diverse array of native and introduced species, some of which reside in the estuary throughout the year, and others that use the estuary seasonally. These species include winter-run and spring-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley steelhead (*Oncorhynchus mykiss*), green sturgeon (*Acipenser medirostris*), delta smelt (*Hypomesus transpacificus*), and longfin smelt (*Spirinchus thaleichthys*), all of which are listed by either the federal or California Endangered Species Acts.

The fish fauna that currently characterizes this system (including native and nonnative species) can be most easily described with respect to feeding guilds: planktivores, small benthic predators, bottom-feeding omnivores, and piscivores. The main planktivores in the estuary include the native delta and longfin smelt, hitch (*Lavinia exilicauda*), and several introduced species. Small benthic predators include native prickly sculpin (*Cottus asper*), tule perch (*Hysterocarpus traski*), starry flounder (*Platichthys stellatus*), juvenile white sturgeon (*Acipenser transmontanus*), juvenile Sacramento splittail (*Pogonichthys macrolepidotus),* and Pacific staghorn sculpin (*Leptocottus armatus*), as well as introduced species. Bottom-feeding omnivores include native adult Sacramento splittail, and Sacramento sucker (*Catostomus occidentalis*) and the introduced common carp (*Cyprinus carpio*). The most abundant piscivores in the system are introduced species: striped bass (*Morone saxatilis*), white catfish (*Ameiurus catus*), channel catfish (*Ictalurus punctatus*), and largemouth bass (*Micropterus salmoides*), which often prey on smaller migratory fishes such as juvenile salmon and steelhead (Moyle 2002).

2.1.1.1.2 Central Valley Floor

The Central Valley floor is composed of warm waterways including sluggish river channels, swamps, sloughs, and long stretches of open water. The Central Valley floor fish fauna is composed primarily of species from the deep-bodied fish assemblage. Native deep-bodied fishes, such as Sacramento perch (*Archoplites interruptus*) and tule perch, and juvenile fishes occupy the stagnant backwaters, while specialized adult cyprinids (hitch, Sacramento blackfish [*Orthodon microlepidotus*], and splittail) inhabit the long stretches of open water. Large Sacramento pikeminnows (*Ptychocheilus grandis*) and suckers are also abundant, migrating upstream to spawn in tributaries. Anadromous salmon, steelhead, and sturgeon pass through this zone on their way upstream to spawn (Moyle 2002). This domain is now dominated by introduced species.



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Source: Chris Mari van Dyck, 2000

Aquatic Zoogeographic Provinces

Figure 2-1

2.1.1.1.3 Central Valley Foothills

Central Valley foothill streams and rivers ascend from the valley floor to the Sierra and Coast Range mountains. These streams and rivers are home to three fish assemblages as defined by Moyle (2002). From lowest to highest elevation, they are the pikeminnow-hardhead-sucker assemblage, the California roach assemblage, and the rainbow trout assemblage. The pikeminnow-hardhead-sucker assemblage occurs just above the valley floor at elevations of 80 to 1,500 feet. This assemblage typically inhabits streams with average summer flows of >300 liters/second, with deep, rocky pools and wide shallow riffles. Water quality and habitat complexity is usually high, although some streams may become intermittent during summer, and summer water temperatures may exceed 25°C. Sacramento pikeminnow and Sacramento sucker are generally the most abundant fishes of this assemblage, while hardhead (*Mylopharodon conocephalus*) are confined to cooler waters in reaches with deep, rock-bottomed pools.

The California roach assemblage overlaps substantially in elevation with the pikeminnow-hardhead-sucker assemblage, although it does not extend to the lowest elevations. This assemblage is found in small, warm tributaries to larger streams that flow through open foothill woodlands of oak and foothill pine. These streams are typically intermittent during summer, resulting in the formation of stagnant pools that can exceed 30°C during the day. In the winter and spring these streams are swift and vulnerable to flooding. These streams provide habitat for the California roach (*Lavinia symmetricus*), which is capable of withstanding high temperature and low oxygen levels due to its small size.

The rainbow trout assemblage overlaps with the upper elevations of the pikeminnow-hardhead-sucker and California roach assemblage and extends to the highest elevations. These streams are characterized by swift, permanent flows, steep gradients, and cool temperatures. The water is well oxygenated and cover is abundant. Sculpin (*Cottus* spp.), Sacramento sucker, and speckled dace (*Rhinichthys osculus*) are often part of this assemblage. Introduced brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) are often found in this assemblage as well, although they generally do not occur at the lower elevations.

2.1.1.1.4 Central Valley Reservoirs

Dams constructed to store water in the Central Valley of California now provide habitat for a mix of exotic and native species. The nature of the fish fauna in a given reservoir is determined by its elevation, size, location, and water quality. California reservoirs range from clear, oligotrophic, cold-water impoundments at high elevations to turbid, eutrophic, warm-water impoundments at low elevations, but most are found at middle elevations in the foothills. These reservoirs usually provide habitat for warm-water fishes in surface and edge waters and salmonids in deeper, cooler water.

2.1.1.2 Clear Lake Subprovince

The Clear Lake Subprovince includes Clear Lake, located in a small drainage basin in the Coast Range at an approximately 1,319-foot elevation, and the surrounding watershed. The native fish fauna primarily consists of species found in quiet waters of the Central Valley floor (Moyle 2002). The lake historically supported populations of many native species from the deep-bodied fish assemblage of the Central Valley. These fish were variants adapted to lake environments. Today only four natives, hitch, blackfish, tule perch, and prickly sculpin, have large populations, and many introduced species have come to dominate the lake’s fauna. The streams in this subprovince provide a home for Sacramento pikeminnow, Sacramento sucker, California roach, and rainbow trout (*Oncorhynchus mykiss*).

2.1.1.3 Monterey Bay Subprovince

The Monterey Bay Subprovince is composed of three major streams that flow into Monterey Bay, the San Lorenzo, Pajaro, and Salinas rivers, as well as the small coastal drainages from Santa Cruz to San Francisco (Moyle 2002). This subprovince had nearly the full complement of species from the Central Valley floor, excluding hardhead and splittail), as well as saltwater dispersant fishes including the Pacific lamprey (*Lampetra tridentata*), threespine stickleback (*Gasterosteus aculeatus*), prickly sculpin, steelhead, and Coho salmon (*Oncorhynchus kisutch*) (Moyle 2002).

2.1.2 North Coast Province

The North Coast Province consists of coastal drainages from the Golden Gate in San Francisco Bay to the Smith River on the Oregon border, excluding the mouth of the lower Klamath River (Moyle 2002). North Coast streams are highly variable, ranging from warm, intermittent streams to permanent, cold-flowing streams. Because these streams drain low mountain ranges and do not develop snowpacks, their flow patterns largely reflect rainfall. As a consequence, they may be raging torrents in winter and spring, and small trickling streams in summer. Coastal streams and rivers within this province have largely independent zoogeographic histories, but are very similar with respect to their faunal assemblages. The Russian River is unique in this region in that it provides a home to much of the Sacramento-San Joaquin freshwater dispersant fauna. In general, however, anadromous and other saltwater dispersant fishes dominate the fauna in the North Coast Province.

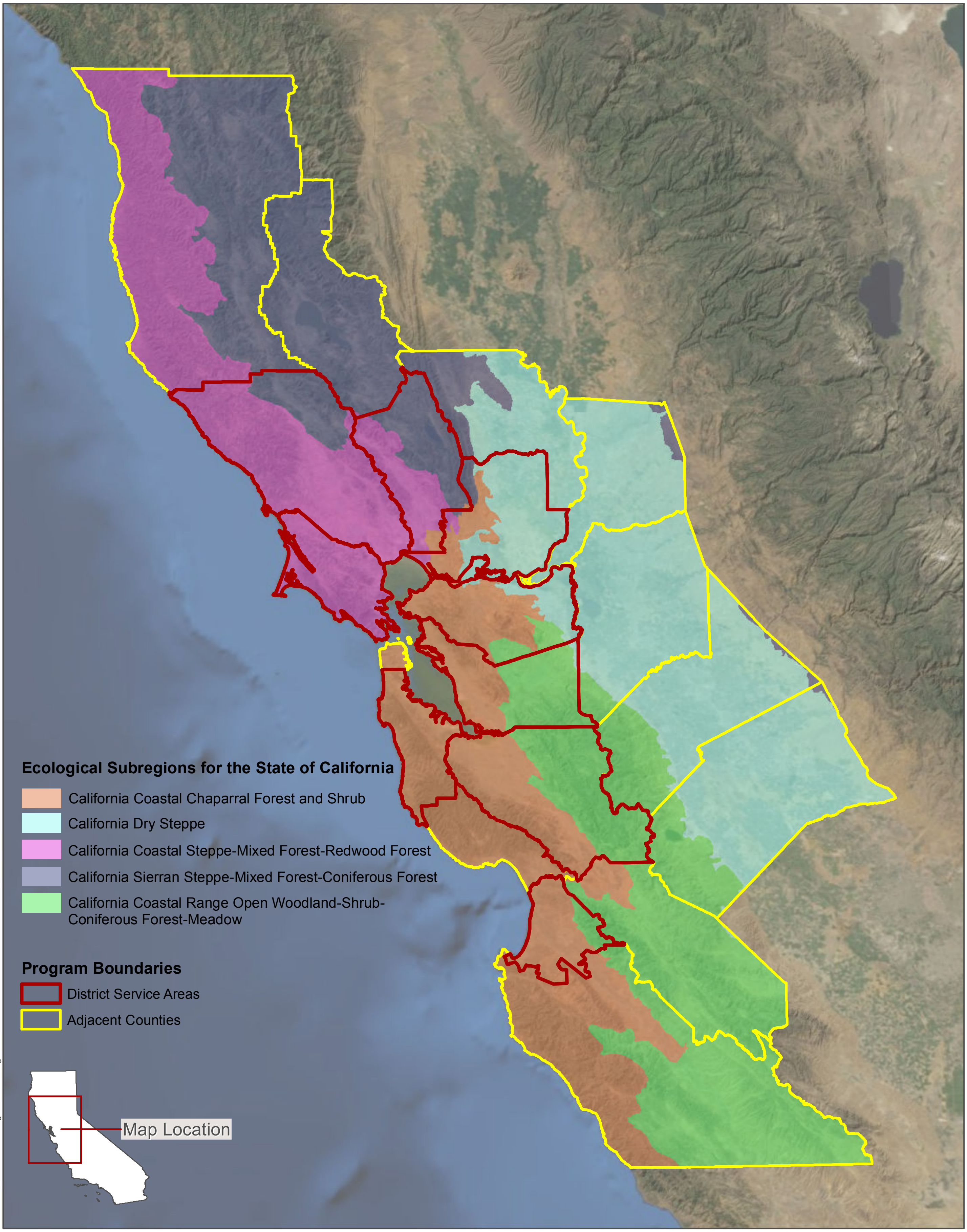
Three intergrading fish assemblages are observed in this area: resident trout, anadromous fishes, and estuarine fishes. Most of the fish in this subprovince are anadromous or saltwater dispersant species, but a few freshwater fish from the Central Valley are also observed here. The resident trout assemblage occupies the uppermost reaches of larger watersheds, typically above natural barriers to migration. The water is cold, swift, and well- oxygenated. This area is typically dominated by rainbow trout. The anadromous fish assemblage (steelhead, Coho, and lamprey) is distributed as far upstream as fishes can migrate and downstream to reaches influenced by tidal action. Streams in this area are cold and fast moving; however, pools become increasingly large and frequent as streams approach the ocean. Long stretches of shallow riffles over rock, gravel, or sand between pools there are used by anadromous salmon for spawning. Lamprey, three-spine stickleback, prickly and coast-range sculpin (*Cottus aleuticus*), California roach and Sacramento sucker are also present. The estuarine fish assemblage occupies areas of streams affected by daily tides. Consequently, these fish experience reversing currents, temperature fluctuation, and salinity gradients daily. Species found in the estuarine areas include threespine stickleback, prickly sculpin, coastrange sculpin, staghorn sculpin, topsmelt (*Atherinops affinis*), starry flounder, and tidewater goby (*Eucyclogobius newberryi*) (Moyle 2002).

2.1.3 South Coast Province

The South Coast Province includes 10 large watersheds and many smaller coastal drainages from Baja California north to Monterey Bay. This province has somewhat limited fish fauna with a relatively long, complex history due to the arid conditions and active geological history that characterize these regions (Moyle 2002). Except for streams within the Los Angeles Basin, most of this province has been dominated by salt water dispersants, including anadromous rainbow trout and Pacific lamprey. Multiple euryhaline marine species are found in lagoons and lower reaches of streams within the South Coast Province, but the tidewater goby and California killifish (*Fundulus parvipinnis*) are two species that are found only in these habitats (Moyle 2002).

2.2 Terrestrial Habitats

Due to the extent of the Program Areas, terrestrial habitats are described at the province level (McNab and Ayers 1996). The Program Areas include portions of five provinces (Figure 2-2), all of which occur in one or more of the District Program Areas. The provinces for each district and its boundary counties are provided in Table 2-2.



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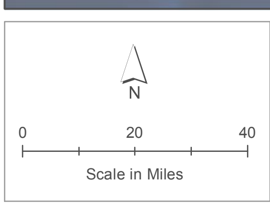

Source: US Forest Service, Pacific Southwest Region, Ecological Subregions for the State of California

Ecoregions in Program Areas

Figure 2-2

Table 2-2 Ecoregion Provinces by District and Adjacent Counties

District	California Dry Steppe	California Coastal Chaparral, Forest, and Scrub	California Coastal Steppe, Mixed Forest, Redwood Forest	California Sierran Steppe, Mixed Forest, Coniferous Forest	California Coastal Range Open Woodland, Shrub, Coniferous Forest, Meadow
ACMAD	yes	yes	--	--	yes
ACMAD adjacent	yes	yes	--	--	yes
ACVCSD	yes	yes	--	--	yes
ACVCSD adjacent	yes	yes	--	--	yes
CCMVCD	yes	yes	--	--	yes
CCMVCD adjacent	yes	yes	--	--	yes
MSMVCD	--	--	yes	yes	--
MSMVCD adjacent	--	yes	yes	yes	--
NCMAD	--	yes	yes	yes	--
NCMAD adjacent	yes	yes	yes	yes	--
NSVMAD	--	yes	--	--	yes
NSVMAD adjacent	--	yes	--	--	yes
SMCMVCD	--	yes	--	--	--
SMCMVCD adjacent	--	yes	--	--	yes
SCCVCD	--	yes	--	--	yes
SCCVCD adjacent	yes	yes	--	--	yes
SCMAD	yes	yes	yes	yes	--
SCMAD adjacent	yes	yes	yes	yes	--

2.2.1 California Dry Steppe

The California Dry Steppe province once covered the Central Valley of California. Although much of the Central Valley is now subject to agricultural uses and grazing, it was originally dominated by native grasses and wildflowers, including bunchgrasses (McNab and Ayers 1996). While remnant stands of native grasslands remain, much of the uncultivated land in this valley is now dominated by exotic species such as wild oats (*Avena* spp.), brome grasses (*Bromus* spp.), filarees (*Erodium* spp.), Italian ryegrass (*Lolium perenne* ssp. *multiflorum*), and both exotic and native fescues (*Vulpia* spp.). Native wildflowers and some native grasses persist among the exotic species. Rivers in the Sacramento Valley and northern San Joaquin Valley are fringed with riparian vegetation, while freshwater marshes line the lower reaches of the San Joaquin and Sacramento rivers. Portions of this province are in the ACMAD, ACVCSD, CCMVCD and the SCMAD. Additionally, portions of this province are in adjacent counties for the ACMAD, ACVCSD, CCMVCD, NCMAD, SCCVCD, and SCMAD.

2.2.2 California Coastal Chaparral, Forest, and Scrub

The lands along the central and southern coasts of California, as well as the seaward side of the Coast Ranges in this area, are part of the California Coastal Chaparral, Forest, and Scrub province (McNab and Ayers 1996). A variety of plant communities are found in this province. Representative plant communities include coastal scrubs dominated by coyote bush (*Baccharis pilularis*), California sagebrush (*Artemisia californica*), and bush lupine (*Lupinus* spp.) or sages (*Salvia* spp.) and chaparral types dominated by chamise (*Adenostoma fasciculatum*) and various manzanitas (*Arctostaphylos* spp.) and ceanothus (*Ceanothus* spp.). Gentler slopes support live oak and white oak woodlands and forests and coastal plains and valleys support grassland communities. Riparian forests and willow scrub grow along streams (Holland 1986). However, much of the coastal plain and valley floors have been converted to agriculture or urban uses. Portions of this province are in all districts except the MSVCD. Additionally, portions of this province are in adjacent counties for all nine districts.

2.2.3 California Coastal Steppe, Mixed Forest, and Redwood Forest Province

The California Coastal Chaparral, Forest, and Scrub province covers the lands along the north coast of California and the seaward side of the North Coast Ranges (McNab and Ayers 1996). Inland slopes support a mixed evergreen forest dominated by coast live oak (*Quercus agrifolia*), tan oak (*Lithocarpus densiflorus*), madrone (*Arbutus menziesii*), and Douglas fir. Redwood forests (*Sequoia sempervirens*) are typically found on the seaward slopes of coastal northwestern California. Associated species include Douglas fir (*Pseudotsuga menziesii*) and other conifers (Holland 1986). Oaks may form distinct patches of oak woodland (Holland 1986). Portions of this province are in the MSMVCD, NCMAD, and SCMAD, as well as adjacent counties for these three districts.

2.2.4 Sierran Steppe–Mixed Forest–Coniferous Forest–Alpine Meadow Province

The Sierran Steppe–Mixed Forest–Coniferous Forest–Alpine Meadow province covers most of interior Northern California, as well as the Sierra Nevada, and extends into southern Oregon (MacNab and Ayers 1996). Shrub and conifer communities cover the lower slopes and foothills, from about 1,500 to 4,000 feet. On higher slopes, foothill pine and blue oak often dominate, forming open woodlands. Chaparral covers extensive areas. Montane forests are found between about 2,000 and 6,000 feet in the Cascades. The dominant trees are ponderosa pine (*Pinus ponderosa*), Jeffrey pine (*Pinus jeffreyi*), Douglas fir, firs (*Abies* spp.), and incense cedar (*Calocedrus decurrens*), but several other conifers also occur. Dense chaparral communities of manzanita, buckbrush, and buckthorn may carpet open slopes or provide understory in open forests (Holland 1986). Other communities are found in the Sierra Nevada and at higher elevations. They are not described in this section because they are outside the Program Area.

Portions of this province are in the MSMVCD, NCMAD, and SCMAD, as well as adjacent counties for these three districts.

2.2.5 California Coastal Range Open Woodland-Shrub-Coniferous Forest–Meadow Province

The California Coastal Range Open Woodland-Shrub-Coniferous Forest–Meadow province covers the lands along the interior of the Central and South Coast ranges of California, including part of the Transverse Ranges of Southern California (MacNab and Ayers 1996).This province also supports live oak forests, woodlands, and chaparral, but the conditions are drier than in the California Coastal Chaparral, Forest, and Scrub province. Interior live oaks (*Quercus wislizenii*) and other oaks are found here, in addition to coast live oak and madrone (Holland 1986). Interior valleys support grassland and coastal scrub communities. As in the neighboring provinces, a riparian forest grows along streams. At higher elevations and near the ocean, chaparral may be interspersed with coniferous forests.

Portions of this province are in the ACMAD, ACVCSD, CCMVCD, NSVMAD, SMCMVCD, SCCVCD, and SCMAD. Additionally, portions of this province are in adjacent counties for these seven districts and the SMCMVCD.

2.3 Sensitive Natural Communities

Sensitive Natural Communities include both occurrences of certain rarer community types, or specific stands of ecological importance for other community types. Approximately 50 types of natural communities that are tracked in the California Natural Diversity Database (CDFG 2012) occur in the Program Area. These types include dune, scrub, chaparral, native grassland, wildflower, alkali, vernal pool, bog, seep, fen, marsh, riparian scrub, riparian woodland, riparian forest, and nonriparian forests and woodlands.

2.4 Special Status Species

Many special-status species occur in the Program Area, including 157 species that are listed as endangered or threatened under the federal or California Endangered Species Acts (CDFG 2012). A full list of these species and brief summaries of their status and habitats is provided in Attachment A, Lists of Species.

2.5 Regulatory Setting

This section focuses on the regulations primarily addressing plant and animal species. Regulations governing pesticide use are contained in Sections 6.1.3 and 7.1.4 of the Draft PEIR.

2.5.1 Federal

2.5.1.1 Endangered Species Act of 1973 (16 USC Section 1531 et seq.; 50 CFR Parts 17 and 222)

This law includes provisions for protection and management of species that are federally listed as threatened or endangered and designated critical habitat for these species. This law prohibits “take” of federally listed species, except as authorized under an incidental take permit or incidental take statement. The United States Fish and Wildlife Service (USFWS) is the administering agency for this authority for freshwater species. The National Marine Fisheries Service (NMFS) is the administering agency for anadromous species.

Magnusson-Stevenson Fishery Conservation and Management Act 1996 (Public Law 94-265)

This law provides for the conservation and management of all fish resources within the exclusive economic zone of the U.S. and supports and encourages the implementation and enforcement of international fisheries agreements for conservation and management of highly migratory species. It called for the establishment of Regional Fisheries Management Councils to develop, implement, monitor, and revise fish management plans to promote domestic commercial and recreational fishing. Specifically to this Program, it calls for the protection of essential fish habitat in review of projects conducted under federal permits, licenses, or other authorities that affect or have the potential to affect such habitat. The NMFS is responsible for the administration of this act.

Migratory Bird Treaty Act (16 USC Section(s) 703-711; 50 CFR Subchapter B)

This law includes provisions for protection of migratory birds, including basic prohibitions against any taking not authorized by federal regulation. The administering agency is the USFWS.

Bald and Golden Eagles Protection Act (16 USC Section(s) 668; 50 CFR Part 22)

This act makes it illegal to import, export, take (which includes molest or disturb[1]), sell, purchase, or barter any bald eagle or golden eagle or part thereof. The golden eagle, however, is accorded somewhat lighter protection under this act than the bald eagle. The administrating agency is the USFWS.

Clean Water Act of 1977 [33 USC Section(s) 1251-1376; 30 CFR Section(s) 330.5 (a)(26)]

These sections provide for the protection of wetlands. The administering agency for the above authority is the United States Army Corps of Engineers (USACE).

Executive Order 11990, Protection of Wetlands (May 24, 1977)

This order provides for the protection of wetlands. The administering agency for the above authority is the USACE.

2.5.2 State

2.5.2.1 Porter-Cologne Water Quality Control Act of 1970

This law provides the California State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control Boards (RWQCBs) with authority to establish Water Quality Control Plans (Basin Plans) that are reviewed and revised periodically. The SWRCB and the RWQCBs carry out the Federal Clean Water Act, including the National Pollutant Discharge Elimination System (NPDES) permitting process for point source discharges and the CWA Section 303 water quality standards program. The administering agencies are the SWRCB and the RWQCBs.

California Fish and Wildlife Code Section 1600 et seq.

This law provides for protection and conservation of fish and wildlife resources with respect to any project that may substantially divert or obstruct the natural flow of, or substantially change or use any material from the bed, channel, or bank of any river, stream, or lake. The administering agency is the California Department of Fish and Wildlife (CDFW).

California Endangered Species Act of 1984 (California Fish and Wildlife Code Sections 2050 2098)

This law provides for the protection and management of species and subspecies listed by the State of California as endangered or threatened, or designated as candidates for such listing. They are listed at 14 CCR Section 670.5. This law prohibits "take" of state-listed or candidate species, except as otherwise authorized by the Fish and Wildlife Code. (The term "take" is defined by Section 86 of the Fish and Wildlife Code as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill." This definition is different in some respects from the definition of "take" under the Federal Endangered Species Act.) The administering agency is the CDFW.

California Fish and Wildlife Code §3503

This law prohibits take, possession, or needless destruction of any bird egg or nest, except as otherwise provided by the Fish and Wildlife Code or regulation made pursuant thereto. The administering agency is the CDFW.

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[1] "Disturb means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle, (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.''

California Fish and Wildlife Code §3503.5

This law prohibits take, possession, or destruction of any bird of prey (birds in the order of Falconiformes or Strigiformes), except as otherwise provided by the Fish and Wildlife Code or regulation adopted pursuant thereto. The administering agency is the CDFW.

California Fish and Wildlife Code §3511, 4700, and 5050

These laws prohibit take or possession of birds, mammals, and reptiles listed as "fully protected," except as provided by the Fish and Wildlife Code. The administering agency is the CDFW.

California Fish and Wildlife Code Section 5650

This law protects water quality from substances or materials deleterious to fish, plant life, or bird life. It prohibits such substances or materials from being placed in waters or places where they can pass into waters of the state, except as authorized pursuant to, and in compliance with, the terms and conditions of permits or authorizations of the State Water Resources Control Board or a Regional Water Quality Control Board such as a waste discharge requirement issued pursuant to California Water Code Section 13263, a waiver issued pursuant to Water Code Section 13269(a), or permit pursuant to Water Code Section 13160. The administering agency for Fish and Wildlife Code Section 5650 is the CDFW.

Natural Community Conservation Planning Act (California Fish and Wildlife Code §2800 to 2835)

This law provides for the development of Natural Community Conservation Plans (NCCP) to provide for regional or area-wide protection and perpetuation of natural wildlife diversity, while allowing compatible and appropriate development and growth. The administering agency is the CDFW.

Native Plant Protection Act; California Fish and Wildlife Code §1900 et seq.

This law provides for the preservation, protection, and enhancement of endangered or rare native plants of the state. The Native Plant Protection Act allows for the designation of endangered and rare native plant species and states that no person shall take any native plant, or any part or product thereof that the commission has determined to be an endangered native plant or rare native plant, except as otherwise provided in the act. The administering agency is the CDFW.

California Food and Agricultural Code, Section(s) 12976 and Section(s) 12981

This code states that no pesticide application should be made or continued when a reasonable possibility exists of damage to nontarget crops, animals, or other public or private property. The administering agency for the above authority is the California Department of Pesticide Regulation (CDPR).

California Food and Agricultural Code, Section(s) 29102

This code provides for the protection of bees from pesticide use through notification of beekeepers and the establishment of citrus bee protection areas. Prohibited applications to citrus within a citrus/bee protection area include any pesticide toxic to bees, except those exempted in a subsequent subsection during a citrus bloom period, unless the need for control of lepidoptera larvae or citrus thrips has been established by written recommendation of a representative of the University of California, Agricultural Extension Service, or a licensed agricultural pest control adviser. The recommendation should state either that the citrus planting does not meet the citrus bloom period criteria, or why alternatives less hazardous to bees would not be effective. The administering agency for the above authority is the CDPR.

Stipulated Injunction and Order, Protection of California Red-Legged Frog from Pesticides

On October 20, 2006, the U.S. District Court for the Northern District of California imposed no-use buffer zones around California red-legged frog upland and aquatic habitats for certain pesticides. This injunction and order will remain in effect for each pesticide listed in the injunction until the USEPA goes through formal 7(A)(2) consultation with the USFWS on each of the 66 active ingredients, and the USFWS issues a Biological Opinion including a “not likely to adversely affect” statement for the pesticides. Under the injunction and order, no-use buffer zones of 60 feet for ground applications and 200 feet for aerial applications apply from the edge of the following California red-legged frog habitats as defined by the USFWS and the Center for Biological Diversity: Aquatic Feature, Aquatic Breeding Habitat, Nonbreeding Aquatic Habitat, and Upland Habitat. These habitats are found in 33 counties of California.

A series of documents that define Interim Measures for Use of Pesticides for various counties in California have been prepared by the CDFA. Interim measures have been defined for all of the counties in the Program Area.

2.5.3 Local

Local governing bodies may pass ordinances that regulate or restrict pesticide use within their jurisdictional areas. For example, a city council may pass an ordinance that restricts pesticide use in municipal buildings and in public parks, and a school district board can decree that certain pesticides cannot be used in schools. Local governing bodies may pass ordinances that regulate or restrict pesticide use in their own operations. However, these restrictions do not apply to state operations and would not be applicable to treatments proposed by the Districts under the Program because California state law preempts local regulation and restriction of pesticide use. The individual districts will work with the local entities and property owners to implement best management practices for the protection of public health.

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Integrated Mosquito and Vector Management Programs

ATTACHMENT

A

LIST OF SPECIAL-STATUS SPECIES OCCURRING IN THE PROGRAM AREAS

Table A-1 CNDDB Occurrences for Special-status Plant Species by District and Adjacent Program Areas

Species Name	Status	Habitat	AM1	AM2	AV1	AV2	CC1	CC2	MS1	MS2	NC1	NC2	NS1	NS2	SC1	SC2	SM1	SM2	So1	So2
bristlecone fir *Abies bracteata*	RPR, 1B	lower montane coniferous forest. rocky sites in Monterey and San Luis Obispo Counties. 210-1600 m.												●						
pink sand-verbena *Abronia umbellata* var. *breviflora*	RPR, 1B	coastal dunes and coastal strand. foredunes and interdunes with sparse cover. Abronia umbellata var. breviflora is usually the plant closest to the ocean. 0-12 m.							●	●		●								
San Mateo thorn-mint *Acanthomintha duttonii*	FE, SE, RPR, 1B	chaparral, valley and foothill grassland, coastal scrub. extant populations only known from very uncommon serpentinite vertisol clays; in relatively open areas. 50-200 m.														●	●			
red-flowered bird's-foot-trefoil *Acmispon rubriflorus*	RPR, 1B	valley and foothill grassland, cismontane woodland. most recent sighting from sterile, red soils-volcanic mudflow deposits. 200-425 m.														●				
Blasdale's bent grass *Agrostis blasdalei*	RPR, 1B	coastal dunes, coastal bluff scrub, coastal prairie. includes agrostis blasdalei var. marinensis, state-listed rare. sandy or gravelly soil close to rocks; often in nutrient-poor soil with sparse vegetation. 5-150 m.							●	●		●		●		●	●	●		
Henderson's bent grass *Agrostis hendersonii*	RPR 3	valley and foothill grassland, vernal pools. little information exists; moist places in grassland or vernal pool habitat. 70-305 m.														●				
vernal pool bent grass *Agrostis lacuna-vernalis*	RPR, 1B	vernal pools. in mima mound areas or on the margins of vernal pools. 115-145 m.												●						
grass alisma *Alisma gramineum*	RPR 2	marshes and swamps. freshwater marsh. 390-1800 m.								●										
Hickman's onion *Allium hickmanii*	RPR, 1B	closed-cone coniferous forest, chaparral, coastal scrub, valley and foothill grassland, coastal prairie. sandy loam, damp ground and vernal swales; mostly in grassland though can be assoc. with chaparral or woodland. 20-200 m											●	●						
Franciscan onion *Allium peninsulare* var. *franciscanum*	RPR, 1B	cismontane woodland, valley and foothill grassland. clay soils; often on serpentine. dry hillsides. 100-300 m.							●	●		●				●	●			
Sharsmith's onion *Allium sharsmithiae*	RPR, 1B	cismontane woodland. rocky, serpentine slopes. 400-1200 m.	●		●			●	●			●				●				
Sonoma alopecurus *Alopecurus aequalis* var. *sonomensis*	FE, RPR, 1B	freshwater marshes and swamps, riparian scrub. wet areas, marshes, and riparian banks with other wetland species. 5-360 m.							●			●								
Napa false indigo *Amorpha californica* var. *napensis*	RPR, 1B	broadleafed upland forest, chaparral, cismontane woodland. openings in forest or woodland or in chaparral. 150-2000 m							●	●	●	●		●						●
large-flowered fiddleneck *Amsinckia grandiflora*	FE, SE, RPR, 1B	cismontane woodland, valley and foothill grassland. annual grassland in various soils. 275-550 m.	●	●	●	●	●	●								●				
bent-flowered fiddleneck *Amsinckia lunaris*	RPR, 1B	cismontane woodland, valley and foothill grassland. 50-500 m.	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●		●
scabrid alpine tarplant *Anisocarpus scabridus*	RPR, 1B	upper montane coniferous forest. open stony ridges, metamorphic scree slopes of mountain peaks, and cliffs in or near red fir forest. 1650-2300 m.								●		●								
slender silver moss *Anomobryum julaceum*	RPR 2	broadleafed upland forest, lower montane coniferous forest, north coast coniferous forest. moss, which grows on damp rocks and soil; acidic substrates. usually seen on roadcuts. 100-1000 m.		●		●	●		●			●		●		●		●		

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SM1 = SMCMVCD
SM2 = SMCMVCD adjacent
S01 = SCMAD
S02 = SCMAD adjacent

Table A-1 CNDDB Occurrences for Special-status Plant Species by District and Adjacent Program Areas

Species Name	Status	Habitat	AM1	AM2	AV1	AV2	CC1	CC2	MS1	MS2	NC1	NC2	NS1	NS2	SC1	SC2	SM1	SM2	So1	So2
McDonald's rockcress *Arabis mcdonaldiana*	FE, SE, RPR, 1B	lower montane coniferous forest, upper montane coniferous forest. rocky outcrops, ridges, slopes, and flats on serpentine. 135-1455 m.								●										
Anderson's manzanita *Arctostaphylos andersonii*	RPR, 1B	broadleaved upland forest, chaparral, north coast coniferous forest. open sites, redwood forest. 180-800 m.		●		●								●	●	●	●	●		
Mt. Diablo manzanita *Arctostaphylos auriculata*	RPR, 1B	chaparral. in canyons and on slopes. on sandstone. 120-500 m.		●		●	●													
Baker's manzanita *Arctostaphylos bakeri* ssp. *bakeri*	SR, RPR, 1B	broadleafed upland forest, chaparral. entire species state-listed rare. often on serpentine. this is the state-listed rare taxon, also known as a. bakeri in title 14. 75-230 m.							●			●								
The Cedars manzanita *Arctostaphylos bakeri* ssp. *sublaevis*	SR, RPR, 1B	chaparral, closed-cone coniferous forest. entire species listed state rare. in serpentine chaparral and sargent cypress woodland; typically in canyons and on slopes. 275-600 m.							●			●								
Sonoma canescent manzanita *Arctostaphylos canescens* ssp. *sonomensis*	RPR, 1B	chaparral, lower montane coniferous forest. sometimes found on serpentine. 180-1700 m.							●	●		●								
Arroyo de la Cruz manzanita *Arctostaphylos cruzensis*	RPR, 1B	broadleafed upland forest, coastal bluff scrub, closed-cone coniferous forest, chaparral, coastal scrub, and grassland. on sandy soils in several different habitat types from chaparral to coastal scrub to woodland. 60-310 m.							●			●		●						
Vine Hill manzanita *Arctostaphylos densiflora*	SE, RPR, 1B	chaparral. acid marine sand. 50-100 m.							●			●								
Little Sur manzanita *Arctostaphylos edmundsii*	RPR, 1B	coastal bluff scrub, chaparral. includes a. edmundsii var. parvifolia, state-listed rare. forming mounds on sandy terraces on ocean bluffs. 30-105 m.												●						
Franciscan manzanita *Arctostaphylos franciscana*	RPR, 1B	chaparral. serpentine outcrops in chaparral. 60-300 m.																●		
Gabilan Mountains manzanita *Arctostaphylos gabilanensis*	RPR, 1B	chaparral, cismontane woodland. grainitic substrates. 300-700 m.											●	●		●				
Schreiber's manzanita *Arctostaphylos glutinosa*	RPR, 1B	closed-cone coniferous forest, chaparral. mudstone or diatomaceous shale outcrops; often with pinus attenuata. 170-690 m.												●		●		●		
Hooker's manzanita *Arctostaphylos hookeri* ssp. *hookeri*	RPR, 1B	chaparral, coastal scrub, closed-cone coniferous forest, cismontane woodland. sandy soils, sandy shales, sandstone outcrops. 85-300 m.											●	●		●		●		
San Bruno Mountain manzanita *Arctostaphylos imbricata*	SE, RPR, 1B	chaparral, coastal scrub. mostly known from a few sandstone outcrops in chaparral. 275-365 m.														●	●			
Konocti manzanita *Arctostaphylos manzanita* ssp. *elegans*	RPR, 1B	chaparral, cismontane woodland, lower montane coniferous forest. volcanic soils. 395-1400 m.							●	●	●	●								●
Contra Costa manzanita *Arctostaphylos manzanita* ssp. *laevigata*	RPR, 1B	chaparral. rocky slopes. 500-1100 m.		●		●	●													
Mt. Tamalpais manzanita *Arctostaphylos montana* ssp. *montana*	RPR, 1B	chaparral, valley and foothill grassland. serpentine slopes in chaparral and grassland. 160-760 m.							●			●								

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Presidio manzanita *Arctostaphylos montana* ssp. *ravenii*	FE, SE, RPR, 1B	chaparral, coastal prairie, coastal scrub. open, rocky serpentine slopes. 20-215 m.																●		
Montara manzanita *Arctostaphylos montaraensis*	RPR, 1B	chaparral, coastal scrub. slopes and ridges. 150-500 m.														●	●			
Toro manzanita *Arctostaphylos montereyensis*	RPR, 1B	chaparral, cismontane woodland, coastal scrub. sandy soil, usually with chaparral associates. 30-730 m.											●	●						
pygmy manzanita *Arctostaphylos nummularia* ssp. *mendocinoensis*	RPR, 1B	closed-cone coniferous forest. acidic, sandy-clay soils in dwarf coniferous forest. 90-200 m.								●										
Ohlone manzanita *Arctostaphylos ohloneana*	RPR, 1B	coastal scrub, closed cone coniferous forests. Monterey shale. 450-530 m.												●		●		●		
Pacific manzanita *Arctostaphylos pacifica*	SE, RPR, 1B	coastal scrub.																		
Pajaro manzanita *Arctostaphylos pajaroensis*	RPR, 1B	chaparral. sandy soils. 30-760 m.											●	●		●		●		
pallid manzanita *Arctostaphylos pallida*	FT, SE, RPR, 1B	broadleafed upland forest, closed-cone coniferous forest, chaparral, cismontane woodland, coastal scrub. grows on uplifted marine terraces on siliceous shale or thin chert. may require fire. 185-465 m.	●	●	●	●	●	●								●				
sandmat manzanita *Arctostaphylos pumila*	RPR, 1B	closed-cone coniferous forest, chaparral, cismontane woodland, coastal dunes, coastal scrub. on sandy soil with other chaparral associates. 3-205 m.											●	●						
Kings Mountain manzanita *Arctostaphylos regismontana*	RPR, 1B	broadleaved upland forest, chaparral, north coast coniferous forest. granitic or sandstone outcrops. 305-730 m.		●		●								●	●	●	●	●		
Bonny Doon manzanita *Arctostaphylos silvicola*	RPR, 1B	chaparral, closed-cone coniferous forest, lower montane coniferous forest. only known from zayante (inland marine) sands in Santa Cruz County. 120-390 m.												●		●		●		
Rincon Ridge manzanita *Arctostaphylos stanfordiana* ssp. *decumbens*	RPR, 1B	chaparral. highly restricted endemic to red rhyolites in Sonoma County. 75-310 m.							●	●	●	●								●
Raiche's manzanita *Arctostaphylos stanfordiana* ssp. *raichei*	RPR, 1B	chaparral, lower montane coniferous forest. on periphery of mcnab cypress grove on serpentine. slopes and ridges. 450-1000 m.								●		●								
Marin manzanita *Arctostaphylos virgata*	RPR, 1B	broadleafed upland forest, closed-cone coniferous forest, chaparral, north coast coniferous forest. only known from about 20 eos in Marin County. on sandstone or granitic soil. 60-700 m.							●			●								
marsh sandwort *Arenaria paludicola*	FE, SE, RPR, 1B	marshes and swamps. growing up through dense mats of typha, juncus, scirpus, etc. in freshwater marsh. 10-170 m.												●		●		●		
Indian Valley spineflower *Aristocapsa insignis*	RPR, 1B	cismontane woodland. 300-600 m.												●						
Humboldt milk-vetch *Astragalus agnicidus*	SE, RPR, 1B	broadleafed upland forest, redwood forest. disturbed openings in partially timbered forest lands; also along ridgelines; south aspects. 575-750 m.								●										

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Species Name	Status	Habitat	AM1	AM2	AV1	AV2	CC1	CC2	MS1	MS2	NC1	NC2	NS1	NS2	SC1	SC2	SM1	SM2	So1	So2
Clara Hunt's milk-vetch *Astragalus claranus*	FE, ST, RPR, 1B	cismontane woodland, valley and foothill grassland, chaparral. open grassy hillsides, esp. on exposed shoulders in thin, volcanic clay soil moist in spring. 75-235 m.							●	●	●	●								●
coastal marsh milk-vetch *Astragalus pycnostachyus* var. *pycnostachyus*	RPR, 1B	coastal dunes, coastal salt marshes. mesic sites in dunes or along streams or coastal salt marshes. 0-30 m.							●			●				●	●			
Jepson's milk-vetch *Astragalus rattanii* var. *jepsonianus*	RPR, 1B	cismontane woodland, valley and foothill grassland, chaparral. commonly on serpentine in grassland or openings in chaparral. 320-700 m.								●	●	●								●
Ferris' milk-vetch *Astragalus tener* var. *ferrisiae*	RPR, 1B	meadows, valley and foothill grassland. subalkaline flats on overflow land in the Central Valley; usually seen in dry, adobe soil. 5-75 m.										●								●
alkali milk-vetch *Astragalus tener* var. *tener*	RPR, 1B	alkali playa, valley and foothill grassland, vernal pools. low ground, alkali flats, and flooded lands; in annual grassland or in playas or vernal pools. 1-170 m.	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●		●
coastal dunes milk-vetch *Astragalus tener* var. *titi*	FE, SE, RPR, 1B	coastal bluff scrub, coastal dunes. moist, sandy depressions of bluffs or dunes along and near the pacific ocean; one site on a clay terrace. 1-50 m.												●						
heartscale *Atriplex cordulata* var. *cordulata*	RPR, 1B	chenopod scrub, valley and foothill grassland, meadows. alkaline flats and scalds in the Central Valley, sandy soils. 1-150(600)m.	●	●	●	●	●	●				●				●				●
Lost Hills crownscale *Atriplex coronata* var. *vallicola*	RPR, 1B	chenopod scrub, valley and foothill grassland, vernal pools. in powdery, alkaline soils that are vernally moist with frankenia, atriplex spp. and distichlis. 0-605 m.														●				
brittlescale *Atriplex depressa*	RPR, 1B	chenopod scrub, meadows, playas, valley and foothill grassland, vernal pools. usually in alkali scalds or alk. clay in meadows or annual grassland; rarely associate with riparian, marshes, or v.p's. 1-320 m.	●	●	●	●	●	●				●				●				●
San Joaquin spearscale *Atriplex joaquinana*	RPR, 1B	chenopod scrub, alkali meadow, valley and foothill grassland. in seasonal alkali wetlands or alkali sink scrub with distichlis spicata, frankenia, etc. 1-250 m.	●	●	●	●	●	●		●	●	●		●	●	●		●	●	●
lesser saltscale *Atriplex minuscula*	RPR, 1B	chenopod scrub, playas, valley and foothill grassland. in alkali sink and grassland in sandy, alkaline soils. 20-100 m.	●		●			●								●				
vernal pool smallscale *Atriplex persistens*	RPR, 1B	vernal pools. alkaline vernal pools. 10-115 m.										●				●			●	
subtle orache *Atriplex subtilis*	RPR, 1B	valley and foothill grassland. little info available. madrono vol. 44 no. 2 only source currently. 40-100 m.														●				
San Simeon baccharis *Baccharis plummerae* ssp. *glabrata*	RPR, 1B	coastal scrub. in open shrub-grassland associations. 90-375 m.												●						
big-scale balsamroot *Balsamorhiza macrolepis*	RPR, 1B	valley and foothill grassland, cismontane woodland. sometimes on serpentine. 35-1000 m.	●	●	●	●		●	●	●	●	●			●	●		●	●	●
Sonoma sunshine *Blennosperma bakeri*	FE, SE, RPR, 1B	vernal pools, valley and foothill grassland. vernal pools and swales. 10-100 m.							●			●								
Point Reyes blennosperma *Blennosperma nanum* var. *robustum*	SR, RPR, 1B	coastal prairie, coastal scrub. on open coastal hills in sandy soil. 10-145 m.							●	●		●								

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big tarplant *Blepharizonia plumosa*	RPR, 1B	valley and foothill grassland. dry hills and plains in annual grassland. clay to clay-loam soils; usually on slopes and often in burned areas. 15-455 m.	●	●	●	●	●	●				●				●			●	
Mount Day rockcress *Boechera rubicundula*	RPR, 1B	chaparral. rocky slopes. 1200 m.													●			●		
Snow Mountain rockcress *Boechera ultraalsa*	RPR, 1B	upper montane coniferous forest. rocky sites. 1800 m.								●		●								
rattlesnake fern *Botrypus virginianus*	RPR 2	bogs and fens, lower montane coniferous forest, meadows and seeps, riparian forest. 715-1355 m.								●										
watershield *Brasenia schreberi*	RPR 2	freshwater marshes and swamps. aquatic from water bodies both natural and artificial in California.		●		●		●		●		●								●
narrow-anthered brodiaea *Brodiaea leptandra*	RPR, 1B	broadleafed upland forest, chaparral, lower montane coniferous forest. 110-915 m.							●	●	●	●								●
Indian Valley brodiaea *Brodiaea rosea*	SE, RPR, 1B	closed-cone coniferous forest, chaparral, cismontane woodland, valley and foothill grassland, meadows. serpentine gravelly creek bottoms, and in meadows and swales. 335-1450 m.								●		●								
Thurber's reed grass *Calamagrostis crassiglumis*	RPR 2	coastal scrub, freshwater marsh. usually in marshy swales surrounded by grassland or coastal scrub. 10-45 m.							●	●		●								
leafy reed grass *Calamagrostis foliosa*	SR, RPR 4	coastal bluff scrub, north coast coniferous forest. rocky cliffs and ocean-facing bluffs. 0-1220 m. state-listed rare. element occurrences archived; cnps list 4.								●										
round-leaved filaree *California macrophylla*	RPR, 1B	cismontane woodland, valley and foothill grassland. clay soils. 15-1200 m.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
late-flowered mariposa-lily *Calochortus fimbriatus*	RPR, 1B	chaparral, cismontane woodland. dry, open coastal woodland, chaparral; on serpentine. 270-1910 m.												●						
Mt. Diablo fairy-lantern *Calochortus pulchellus*	RPR, 1B	chaparral, cismontane woodland, riparian woodland, valley and foothill grassland. on wooded and brushy slopes. 200-800 m.	●	●	●	●	●	●								●				
The Cedars fairy-lantern *Calochortus raichei*	RPR, 1B	closed-cone coniferous forest, chaparral. on serpentine. usually on shaded slopes, but also on barrens and talus. 200-490 m.							●			●								
Tiburon mariposa-lily *Calochortus tiburonensis*	FT, ST, RPR, 1B	valley and foothill grassland. on open, rocky, slopes in serpentine grassland. 50-150 m.							●	●	●	●								●
Hoover's calycadenia *Calycadenia hooveri*	RPR, 1B	cismontane woodland, valley and foothill grassland. on exposed, rocky, barren soil. 65-260 m.														●				
small-flowered calycadenia *Calycadenia micrantha*	RPR, 1B	chaparral, valley and foothill grassland, meadows and seeps, lower montane coniferous forest. rocky talus or scree; sparsely vegetated areas. occasionally on roadsides; sometimes on serpentine. 5-1500 m.								●		●		●						
dwarf calycadenia *Calycadenia villosa*	RPR, 1B	chaparral, cismontane woodland, valley and foothill grassland, meadows and seeps. open, dry meadows, hillsides, gravelly outwashes. 215-1275 m.																		
Santa Cruz Mountains pussypaws *Calyptridium parryi* var. *hesseae*	RPR, 1B	chaparral, cismontane woodland. sandy or gravelly openings. 305-1530 m.		●		●								●	●	●		●		
coast range bindweed *Calystegia collina* ssp. *tridactylosa*	RPR, 1B	chaparral, cismontane woodland. rocky, gravelly openings in serpentine. 0-600 m.								●		●								

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coastal bluff morning-glory *Calystegia purpurata* ssp. *saxicola*	RPR, 1B	coastal dunes, coastal scrub. 15-105 m.		●		●	●		●	●		●								
San Benito evening-primrose *Camissonia benitensis*	FT, RPR, 1B	chaparral, cismontane woodland. on gravelly serpentine alluvial terraces. 750-1280 m.												●		●				
Hardham's evening-primrose *Camissoniopsis hardhamiae*	RPR, 1B	chaparral, cismontane woodland. decomposed carbonate. 330-500 m.												●						
swamp harebell *Campanula californica*	RPR, 1B	bogs and fens, closed-cone coniferous forest, coastal prairie, meadows, freshwater marsh, n coast coniferous forest. bogs and marshes in a variety of habitats; uncommon where it occurs. 1-405 m.							●	●		●				●		●		
chaparral harebell *Campanula exigua*	RPR, 1B	chaparral. rocky sites, usually on serpentine in chaparral. 300-1250 m.	●	●	●	●	●	●						●	●	●		●		
Sharsmith's harebell *Campanula sharsmithiae*	RPR, 1B	chaparral. serpentine barrens. 490-855 m.		●		●									●	●		●		
seaside bittercress *Cardamine angulata*	RPR 2	north coast coniferous forest, lower montane coniferous forest. wet areas, streambanks. 65-915 m.																		
white sedge *Carex albida*	FE, SE, RPR, 1B	freshwater marsh, bogs and fens, meadows and seeps. wet meadows and marshes. 35-55 m.							●			●								
California sedge *Carex californica*	RPR 2	bogs and fens, closed-cone coniferous forest, coastal prairie, meadows, marshes and swamps. meadows, drier areas of swamps, marsh margins. 90-250 m.								●										
bristly sedge *Carex comosa*	RPR 2	marshes and swamps. lake margins, wet places; site below sea level is on a delta island. -5-1005 m.		●		●	●	●	●	●		●		●		●	●	●		●
porcupine sedge *Carex hystericina*	RPR 2	marshes and swamps. wet places, such as stream edges. 610-915 m.								●		●								
Klamath sedge *Carex klamathensis*	RPR, 1B	meadows and seeps, chaparral, cismontane woodland. serpentine. 1000-1140 m.								●		●								
lagoon sedge *Carex lenticularis* var. *limnophila*	RPR 2	bogs and fens, marshes and swamps, north coast coniferous forest. lakeshores, beaches. 0-6 m.								●										
bristle-stalked sedge *Carex leptalea*	RPR 2	bogs and fens, meadows, marshes and swamps. mostly known from bogs and wet meadows. 0-790 m.																		
livid sedge *Carex livida*	RPR 1A	bogs and fens. historically known from a sphagnum bog in California. 120 m.							●	●		●								
Lyngbye's sedge *Carex lyngbyei*	RPR 2	marshes and swamps (brackish or freshwater). 0 m.							●	●		●								
San Luis Obispo sedge *Carex obispoensis*	RPR, 1B	closed-cone coniferous forest, chaparral, coastal prairie, coastal scrub, valley and foothill grassland. usually in transition zone on sand, clay, or serpentine; in seeps. 5-790 m.												●						
deceiving sedge *Carex saliniformis*	RPR, 1B	coastal prairie, coastal scrub, meadows and seeps, marshes and swamps (coastal salt). mesic sites. 3-230 m.							●	●		●		●		●		●		
green yellow sedge *Carex viridula* ssp. *viridula*	RPR 2	bogs and fens, marshes and swamps (freshwater), north coast coniferous forest. mesic sites. 0-1600 m.								●										

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Muir's tarplant *Carlquistia muirii*	RPR, 1B	chaparral, lower montane coniferous forest, upper montane coniferous forest. crevices of granite ledges and dry sandy soils. 1100-2500 m.												●						
Oregon coast paintbrush *Castilleja affinis* ssp. *litoralis*	RPR 2	coastal bluff scrub, coastal dunes, coastal scrub. sandy sites. 15-100 m.								●										
Tiburon paintbrush *Castilleja affinis* ssp. *neglecta*	FE, ST, RPR, 1B	valley and foothill grassland. rocky serpentine sites. 75-400 m.		●		●			●	●	●	●			●			●		●
Humboldt Bay owl's-clover *Castilleja ambigua* ssp. *humboldtiensis*	RPR, 1B	coastal salt marsh. in coastal saltmarsh with spartina, distichlis, salicornia, jaumea. 0-3 m.							●	●		●								
pink johnny-nip *Castilleja ambigua* ssp. *insalutata*	RPR, 1B	coastal bluff scrub, coastal prairie. 0-100 m.											●	●						
succulent owl's-clover *Castilleja campestris* ssp. *succulenta*	FT, SE, RPR, 1B	vernal pools, valley and foothill grassland. moist places, often in acidic soils. 25-750 m.		●		●		●								●				
Mendocino Coast paintbrush *Castilleja mendocinensis*	RPR, 1B	coastal bluff scrub, coastal scrub, coastal prairie, closed-cone coniferous forest, coastal dunes. often on sea bluffs or cliffs in coastal bluff scrub or prairie. 0-160 m.							●	●		●								
pink creamsacs *Castilleja rubicundula* ssp. *rubicundula*	RPR, 1B	chaparral, meadows and seeps, valley and foothill grassland. openings in chaparral or grasslands. on serpentine. 20-900 m.		●		●				●	●	●			●			●		●
Pitkin Marsh paintbrush *Castilleja uliginosa*	SE, RPR 1A	freshwater marsh. last known remaining plant died in 1987; was known from overgrown freshwater marsh. 60 m.							●			●								
Lemmon's jewel-flower *Caulanthus lemmonii*	RPR, 1B	pinyon-juniper woodland, valley and foothill grassland. 80-1220 m.	●	●	●	●		●						●		●				
Rincon Ridge ceanothus *Ceanothus confusus*	RPR, 1B	closed-cone coniferous forest, chaparral, cismontane woodland. known from volcanic or serpentine soils, dry shrubby slopes. 75-1065 m.							●	●	●	●								●
Calistoga ceanothus *Ceanothus divergens*	RPR, 1B	chaparral, cismontane woodland. rocky, serpentine or volcanic sites. 165-950 m.							●	●	●	●								●
Coyote ceanothus *Ceanothus ferrisiae*	FE, RPR, 1B	chaparral, valley and foothill grassland, coastal scrub. serpentine sites in the Mt. Hamilton range. 120-455 m.		●		●									●			●		
Vine Hill ceanothus *Ceanothus foliosus* var. *vineatus*	RPR, 1B	chaparral. sandy, acidic soil in chaparral. 45-85 m.							●			●								
Mt. Vision ceanothus *Ceanothus gloriosus* var. *porrectus*	RPR, 1B	closed-cone coniferous forest, coastal prairie, coastal scrub, valley and foothill grassland. low shrub in a variety of habitats on Pt. Reyes; sandy soils. 25-305 m.							●			●								
Mason's ceanothus *Ceanothus masonii*	SR, RPR, 1B	chaparral. serpentine ridges or slopes in chaparral or transition zone. 230-500 m.							●			●								
holly-leaved ceanothus *Ceanothus purpureus*	RPR, 1B	chaparral. rocky, volcanic slopes. 120-640 m.							●	●	●	●							●	●
Sonoma ceanothus *Ceanothus sonomensis*	RPR, 1B	chaparral. sandy, serpentine or volcanic soils. 210-800 m.							●	●	●	●								●
Congdon's tarplant *Centromadia parryi* ssp. *congdonii*	RPR, 1B	valley and foothill grassland. alkaline soils, sometimes described as heavy white clay. 1-230 m.	●	●	●	●	●	●				●	●	●	●	●	●	●	●	

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pappose tarplant *Centromadia parryi* ssp. *parryi*	RPR, 1B	coastal prairie, meadows and seeps, coastal salt marsh, valley and foothill grassland. vernally mesic, often alkaline sites. 2-420 m.							●	●	●	●				●	●		●	●
Hoover's spurge *Chamaesyce hooveri*	FT, RPR, 1B	vernal pools, valley and foothill grassland. vernal pools on volcanic mudflow or clay substrate. 25-130 m.														●				
dwarf soaproot *Chlorogalum pomeridianum* var. *minus*	RPR, 1B	chaparral, valley and foothill grassland. serpentine. 240-970 m.							●	●		●								
Santa Lucia purple amole *Chlorogalum purpureum* var. *purpureum*	FT, RPR, 1B	cismontane woodland, valley and foothill grassland. often in grassy areas with blue oaks in foothill woodland. 300-330 m.												●						
Point Reyes bird's-beak *Chloropyron maritimum* ssp. *palustre*	RPR, 1B	coastal salt marsh. usually in coastal salt marsh with salicornia, distichlis, jaumea, spartina, etc. 0-15 m.	●	●	●	●		●	●			●			●	●	●	●		
hispid bird's-beak *Chloropyron molle* ssp. *hispidum*	RPR, 1B	meadows, playas, valley and foothill grassland. in damp alkaline soils, especially in alkaline meadows and alkali sinks with distichlis. 10-155 m.	●		●			●				●				●			●	
soft bird's-beak *Chloropyron molle* ssp. *molle*	FE, SR, RPR, 1B	coastal salt marsh. in coastal salt marsh with Distichlis, Salicornia, Frankenia, etc. 0-3 m.		●		●	●	●	●	●	●	●							●	●
palmate-bracted bird's-beak *Chloropyron palmatum*	FE, SE, RPR, 1B	chenopod scrub, valley and foothill grassland. usually on Pescadero silty clay which is alkaline, with Distichlis, Frankenia, etc. 5-155 m.	●	●	●	●		●				●				●				●
Hernandez spineflower *Chorizanthe biloba* var. *immemora*	RPR, 1B	chaparral, cismontane woodland. sandy and gravelly soils on the east slope of the Diablo Range. 695-750 m.												●		●				
Brewer's spineflower *Chorizanthe breweri*	RPR, 1B	chaparral, cismontane woodland, coastal scrub, closed-cone coniferous forest. rocky or gravelly serpentine sites; usually in barren areas. 45-800 m.												●						
San Francisco Bay spineflower *Chorizanthe cuspidata* var. *cuspidata*	RPR, 1B	coastal bluff scrub, coastal dunes, coastal prairie, coastal scrub. closely related to c. pungens. sandy soil on terraces and slopes. 5-550 m.	●		●			●	●			●				●	●	●		
woolly-headed spineflower *Chorizanthe cuspidata* var. *villosa*	RPR, 1B	coastal scrub, coastal dunes, coastal prairie. sandy places near the beach. 3-60 m.							●			●								
Howell's spineflower *Chorizanthe howellii*	FE, ST, RPR, 1B	coastal dunes, coastal prairie, coastal scrub. sand dunes, sandy slopes, and sandy areas in coastal prairie. 0-35 m.								●										
Ben Lomond spineflower *Chorizanthe pungens* var. *hartwegiana*	FE, RPR, 1B	lower montane coniferous forest. zayante coarse sands in maritime ponderosa pine sandhills. 120-470 m.												●		●		●		
Monterey spineflower *Chorizanthe pungens* var. *pungens*	FT, RPR, 1B	coastal dunes, chaparral, cismontane woodland, coastal scrub. sandy soils in coastal dunes or more inland within chaparral or other habitats. 0-150 m.											●	●		●		●		
straight-awned spineflower *Chorizanthe rectispina*	RPR, 1B	chaparral, cismontane woodland, coastal scrub. often on granite in chaparral. 85-1035 m.												●						
Scotts Valley spineflower *Chorizanthe robusta* var. *hartwegii*	FE, RPR, 1B	meadows, valley and foothill grassland. in grasslands with mudstone and sandstone outcrops. 230-245 m.														●		●		

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Species Name	Status	Habitat	AM1	AM2	AV1	AV2	CC1	CC2	MS1	MS2	NC1	NC2	NS1	NS2	SC1	SC2	SM1	SM2	So1	So2
robust spineflower *Chorizanthe robusta* var. *robusta*	FE, RPR, 1B	cismontane woodland, coastal dunes, coastal scrub. sandy terraces and bluffs or in loose sand. 3-120 m.	●	●	●	●		●	●			●	●	●	●	●	●	●		
Sonoma spineflower *Chorizanthe valida*	FE, SE, RPR, 1B	coastal prairie. sandy soil. 10-50 m.							●			●								
Bolander's water-hemlock *Cicuta maculata* var. *bolanderi*	RPR 2	marshes, fresh or brackish water. 0-200 m.		●		●	●	●				●							●	●
Franciscan thistle *Cirsium andrewsii*	RPR, 1B	coastal bluff scrub, broadleaved upland forest, coastal scrub. sometimes serpentine seeps. 0-135 m.		●		●	●		●			●				●	●	●		
slough thistle *Cirsium crassicaule*	RPR, 1B	chenopod scrub, marshes and swamps, riparian scrub. sloughs, riverbanks, and marshy areas. 3-100 m.		●		●		●												
Mt. Hamilton fountain thistle *Cirsium fontinale* var. *campylon*	RPR, 1B	cismontane woodland, chaparral, valley and foothill grassland. in seasonal and perennial drainages on serpentine. 95-890 m.	●	●	●	●		●							●	●		●		
fountain thistle *Cirsium fontinale* var. *fontinale*	FE, SE, RPR, 1B	valley and foothill grassland, chaparral. serpentine seeps and grassland. 90-180 m.														●	●			
Suisun thistle *Cirsium hydrophilum* var. *hydrophilum*	FE, RPR, 1B	salt marsh. grows with scirpus, distichlis near small watercourses within saltmarsh. 0-1 m.										●							●	
Mt. Tamalpais thistle *Cirsium hydrophilum* var. *vaseyi*	RPR, 1B	broadleafed upland forest, chaparral, meadows and seeps. serpentine seeps and streams in chaparral and woodland. 240-620 m.							●			●								
compact cobwebby thistle *Cirsium occidentale* var. *compactum*	RPR, 1B	chaparral, coastal dunes, coastal prairie, coastal scrub. on dunes and on clay in chaparral; also in grassland. 5-155 m.												●				●		
lost thistle *Cirsium praeteriens*	RPR 1A	little information exists on this plant; it was collected from the Palo Alto area at the turn of the 20th century. although not seen since 1901, this Cirsium is thought to be quite distinct from other Cirsiums according to D. Keil. 0-100 m.		●		●									●	●	●	●		
Whitney's farewell-to-spring *Clarkia amoena* ssp. *whitneyi*	RPR, 1B	coastal bluff scrub, coastal scrub. 10-100 m.								●										
Raiche's red ribbons *Clarkia concinna* ssp. *raichei*	RPR, 1B	coastal bluff scrub. highly exposed rocky bluffs with a near-vertical slope. 0-100 m.							●			●								
Presidio clarkia *Clarkia franciscana*	FE, SE, RPR, 1B	coastal scrub, valley and foothill grassland. serpentine outcrops in grassland or scrub. 20-335 m.	●		●			●								●		●		
Vine Hill clarkia *Clarkia imbricata*	FE, SE, RPR, 1B	chaparral, valley and foothill grassland. acidic, sandy soil. 50-75 m.							●			●								
Jolon clarkia *Clarkia jolonensis*	RPR, 1B	cismontane woodland. 500 m.											●	●						
beaked clarkia *Clarkia rostrata*	RPR, 1B	cismontane woodland, valley and foothill grassland. north-facing slopes; sometimes on sandstone. 60-460 m.														●				
San Antonio collinsia *Collinsia antonina*	RPR, 1B	chaparral, cismontane woodland. shale substrates. 280-365 m.												●						
round-headed Chinese-houses *Collinsia corymbosa*	RPR, 1B	coastal dunes. 0-20 m.																●		

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Species Name	Status	Habitat	AM1	AM2	AV1	AV2	CC1	CC2	MS1	MS2	NC1	NC2	NS1	NS2	SC1	SC2	SM1	SM2	So1	So2
San Francisco collinsia *Collinsia multicolor*	RPR, 1B	closed-cone coniferous forest, coastal scrub. on decomposed shale (mudstone) mixed with humus. 30-250 m.		●		●			●			●	●	●	●	●	●	●		
Oregon goldthread *Coptis laciniata*	RPR 2	north coast coniferous forest, meadows and seeps. mesic sites such as moist streambanks. 0-1000 m.								●										
Mt. Diablo bird's-beak *Cordylanthus nidularius*	SR, RPR, 1B	chaparral. grassy or rocky areas within serpentine chaparral. 600-800 m.		●		●	●													
seaside bird's-beak *Cordylanthus rigidus* ssp. *littoralis*	SE, RPR, 1B	closed-cone coniferous forest, chaparral, cismontane woodland, coastal scrub, coastal dunes. sandy, often disturbed sites, usually within chaparral or coastal scrub. 0-215 m.											●	●						
Pennell's bird's-beak *Cordylanthus tenuis* ssp. *capillaris*	FE, SR, RPR, 1B	closed-cone coniferous forest, chaparral. in open or disturbed areas on serpentine within forest or chaparral. 45-230 m.							●			●								
serpentine cryptantha *Cryptantha dissita*	RPR, 1B	chaparral. serpentine outcrops. 330-730 m.							●	●	●	●								●
deep-scarred cryptantha *Cryptantha excavata*	RPR, 1B	cismontane woodland. sandy, gravelly, dry streambanks. 100-500 m.								●										
Hoover's cryptantha *Cryptantha hooveri*	RPR 1A	valley and foothill grassland. in coarse sand. ?-150 m.		●		●	●									●				
Mariposa cryptantha *Cryptantha mariposae*	RPR, 1B	chaparral. on serpentine outcrops. 200-650 m.														●				
Jepson's dodder *Cuscuta jepsonii*	RPR, 1B	north coast coniferous forest. streamsides. 1200-2300 m.								●		●								
Peruvian dodder *Cuscuta obtusiflora* var. *glandulosa*	RPR 2	marshes and swamps (freshwater). freshwater marsh. 15-280 m.						●	●			●				●				●
Mendocino dodder *Cuscuta pacifica* var. *papillata*	RPR, 1B	coastal dunes. interdune depressions. annual parasitic vine observed on Gnaphalium, Silene and Lupinus. 0-50 m.							●	●		●								
tear drop moss *Dacryophyllum falcifolium*	RPR, 1B	coast redwood forest, north coast coniferous forest. limestone substrates and rock outcrops. 50-275 m.												●		●		●		
Livermore tarplant *Deinandra bacigalupii*	RPR, 1B	meadows and seeps. alkaline meadows. 150-185 m.	●		●			●								●				
Hall's tarplant *Deinandra halliana*	RPR, 1B	cismontane woodland, chenopod scrub, valley and foothill grassland. reported from a variety of substrates incl. clay, sand, and alkaline soils. 300-950 m.												●		●				
Baker's larkspur *Delphinium bakeri*	FE, SE, RPR, 1B	coastal scrub, grasslands. only site occurs on nw-facing slope, on decomposed shale. historically known from grassy areas along fence lines too. 90-205 m.							●			●								
Hospital Canyon larkspur *Delphinium californicum* ssp. *interius*	RPR, 1B	cismontane woodland, chaparral. in wet, boggy meadows, openings in chaparral and in canyons. 225-1060 m.	●	●	●	●	●	●						●	●	●		●		
Hutchinson's larkspur *Delphinium hutchinsoniae*	RPR, 1B	broadleafed upland forest, chaparral, coastal prairie, coastal scrub. on semi-shaded, slightly moist slopes, usually west-facing. 0-365 m.											●	●						
golden larkspur *Delphinium luteum*	FE, SR, RPR, 1B	chaparral, coastal prairie, coastal scrub. north-facing rocky slopes. 0-100 m.							●			●								

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recurved larkspur *Delphinium recurvatum*	RPR, 1B	chenopod scrub, valley and foothill grassland, cismontane woodland. on alkaline soils; often in valley saltbush or valley chenopod scrub. 3-685 m.	●	●	●	●	●	●				●		●		●			●	
umbrella larkspur *Delphinium umbraculorum*	RPR, 1B	cismontane woodland. mesic sites. 400-1600 m.												●						
Norris' beard moss *Didymodon norrisii*	RPR 2	cismontane woodland, lower montane coniferous forest. moss from seasonally wet sheet drainages on exposed rock slabs or terraces that completely dry in summer. less frequent		●		●	●		●	●		●		●		●		●		
western leatherwood *Dirca occidentalis*	RPR, 1B	broadleafed upland forest, chaparral, closed-cone coniferous forest, cismontane woodland, north coast coniferous forest, riparian forest, riparian woodland. on brushy slopes, mesic sites; mostly in mixed evergreen and foothill woodland communities. 30-550 m.	●	●	●	●	●	●	●			●			●	●	●	●		
dwarf downingia *Downingia pusilla*	RPR 2	valley and foothill grassland (mesic sites), vernal pools. vernal lake and pool margins with a variety of associates. in several types of vernal pools. 1-485 m.		●		●		●	●	●	●	●				●			●	●
Santa Clara Valley dudleya *Dudleya abramsii* ssp. *setchellii*	FE, RPR, 1B	valley and foothill grassland, cismontane woodland. on rocky serpentine outcrops and on rocks within grassland or woodland. 80-335 m.		●		●									●			●		
Koch's cord moss *Entosthodon kochii*	RPR, 1B	cismontane woodland, valley and foothill grasslands. moss growing on soil on river banks. known from serpentine on the plumas nf. 500-1000 m.							●	●		●								
Snow Mountain willowherb *Epilobium nivium*	RPR, 1B	upper montane coniferous forest, chaparral. in crevices of rocky outcrops, and dry talus and shale slopes. 785-2500 m.								●		●								
Oregon fireweed *Epilobium oreganum*	RPR, 1B	bogs and fens, meadows, lower montane coniferous forest, upper montane coniferous forest. in and near springs and bogs; at least sometimes on serpentine. 500-2610 m.								●										
Brandegee's eriastrum *Eriastrum brandegeeae*	RPR, 1B	chaparral, cismontane woodland. on barren volcanic soils; often in open areas. 425-840 m.								●		●								
yellow-flowered eriastrum *Eriastrum luteum*	RPR, 1B	broadleafed upland forest, cismontane woodland, chaparral. on bare sandy decomposed granite slopes. 360-1000 m.												●						
Tracy's eriastrum *Eriastrum tracyi*	SR, RPR 3	chaparral, cismontane woodland. gravelly shale or clay; often in open areas. 315-760 m.		●		●				●		●			●	●		●		
Eastwood's goldenbush *Ericameria fasciculata*	RPR, 1B	closed-cone coniferous forest, chaparral (maritime), coastal scrub, coastal dunes. in sandy openings. 30-275 m.											●	●						
Greene's narrow-leaved daisy *Erigeron greenei*	RPR, 1B	chaparral. serpentine and volcanic substrates, generally in shrubby vegetation. 75-1060 m.							●	●	●	●								●
serpentine daisy *Erigeron serpentinus*	RPR, 1B	chaparral. serpentine seeps. 60-670 m.							●			●								
supple daisy *Erigeron supplex*	RPR, 1B	coastal bluff scrub, coastal prairie. usually in grassy sites. 10-50 m.							●	●		●								
Ione buckwheat *Eriogonum apricum* var. *apricum*	FE, SE, RPR, 1B	chaparral. in gravelly openings on ione formation soil. 80-150 m.						●												●
Butterworth's buckwheat *Eriogonum butterworthianum*	SR, RPR, 1B	chaparral, valley and foothill grassland. dry sandstone outcrops and crevices. 585-740 m.												●						

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The Cedars buckwheat *Eriogonum cedrorum*	RPR, 1B	closed-cone coniferous forest. serpentine. barren rock and talus steep slopes. 365-550 m.							●			●								
Eastwood's buckwheat *Eriogonum eastwoodianum*	RPR, 1B	cismontane woodland. shale, including diatomaceous shale. 500-1000 m.												●						
Kellogg's buckwheat *Eriogonum kelloggii*	FC, SE, RPR, 1B	lower montane coniferous forest, chaparral. rocky, serpentine sites. 925-1220 m.								●										
Tiburon buckwheat *Eriogonum luteolum* var. *caninum*	RPR, 1B	chaparral, valley and foothill grassland, cismontane woodland, coastal prairie. serpentine soils; sandy to gravelly sites. 0-700 m.	●		●			●	●			●				●				
Snow Mountain buckwheat *Eriogonum nervulosum*	RPR, 1B	chaparral. dry serpentine outcrops, balds, and barrens. 300-2100 m.							●	●	●	●								●
Pinnacles buckwheat *Eriogonum nortonii*	RPR, 1B	chaparral, valley and foothill grassland. sandy soils; often on recent burns; western Santa lucias. 390-975 m.											●	●		●				
Ben Lomond buckwheat *Eriogonum nudum* var. *decurrens*	RPR, 1B	chaparral, cismontane woodland, lower montane coniferous forest. ponderosa pine sandhills in Santa Cruz County. 50-800 m.		●		●								●	●	●	●	●		
Antioch Dunes buckwheat *Eriogonum nudum* var. *psychicola*	RPR, 1B	interior dunes. grows on the antioch dunes (interior dune system) with lupinus albifrons, gutierrezia californica, and introduced grasse		●		●	●													
Temblor buckwheat *Eriogonum temblorense*	RPR, 1B	valley and foothill grassland. barren clay or sandstone substrates. 300-1000 m.												●						
Mt. Diablo buckwheat *Eriogonum truncatum*	RPR, 1B	chaparral, coastal scrub, valley and foothill grassland. dry, exposed clay or sandy substrates. 3-350 m.		●		●	●					●							●	
San Mateo woolly sunflower *Eriophyllum latilobum*	FE, SE, RPR, 1B	cismontane woodland. often on roadcuts; found on and off of serpentine. 45-150 m.														●	●			
Hoover's button-celery *Eryngium aristulatum* var. *hooveri*	RPR, 1B	vernal pools. alkaline depressions, vernal pools, roadside ditches and other wet places near the coast. 5-45 m.	●	●	●	●		●						●	●	●	●	●		
Loch Lomond button-celery *Eryngium constancei*	FE, SE, RPR, 1B	vernal pools. volcanic ash flow vernal pools. 625-855 m.							●	●		●								
Tuolumne button-celery *Eryngium pinnatisectum*	RPR, 1B	vernal pools, cismontane woodland, lower montane coniferous forest. volcanic soils; vernal pools and mesic sites within other natural communities. 250-450 m.						●												●
Delta button-celery *Eryngium racemosum*	SE, RPR, 1B	riparian scrub. seasonally inundated floodplain on clay. 3-75 m.		●		●	●	●								●				
spiny-sepaled button-celery *Eryngium spinosepalum*	RPR, 1B	vernal pools, valley and foothill grassland. some sites on clay soil of granitic origin; vernal pools, within grassland. 100-420 m.														●				
sand-loving wallflower *Erysimum ammophilum*	RPR, 1B	chaparral (maritime), coastal dunes, coastal scrub. sandy openings. 0-130 m.											●	●		●	●	●		
Contra Costa wallflower *Erysimum capitatum* var. *angustatum*	FE, SE, RPR, 1B	inland dunes. stabilized dunes of sand and clay near Antioch along the San Joaquin river. 3-20 m.		●		●	●													
Menzies' wallflower *Erysimum menziesii* ssp. *menziesii*	FE, SE, RPR, 1B	coastal dunes. localized on dunes and coastal strand. 0-35 m.								●				●						
Yadon's wallflower *Erysimum menziesii* ssp. *yadonii*	FE, SE, RPR, 1B	coastal dunes. foredunes. 0-15 m.												●						

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Santa Cruz wallflower *Erysimum teretifolium*	FE, SE, RPR, 1B	lower montane coniferous forest, chaparral. inland marine sands (Zayante coarse sand). 120-610 m.											●	●		●		●		
giant fawn lily *Erythronium oregonum*	RPR 2	cismontane woodland, meadows and seeps. openings. sometimes on serpentine; rocky sites. 100-500 m.								●										
coast fawn lily *Erythronium revolutum*	RPR 2	bogs and fens, broadleafed upland forest, north coast coniferous forest. 0-1065 m.								●										
diamond-petaled California poppy *Eschscholzia rhombipetala*	RPR, 1B	valley and foothill grassland. alkaline, clay slopes and flats. 0-975 m.	●	●	●	●	●	●								●				
minute pocket moss *Fissidens pauperculus*	RPR, 1B	north coast coniferous forest. moss growing on damp soil along the coast. in dry streambeds and on stream banks. 10-100 m.							●	●		●		●		●		●		
Hillsborough chocolate lily *Fritillaria biflora* var. *ineziana*	RPR, 1B	cismontane woodland, valley and foothill grassland. probably on serpentine; most recent site is in serpentine grassland. 90-160 m.														●	●			
talus fritillary *Fritillaria falcata*	RPR, 1B	chaparral, cismontane woodland, lower montane coniferous forest. on shale, granite, or serpentine talus. 300-1525 m.	●	●	●	●		●						●	●	●		●		
Marin checker lily *Fritillaria lanceolata* var. *tristulis*	RPR, 1B	coastal bluff scrub, coastal scrub, coastal prairie. occurrences reported from canyons and riparian areas as well as rock outcrops; often on serpentine. 30-300 m.							●			●								
fragrant fritillary *Fritillaria liliacea*	RPR, 1B	coastal scrub, valley and foothill grassland, coastal prairie. often on serpentine; various soils reported though usually clay, in grassland. 3-410 m.	●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	
adobe-lily *Fritillaria pluriflora*	RPR, 1B	chaparral, cismontane woodland, foothill grassland. usually on clay soils; sometimes serpentine. 55-820 m.								●	●	●							●	●
Roderick's fritillary *Fritillaria roderickii*	SE, RPR, 1B	coastal bluff scrub, coastal prairie, valley and foothill grassland. grassy slopes, mesas. 15-610 m.							●	●		●								
San Benito fritillary *Fritillaria viridea*	RPR, 1B	chaparral. serpentine slopes. 200-1525 m.												●		●				
Cone Peak bedstraw *Galium californicum* ssp. *luciense*	RPR, 1B	broadleaved upland forest, lower montane coniferous forest, cismontane woodland. in forest duff or gravelly talus of pine and oak forest, in partial shade. 875-1525 m.												●						
Santa Lucia bedstraw *Galium clementis*	RPR, 1B	lower montane coniferous forest, upper montane coniferous forest. forming soft mats in shady rocky patches; on granite or serpentine; mostly on exposed peaks. 1130-1780 m.												●						
Hardham's bedstraw *Galium hardhamiae*	RPR, 1B	closed-cone coniferous forest. on serpentine with cupressus sargentii. 390-975 m.												●						
Mendocino gentian *Gentiana setigera*	RPR, 1B	lower montane coniferous forest, meadows. meadows, seeps and bogs. usually or always on serpentine. 490-1065 m.								●										
blue coast gilia *Gilia capitata* ssp. *chamissonis*	RPR, 1B	coastal dunes, coastal scrub. 2-200 m.							●			●						●		
Pacific gilia *Gilia capitata* ssp. *pacifica*	RPR, 1B	coastal bluff scrub, coastal prairie, valley and foothill grassland. 5-300 m.								●										
woolly-headed gilia *Gilia capitata* ssp. *tomentosa*	RPR, 1B	coastal bluff scrub. rocky outcrops on the coast. 15-155 m.							●			●								
dark-eyed gilia *Gilia millefoliata*	RPR, 1B	coastal dunes. 2-20 m.							●	●		●						●		

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sand gilia *Gilia tenuiflora* ssp. *arenaria*	FE, ST, RPR, 1B	coastal dunes, coastal scrub, chaparral (maritime), cismontane woodland. bare, wind-sheltered areas often near dune summit or in the hind dunes; 2 records from pleistocene inland dunes. 0-245 m.											●	●		●		●		
delicate bluecup *Githopsis tenella*	RPR, 1B	chaparral, cismontane woodland. mesic sites. 1100-1900 m.												●						
American manna grass *Glyceria grandis*	RPR 2	meadows. wet meadows, ditches, streams, and ponds in valleys and lower elevations in the mountains. 15-1980 m.								●										
Boggs Lake hedge-hyssop *Gratiola heterosepala*	SE, RPR, 1B	marshes and swamps (freshwater), vernal pools. clay soils; usually in vernal pools, sometimes on lake margins. 5-2400 m.		●		●		●		●		●				●			●	●
San Francisco gumplant *Grindelia hirsutula* var. *maritima*	RPR 3	coastal scrub, coastal bluff scrub, valley and foothill grassland. sandy or serpentine slopes, sea bluffs. 15-400 m.														●	●	●		
Guggolz's harmonia *Harmonia guggolziorum*	RPR, 1B	chaparral. open areas on serpentine. 160-195 m.								●										
Hall's harmonia *Harmonia hallii*	RPR, 1B	chaparral. serpentine hills and ridges. open, rocky areas within chaparral. 500-900 m.								●	●	●								●
Diablo helianthella *Helianthella castanea*	RPR, 1B	broadleaved upland forest, chaparral, cismontane woodland, coastal scrub, riparian woodland, valley and foothill grassland. usually in chaparral/oak woodland interface in rocky, azonal soils. often in partial shade. 25-1150 m.	●	●	●	●	●	●	●			●				●	●	●		
white seaside tarplant *Hemizonia congesta* ssp. *congesta*	RPR, 1B	coastal scrub, valley and foothill grassland. grassy valleys and hills, often in fallow fields. 25-200 m.							●	●		●				●	●	●		
short-leaved evax *Hesperevax sparsiflora* var. *brevifolia*	RPR, 1B	coastal bluff scrub, coastal dunes. sandy bluffs and flats. 0-200 m.							●	●		●		●		●	●	●		
Santa Cruz cypress *Hesperocyparis abramsiana* var. *abramsiana*	FE, SE, RPR, 1B	closed-cone coniferous forest, lower montane coniferous forest. restricted to the Santa Cruz mountains, on sandstone and granitic-derived soils; often with p. attenuata, redwoods. 300-800 m.												●		●		●		
Butano Ridge cypress *Hesperocyparis abramsiana* var. *butanoensis*	FE, SE, RPR, 1B	closed-cone coniferous forest, lower montane coniferous forest, chaparral. sandstone. 400-490 m.														●	●			
Gowen cypress *Hesperocyparis goveniana*	FT, RPR, 1B	closed-cone coniferous forest. coastal terraces; usually in sandy soils; sometimes with Monterey pine, bishop pine. 100-125 m.												●						
Monterey cypress *Hesperocyparis macrocarpa*	RPR, 1B	closed-cone coniferous forest. granitic soils. 10-30 m.												●						
pygmy cypress *Hesperocyparis pygmaea*	RPR, 1B	closed-cone coniferous forest. on podzol-like Blacklock soil in pygmy cypress forest community. 35-305 m.							●	●		●								
glandular western flax *Hesperolinon adenophyllum*	RPR, 1B	chaparral, cismontane woodland, valley and foothill grassland. serpentine soils; generally found in serpentine chaparral. 425-1315 m.								●		●								
two-carpellate western flax *Hesperolinon bicarpellatum*	RPR, 1B	serpentine chaparral. serpentine barrens at edge of chaparral. 150-820 m.							●	●	●	●								●

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Species Name	Status	Habitat	AM1	AM2	AV1	AV2	CC1	CC2	MS1	MS2	NC1	NC2	NS1	NS2	SC1	SC2	SM1	SM2	So1	So2
Brewer's western flax *Hesperolinon breweri*	RPR, 1B	chaparral, cismontane woodland, valley and foothill grassland. often in rocky serpentine soil in serpentine chaparral and serpentine grassland. 30-885 m.		●		●	●			●	●	●							●	●
Marin western flax *Hesperolinon congestum*	FT, ST, RPR, 1B	chaparral, valley and foothill grassland. in serpentine barrens and in serpentine grassland and chaparral. 30-365 m.							●			●				●	●	●		
Lake County western flax *Hesperolinon didymocarpum*	SE, RPR, 1B	chaparral, cismontane woodland, valley and foothill grassland. serpentine soil in open grassland and near chaparral. 330-365 m.								●		●								
drymaria-like western flax *Hesperolinon drymarioides*	RPR, 1B	closed-cone coniferous forest, chaparral, cismontane woodland, valley and foothill grassland. serpentine soils, mostly within chaparral. 390-1000 m.								●	●	●								●
Tehama County western flax *Hesperolinon tehamense*	RPR, 1B	chaparral, cismontane woodland. serpentine barrens in chaparral. 225-1155 m.	●		●			●		●	●	●				●				●
woolly rose-mallow *Hibiscus lasiocarpos* var. *occidentalis*	RPR, 1B	marshes and swamps (freshwater). moist, freshwater-soaked river banks and low peat islands in sloughs; in calif., known from the delta watershed. 0-150 m.		●		●	●	●		●		●							●	●
Loma Prieta hoita *Hoita strobilina*	RPR, 1B	chaparral, cismontane woodland, riparian woodland. serpentine; mesic sites.	●	●	●	●	●	●						●	●	●		●		
Santa Cruz tarplant *Holocarpha macradenia*	FT, SE, RPR, 1B	coastal prairie, valley and foothill grassland. light, sandy soil or sandy clay; often with nonnatives. 10-260 m.	●	●	●	●	●	●	●			●	●	●		●		●		
Bolander's horkelia *Horkelia bolanderi*	RPR, 1B	lower montane coniferous forest, chaparral, meadows, valley and foothill grassland. grassy margins of vernal pools and meadows. 450-850 m.								●		●								
Kellogg's horkelia *Horkelia cuneata* var. *sericea*	RPR, 1B	closed-cone coniferous forest, coastal scrub, chaparral. old dunes, coastal sandhills; openings. 10-200 m.	●		●			●	●			●	●	●		●	●	●		
Point Reyes horkelia *Horkelia marinensis*	RPR, 1B	coastal dunes, coastal prairie, coastal scrub. sandy flats and dunes near coast; in grassland or scrub plant communities. 5-30 m.							●	●		●		●		●	●	●		
thin-lobed horkelia *Horkelia tenuiloba*	RPR, 1B	coastal scrub, chaparral. sandy soils; mesic openings. 45-500 m.							●	●		●								
water howellia *Howellia aquatilis*	FT, RPR 2	freshwater marshes and swamps, lower montane coniferous forest. in clear ponds with other aquatics and surrounded by ponderosa pine forest and sometimes riparian associates. 3-1375 m								●										
California satintail *Imperata brevifolia*	RPR 2	coastal scrub, chaparral, riparian scrub, mojavean scrub, meadows and seeps (alkali). mesic sites, alkali seeps, riparian areas. 0-500 m.								●		●								
Carquinez goldenbush *Isocoma arguta*	RPR, 1B	valley and foothill grassland. alkaline soils, flats, lower hills. on low benches near drainages and on tops and sides of mounds in swale habitat. 1-20 m.		●		●	●					●							●	
Northern California black walnut *Juglans hindsii*	RPR, 1B	riparian forest, riparian woodland. few extant native stands remain; widely naturalized. deep alluvial soil associated with a creek or stream. 0-395 m.		●		●	●	●		●	●	●							●	●
Ahart's dwarf rush *Juncus leiospermus* var. *ahartii*	RPR, 1B	vernal pools. restricted to the edges of vernal pools. 30-100 m.						●												●

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Santa Lucia dwarf rush *Juncus luciensis*	RPR, 1B	vernal pools, meadows, lower montane coniferous forest, chaparral, great basin scrub. vernal pools, ephemeral drainages, wet meadow habitats and streamsides. 300-2040 m.								●	●			●		●				●
knotted rush *Juncus nodosus*	RPR 2	meadows, marshes and swamps. mesic sites and lake margins. 1130-1700 m.														●				
hair-leaved rush *Juncus supiniformis*	RPR 2	marshes and swamps, bogs and fens. 20-100 m.								●										
small groundcone *Kopsiopsis hookeri*	RPR 2	north coast coniferous forest. open woods, shrubby places, generally on gaultheria shallon. 90-885 m.							●	●		●								
forked hare-leaf *Lagophylla dichotoma*	RPR, 1B	valley and foothill grassland, cismontane woodland. in openings. gravelly roadsides to loam soil to dry clay; not known from serpentine. 50-760 m.												●		●				
Burke's goldfields *Lasthenia burkei*	FE, SE, RPR, 1B	vernal pools, meadows and seeps. most often in vernal pools and swales. 15-580 m.							●	●	●	●								●
Baker's goldfields *Lasthenia californica* ssp. *bakeri*	RPR, 1B	closed-cone coniferous forest, coastal scrub. openings. 60-520 m.							●	●		●								
perennial goldfields *Lasthenia californica* ssp. *macrantha*	RPR, 1B	coastal bluff scrub, coastal dunes, coastal scrub. 5-520 m.							●	●		●				●	●			
Contra Costa goldfields *Lasthenia conjugens*	FE, RPR, 1B	valley and foothill grassland, vernal pools, cismontane woodland. extirpated from most of its range; extreme. endangered. vernal pools, swales, low depressions, in open grassy areas. 1-445 m.	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●
Coulter's goldfields *Lasthenia glabrata* ssp. *coulteri*	RPR, 1B	coastal salt marshes, playas, valley and foothill grassland, vernal pools. usually found on alkaline soils in playas, sinks, and grasslands. 1-1400 m.										●				●				●
Delta tule pea *Lathyrus jepsonii* var. *jepsonii*	RPR, 1B	freshwater and brackish marshes. often found with typha, aster lentus, rosa calif., juncus spp., scirpus, etc. usually on marsh and slough edges.		●		●	●	●	●	●	●	●							●	●
marsh pea *Lathyrus palustris*	RPR 2	bogs and fens, lower montane coniferous forest, marshes and swamps, north coast coniferous forest, coastal prairie, coastal scrub. moist coastal areas. 1-100 m.								●										
beach layia *Layia carnosa*	FE, SE, RPR, 1B	coastal dunes. hugely reduced in range along California's north coast dunes. on sparsely vegetated, semi-stabilized dunes, usually behind foredunes. 0-75 m.							●			●		●			●	●		
rayless layia *Layia discoidea*	RPR, 1B	chaparral, cismontane woodland, lower montane coniferous forest. on serpentine alluvium and serpentine talus. 785-1585 m.												●		●				
pale-yellow layia *Layia heterotricha*	RPR, 1B	cismontane woodland, pinyon-juniper woodland, valley and foothill grassland. alkaline or clay soils; open areas. 270-1365 (2675)m.												●		●				
Munz's tidy-tips *Layia munzii*	RPR, 1B	chenopod scrub, valley and foothill grassland. hillsides, in white-grey alkaline clay soils, with grasses and chenopod scrub associates. 45-760 m.																		
Colusa layia *Layia septentrionalis*	RPR, 1B	chaparral, cismontane woodland, valley and foothill grassland. scattered colonies in fields and grassy slopes in sandy or serpentine soil. 145-1095 m.							●	●	●	●								●

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legenere *Legenere limosa*	RPR, 1B	vernal pools. many historical occurrences are extirpated. in beds of vernal pools. 1-880 m.	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●
Panoche pepper-grass *Lepidium jaredii* ssp. *album*	RPR, 1B	valley and foothill grassland. white or grey clay lenses on steep slopes; incidental in alluvial fans and washes. clay and gypsum-rich soils. 65-910 m.												●		●				
Heckard's pepper-grass *Lepidium latipes* var. *heckardii*	RPR, 1B	valley and foothill grassland, vernal pools. grassland, and sometimes vernal pool edges. alkaline soils. 3-30 m.						●				●				●			●	●
coast yellow leptosiphon *Leptosiphon croceus*	RPR, 1B	coastal bluff scrub, coastal prairie. 10-150 m.							●			●				●	●			
Jepson's leptosiphon *Leptosiphon jepsonii*	RPR, 1B	chaparral, cismontane woodland. open to partially shaded grassy slopes. on volcanics or the periphery of serpentine substrates. 100-500 m.							●	●	●	●								●
rose leptosiphon *Leptosiphon rosaceus*	RPR, 1B	coastal bluff scrub. 0-100 m.							●			●				●	●	●		
Mt. Hamilton coreopsis *Leptosyne hamiltonii*	RPR, 1B	cismontane woodland. on steep shale talus with open southwestern exposure. 530-1300 m.	●	●	●	●		●							●	●		●		
Crystal Springs lessingia *Lessingia arachnoidea*	RPR, 1B	coastal sage scrub, valley and foothill grassland, cismontane woodland. grassy slopes on serpentine; sometimes on roadsides. 60-200 m.							●			●				●	●			
San Francisco lessingia *Lessingia germanorum*	FE, SE, RPR, 1B	coastal scrub. from remnant dunes. open sandy soils relatively free of competing plants. 20-125 m.														●	●	●		
smooth lessingia *Lessingia micradenia* var. *glabrata*	RPR, 1B	chaparral. serpentine; often on roadsides. 120-485 m.																		
Tamalpais lessingia *Lessingia micradenia* var. *micradenia*	RPR, 1B	chaparral, valley and foothill grassland. usually on serpentine, in serpentine grassland or serpentine chaparral. often on roadsides. 100-305 m.							●			●								
Stebbins' lewisia *Lewisia stebbinsii*	RPR, 1B	upper montane coniferous forest, lower montane coniferous forest. relatively barren exposed ridges and slopes in nutrient poor soils (mostly serpentine). 1680-2050 m.								●										
Mason's lilaeopsis *Lilaeopsis masonii*	SR, RPR, 1B	freshwater and brackish marshes, riparian scrub. tidal zones, in muddy or silty soil formed through river deposition or river bank erosion. 0-10 m.	●	●	●	●	●	●	●	●	●	●				●			●	●
coast lily *Lilium maritimum*	RPR, 1B	closed-cone coniferous forest, coastal prairie, coastal scrub, broadleaved upland forest, north coast coniferous forest. historically in sandy soil, often on raised hummocks or bogs; today mostly in roadside ditches. 10-335 m.							●	●		●								
Pitkin Marsh lily *Lilium pardalinum* ssp. *pitkinense*	FE, SE, RPR, 1B	cismontane woodland, meadows and seeps, freshwater marsh. saturated, sandy soils with grasses and shrubs. 35-65 m.							●			●								
Baker's meadowfoam *Limnanthes bakeri*	RPR, 1B	freshwater marsh, valley and foothill grassland, meadows and seeps, vernal pools. seasonally moist or saturated sites within grassland; also in swales, roadside ditches and margins of marshy areas. 175-910 m								●										

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Point Reyes meadowfoam *Limnanthes douglasii* ssp. *sulphurea*	SE, RPR, 1B	fresh. marsh, vernal pools, coastal prairie, meadows and seeps, cismontane woodland. vernally wet depressions in open rolling, coastal prairies and meadows; typically in dark clay soil. 10-120 m.							●			●				●	●			
Sebastopol meadowfoam *Limnanthes vinculans*	FE, SE, RPR, 1B	mesic meadows, vernal pools, valley and foothill grassland. swales, wet meadows and marshy areas in valley oak savanna; on poorly drained soils of clays and sandy loam. 15-115 m.							●	●	●	●								●
Delta mudwort *Limosella australis*	RPR 2	riparian scrub, freshwater marsh, brackish marsh. probably the rarest of the suite of delta rare plants. usually on mud banks of the delta in marshy or scrubby riparian associations; often with lilaeopsis masonii. 0-3 m.		●		●	●	●											●	●
Mt. Hamilton lomatium *Lomatium observatorium*	RPR, 1B	cismontane woodland. open to partially shaded openings in pinus coulteri-oak woodland. sedimentary franciscan rocks and volcanics. 1219-1330 m.														●				
Anthony Peak lupine *Lupinus antoninus*	RPR, 1B	upper montane coniferous forest, lower montane coniferous forest. open areas with surrounding forest; rocky sites. 1210-2285 m.								●		●								
Milo Baker's lupine *Lupinus milo-bakeri*	ST, RPR, 1B	cismontane woodland, valley and foothill grassland. in roadside ditches, dry gravelly areas along roads, and along small streams. 360-440 m.								●										
Cobb Mountain lupine *Lupinus sericatus*	RPR, 1B	chaparral, cismontane woodland, lower montane coniferous forest. in stands of knobcone pine-oak woodland, on open wooded slopes in gravelly soils; sometimes on serpentine. 180-1500 m.							●	●	●	●								
Tidestrom's lupine *Lupinus tidestromii*	FE, SE, RPR, 1B	coastal dunes. includes Lupinus tidestromii var. tidestromii, state-listed endangered. partially stabilized dunes, immediately near the ocean. 0-35 m.							●			●		●						
showy golden madia *Madia radiata*	RPR, 1B	valley and foothill grassland, cismontane woodland, chenopod scrub. mostly on adobe clay in grassland or among shrubs. 25-1125 m.		●		●	●	●						●	●	●		●		
Abbott's bush-mallow *Malacothamnus abbottii*	RPR, 1B	riparian scrub. among willows near rivers and along roadsides. 135-525 m.												●						
Indian Valley bush-mallow *Malacothamnus aboriginum*	RPR, 1B	cismontane woodland, chaparral. granitic outcrops and sandy bare soil, often in disturbed soils. 150-1700 m.		●		●								●	●	●	●	●		
arcuate bush-mallow *Malacothamnus arcuatus*	RPR, 1B	chaparral. gravelly alluvium. 80-355 m.		●		●								●	●	●	●	●		
Davidson's bush-mallow *Malacothamnus davidsonii*	RPR, 1B	coastal scrub, riparian woodland, chaparral. sandy washes. 180-855 m.												●		●	●			
Hall's bush-mallow *Malacothamnus hallii*	RPR, 1B	chaparral. some populations on serpentine. 10-550 m.		●		●	●			●		●			●	●	●	●		
Mendocino bush-mallow *Malacothamnus mendocinensis*	RPR, 1B	cismontane woodland. open, roadside banks. label location info inconsistent with elevation info. 420-575 m?								●										
Carmel Valley bush-mallow *Malacothamnus palmeri* var. *involucratus*	RPR, 1B	cismontane woodland, chaparral. talus hilltops and slopes, sometimes on serpentine. burn dependent. 30-1100 m.											●	●		●				

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Arroyo Seco bush-mallow *Malacothamnus palmeri* var. *lucianus*	RPR, 1B	chaparral, meadows and seeps. gravel banks and sandstone rocks on west-facing slopes in full sun. 10-915 m.												●						
Santa Lucia bush-mallow *Malacothamnus palmeri* var. *palmeri*	RPR, 1B	chaparral. dry rocky slopes, mostly near summits, but occasionally extending down canyons to the sea. 60-365 m.												●						
Carmel Valley malacothrix *Malacothrix saxatilis* var. *arachnoidea*	RPR, 1B	chaparral. rock outcrops or steep rocky roadcuts. 25-1215 m.												●						
Oregon meconella *Meconella oregana*	RPR, 1B	coastal prairie, coastal scrub. open, moist places. 250-500 m.		●		●	●								●			●		
northern microseris *Microseris borealis*	RPR 2	bogs and fens, meadows and seeps, lower montane coniferous forest. 940-2000 m.								●										
marsh microseris *Microseris paludosa*	RPR, 1B	closed-cone coniferous forest, cismontane woodland, coastal scrub, valley and foothill grassland. 5-300 m.							●	●		●	●	●		●	●	●		
elongate copper moss *Mielichhoferia elongata*	RPR 2	cismontane woodland. commonly called "copper mosses". moss growing on very acidic, metamorphic rock or substrate; usually in higher portions in fens. often on substrates natu							●	●		●		●		●		●		
Merced monardella *Monardella leucocephala*	RPR 1A	valley and foothill grassland. known from riverbeds, moist sandy depressions; requires moist subalkaline sands assoc with low elev grassland. 35-100 m.														●				
Palmer's monardella *Monardella palmeri*	RPR, 1B	cismontane woodland, chaparral. on serpentine, often found associated with sargent cypress forests. 200-800 m.												●						
San Joaquin woollythreads *Monolopia congdonii*	FE, RPR, 1B	chenopod scrub and valley and foothill grassland. alkaline or loamy plains; sandy soils, often with grasses and within chenopod scrub. 60-800 m.										●		●		●				●
woodland woollythreads *Monolopia gracilens*	RPR, 1B	chaparral, valley and foothill grasslands (serpentine), cismontane woodland, broadleafed upland forests, north coast con grassy sites, in openings; sandy to rocky soils. often seen on serpentine after burns but may have only weak affinity to	●	●	●	●	●	●					●	●	●	●	●	●		
Lime Ridge navarretia *Navarretia gowenii*	RPR, 1B	chaparral on calcium carbonate-rich soil with high clay content. 180-305 m		●		●	●									●				
Baker's navarretia *Navarretia leucocephala* ssp. *bakeri*	RPR, 1B	cismontane woodland, meadows and seeps, vernal pools, valley and foothill grassland, lower montane coniferous forest. vernal pools and swales; adobe or alkaline soils. 5-950 m.							●	●	●	●							●	●
few-flowered navarretia *Navarretia leucocephala* ssp. *pauciflora*	FE, ST, RPR, 1B	vernal pools. volcanic ash flow, and volc substrate vernal pools. 400-855 m.								●	●	●								●
many-flowered navarretia *Navarretia leucocephala* ssp. *plieantha*	FE, SE, RPR, 1B	vernal pools. volcanic ash flow vernal pools. 30-950 m.							●	●		●								
small pincushion navarretia *Navarretia myersii* ssp. *deminuta*	RPR, 1B	vernal pools. known from only one site in lake County in vernal pool habitat on clay-loam soil; also in roadside depressions. 355 m.								●		●								
pincushion navarretia *Navarretia myersii* ssp. *myersii*	RPR, 1B	vernal pools, valley and foothill grassland. clay soils within nonnative grassland. 20-330 m.						●								●				●

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shining navarretia *Navarretia nigelliformis* ssp. *radians*	RPR, 1B	cismontane woodland, valley and foothill grassland, vernal pools. apparently in grassland, and not necessarily in vernal pools. 200-1000 m.	●	●	●	●	●	●						●		●				
prostrate vernal pool navarretia *Navarretia prostrata*	RPR, 1B	coastal scrub, valley and foothill grassland, vernal pools. alkaline soils in grassland, or in vernal pools. mesic, alkaline sites. 15-700 m.	●	●	●	●		●						●	●	●		●		
Marin County navarretia *Navarretia rosulata*	RPR, 1B	closed-cone coniferous forest, chaparral. dry, open rocky places; can occur on serpentine. 200-635 m.							●	●	●	●								●
Robbins' nemacladus *Nemacladus secundiflorus* var. *robbinsii*	RPR, 1B	chaparral, valley and foothill grassland. dry, sandy or gravelly slopes. 350-1700 m.												●		●				
Colusa grass *Neostapfia colusana*	FT, SE, RPR, 1B	vernal pools. usually in large, or deep vernal pool bottoms; adobe soils. 5-110 m.										●				●			●	●
Antioch Dunes evening-primrose *Oenothera deltoides* ssp. *howellii*	FE, SE, RPR, 1B	interior dunes. remnant river bluffs and sand dunes east of Antioch. 0-30 m.		●		●	●	●												●
Wolf's evening-primrose *Oenothera wolfii*	RPR, 1B	coastal bluff scrub, coastal dunes, coastal prairie, lower montane coniferous forest. sandy substrates; usually mesic sites. 3-800 m.								●										
northern adder's-tongue *Ophioglossum pusillum*	RPR 2	marshes and swamps, meadows and seeps. marsh edges, low pastures, grassy roadside ditches. also described as in "open swamp." 1000-2000 m.								●										
San Joaquin Valley Orcutt grass *Orcuttia inaequalis*	FT, SE, RPR, 1B	vernal pools. 30-755 m.										●				●			●	
hairy Orcutt grass *Orcuttia pilosa*	FE, SE, RPR, 1B	vernal pools. 25-125 m.														●				
slender Orcutt grass *Orcuttia tenuis*	FT, SE, RPR, 1B	vernal pools. 30-1735 m.						●		●		●								●
Sacramento Orcutt grass *Orcuttia viscida*	FE, SE, RPR, 1B	vernal pools. 30-100 m.						●												●
Kellman's bristle moss *Orthotrichum kellmanii*	RPR, 1B	chaparral, cismontane oak woodland. sandstone outcrops with high calcium concentrations from eroded boulders out of non-calcareous sandstone bedrock. rock o												●		●	●	●		
seacoast ragwort *Packera bolanderi* var. *bolanderi*	RPR 2	coastal scrub, north coast coniferous forest. 30-650 m.								●										
Geysers panicum *Panicum acuminatum* var. *thermale*	SE, RPR, 1B	closed-cone coniferous forest, riparian forest, valley and foothill grassland. usually around moist, warm soil in the vicinity of hot springs. 305-825 m.							●			●								
Dudley's lousewort *Pedicularis dudleyi*	SR, RPR, 1B	chaparral, north coast coniferous forest, valley and foothill grassland. deep shady woods of older coast redwood forests; also in maritime chaparral. 100-490 m.												●		●	●	●		
Sonoma beardtongue *Penstemon newberryi* var. *sonomensis*	RPR, 1B	chaparral. crevices in rock outcrops and talus slopes. 180-1390 m.							●	●	●	●								●
white-rayed pentachaeta *Pentachaeta bellidiflora*	FE, SE, RPR, 1B	valley and foothill grassland. open dry rocky slopes and grassy areas, often on soils derived from serpentine bedrock. 35-620 m.							●			●		●		●	●	●		

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San Benito pentachaeta *Pentachaeta exilis* ssp. *aeolica*	RPR, 1B	cismontane woodland, valley and foothill grassland. grassy areas. 635-855 m.		●		●								●	●	●		●		
Merced phacelia *Phacelia ciliata* var. *opaca*	RPR, 1B	valley and foothill grassland. adobe or clay soils of valley floors, open hills, or alkaline flats. 60-150 m.														●				
North Coast phacelia *Phacelia insularis* var. *continentis*	RPR, 1B	coastal bluff scrub, coastal dunes. open maritime bluffs, sandy soil. 10-160 m.							●	●		●								
Mt. Diablo phacelia *Phacelia phacelioides*	RPR, 1B	chaparral, cismontane woodland. adjacent to trails, on rock outcrops and talus slopes; sometimes on serpentine. 500-1370 m.		●		●	●							●	●	●		●		
Bolander's beach pine *Pinus contorta* ssp. *bolanderi*	RPR, 1B	closed-cone coniferous forest. podzol-like soils with Mendocino cypress and bishop pine; within pygmy cypress forest. 35-250 m.								●										
Monterey pine *Pinus radiata*	RPR, 1B	closed-cone coniferous forest, cismontane woodland. three primary stands are native to California. dry bluffs and slopes. 25-185 m.											●	●		●	●	●		
white-flowered rein orchid *Piperia candida*	RPR, 1B	north coast coniferous forest, lower montane coniferous forest, broadleafed upland forest. coast ranges from Santa Cruz County north; on serpentine. forest duff, mossy banks, rock outcrops and muskeg. 0-1200 m.		●		●			●	●		●		●	●	●	●	●		
Point Reyes rein orchid *Piperia elegans* ssp. *decurtata*	RPR, 1B	coastal bluff scrub. 15-185 m.							●			●								
Yadon's rein orchid *Piperia yadonii*	FE, RPR, 1B	closed-cone coniferous forest, chaparral, coastal bluff scrub. on sandstone and sandy soil, but poorly drained and often dry. 10-415 m.											●	●						
Choris' popcornflower *Plagiobothrys chorisianus* var. *chorisianus*	RPR, 1B	chaparral, coastal scrub, coastal prairie. mesic sites. 15-100 m.	●		●			●						●		●	●	●		
San Francisco popcornflower *Plagiobothrys diffusus*	SE, RPR, 1B	valley and foothill grassland, coastal prairie. historically from grassy slopes with marine influence. 60-485 m.	●		●			●						●		●	●	●		
hairless popcornflower *Plagiobothrys glaber*	RPR 1A	meadows and seeps, marshes and swamps. coastal salt marshes and alkaline meadows. 5-180 m.	●	●	●	●		●						●	●	●		●		
bearded popcornflower *Plagiobothrys hystriculus*	RPR, 1B	vernal pools, valley and foothill grassland. wet sites. 10-50 m.								●	●	●							●	●
Mayacamas popcornflower *Plagiobothrys lithocaryus*	RPR 1A	meadows? valley and foothill grassland, cismontane woodland, chaparral? moist sites. 285-450 m.								●		●								
Petaluma popcornflower *Plagiobothrys mollis* var. *vestitus*	RPR 1A	valley and foothill grassland, coastal salt marsh? wet sites in grassland, possibly coastal marsh margins. 10-50 m.							●			●								
Calistoga popcornflower *Plagiobothrys strictus*	FE, ST, RPR, 1B	broadleafed upland forest, meadows and seeps, valley and foothill grassland, vernal pools. alkaline sites near thermal springs and on margins of vernal pools in heavy, dark, adobe-like clay. 90-160 m.								●	●									●
hooked popcornflower *Plagiobothrys uncinatus*	RPR, 1B	chaparral, cismontane woodland, valley and foothill grassland, coastal bluff scrub. sandstone outcrops and canyon sides; often in burned or disturbed areas. 300-820 m.												●		●				
warty popcorn-flower *Plagiobothrys verrucosus*	RPR 2	chaparral. shale substrate. 610-760 m.		●		●									●	●		●		

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North Coast semaphore grass *Pleuropogon hooverianus*	ST, RPR, 1B	broadleafed upland forest, meadows and seeps, north coast coniferous forest. wet grassy, usually shady areas, sometimes freshwater marsh; associated with forest environments; 10-1150 m.							●	●		●								
Napa blue grass *Poa napensis*	FE, SE, RPR, 1B	meadows and seeps, valley and foothill grassland. moist alkaline meadows fed by runoff from nearby hot springs. 100-125 m.									●									●
Santa Lucia mint *Pogogyne clareana*	SE, RPR, 1B	riparian woodland. tributaries of the Nacimiento River, in moist sandy soil. 300-490 m.																		
Oregon polemonium *Polemonium carneum*	RPR 2	coastal prairie, coastal scrub, lower montane coniferous forest. 0-1830 m.	●		●			●	●			●				●	●	●		
Scotts Valley polygonum *Polygonum hickmanii*	FE, SE, RPR, 1B	valley and foothill grassland. Purisima sandstone or mudstone with a thin soil layer, vernally moist due to runoff. 210-250 m.												●		●		●		
Marin knotweed *Polygonum marinense*	RPR 3	marshes and swamps. coastal salt marshes and brackish marshes. 0-10 m.							●	●	●	●							●	●
Nuttall's ribbon-leaved pondweed *Potamogeton epihydrus*	RPR 2	marshes and swamps. shallow water, ponds, lakes, streams, irrigation ditches. 400-2110 m.								●										
eel-grass pondweed *Potamogeton zosteriformis*	RPR 2	marshes and swamps. ponds, lakes, streams. 0-1860 m.		●		●	●			●		●								
Hickman's cinquefoil *Potentilla hickmanii*	FE, SE, RPR, 1B	coastal bluff scrub, closed-cone coniferous forest, meadows and seeps, marshes and swamps. freshwater marshes, seeps, and small streams in open or forested areas along the coast. 5-125 m.											●	●		●	●			
Cunningham Marsh cinquefoil *Potentilla uliginosa*	RPR 1A	freshwater marshes and swamps. found in permanent, oligotrophic wetlands.30-40 m.							●			●								
Hartweg's golden sunburst *Pseudobahia bahiifolia*	FE, SE, RPR, 1B	valley and foothill grassland, cismontane woodland. clay soils, predominantly on the northern slopes of knolls, but also along shady creeks or near vernal pools. 15-150 m.														●				
dwarf alkali grass *Puccinellia pumila*	RPR 2	meadows and seeps, marshes and swamps. mineral spring meadows and coastal salt marshes. 1-10 m.								●										
Tamalpais oak *Quercus parvula* var. *tamalpaisensis*	RPR, 1B	lower montane coniferous forest. 100-750 m.							●			●								
white beaked-rush *Rhynchospora alba*	RPR 2	bogs and fens, marshes and swamps. freshwater marshes and sphagnum bogs. 60-2000 m.							●	●		●								
California beaked-rush *Rhynchospora californica*	RPR, 1B	bogs and fens, marshes and swamps, lower montane coniferous forest, meadows and seeps. freshwater seeps and open marshy areas. 45-1000 m.							●	●	●	●								●
brownish beaked-rush *Rhynchospora capitellata*	RPR 2	lower montane coniferous forest, meadows and seeps, marshes and swamps, upper montane coniferous forest. mesic sites. 455-2000 m.							●			●								
round-headed beaked-rush *Rhynchospora globularis*	RPR 2	marshes and swamps. freshwater marsh. 45-60 m.							●			●								
pine rose *Rosa pinetorum*	RPR, 1B	closed-cone coniferous forest. 2-300 m.											●	●		●		●		

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Sanford's arrowhead *Sagittaria sanfordii*	RPR, 1B	marshes and swamps. in standing or slow-moving freshwater ponds, marshes, and ditches. 0-610 m.		●		●		●				●							●	●
great burnet *Sanguisorba officinalis*	RPR 2	bogs and fens, meadows and seeps, broadleafed upland forest, marshes and swamps, north coast coniferous forest, ripar. forest. rocky serpentine seepage areas and along stream borders. 60-1400 m.								●										
adobe sanicle *Sanicula maritima*	SR, RPR, 1B	meadows and seeps, valley and foothill grassland, chaparral, coastal prairie. moist clay or ultramafic soils. 30-240 m.	●		●			●						●		●		●		
rock sanicle *Sanicula saxatilis*	SR, RPR, 1B	broadleafed upland forest, chaparral, valley and foothill grassland. bedrock outcrops and talus slopes in chaparral or oak woodland habitat. 615-1215 m.		●		●	●								●			●		
marsh skullcap *Scutellaria galericulata*	RPR 2	marshes and swamps, lower montane coniferous forest, meadows and seeps. swamps and wet places. 0-2100 m.		●		●	●	●							●			●		●
side-flowering skullcap *Scutellaria lateriflora*	RPR 2	meadows and seeps, marshes and swamps. wet meadows and marshes. in the delta, often found on logs. -3-500 m.		●		●	●	●												●
Lake County stonecrop *Sedella leiocarpa*	FE, SE, RPR, 1B	valley and foothill grassland, vernal pools, cismontane woodland. level areas that are seasonally wet and dry out in late spring; substrate usually of volcanic origin. 365-790 m.								●		●								
Red Mountain stonecrop *Sedum laxum* ssp. *eastwoodiae*	FC, RPR, 1B	lower montane coniferous forest. serpentine soils among rocks. 600-1200 m.								●										
chaparral ragwort *Senecio aphanactis*	RPR 2	cismontane woodland, coastal scrub. drying alkaline flats. 20-575 m.	●	●	●	●	●	●				●		●		●		●	●	
Point Reyes checkerbloom *Sidalcea calycosa* ssp. *rhizomata*	RPR, 1B	marshes and swamps. freshwater marshes near the coast. 5-75(245)m.							●	●		●								
Hickman's checkerbloom *Sidalcea hickmanii* ssp. *hickmanii*	RPR, 1B	chaparral. grassy openings in chaparral, and on dry ridges. 330-1640 m.												●						
Napa checkerbloom *Sidalcea hickmanii* ssp. *napensis*	RPR, 1B	chaparral. rhyolitic substrates. 415-610 m.							●	●	●	●								●
Lake Pillsbury checkerbloom *Sidalcea hickmanii* ssp. *pillsburiensis*	RPR, 1B	chaparral. openings in chaparral on Franciscan soils. 700 m.								●		●								
Marin checkerbloom *Sidalcea hickmanii* ssp. *viridis*	RPR, 1B	chaparral. serpentine or volcanic soils; sometimes appears after burns. 0-430 m.							●			●								
Keck's checkerbloom *Sidalcea keckii*	FE, RPR, 1B	cismontane woodland, valley and foothill grassland grassy slopes in blue oak woodland. 180-425 m.								●	●	●				●			●	●
Siskiyou checkerbloom *Sidalcea malviflora* ssp. *patula*	RPR, 1B	coastal prairie, broadleafed upland forest. open coastal forest. 15-65 m.								●										
purple-stemmed checkerbloom *Sidalcea malviflora* ssp. *purpurea*	RPR, 1B	broadleafed upland forest, coastal prairie. 15-65 m.							●	●		●								
marsh checkerbloom *Sidalcea oregana* ssp. *hydrophila*	RPR, 1B	meadows and seeps, riparian forest. wet soil of streambanks, meadows. 545-2300 m.							●	●	●	●								●
Kenwood Marsh checkerbloom *Sidalcea oregana* ssp. *valida*	FE, SE, RPR, 1B	marshes and swamps. edges of freshwater marshes. 115-150 m.							●			●								

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Red Mountain catchfly *Silene campanulata* ssp. *campanulata*	SE, RPR 4	lower montane coniferous forest, chaparral. state-listed endangered, but cnps list 4; eo's mostly archived. rocky dry shallow serpentine soil. 420-1200 m. element occurrences archived; cnps list 4.								●										
San Francisco campion *Silene verecunda* ssp. *verecunda*	RPR, 1B	coastal scrub, valley and foothill grassland, coastal bluff scrub, chaparral, coastal prairie. often on mudstone or shale; one site on serpentine. 30-645 m.												●		●	●	●		
prairie wedge grass *Sphenopholis obtusata*	RPR 2	cismontane woodland, meadows and seeps. open moist sites, along rivers and springs, alkaline desert seeps. 360-2325 m.														●				
Santa Cruz microseris *Stebbinsoseris decipiens*	RPR, 1B	broadleafed upland forest, closed-cone coniferous forest, chaparral, coastal prairie, coastal scrub. open areas in loose or disturbed soil, usu. derived from sandstone, shale or serp., on seaward slopes. 10-500 m.							●			●	●	●		●	●	●		
Metcalf Canyon jewel-flower *Streptanthus albidus* ssp. *albidus*	FE, RPR, 1B	valley and foothill grassland. relatively open areas in dry grassy meadows on serpentine soils; also on serpentine balds. 45-245 m.		●		●									●			●		
most beautiful jewel-flower *Streptanthus albidus* ssp. *peramoenus*	RPR, 1B	chaparral, valley and foothill grassland, cismontane woodland. serpentine outcrops, on ridges and slopes. 120-730 m.	●	●	●	●	●	●					●	●	●	●		●		
Tamalpais jewel-flower *Streptanthus batrachopus*	RPR, 1B	closed-cone coniferous forest, chaparral. talus serpentine outcrops. 410-650 m.							●			●								
Socrates Mine jewel-flower *Streptanthus brachiatus* ssp. *brachiatus*	RPR, 1B	chaparral, closed-cone coniferous forest. serpentine areas and serpentine chaparral. 480-970 m.							●	●	●	●								●
Freed's jewel-flower *Streptanthus brachiatus* ssp. *hoffmanii*	RPR, 1B	chaparral, cismontane woodland. serpentine rock outcrops, primarily in geothermal development areas. 480-1030 m.							●	●		●								
Mt. Hamilton jewel-flower *Streptanthus callistus*	RPR, 1B	chaparral, cismontane woodland. open talus slopes on shale with grey pine and/or black oak. 600-790 m.													●			●		
Hoffman's bristly jewel-flower *Streptanthus glandulosus* ssp. *hoffmanii*	RPR, 1B	chaparral, cismontane woodland, valley and foothill grassland. moist, steep rocky banks, in serpentine and non-serpentine soil. 120-475 m.							●			●								
Tiburon jewel-flower *Streptanthus glandulosus* ssp. *niger*	FE, SE, RPR, 1B	valley and foothill grassland. shallow, rocky serpentine slopes. 30-150 m.							●			●								
Mount Tamalpais bristly jewel-flower *Streptanthus glandulosus* ssp. *pulchellus*	RPR, 1B	chaparral, valley and foothill grassland. serpentine slopes. 150-800 m.							●			●								
green jewel-flower *Streptanthus hesperidis*	RPR, 1B	chaparral, cismontane woodland. openings in chaparral or woodland; serpentine, rocky sites. 130-760 m.								●	●	●								●
Mt. Diablo jewel-flower *Streptanthus hispidus*	RPR, 1B	valley and foothill grassland, chaparral. talus or rocky outcrops. 275-970 m.		●		●	●													
Arburua Ranch jewel-flower *Streptanthus insignis* ssp. *lyonii*	RPR, 1B	coastal scrub. serpentine slopes, also on non-serpentine. 230-850 m.														●				

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Table A-1 CNDDB Occurrences for Special-status Plant Species by District and Adjacent Program Areas

Species Name	Status	Habitat	AM1	AM2	AV1	AV2	CC1	CC2	MS1	MS2	NC1	NC2	NS1	NS2	SC1	SC2	SM1	SM2	So1	So2
early jewel-flower *Streptanthus vernalis*	RPR, 1B	chaparral, closed-cone coniferous forest. on serpentine. 610 m.							●	●		●								
slender-leaved pondweed *Stuckenia filiformis*	RPR 2	marshes and swamps. shallow, clear water of lakes and drainage channels. 15-2310 m.	●	●	●	●	●	●				●			●	●	●	●	●	
Mason's neststraw *Stylocline masonii*	RPR, 1B	chenopod scrub, pinyon-juniper woodland. sandy washes. 100-1200 m.												●						
California seablite *Suaeda californica*	FE, RPR, 1B	marshes and swamps. margins of coastal salt marshes. 0-5 m.	●	●	●	●	●	●							●	●		●		
Suisun Marsh aster *Symphyotrichum lentum*	RPR, 1B	marshes and swamps (brackish and freshwater). most often seen along sloughs with phragmites, scirpus, blackberry, typha, etc. 0-3m.		●		●	●	●		●	●	●							●	●
robust false lupine *Thermopsis robusta*	RPR, 1B	north coast coniferous forest, broadleafed upland forest. ridgetops; sometimes on serpentine. 360-1290 m.								●										
alpine crisp moss *Tortella alpicola*	RPR 2	cismontane woodland. moss on volcanic rock (in California). wide ecological tolerance: shaded or exposed, wet or dry, low to high elevations.								●		●								
California screw moss *Tortula californica*	RPR, 1B	chenopod scrub, valley and foothill grassland. moss growing on sandy soil. 10-1460 m.												●						
beaked tracyina *Tracyina rostrata*	RPR, 1B	cismontane woodland, valley and foothill grassland. open grassy meadows within oak woodland and grassland habitats. 150-500 m.							●	●		●								
Wright's trichocoronis *Trichocoronis wrightii* var. *wrightii*	RPR 2	marshes and swamps, riparian forest, meadows and seeps, vernal pools. mud flats of vernal lakes, drying river beds, alkali meadows. 5-435 m.		●		●		●								●				
cylindrical trichodon *Trichodon cylindricus*	RPR 2	broadleafed upland forest, upper montane coniferous forest. moss growing in openings on sandy or clay soils on roadsides, stream banks, trails or in fields. 50-1500 m.								●		●								
Napa bluecurls *Trichostema ruygtii*	RPR, 1B	cismontane woodland, chaparral, valley and foothill grassland, vernal pools, lower montane coniferous forest. often in open, sunny areas. also has been found in vernal pools. 30-590 m.								●	●	●							●	●
showy rancheria clover *Trifolium amoenum*	FE, RPR, 1B	valley and foothill grassland, coastal bluff scrub. sometimes on serpentine soil, open sunny sites, swales. most recently sited on roadside and eroding cliff face. 5-560 m.							●	●	●	●				●	●		●	●
Santa Cruz clover *Trifolium buckwestiorum*	RPR, 1B	coastal prairie, broadleafed upland forest, cismontane woodland. moist grassland. 60-545 m.							●	●		●	●	●		●		●		
saline clover *Trifolium hydrophilum*	RPR, 1B	marshes and swamps, valley and foothill grassland, vernal pools. mesic, alkaline sites. 0-300 m.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Pacific Grove clover *Trifolium polyodon*	SR, RPR, 1B	closed-cone coniferous forest, meadows and seeps, coastal prairie. along small springs and seeps in grassy openings. 5-120 m.											●	●						
Monterey clover *Trifolium trichocalyx*	FE, SE, RPR, 1B	closed-cone coniferous forest. poorly drained, low nutrient soil underlain with hardpan; also openings and burned areas. 120-205 m.								●				●						
San Francisco owl's-clover *Triphysaria floribunda*	RPR, 1B	coastal prairie, valley and foothill grassland. on serpentine and nonserpentine substrate (such as at Pt. Reyes). 10-160 m.							●			●					●	●		

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Species Name	Status	Habitat	AM1	AM2	AV1	AV2	CC1	CC2	MS1	MS2	NC1	NC2	NS1	NS2	SC1	SC2	SM1	SM2	So1	So2
coastal triquetrella *Triquetrella californica*	RPR, 1B	coastal bluff scrub, coastal scrub valley and foothill grasslands. grows within 30 m from the coast in coastal scrub, grasslands and in open gravels on roadsides, hillsides, rocky slopes,		●		●	●		●	●		●					●	●		●
Cook's triteleia *Triteleia ixioides* ssp. *cookii*	RPR, 1B	cismontane woodland, closed-cone coniferous forest. streamsides, wet ravines; on serpentine and in serpentine seeps. sometimes near cypresses. ?-500 m.												●						
caper-fruited tropidocarpum *Tropidocarpum capparideum*	RPR, 1B	valley and foothill grassland. alkaline clay. 0-455 m.	●	●	●	●	●	●						●		●				
Greene's tuctoria *Tuctoria greenei*	FE, SR, RPR, 1B	vernal pools, valley and foothill grassland. dry bottoms of vernal pools in open grasslands. 30-1065 m.						●								●				
Crampton's tuctoria or Solano grass *Tuctoria mucronata*	FE, SE, RPR, 1B	vernal pools, valley and foothill grassland. clay bottoms of drying vernal pools and lakes in valley grassland. 5-10 m.		●		●						●							●	●
oval-leaved viburnum *Viburnum ellipticum*	RPR 2	chaparral, cismontane woodland, lower montane coniferous forest. 215-1400 m.		●		●	●		●	●	●	●								●
alpine marsh violet *Viola palustris*	RPR 2	coastal scrub, bogs and fens. swampy, shrubby places in coastal scrub or coastal bogs. 0-15 m.								●										

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Table A-2 CNDDB Occurrences for Special-status Wildlife Species by District and Adjacent Program Areas

Species Name	Status	Habitat	AM1	AM2	AV1	AV2	CC1	CC2	MS1	MS2	NC1	NC2	NS1	NS2	SC1	SC2	SM1	SM2	So1	So2
Invertebrates																				
Lange's metalmark butterfly *Apodemia mormo langei*	FE	inhabits stabilized dunes along the San Joaquin river. endemic to Antioch Dunes, Contra Costa County. primary host plant is *Eriogonum nudum var auriculatum*; feeds on nectar of other wildflowers, as well as host plant.		●		●	●													
Conservancy fairy shrimp *Branchinecta conservatio*	FE	endemic to the grasslands of the northern two-thirds of the Central Valley; found in large, turbid pools. inhabit astatic pools located in swales formed by old, braided alluvium; filled by winter/spring rains, last until June.										●				●			●	●
longhorn fairy shrimp *Branchinecta longiantenna*	FE	endemic to the eastern margin of the central coast mountains in seasonally astatic grassland vernal pools. inhabit small, clear-water depressions in sandstone and clear-to-turbid clay/grass-bottomed pools in shallow swales.	●	●	●	●	●	●								●				
vernal pool fairy shrimp *Branchinecta lynchi*	FT	endemic to the grasslands of the Central Valley, central coast mountains, and south coast mountains, in astatic rain-filled pools. inhabit small, clear-water sandstone-depression pools and grassed swale, earth slump, or basalt-flow depression pools.	●	●	●	●	●	●		●	●	●		●		●			●	●
San Bruno elfin butterfly *Callophrys mossii bayensis*	FE	coastal, mountainous areas with grassy ground cover, mainly in the vicinity of San Bruno Mountain, San Mateo County. colonies are located on steep, north-facing slopes within the fog belt. larval host plant is *Sedum spathulifolium*.		●		●	●		●			●				●	●			
Ohlone tiger beetle *Cicindela ohlone*	FE	remnant native grasslands with California oatgrass and purple needlegrass in Santa Cruz County. substrate is poorly-drained clay or sandy clay soil over bedrock of Santa Cruz mudstone.											●			●		●		
valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	FT	occurs only in the Central Valley of California, in association with blue elderberry (Sambucus mexicana). prefers to lay eggs in elderberrries 2-8 inches in diameter; some preference shown for "stressed" elderberries.		●		●		●		●	●	●				●			●	●
Delta green ground beetle *Elaphrus viridis*	FT	restricted to the margins of vernal pools in the grassland area between Jepson Prairie and Travis AFB. prefers the sandy mud substrate where it slopes gently into the water, with low-growing vegetation, 25-100% cover.										●							●	
Smith's blue butterfly *Euphilotes enoptes smithi*	FE	most commonly associated with coastal dunes and coastal sage scrub plant communities in Monterey and Santa Cruz Counties. hostplant: *Eriogonum latifolium* and *Eriogonum* parvifolium are utilized as both larval and adult foodplants.											●	●		●		●		
Bay checkerspot butterfly *Euphydryas editha bayensis*	FT	restricted to native grasslands on outcrops of serpentine soil in the vicinity of San Francisco Bay. *Plantago erecta* is the primary host plant; *Orthocarpus densiflorus* and *O. purpurscens* are the secondary host plants.	●	●	●	●	●	●						●	●	●	●	●		
vernal pool tadpole shrimp *Lepidurus packardi*	FE	inhabits vernal pools and swales in the Sacramento valley containing clear to highly turbid water. pools commonly found in grass bottomed swales of unplowed grasslands. some pools are mud-bottomed and highly turbid.	●	●	●	●	●	●				●				●			●	●
Mission blue butterfly *Plebejus icarioides missionensis*	FE	inhabits grasslands of the San Francisco peninsula. three larval host plants: *Lupinus albifrons, L. variicolor*, and *L. formosus*, of which *L. albifrons* is favored.							●			●				●	●	●		

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lotis blue butterfly *Plebejus idas lotis*	FE	inhabits wet meadows or poorly-drained sphagnum-willow bogs, where soils are waterlogged and acidic; north coastal California. inhabits upper edges of peat bog between peat and surrounding low willows; hostplant is *Lotus formosissimus*.								●										
Mount Hermon (=barbate) June beetle *Polyphylla barbata*	FE	known only from sand hills in vicinity of Mt. Hermon, Santa Cruz County.												●		●		●		
callippe silverspot butterfly *Speyeria callippe callippe*	FE	restricted to the northern coastal scrub of the San Francisco peninsula. hostplant is *Viola pedunculata*. most adults found on e-facing slopes; males congregate on hilltops in search of females.														●	●	●		
Behren's silverspot butterfly *Speyeria zerene behrensii*	FE	restricted to the pacific side of the coast ranges, from point arena to Cape Mendocino, Mendocino County inhabits coastal terrace prairie habitat. foodplant is *Viola* sp.							●	●		●								
Myrtle's silverspot *Speyeria zerene myrtleae*	FE	restricted to the foggy, coastal dunes/hills of the point reyes peninsula; extirpated from coastal San Mateo County. larval foodplant thought to be *Viola adunca*.							●			●				●	●			
California freshwater shrimp *Syncaris pacifica*	FE, SE,	endemic to Marin, Napa, and Sonoma Counties. found in low elevation, low gradient streams where riparian cover is moderately shallow pools away from main streamflow. winter: undercut banks with exposed roots. summer: leafy branches touching water.							●	●	●	●								●
Zayante band-winged grasshopper *Trimerotropis infantilis*	FE	isolated sandstone deposits in the Santa Cruz Mountains (the Zayante Sand Hills ecosystem) mostly on sand parkland habitat but also in areas with well-developed ground cover and in sparse chaparral with grass.		●		●								●	●	●		●		
Fish																				
Sacramento perch *Archoplites interruptus*	SSC	historically found in the sloughs, slow-moving rivers, and lakes of the Central Valley. prefers warm water. aquatic vegetation is essential for young. tolerates wide range of physio-chemical water conditions.		●		●	●													●
Kern brook lamprey *Entosphenus hubbsi*	SSC	San Joaquin river system and kern river. gravel-bottomed areas for spawning and muddy-bottomed areas where ammocoetes can burrow and feed.														●				
tidewater goby *Eucyclogobius newberryi*	FE, SSC	brackish water habitats along the California coast from Agua Hedionda Lagoon, San Diego County to the mouth of the smith river. found in shallow lagoons and lower stream reaches, they need fairly still but not stagnant water and high oxygen levels.	●		●			●	●	●		●	●	●		●	●	●		
Delta smelt *Hypomesus transpacificus*	FT, SE	Sacramento-San Joaquin Delta. seasonally in Suisun Bay, Carquinez Strait and San Pablo Bay. seldom found at salinities > 10 ppt. most often at salinities < 2ppt.		●		●		●				●							●	●
Russian River tule perch *Hysterocarpus traski pomo*	SSC	low elevation streams of the Russian River system. requires clear, flowing water with abundant cover. they also require deep (> 1 m) pool habitat.							●			●								
Clear Lake hitch *Lavinia exilicauda chi*	SSC	found only in Clear Lake, Lake County, and associated ponds. spawns in streams flowing into clear lake. adults found in the limnetic zone. juveniles found in the nearshore shallow-water habitat hiding in the vegetation.								●		●								
Navarro roach *Lavinia symmetricus navarroensis*	SSC	habitat generalists. found in warm intermittent streams as well as cold, well-aerated streams.							●	●		●								

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Gualala roach *Lavinia symmetricus parvipinnis*	SSC	found only in the Gualala River.							●	●		●								
San Joaquin roach *Lavinia symmetricus* ssp. 1	SSC	tributaries to the San Joaquin river from the Cosumnes River south.														●				
Tomales roach *Lavinia symmetricus* ssp. 2	SSC	tributaries to Tomales Bay.							●			●								
hardhead *Mylopharodon conocephalus*	SSC	low to mid-elevation streams in the Sacramento-San Joaquin drainage. also present in the Russian River. clear, deep pools with sand-gravel-boulder bottoms and slow water velocity. not found where exotic centrarchids predominate.		●		●		●	●			●				●	●	●		
pink salmon *Oncorhynchus gorbuscha*	SSC	most spawn in intertidal or lower reaches of streams and rivers in September and October move further upstream in Sacramento river. optimal temperature is 5.6 to 14.4ºC. embryos and alevins require fast-flowing, well oxygenated water for development and survival.								●										
Coho salmon - central California coast ESU *Oncorhynchus kisutch*	FE, SE	federal listing = populations between Punta Gorda and San Lorenzo River. state listing = populations south of Punta Gorda. require beds of loose, silt-free, coarse gravel for spawning. also need cover, cool water and sufficient dissolved oxygen.							●	●		●		●		●		●		
Coho salmon - southern Oregon / northern California ESU *Oncorhynchus kisutch*	FT, ST, SSC	federal listing refers to populations between Cape Blanco, Oregon and Punta Gorda, Humboldt County, California. state listing refers to populations between the Oregon border and Punta Gorda, California.																		
summer-run steelhead trout *Oncorhynchus mykiss irideus*	SSC	northern California coastal streams south to Middle Fork Eel River. within range of Klamath Mountains Province DPS and northern California DPS. cool, swift, shallow water and clean loose gravel for spawning, and suitably large pools in which to spend the summer.								●										
steelhead - central California coast DPS *Oncorhynchus mykiss irideus*	FT	from Russian River, south to Soquel Creek and to, but not including, Pajaro River. also San Francisco and San Pablo Bay basins.							●	●	●	●		●		●	●	●		●
steelhead - northern California DPS *Oncorhynchus mykiss irideus*	FT, SSC	coastal basins from redwood creek south to the Gualala River, inclusive. does not include summer-run steelhead.								●										
steelhead - south/central California coast DPS *Oncorhynchus mykiss irideus*	FT, SSC	fed listing refers to runs in coastal basins from the Pajaro River south to, but not including, the Santa Maria River.		●		●								●	●	●		●		
Chinook salmon - Sacramento River winter-run ESU *Oncorhynchus tshawytscha*	FE, SE	Sacramento river below Keswick Dam. spawns in the Sacramento river but not in tributary streams. requires clean, cold water over gravel beds with water temperatures between 6 and 14 c for spawning.										●								●
Chinook salmon - Central Valley spring-run ESU *Oncorhynchus tshawytscha*	FT, ST	adult numbers depend on pool depth and volume, amount of cover, and proximity to gravel. water temps >27 c is lethal to adults federal listing refers to pops spawning in Sacramento river and tributaries.										●								●
Sacramento splittail *Pogonichthys macrolepidotus*	SSC	endemic to the lakes and rivers of the Central Valley, but now confined to the delta, Suisun Bay and associated marshes. slow moving river sections, dead end sloughs. requires flooded vegetation for spawning and foraging for young.		●		●		●	●			●				●			●	●

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longfin smelt *Spirinchus thaleichthys*	ST, SSC	euryhaline, nektonic and anadromous. found in open waters of estuaries, mostly in middle or bottom of water column. prefer salinities of 15-30 ppt, but can be found in completely freshwater to almost pure seawater.							●			●								
Amphibians																				
California tiger salamander *Ambystoma californiense*	FT, ST, SSC	Central Valley DPS federally listed as threatened. Santa Barbara and Sonoma Counties DPS federally listed as endangered. need underground refuges, especially ground squirrel burrows and vernal pools or other seasonal water sources for breeding	●	●	●	●		●	●			●	●	●	●	●	●	●	●	●
Santa Cruz long-toed salamander *Ambystoma macrodactylum croceum*	FE, SE,	wet meadows near sea level in a few restricted locales in Santa Cruz and Monterey Counties. aquatic larvae prefer shallow (<12 inches) water, using clumps of vegetation or debris for cover. adults use mammal burr											●	●		●		●		
arroyo toad *Anaxyrus californicus*	FE, SSC	semi-arid regions near washes or intermittent streams, including valley-foothill and desert riparian, desert wash, etc. rivers with sandy banks, willows, cottonwoods, and sycamores; loose, gravelly areas of streams in drier parts of range.												●						
Pacific tailed frog *Ascaphus truei*	SSC	occurs in montane hardwood-conifer, redwood, Douglas-fir and ponderosa pine habitats. restricted to perennial montane streams. tadpoles require water below 15 degrees C.																		
northern leopard frog *Lithobates pipiens*	SSC	native range is east of Sierra Nevada-Cascade crest. near permanent or semi-permanent water in a variety of habitats. highly aquatic species. shoreline cover, submerged and emergent aquatic vegetation are important habitat characteristics														●				
northern red-legged frog *Rana aurora*	SSC	humid forests, woodlands, grasslands, and streamsides in northwestern California, usually near dense riparian cover. generally near permanent water, but can be found far from water, in damp woods and meadows, during non-breeding season.								●										
foothill yellow-legged frog *Rana boylii*	SSC	partly-shaded, shallow streams and riffles with a rocky substrate in a variety of habitats. need at least some cobble-sized substrate for egg-laying. need at least 15 weeks to attain metamorphosis.	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●
California red-legged frog *Rana draytonii*	FT, SSC	lowlands and foothills in or near permanent sources of deep water with dense, shrubby or emergent riparian vegetation. requires 11-20 weeks of permanent water for larval development. must have access to estivation habitat.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
southern torrent salamander *Rhyacotriton variegatus*	SSC	coastal redwood, Douglas-fir, mixed conifer, montane riparian, and montane hardwood-conifer habitats. old growth forest. cold, well-shaded, permanent streams and seepages, or within splash zone or on moss-covered rock within trickling water.								●										
western spadefoot *Spea hammondii*	SSC	occurs primarily in grassland habitats, but can be found in valley-foothill hardwood woodlands. vernal pools are essential for breeding and egg-laying.	●	●	●	●		●				●		●		●				●
Coast Range newt *Taricha torosa*	SSC	coastal drainages from Mendocino County to San Diego County. lives in terrestrial habitats and will migrate over 1 km to breed in ponds, reservoirs and slow moving streams.											●	●		●				

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Reptiles																				
black legless lizard *Anniella pulchra nigra*	SSC	sand dunes and sandy soils in the Monterey Bay and Morro Bay regions. inhabit sandy soil/dune areas with bush lupine and mock heather as dominant plants. moist soil is essential.											●	●		●		●		
silvery legless lizard *Anniella pulchra pulchra*	SSC	sandy or loose loamy soils under sparse vegetation. soil moisture is essential. they prefer soils with a high moisture content.		●		●	●	●					●	●		●				
western pond turtle *Emys marmorata*	SSC	a thoroughly aquatic turtle of ponds, marshes, rivers, streams and irrigation ditches, usually with aquatic vegetation, be need basking sites and suitable (sandy banks or grassy open fields) upland habitat up to 0.5 km from water for egg-laying.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
blunt-nosed leopard lizard *Gambelia sila*	FE, SE	resident of sparsely vegetated alkali and desert scrub habitats, in areas of low topographic relief. seeks cover in mammal burrows, under shrubs or structures such as fence posts; they do not excavate their own burrows.												●		●				
San Joaquin whipsnake *Masticophis flagellum ruddocki*	SSC	open, dry habitats with little or no tree cover. found in valley grassland and saltbush scrub in the San Joaquin Valley. needs mammal burrows for refuge and oviposition sites.	●	●	●	●	●	●						●		●				
Alameda whipsnake *Masticophis lateralis euryxanthus*	FT, ST	typically found in chaparral and scrub habitats but will also use adjacent grassland, oak savanna and woodland habitats. mostly south-facing slopes and ravines, with rock outcrops, deep crevices or abundant rodent burrows, where shrubs form a	●	●	●	●	●	●							●	●		●		
coast horned lizard *Phrynosoma blainvillii*	SSC	frequents a wide variety of habitats, most common in lowlands along sandy washes with scattered low bushes. open areas for sunning, bushes for cover, patches of loose soil for burial, and abundant supply of ants and other insects.	●	●	●	●	●	●					●	●	●	●		●		
giant garter snake *Thamnophis gigas*	FT, ST	prefers freshwater marsh and low gradient streams. has adapted to drainage canals and irrigation ditches. this is the most aquatic of the garter snakes in California.		●		●		●				●				●			●	●
two-striped garter snake *Thamnophis hammondii*	SSC	coastal California from vicinity of Salinas to northwest Baja California. from sea to about 7,000 ft elevation. highly aquatic, found in or near permanent fresh water. often along streams with rocky beds and riparian growth.												●		●				
San Francisco garter snake *Thamnophis sirtalis tetrataenia*	FE, SE	vicinity of freshwater marshes, ponds and slow moving streams in San Mateo County and extreme northern Santa Cruz County. prefers dense cover and water depths of at least one foot. upland areas near water are also very important.												●		●	●	●		
Birds																				
northern goshawk *Accipiter gentilis*	SSC	within, and in vicinity of, coniferous forest. uses old nests, and maintains alternate sites. usually nests on north slopes, near water. red fir, lodgepole pine, Jeffrey pine, and aspens are typical nest trees.								●		●								
tricolored blackbird *Agelaius tricolor*	SSC	highly colonial species, most numerous in Central Valley and vicinity. largely endemic to California. requires open water, protected nesting substrate, and foraging area with insect prey within a few km of the colony.	●	●	●	●		●	●	●	●	●	●	●	●	●		●	●	●
grasshopper sparrow *Ammodramus savannarum*	SSC	dense grasslands on rolling hills, lowland plains, in valleys and on hillsides on lower mountain slopes. favors native grasslands with a mix of grasses, forbs and scattered shrubs. loosely colonial when nesting.							●	●		●							●	

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golden eagle *Aquila chrysaetos*	FP	rolling foothills, mountain areas, sage-juniper flats, and desert. cliff-walled canyons provide nesting habitat in most parts of range; also, large trees in open areas.	●	●	●	●	●	●		●	●	●	●	●	●	●		●	●	●
short-eared owl *Asio flammeus*	SSC	found in swamp lands, both fresh and salt; lowland meadows; irrigated alfalfa fields. tule patches/tall grass needed for nesting/daytime seclusion. nests on dry ground in depression concealed in vegetation.		●		●	●					●	●	●		●	●		●	
long-eared owl *Asio otus*	SSC	riparian bottomlands grown to tall willows and cottonwoods; also, belts of live oak paralleling stream courses. require adjacent open land productive of mice and the presence of old nests of crows, hawks, or magpies for breeding.												●		●	●			
burrowing owl *Athene cunicularia*	SSC	open, dry annual or perennial grasslands, deserts and scrublands characterized by low-growing vegetation. subterranean nester, dependent upon burrowing mammals, most notably, the California ground squirrel.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
marbled murrelet *Brachyramphus marmoratus*	FT, SE	feeds near-shore; nests inland along coast from Eureka to Oregon border and from half moon bay to Santa Cruz. nests in old-growth redwood-dominated forests, up to six miles inland, often in Douglas-fir.												●		●		●		
Swainson's hawk *Buteo swainsoni*	SSC	breeds in grasslands with scattered trees, juniper-sage flats, riparian areas, savannahs, and agricultural or ranch lands requires adjacent suitable foraging areas such as grasslands, or alfalfa or grain fields supporting rodent populations.	●	●	●	●	●	●		●	●	●				●			●	●
western snowy plover *Charadrius alexandrinus nivosus*	FT, SSC	sandy beaches, salt pond levees and shores of large alkali lakes. needs sandy, gravelly or friable soils for nesting.	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●		●
mountain plover *Charadrius montanus*	SSC	short grasslands, freshly plowed fields, newly sprouting grain fields, and sometimes sod farms short vegetation, bare ground and flat topography. prefers grazed areas and areas with burrowing rodents.										●		●		●			●	●
northern harrier *Circus cyaneus*	SSC	coastal salt and fresh-water marsh. nest and forage in grasslands, from salt grass in desert sink to mountain cienagas. nests on ground in shrubby vegetation, usually at marsh edge; nest built of a large mound of sticks in wet areas.	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●
western yellow-billed cuckoo *Coccyzus americanus occidentalis*	FC, SE	riparian forest nester, along the broad, lower flood-bottoms of larger river systems. nests in riparian jungles of willow, often mixed with cottonwoods, with lower story of blackberry, nettles, or wild grape.		●		●		●	●	●		●		●		●				●
yellow rail *Coturnicops noveboracensis*	SSC	summer resident in eastern Sierra Nevada in Mono County. fresh-water marshlands.														●				
black swift *Cypseloides niger*	SSC	coastal belt of Santa Cruz and Monterey County; central and southern Sierra Nevada; San Bernardino and San Jacinto Mountains. breeds in small colonies on cliffs behind or adjacent to waterfalls in deep canyons and sea-bluffs above the surf; foraging		●		●			●	●	●	●		●	●	●	●	●		●
yellow warbler *Dendroica petechia brewsteri*	SSC	riparian plant associations. prefers willows, cottonwoods, aspens, sycamores, and alders for nesting and foraging. also nests in montane shrubbery in open conifer forests.	●	●	●	●		●	●	●		●		●		●				
white-tailed kite *Elanus leucurus*	FP	rolling foothills and valley margins with scattered oaks and river bottomlands or marshes next to deciduous woodland. open grasslands, meadows, or marshes for foraging close to isolated, dense-topped trees for nesting and perching.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

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American peregrine falcon *Falco peregrinus anatum*	SSC	near wetlands, lakes, rivers, or other water; on cliffs, banks, dunes, mounds; also, human-made structures. nest consists of a scrape or a depression or ledge in an open site.	●	●	●	●		●		●	●	●		●	●	●	●	●	●	●
tufted puffin *Fratercula cirrhata*	SSC	open-ocean bird; nests along the coast on islands, islets, or (rarely) mainland cliffs. requires sod or earth into which the birds can burrow, on island cliffs or grassy island slopes.							●	●		●		●						
saltmarsh common yellowthroat *Geothlypis trichas sinuosa*	SSC	resident of the San Francisco Bay region, in fresh and salt water marshes. requires thick, continuous cover down to water surface for foraging; tall grasses, tule patches, willows for nesting.	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●
California condor *Gymnogyps californianus*	FE, SE	require vast expanses of open savannah, grasslands, and foothill chaparral in mountain ranges of moderate altitude. deep canyons containing clefts in the rocky walls provide nesting sites. forages up to 100 miles from roost/nest.												●		●				
bald eagle *Haliaeetus leucocephalus*	SE	ocean shore, lake margins, and rivers for both nesting and wintering. most nests within 1 mile of water. nests in large, old-growth, or dominant live tree with open branches, especially ponderosa pine. roosts communally in winte	●	●	●	●	●	●		●	●	●		●		●				●
yellow-breasted chat *Icteria virens*	SSC	summer resident; inhabits riparian thickets of willow and other brushy tangles near watercourses. nests in low, dense riparian, consisting of willow, blackberry, wild grape; forages and nests within 10 ft of ground.	●	●	●	●		●		●		●		●		●			●	
loggerhead shrike *Lanius ludovicianus*	SSC	broken woodlands, savannah, pinyon-juniper, Joshua tree, and riparian woodlands, desert oases, scrub and washes. prefers open country for hunting, with perches for scanning, and fairly dense shrubs and brush for nesting.		●		●	●	●	●			●				●				
California black rail *Laterallus jamaicensis coturniculus*	ST	inhabits freshwater marshes, wet meadows and shallow margins of saltwater marshes bordering larger bays. needs water depths of about 1 inch that does not fluctuate during the year and dense vegetation for nesting habitat.	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●
Suisun song sparrow *Melospiza melodia maxillaris*	SSC	resident of brackish-water marshes surrounding Suisun Bay. inhabits cattails, tules and other sedges, and salicornia; also known to frequent tangles bordering sloughs.		●		●	●	●				●				●			●	●
Alameda song sparrow *Melospiza melodia pusillula*	SSC	resident of salt marshes bordering south arm of San Francisco Bay. inhabits salicornia marshes; nests low in grindelia bushes (high enough to escape high tides) and in salicornia.	●	●	●	●	●	●							●	●	●	●		
San Pablo song sparrow *Melospiza melodia samuelis*	SSC	resident of salt marshes along the north side of San Francisco and San Pablo Bays. inhabits tidal sloughs in the salicornia marshes; nests in grindelia bordering slough channels.		●		●	●		●	●	●	●							●	●
ashy storm-petrel *Oceanodroma homochroa*	SSC	colonial nester on off-shore islands. usually nests on driest part of islands. forages over open ocean. nest sites on islands are in crevices beneath loosely piled rocks or driftwood, or in caves.							●	●		●						●		
California brown pelican *Pelecanus occidentalis californicus*	SSC, FP	colonial nester on coastal islands just outside the surf line. nests on coastal islands of small to moderate size which afford immunity from attack by ground-dwelling predators. roost												●						
purple martin *Progne subis*	SSC	inhabits woodlands, low elevation coniferous forest of Douglas-fir, ponderosa pine, and Monterey pine. nests in old woodpecker cavities mostly, also in human-made structures. nest often located in tall, isolated tree/snag.						●		●	●	●		●						●

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California clapper rail *Rallus longirostris obsoletus*	FE, SE	salt-water and brackish marshes traversed by tidal sloughs in the vicinity of San Francisco Bay. associated with abundant growths of pickleweed, but feeds away from cover on invertebrates from mud-bottomed sloughs.	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●
bank swallow *Riparia riparia*	ST	colonial nester; nests primarily in riparian and other lowland habitats west of the desert. requires vertical banks/cliffs with fine-textured/sandy soils near streams, rivers, lakes, ocean to dig nesting hole.	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●		●
black skimmer *Rynchops niger*	SSC	nests on gravel bars, low islets, and sandy beaches, in unvegetated sites. nesting colonies usually less than 200 pairs.	●		●			●								●				
California least tern *Sternula antillarum browni*	FE, SE	nests along the coast from San Francisco Bay south to northern Baja California. colonial breeder on bare or sparsely vegetated, flat substrates: sand beaches, alkali flats, landfills, or paved areas.	●	●	●	●	●	●				●			●	●	●	●	●	
least Bell's vireo *Vireo bellii pusillus*	FE, SE	summer resident of southern California in low riparian in vicinity of water or in dry river bottoms; below 2000 ft. nests placed along margins of bushes or on twigs projecting into pathways, usually willow, baccharis, mesquite.		●		●						●		●	●	●		●		●
yellow-headed blackbird *Xanthocephalus xanthocephalus*	SSC	nests in freshwater emergent wetlands with dense vegetation and deep water. often along borders of lakes or ponds. nests only where large insects such as odonata are abundant, nesting timed with maximum emergence of aquatic insects.		●		●	●	●				●				●				●
Mammals																				
Nelson's antelope squirrel *Ammospermophilus nelsoni*	ST	western San Joaquin valley from 200-1200 ft elev. on dry, sparsely vegetated loam soils. dig burrows or use k-rat burrows. need widely scattered shrubs, forbs and grasses in broken terrain with gullies and washes												●		●				
pallid bat *Antrozous pallidus*	SSC	deserts, grasslands, shrublands, woodlands and forests. most common in open, dry habitats with rocky areas for roosting. roosts must protect bats from high temperatures. very sensitive to disturbance of roosting sites.	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●
Point Arena mountain beaver *Aplodontia rufa nigra*	FE, SSC	coastal areas of point arena with springs or seepages. north-facing slopes of ridges and gullies with friable soils and thickets of undergrowth.								●										
Point Reyes mountain beaver *Aplodontia rufa phaea*	SSC	coastal area of Point Reyes in areas of springs or seepages. north-facing slopes of hills and gullies in areas overgrown with sword ferns and thimbleberries.							●			●								
Sonoma tree vole *Arborimus pomo*	SSC	north coast fog belt from Oregon border to Sonoma County in Douglas-fir, redwood and montane hardwood-conifer forests. feeds almost exclusively on Douglas-fir needles. will occasionally take needles of grand fir, hemlock or spruce.							●	●		●								
Guadalupe fur-seal *Arctocephalus townsendi*	FT, ST	breeds on Isla De Guadalupe off of Mexico, occasionally found on San Miguel, San Nicolas, and San Clemente Islands. prefers shallow, nearshore island water, with cool and sheltered rocky areas for haul-outs.																●		
Townsend's big-eared bat *Corynorhinus townsendii*	SSC	throughout California in a wide variety of habitats. most common in mesic sites. roosts in the open, hanging from walls and ceilings. roosting sites limiting. extremely sensitive to human disturbance.	●		●			●	●	●	●	●		●		●		●		●

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giant kangaroo rat *Dipodomys ingens*	FE, SE,	annual grasslands on the western side of the San Joaquin valley, marginal habitat in alkali scrub. need level terrain and sandy loam soils for burrowing.												●		●				
big-eared kangaroo rat *Dipodomys venustus elephantinus*	SSC	chaparral-covered slopes of the southern part of the Gabilian Range, in the vicinity of the Pinnacles. forages under shrubs and in the open. burrows for cover and for nesting.												●						
southern sea otter *Enhydra lutris nereis*	FT	nearshore marine environments from about Ano Nuevo, San Mateo County to Point Sal, Santa Barbara County needs canopies of giant kelp and bull kelp for rafting and feeding. prefers rocky substrates with abundant invertebrates.							●			●								
Steller (=northern) sea-lion *Eumetopias jubatus*	FT	breeds on Ano Nuevo, San Miguel and Farallon Islands, pt. St. George, and Sugarloaf. hauls-out on islands and rocks. needs haul-out and breeding sites with unrestricted access to water, near aquatic food supply and with no human disturbance.																●		
western mastiff bat *Eumops perotis californicus*	SSC	many open, semi-arid to arid habitats, including conifer and deciduous woodlands, coastal scrub, grasslands, chaparral etc. roosts in crevices in cliff faces, high buildings, trees and tunnels.	●	●	●	●		●						●		●				
California wolverine *Gulo gulo*	FC, ST	found in the north coast mountains and the Sierra Nevada. found in a wide variety of high elevation habitats. needs water source. uses caves, logs, burrows for cover and den area. hunts in more open areas. can travel long distances								●										
western red bat *Lasiurus blossevillii*	SSC	roosts primarily in trees, 2-40 ft above ground, from sea level up through mixed conifer forests. prefers habitat edges and mosaics with trees that are protected from above and open below with open areas for foraging.		●		●	●	●	●	●	●	●		●		●			●	●
Humboldt marten *Martes americana humboldtensis*	SSC	occurs only in the coastal redwood zone from the Oregon border south to Sonoma County. associated with late-successional coniferous forests, prefer forests with low, overhead cover.								●		●								
Pacific fisher *Martes pennanti* (*pacifica*) DPS	FC, SSC	intermediate to large-tree stages of coniferous forests and deciduous-riparian areas with high percent canopy closure. uses cavities, snags, logs and rocky areas for cover and denning. needs large areas of mature, dense forest.								●		●								
San Pablo vole *Microtus californicus sanpabloensis*	SSC	saltmarshes of San Pablo Creek, on the south shore of San Pablo Bay. constructs burrow in soft soil. feeds on grasses, sedges and herbs. forms a network of runways leading from the burrow																		
San Francisco dusky-footed woodrat *Neotoma fuscipes annectens*	SSC	forest habitats of moderate canopy and moderate to dense understory. may prefer chaparral and redwood habitats. constructs nests of shredded grass, leaves and other material. may be limited by availability of nest-building materials.	●	●	●	●	●	●						●	●	●		●		
riparian (=San Joaquin Valley) woodrat *Neotoma fuscipes riparia*	FE, SSC	riparian areas along the San Joaquin, Stanislaus and Tuolumne Rivers. need areas with mix of brush and trees. need suitable nesting sites in trees, snags or logs.						●								●				
Monterey dusky-footed woodrat *Neotoma macrotis luciana*	SSC	forest habitats of moderate canopy and moderate to dense understory. also in chaparral habitats. nests constructed of grass, leaves, sticks, feathers, etc. population may be limited by availability of nest materials												●		●				
big free-tailed bat *Nyctinomops macrotis*	SSC	low-lying arid areas in southern California. need high cliffs or rocky outcrops for roosting sites. feeds principally on large moths.	●	●	●	●	●	●								●	●			

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Tulare grasshopper mouse *Onychomys torridus tularensis*	SSC	hot, arid valleys and scrub deserts in the southern San Joaquin valley. diet almost exclusively composed of arthropods, therefore needs abundant supply of insects.												●		●				
Salinas pocket mouse *Perognathus inornatus psammophilus*	SSC	annual grassland and desert shrub communities in the Salinas Valley. fine-textured, sandy, friable soils. burrows for cover and nesting.																		
salt-marsh harvest mouse *Reithrodontomys raviventris*	FE, SE	only in the saline emergent wetlands of San Francisco Bay and its tributaries. pickleweed is primary habitat. do not burrow, build loosely organized nests. require higher areas for flood escape.	●	●	●	●	●	●	●	●	●	●			●	●	●	●	●	●
Alameda Island mole *Scapanus latimanus parvus*	SSC	only known from Alameda island. found in a variety of habitats, especially annual and perennial grasslands. prefers moist, friable soils. avoids flooded soils.	●		●			●								●				
Suisun shrew *Sorex ornatus sinuosus*	SSC	tidal marshes of the northern shores of San Pablo and Suisun Bays. require dense low-lying cover and driftweed and other litter above the mean high tide line for nesting and foraging.																	●	
salt-marsh wandering shrew *Sorex vagrans halicoetes*	SSC	salt marshes of the south arm of San Francisco Bay. medium high marsh 6-8 ft above sea level where abundant driftwood is scattered among salicornia.	●	●	●	●	●	●	●	●	●	●			●	●	●	●		●
riparian brush rabbit *Sylvilagus bachmani riparius*	FE, SE	riparian areas on the San Joaquin River in northern Stanislaus County. dense thickets of wild rose, willows, and blackberries.		●		●		●								●				
American badger *Taxidea taxus*	SSC	most abundant in drier open stages of most shrub, forest, and herbaceous habitats, with friable soils. needs sufficient food, friable soils and open, uncultivated ground. preys on burrowing rodents. digs burrows.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
San Joaquin kit fox *Vulpes macrotis mutica*	FE, ST	annual grasslands or grassy open stages with scattered shrubby vegetation. need loose-textured sandy soils for burrowing, and suitable prey base.	●	●	●	●	●	●						●	●	●		●		
Point Reyes jumping mouse *Zapus trinotatus orarius*	SSC	primarily in bunch grass marshes on the uplands of point reyes. also present in coastal scrub, grassland, and meadows. eats mainly grass seeds with some insects and fruit taken. builds grassy nests on ground under vegetation, burrows in winter							●			●						●		

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Table A-3 Special-status Fish Species by Region

Species	Status	Sacramento San Joaquin	North Coast	South Coast
Kern brook lamprey *Lampetra hubbsi*	SSC	+		
Green sturgeon Acipenser medirostris	FT[1]	+	+	
Arroyo chub *Gila orcutti*	SSC			+
Hitch *Lavinia exilicauda*	SSC[2]	+		+*
California roach *Lavinia symmetricus*	SSC	+	+	+*
Sacramento splittail *Pogonichthys macrolepidotus*	SSC	+		
Delta smelt *Hypomesus transpacificus*	SE, FT	+		
Longfin smelt *Spirinchus thaleichthys*	ST	+	+	
Eulachon *Thaleichthys pacificus*	SSC		+	
Coho salmon *Oncorhynchus kisutch*	ST[3], SE[4], FT[3], FE[4]		+	
Chinook salmon *Oncorhynchus tshawytscha*	ST[5], SE[6], FT[7], FE[8]	+	+	
Chum salmon *Oncorhynchus keta*	SSC	+	+	
Rainbow trout/Steelhead Oncorhynchus mykiss	FT[9], FE[10]	+	+	+
Coastal cutthroat trout *Oncorhynchus clarki*	SSC		+	
Sacramento perch *Archoplites interruptus*	SSC	+		
Russian River tule perch *Hysterocarpus traski*	SSC	+	+	
Tidewater goby *Eucyclogobius newberryi*	FE, SSC[11]	+	+	+

FE = Federally listed as Endangered
FT = Federally listed as Threatened
SE = State-listed as Endangered
ST = State-listed as Threatened

[1] Southern DPS
[2] Clear Lake subspecies only
[3] South Oregon/No. CA ESU
[4] Central CA Coast ESU
[5] Sacramento River Spring-run
[6] Winter-run
[7] California Coastal ESU, Central Valley spring-run
[8] Sacramento River winter-run
[9] Northern CA ESU, Central CA Coast ESU, South-Central CA Coast ESU, Central Valley ESU
[10] Southern CA ESU
[11] Populations in Orange Co. and south. Populations north of Orange Co. delisted

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Integrated Mosquito and Vector Management Programs

APPENDIX

B

ECOLOGICAL & HUMAN HEALTH ASSESSMENT REPORT

Ecological & Human Health Assessment Report

Project Name	Integrated Mosquito and Vector Management Programs for Nine Districts
Date	June 2013

Prepared for:

Alameda County Mosquito Abatement District
Alameda County Vector Control Services District
Contra Costa Mosquito and Vector Control District
Marin/Sonoma Mosquito and Vector Control District
Napa County Mosquito Abatement District
Northern Salinas Valley Mosquito Abatement District
San Mateo County Mosquito and Vector Control District
Santa Clara County Vector Control District
Solano County Mosquito Abatement District

Prepared by:

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Table of Contents

Attachments

Tables

Figures

Acronyms

µg/cm^2	microgram per square centimeter
2,4-D	2,4-Dichlorophenoxy acetic acid
AA-ITU	*Ae. aegypti* International Toxic Unit
ACMAD	Alameda County Mosquito Abatement District
ACVCSD	Alameda County Vector Control Services District
ae	acid equivalent
AI or a.i.	active ingredient
ALS	acetolactate synthesis
AMPA	aminomethylphosphonic acid
APEs	alkylphenol ethoxylates
ATP	adenosine triphosphate
BCF	bioconcentration factor
BMP	Best Management Practice
Bs	*Bacillus sphaericus*
Bti	*Bacillus thuringiensis* subspecies *israelensis*
bw	body weight
Cal/EPA	California Environmental Protection Agency
CCMVCD	Contra Costa Mosquito and Vector Control District
CDPH	California Department of Public Health
CDPR	California Department of Pesticide Regulation
CEQA	California Environmental Quality Act
CFU	colony forming units
CNS	central nervous system
DDVP	Dichlorvos
DOD	Department of Defense
EEC	expected environmental concentrations
EPSP	enzyme 5-enolpyruvylshikimate 3-phosphate
IPCS	International Programme on Chemical Safety
IPM	Integrated Pest Management
ITUs	International Toxic Units
LC	lethal concentration

LC_{50}	median lethal dose
LD	lethal dose
LOAEC	lowest observed adverse effect concentration
LOAEL	lowest observed adverse effect level
MSMVCD	Marin/Sonoma Mosquito and Vector Control District
MVCAC	Mosquito and Vector Control Association of California Coastal Region
NCMAD	Napa County Mosquito Abatement District
NOAEC	no observed adverse effect concentration
NOAELs	no observed adverse effect level
NOEC	no observable effect concentration
NSVMAD	Northern Salinas Valley Mosquito Abatement District
PBO	Piperonyl Butoxide
PEIR	Programmatic Environmental Impact Report
PPE	personal protective equipment
ppm	parts per million
Programs	Integrated Mosquito and Vector Management Programs
REDs	reregistration eligibility decisions
RUP	restricted-use pesticide
SCCVCD	Santa Clara County Vector Control District
SCMAD	Solano County Mosquito Abatement District
SMCMVCD	San Mateo County Mosquito and Vector Control District
SWRCB	State Water Resources Control Board
TBEE	triclopyr butoxyethyl ester
TEA	triethylamine
TPA or di-acid	tetrachloroterephthalic acid
ULV	Ultra Low Volume
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UV	ultraviolet

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1 Executive Summary

The nine northern California Districts (members of the Mosquito Vector Control Association of California Coastal Region [MVCAC]) participating in this CEQA Compliance effort engage in mosquito and other vector control activities to protect the public health in their respective Program Areas. These activities are being evaluated for compliance with the California Environmental Quality Act (CEQA) based on current CEQA statutes and Guidelines and recent case law. This draft technical report provides an evaluation of the potential hazards (and estimated risks) of the pesticide application activities used, and in some cases, planned, for vector control. The information provided by the Districts has been synthesized and evaluated to identify any potential environmental concerns due to use of potentially hazardous chemicals. This evaluation was based on a review of the documented characteristics of each chemical, including the efficacy, mode of action, candidate target species, reported toxicity to humans and wildlife, and likely fate and transport under application conditions. The information in this report is intended to be used to support the preparation of a Programmatic Environmental Impact Report (PEIR). The term pesticide as used herein refers to all modes of chemical and biological control, including insecticides, herbicides, and adjuvants unless otherwise indicated.

Each of the nine Districts provided extensive information about their pesticide use in support of this Human and Ecological Health Impact Assessment including:

- Pesticides used by each District
- Types of application sites (e.g., habitat types)
- Number of treatments per application site
- Total amount used per treatment for each application site, based on seasonal uses

This information is summarized in Attachment A. This draft technical report provides results of the review and evaluation of 46 active ingredients used and potentially considered for future use by the Districts. The objective was to identify those that may pose potential human health or ecological concern when used by the Districts. Documented toxicity and environmental fate of the pesticides were reviewed and evaluated, based primarily on the active ingredient, and the results are summarized in Section 4-(Table 4-1).

The pesticide application scenarios that result in reasonable efficacy with minimal unwanted estimated risk are preferred and are the basis of Integrated Pest Management (IPM) approaches practiced by the Districts.

Using the available information about the active ingredients reviewed, there were several overarching parameters that are known to adversely impact risk. Primary factors considered include the inherent toxicity and mode of action of the chemical. Other important factors that are considered include the possible transport and fate of the chemical in various media, the reported likely exposure routes, and documented ecological and human studies supporting the toxicity data. Several important parameters, such as the retention time (half-life) in various media are also considered, but are dependent on specific conditions at the time of application. Based on these criteria, several pesticides received additional discussion during the MVCAC workshop with the Districts on February 20, 2013.

Using the approach discussed above, select active ingredients were identified (Table 1-1) and discussed during the workshop to supplement the information contained in Chapter 4-and relevant to the evaluation of potential risk. Each of these pesticides exhibits at least one parameter that appears to drive potential risk, and the Districts provided additional information on measures employed to minimize potential risk.

The toxicity and adverse effects information collected, reviewed and critiqued for each of the pesticide products evaluated in this document is based primarily on results of laboratory studies that are extrapolated to appropriate potential receptor species In assessing the toxicity information in this document, it should be remembered that most toxicity data are derived from rigidly controlled laboratory animal studies designed to determine the potential adverse effects of the chemical under several possible routes of exposure. In these studies, the species of interest is exposed to 100% chemical at several doses to determine the lowest concentration resulting in a predetermined adverse effect (LOAEL) on numerous physiological and behavioral systems. The second component of these tests is to determine the highest concentration of chemical that results in no measurable adverse effect (NOAEL).

However, these laboratory tests are designed to document the effects of the chemical when there is a continuous, controlled exposure and do not realistically reflect the likely exposures or toxicity in the field application scenarios. In the field, animals can move around, are able to make selections of food and prey and often avoid sprayed areas completely. As such, the toxicity information is intended as guidance for determining the “safe” levels of applications that would not adversely impact non-target species. Because the applications are conducted under rigid Best Management Practices (BMPs), using the minimum effective pesticide application concentrations and do not result in continuous exposures, these laboratory derived estimates of potential risk are not appropriate for the actual exposures and effects in the field.

Table 1-1 Active Ingredients Identified for Discussion

Active Ingredient	Vector	Potential Issue
Methoprene	Mosquitoes	Prevalent use; toxicity to aquatics and insects
Etofenprox	Mosquitoes	Toxicity to aquatic organisms; no synergist required
Bti	Mosquitoes	Prevalent use; public concerns
Pyrethrins	Mosquitoes	Prevalent use; requires synergist (PBO)
Resmethrin	Mosquitoes	Requires synergist (e.g., PBO); potential endocrine disruptor
Vegetable Oil (coconut oil)/mix	Mosquitoes	Contains low percentage of petroleum distillate
Permethrin	Mosquitoes/yellow jacket wasps	Toxicity to aquatic organisms; potential endocrine disruptor
Lambda-cyhalothrin	Yellow jacket wasp	Toxicity to aquatic organisms; potential to bioaccumulate
Bromadiolone	Rats	Toxicity to non-target organisms including mammals, birds, aquatics
Difethialone	Rats	Toxicity to non-target organisms including mammals, birds, aquatics
Alkylphenol ethoxylates	Weeds	Toxicity to aquatic organisms; Moderately bioaccumulative
Glyphosate	Weeds	Prevalent use; possible endocrine disruptor
Diuron	Weeds	Prevalent use; toxicity to freshwater fish
Benfluralin	Weeds	Toxicity to aquatics; potential for bioaccumulation/endocrine disruption

This document provides information in tables and appendices about the parameters used to evaluate 46 active ingredients and a summary of the ecological and human health issues that may indicate a potential concern when used for vector control.

2 Introduction

This report provides a Human and Ecological Health Assessment of pesticides and herbicides contained in the Integrated Mosquito and Vector Management Programs (Programs) for nine mosquito abatement and/or vector control districts in northern California. The nine districts are: Alameda County Mosquito Abatement District (ACMAD), Alameda County Vector Control Services District (ACVCSD), Contra Costa Mosquito and Vector Control District (CCMVCD), Marin/Sonoma Mosquito and Vector Control District (MSMVCD), Napa County Mosquito Abatement District (NCMAD), Northern Salinas Valley Mosquito Abatement District (NSVMAD), San Mateo County Mosquito and Vector Control District (SMCMVCD), Santa Clara County Vector Control District (SCCVCD), and the Solano County Mosquito Abatement District (SCMAD). The Programs provide for mosquito and/or vector control activities within each District's Program Area. The nine District Program Areas include both the Program Areas within the Districts and the surrounding counties where the Districts may provide mosquito and/or other vector management services when requested.

The immediate nine District Program Areas are located in the following nine counties of the state: Alameda, Contra Costa, Marin, Monterey, Napa, San Mateo, Sonoma, Solano, and Santa Clara. Control activities may also be provided in areas adjacent to the District Program Areas upon request of the adjacent jurisdictions to protect the health and safety of residents in adjacent jurisdictions. Actions that would be taken outside of the nine Districts' Program Areas are the same types of actions undertaken within the Districts' Program Areas and in similar types of habitats or sites. Therefore, the nine District Program Areas addressed in this report also include the nine additional surrounding counties: Mendocino, Merced, Lake, Sacramento, San Benito, San Joaquin, Santa Cruz, Stanislaus, Yolo, and the portion of Monterey County south of the NSVMAD.

A health assessment has been conducted to evaluate the potential risks posed by the chemical treatments/pesticide and herbicide formulations to non-target organisms, including humans and sensitive ecological receptors. Pesticides and herbicides are handled separately but in parallel during the evaluation. The first level of investigation is a toxicity/hazards evaluation comprised of a comprehensive literature review for the active ingredients contained in the chemical products and formulations used for vector control. This evaluation was performed to support the Programmatic Environmental Impact Report (PEIR) for each District. Reviewed toxicity literature included peer-reviewed publications, California Department of Pesticide Regulation (CDPR) data and reports, United States Environmental Protection Agency (USEPA) reports, and California Department of Public Health (CDPH) reports. The processes employed for the evaluation and the selection of active ingredients to focus on are described below. Although this document is intended to address the active ingredients most likely to engender some perceived or real concern by the public and regulators, the report includes hazard information about all active ingredients representing products in use or planned by the Districts represented in this report.

In general, application scenarios employed by the Districts represented in this report include several basic, yet critical, Best Management Practices (BMP) to minimize and often negate any potential exposures that might result in unwanted adverse effects to non-target species. Additional integrated pest management (IPM) and BMP practices are utilized by each District.

The results of this assessment are based on assumptions about toxicity and mode of action derived from available information and data, including the published literature. In addition to the documented efficacy (toxicity) to target species and vectors, this assessment also considers the potential risk to sensitive non-target organisms inventoried in a variety of habitat types in the Northern California Coastal Region and presented in the MVCAC Biological Resources Technical Report. Application scenarios and other data were evaluated to estimate the potential for exposures to sensitive non-target ecological receptors. Some of the potential pesticide applications that might result in unacceptable estimated risk have been identified. While the majority of the active ingredients representing products used by the Districts are openly available and do not suggest an unacceptable risk, this review addresses the information and assumptions about possible use patterns and possible exposure issues.

2.1 General Issues Associated with the Current Pesticide Use

The Districts currently employ a combination of methods in their IPM programs for vector control, including the application of a variety of pesticide formulations by several mechanisms. These formulations, registered by the USEPA and California Environmental Protection Agency (Cal/EPA) are methodically applied by the Districts to minimize potential impacts to non-target receptors. However, the potential for impact to humans and ecological receptors from these chemicals was examined in order to provide defensible evidence to support conclusions reached about their safety and proper use scenarios.

Application scenarios employed by the Districts represented in this report include several basic, yet critical, BMPs to minimize and often negate any potential exposures that might result in unwanted adverse effects to non-target species. Pesticide application safety is maximized by the Districts by:

- applications according to strict adherence to label instructions
- restricting applications to low wind conditions to minimize drift
- using Ultra Low Volume (ULV) applications whenever possible
- applications late at night when non-target species (e.g. bees, etc.) are not active
- observation and documentation of nearby water sources and adherence to buffer zones
- use of appropriate protective personal equipment (PPE) by applicators and field crews
- careful reporting and tracking of all pesticide uses by the District
- applications only on an “as needed” or “as appropriate” basis

Additional IPM and BMP practices tailored for each District are also utilized.

The objective of this report is to address and evaluate the potential for human and ecological hazards of application scenarios of the active ingredients contained in a variety of products and formulations used by the Districts in their efforts to control and abate mosquito and other vector infestations. The review of toxicity literature and environmental fate information focused on developing a scientifically defensible summary of the safety of these applications. If some level of concern or perception about unintended effects of the applications results from the evaluation, approaches will be developed to mitigate or prevent real or perceived adverse effects, including BMPs.

2.2 Human and Ecological Health Evaluation

2.2.1 Human Health Impact Evaluation

Pesticides used by the nine Districts were investigated to provide a preliminary toxicity assessment related to potential impacts to humans. Pesticide formulations, label recommendations, and application procedures were also reviewed to evaluate the potential likelihood for bioaccumulation and/or food item biomagnification. For each pesticide and herbicide evaluated, written explanations are provided regarding the physiochemical characteristics of the product, including absorption, metabolism, and elimination; and any other specific reported evidence of reproductive, developmental, or carcinogenic effects.

2.2.2 Ecological Health Impact Evaluation

A general hazard evaluation was conducted for the pesticides and herbicides used by the nine Districts and reported application scenarios (alternatives). The potential impacts to representative invertebrates, wildlife, fish, and aquatic plants were considered, and then evaluated using a hazard evaluation of the active ingredients.

The evaluation included a review and evaluation of the current toxicity literature (available field and lab studies) relevant to ecological receptor impacts, and information relevant to the ultimate environmental fate for these active ingredients. The behavior of these materials in the environment (including fate and transport) are evaluated for chemicals reportedly handled by Districts' staffs. The potential effects could be caused by the active ingredients' mechanism of action (potential toxicity), as well as the potential for bioconcentration, bioaccumulation, or biomagnification.

The hazard and risk evaluations of the pesticides and herbicides used by the nine Districts were conducted in separate, but related phases. In the first phase, the objective was to determine and document the chemical characteristics and potential for adverse impacts when used as intended by the Districts. During the subsequent evaluation for the PEIR, this will be accomplished using a tiered sorting technique in which each chemical (active ingredient) will be ranked according to several criteria: 1) The documented toxicity of the active ingredient as indicated in the open literature; 2) The target species by vector; 3) The non-target species and biota that are likely to be exposed; 4) The likely media to be exposed for each chemical; and 5) Possible sensitive seasonal exposure conditions (Figure 1).

2.3 Initial Approach

The evaluations conducted for each active ingredient provide a general indication of the potential for human or ecological risk and possible adverse effects to non-target organisms.

This approach was used to develop the list of chemicals used by each District that should be of little or no concern when used according to product labels and to identify those (if any) that may be problematic in certain use scenarios. Pesticides are first reviewed for target vector efficacy, based on both documented laboratory and field studies. Pesticide efficacy is of prime importance in the evaluations, but efficacy is contrasted to potential adverse impacts in the determination of the safety of use. To provide an indication of the possible adverse effects of each pesticide, the characteristics of its application scenarios are scored for relative "safety".

> Pesticides proposed for use with low potential exposure to people including sensitive populations (i.e., children, the elderly).

> Pesticides proposed for use with very low or minimal toxicity (hazard) based on the above analyses.

> Pesticides with the least potential for toxicity when used in or near important habitats for sensitive or non-target species.

> Pesticides showing little or no extraordinary seasonal potential impacts.

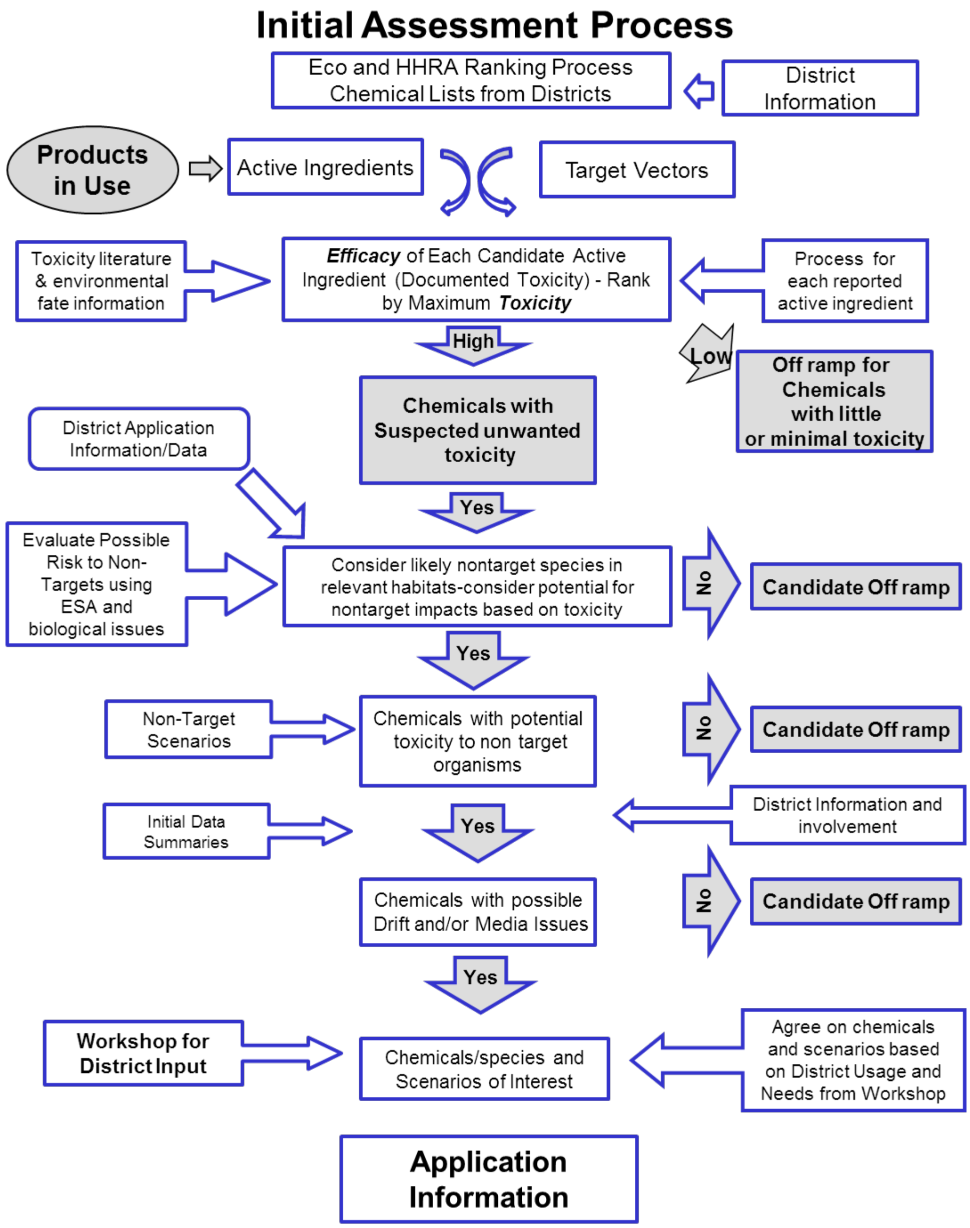

Figure 1 Process to Identify Chemicals for Further Discussion

2.3.1.1 Components of a Review

2.3.1.1.1 Problem Formulation

> Ecological effects characterization

> Identification of the environmental setting and pesticide of interest

> Characterization of pesticide mechanism of action

> Possible transport pathways

> Categories of receptors likely affected

> Identification of application scenarios provided by the Districts

2.3.1.1.2 Exposure Estimates

> Assumptions about potential exposures, including extent, timing and quantity

> Assumptions about potential species that might be exposed

2.3.1.1.3 Basic Risk Estimates

This information was used to:

> Identify likely uncertainties in the exposures

> Develop ranges of potential effects using "what if" parameter estimates.

> Determine estimate of risk needed to collect more information

The results of the evaluation for each of the pesticides of interest were used to qualitatively assess the potential for adverse effects of each active ingredient and select candidates for additional evaluation and characterization. These results are summarized immediately following discussion of environmental fate and toxicity for each pesticide throughout Section 4. Final conclusions and recommendations are included in Section 5.

The pesticide application scenarios that should result in low or "acceptable" results for the estimated risk will remain in the suite of potential control options while those with higher estimated risk estimates are identified. The process is graphically described in the following flow diagram (Figure 2).

At the conclusion of the initial evaluations, and in conjunction with the District managers, the results and possible recommendations for use scenarios based on acceptable risk estimates were the topic of a workshop conducted on February 20, 2013. The objective of the workshop was to discuss, review, and agree to the list of the active ingredients that should be included in the report and information about many of the BMPs used.

Safety evaluations generally follow the USEPA guidance (Figure 2) for pesticide evaluations, with a focus on the relevant uses and exposures identified and agreed upon during the Workshop.

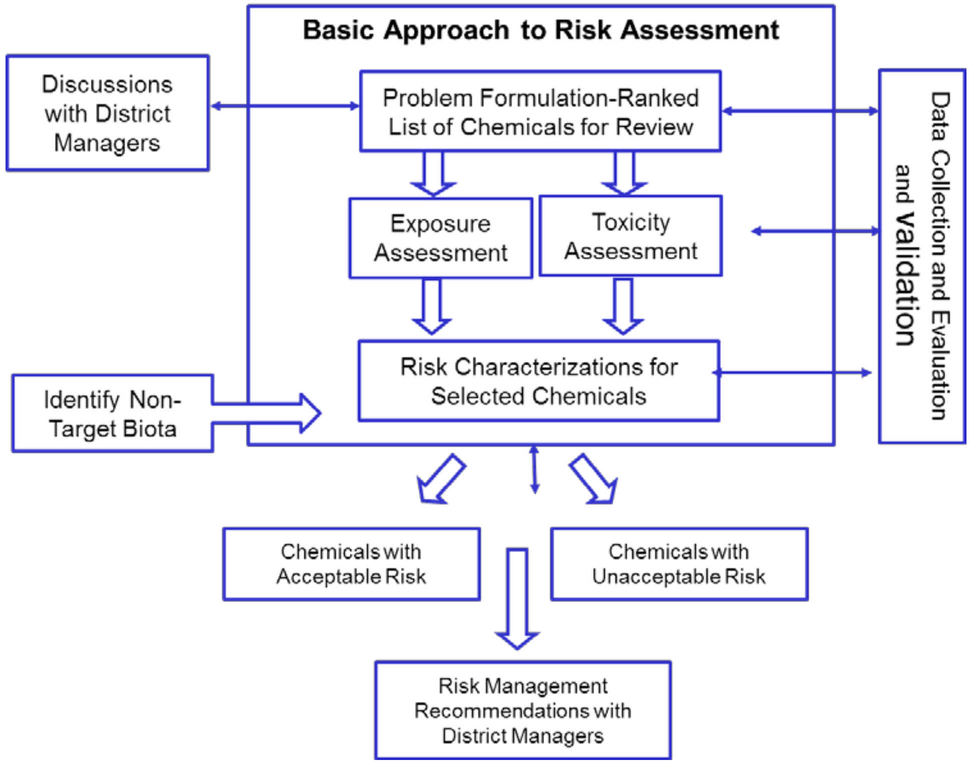

Figure 2 Process Used by USEPA to Evaluate Potential Risk for Chemicals

2.4 Approach to Refinement

The pesticide application scenarios that result in low or acceptable estimated risk as determined in the initial review of hazard information were categorized as lower potential risk, while others with higher potential estimated risk are identified and discussed with a focus on District-specific information about BMPs employed by staff and applicators. The process includes the following:

> Development of the relationships that describe the type of pesticides/herbicides used by the Districts against the target pest(s), the locations of intended uses (water bodies, grasses, forests, urban, residential, etc.), and the likely human and wildlife populations that might be inadvertently exposed.

> Evaluation of the inherent hazard (toxicity) of the pesticide(s)/herbicide(s) to non-target receptors (humans and wildlife).

> As a subsequent task in the PEIR, consider the potential exposure of humans and non-target species to each of the pesticides/herbicides based on the application scenarios, the concentrations used, and the likelihood that the application will reach or contact any populations of concern.

> The information in the PEIR provides estimates of potential "risk" and possible safety issues for each of the typical pesticide application scenarios.

3 Vector Control Chemical Categories

The chemical products reported by the Districts, application scenarios, and potential new products and formulations for future use were obtained during project initiation and preparation of the PEIR Project Description. Application information provided by the Districts included the number of treatments and total amount applied of each product to specific habitat types during four quarters from Summer 2011 through Spring 2012 (see Attachment A). These data were integral for elucidating the estimated loading and potential exposures to different habitats that support non-target organisms. The evaluation focused on the active ingredients of the products/formulations. The target organisms and primary modes of action for the pesticide and herbicide active ingredients are described below. Tables 3-1 and 3-2 present the pesticide (non-herbicide) and herbicide products, respectively that are currently in use containing active ingredients reported here and the number of Districts using that Product.

Table 3-1 Pesticide Products Containing Reported Active Ingredients

Product	Active Ingredient	Vector	Number of Districts
Agnique MMF	Biodegradable Alcohol Ethoxylated Surfactant	Mosquito	6
Agnique MMF G	Biodegradable Alcohol Ethoxylated Surfactant	Mosquito	3
Altosid Briquets 30-Day	Methoprene	Mosquito	6
Altosid Liquid Larvicide SR5	Methoprene	Mosquito	5
Altosid Liquid Larvicide Concentrate (SR20)	Methoprene	Mosquito	5
Altosid Pellets	Methoprene	Mosquito	7
Altosid Pellets WSP	Methoprene	Mosquito	3
Altosid SBG Single Brood Granule	Methoprene	Mosquito	2
Altosid XR-Briquets	Methoprene	Mosquito	7
Altosid XR-G	Methoprene	Mosquito	4
Astro®, Ortho® products, Bonide® products, Tengard® products, etc.	Permethrin	Yellow jacket wasp	1
Bell Terad 3 Blox	Cholecalciferol	Rat	1
BVA-2	Petroleum Distillate	Mosquito	7
Clarke Biomist 4 + 12 ULV	Permethrin and Piperonyl Butoxide (PBO)	Mosquito	1
Contrac 8 oz blk	Bromadiolone	Rat	1
Contrac All-Weather Blox	Bromadiolone	Rat	2
Contrac Super Blox	Bromadiolone	Rat	2
Delta Dust	Deltamethrin	Yellow jacket wasp	2
Ditrac Blox	Diphacinone	Rat	2
Ditrac Tracking Powder	Diphacinone	Rat	1

Table 3-1 Pesticide Products Containing Reported Active Ingredients

Product	Active Ingredient	Vector	Number of Districts
Drione	Pyrethrin and Piperonyl Butoxide and Amorphous Silica Gel	Yellow jacket wasp	5
EcoExempt IC2	Rosemary Oil	Mosquito	1
FirstStrike Soft Bait	Difethialone	Rat	2
FourStar 180 Day Microbial Briquets	*Bacillus sphaericus* and *Bacillus thuringiensis israelensis*	Mosquito	4
FourStar 45 Day Microbial Briquets	*Bacillus sphaericus* and *Bacillus thuringiensis israelensis*	Mosquito	4
FourStar 90 Day Microbial Briquets	*Bacillus sphaericus* and *Bacillus thuringiensis israelensis*	Mosquito	2
FourStar SBG (Single Brood Bti Sand Granule)	*Bacillus thuringiensis israelensis*	Mosquito	1
Golden Bear 1111	Aliphatic Petroleum Hydrocarbons	Mosquito	4
Kontrol 4-4	Permethrin and PBO	Mosquito	1
MetaLarv SP-T	Methoprene	Mosquito	1
MGK Pyrocide 7396	Pyrethrins and PBO	Mosquito	4
Natular 2EC	Spinosad	Mosquito	2
Natular G30	Spinosad	Mosquito	3
Natular XRT	Spinosad	Mosquito	1
Permanone	Permethrin and PBO	Mosquito	1
Pyrenone 25-5	Pyrethrins and PBO	Mosquito	5
Pyrocide Mosquito Adulticiding Concentrate for ULV Fogging 7067	Pyrethrins and PBO	Mosquito	1
Scourge 18% + 12%*	Resmethrin and PBO	Mosquito	1
Skeeter Abate	Temephos	Mosquito	2
Spectracide Pro®	Tetramethrin and Permethrin and PBO	Yellow jacket wasp	1
Spectracide®	Prallethrin and Lambda-cyhalothrin	Yellow jacket wasp	1
Summit B.T.I. Briquettes	*Bacillus thuringiensis israelensis*	Mosquito	1
Teknar HP-D	*Bacillus thuringiensis israelensis*	Mosquito	2
Teknar SC	*Bacillus thuringiensis israelensis*	Mosquito	1
VectoBac 12AS	*Bacillus thuringiensis israelensis*	Mosquito	5
VectoBac G	*Bacillus thuringiensis israelensis*	Mosquito	5
VectoBac GS Biological Larvicide	*Bacillus thuringiensis israelensis*	Mosquito	1
VectoBac Technical Powder Biological Larvicide	*Bacillus thuringiensis israelensis*	Mosquito	1
VectoBac WDG Biological Larvicide	*Bacillus thuringiensis israelensis*	Mosquito	1

Table 3-1 Pesticide Products Containing Reported Active Ingredients

Product	Active Ingredient	Vector	Number of Districts
VectoLex CG	*Bacillus sphaericus*	Mosquito	7
VectoLex WDG	*Bacillus sphaericus*	Mosquito	4
VectoLex WSP	*Bacillus sphaericus*	Mosquito	5
VectoMax CG	*Bacillus sphaericus* and *Bacillus thuringiensis israelensis*	Mosquito	3
VectoMax WSP	*Bacillus sphaericus* and *Bacillus thuringiensis israelensis*	Mosquito	2
Wasp-Freeze	Phenothrin and Trans Allethrin	Yellow jacket wasp	3
Zenivex E4	Etofenprox	Mosquito	4
Zenivex E20	Etofenprox	Mosquito	5

Table 3-2 Herbicide Products Containing Reported Active Ingredients

Product	Active Ingredient	Vector	Number of Districts
Alligare Dithiopyr 40	dithiopyr	Weed	1
Alligare Glyphosate 4-Plus	glyphosate	Weed	1
Alligare Glyphossate 5.4	glyphosate	Weed	1
Alligare Imazapyr 2 SL	imazapyr	Weed	1
Alligare Oryzalin 4	oryzalin	Weed	1
Alligare Triclopyr 3	triclopyr	Weed	1
AMVAC Dacthal	DCPA	Weed	1
Aquamaster	Glyphosate	Weed	3
Balan	Benefin	Weed	1
Blazon Pattern Indicator	Polymeric Colorant (proprietary)	Weed	2
Buccaneer	Glyphosate	Weed	1
BullsEye Pattern Indicator	Proprietary Colorant	Weed	2
Competitor	Modified Vegetable Oil	Weed	2
Dacthal	DCPA	Weed	1
Dimension Ultra 40WP	dithiopyr	Weed	1
Ecomazapyr 2 SL	imazapyr	Weed	1
Garlon-3A	Triclopyr	Weed	1
Green Light Amaze XL 2G	Benefit, Oryzalin	Weed	2
Habitat	Imazapyr	Weed	2
Imazapyr 4-SL	imazapyr	Weed	1

Table 3-2 Herbicide Products Containing Reported Active Ingredients

Product	Active Ingredient	Vector	Number of Districts
Karmex XP	Diuron	Weed	1
Liberate	Lecithin, methyl esters of fatty acids, alcohol ethoxylate	Weed	1
Monterey Nutgrass "Nihilator"	Bentazon (sodium salt)	Weed	1
Monterey Turflon Ester, * Turflon, * Garlon 3®, * Renovate®	Triclopyr	Weed	1
Monterey Weed Whacker	2,4-DP (dimethylamine salt)	Weed	1
MOR-ACT	Paraffin base petroleum oil	Weed	1
MSO	Methylated seed oil of Soybean	Weed	1
No Foam A	Alkyl Phenol Ethoxylate / Isopropanol	Weed	1
No Foam Defoamer	Polydimethylsiloxane & Silicon	Weed	1
Oust XP	Sulfometuron Methyl	Weed	2
Pennant Magnum	Metolachlor	Weed	1
Polaris	Imazapyr	Weed	2
Pro-Spreader Activator	Alkyl Phenol Ethoxylate / Isopropanol	Weed	2
R-11 Spreader Activator	Alkyl Phenol Ethoxylate / Butyl alcohol	Weed	1
Renovate 3	triclopyr	Weed	1
Reward	Diquat dibromide	Weed	1
Roundup Pro Max®	Glyphosate	Weed	2
Roundup Pro®	Glyphosate	Weed	3
Roundup®	Glyphosate	Weed	1
Rodeo®	Glyphosate	Weed	1
RoundupMax	Glyphosate	Weed	1
Scotts Halts Crabgrass Preventer	Pendimethalin	Weed	1
Trimec Lawn Weed Killer, * Spectricide® Weed Stop®, * Ortho® Weed-b-Gon®, * Weed Killer for Lawns, * Bayer Advanced™ Southern Weed Killer	2,4-D (2,4-dichlorophenoxy acetic acid)	Weed	1
Tripleline Foam-Away	Polydimethylsiloxane	Weed	1
Turf Trax Blue	Polymeric Colorant (proprietary)	Weed	1
Turfgro NIS	Ethanol 2,2-oxybis	Weed	1
Vigoro Crabgrass Preventer, * Monsanto Dimension®	Dithiopyr	Weed	1

3.1 Mosquito Control

3.1.1 Adulticides

Adulticides are generally applied as aerosols using ultra-low-volume (ULV) techniques. Aerial and ground application techniques are used to distribute the insecticides. Adulticide treatments are most frequently timed to correspond with mosquito activity (flying) when exposure is greatest to the insecticide aerosol mist (dusk to dawn) and granular material. In addition, residual barrier treatment applications are used in mosquito resting areas and migratory stops. These treatments are usually applied as large liquid droplets with a sprayer during daylight hours. The primary objective of this type of treatment is the temporary prevention of re-infestation.

3.1.1.1 Pyrethroids

Pyrethroids are synthetic analogs of pyrethrins (from the Chrysanthemum plant) and have similar neurological effects on target organisms. These compounds cause rapid mortality of adult mosquitoes by interfering with sodium channel function in the nervous system.

3.1.2 Larvicides

Larvicides are used to manage immature life stages of mosquitoes including larvae and pupae in aquatic habitats. Temporary aquatic habitats are usually targeted because permanent water bodies generally support natural mosquito predators such as fish. The larvicides are applied using ground application equipment, fixed wing aircraft and rotary aircraft.

3.1.2.1 Contact Pesticides

(S)-Methoprene is a hormone analogue that interferes with insect larval development (growth regulator). This chemical does not exhibit the nonspecific target effects of neurological toxins such as pyrethrin.

Spinosad is a natural insecticide derived from the fermentation of a common soil microorganism, *Saccharopolyspora spinosa*. Spinosad alters nicotine acetylcholine receptors in insects causing constant involuntary nervous system impacts ultimately leading to paralysis and death.

3.1.2.2 Surface Active Agents

Petroleum- and plant-based (ethoxylated isotearyl alcohols) oils are used as surface-active agents effective against larvae and pupae. These oils are effective against these immature life stages when inhaled at the water surface or by physically forming a surface film that drowns the mosquito. These treatments may also be effective against adult mosquitoes during adult emergence.

3.1.2.3 Stomach Toxins

Bacterial larvicides such as Bti (*Bacillus thuringiensis israelensis*) and Bs (*Bacillus sphaericus*) are highly selective (for mosquitoes) microbial pesticides that when ingested, produce gut toxins that cause destruction of the insect gut wall leading to paralysis and death. These microbial agents are delivered as endospores in granular, powder, or liquid concentrate formulations.

3.2 Other Vector Control

There are a variety of pesticides used for the control of vectors including rats, ticks, yellow jackets wasps, and weeds.

3.2.1 Rats

Toxic baits may be used to achieve adequate control of rats when populations become too large to impact using traps. Federal EPA changes to rodenticide regulations occurred in 2011 (http://www.epa.gov/pesticides/mice-and-rats/) in an effort to reduce the hazard to wildlife, pets and children. The use of baits is confounded by the potential for food web transfer of the bait to other trophic level receptors that might also encounter and eat the raw bait or predate an animal that has ingested the bait.

3.2.1.1 Anticoagulant Rodenticides

Anticoagulant rodenticides cause fatal internal bleeding by thinning the animal's blood and preventing clotting. Two groups of anticoagulants exist including the older "first-generation" compounds effective if consumed over multiple doses and the newer "second-generation" compounds, which are fatal after a single dose. The acute toxicity of second-generation rodenticides presents a greater hazard to wildlife, pets, and children. Products containing second-generation active ingredients are no longer permitted to be sold to the general public. These products remain available to professional pest control personnel, however.

3.2.1.2 Other Rodenticides

Three other rodenticides are available for use in California. Bromethalin and cholecalciferol are chronic rodenticides and achieve successful results similar to those of anticoagulants. Multiple feeding doses are required to induce mortality of rodents. Bromethalin is a neurotoxin, which damages the central nervous system (CNS). Cholecalciferol produces hypercalcemia leading to renal failure and CNS depression, among other generalized symptoms of toxicity. Zinc phosphide is an acute toxicant and causes death within a few hours of consumption. Often, use of this compound requires "pre-baiting" prior to addition of the chemical to rat bait in order to achieve adequate bait acceptance. Zinc phosphide is used to lessen impact on predators in the food web.

3.2.2 Yellow Jacket Wasps

Aerosol insecticides can be effective when applied directly to yellow jacket wasp nest openings. Most conventional pesticides are either pyrethrin or pyrethroids. Synthetic pyrethroid insecticides act as sodium channel modulators and very effective when used against wasps. Pyrethrin compounds act as paralytics and will immobilize the insect temporarily and may cause mortality.

Short-residual pyrethroids include allethrin, phenothrin, resmethrin, sumithrin, and tetramethrin. Longer-lasting pyrethroid insecticides include lambda-cyhalothrin, deltamethrin, and permethrin.

3.2.3 Tick Control

Although tick surveillance is the recommended method to monitor this vector, there are several pesticides that can be useful if an unwanted tick infestation should occur. Ticks (e.g., deer ticks) act as vectors for bacterial pathogens, such as *Borrelia burgdorferi*, the agent of Lyme disease. Currently, deltamethrin is the only active ingredient employed for tick control.

3.2.4 Weed Control

Herbicides are classified in several ways. Pre-emergent herbicides are applied to the soil to prevent seedlings from germinating and emerging. Post-emergent herbicides are applied after seedlings have emerged and control actively growing plants via contact damage or systemic impacts. Contact herbicides cause physical injury to the plant upon contact. Systemic herbicides damage the internal functioning of the plant.

3.2.4.1 Herbicides for Broadleaves

Herbicides for use against annual broadleaf weeds are generally post-emergent applications that affect the plant systemically. 2,4-Dichlorophenoxy acetic acid (2,4-D), imazapyr, triclopyr, sulfometuron methyl, bentazon, diuron, oryzalin, DCPA, dithiopyr, and pendimethalin are examples of broadleaf herbicides.

3.2.4.2 Herbicides for Grass Weeds

Herbicides used against annual grasses (e.g. crabgrass, foxtail, etc.) are pre-emergent applications containing ingredients such as pendimethalin. Weed grasses can be treated with post-emergent applications; however, these tend to be less effective than pre-emergent treatments. Some can be eliminated with spot treatments of potent, nonselective herbicides such as glyphosate, which act systemically by inhibiting the synthesis of the aromatic amino acids phenylalanine, tyrosine, and tryptophan.

3.2.4.3 Herbicides for Sedges

Spot treatments with glyphosate are also useful in eliminating sedges (e.g. yellow and purple nutsedge, green kyllinga, etc.). Pre-emergent materials such as DCPA are effective at killing seeds of green kyllinga, but ineffective against nutsedges.

3.2.4.4 Aquatic Invasive Species

Imazapyr is an imidazolinone herbicide (e.g., Habitat®) that inhibits acetolactate synthesis (ALS), an enzyme necessary for the production of essential amino acids in plants. This class of chemicals includes systemic, nonselective, pre- and post-emergent herbicides used for the control of terrestrial and aquatic weeds (e.g., imidazolinoes, pyrimidinyl thiobenzoates, sulfonylureas, sulfonyl amino carbonyl triazolinone, and triazolopyrimidines). In California, these compounds have been used to combat the invasive purple loosestrife plant in aquatic environments. Unfortunately, this species and others appear to have developed resistance to the ALS-inhibiting family of chemicals. In addition, the non-target impacts of these compounds may cause negative effects to threatened or endangered plants.

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4 Evaluation of Active Ingredients-Results

This section presents the supporting information and results of the evaluation that will be incorporated into the MVCAC EIR. Information below includes a description of the chemical compound, general pesticide use/application techniques, mode of action, toxicity, environmental fate and transport, and potential impact assessment.

Several insecticides were previously evaluated in the Monitoring Plan for Mosquito Larvicides and Adulticides (2011) prepared by MVCAC. Descriptions of these compounds, pesticide use patterns, and environmental fate and transport were updated in this document as needed. Source information for the fate and transport data include USEPA reregistration eligibility decisions (REDs), USEPA risk evaluations, DPR fate reviews, fate reviews from the scientific community, and data provided by manufacturers. Toxicity information was included for select compounds, including details relevant to ULV applied mosquito adulticides. Table 4-1 provides a summary of the toxicity and fate and transport information associated with the active ingredients. In addition, toxicity values for a variety of receptors (human and ecological) are presented later in Chapter 6 in Table 6-1.

The toxicity data included in the numerous tables and charts in this document are generally derived from rigidly controlled laboratory animal studies designed to determine the potential adverse effects of the chemical under several possible routes of exposure. In these studies, the species of interest is exposed to 100 percent chemical at several doses to determine useful information such as the lowest concentration resulting in a predetermined adverse effect (LOAEL) on numerous selected physiological and behavioral systems. The second component of these tests is to determine the highest concentration of chemical that results in no measurable adverse effect (NOAEL).

However, these, and other, coordinated and focused laboratory tests are designed to document the effects of the chemical when a continuous, controlled, exposure exists and do not realistically reflect the likely exposures or toxicity in the District field application scenarios. As such, the toxicity information is intended as an overview of potential issues and guidance for understanding the completely “safe” maximum exposure levels of applications that would not adversely impact humans or nontarget plant and animal species.

Although the regulatory community uses this basic information to provide a relative comparison of the potential for a chemical to result in unwanted adverse effects and this information is reflected in the approved usage labels and MSDSs, in actual practice, the amounts actually applied in the District’s Program Area are substantially less than the amounts used in the laboratory toxicity studies. Because of the large safety factors used to develop recommended product label application rates, the amount of chemical resulting in demonstrated toxicity in the laboratory is much higher than the low exposure levels associated with an actual application. The application concentrations consistent with the labels or MSDSs are designed to be protective of the health of humans and other nontarget species (i.e., low enough to not kill them, weaken them, or cause them to fail to reproduce). However adverse effects may still occur to some non-target organisms.

Chapter 4-provides the results of our review, evaluation, and synthesis of data for each of the selected pesticides in use by the nine Districts. The analysis provides informative results for the Districts that are interested in an evaluation of the potential efficacy and effects of their respective pesticide treatment scenarios. In each case, the evaluations include consideration of four primary parameters:

> Efficacy to target vectors;

> Documented acute and chronic ecological and human toxicity (where available);

> Known media/habitat use scenarios for each pesticide and for each District; and

> Evaluation of potential non-target biota that might be adversely impacted and the associated exposure level.

Using these parameters, the process results in a functional evaluation of the likelihood that each pesticide application scenario (scenarios) could be used safely or otherwise. At the conclusion of each evaluation process, those scenarios that appear to result in potential unwanted (adverse) impacts were subjected to additional evaluation based on generally accepted "risk evaluation" guidelines.

4.1 Pyrethrin, Pyrethroids, Pyrethroid-like Compounds and Synergists

Pyrethroid insecticides are synthetic compounds that are chemically similar to the pyrethrins but have been modified to increase stability and activity against insects. Some synthetic insecticides are similar to pyrethroids, such as etofenprox, but have a slightly different chemical composition. First generation or "Type I" photosensitive pyrethroids include d-allethrin, phenothrin (sumithrin), prallethrin, resmethrin, and tetramethrin. Typically, these pyrethroids are used indoors and around residential areas. The newer second-generation pyrethroids are mostly "Type II" pyrethroids. Chemically, Type II pyrethroids are distinguished from Type I pyrethroids by the presence of an α-cyano group in their structure. The active ingredients that fall into this group include deltamethrin, esfenvalerate, lambda-cyhalothrin, and permethrin. Type II pyrethroids are more toxic (than Type I pyrethroids) because they are less photosensitive and persist longer in the environment.

Pyrethroids affect insect neuroactivity by binding to a protein at the nerve fiber that regulates the voltage-gated sodium channel. This can delay the closing of sodium channels and/or cause a persistent activation of the sodium channels. This often results in repetitive activity (Type I pyrethroid) or blockage of nerve conduction (Type II pyrethroid).

4.1.1 <u>Pyrethrins</u>

Pyrethrins are naturally occurring products distilled from the flowers of Chrysanthemum species. Pyrethrins are composed of a mixture of six compounds: pyrethrin I and II, cinerin I and II, and jasmolin I and II. Pyrethrins are contact poisons that can quickly penetrate the neural system. Pyrethrins act by causing a persistent activation of the sodium channels on insect neurons. Although pyrethrins have an effective "knockdown" action (induction of temporary paralysis), they do not necessarily have high killing properties alone. In order to delay the metabolic action (inhibition of microsomal enzymes) so that a lethal dose is assured, the synergist piperonyl butoxide (PBO) is added to mosquito adulticides (USEPA 2006f).

Pyrethrins were first registered in the U.S. for use as an insecticide in the 1950s. Pyrethrins are used on many agricultural crops; on livestock and animal husbandry premises; for treatment of commercial and industrial facilities and storage areas where raw and processed food/feed commodities are stored or processed; and for wide-area mosquito abatement in areas that include aquatic habitats. They are also used on outdoor household areas, pastureland, aquatic area or standing water, and for hospitals, recreational areas, ULV applications, and mosquito abatement programs (USEPA 2006f, CDPR 2010a).

4.1.1.1 Environmental Fate

The major routes of dissipation for pyrethrins in the environment are photolysis (both in water and soil, with half lives of less than 1 day in both cases) and to a lesser degree, aerobic soil metabolism (Table 4-2). Hydrolysis under alkaline conditions is an important route of dissipation for pyrethrins in water (half-life at pH 9 is 14-to 17 hours); however, this reaction appears to be relatively slow under neutral or acidic conditions, which are more likely to occur in the environment. Pyrethrins are likely to persist under anaerobic conditions. Pyrethrins quickly adsorb to suspended solids in the water column, and partition into the sediment. They adsorb strongly to soil surfaces and are generally considered immobile in soils; therefore, the potential to leach into groundwater is considered low (USEPA 2006f).

Table 4-1 Summary Characteristics of Active Ingredients

Active Ingredient: Chemical or Biological	Fate & Transport			Mode of Action	Human Health[1]	Ecological Health[1]
	Air	Water	Soil			
Pyrethrins	> na	> Major route of dissipation is photolysis. > Quickly adsorb to suspended solids in the water column and partition to the sediment.	> Major route of dissipation is photolysis. > Pyrethrins are likely to persist under anaerobic conditions. > Generally immobile in soils, therefore the potential to leach to groundwater is low.	> Insecticide: > Naturally occurring products distilled from Chrysanthemum spp. flowers. > Contact poisons that act by causing persistent activation of the sodium channels on insect neurons resulting in "knock-down" agent. > The synergist PBO is added to ensure a lethal dose.	> Low to moderate acute toxicity via the oral, dermal, and inhalation routes. > Chronic exposure effects include neurobehavioral, thyroid, and liver effects.	> Very highly toxic to freshwater fish and invertebrates. > Practically nontoxic to birds.
Allethrins and d-trans allethrin	> When used in coils and mats, allethrins are released into the air where they will be degraded by sunlight or be distributed in low concentrations to nearby surfaces.	> Not water soluble. > Photolysis half-life is <8 hrs.	> Adheres moderately to soil containing organic matter.	> Insecticide: Synthetic pyrethroid structurally similar to cinerin I in naturally occurring pyrethrum. > d-trans stereoisomer is the most insecticidally active. > Typically used as a "knock-down" agent. > Synergists such as PBO are added to ensure a lethal dose.	> Slightly to moderately acute toxicity via oral, dermal, and inhalation routes. > Toxicity varies with the amounts of different isomers present. > Not known to cause reproductive, teratogenic, mutagenic, or carcinogenic effects to mammals.	> Highly toxic to fish and invertebrates. > Very toxic to non-target insects. > Practically nontoxic to birds. > Bioaccumulation potential is unknown.
Phenothrin (sumithrin or d-phenothrin)	> na	> Low water solubility. > Major routes of dissipation are photolysis and anaerobic metabolism.	> High affinity for binding to soils and moderate persistence in surface soils. > Low leaching potential, therefore phenothrin is relatively immobile in soils or sediments. > Moderately persistent under aerobic conditions and persistent under anaerobic conditions.	> Insecticide: Adult mosquitoes.	> Low acute toxicity by oral, dermal, and inhalation routes. > Mild eye irritant but not a skin irritant.	> Highly toxic to fish and freshwater invertebrates. > Practically nontoxic to birds.
Prallethrin	> na	> Major route of dissipation is photolysis.	> Major route of dissipation is photolysis. > Readily sorbs to soils and sediments.	> Insecticide: Synthetic pyrethroid with fast "knock-down" activity against insect pests. > Has a neural exciting effect on mosquitoes. > In California, prallethrin is combined with phenothrin in the product Duet (the only prallethrin adulticide used in California).	> Low to moderate acute toxicity via oral, dermal, or inhalation routes. > Mild eye irritant but not a skin irritant.	> Highly toxic to fish and freshwater invertebrates. > Practically nontoxic to birds. > Very toxic to honey bees. > Low toxicity to algae.
Deltamethrin	> na	> Degrades via hydrolysis, photolysis, and microbial action. > May persist in aquatic environments, particularly in the sediment.	> Most persistent in soils with high clay or organic matter content. > Moderately to highly persistent in terrestrial environments.	> Insecticide: Synthetic pyrethroid. > Induce long-lasting inhibition of the sodium ion channel activation gate, resulting in repetitive nerve signals in sensory organs, nerves, and muscles.	> Low to moderate acute toxicity via oral, dermal, or inhalation routes. > Chronic exposure of humans results in choreoathetosis, hypotension, prenatal damage, and shock. > No reported teratogenic, mutagenic, or carcinogenic effects.	> Very highly toxic to fish and invertebrates. Potential bioaccumulation in fish. > Practically nontoxic to birds. > Nonselective insecticide and is highly toxic to non-target insects, including honey bees.

Table 4-1 Summary Characteristics of Active Ingredients

Active Ingredient: Chemical or Biological	Fate & Transport			Mode of Action	Human Health[1]	Ecological Health[1]
	Air	Water	Soil			
Esfenvalerate	> na	> Practically insoluble in water. > Extremely hydrophobic. > When present in surface water, expected to be bind to suspended particulates and organic matter. > Degrades via photolysis and aerobic metabolism.	> Strong tendency to bind to soil. > Relatively immobile in soil and has low tendency to leach. > Degrades via photolysis and aerobic metabolism.	> Insecticide: > Broad spectrum, nonselective, voltage-dependent sodium-channel agonist. > Causes repetitive firing of neurons.	> Moderately toxic via acute routes. > Possible endocrine-disruptor.	> Highly toxic to fish and aquatic invertebrates. Bioaccumulates rapidly in fish. > Moderately toxic to birds. > Highly toxic to honey bees.
Lambda-cyhalothrin*	> na	> Extremely hydrophobic and rapidly adsorbs to soils and sediments. > Primary degradation pathways include photolysis and aerobic metabolism.	> Primary degradation pathways include photolysis and aerobic metabolism.	> Insecticide: Synthetic pyrethroid. > Induces long-lasting inhibition of the sodium ion channel activation gate, resulting in repetitive nerve signals in sensory organs, nerves, and muscles.	> Moderately toxic via acute oral, dermal, and inhalation routes. > Mild eye irritant but not a skin irritant.	> Highly toxic to fish. Potential to bioaccumulate in fish. > Low toxicity to birds. > Highly toxic to honey bees.
Resmethrin	> na	> Primary degradation pathways include photolysis and aerobic metabolism.	> Primary degradation pathways include photolysis and aerobic metabolism. > Low mobility in soil/sediments. > Environmentally persistent in absence of light.	> Insecticide: Synthetic pyrethroid. > Induces long-lasting inhibition of the sodium ion channel activation gate, resulting in repetitive nerve signals in sensory organs, nerves, and muscles.	> Low toxicity via acute oral, dermal, and inhalation routes. > Possible endocrine-disruptor.	> Highly toxic to fish and aquatic invertebrates.
Tetramethrin	> na	> Not persistent in the environment. > Decomposes rapidly by photolysis and hydrolysis in shallow, nonturbid water.	> Slightly mobile in soil.	> Insecticide: Synthetic pyrethroid. > Induces long-lasting inhibition of the sodium ion channel activation gate, resulting in repetitive nerve signals in sensory organs, nerves, and muscles.	> Slightly toxic via acute oral and dermal routes. > Possible human carcinogen.	> Highly toxic to fish and aquatic invertebrates. > Practically nontoxic to birds. > Highly toxic to honey bees.
Permethrin*	> na	> Hydrophobic with low water solubility. > Primary degradation pathways include photolysis and aerobic metabolism.	> Tends to partition to soil and sediment.	> Insecticide > Synthetic pyrethroid. > Induces long-lasting inhibition of the sodium ion channel activation gate, resulting in repetitive nerve signals in sensory organs, nerves, and muscles.	> Slightly toxic via acute oral and dermal routes. > Acute ingestion exposure causes nausea, vomiting, headache, dizziness, anorexia, and hypersalivation. > Possible endocrine-disruptor.	> Highly toxic to fish and aquatic invertebrates. > Practically nontoxic to birds.* > Highly toxic to honey bees. > Dermal exposure can cause life-threatening effects to cats.
Etofenprox	> na	> Virtually insoluble in water. > Stable to hydrolysis. > Susceptible to photolysis.	> Not likely to persist.	> Insecticide: Pyrethroid-like chemical. > Acts on ion channels of the insect nervous system.	> Low toxicity via acute oral, dermal, and inhalation routes.	> Highly toxic to fish and aquatic invertebrates.

Table 4-1 Summary Characteristics of Active Ingredients

Active Ingredient: Chemical or Biological	Fate & Transport			Mode of Action	Human Health[1]	Ecological Health[1]
	Air	Water	Soil			
Piperonyl butoxide (PBO)	> na	> Degrades by photolysis. > Moderately mobile in soil-water systems.	> Degrades rapidly in the environment by photolysis and metabolism by soil microbes. > Moderately mobile in soil-water systems.	> Synergist: added to insecticides. > Enhances the pesticidal properties of other active ingredients, such as pyrethrins and synthetic pyrethroids, by directly binding to microsomal enzymes in the target organism, thereby inhibiting the breakdown of the other pesticides.	> Low toxicity via acute oral, dermal, and inhalation routes. > Possible endocrine-disruptor.	> Moderately toxic to most fish, highly toxic to some fish. > Highly toxic to aquatic invertebrates.
Naled	> Readily degraded in air. > Can volatilize.	> Readily degraded in water. > Degrades by photolysis. > Low water solubility.	> Readily degraded in soil under aerobic and anaerobic conditions. > Most mobile in soil of low organic content such as sandy loam.	> Insecticide: Organophosphate for control of adult mosquitoes.	> Moderately toxic via acute oral, dermal, and inhalation routes. > Rapidly absorbed by oral and inhalation exposure and distributes quickly to all tissues.	> Moderately toxic to fish and aquatic invertebrates. > Lethal effects found for birds and honey bees.
Temephos	> na	> Breaks down via photolysis and microbial degradation. > Extremely hydrophobic with low solubility.	> Adsorbs rapidly to organic material in water and binds strongly to soils.	> Insecticide: Cholinesterase inhibitor for control of mosquito larvae.	> Moderately toxic via acute oral, dermal, and inhalation routes.	> Slightly to moderately toxic to fish. > Highly toxic to aquatic invertebrates. > Toxic to stoneflies and mayflies.
Bacillus sphaericus (Bs)	> na	> Dormant spores persist for several weeks or months. > The δ-endotoxins generally persist for 2 to 4-weeks but are degraded by sunlight and soil microbes.	> Does not percolate through the soil and readily binds to sediments when in water column.	> Mosquito larvicide. > Bacterium contains microscopic protein pro-toxins which paralyzes the gut of larvae when consumed, resulting in starvation.	> Not pathogenic and does not demonstrate any systemic toxicity.	> Not acutely toxic to birds, mammals, fish or invertebrates. > Mosquito predators not affected by secondary exposure.
Bacillus thuringiensis israelensis (Bti)		> Degrade rapidly after exposure to UV light. > The δ-endotoxins are degraded by sunlight and soil microbes.	> Spores may persist in soil for several months.	> Mosquito larvicide. > Bacterium containing microscopic protein pro-toxins that paralyzes the gut.	> Not pathogenic and does not demonstrate any systemic toxicity.	> Not acutely toxic to birds, mammals, fish or invertebrates.
Spinosad	> Persists for a few hours in air.	> Persists for a few hours in water. > Binds readily to organic matter in water.	> Binds readily to organic matter in soil. Readily photo degrades. > Unlikely to leach to groundwater. > Quickly metabolized by soil microbes under aerobic conditions.	> Insecticide: Biologically derived from fermentation of a naturally occurring soil microbe. > Activates the CNS of insects through interaction with neuro-receptors causing continuous stimulation of the nervous system.	> Acute toxicity is low by all routes of exposure. > Not carcinogenic.	> Acute toxicity is low for fish, aquatic invertebrates, amphibians, and birds. > Very highly toxic to moths and butterflies.
Methoprene and s-Methoprene	> na	> Rapidly degrades in aqueous solution. > Degrades via photolysis and microbial metabolism.	> Relatively immobile in soil. > Metabolized in soil under aerobic and anaerobic conditions via photolysis and microbial metabolism.	> Insecticide: Long chain hydrocarbon ester. > Interferes with normal maturation process during insect life cycles, preventing reproduction.	> Very low toxicity via all acute routes.	> Moderately toxic to fish. > Very highly toxic to aquatic invertebrates. > Practically nontoxic to birds and amphibians.
Alcohol Ethoxylated Surfactant (monomolecular film)	> na	> Half-life in water is from 5 to 22 days.	> na	> Larvicide > Spread a thin film on the surface of the water that makes it difficult for larval pests to attach to the water surface, causing them to drown.	> na	> No observable effects to amphibians, fish, or non-target aquatic organisms (e.g., shrimp, snails, worms, mayfly naiad). > Surface-breathing insects may be temporarily impacted.

Table 4-1 Summary Characteristics of Active Ingredients

Active Ingredient: Chemical or Biological	Fate & Transport			Mode of Action	Human Health[1]	Ecological Health[1]
	Air	Water	Soil			
Aliphatic solvents (mineral oils, aliphatic hydrocarbons, petroleum distillates)	> Very low vapor pressure. > Low potential for volatility.	> Very low solubility. > Breakdown in 2 to 3 days.	> High sorption to organic matter.	> Larvicide > Creates a top-coating on water to drown larvae, pupae, and emerging adult mosquitoes.	> No deaths due to any acute doses.	> Practically nontoxic to fish, birds, and honey bees. > Rapid breakdown minimizes impact to non-target organisms.
Potassium Salts (soap salts)	> na	> na	> Degrade quickly by microbes and do not persist.	> Insecticide: > Fatty acids penetrate insect body coverings, disrupting cell membranes and causing dehydration and death.	> Low oral and dermal toxicity, but may cause stomach upset. > May be irritating to the skin and eyes.	> Slightly toxic to fish. > Highly toxic to aquatic invertebrates. > Practically nontoxic to birds.
Chlorophacinone	> Volatizes slowly.	> Low water solubility. > Degrades slowly by acid hydrolysis.	> Degrades slowly by photo degradation. > Moderately persistent and immobile. > Major route of dissipation is aerobic metabolism.	> Rodenticide: > First-generation anticoagulant. Acts by blocking vitamin the K cycle, resulting in the inability to produce blood-clotting factors. Damages capillaries, causing diffuse internal hemorrhaging. Death occurs from hypovolemic shock or severe anemia.	> Highly toxic by all acute exposure routes.	> Toxic to wildlife and fish. > Toxic via primary and secondary ingestion routes.
Diphacinone	> na	> Low water solubility. > Stable to photolysis.	> Volatizes slowly from water to soil. > Susceptible to aerobic soil metabolism. > Binds tightly to soil.	> Rodenticide: > First-generation anticoagulant. Acts by blocking vitamin the K cycle, resulting in the inability to produce blood-clotting factors. Damages capillaries, causing diffuse internal hemorrhaging. Death occurs from hypovolemic shock or severe anemia.	> Highly toxic by all acute exposure routes.	> Slightly to moderately toxic to fish and aquatic invertebrates. Does not accumulate in fish > Slightly toxic to birds. > Possible secondary risk to avian predators and scavengers.
Brodifacoum	> Nonvolatile.	> Low water solubility. > Stable to hydrolysis.	> Relatively persistent. > Immobile in soil.	> Rodenticide: > Second-generation anticoagulant. Acts by blocking vitamin the K cycle, resulting in the inability to produce blood-clotting factors. Damages capillaries, causing diffuse internal hemorrhaging. Death occurs from hypovolemic shock or severe anemia.	> Highly toxic by all acute exposure routes.	> Very highly toxic to fish. > Toxic to birds via primary and secondary ingestion exposure. > Nontoxic to honey bees.
Bromadiolone*	> na	> Stable to hydrolysis.	> Moderately persistent in soil. > Immobile in soil with high organic and clay content. > Susceptible to aerobic soil metabolism.	> Rodenticide > Second-generation anticoagulant. Acts by blocking vitamin the K cycle, resulting in the inability to produce blood-clotting factors. Damages capillaries, causing diffuse internal hemorrhaging. Death occurs from hypovolemic shock or severe anemia.	> Highly toxic by all acute exposure routes.	> Moderately toxic to fish. > Toxic to birds via primary and secondary ingestion exposure.

Table 4-1 Summary Characteristics of Active Ingredients

Active Ingredient: Chemical or Biological	Fate & Transport			Mode of Action	Human Health[1]	Ecological Health[1]
	Air	Water	Soil			
Difethialone*	> na	> Adsorbs to suspended solids and sediments. > Can slowly volatize from water surfaces.	> Immobile in soil.	> Rodenticide > Second-generation anticoagulant. Acts by blocking vitamin the K cycle, resulting in the inability to produce blood-clotting factors. Damages capillaries, causing diffuse internal hemorrhaging. Death occurs from hypovolemic shock or severe anemia.	> Highly toxic by all acute exposure routes. > No genotoxic or carcinogenic effects have been noted.	> Highly toxic to fish and aquatic invertebrates. > Very likely toxic to most mammals. > Likely to adversely affect snakes, non-target rodents, carnivorous mammals. > Highly toxic to birds via primary and secondary routes.
Cholecalciferol (vitamin D)	> Expected to be nonvolatile.	> Essentially insoluble.	> Immobile in soil.	> Rodenticide > Ingestion results in hypercalcemia from mobilization of calcium from bone matrix to blood plasma leading to metastatic calcification of soft tissues.	> Toxic by all acute exposure routes.	> Considered of low hazard to avian and canine species. > May impact non-target rodents. > Not expected to bioconcentrate in mammals because it is metabolized.
Sulfur (fumigant)	> na	> na	> Elemental sulfur becomes incorporated into the natural sulfur cycle. Oxidizes into sulfate and reduces into sulfide. Mediated by microbes.	> Rodenticide > Fumigant. Ignited cartridges produce toxic gases, displacing oxygen in burrows, and causing asphyxiation.	> Low toxicity by acute exposure routes. > No known oncogenic, teratogenic, or reproductive effects.	> Practically nontoxic to fish and aquatic invertebrates. > Nontoxic to birds. > Nontoxic to bees.
Sodium Nitrate (fumigant)	> na	> na	> Sodium nitrates are naturally occurring substances.	> Rodenticide > Fumigant. Pyrolysis of cartridge products results in simple organic and inorganic compounds, such as nitrous oxide and carbon monoxide, which diffuse through burrows causing organisms to die of asphyxiation.	> Low acute oral toxicity. > May cause eye irritation and slight dermal irritation.	> Any non-target organism in the burrow at treatment time will likely be killed. > USEPA recommends that applicators observe signs around burrows carefully for presence of non-targets.
Imazapyr	> Nonvolatile.	> Degradation by photolysis. > Stable to hydrolysis. > Stable to aerobic and anaerobic aquatic metabolism.	> Persistent in soil. > Mobile in soil. > Stable to aerobic and anaerobic soil degradation. > Leaches to groundwater.	> Herbicide > Prevents the synthesis of branched-chain amino acids.	> Slightly toxic via acute oral, dermal, and inhalation routes. > No evidence of carcinogenicity or mutagenicity.	> Practically nontoxic to birds, fish, aquatic invertebrates, and honey bees. > Poses a risk to non-target vascular plants. > Not expected to bioaccumulate.
Glyphosate*	> na	> Highly water soluble. > In aquatic systems, sediment appears to be the major sink for glyphosate residue. > Broken down by microbial degradation.	> Resistant to chemical degradation and sunlight and is fairly unleachable. > Relatively immobile in soil and does not move vertically below the six inch soil layer. > Low tendency to runoff. > Inactivated and biodegraded by microbes under aerobic and anaerobic conditions.	> Herbicide > Plants: Works via the shikimic pathway by inhibiting the enzyme EPSP synthase. Results in stunted growth, malformation, tissue death, etc. > Animals: Shikimic pathway absent in mammals.	> Very low toxicity via oral and dermal routes. > No evidence of carcinogenic or mutagenic effects. > Possible endocrine-disruptor.	> Practically nontoxic to birds, honey bees, fish, and freshwater invertebrates. > No evidence of bioaccumulation.

Table 4-1 Summary Characteristics of Active Ingredients

Active Ingredient: Chemical or Biological	Fate & Transport			Mode of Action	Human Health[1]	Ecological Health[1]
	Air	Water	Soil			
Triclopyr	> Nonvolatile.	> Highly soluble. > Primary loss via photodegradation. > Triclopyr triethylamine (TEA) rapidly dissociates in water to the acid/anion and triethanolamine. > Triclopyr butoxyethanol ester (TBEE) rapidly hydrolyses to the triclopyr acid/anion and butoxyethanol.	> Slightly mobile with sorption to soil increasing with time. > Primary loss via microbial degradation. > Moderately persistent, with persistence increasing with soil depth and anaerobic conditions.	> Herbicide > Pyridine-based synthetic auxin, which causes the plant to overdose on auxin resulting in epinasty, abnormal leaf formation, stem swelling, and death.	> (Technical triclopyr acid) Slightly toxic via acute oral, dermal, and inhalation routes. > (TEA and TBEE) slightly toxic by acute oral and dermal routes. Practically nontoxic by inhalation. > Not carcinogenic.	> (Triclopyr acid) Slightly toxic to birds and practically nontoxic to insects, fish, and aquatic invertebrates. > (TEA) Practically nontoxic to birds and invertebrates. Slightly toxic to fish. > (TBEE) Slightly toxic to birds, moderately to highly toxic to fish and invertebrates. > Does not bioaccumulate rapidly. > Triclopyr has low toxicity to grasses, but can injure conifers.
2,4-D (2,4-dichlorophenoxy acetic acid)	> na	> Found as a free anion in aqueous environments.	> Dissipation due to oxidative microbial mineralization, photodegradation, and leaching.	> Herbicide > Auxin-mimic. > Phenoxy or phenoxyacetic acid which acts as an herbicide, plant growth regulator, and fungicide.	> Low toxicity via oral and dermal routes. > Dose-dependent damage to eyes, thyroid, kidney, adrenals, ovaries, and testes have been observed in chronic studies of rats. > Possible endocrine disruptor.	> Slightly to moderately toxic to birds. > Some formulations highly toxic to fish. Bioconcentrates in fish. > Practically nontoxic to honey bees.
Sulfometuron methyl	> Low potential to volatilize.	> Hydrolysis, photolysis, and microbial degradation are major routes of transformation. > Low tendency to sorb to sediments.	> Hydrolysis, photolysis, and microbial degradation are major routes of transformation. > Potential to leach.	> Herbicide > Inhibits acetolactate synthase, which inhibits the production of amino acids required for cells growth. Retards shoot and root development.	> Low toxicity via oral, dermal, and inhalation routes.	> Nontoxic to birds, aquatic invertebrates, and bees. > Slightly toxic to fish. > Low potential to bioaccumulate. > Phytotoxic to duckweed and a broad range of terrestrial plants.
Bentazon	> na	> Photolysis, and microbial degradation are major routes of dissipation.	> Photolysis, microbial degradation, leaching, and runoff are major routes of dissipation. > Low binding affinity to soil.	> Herbicide: > On contact, bentazon interferes with the ability of plants to use sunlight for photosynthesis by inhibiting electron transport.	> Slightly toxic via oral, dermal, and inhalation routes.	> Slightly toxic to birds and small mammals. > Practically nontoxic to fish and aquatic invertebrates. > Low risk to aquatic plants.
Diuron*	> na	> Major routes of dissipation are microbial degradation.	> Sorption highly correlated with soil organic matter. > Mobile and persistent. > Potential to leach to groundwater and contaminate surface waters.	> Herbicide > Substituted urea that inhibits photosynthesis by limiting the production of ATP, and other necessary metabolic processes. > One of the most commonly used herbicides in California.	> Low toxicity via oral, dermal, and inhalation routes. > Metabolism occurs through hydroxylation and dealkylation. > Known/likely carcinogen based on bladder cancer in rats.	> Slightly to practically nontoxic to birds. > Practically nontoxic to bees. > Moderately to highly toxic to fish and aquatic invertebrates. > Low bioaccumulation potential.
Benfluralin (benefin)*	> Volatizes rapidly.	> Major routes of dissipation are photolysis and anaerobic metabolism.	> Low mobility and variable persistence.	> Herbicide > Inhibits growth by acting as a mitotic disruptor.	> Practically nontoxic by acute oral and dermal routes. > Possible endocrine disruptor.	> Practically nontoxic to birds, small mammals, and honey bees. > Highly toxic to fish and aquatic invertebrates. > Considered to be bioaccumulative.

Table 4-1 Summary Characteristics of Active Ingredients

Active Ingredient: Chemical or Biological	Fate & Transport			Mode of Action	Human Health[1]	Ecological Health[1]
	Air	Water	Soil			
Oryzalin	> na	> Primary degradation process is photolysis.	> Primary degradation process is photolysis. > Not mobile. > Anaerobic conditions in soil cause chemical reduction.	> Herbicide > Disrupts growth processes during germination by inhibiting cell division in plants.	> Practically nontoxic by acute oral route. > Moderately toxic by acute dermal and inhalation routes. > Possible human carcinogen.	> Slightly toxic to practically nontoxic to birds. > Moderately toxic to fish and freshwater invertebrates. > Practically nontoxic to honey bees. > Does not accumulate in fish.
DCPA (chlorthal dimethyl) [metabolite is tetrachloroterephthalic acid (TPA)]	> Volatilization from soil a major route of dissipation.	> Stable to hydrolysis and photolysis.	> Low persistence and mobility. > The DCPA metabolite TPA is unusually mobile and persistent and will leach to groundwater.	> Herbicide > Kills germinating seeds by disrupting microtubule formation in exposed cells, causing abnormal cell division.	> Slightly toxic to practically nontoxic by all acute exposure routes. > Possible human carcinogen. > Possible endocrine disruptor.	> Practically nontoxic to birds on an acute basis, but persistent enough to result in chronic exposure to birds. > Practically nontoxic to bees. > Slightly toxic to practically nontoxic to fish and aquatic invertebrates.
Dithiopyr	> Volatilization contributes more to dissipation than any other route.	> Degrades slowly in water. > Resistant to photolysis and hydrolysis.	> Immobile in soil.	> Herbicide	> Low acute toxicity. > No known mutagenic or carcinogenic effects.	> na
Metalochlor	> na	> Stable under hydrolysis.	> Degradation dependent on microbially-mediated and abiotic processes. Photolysis in soil. > Moderately persistent and mobile. Potential to leach to groundwater.	> Herbicide > Inhibits seedling development by acting as a growth inhibitor by suppressing synthesis of chlorophyll, proteins, fatty acids/lipids, isoprenoids, and flavonoids.	> Slightly toxic via acute routes. > Possible endocrine disruptor.	> Practically nontoxic to birds. > Moderately toxic to fish. > Slightly toxic to aquatic invertebrates. > Low potential for bioaccumulation.
Pendimethalin	> Volatilizes from soil.		> Dissipates into the environment by binding to soil, microbially-mediated metabolism, and volatilization. > Persistence decreases with increased temperature and moisture and/or decreased soil organic carbon.	> Herbicide > Disrupts microtubules.	> Low acute toxicity. > Possible human carcinogen.	> Slightly toxic to birds. > Practically nontoxic to honey bees. > Highly toxic to fish and aquatic invertebrates. > High potential to bioaccumulate.
Alkylphenol ethoxylate (APE)*	> na	> Degrades faster in water than in soil.	> Bind strongly to particulates and are persistent in sediments.* > Aerobic conditions facilitate biotransformation.	> Adjuvant: > Enhance activity of active ingredients in herbicides or offset any problems associated with spray application. > Toxicity of APEs to aquatic organisms increases with alkyl chain length.	> Nonylphenol is of low acute and dermal toxicity. > Possible estrogen-mimics.	> Nonylphenol is persistent in the environment, moderately bioaccumulative, and extremely toxic to aquatic organisms.
Polydimethylsiloxane Fluids	> Volatile.	> Insoluble.	> Typically sorb to particulate matter and become associated with soils and sediments. > Degradation is slow in moist soils and quick in dry soils.	> Adjuvant > Enhance activity of active ingredients in herbicides or offset any problems associated with spray application.	> na	> Appear to be relatively nontoxic to benthic invertebrates. > Exhibits little bioaccumulation potential.

Table 4-1 Summary Characteristics of Active Ingredients

Active Ingredient: Chemical or Biological	Fate & Transport			Mode of Action	Human Health[1]	Ecological Health[1]
	Air	Water	Soil			
Modified Vegetable Oils and Methylated Seed Oil				> Adjuvant > Enhance activity of active ingredients in herbicides or offset any problems associated with spray application.		> Slightly toxic to fish (Competitor™). > Practically nontoxic to Daphnia (Competitor™). > Generally inert or essentially nonphytotoxic.
Lecithin				> Adjuvant > Enhance activity of active ingredients in herbicides or offset any problems associated with spray application.		> Slightly toxic to fish (Liberate™). > Moderately toxic to Daphnia (Liberate™).

[1] Toxicity levels (e.g., slight, low, moderate, high, etc.) are used prevalently in the published literature but are not standardized or representative of specific criteria. They qualitatively describe toxicity in relative terms.

Table 4-2 Degradation of Pyrethrins

Degradation Method	Half-life	Reference
Hydrolysis, pH 9 (water)	14 to 17 Hours	USEPA 2006b
Hydrolysis, neutral or acidic	Slow	USEPA 2006b
Photolysis (water and soil)	<1 Day	USEPA 2006b, Gunasekara 2005
Volatilization (soil)	1.8 to 97 Days	Gunasekara 2005
Aerobic metabolism (soil)	10.5 Days	USEPA 2006b
Anaerobic metabolism (soil)	86.1 Days	USEPA 2006b

4.1.1.2 Human Toxicity

Pyrethrins have low to moderate acute toxicity via the oral, dermal, and inhalation routes (Category III and IV). They are a moderate eye irritant (Category III), a mild dermal irritant (Category IV), and not a skin sensitizer. The oral median lethal concentration (LC50) was found to be 1400 mg/kg in rats, the dermal LC50 was found to be greater than 2000 mg/kg in rabbits, and the inhalation LC50 was found to be 3.4 mg/L in rats (USEPA 2006f) (Table 6.1).

The critical toxicological effects of pyrethrins are (1) neurobehavioral effects (tremors, labored breathing, hyperactivity, secretory signs, matted coats), following acute, short-term, and chronic exposure, with nervous system lesions observed in the rat and mouse following acute exposure; (2) thyroid effects, following chronic exposure in the rat and dog; and (3) liver effects, following short- and long-term exposure in the rat, dog, and mouse. Following inhalation exposure, neurobehavioral effects were observed initially, and respiratory tract lesions were observed at all dose levels. The neurobehavioral effects and the mode of action on the sodium channel are considered relevant to humans because the effects are observed in both the rat and mouse, and the mode of action affects a basic function of the nervous system that is common to all animals (USEPA 2006f) (Table 6.1).

4.1.1.3 Ecological Toxicity

The results of the toxicity testing with the technical grade active ingredient suggest that pyrethrins are very highly toxic to freshwater fish (LC50 = 5.1 µg/L) and invertebrates (median effect concentration [EC50] = 11.6 µg/L), as well as to estuarine/marine fish (LC50 = 16.0 µg/L) and invertebrates (LC50 = 1.4-µg/L) on an acute basis. Chronic toxicity studies show that pyrethrins impair growth (length and weight) of freshwater fish (lowest observed adverse effect concentration [LOAEC] of 3.0 µg/L) and reproduction of freshwater invertebrates (LOAEC of 2.0 µg/L). The chronic no observed adverse effect concentrations (NOAECs) for freshwater fish and invertebrates were reported as 1.9 and 0.86 µg/L, respectively (USEPA 2006f).

Pyrethrins were practically nontoxic to avian species on an acute oral and dietary basis (oral LD50 >2,000 mg/kg bw; dietary LC50 >5,620 mg/kg diet) (USEPA 2006f).

SWRCB has evaluated freshwater aquatic life toxicity data from USEPA's Office of Pesticides' Ecotoxicity Database and has identified the lowest LC50 for pyrethrins as 1.4- µg/L. This value is based on toxicity to scuds and mysid shrimp during 96-hour tests (SWRCB 2012) (Table 6.1).

4.1.1.4 Ecological Toxicity Associated with ULV Application for Mosquito Abatement

The active ingredients used for control of adult mosquitoes have been deliberately selected for lack of persistence and minimal effects on non-target organisms when applied at label rates for ULV mosquito control. The products applied as ULV sprays for adult mosquito control are not formulated for persistence, because their purpose is to kill active adult mosquitoes in flight.

Three of the studies discussed below investigated aquatic toxicity following ULV applications of pyrethrins. One study using laboratory toxicity tests on samples after aerial application found no significant mortality to *Ceriodaphnia dubia* following aerial application, and inconclusive results for *Hyalella azteca* (sediment collected prior to application was toxic to *H. azteca*) (Weston et al. 2006). Another study found no significant mortality in caged mosquito larvae or mosquitofish after truck application, and no significant difference in macroinvertebrate abundance, biomass, or species diversity (Jensen et al. 1999). Another study (Lawler et al. 2008) used caged organisms (*Daphnia magna* and *Callibaetis californicus*) to evaluate toxicity after multiple applications, and found no significant difference in mortality.

Following aerial applications of Evergreen Crop Protection EC 60-6 (6 percent pyrethrins, 60 percent PBO) in Sacramento for West Nile virus, Larry Walker and Associates (2006) reported results of water testing on samples from 10 waterways within the treatment area. Treated areas were sprayed nightly for 3 days. One additional application occurred 9 days prior to the 3-day event at selected locations. Samples were taken immediately after application (within 1 to 6 hours), and the next day (16 to 23 hours after the application). Pyrethrins concentrations were detected between 0.234-to 3.77 µg/L from 9 of 26 samples collected immediately after the application. The average concentration for samples collected 1 to 6 hours after application was 0.270 µg/L. Pyrethrins were not detected (<0.2 µg/L) 16 to 23 hours after each spray event.

Testing was also carried out by Weston et al. (2006) following the same applications. Prior to aerial spraying, pyrethrins were not detected in water or sediment samples. Pyrethrins were not detected in water samples taken 10 to 34-hours after the spray applications; however, pyrethrins were detected in sediment samples after aerial spraying at concentrations ranging from 93.1 to 403 micrograms per kilogram [µg/kg] in 4-of 6 samples. Neither water nor sediment was tested at later intervals, so the duration of persistence could not be determined in this study. Laboratory tests were conducted to determine the effects of short-term chronic exposure of *Ceriodaphnia dubia* to water collected after the spray events, following USEPA protocol. No significant differences in mortality were observed. In addition, sediment toxicity tests were performed with the amphipod *Hyalella azteca,* and toxicity was observed in samples collected both before and after application. The authors concluded that pyrethrins should present little risk to aquatic organisms due to the low toxicity and lack of long-term persistence.

Water and soil deposition of pyrethrins following aerial applications was evaluated at two sites in California by Schleier et al. (2008). Water was sampled after aerial applications of pyrethrins and PBO in irrigation ditches at one site (Princeton) and in static ponds at another (Colusa). Pyrethrins were not detected following spray events at either site (the reporting limit was 0.5 µg/L or less). The authors concluded that the amounts of pyrethrins and PBO deposited on the ground and in water after aerial ULV insecticide applications are probably lower than those estimated by previously published studies to predict exposure and risk.

Deposition of pyrethrins following truck-mounted application was evaluated in large seasonal wetlands in California (Jensen et al. 1999). Pyrethrins were not detected (<20 µg/L) in surface waters one hour after ULV applications. The authors found no significant differences in macroinvertebrate abundance and biomass or species diversity in areas treated with any of the materials when compared with untreated ponds. No mortality occurred in mosquitofish held in water (in sentinel cages in treated ponds). Similarly, no difference in mortality was observed for mosquito larvae held in water (in sentinel cages in treated ponds) when compared with untreated ones. The authors concluded that ULV applications for adult mosquito control were not likely to significantly affect aquatic insects or fish in these habitats.

Lawler et al. (2008) evaluated pyrethrins and PBO in sediment following multiple applications of pyrethrins from truck-mounted equipment in the Colusa and Sacramento National Wildlife Refuges in California. Stock tanks were filled with a layer of soil overlain with 1,150 liters of water. Zooplankton (*Daphnia magna*) were held in sentinel cages in the water column and mayfly larvae (*Callibaetis californicus*) were placed in cages at the bottom of each tank, where they were in contact with sediment. ULV applications of pyrethrins were made from truck-mounted equipment twice weekly for six weeks. Pyrethrins concentration in sediments and sentinel survival were evaluated after 5 and 11 spray event applications. Pyrethrins were found at low concentrations (23.1 and 33.1 µg/kg) in 2 of 6 tanks after five spray events, but there was no evidence of accumulation in sediments. After 11 spray events, sediment in 4 of 6 tanks (including one that had held residues after spray 5) contained no detectable amount of pyrethrins (<2 µg/kg), one tank had pyrethrins concentrations at 4 µg/kg, and another at 34.5 µg/kg. There was no significant difference in mortality for mayfly larvae held in sentinel cages on the sediment. Likewise, there was no significant difference in mortality seen in *D. magna* held in the water column. PBO-synergized pyrethrins had no detectable effect on the survival of *D. magna* held in tanks in the spray area, even after 11 biweekly spray events. They concluded that applications of pyrethrins and PBO at rates used for mosquito control did not have detectable effects on the indicator species.

Several papers were published documenting that ULV-applied mosquito adulticides do not accumulate in water or sediment during repeated applications. Chemical testing was conducted following multiple spray events by Amweg et al (2006). There was no increase in the level of pyrethrins or PBO following multiple daily spray events, and the concentration had returned to background level when samples taken one week after the last application were tested. Similarly, Lawler et al. (2008) reported that the concentration of pyrethrins and PBO in tanks within a treated area were not significantly higher after 11 applications than in samples taken after the fifth application. In many cases, the concentrations were actually lower following the 11th spray event than after the fifth spray event.

4.1.1.5 Summary of Toxicity and Potential Effects

Pyrethrins readily degrade in water and soil, but may persist under anoxic conditions. They tend to strongly adsorb to soil surfaces, and hence have low potential to leach into groundwater. These chemicals may have low to moderate acute toxicity to mammals; however, proper personal protective equipment would alleviate potential for human exposure, especially when delivered via ULV techniques. Pyrethrins may be highly toxic to fish (freshwater, estuarine, marine) and invertebrates, although, exposures would likely be low during and following ULV applications, which are designed to prevent environmental persistence and potential impacts to non-target ecological receptors.

Pyrethrin is used for both mosquito (five Districts) and yellow jacket wasp (three Districts) control. For yellow jacket wasp control, pyrethrin (1 percent of the formulation) was applied around parks, landscaping, and directly into ground nests. A single product was applied several hundred times throughout the reporting year at approximately one-ounce doses. For mosquito control, pyrethrin is applied to manmade and natural sites including ditches, and moving and standing water. Three products containing pyrethrin (5 percent) were applied several hundred times throughout the reporting year.

4.1.2 Allethrins and *d-trans* allethrin

Allethrins are synthetic pyrethroids that are structurally very similar to cinerin I in naturally occurring pyrethrum. There are three asymmetric carbons and, thus, eight potential isomers; however, four isomers are present in the greatest concentration for product formulations. One of the stereoisomers, d trans of d isomer (d-trans allethrin), is recognized as being the most insecticidally active and toxicologically important of the four isomers. Allethrins are typically used as a “knock-down” agent and a different, residual pesticide is co-formulated with allethrins in the end-use products to kill the target pests (USEPA 2009b). D-trans allethrin is usually combined with synergists such as PBO.

Allethrins are used to control flying and crawling insects in a number of commercial, horticultural and residential applications. Commercial applications include space, broadcast and crack and crevice treatments in a variety of commercial, industrial, residential, and institutional sites. Horticultural applications include foliar and fogger treatment on nonfood plants. Residential uses include pest control in homes and outdoor domestic structures, on gardens, and direct application to pets. Allethrins are also approved for use in commercial animal premise (indoor) misting systems (USEPA 2009b).

4.1.2.1 Environmental Fate

Allethrins were the first pyrethroids developed and they differ from more recently developed pyrethroids in their high photolability (USEPA 2009b). The photolysis half-life is less than 8 hours (WHO 1989). Allethrins (and the d-trans allethrin component) are not soluble in water and are expected to adhere moderately to soil containing organic matter. When used in mosquito coils and mats, allethrins are released into the air where they will either be degraded by sunlight or be distributed in low concentrations to nearby surfaces.

4.1.2.2 Human Toxicity

The toxicity of allethrin varies with the amounts of different isomers present. The LD50 of allethrin in male rats is 1,100 mg/kg (685 mg/kg in female rats) while the LD50 of *d-trans* allethrin in rats is 860 mg/kg. Allethrin is slightly toxic to moderately toxic by dermal absorption and ingestion. The dermal LD50 of allethrin in rabbits is 11,332 mg/kg. Dermal exposure results in itching, burning, tingling, and numbness. Large doses by any route can cause physical symptoms such as nausea, vomiting, diarrhea, tremors, convulsions, and coma. A chronic dosage of 50 mg/kg/day for two years produced no detectable effect in dogs. Allethrin is not known to cause reproductive, teratogenic, mutagenic, or carcinogenic effects to mammals (EXTOXNET 1993a) (Table 6.1).

4.1.2.3 Ecological Toxicity

The chemical is practically nontoxic to birds but highly toxic to fish and invertebrates with the *d-trans* isomer exhibiting greater toxicity to non-target insects than allethrin (EXTOXNET 1993a). The LC50 for fish ranges from 0.0026 to 0.08 mg/L (USEPA 2009b). The bioaccumulation potential of allethrin is unknown (Table 6.1).

4.1.2.4 Summary of Toxicity and Potential Effects

Allethrins readily degrade via photolysis especially when released into the air following coil deployment. Residual released material may deposit to soil surfaces and moderately adhere to organic matter. Allethrins may be highly toxic to fish, invertebrates, and non-target insects, but they are unstable in the environment and likely do not pose unacceptable risk to ecological receptors.

Allethrins, including *d-trans* allethrin are intermittently used to target yellow jacket wasp nests. Allethrin (*d-trans* isomer) is combined with another active ingredient, phenothrin in a single product used by two Districts for wasp and yellow jacket control. This product was used in 12 applications of 37.5 ounces (volume) (<0.1 ounces of active ingredients) during the summer of 2011 (of the reporting year). Because allethrins are used in localized, low-volume applications, environmental persistence is not expected nor is unwanted exposure to non-target ecological or human receptors.

4.1.3 Phenothrin (sumithrin or d-phenothrin)

Phenothrin has been registered by the EPA since 1976, and is used to control adult mosquitoes, and as an insecticide in transport vehicles such as aircraft, ships, railroad cars, and truck trailers. It is also used as an insecticide and miticide in commercial, industrial, and institutional nonfood areas, in homes and gardens, in greenhouses, and in pet quarters and on pets, and is used in urban areas, outdoor residential areas, around buildings and structures, at recreational areas, golf courses, zoos, and for agricultural crops (CDPR 2010a).

4.1.3.1 *Environmental Fate*

Phenothrin has a relatively high affinity for binding to soils, moderate persistence in surface soils, and low solubility. Its low leaching potential means that it is likely to remain immobile once it binds to soil sediments. The major routes of dissipation of phenothrin in the environment are photolysis in water (half-life at 6.5 days) and aerobic metabolism (in soil from 18.6 to 25.8 days, and in aquatic environments at 36.1 days) (Table 4-3). Even though phenothrin is likely to undergo photolysis in water, its high affinity for binding to particulate matter makes photolysis less likely to happen, except during the brief period in which the chemical is suspended in water before binding to sediment. Phenothrin is moderately persistent under aerobic conditions and is persistent under anaerobic conditions (USEPA 2008b).

Table 4-3 Degradation of Phenothrin

Degradation Method	Half-life	Reference
Hydrolysis, all pH levels	Stable	USEPA 2008a
Photolysis (water)	6.5 Days	USEPA 2008a
Aerobic metabolism (water)	36.1 Days	USEPA 2008a
Aerobic metabolism (soil)	18.6 to 25.8 Days	USEPA 2008a
Anaerobic metabolism (water)	173.3 Days	USEPA 2008a

4.1.3.2 *Human Toxicity*

Phenothrin is not known to be acutely toxic at high exposure levels to humans or mammals. Phenothrin exhibits low acute toxicity by oral (Category III), dermal (Category III), and inhalation (Category IV) routes of exposure. Phenothrin is a mild eye irritant (Category III) but is not a skin irritant or a skin sensitizer. The oral LC50 was found to be greater than 5,000 mg/kg in rats, the dermal LC50 was found to be greater than 2000 mg/kg in rats and the inhalation LC50 was found to be greater than 2.1 mg/L in rats (USEPA 2008b).

Neurotoxic effects were observed in developmental toxicity studies but not observed in other acute, chronic, and subchronic toxicity studies done in rats and dogs up to the limit dose of 20,000 mg/kg/day. Maternal toxicity in rats was evidenced by the appearance of generalized clinical effects in dosed individuals; these effects included decreased maternal weight gain and decreased food consumption at the highest dosage tested of 3000 mg/kg/day (USEPA 2008b) (Table 6.1).

4.1.3.3 *Ecological Toxicity*

Phenothrin technical grade active ingredient is highly toxic on an acute basis, with the LC50 ranging from 15.8 to 18.3 µg/L for freshwater fish. Phenothrin is also highly toxic to estuarine/marine fish on an acute basis. The LC50 for estuarine and marine fish ranges from 38.3 to 94.2 µg/L. Phenothrin is very highly toxic to freshwater invertebrates. The EC50 for freshwater invertebrates is 4.4-µg/L. Chronic data for phenothrin show adverse reproductive effects for freshwater invertebrates at a NOAEC of 0.47 µg/L. This indicates a potential for chronic reproductive effects to freshwater invertebrates as a result of phenothrin exposure. Additional chronic effects to estuarine and marine invertebrates are expected based on the chronic reproductive toxicity to freshwater invertebrates and the acute effects to estuarine and marine invertebrates (USEPA 2008b).

Based on studies of avian acute dietary toxicity, phenothrin can be classified as practically nontoxic to avian species. The LC50 for avian dietary toxicity is above 5,000 parts per million (ppm) (USEPA 2008b).

SWRCB has evaluated freshwater aquatic life toxicity data from USEPA's Office of Pesticides' Ecotoxicity Database and has identified the lowest LC50 for phenothrin as 0.025 µg/L. This value is based on toxicity to mysid shrimp during a 96 hour test (SWRCB 2012) (Table 6.1).

4.1.3.4 Ecological Toxicity associated with ULV Application for Mosquito Abatement

Davis and Peterson (2008) measured family diversity, richness, and evenness at 1, 7, 14, and 28 days after truck application of phenothrin applied as Anvil 10+10 ULV. Most response variables showed no significant treatment effect, although there were some reductions in number of individuals. The authors concluded that the reductions in aquatic non-target populations did not suggest any trends or persistent deleterious biological effects following a single adulticide application.

New York City Department of Health sampled 32 locations for phenothrin and PBO before and after spray events during mosquito adulticide applications that occurred during July through September 2000. Out of the 68 post-application samples collected by the city, only two had concentrations of either phenothrin or PBO greater than the 0.5 µg/L reporting limit: 1.10 µg/L for phenothrin on August 18, 2000, at Mt. Loretto Pond on Staten Island; and 1.03 µg/L for PBO and 0.55 µg/L for phenothrin for a sample collected on August 5, 2000, at Alley Park Pond in Queens (Suffolk County 2006).

Zulkosky et al. (2005) evaluated phenothrin applied as Anvil. In 2002, phenothrin was not detected in either spray event (detection limit of 0.0005 µg/L). In 2003, phenothrin was detected at 0.0011 µg/L immediately after spray application, but was not detected in samples collected 1 to 10 days after spraying Anvil.

The Massachusetts Department of Agricultural Resources (2010) conducted a study where phenothrin was applied aerially as Anvil 10+10 ULV to six sites. There were no detections of phenothrin during this study (Massachusetts Department of Agricultural Resources 2010).

4.1.3.5 Summary of Toxicity and Potential Effects

Phenothrin is generally applied using ULV techniques, which encourages dissipation rather than persistence in the environment. It is not expected to pose unacceptable risk to human or ecological receptors, because it is handled in small amounts using proper personal protective equipment (by the applicator) and its low potential for exposure to non-targets.

As stated above, phenothrin and *d-trans* allethrins are used in conjunction for yellow jacket wasp control. One product containing *d-trans* allethrins was used in limited amounts by two districts during the reporting year. Phenothrins are used in localized, low-volume applications, therefore environmental persistence and meaningful exposure to non-target ecological receptors is not expected.

4.1.4 Prallethrin

Prallethrin is a synthetic pyrethroid with fast knock-down activity against household insect pests. It is used in household insecticide products against mosquitoes, houseflies, and cockroaches. Prallethrin also has veterinary uses in the treatment of domestic pets. Prallethrin has been applied in urban areas, outdoor residential areas, recreational areas, golf courses, around building and structures and at areas of standing water (CDPR 2010a). Prallethrin has an exciting effect on mosquitoes, and is added to Duet (the only prallethrin-containing adulticide product used in California) primarily for this property rather than its inherent toxicity. The other active ingredient in Duet is phenothrin.

4.1.4.1 Environmental Fate

Prallethrin readily sorbs to soils and sediments. The major route of dissipation of prallethrin in the environment is photolysis in both water (half-life at 13.6 hours) and soil (at 25 days) (Sumitomo Chemical 2009).

4.1.4.2 Human Toxicity

Prallethrin has low to moderate acute toxicity via the oral, dermal, and inhalation routes (Category II, III and IV). It is a moderate eye irritant (Category III), not a dermal sensitizer, and is nonirritating to skin. The oral LC50 was found to be 460 to 640 mg/kg to rats, the dermal LC50 was found to be greater than 5000 mg/kg, and the inhalation LC50 was found to be 288 to 333 mg/m^3 (USEPA 2003a) (Table 6.1).

4.1.4.3 Ecological Toxicity

Prallethrin is highly toxic to fish (LC50 of 17.6 µg/L based on a 96 hour acute toxicity test to zebrafish (*Danio rerio*) and aquatic invertebrates (EC50 of 19 µg/L based on a 48 hour acute toxicity test to *Daphnia magna*). Prallethrin has low toxicity to algae (EC50 of 4.9 mg/L based on a 72 hour acute toxicity test to *Scenedesmus subspicatus*) and birds (LD50 of 1171 mg/kg for bobwhite quail). It is very toxic to bees (Agro-allianace Pty Ltd nd).

SWRCB has evaluated freshwater aquatic life toxicity data from USEPA's Office of Pesticides' Ecotoxicity Database and has identified the lowest LC50 for prallethrin as 3.9 µg/L. This value is based on toxicity to mysid shrimp during a 96 hour test (SWRCB 2012) (Table 6.1).

4.1.4.4 Summary of Toxicity and Potential Effects

Like other Type 1 pyrethroids, prallethrin is readily degraded via photolysis and is less environmentally persistent than the Type 2 variety. Prallethrin is used to treat domestic pets and is therefore, not expected to cause significant mammalian toxicity. Prallethrin is practically nontoxic to birds but is highly toxic to non-target organisms including, fish, aquatic invertebrates, and honey bees.

Prallethrin is intermittently used to target yellow jacket and paper wasp nests. Localized applications are generally completed during the fall and sometimes winter months. Because this active ingredient is used in localized, low-volume applications, it is not expected to persist in the environment or pose unwanted toxicity to non-target ecological or human receptors.

4.1.5 Deltamethrin

Deltamethrin is a pyrethroid that kills insects on contact and through ingestion. Type II pyrethroids such as deltamethrin induce long-lasting inhibition of the sodium ion channel activation gate. This results in prolonged permeability of the nerve to sodium and produces a series of repetitive nerve signals in sensory organs, nerves, and muscles. The mechanism is the same for target and non-target organisms (National Pesticide Information Center 2010). The primary use of deltamethrin (approximately 85 percent of the total production) is for crop protection. Deltamethrin is also used to protect stored commodities such as cereals, grains, and coffee beans. Other uses include insect control for public health concerns, pest control in forestry, pest control in animal facilities, parasite control on animals, and as a wood preservative (CDPR 2000). Deltamethrin is used as a mosquito adulticide to a limited extent in California, but public health uses typically target other vectors such as yellow jackets. It is used as a barrier application and not a ULV application and it is not used over or adjacent to water bodies. Formulations used for mosquitoes include Suspend SC Insecticide (primarily used), and K-Othrine SC Insecticide.

4.1.5.1 Environmental Fate

Deltamethrin degrades via hydrolysis, photolysis, and microbial action (Table 4-4) and is more persistent in soils with a high clay or organic matter content. The half-life of deltamethrin is approximately 25 to 33 days under aerobic conditions (CDPR 2000, FAO-WHO 2002a).

Table 4-4 Degradation of Deltamethrin

Degradation Method	Half-life	Reference
Hydrolysis, pH 8	31 Days	FAO-WHO 2002
Hydrolysis, pH 9	2.5 Days	FAO-WHO 2002
Photolysis (water)	<21 Days	FAO-WHO 2002
Photolysis (soil)	48 Days	FAO-WHO 2002
Aerobic metabolism (soil)	22 to 25 Days	FAO-WHO 2002

Table 4-4 Degradation of Deltamethrin

Degradation Method	Half-life	Reference
Anaerobic metabolism (soil)	32 to 36 Days	FAO-WHO 2002
Field conditions (soil)	14 to <150 Days	FAO-WHO 2002

4.1.5.2 Human Toxicity

Deltamethrin is of low to moderate acute toxicity. The oral LD50 for rats is 30 mg/kg in an oil vehicle or >5,000 mg/kg in a water vehicle. The LD50 for dogs is 300 mg/kg (EXTOXNET 1995a). The acute dermal LD50 for rabbits is >2,000 mg/kg and no skin irritation and slight eye irritation were reported (EXTOXNET 1995a). Symptoms of acute exposure in humans include ataxia, convulsions, dermatitis, edema, diarrhea, headache, irritability, among others (EXTOXNET 1995a). Symptoms of chronic exposure of humans to deltamethrin include choreoathetosis, hypotension, prenatal damage, and shock (EXTOXNET 1995a). Deltamethrin has no reported teratogenic, mutagenic, or carcinogenic effects. Mice fed doses of deltamethrin during gestation showed no changes in the number of implants, fetal mortality, fetal weight, or malformations (EXTOXNET 1995a) (Table 6.1).

4.1.5.3 Ecological Toxicity

Deltamethrin is very highly toxic to fish and aquatic invertebrates. It is practically nontoxic to birds (USEPA 2010a). Of particular importance when using pyrethroids in general is to note that non-target insects may have the same approximate sensitivity as mosquito larvae (Mian and Mulla 1992). These include mayflies, stoneflies, whirligig beetle, caddisflies, and the snipefly. The water boatman and backswimmer have low sensitivity to some pyrethroids. See Table 2 of Mian and Mulla (1992). Deltamethrin is very highly toxic to honey bees (USEPA 2010a) (Table 6.1).

4.1.5.4 Summary of Toxicity and Potential Effects

Deltamethrin may be persistent in high organic matter soils and aquatic sediments. It is nonselective and therefore, may pose risk to non-target organisms such as honey bees. Deltamethrin is highly toxic to fish (and bioaccumulative) and invertebrates, however, it is generally not applied to aquatic systems. It is not expected to pose risk to aquatic receptors under the prescribed application usage by the MVCAC districts.

One product containing deltamethrin (0.05 percent) is used by two Districts for yellow jacket wasp control. It is primarily used in the summer months to specifically target yellow jacket wasp ground nests. It was applied almost 300 times during the summer of 2011. There are a range of limited exposure and localized and limited usage patterns and potential unwanted effects are dependent on the use.

4.1.6 Esfenvalerate

Esfenvalerate is a broad-spectrum nonselective insecticide applied as needed for the control of a wide selection of arthropod pests. Esfenvalerate is a mixture of four stereoisomers, enriched with the S,S-isomer, the most insecticidally active isomer. (The parent mixture, fenvalerate, is a mixture of the same four isomers in relatively equal proportions.) Esfenvalerate containing products registered for use in California are applied for home/garden consumer use, commercial pesticide application use, and agricultural production use (Kelley 2003). Esfenvalerate is a voltage-dependent sodium-channel agonist. Esfenvalerate works against the insect nervous system, resulting in repetitive firing of neurons.

4.1.6.1 Environmental Fate

Esfenvalerate is practically insoluble in water, extremely hydrophobic and has a strong tendency to bind to soil particles. Esfenvalerate, as a result of these characteristics, is relatively immobile in soil and shows a low tendency to leach. Esfenvalerate, when present in surface waters, is expected to be bound to suspended particulates (clay, soil, and sediment particles) and to organic matter (Kelley 2003). Primary degradation pathways include photolysis and aerobic metabolism (Table 4-5). (FAO-WHO 2002b)

Table 4-5 Degradation of Esfenvalerate

Degradation Method	Half-life	Reference
Hydrolysis, pH 5–9	64 to 130 Days	FAO-WHO 2002b, Kelley 2003
Photolysis (water)	6 to 17.2 Days	FAO-WHO 2002b, Kelley 2003
Photolysis (soil)	3 to 15.8 Days	FAO-WHO 2002b, Kelley 2003
Aerobic metabolism (water)	4 to 72.3 Days	Kelley 2003
Aerobic metabolism (soil)	35 to 546 Days	FAO-WHO 2002b, Kelley 2003
Anaerobic metabolism (water)	65 to 79 Days	Kelley 2003
Anaerobic metabolism (soil)	104 to 203 Days	Kelley 2003

4.1.6.2 Human Toxicity

Esfenvalerate is relatively new compared to other pesticides on the market; therefore, the usage history for this compound is incomplete. The oral LD50 of esfenvalerate in rats is 458 mg/kg. The dermal LD50 in rabbits is 2,000 mg/kg (considered moderately toxic). The inhalation LC50 in rats is greater than 2.93 mg/L (EXTOXNET 1994). Esfenvalerate has not been implicated in cancer or birth defects in mammal studies. Esfenvalerate is included in the final list of candidate chemicals for screening under the USEPA Endocrine Disruptor Screening Program (USEPA 2009a) (Table 6.1).

4.1.6.3 Ecological Toxicity

Esfenvalerate is moderately toxic to birds. The acute oral LD50 for mallard ducks is 9,932 mg/kg. The compound is highly toxic to fish and aquatic invertebrates. Esfenvalerate is highly toxic to bees. The compound tends to repel bees for a day or two after application. Most intoxicated bees die in the field before they can return to the hive (EXTOXNET 1994). The 96-hr LC50 is 0.00026 mg/L for bluegill and rainbow trout and 0.00024-mg/L for *Daphnia magna* (EXTOXNET 1994). Esfenvalerate rapidly bioaccumulates in fish. The bioaccumulation factor in rainbow trout is about 400 times the background esfenvalerate water concentrations. The chemical is also highly toxic to bees (EXTOXNET 1994) (Table 6.1).

4.1.6.4 Summary of Toxicity and Potential Effects

Esfenvalerate is insoluble in water and tends to bind to organic matter in soils and sediment with low leaching potential. Degradation occurs through photolysis and aerobic metabolism, therefore it does not appear to persist in the environment. This pesticide is generally deployed in bait stations above the ground, which limits its release to the soil surface and aquatic systems. Esfenvalerate is considered moderately toxic to mammals and birds; and highly toxic to aquatic invertebrates and honey bees. In addition, it is both highly toxic to and bioaccumulative in fish.

Esfenvalerate was not used by the MVCAC districts during the reporting year. As a result, potential loading scenarios to different habitats types could not be determined. Potential non-target biological receptors could also not be surmised due to the lack of habitat-specific application data. However, as noted above, honey bees could be at risk from this pesticide. There is a lack of persistence potential and the Districts did not use esfenvalerate products during the reporting year.

4.1.7 Lambda-cyhalothrin

Lambda-cyhalothrin is a synthetic pyrethroid insecticide used for controlling pest insects in agriculture, public health, and in construction and households. Lambda-cyhalothrin is a 1:1 mixture of two of the four enantiomers, which constitute cyhalothrin. Insecticidal products containing lambda-cyhalothrin have been widely used to control insect pests in agriculture, public health, and homes and gardens (He et al. 2008).

4.1.7.1 Environmental Fate

Lambda-cyhalothrin is an extremely hydrophobic compound and has rapid and strong adsorption to soils and sediments. Lambda-cyhalothrin residues dissolved in water decrease rapidly if suspended solids and/or organic materials are present because lambda-cyhalothrin molecules are strongly adsorbed by particulates and plants (He et al. 2008). Primary degradation pathways include photolysis and aerobic metabolism (FAO-WHO 2008).

Table 4-6 Degradation of Lambda-cyhalothrin

Degradation Method	Half-life	Reference
Hydrolysis, pH 5	Stable	FAO-WHO 2008
Hydrolysis, pH 7	454 to Days	FAO-WHO 2008
Hydrolysis, pH 9	7.3 Days	FAO-WHO 2008
Photolysis	24 Days	FAO-WHO 2008
Aerobic metabolism (soil)	22 to 83 Days	FAO-WHO 2008
Microcosm (water)	<1 Day	He, et al. 2008

4.1.7.2 General Toxicity

In 2005, a pyrethroid insecticide analysis report was completed for the Sacramento, San Joaquin, and Central valleys to summarize existing information on pyrethroid usage patterns, fate and transport, and toxicity (Oros and Werner 2005). The report identified lambda-cyhalothrin as one of the top five pyrethroids used in these areas to manage pests in a variety of settings and applications. According to Oros and Werner (2005), lambda-cyhalothrin has been found in sediments at levels that are known to be toxic to the several representative invertebrate species in the Sacramento, San Joaquin, and Central valleys.

4.1.7.3 Human Toxicity

Lambda-cyhalothrin is moderately toxic via the acute oral, dermal, and inhalation routes (NPIC 2001).The median lethal oral dose (LD50) of lambda-cyhalothrin has been reported at 56 to 79 mg/kg for female and male rats, respectively or as high as 144-mg/kg (Ray 1991). Technical-grade lambda-cyhalothrin is less toxic when exposure occurs dermally, given its relatively poor absorption by this route; dermal LD50s of 632 mg/kg and 696 mg/kg for male and female rats have been cited. One of the formulated products, Karate®, can cause significant skin and eye irritation (Ray 1991).

Acute exposure to lambda-cyhalothrin has been linked with changes in neurological function when administered at a single dose of 0, 2.5, 10, or 35 mg/kg-d, a result consistent with its action on sodium channel permeability (USEPA 2002). Rats exposed for 4-hours to an aerosol of cyhalothrin at concentrations of 3.68 to 68 mg/m^3 exhibited a concentration-dependent increase in signs of neurotoxicity. Effects ranged from lethargy and salivation at the lowest concentration, to death (shortly after termination of exposure) at the highest concentration (Curry and Bennet 1985).

Chronic studies of lambda-cyhalothrin and cyhalothrin have repeatedly and consistently documented decreased body weight gain and reduced food consumption exposure levels as low as 0.9 mg/kg/day, with numerous study results yielding NOAELs of 1 to 2.5 mg/kg/day. Signs of neurotoxicity and changes in organ weights are also common effects of chronic exposure to lambda-cyhalothrin and cyhalothrin (USEPA 2002, 2004a, 2007b, a).

Although little research on the developmental toxicity of lambda-cyhalothrin is publically available, the information provided by the USEPA indicates that the maternal NOAEL was 10 mg/kg-d for both species (USEPA 2002, 2004a). The developmental NOAEL was the highest dose tested in each study; in rats, it was 15 mg/kg-d, and in rabbits, 30 mg/kg-d. A study of the reproductive effects of this compound over three generations indicated a LOAEL of 5.0 mg/kg-d which elicited adverse effects in both the parents and pups, with toxicity manifested as reduced body weight and body weight gain in the parents, and reduced pup weight and reduced pup weight gain during lactation (USEPA 2002, 2004a). No genotoxicity data for cyhalothrin or lambda-cyhalothrin were identified in recent USEPA pesticide tolerance documents (USEPA 2002, 2004a, 2007b,). A chronic feeding study of cyhalothrin in the diets of rats resulted in no oncogenic effects (USEPA 2002) (Table 6.1).

4.1.7.4 Ecological Toxicity

Lambda-cyhalothrin is of low toxicity to birds. The oral LD50 for the mallard duck is >3,950 mg/kg and the dietary LC50 for the bobwhite quail is 5,300 mg/kg (WHO 2007). A 1-year neurotoxicity study on the dog where lambda-cyhalothrin was administered by gavage, derived a NOAEL of 0.5 mg/kg bw per day and a LOAEL of 3.5 mg/kg bw per/day. Systemic neurotoxicity (i.e., ataxia, tremors, and occasionally convulsions) was observed, with an overall NOAEL of 0.5 mg/kg bw per day. Signs of systemic neurotoxicity were observed from the first week and generally occurred within a few hours after treatment (PMRA 2003). In 2007, the USEPA released a revised Pesticide Tolerance for lambda-cyhalothrin, published in the Federal Register Volume 72, Number 157, indicating that the dog is known as the most vulnerable to toxic effects.

Lambda-cyhalothrin is highly toxic to aquatic organisms, including fish, shellfish, shrimp, crabs and clams (He et al. 2008). The 96-hr LC50 is 0.21 µg/L for bluegill (WHO 2007) and 0.24-µg/L for rainbow trout (He et al. 2008). The 48-hr LC50 for *Daphnia magna* is 0.36 µg/L (He et al. 2008).

Lambda-cyhalothrin is known to be toxic to honey bees. As presented by IPCS, honey bees have an oral LD50 of 0.97 µg/bee. Additionally, He et al. (2008) reported an oral LD50 over 48-hours and contact LD50 of 0.038 µg/bee and 0.909 µg/bee (Table 6.1).

4.1.7.5 Summary of Toxicity and Potential Effects

Lambda-cyhalothrin may be persistent in the absence of light and has been found at concentrations known to be toxic to aquatic invertebrates. The potential for persistence of this chemical and its toxicity to mammals, aquatic organisms (vertebrates and invertebrates), and non-target insects such as honey bees is of concern from a potential human and ecological risk perspective.

Lambda-cyhalothrin is available to the public in commonly-used products for residential wasp control. Lambda-cyhalothrin is used by one district for targeted application to yellow jacket and paper wasp nests. This product (0.01 percent lambda-cyhalothrin) is used throughout the year and exceeded 2,000 ounces (volume) of product and less than one ounce of active ingredient during the reporting year. Some of the Districts use products containing this active ingredient as a courtesy to the public to assist with wasp control at residences (restricted to yards, gardens, and home exteriors). The amount applied directly to wasp nests (by the public and the Districts) is minute and there is little to no potential for non-target organism exposures. The potential for human exposure (public and trained professionals [e.g., District staff]) is extremely low when use product label instructions are properly followed.

Although there is a potential for environmental persistence and exposure to domestic pets and non-target receptors, this a.i. is readily available as an insect spray and the uses by the Districts are generally focused, and very localized to minimize or eliminate those exposures.

4.1.8 Resmethrin

Resmethrin has been registered by the EPA since 1967, and is used to control flying and crawling insects in the home, lawn, garden, and industrial sites. It can also be used to control insects on ornamental plants (outdoor and greenhouse use), on pets and horses, and as a mosquitocide. Resmethrin is also used at commercial and industrial areas, warehouses, urban areas, and golf courses, and on aquatic areas or standing water, and selected agricultural crops. Because of its toxicity to fish, resmethrin is a restricted-use pesticide (RUP) for the purpose of public health mosquito abatement, and is available for this use only by certified pesticide applicators or persons under their direct supervision. Resmethrin works by interacting with sodium channels in the peripheral and central nervous system of target organisms (USEPA 2006g).

4.1.8.1 Environmental Fate

Resmethrin degrades rapidly when exposed to light; however, when not subject to photolysis, resmethrin tends to be environmentally persistent (Table 4-7). Reported half-lives in water range from 22 minutes (photolysis in seawater) to 37 days (aerobic metabolism). Resmethrin has low mobility and has a high affinity to bind to soils/sediments and organic carbon (USEPA 2006g).

Table 4-7 Degradation of Resmethrin

Degradation Method	Half-life	Reference
Hydrolysis, pH 5 – 9	>89 Days	USEPA 2006c
Photolysis (distilled water)	47 minutes	USEPA 2006c
Photolysis (seawater)	22 minutes	USEPA 2006c
Aerobic metabolism (water)	37 Days	USEPA 2006c
Aerobic metabolism (soil)	198 Days	USEPA 2006c
Anaerobic metabolism (soil)	Stable	USEPA 2006c

4.1.8.2 Human Toxicity

Resmethrin has low acute toxicity via the oral (Category III), dermal (Category III), and inhalation (Category IV) routes of exposure. It is not an eye or skin irritant nor is it a skin sensitizer. The oral LC50 was 4639 to 6091 mg/kg in rats, the dermal LC50 was found to be greater than 2000 mg/kg in rabbits, and the inhalation LC50 was found to be 5.28 mg/L in rats (USEPA 2006g). Resmethrin is included in the final list of chemicals for screening under the USEPA Endocrine Disruptor Screening Program (USEPA 2009a) (Table 6.1).

4.1.8.3 Ecological Toxicity

Resmethrin is moderately toxic to birds. The oral LD50 for red-winged blackbirds is 75 mg/kg. Resmethrin technical grade active ingredient is very highly toxic to freshwater fish and invertebrates and to estuarine/marine fish and invertebrates. The LC50 or EC50 ranges from 0.28 to 11 µg/L for rainbow trout (*Oncorhynchus mykiss*), water flea (*Daphnia magna*), sheepshead minnow (*Cyprinodon variegatus*), and pink shrimp (*Penaeus duorarum*). Both freshwater fish and estuarine/marine fish early life-stage chronic toxicity tests were used to evaluate the chronic toxicity of resmethrin. Results from the freshwater fish early life-stage toxicity test indicated a NOAEC of 0.32 µg/L and an LOAEC of 0.59 µg/L (EPA 2006b). Resmethrin is very highly toxic to honey bees (LD50 = 0.063 µg/bee) (USEPA 2006g).

SWRCB has evaluated aquatic life toxicity data from USEPA's Office of Pesticides' Ecotoxicity Database and has identified the lowest LC50 for resmethrin of 0.28 µg/L (SWRCB 2012). This value is based on toxicity to rainbow trout during a 96-hour test (Table 6.1).

4.1.8.4 Ecological Toxicity associated with ULV Application for Mosquito Abatement

Abbene et al. (2005) evaluated deposition of resmethrin in formulation with PBO (Scourge) following truck-mounted applications in fresh and salt water marshes at 6 sites. Resmethrin was not detected in water samples from any site (<0.005 µg/L). Deposition of resmethrin following aerial applications by helicopter was assessed in the same report (Abbene et al. 2005). Applied materials were detected in some water samples taken within 30 minutes of the application. The average concentration of resmethrin following helicopter applications was 0.037 µg/L. The highest concentrations were found in some samples collected from surface water within 1 hour of helicopter applications (0.293 µg/L resmethrin). The authors carried out a series of sample collections after two spray events to evaluate the persistence of the material in water. Resmethrin displayed an exponential decrease and was not detected (<0.005 µg/L) within 9 hours of the application. One site included two repeat weekly applications of resmethrin following an application of methoprene the prior week. Concentrations of resmethrin and PBO measured after the second application were lower than those measured after the first application.

The same study included effects of aerial applications of resmethrin and PBO on two aquatic organisms: the sheepshead minnow (*Cyprinodon variegatus*) and the estuarine grass shrimp (*Palaemonetes pugio*) (Suffolk County 2006). The field study faced problems with low dissolved oxygen and high temperature, which compromised their ability to detect toxicity that may have been due to pesticide exposure. Therefore, dosing experiments and prey capture tests were conducted in the laboratory to measure toxicity of the applied products. These tests demonstrated that the doses used in the spray were not directly toxic to grass shrimp and did not affect their ability to capture prey under controlled conditions. Further laboratory experiments demonstrated that all of the mortality seen in the field could have been caused by low dissolved oxygen alone, using a USEPA time-to-death approach. Furthermore, their data showed that the chemicals used had very low persistence in the water column, as discussed above. Resmethrin was never detected in sediment and was not detected in samples from surface water taken more than 2 hours after the spray.

A related study evaluated benthic community structure, and found that benthic population differences could not be attributed to the application of pesticides, but were more likely due to environmental differences (Suffolk County 2006).

Zulkosky et al. (2005) sampled freshwater ponds, salt marshes, tidal inlets and embayments, and marine coastal water off Staten Island, New York within an hour after mosquito control applications of resmethrin (Scourge). In 2002, resmethrin was detected in five of ten locations at concentrations ranging from 0.0017 to 0.98 µg/L (detection limit of 0.0005 µg/L). No information was provided on application methods at each site.

4.1.8.5 Summary of Toxicity and Potential Effects

Resmethrin may also be persistent in environments free of light (e.g., bound to organic matter in anoxic soils and sediments). Due the potential for persistence and high toxicity to both aquatic and estuarine/marine fish and invertebrates, as well as the potential for endocrine disruption, this RUP may be of concern from a potential ecological risk perspective.

Resmethrin is contained in one product (18.5 percent) used by one of the Districts. It is applied to tree holes, residential areas near reclaimed marshes, and industrial areas for mosquito control. Seven applications during the spring and summer (2012 and 2011, respectively) resulted in the use of almost two gallons of product (<0.5 gallons of resmethrin). Studies have shown rapid dissipation/low persistence and no observed aquatic fish and invertebrate toxicity following aerial ULV applications.

Scourge® is being phased out of the District’s program and replaced with a nonresmethrin alternative, making this product less problematic.

4.1.9 Tetramethrin

Tetramethrin is part of the pyrethroid class of pesticides and was first registered in 1968. It is a broad spectrum, nonsystemic, synthetic pyrethroid used to control flying and crawling insects in a number of commercial, horticultural and residential applications. Commercial applications include space, broadcast and crack-and-crevice treatment in a variety of commercial, industrial, residential, and institutional sites. Horticultural applications include foliar and fogger treatment on nonfood plants. Residential uses include pest control in homes and outdoor domestic structures, on gardens and direct application to cats, dogs and horses. Tetramethrin is a mixture of four stereoisomers designated as 1R-trans, 1R-cis, 1S-trans, and 1S-cis in an approximate ratio of 4:1:4:1. The first two isomers are the most insecticidally active (USEPA 2010c).

4.1.9.1 Environmental Fate

Tetramethrin is not a persistent pyrethroid in the environment (Table 4-8). It may be co-formulated with synergists, other active ingredients such as pyrethrins and pyrethroids, and growth inhibitors. These other ingredients are more persistent than tetramethrin and provide residual activity against insects not initially exposed. Tetramethrin decomposes rapidly by photolysis and hydrolysis in shallow, nonturbid water. Tetramethrin is slightly mobile in soil (USEPA 2010c).

Table 4-8 Degradation of Tetramethrin

Degradation Method	Half-life	Reference
Hydrolysis, pH 5	15.9 to 19.7 Days	USEPA 2010b
Hydrolysis, pH 7	0.89 to 1.06 Days	USEPA 2010b
Hydrolysis, pH 9	13 to 20 minutes	USEPA 2010b
Photolysis (air)	30 minutes	USEPA 2010b

4.1.9.2 Human Toxicity

The USEPA considers tetramethrin to be slightly toxic via the oral and dermal routes (Category III or IV) and classifies it as a Category III eye irritant. The oral LD50 for rats is >5,000 mg/kg. The dermal LD50 for rabbits is >2,000 mg/kg. Tetramethrin meets the criteria for classification as a possible human carcinogen (USEPA 2010c) (Table 6.1).

4.1.9.3 Ecological Toxicity

The USEPA evaluated the potential ecological risk posed by use of tetramethrin both indoors and outdoors and concluded that exposure to non-target organisms is unlikely. Tetramethrin is considered practically nontoxic to birds and terrestrial mammals. The oral LD50 for bobwhite quail is >2,250 mg/kg bw (USEPA 2010c). Tetramethrin is considered highly toxic to aquatic organisms. The 96-hr LC50 of tetramethrin for rainbow trout is 3.7 µg/L. The 48-hr EC50 for immobilization of *Daphnia magna* is 45 µg/L (USEPA 2010c). Tetramethrin is also highly toxic to honey bees. The contact 48-hr LD50 is 0.155 µg/bee (Table 6.1).

4.1.9.4 Summary of Toxicity and Potential Effects

Tetramethrin is not persistent in the environment and degrades rapidly (photolysis and hydrolysis) in surface waters. It is only slightly mobile in saturated soils and is highly toxic to fish and aquatic invertebrates, as well as honeybees. Tetramethrin does not appear to pose a risk to humans; however, it has been classified as a possible human carcinogen.

Tetramethrin is used by one district during the spring, summer, and fall for yellow jacket and paper wasp control. A single product (containing 0.1 percent tetramethrin) was applied directly to more than 80 nests, which corresponded to approximately 2,000 ounces (volume) of product, or approximately 2 ounces of active ingredient used during the reporting year. Although there is a potential for effects to fish and aquatic invertebrates, the uses by the Districts are generally focused, and very localized to minimize or eliminate those potential nontarget exposures.

4.1.10 Permethrin

Permethrin is a Type I pyrethroid (i.e., it lacks a cyano group at the α carbon position of the alcohol moiety) that primarily targets the nervous system of insects, causing muscle spasms, paralysis, and death (USEPA 2006d). Permethrin has been registered by the EPA since 1979, and is currently registered and sold in a number of products such as household insect foggers and sprays, tick and flea sprays for yards, flea dips and sprays for cats and dogs, termite treatments, agricultural and livestock products, and mosquito abatement products. Permethrin is also used at urban areas, household gardens, recreation areas, golf courses, hospitals, zoos, pastureland, and animal husbandry areas (CDPR 2010a).

4.1.10.1 Environmental Fate

Permethrin has very low mobility, is moderately persistent and has a high affinity to bind to soils/sediments and organic carbon. The relatively low water solubility and hydrophobic nature of permethrin leads to strong soil adsorption and a tendency to partition to sediment in aquatic systems. It is also slow to hydrolyze and biodegrade. Reported half-lives in surface water range from 1.8 hours to <2.5 days (Imgrund 2003). Major degradation pathways include photolysis and microbial metabolism (Table 4-9).

Table 4-9 Degradation of Permethrin

Degradation Method	Half-life	Reference
Hydrolysis	Stable (pH 3-6), 125–350 Days (pH 9)	DPR 2010, USEPA 2009a
Photolysis, ponds (water)	19.6 to 27.1 Hours	Imgrund 2003
Photolysis (soil)	104 to 324-Days	Imgrund 2003
Aerobic metabolism (soil)	3.5 to 113 Days	Imgrund 2003
Anaerobic metabolism (water)	113 to 175 Days	USEPA 2009a
Anaerobic metabolism (soil)	<3 to 197 Days	Imgrund 2003
Sediment/seawater degradation	<2.5 Days	Imgrund 2003
Streams, pH 7.0 to 7.5, 13 to 15°C	1.8 to 20.4 Hours	Imgrund 2003

4.1.10.2 Human Toxicity

Acute oral studies conducted with rats by the Department of Defense (DOD 1977) showed that exposure to permethrin caused tremors, weight loss, and increased liver and kidney weights starting at 185 mg/kg. The NOAELs in the DOD studies ranged from 92 to 210 mg/kg.

Oral LD50 values in rats range from 220 mg/kg to 8900 mg/kg and in mice, from 230 mg/kg to 1,700 mg/kg (IPCS 1999). The lethal dose of permethrin depended both on the vehicle in which permethrin was administered, as well as the cis/trans composition of the mixture. Permethrin is only slightly toxic via the dermal route, with an LD50 >2,000 mg/kg in rabbits (Braun and Killeen 1975b, Sauer 1980a). Permethrin of various cis/trans formulations has caused only very mild irritation when applied to either intact or abraded skin of rabbits (Braun and Killeen 1975b, a, Sauer 1980c, b). Dermal exposure in humans can cause tingling and pruritus with blotchy erythema on exposed skin, and has caused transient paresthesia (ATSDR 2003).

In humans, acute effects observed subsequent to ingestion of permethrin included nausea, vomiting, abdominal pain, headache, dizziness, anorexia, and hypersalivation. Reports of severe poisoning are rare and usually follow ingestion of substantial, but poorly described, amounts of permethrin. Symptoms of severe poisoning include impaired consciousness, muscle fasciculation, convulsions, and noncardiogenic pulmonary edema (ATSDR 2003). Dermal exposure in humans can cause tingling and pruritus (itchy sensation) with blotchy erythema (reddening of the skin) on exposed skin. Systemic effects are similar to those seen in acute and chronic ingestion with prolonged contact or contact with high concentrations of permethrin. Acute toxicity to permethrin via inhalation has been shown to be very small. The 4-hour LC50 was 23.5 mg/L for inhalation in rats (Kidd and James 1991).

The USEPA (2006a) has classified permethrin as category III for acute oral and acute dermal toxicity; category III for eye irritation potential, and category IV for dermal irritation potential. Technical grade permethrin is not considered a skin sensitizer (USEPA 2006a). Permethrin is included in the final list of chemicals for screening under the USEPA Endocrine Disruptor Screening Program (USEPA 2009a) (Table 6.1).

4.1.10.3 Ecological Toxicity

Permethrin can be toxic to wildlife at high doses and it should not be applied or allowed to drift to crops or weeds where active foraging takes place (USEPA 2006d). However, in controlled toxicity tests with mammals permethrin is considered to have low mammalian toxicity (Nowak et al. 2000). Permethrin has low toxicity to dogs (Richardson 1999), gerbils, guinea pigs, hamsters, mice and rats (Sutton et al. 2007); however, dermal exposure in cats of 100 mg/kg of permethrin (equivalent to 1 mL of a 45 percent PSO in a 4.5 kg cat) has resulted in life-threatening effects (Hansen 2006).

Permethrin is practically nontoxic to birds (USEPA 2006d). The acute 5-day dietary LC50 for mallard ducks is >10,000 mg/kg/day.

Permethrin is very highly toxic to fish and aquatic invertebrates. The 96-hr LC50 for bluegill sunfish is 0.79 µg/L. The EC50 for *Hexagenia bilineata* is 0.1 µg/L (USEPA 2006d).

Permethrin is highly toxic to bees in laboratory conditions from contact exposure. Acute contact and oral toxicity reported by USEPA (USEPA 2006d), was an LD50 of 0.13 µg/bee and 0.024-µg/bee, respectively. Theiling and Croft (1988) indicate that severe losses may be expected if bees are present at the time of treatment, or within a day thereafter. However, when used properly, permethrin has a strong repellent effect in the environment and has been considered to pose little risk to bees (USEPA 2006d) (Table 6.1).

4.1.10.4 Ecological Toxicity associated with ULV Application for Mosquito Abatement

Deposition of permethrin following truck-mounted application was evaluated in large seasonal wetlands in California (Jensen et al. 1999). Permethrin was not detected (<20 µg/L) in surface waters 1 hour after ULV applications. The authors found no significant differences in macroinvertebrate abundance and biomass or species diversity in areas treated with any of the materials when compared with untreated ponds. No mortality occurred in mosquitofish held in sentinel cages in treated ponds. Similarly, no difference in mortality was observed for mosquito larvae held in sentinel cages in treated ponds when compared with untreated ones. The authors concluded that ULV applications for adult mosquito control were not likely to significantly affect aquatic insects or fish in these habitats.

Davis and Peterson (2008) measured family diversity, richness, and evenness at 1, 7, 14, and 28 days after truck application of permethrin. Most response variables showed no significant treatment effect, although there were some reductions in number of individuals. The authors concluded that the reductions in aquatic non-target populations did not suggest any trends or persistent deleterious biological effects following a single adulticide application. Significant differences for the pond study were found on the dates closest to the spray event.

Pierce et al. (2005) evaluated deposition after two permethrin ULV applications made with truck-mounted equipment on Key Largo, Florida. They collected samples in the Atlantic Ocean and Florida Bay on either side of the treated area, including measurement of pesticide residues on glass fiber pads set on floats above the water surface, and water collected from the surface microlayer and 20 centimeters below the surface. Water was sampled from a canal running through the treated area following a third application. With the exception of a 0.07 µg/L sample from the bay, permethrin was not detected in the offshore samples; however, permethrin was detected in samples of the water surface microlayer taken from the canal. Detection of permethrin occurred in samples of the surface microlayer taken 2 to 4-hours after the applications (5.1 to 9.4-µg/L). Samples taken below the water surface did not contain detected residues. Within 12 hours of the application, permethrin was undetected in either surface microlayer or subsurface water. The application was carried out shortly before the arrival of a hurricane, and droplet size was not reported. This is the only published study in which significant amounts of pesticide were detected following an application by truck-mounted equipment. This study did not measure PBO concentrations.

4.1.10.5 Summary of Toxicity and Potential Effects

Permethrin may also be persistent in environments free of light (e.g., bound to organic matter in anoxic soils and sediments). Due the potential for persistence and high toxicity to both aquatic and estuarine/marine fish and invertebrates, as well as the potential for endocrine disruption, this RUP may be of concern from a potential ecological risk perspective.

Permethrin is used by three Districts for mosquito or yellow jacket wasp control during the spring, summer, and fall. Four products containing permethrin were used during the reporting year. Some Districts reported permethrin use in volume while others reported use by weight. For the reporting year, approximately 3 ounces (weight) and approximately 20 ounces (volume) of permethrin were applied. These products were used in reclaimed marshes, around residences, and applied directly to ground nests. Three of the products used contain between 2.5 and 4.6 percent permethrin. The fourth and most commonly used product contains 0.25 percent permethrin.

Studies have shown rapid dissipation/low persistence and no observed aquatic fish and invertebrate toxicity following aerial ULV applications; however, these studies are limited and inconclusive. Based on its potential for endocrine disruption, usage patterns, as well as the availability of safer alternatives for wasp control this product is generally used with careful and strict BMP applications.

4.1.11 Etofenprox

Etofenprox is a pyrethroid-like insecticide registered by the EPA since 2001. Similar to pyrethroids, etofenprox acts on ion channels of the insect nervous system. It is used as an insecticide with contact and stomach action against many pests on a broad range of crops. Etofenprox differs in structure from pyrethroids in that it lacks a carbonyl group and has an ether moiety, whereas pyrethroids contain ester moieties. It is used as an indoor nonfood crack and crevice insecticide, a spot treatment for pets, and as an outdoor fogger to control a variety of insect pests. Etofenprox is used in backyards, patios, barns, picnic areas, and other areas where flying and crawling insects are a problem. It is also used as a mosquito adulticide.

4.1.11.1 Environmental Fate

Etofenprox is virtually insoluble in water, stable to hydrolysis, and is rapidly degraded with light (Table 4-10). In water/sediment systems, etofenprox degrades relatively quickly. Residues of etofenprox are not likely to persist in the environment (FAO-WHO 2011).

Table 4-10 Degradation of Etofenprox

Degradation Method	Half-life	Reference
Hydrolysis	Stable	FAO-WHO 2011
Photolysis (water)	1.7 to 7.9 Days	Central Life Sciences 2009, FAO-WHO 2011
Photolysis (soil)	4.4 Day	Central Life Sciences 2009
Water/sediment systems (water)	1 to 10 Days	FAO-WHO 2011
Water/sediment systems (sediment)	6 to 20 Days	FAO-WHO 2011

4.1.11.2 Human Toxicity

Etofenprox has low acute toxicity via the oral, dermal, and inhalation routes. It is not an acute eye or skin irritant and is not a dermal sensitizer, however etofenprox does cause skin irritation after repeated exposure (USEPA 2008a).The acute oral and dermal LD50 values in rats are both greater than 2,000 mg/kg. The acute oral LD50 value in the dog is greater than 5,000 mg/kg. The acute 4-hour inhalation LC50 value in the rat is greater than 5.88 mg/L. Etofenprox was not irritating to rabbit skin or rabbit eyes. Etofenprox was not a skin sensitizer in the guinea-pig maximization test (FAO-WHO 2011). The major target organs of etofenprox are the liver, thyroid, kidney, and hematopoietic system (EPA 2008d). In rats the target organs are the liver and thyroid. The NOAEL for chronic toxicity is 3.7 mg/kg/day for male rats. The target organ in mice is the kidney. The NOAEL is 3.1 mg/kg/day for mice (Wellmark International 2010) (Table 6.1).

4.1.11.3 Ecological Toxicity

Etofenprox is toxic to aquatic organisms, including fish and invertebrates. The LC50 for rainbow trout is 3.3 µg/L and the LC50 for bluegill is 8.5 µg/L. Product formulations are toxic to bees exposed to direct treatment on blooming crops and weeds (Wellmark International 2010).

SWRCB has evaluated freshwater aquatic life toxicity data from USEPA Office of Pesticides' Ecotoxicity Database and has identified the lowest LC50 for etofenprox as 0.019 µg/L. This value is based on toxicity to mysid shrimp during a 96 hour test (SWRCB 2012) (Table 6.1).

4.1.11.4 Summary of Toxicity and Potential Effects

Etofenprox does not tend to persist in the environment or appear to pose a risk to mammals as it is frequently applied to backyards and patios, and sometimes directly to domestic pets. It does exhibit some toxicity to fish and aquatic invertebrates; however, it degrades rapidly in surface waters thereby reducing the potential for long-term exposures and adverse effects.

Etofenprox was applied as a single application to a waste treatment plant in both fall and summer by one District during the reporting year. Approximately 14-ounces (volume) of etofenprox was used for the two treatments. It is generally applied during the nighttime hours when sensitive receptors such as honeybees are not active. Etofenprox is available in a new product, Zenivex that does not require synergists such as PBO. Therefore, it likely exhibits less toxicity than others that require co-application with other chemicals, including synergists to increase its efficacy for mosquito control. Based on toxicity, environmental fate, and usage patterns, etofenprox, using BMPs, is not likely to result in unwanted adverse impacts.

4.1.12 Piperonyl Butoxide

PBO was first registered in the 1950s and acts as a synergist. Synergists are chemicals that primarily enhance the pesticidal properties of other active ingredients, such as pyrethrins and synthetic pyrethroids. PBO is a registered active ingredient in products used to control many different types of flying and crawling insects and arthropods, although there are no products that contain only PBO. It is registered for use in agricultural, residential, commercial, industrial, and public health sites. PBO interferes with the insect's ability to detoxify pyrethrins and pyrethroids, thus enhancing the product's effectiveness. PBO inhibits microsomal enzymes in target organisms by direct binding to these enzymes and inhibits the breakdown of other pesticides including pyrethrins and pyrethroids (USEPA 2006e).

4.1.12.1 Environmental Fate

PBO degrades rapidly in the environment by photolysis in water and is metabolized by soil microorganisms (Table 4-11). Other tested routes of degradation, such as hydrolysis, aerobic and anaerobic aqueous metabolism, are very slow or have questionable rates due to experimental difficulties, as in the case of soil photodegradation. PBO is moderately mobile in soil-water systems (USEPA 2006e).

Table 4-11 Degradation of Piperonyl Butoxide

Degradation Method	Half-life	Reference
Hydrolysis, pH 5-9	Stable	USEPA 2006b, FAO-WHO 2002c
Photolysis (water)	8.4 Hours	USEPA 2006b
Aerobic metabolism (water/sediment)	>30 Days	FAO-WHO 2002c
Anaerobic metabolism (water/sediment)	>181 Days	FAO-WHO 2002c
Terrestrial dissipation (soil)	1 to 14 Days	FAO-WHO 2002c

4.1.12.2 Human Toxicity

PBO has a low acute toxicity by oral, inhalation and dermal routes. It has been assigned toxicity USEPA Category III by oral and dermal and Category IV by inhalation exposure routes. In the acute studies, PBO has been identified as minimally irritating to eyes and skin, and is a dermal sensitizer. The oral LC50 was 4,570 to 7,220 mg/kg in rats, the dermal LC50 was found to be greater than 2,000 mg/kg in rabbits, and the inhalation LC50 was found to be greater than 5.9 mg/L in rats (USEPA 2006e). The major target organ for PBO is the liver. Subchronic studies in rats showed PBO treatment caused increases in liver weight and clinical parameters such as cholesterol and enzyme activity compared to controls (USEPA 2006e). PBO is included in the final list of chemicals for screening under the USEPA Endocrine Disruptor Screening Program (USEPA 2009a) (Table 6.1).

4.1.12.3 Ecological Toxicity

PBO is moderately toxic to freshwater fish on an acute basis (LC50 = 1.9 mg/L) based on studies of rainbow trout (*Oncorhynchus mykiss*). PBO ranges from moderately toxic (LC50 = 12.0 mg/L) to highly toxic (LC50 = 0.51 mg/L for waterflea, *Daphnia magna*) to freshwater invertebrates on an acute basis. PBO is moderately toxic to estuarine/marine fish (LC50 = 3.94-mg/L) based on observed effects to sheepshead minnow (*Cyprinodon variegatus*) on an acute basis. PBO is highly toxic to estuarine invertebrates (LC50 = 0.49 mg/L) based on studies with mysid shrimp (*Mysidopsis bahia*). PBO is highly toxic to amphibians on an acute basis (LC50 = 0.21 mg/L) based on studies with western chorus frog tadpoles (*Pseudacris triseriata*) (USEPA 2006e).

A chronic early life stage of fish study with fathead minnow evaluated embryo survival at hatch and length and weight of larvae. This study found a LOEC of 0.11 mg/L. A study with water fleas found a LOEC of 0.047 mg/L (USEPA 2006e)

SWRCB has evaluated toxicity data from U.S. EPA's Office of Pesticides' Ecotoxicity Database for PBO when applied in formulation with pyrethrins. The lowest LC50 was 0.14-µg/L, based on toxicity to mysid shrimp during a 96-hour test. Toxicity data was also evaluated for PBO when applied in formulation with resmethrin. SWRCB identified the lowest LC50 as 1.3 µg/L based on toxicity to pink shrimp during a 96-hour test. For PBO applied in formulations other than pyrethrins or resmethrin, SWRCB identified the lowest LC50 as 490 µg/L based on toxicity to mysid shrimp during a 96-hour test (SWRCB 2012). PBO is practically nontoxic to honey bees on an acute oral basis (LD50 >25 µg/bee) (USEPA 2006e) (Table 6.1).

4.1.12.4 Ecological Toxicity associated with ULV Application for Mosquito Abatement

Following aerial applications of Evergreen Crop Protection EC 60-6 (6 percent pyrethrins, 60 percent PBO) in Sacramento for West Nile virus, Larry Walker Assoc. (2006) reported results of water testing on samples from 10 waterways within the treatment area. Treated areas were sprayed nightly for 3 days. One additional application occurred 9 days prior to the 3-day event at selected locations. Samples were taken immediately after application (within 1 to 6 hours), and the next day (16 to 23 hours after the application). Piperonyl butoxide was detected in water from 14-of the 25 samples collected after the application. Concentration of PBO ranged from <1.0 to 20 µg/L (average 2.036 µg/L) immediately after application. PBO concentrations ranged from <1.0 to 4.2 µg/L with an average of 0.853 µg/L in samples taken between 16 and 23 hours after application. Of the 31 samples taken between 16 and 23 hours after application, PBO was detected in 11 samples. Water samples were tested eight days following aerial applications, from four sites. No PBO was detected in any of these samples, therefore, the duration of persistence of PBO appears to be greater than 16 hours, but less than 1 week.

Testing was also carried out by Weston et al. (2006) following the same applications. Prior to aerial spraying, PBO was not detected in sediment samples; however, PBO was detected at 0.2 µg/L in 2 of 4 water samples. PBO was detected in water (0.44-to 3.92 µg/L, all 7 samples) and sediment (16 to 61.4 µg/kg, for 4-of 6 samples) at 10 to 34-hours after application. Neither water nor sediment was tested at later intervals, so the duration of persistence could not be determined in this study. Laboratory tests were conducted to determine the effects of short-term chronic exposure of *Ceriodaphnia dubia* to water collected after the spray events, following USEPA protocol. No significant differences in mortality were observed. In addition, sediment toxicity tests were performed with the amphipod *Hyalella azteca,* and toxicity was observed in samples collected both before and after application. The authors concluded that pyrethrins and PBO should present little risk to aquatic organisms due to the low toxicity and lack of long-term persistence, but that PBO had the potential to enhance toxicity of other pesticides, especially pyrethroids, already present in the environment. Weston et al. performed additional laboratory tests to determine the effect of PBO on toxicity of pyrethroids present on sediment, and found that even by removing 80 percent of the overlying water and replacing it with fresh PBO solution daily, within 24-hours, over 30 percent of PBO is lost, most likely to photo degradation. The results indicated that most sediments present at the creeks used for this study already contained concentrations of pyrethroids acutely lethal to *H. azteca* from urban uses not related to mosquito control activities.

Water and soil deposition of pyrethrins and PBO following aerial applications was evaluated at two sites in California (Schleier III et al. 2008). Water was sampled after aerial applications of pyrethrins and PBO in irrigation ditches at one site (Princeton) and in static ponds at another (Colusa). PBO was detected at low levels and decreased exponentially with time. Average PBO concentrations were 0.0125 to 0.0199 microgram per square centimeter (µg/cm^2) on ground deposition pads and 0.1723 to 1.274-µg/L in water samples, immediately following the applications. Within 36 hours of the applications, PBO had decreased to background levels in water. Concentrations of PBO decreased 77 percent between 1 and 12 hours after the spray event. The authors concluded that the amounts of pyrethrins and PBO deposited on the ground and in water after aerial ULV insecticide applications are probably lower than those estimated by previously published studies to predict exposure and risk.

Lawler et al. (2008) evaluated pyrethrins and PBO in sediment following multiple applications of pyrethrins formulated with PBO from truck-mounted equipment in the Colusa and Sacramento National Wildlife Refuges in California. Stock tanks were filled with a layer of soil overlain with 1,150 liters of water. Zooplankton (*Daphnia magna*) were held in sentinel cages in the water column and mayfly larvae

(*Callibaetis californicus*) were placed in cages at the bottom of each tank, where they were in contact with sediment. ULV applications of pyrethrins formulated with PBO were made from truck-mounted equipment twice weekly for six weeks. Concentration in sediments and sentinel survival were evaluated after application 5 and 11. PBO concentrations ranging from 8.37 to 14.9 µg/kg were seen in 5 of 6 tanks after five applications, but in only 2 of 6 tanks after 11 applications (1.93 and 2.55 µg/kg). There was no significant difference in mortality for mayfly larvae held in sentinel cages on the sediment. Likewise, there was no significant difference in mortality seen in *D. magna* held in the water column. They concluded that applications of pyrethrins and PBO at rates used for mosquito control did not have detectable effects on the indicator species. The persistence of PBO in sediment was not evaluated in this study. PBO-synergized pyrethrins had no detectable effect on the survival of *D. magna* held in tanks in the spray area, even after 11 biweekly spray events.

Amweg et al. (2006) evaluated deposition of PBO in water and sediment following truck-mounted applications of synergized pyrethrins to a freshwater wetland in Colusa County in 2004. PBO was detected in 2 of 18 sediment samples above the reporting limit of 2.0 µg/kg, at 3.27 and 3.0 µg/kg, respectively. PBO was detected in 3 of 10 samples of water at concentrations above the reporting limit of 0.01 µg/L, ranging from 0.04-to 0.08 µg/L. The highest concentrations of PBO were observed in samples obtained within 12 hours of spraying; concentrations in water and sediment were below the reporting limit in samples taken one week after the last ULV application (Amweg et al. 2006).

Several papers were published documenting that ULV-applied mosquito adulticides do not accumulate in water or sediment during repeated applications. Chemical testing was conducted following multiple spray events in 2006 by Amweg et al. There was no increase in the level of pyrethrins or PBO following multiple daily spray events, and the concentration had returned to background level when samples taken one week after the last application were tested. Similarly, Lawler et al. (2008), reported that the concentration of pyrethrins and PBO in tanks within a treated area were not significantly higher after 11 applications than in samples taken after the fifth application. In many cases, the concentrations were actually lower following the 11th spray event than after the fifth spray event. Accumulation of PBO was evaluated by Amweg et al. (2006). PBO did not accumulate in water or sediment, even after eight biweekly applications by truck-mounted equipment over the course of two months.

ULV applications of the resmethrin formulated with PBO in Suffolk County New York have been evaluated (Abbene et al. 2005). Deposition of resmethrin and PBO following truck-mounted applications in fresh and salt water marshes was assessed at 6 sites. PBO was detectable at low levels (0.008 µg/L and 0.017 µg/L) in 2 of 6 water samples taken immediately after the application. Deposition of resmethrin and PBO following aerial applications by helicopter was assessed in the same report (Abbene et al. 2005). Applied materials were detected in some water samples taken within 30 minutes of the application. PBO was detected more frequently than resmethrin, and detection of PBO was more common after helicopter applications (83 percent) than following those carried out by truck (33.3 percent). The average concentration of PBO was 4.361 µg/L. The highest concentrations were found in some samples collected from surface water within 1 hour of helicopter applications (59.8 µg/L PBO). The authors carried out a series of sample collections after two spray events to evaluate the persistence of the materials in water. PBO was not detected (<0.005 µg/L) in samples taken 96 hours after the application (Abbene et al. 2005). One site included two repeat weekly applications of resmethrin follow an application of methoprene the prior week. Concentrations of resmethrin and PBO measured after the second application were lower than those measured after the first application.

The same study included effects of aerial applications of resmethrin and PBO on two aquatic organisms: the sheepshead minnow (*Cyprinodon variegatus*) and the estuarine grass shrimp (*Palaemonetes pugio*) (Suffolk County 2006). The field study faced problems with low dissolved oxygen and high temperature, which compromised their ability to detect toxicity that may have been due to pesticide exposure. Therefore, dosing experiments and prey capture tests were conducted in the laboratory to measure toxicity of the applied products. These tests demonstrated that the doses used in the spray were not directly toxic to grass shrimp and did not affect their ability to capture prey under controlled conditions. Further laboratory experiments demonstrated that all of the mortality seen in the field could have been caused by low dissolved oxygen alone, using a USEPA time-to-death approach. Furthermore, their data showed that the chemicals used had very low persistence in the water column, as discussed above. PBO was last detected in samples taken 48 hours after the spray.

Another related study evaluated benthic community structure, and found that benthic population differences could not be attributed to the application of pesticides, but were more likely due to environmental differences (Suffolk County 2006).

Zulkosky et al. (2005) sampled freshwater ponds, salt marshes, tidal inlets and embayments, and marine coastal water off Staten Island, New York within an hour after mosquito control applications of resmethrin formulated with PBO (Scourge). PBO was detected in all but one location at concentrations ranging from 0.0006 to 15 µg/L. PBO was still present at three locations in samples collected three days after a Scourge spray. No information was provided on application methods at each site. Zulkosky et al. (2005) also evaluated phenothrin (in formulation with PBO) applied as Anvil. In 2002, PBO was detected in all samples at concentrations ranging from 0.0003 to 0.0007 µg/L. In 2003, PBO was detected at 0.020 µg/L immediately after spraying Anvil and was found at concentrations ranging from <0.0005 to 0.007 µg/L 10 days later.

New York City Department of Health sampled 32 locations for phenothrin formulated with PBO before and after spray events during mosquito adulticide applications that occurred during July through September 2000. Out of the 68 post-application samples collected by the city, only one sample had concentrations of PBO greater than the 0.5 µg/L reporting limit: 1.03 µg/L for PBO for a sample collected on August 5, 2000, at Alley Park Pond in Queens (Suffolk County 2006).

The Massachusetts Department of Agricultural Resources conducted a study where phenothrin formulated with PBO was applied aerially as Anvil 10+10 ULV to six sites. There were no detections of phenothrin during this study; however, PBO was detected at 0.12 µg/L. (Massachusetts Department of Agricultural Resources 2010).

Davis and Peterson (2008) also evaluated phenothrin formulated with PBO and applied as Anvil 10+10 ULV. The authors concluded that the reductions in aquatic non-target populations did not suggest any trends or persistent deleterious biological effects following a single adulticide application.

4.1.12.5 Summary of Toxicity and Potential Effects

PBO has been an effective synergist used in mixtures with other insecticidal active ingredients since the 1950s. It degrades rapidly in soil and water and, therefore, does not tend to persist in the environment. PBO may be highly toxic to some species of fish and aquatic invertebrates and is being evaluated as a possible endocrine disruptor.

PBO is contained as a secondary ingredient along with pyrethrin, resmethrin, and permethrin in several products used by eight Districts. These products are used throughout the year in manmade and natural sites with standing and moving water, as well as tree holes, ditches, and residential areas. There were several hundred applications during the reporting year. It is generally applied using ULV techniques, which are designed for low chemical persistence and toxicity to non-target receptors. PBO is not expected to pose risk to aquatic organisms especially when applied using ULV techniques; however, it has been shown to have the potential to enhance toxicity of other pesticides and should be considered when it is an additive to a pesticide formulation.

4.2 Organophosphate Insecticides

4.2.1 Naled

Naled is an organophosphate insecticide that has been registered since 1959 for use in the U.S. It is used in rotation with pyrethrins or pyrethroids for control of adult mosquitos to avoid the development of resistance. In addition to use for controlling adult mosquitoes, naled also has indoor and outdoor general use, and is used on food and feed crops, farms, dairies, pastureland, and in greenhouses and over standing water (CDPR 2010a). Dichlorvos (DDVP), a registered OP insecticide, is a metabolite of naled (USEPA 2006c).

4.2.1.1 Environmental Fate

Naled is readily degraded in water, under sunlight, in soil under aerobic and anaerobic conditions (Table 4-12), in the air, and on plants. On plant surfaces, naled is degraded to DDVP. Naled is more mobile in soil of low organic content such as sandy loam when compared with other soil types (CDPR 1999). Naled has low water solubility and can volatilize (CDPR 1999, 2001).

Table 4-12 Degradation of Naled

Degradation Method	Half-life	Reference
Hydrolysis, pH 5 (water)	96 Hours	DPR 1999
Hydrolysis, pH 7 (water)	15.4 to 17 Hours	DPR 1999
Hydrolysis, pH 9 (water)	1.6 to 1.7 Hours	DPR 1999
Photolysis (water)	3.7 to 4.4-Days	DPR 1999
Photolysis (plant surfaces)	<5 Days	DPR 1999
Aerobic metabolism (soil)	3 Days	DPR 1999
Anaerobic metabolism (soil)	6 Days	DPR 1999

4.2.1.2 Human Toxicity

Naled is rapidly absorbed by all routes (oral, inhalation, and intraperitoneal) and distributes to all tissues in the rat, chicken, goat, and cow. The oral LC50 for naled technical grade active ingredient is 81 to 336 mg/kg in rats or mice, the dermal LC50 is 354-to 800 mg/kg in rats or rabbits, and the inhalation LC50 is 3.1 to 156 mg/L in rats or mice (CDPR 1999) (Table 6.1).

4.2.1.3 Ecological Toxicity

Naled technical grade active ingredient was found to be moderately toxic to highly toxic to wide range of species including rainbow trout (LC50 = 0.08 mg/L), blue gill (LC50 = 0.33 mg/L), sheepshead minnow (LC50 = 1.2 mg/L), mullet (LC50 = 0.55 mg/L), daphnia (LC50 = 0.35 µg/L), pink shrimp (EC50 = 5.5 µg/L), grass shrimp (LC50 = 8.9 mg/L), and eastern oyster (EC50 = 0.19 mg/L). Lethal effects were also found in honey bees (LD50 = 0.48 µg/bee) and mallards (LD50 = 52 mg/kg) (CDPR 1999).

SWRCB has evaluated the U.S. EPA’s Office of Pesticides’ Ecotoxicity Database to access toxicity of naled to freshwater aquatic life and has identified LC50 values that range from 0.14-to 3,300 µg/L (SWRCB 2012) (Table 6.1).

4.2.1.4 Ecological Toxicity associated with ULV Application for Mosquito Abatement

Tucker et al. (1987) evaluated deposition and non-target effects for truck-mounted and aerial applications of naled. The maximum concentration of naled in water samples following truck applications (0.71 µg/L) occurred 15 minutes after the application. The concentration in water decreased exponentially after this; detected concentrations persisted for 4-hours. No significant mortality was observed in copepods or fish exposed from truck-mounted applications. The same study evaluated deposition of these materials following applications made from aircraft (Tucker et al. 1987). The maximum concentration of naled in water samples following aerial applications (20.15 µg/L) occurred 27 minutes after the application. The concentration in water decreased exponentially after this; detected concentrations persisted for 9 hours. Deposition rates for naled from aerial applications were much higher (47 to 68 percent) than those resulting from ground applications (21 to 22 percent). The authors reported significant mortality in copepods held in sentinel cages in the treated area and exposed to naled by aerial application. No significant mortality was observed for juvenile fish held in the treated area. This is the only report of significant mortality in aquatic organisms following a ULV application. The size of droplets released is not given and the amount of material recovered from glass filter pads placed on the ground was unusually high. Perhaps the conditions of the applications resulted in a greater proportion of the product reaching the ground.

In what may have been the same study, Wang et al. (1987) also investigated the fate of naled after aerial ULV applications of mosquito adulticides at a salt marsh in Florida. Approximately 30 minutes after application, the concentration of naled in the water was 20.15 µg/L, decreasing to 0.2 µg/L at 6.45 hours, and was not detected at 12.45 hours (detection limit of 0.05 µg/L). The peak concentration of dichlorvos (a breakdown product of naled) was 2.22 µg/L approximately 30 minutes after application, and was still detectable at 12.45 hours (0.28 µg/L).

Deposition of naled during aerial applications was also evaluated (Pierce et al. 2005). Naled was detected in low concentrations (0.19 µg/L) in the water surface microlayer at 1 of 18 sites. It was not detected in subsurface water (detection limit 0.05 µg/L). Residues were not detectable in the water surface microlayer 12 hours after the application. Dichlorvos, a breakdown product of naled, and itself a registered pesticide, was detected at 2 to 4-hours after the application. Trace amounts were still detectable at 10 to 12 hours post-treatment.

4.2.1.5 Summary of Toxicity and Potential Effects

Naled has low water solubility and is mobile in some soils. It is moderately toxic to mammals, fish, and aquatic vertebrates. Naled was not used by the Districts during the reporting year.

4.2.2 Temephos

Temephos is a cholinesterase inhibitor registered by the EPA in 1965 to control mosquito larvae (USEPA 2000). Temephos is the only organophosphate with larvicidal use and is often used to help prevent mosquitoes from developing resistance to the bacterial larvicides. Temephos is used on lakes, ponds, reservoirs, swamps, marshes, tidal areas, intermittently flooded areas, catch basins, drainage systems, irrigation systems, ornamental ponds, wastewater, polluted and stagnant water, and is applied by mosquito abatement Districts (CDPR 2010a). MVCAC member agencies primarily apply temephos to manmade sources such as tire piles, utility vaults, and cemetery urns. Mosquito control products containing temephos are not labeled for application to agricultural lands or pasture and are not used in such sites. Temephos provides effective control of mosquito larvae in highly polluted water (containing high levels of decaying organic matter, such as rotting leaves or manure).

Temephos is a broad-spectrum insecticide and has also been used operationally to control midges and black flies for many years. However, the concentration that effectively controls mosquito larvae is well below that needed for control of other insects. In addition, midges and black flies are found in different habitats than larval mosquitoes. The larval stage of most midges develop in sediment at the bottom of water bodies, while black flies develop attached to hard surfaces in swift moving rivers and streams. Materials commercially available for midge control are heavy and designed to release their active ingredients on the floor of the water body and those for control of black flies are placed in flowing streams and allowed to move down with the current.

4.2.2.1 Environmental Fate

The presence of microorganisms in aquatic environments and exposure to sunlight are likely to be the predominant means of transformation/dissipation of temephos (Table 4-13; (USEPA 1998a)). Temephos is an extremely hydrophobic material with low solubility. It adsorbs rapidly onto organic material in the water and binds strongly to soils. Temephos breaks down in water through photodegradation and bacterial degradation (USEPA 2000).

Table 4-13 Degradation of Temephos

Degradation Method	Half-life	Reference
Hydrolysis	>86 Days	USEPA 1998a
Photolysis (water)	15 Days	USEPA 1998a
Aerobic metabolism (water)	17.2 Days	USEPA 1998a
Anaerobic metabolism (water)	12.2 to 27.2 Days	USEPA 1998a

The RED cites a study submitted by the registrant in which temephos was monitored in sediments following field applications for mosquito control over a 3-year period. The active ingredient became undetectable in sediment after 24-hours (USEPA 2000). Lores et al. (1985) found that concentrations in water of 15 to 60 ppb immediately following the application declined to 2 to 5 ppb within 24-hours. Sanders et al. (1981) reported similar results. Pierce et al. (1989) examined aerial application of liquid formulation of temephos to a mangrove swamp in Florida, and found the material had become undetectable 4-hours after the application in intertidal water. It persisted in simulated intertidal pools for 72 hours. The liquid and BG formulation products are designed to deliver the active ingredient to the water surface in order to maximize exposure of mosquito larvae.

4.2.2.2 Human Toxicity

Temephos is moderately toxic via the oral, dermal, and inhalation routes. The oral LD50 in rats is 444-mg/kg. The dermal LD50 in rabbits is 970 mg/kg. The inhalation LC50 in rats is 1.3 mg/L (USEPA 2012) (Table 6.1).

4.2.2.3 Ecological Toxicity

Temephos has low toxicity for vertebrates at the levels used for mosquito control (USEPA 2000). However, it is toxic to insects and some other invertebrates (Brown et al. 1996), and the margin of safety between concentrations effective for mosquito control and levels at which non-target impacts occur is much narrower than that of s-methoprene or the bacterial larvicides (Brown et al. 1999, Lawler et al. 1999, Hurst et al. 2007).

Temephos is slightly to moderately toxic to fish (USEPA 2000); however, field applications result in concentrations of temephos far lower than that at which fish are affected. Field studies have repeatedly demonstrated a lack of impact on fish inhabiting treated sites. Mulla et al. (1964) reported that temephos was nontoxic to mosquito fish that were confined in screened cages for one week in artificial ponds treated with 0.1 pound per acre AI. Similarly, no significant mortality was observed in juvenile snook (*Centropomis undecimalis*) or sheepshead minnow (*Cyprinodon variegatus*) caged in a mangrove swamp treated with aerial applications of liquid temephos (Pierce et al. 1989). Tietze et al. (1991) demonstrated laboratory tests that liquid formulations of temephos were nontoxic to young mosquitofish (3 to 5 days old) at field application rates. Mosquitofish exhibited no mortality when exposed to up to 100 times field application rates.

Temephos is highly toxic to aquatic invertebrates, but many groups are only impacted at concentrations far above those used for mosquito control applications (USEPA 2000). Von Windeguth and Patterson (1966) conducted laboratory tests on temephos and fenthion (another organophosphate) to determine margin of safety for treatment of midges in a lake. The dose of fenthion used for midges was above that which caused mortality in shrimp and amphipods. Abate (temephos) was less toxic to most aquatic non-target organisms than fenthion and not toxic to shrimp (*Palaemonetes paludosus*) and amphipods (*Hyalella azteca*) at concentrations used for mosquito control applications (LD50 was 1 mg/L and 0.65 mg/L, respectively). Neither product was toxic to fish at levels necessary to kill midge larvae (0.25 lb active ingredient per acre). In field tests, they reported that no noticeable mortality was observed for Odonates (dragonflies), copepods, ostracods, or shrimp (Von Windeguth and Patterson 1966).

Temephos does have an immediate impact on some groups of planktonic crustaceans, with copepods and brachiopods (*cladocera*) being more sensitive than amphipods or ostracods. Fortin et al. (1987) studied the impact of temephos on non-target organisms in rectangular manmade ponds. Application of temephos resulted in an immediate reduction in populations of copepods and cladocerans, but populations began to recover within 3 days and had reached pre-treatment levels within 2 to 3 weeks. Ostracods in the ponds were not affected. Helgen et al. (1988) also reported sharp reductions in populations of calanoid copepods (*Diaptomus leptopus*) and cladocerans (*Daphnia pulex*, *Simocephalus* sp., and Chydoridae) following applications of temephos. Copepods exhibited varying degrees of recovery. However, some cladocerans remained absent from the treated area for up to 35 days. In an open field setting, Lawler et al. (1999) reported that aerial applications of temephos to a mangrove swamp in Florida resulted in no observable effect on survival of amphipods (Talitridae), the primary non-target organism present.

Several studies have evaluated effects on non-target insects. A field study of repeated applications of temephos to a saltmarsh in New Jersey concluded that species richness, diversity, and community structure of aquatic insects was unaffected (Campbell and Denno 1976). Stoneflies and mayflies are particularly susceptible to temephos and the label carries a prohibition against applying Abate in habitats containing these organisms.

Among the materials available for control of mosquito larvae, temephos has the narrowest margin of impact and the greatest potential for effects to non-target organisms. However, it is an effective method of control in isolated sources that may be difficult to treat by other means, such as sources with high concentrations of organic material, and ones in which other less toxic alternatives have failed to produce adequate levels of control. Temephos was in widespread use in California for control of larval mosquitoes from 1965 into the mid-1980s. The microbial pesticides, methoprene, and surface oils are used much more frequently now and have largely replaced temephos as the method of choice for larval sources in water of the U.S. Temephos is more widely used in other parts of the U.S. such as Delaware, New Jersey, New York, Maryland, and Florida (Table 6.1).

4.2.2.4 Summary of Toxicity and Potential Effects

Temephos has extremely low water solubility and binds strongly to soils. It is moderately acutely toxic to mammals and fish, but highly toxic to non-target aquatic invertebrates (e.g., stoneflies, mayflies). The USEPA (2000) states that there is likely no exposure of people to temephos in drinking water or from residential use. It is not expected to have direct impact on terrestrial animals and the use of temephos has declined over time (USEPA 2000). Temephos was used in one product by two Districts during the reporting year. It is typically applied in all four quarters of the year resulting in the use of over 1,000 pounds of product. Active ingredient concentration in this product is 5 percent resulting in a total use of about 50 pounds of AI. Based upon the environmental fate, toxicity, and BMP approaches, the use patterns for temephos should not result in unwanted adverse effects.

4.3 Mosquito Larvicides

4.3.1 *Bacillus sphaericus* (Bs)

Microbial larvicides are bacteria that are registered as pesticides for control of mosquito larvae in outdoor areas such as irrigation ditches, flood water, standing ponds, woodland pools, pastures, tidal water, fresh- or saltwater marshes, and stormwater retention areas (USEPA 2007c). The microbial larvicides concentrates registered for use in California include *Bacillus sphaericus* (Bs) and *Bacillus thuringiensis* subspecies *israelensis* (Bti). These concentrates include fermentation solids, bacterial spores, and insecticidal toxins. Their mode of action requires that they be ingested to be effective, which means they cannot be used to control mosquitoes at some life stages (late 4^{th} instar larvae and pupae). Bs spores contain a protein that damages and paralyzes the gut of mosquito larvae that ingest the *spores*, thus starving the larvae (USEPA 1999). A standard bioassay similar to that used for Bti has been developed to determine preparation potencies.

Bs was first registered by the EPA in 1991 for use against mosquito larvae. Bs can control mosquito larvae in highly organic aquatic environments, including sewage waste lagoons, animal waste ponds, and septic ditches. Bs is used on rice, fruit trees, walnuts, almonds, corn, asparagus, cotton, dates, and other crops. It is also applied to alfalfa, pastures, agricultural drainage systems, animal drinking water, fodder grasses, irrigation systems, swimming pools, ornamental ponds and fountains, catch basins, wastewater, bilge water, industrial processing water, industrial waste disposal systems, solid wastes sites, garbage dumps, and on tidal areas, swamps, marshes, bogs, intermittently flooded areas, standing water, and by mosquito abatement Districts (CDPR 2010a).

4.3.1.1 Environmental Fate

Dormant Bs spores may persist in the environment for several weeks to months; however, the δ-endotoxins generally persist for 2 to 4-weeks following application. Factors affecting its persistence include the formulation of the *B. sphaericus* product, agitation of the waterbody, receiving water quality and temperature. The δ-endotoxins produced by Bs degrade rapidly in sunlight as a result of exposure to ultraviolet radiation and are degraded by soil microorganisms. Bs, as with other soil microbes, does not percolate through the soil and readily binds to sediments within the water column, and is, therefore, not available to contaminate ground water (Maine Department of Environmental Protection 2010). Field evaluations of VectoLex-CG (a commercial formulation of *B. sphaericus*) have shown environmental persistence for several weeks (Mulla et al. 1988).

4.3.1.2 Human Toxicity

Bs is not pathogenic and does not demonstrate any systemic toxicity. An acute oral toxicity/pathogenicity study was conducted with Bs technical material in rats. An oral dose of approximately 1×10^8 colony forming units (CFU) administered to rats resulted in no mortalities, no evidence of pathogenicity or treatment related toxicity in rats given an oral, intratracheal installation or intravenous dose. In an acute oral toxicity study, Bs technical material caused no deaths in rats given a dose of 5,000 mg/kg; therefore the acute oral LD50 was greater than 5,000 mg/kg. There was no mortality in rabbits over the 14-day observation period following a 2,000 mg/kg dermal application for 24-hours; thus, the acute dermal LD50 was greater than 2,000 mg/kg. In a 4-hour acute inhalation toxicity study in rats, the maximum attainable concentration was 0.09 mg/L, with 13.3 percent of the particles having a mass median aerodynamic diameter of >10 microns. Since there was no mortality or no clinical signs during exposure or the 14-day observation period, the 4-hour inhalation LC50 was greater than 0.09 mg/L. Dermal irritation of Bs technical material was moderately irritating to rabbit skin at 72 hours. Irritation and iridal effects following a 100 mg aliquot of Bs placed in the eye of rabbits were no longer present at day 10 post-treatment (USEPA 1997a) (Table 6.1).

4.3.1.3 Ecological Toxicity

Available literature indicates that Bs is not acutely toxic to non-target species, including birds, mammals, fish and invertebrates. Bs has a very low toxicity for fish, and all aquatic invertebrates. Amounts that effectively control mosquito larvae are many levels of magnitude below those, which affect other organisms. Acute aquatic freshwater organism toxicity tests were conducted on bluegill sunfish, rainbow trout and daphnids. The 96-hour LC50 and No Observable Effect Concentration (NOEC) value for bluegill sunfish and rainbow trout was greater than 15.5 mg/L; the 48-hour EC 50 and NOEC value for daphnids was greater than 15.5 mg/L. Acute aquatic saltwater organism toxicity tests were conducted on sheepshead minnows, shrimp and oysters. The 96-hour LC50 value for both sheepshead minnows and shrimp was 71 mg/L, while the NOEC value was 22 mg/L for sheepshead minnows and 50 mg/L for shrimp. The 96-hour EC50 value for oysters was 42 mg/L with an NOEC of 15 mg/L. The LC50 and NOEC value for immature mayflies was 15.5 mg/L. Additional studies on various microorganisms and invertebrates, specifically cladocerans, copepods, ostracods, mayflies, chironomid midges, water beetles, backswimmers, water boatmen, giant water bugs, and crawfish, have shown no adverse effects or negative impacts (Miura et al. 1981, Holck and Meek 1987, Key and Scott 1992, Tietze et al. 1993). Furthermore, Ali (1991) states that although *B. sphaericus* is known to be highly toxic to mosquito larvae, Bs does not offer any potential for midge control.

Applications of Bs also leave populations of mosquito predators intact and do not cause secondary effects when treated larvae are consumed by other insects. Key and Scott (1992) conducted laboratory studies with Bs on the grass shrimp *Palaemonetes pugio* and the mummichog *Fundulus heteroclitus*. Their study indicated that both Bti and Bs larvicides have large margins of safety. In a study by Aly and Mulla (1987), aquatic mosquito predators were fed with *Cx. quinquefasciatus* 4^{th} instar larvae intoxicated with either Bti or Bs preparations. Although the mosquito larvae contained large amounts of the bacterial preparations in their gut, no effect upon longevity or ability to molt was observed in the backswimmer *Notonecta undulata*, in naiads of the dragonfly *Tarnetrum corruptum*, or in naiads of the damselfly *Enallagma civile*. Equally, the reproduction of *N. undulata* and the predation rate and ability to emerge normally in *T. corruptum* and *E. civile* were not affected by ingestion of large amounts of bacterial toxins.

Bs has not been found to have adverse effects on chironomids or any other aquatic species at levels used for mosquito control (Table 6.1).

4.3.1.4 Summary of Toxicity and Potential Effects

Bs is an effective microbial pesticide specifically targeted at mosquito larvae. A common member of microbial communities and a natural biological enemy of mosquito larvae, Bs does not exhibit toxicity or risk to non-target organisms. This microbial active ingredient is used by eight of the Districts, typically throughout the year, including during each quarter of the reporting year. Bs is contained in nine products, which are applied to both standing and moving water at natural and manmade sites. Several thousand applications occurred during the reporting year. Concentrations of the active ingredient in these products range from 6 to 51.2 percent.

Based upon the environmental fate, toxicity, and use patterns by the districts during the reporting year, it should not result in unwanted adverse effects.

4.3.2 *Bacillus thuringiensis* subspecies *israelensis* (Bti)

Bti concentrates are made up of the dormant spore form of the bacterium and an associated pure toxin. The toxin disrupts the gut in mosquito larvae by binding to receptor cells (USEPA 2007c). *Bti* organisms produce five different microscopic protein pro-toxins packaged inside one larger protein container or crystal. The crystal is commonly referred to as delta (δ-) endotoxin. This toxin consists of five proteins that are released only under extremely alkaline conditions. Mosquitoes are unique in having very alkaline conditions within the midgut (the stomach of vertebrates contains acid). When a mosquito larva ingests the δ -endotoxin, the five proteins are released in the alkaline environment of the insect larval gut. The five proteins are converted into five different toxins by specific enzymes present in the gut of mosquito larvae. Once converted, these toxins destroy the gut wall, which leads to paralysis and death of the larvae. Bti is toxic to larval stages of all genera of mosquitoes, and to black flies (*Simuliidae*). The dependence on alkaline conditions and the presence of specific enzymes gives this material a high degree of specificity for mosquitoes and black flies. Bti is also used for control of chironomids, but much higher levels are needed for effective control.

An isolate of Bt was first registered by the EPA in 1961 for use as an insecticide (USEPA 1998f). The subspecies israelensis (Bti) was first registered as an insecticide in 1983. One formulation of Bti is used in California for controlling gnats on greenhouse crops, peppers, tomatoes, celery, cabbage, leafy vegetables, cauliflower, walnuts, almonds, dates, corn, asparagus, bananas, fruit trees, and other crops. It is applied for mosquito control on rice, alfalfa, pastures, animal drinking water, ornamental nurseries, ornamental ponds, irrigation systems, swimming pools, drainage systems, lakes, streams, swamps, marshes, tidal areas, standing water, polluted or stagnant water, sewage systems, intermittently flooded areas, catch basins, domestic dwellings, and by mosquito abatement Districts and by ULV application (CDPR 2010a).

4.3.2.1 Environmental Fate

Bti toxins degrade rapidly in the phyllosphere as a result of exposure to ultraviolet (UV) light. Bti toxins may persist in soil for several months, yet a half-life for typical Bti products on foliage is approximately 1 to 4-days (USEPA 1998g).

Generally, Bti persists in the environment for periods measured in days. Factors that affect persistence and efficacy of Bti in the environment may include, but are not limited to, the formulation of the Bti product, agitation of the waterbody, receiving water quality and temperature. Solid and granule formulations, which act through a slow release action, generally persist for longer periods than liquid formulations. Agitation of sediments in the water column acts to resuspend Bti and, therefore, causes the bacterium to persist as an available pesticide for longer periods. Waters with higher organic content generally require higher doses of Bti due to lower ingestion rates by mosquito larvae. Similarly, lower water temperatures reduce the feeding rate of mosquito larvae and, therefore, may result in a longer persistence of the solid and granule formulations (Maine Department of Environmental Protection 2010).

Toxins produced by Bti degrade rapidly in sunlight as a result of exposure to ultraviolet radiation. Persistence of Bti is low in the environment, usually lasting 1 to 4-days due to sensitivity to UV light. The δ-endotoxins produced by Bti degrade by soil microorganisms with soil half-lives of 3 to 6 days. The bacterium is moderately persistent in soil with a half-life of 4-months. Bti, as with other soil microbes, does not percolate through the soil and readily binds to sediments within the water column, and is, therefore, not available to contaminate ground water (Maine Department of Environmental Protection 2010).

4.3.2.2 Human Toxicity

No known mammalian health effects have been demonstrated in any infectivity/pathogenicity study. Studies for acute oral toxicity have found no adverse toxic effects, infectivity, or pathogenicity at doses up to 4.7×10^{11} spores/kg. Studies on acute pulmonary toxicity have found no adverse toxic effects, infectivity, or pathogenicity at doses up to 2.6×10^{7} spores/kg. Studies on acute intraperitoneal toxicity have found Bti to be nontoxic at dose levels below 10^{8} CFU per animal (USEPA 1998g) (Table 6.1).

4.3.2.3 Ecological Toxicity

Due to the relatively short insecticidal half-life of Bti spores and crystals, the exposure and subsequent risk to non-target wildlife is limited to the time immediately after application. Toxicity and infectivity risks due to δ-endotoxins effects to non-target avian, freshwater fish, freshwater aquatic invertebrates, estuarine and marine animals, arthropod predators/parasites, honey bees, annelids and mammalian wildlife will be minimal to nonexistent at the label use rates of registered Bti active ingredients.

Bti δ-endotoxin has a direct adverse effect on the target insect orders (*Lepidoptera, Coleoptera, Diptera*), but susceptibility varies widely among individual species. Any one registered product has a narrow susceptible insect range (USEPA 1998g).

The amount of toxins contained within Bti products is reported indirectly as the result of at least two different bioassays, and is difficult to equate to one another. Prepared volumes of toxins are applied to living mosquito larvae and the resulting mortality produces through formulae numerical measures known as International Toxic Units (ITUs) and *Ae. aegypti* International Toxic Units (AA-ITUs). These measures are only roughly related to observed efficacy in the field, and are therefore inappropriate to consolidate and report on like other toxicants (active ingredients). There is currently no chemical test that will differentiate Bti mosquito control products from other spore forming bacilli existing in the environment.

Bti applied at label rates has virtually no adverse effects on applicators, livestock, or wildlife, including beneficial insects, annelid worms, flatworms, crustaceans, mollusks, fish, amphibians, reptiles, birds, or mammals (Garcia et al. 1981, Holck and Meek 1987, Gharib and Hilsenhoff 1988); (Miura et al. 1980, Mulla et al. 1982, Reish et al. 1985, Siegel and Shadduck 1987, Knepper and Walker 1989, Merrit et al. 1989, Tietze et al. 1991, Molloy 1992, Tietze et al. 1992, Tietze et al. 1993, La Clair et al. 1998). However, non-target activity on larvae of some insect species closely related to mosquitoes and found with mosquito larvae in aquatic habitats has been observed. There have been reported impacts in larvae belonging to the midge families Chironomidae, Ceratopogonidae, and Dixidae (Mulla et al. 1990, Molloy 1992, Anderson et al. 1996). These non-target insect species, taxonomically closely related to mosquitoes and black flies, apparently contain the necessary gut pH and enzymes to activate delta-endotoxins. However, the concentration of Bti required to cause these effects is 10 to 1,000 times higher than maximum allowed label rates for mosquito control.

Bacterial spores of Bti are uniquely toxic to nematoceran Diptera (mosquitoes, midges, blackflies, psychodids, and ceratopogonids) (Lacey and Mulla 1990). That result was reported after reviewing Bti studies conducted using a variety of Bti formulations, and under a variety of test conditions. Lacey and Mulla (1990) concluded that Bti was a highly selective larvicide that produced minimal adverse impact on the environment. Garcia et al. (1981) tested a total of 23 species of aquatic organisms other than mosquito larvae using various formulations of Bti in his laboratory. No mortality was observed for these species with the exception of *Chironomus maturus* and a *Simulium* sp. (black fly), which showed a degree of susceptibility similar to that of mosquito larvae. Miura et al. (1980) found Bti at rates used for mosquito control to be very safe to organisms associated with mosquito breeding habitats. A total of 28 species or species groups were treated with the bacterium under simulated or field conditions, with no adverse effects observed, except for chironomid larvae, which were slightly affected. However, the effect was so light that the population in the field continuously increased after the treatment. Miura et al. (1981) found Bti and Bs, when applied at rates used for mosquito control, was very safe to organisms associated with mosquito breeding habitats, including the natural enemies of mosquito larvae. When various aquatic organisms were exposed to the bacteria under laboratory or field conditions, no adverse effect was noted on the organisms, with the exceptions of chironomid and psychodid larvae. Chironomid larvae were slightly affected by Bti treatment at a rate used for mosquito control, but pyschodid larvae were only affected at the higher concentration (50 mg/L).

Exposure of brook trout (*Salvelinus fontinalis)* fry to 4,500 and 6,000 milligrams per liter (mg/L) Teknar (a liquid formulation of Bti) (more than 50 times the allowed label rate for mosquito control) for 45 minutes resulted in 20 and 86.4-percent mortality, respectively (Fortin et al. 1986). Some species of chironomids are also susceptible to Bti, but at doses much higher than those used to control mosquito larvae (Mulla et al., 1990). Bti has been used extensively for control of mosquitoes in Germany without affecting populations of chironomids (Becker and Margalit 1993)

A number of Bti fermentation-based products tested at high-dose levels have shown intrinsic toxicity to non-target organisms. Investigations conducted to determine the source of the non-target activity have implicated heat-labile soluble substances contaminating the technical material. Toxic effects have been seen in aquatic invertebrate *Daphnia magna*, the honeybee, some beneficial insects and fish (rainbow trout, bluegill) studies, with Daphnia being the most sensitive indicator of toxicity. The impurities are found in the supernatant fluids separate from the delta-endotoxins. The toxicity does not appear to be due to the heat-stable β-exotoxin, because autoclaving of the test material renders the supernatant fluids innocuous. The heat-labile, soluble toxic impurities have thus far been seen in Bti subspecies *kurstaki*, *aizawai*, and *israelensis*, but may possibly be present in other Bti varieties. Damgaard (1995) reported varying levels of at least one soluble exotoxin in all commercial Bti products tested (Damgaard 1995). Bti subspecies *aizawai*-based products show the greatest negative effects on non-target organisms. With Bti subspecies *kurstaki*, the manifestation of the toxin(s) appears to be at least partly related to production methodology, especially the composition of the growth media used in industrial fermentation. In response to concerns, the manufacturer of VectoBac has completed continuous 10-day exposure tests on *Daphnia magna* with the active ingredients found in VectoBac products (fermentation solids and solubles produced by *Bti* strain AM65-52). Results indicated that the LC50 is higher than 50 mg/L for *Daphnia magna* when exposed continuously for 10 days. Based on maximum label rates of VectoBac products, expected environmental concentrations (EEC) of active ingredients do not exceed 1 mg/L immediately following application, based on a conservative assumption of a water depth of 10 cm. Therefore, application of VectoBac at label rates will not result in active ingredient concentrations approaching 10 percent of the LC50 for *Daphnia magna* (DeChant 2010).

Evidence indicates that some species of chironomid larvae (which are closely related to mosquitoes) are the only non-target aquatic species that may be affected at concentrations of Bti used for mosquito control. Observed effects on chironomids were slight and populations in the field continuously increased after the treatment (Table 6.1).

4.3.2.4 Summary of Toxicity and Potential Effects

Bti is an effective microbial pesticide specifically targeted at mosquito larvae. Bti is a natural enemy of mosquito larvae and, therefore does not pose risk to non-target organisms, including humans and ecological receptors. This microbial larvicide is used by eight of the districts, typically throughout the year (all quarters during the reporting year). Bti is contained in 12 products used by the Districts during the reporting year. Proper PPE is used during handling, loading, and applying of the liquid form of Bti. Bti is an important and safe component of any IPM program for mosquito larvae control.

It is important to distinguish this subspecies from Bt, which is frequently used in corn. In addition, Bti is a microbial gut toxin product and not a “live” bacterium. Bti is considered one of the safest natural forms of mosquito control.

4.3.3 Spinosad

Spinosad was first registered for use in California in 1996 for use as an agricultural insecticide, and more recently, registration has been approved for the use of mosquito control in California in areas such as dormant rice fields, wastewater, and temporary standing water (CDPR 2010b). Spinosad is used on a variety of crops, ornamental plants, greenhouses, ornamental lawns, and gardens; rangeland, pastures, animal husbandry premises, dairy barns, silos, and cattle; industrial sites, cracks and crevices, rights-of-way, recreation areas, golf courses, outdoor buildings and structures, and household or domestic dwellings (CDPR 2010a).

Spinosad is a biologically derived insecticide produced from the fermentation of *Saccharopolyspora spinosa*, a naturally occurring soil organism. Spinosad is a mixture of spinosyn A and spinosyn D; commercial formulations contain a spinosyn A to spinosyn D ratio of approximately 85:15. Spinosad activates the central nervous system of insects through interaction with neuro-receptors and causes continuous stimulation of the insect nervous system (Kollman 2002, Clarke Mosquito Control 2009). The EPA has classified spinosad as a “reduced risk” compound because it is an alternative to more toxic, organophosphate insecticides (CDPR 2002).

4.3.3.1 *Environmental Fate*

The routes of spinosad dissipation and transformation in the environment include photodegradation and biotransformation on plant surfaces, aqueous photolysis, photodegradation on soil, and biotransformation via soil microorganisms (Table 4-14). Aqueous photolysis is rapid in natural sunlight, and is the primary route of degradation in aquatic systems exposed to sunlight. In the soil environment, spinosad adsorbs strongly to soil particles and is unlikely to leach to great depths. It is photodegraded quickly on soil exposed to sunlight, but the degradation rate is decreased at longer exposure times. Spinosad is quickly metabolized by soil microorganisms under aerobic condition. Under anaerobic conditions, the degradation rate is slower (Kollman 2002). Photolysis results in degradates that are orders of magnitude less toxic than Spinosad.

Table 4-14 Degradation of Spinosad

Degradation Method	Half-life	Reference
Hydrolysis, pH 7-9 (water)	Stable	Kollman 2002
Photolysis (water)	0.84 to 0.96 Day	Kollman 2002
Photolysis (soil)	8.68 to 9.44-Days	Kollman 2002
Aerobic metabolism (soil)	14.5 to 17.3 Days	Kollman 2002
Anaerobic metabolism (soil)	161 to 250 Days	Kollman 2002

4.3.3.2 *Human Toxicity*

Spinosad is of low acute toxicity by all exposure routes. The oral LD50 for rats is >5,000 mg/kg. The dermal LD50 for rabbits is >2,800 mg/kg. The inhalation LC50 for rats is >5.18 mg/L (USDA 1999). There has been no evidence of mutagenic or carcinogenic effects in chronic studies (Table 6.1).

4.3.3.3 *Environmental Toxicity*

Spinosad is slightly to moderately toxic to fish and most aquatic invertebrates (USDA 1999). Acute LC50 values for bluegill and sheepshead minnow are greater than 5,000 µg/L and 7,000 µg/L, respectively, and the chronic NOAEC values for trout and sheepshead minnow are both greater than 1,000 µg/L (Goudie 2010). Hertlein et al. (2010) stated that no negative impacts were observed for individual mosquito fish held in water containing up to 50,000 µg/L of spinosad. This material also has low acute toxicity for fresh and saltwater invertebrates, with an acute EC 50 of greater than 10,000 µg/L for daphnia (Goudie 2010). The acute EC50 for oysters was greater than 300 µg/L (Goudie 2010). Laboratory studies demonstrate some toxicity for some aquatic invertebrates under chronic exposure, but residues dissipate rapidly and are rapidly degraded by photolysis with a half-life in water of less than half a day (Goudie 2010). Stark and Vargas (2003) reported a decline in *Daphnia pulex* when exposed to Spinosad in the laboratory. However, the organisms were held in a continuous renewal system, with fresh Spinosad added every 24 hours. Mortality also occurred in daphnia held in Plexiglas enclosures at a field site during applications of Spinosad (Duchet et al. 2008). However, mortality occurred immediately after the applications and the authors also noted that the Spinosad dissipated rapidly from the water column and was detected at 4 to 13 percent of the initial concentrations (8 to 33 µg/L) in water 4-days after its application (Duchet et al. 2008). Hertlein et al. (2010), reporting an unpublished study by Laddoni (2006, no citation available) noted slight impacts on nonmosquito insects (*Dyticsidae, Histeridae, Libellulidae, Notonectidae*) were observed in an artificial pond treated with 50 ppb or 50 g/ha of spinosad. However, this is above field use rates and the authors concluded that Spinosad was minimally disruptive to non-targets when applied near field use rates (15 to 25 ppb).

Spinosad is practically nontoxic to birds. The acute oral LD50 for bobwhite quail and mallard ducks is >2,000 mg/kg (USDA 1999).

While high doses and/or chronic exposure of Spinosad may adversely affect some aquatic invertebrates, the short-term exposure at levels used for mosquito control is unlikely to have unwanted effects (Table 6.1).

4.3.3.4 Summary of Toxicity and Potential Effects

Spinosad readily degrades by a number of chemical and biological processes and is not environmentally persistent. Although toxicity is low to mammals, fish, invertebrates, and birds, non-target insects (e.g., some species of moths and butterflies) could be at risk. However, low amounts typically used for mosquito control would not likely pose a significant risk to potential ecological receptors.

Spinosad is used by four of the Districts throughout the year, including during each quarter of the reporting year. It is applied in three different products (0.5 to 20 percent Spinosad) to standing and moving water in natural and anthropogenic sites. These products were applied several thousand times throughout the reporting year.

Based on the environmental fate, human and ecological toxicity, and usage patterns, using BMP application practices, spinosad should not result in unwanted adverse effects.

4.3.4 Methoprene and s-Methoprene

Methoprene is a long chain hydrocarbon ester classified as an insect growth regulator and selective larvicide. Methoprene consists of two enantiomers: S-methoprene and R-methoprene. S-methoprene is the biologically active enantiomer in the racemic compound (FAO-WHO 2005). (Fate and transport characteristics of the s-enantiomer and the mixture are similar, but toxicity differs.) Methoprene is used principally against mosquitoes, but is effective against a range of insects, including the orders Diptera, Lepidoptera and Coleoptera. Methoprene is an insect growth regulator that interferes with the normal maturation process of insects, preventing them from completing their life cycle and reaching adulthood, thus ultimately preventing them from reproduction (Csondes 2004).

Methoprene was first registered by the EPA in 1975 (USEPA 1991e). Methoprene is used indoors and outdoors at domestic dwellings, in flea and tick treatments for cats and dogs, for crack and crevice treatments, and on outdoor buildings and structures, recreation areas, swimming pools, golf courses, ornamental lawns, ornamental ponds, and shrubs. Methoprene is used at animal husbandry premises, on cattle, barnyards, rangeland, pastures, fallow land, and in animal drinking water. It is used at industrial sites, on highway rights-of-way, industrial waste disposal systems, industrial/commercial ponds, wastewater, and bilge water. Methoprene can be applied to irrigation systems, orchards, crops, berries, fruit trees, and rice. It is also used in drainage systems, swamps, marshes, intermittently flooded areas, catch basins, polluted stagnant water, sewage systems, and applied by mosquito abatement Districts (CDPR 2010a).

Methoprene products used in mosquito control are applied as briquets, pellets, sand granules, and liquids. The liquid and pelletized formulations can be applied by helicopter and fixed-wing aircraft or ground-based equipment. Methoprene is applied either in response to observed high populations of mosquito larvae at a site, or as a sustained-release product that can persist for 4-months or longer if a site has limited accessibility and has regularly produced immature mosquitoes in the past.

4.3.4.1 Environmental Fate

When methoprene is released into water, it sorbs to suspended solids and sediments. When applied to soil, methoprene is relatively immobile, tending to reside in the top few centimeters of the soil (Csondes 2004). Methoprene (and s-methoprene) is a very short-lived material in nature (Table 4-15). It rapidly degrades in aqueous solution and on inert surfaces by photolysis. It is metabolized in soil under both aerobic and anaerobic conditions. Degradation in the aquatic environment is due to both microbial metabolism and photolysis (USEPA 1991e).

Table 4-15 Degradation of Methoprene/s-Methoprene

Degradation Method	Half-life	Reference
Hydrolysis (water)	Stable	FAO-WHO 2005
Photolysis (thin film)	6 Hours	FAO-WHO 2005
Photolysis (water/sediment system)	<1 Day	FAO-WHO 2005
Aerobic metabolism (pond water)	30 to 40 Hours	FAO-WHO 2005
Aerobic metabolism (soil)	10 Days	FAO-WHO 2005; USEPA 1991b
Anaerobic metabolism (soil)	14 Days	USEPA 1991b
Field dissipation (pond water)	13 Days	Csondes 2004

4.3.4.2 Human Toxicity

Methoprene is of very low acute toxicity by all routes (USEPA 1991c). The oral LD50 for rats is >10,000 mg/kg. The dermal LD50 for rabbits is >2,000 mg/kg. The inhalation LC50 for rats is >210 mg/L (USEPA 1991c, 2001) (Table 6.1).

4.3.4.3 Ecological Toxicity

Methoprene is practically nontoxic to birds. The oral LD50 for mallard ducks is >2,000 mg/kg. It is moderately toxic to freshwater fish. The 96-hr LC50 for bluegill sunfish is 1.52 µg/L. Methoprene is highly toxic to aquatic invertebrates. The 48-hr EC50 of technical methoprene for *Daphnia magna* is 89 µg/L (USEPA 1991c).

Methoprene is applied at very low concentrations for mosquito control. The manufacturer has developed a number of formulations to maintain an effective level of the active material in the mosquito habitat (0.5 to 3.0 parts per billion [ppb]; (Scientific Peer Review Panel 1996) for a practical duration, thus minimizing the cost and potential impacts associated with high-frequency repeat applications (see Table 2-4). Rate of release and data generated under laboratory and field conditions with methoprene mosquito product formulations, including slow release briquet formulations, indicate a maximal rate of release of ≤4-ppb (EPA 2001). Ross et al. (1994) conducted microcosm studies, which applied 5 sustained release methoprene formulations at maximum label application rates to tanks containing water 6 inches deep. Methoprene concentrations were measured 1, 2, 4, 7, 14, 21, 28, and 35 days after treatment, and the highest methoprene concentration measured was 6 ppb.

Exhaustive reviews of the published literature on this material attest to its lack of adverse environmental impact (Mian and Mulla 1992, Scientific Peer Review Panel 1996, Glare and O'Callaghan 1999, State of Minnesota 1999, USEPA 2001). The acute, short-term toxicity of ZR-515 (methoprene) was also tested on 35 aquatic organisms, including Protozoa, Platyhelminths, Rotatoria, Annelida, Arthropoda, Mollusca, Chordata and Thallophyta, and LC50 values of 0.9 to 5.0 mg/L were calculated (250 to 1,000 times label rates) (Miura and Takahashi 1973). Dosages used for larval mosquito control produced no adverse effect on the organisms tested, except for some sensitivity in the aquatic Diptera (flies) in the families Chironomidae, Ephydridae, and Psychodidae.

Bircher and Ruber (1988) assessed the toxicity of methoprene to all lifecycle stages of the salt marsh copepod (*Apocyclops spartinus*) at concentrations ranging from 100 to 10,000 µg/L. In general, the copepods were resistant to concentrations of methoprene used to control mosquitoes, but early larval stages did show some mortalities (the calculated 48-hour LC50, adjusted for control mortality, was

800 µg/L). Christiansen et al. (1977) showed a reduction in survival of larvae of the mud-crab *Rhithropanopeus harrisii* (Gould) in the laboratory under a range of salinity and temperature conditions, when exposed to 10, 100, and 1,000 µg/L methoprene, levels 5 to 500 times field application rates. McKenney and Mathews (1988) reported that larval survival, growth, and energy metabolism of an estuarine shrimp *Palaemonetes pugio* were altered by exposure to 100 µg/L of methoprene (50 times greater than application rates). However, Wirth et al. (2001) reported no observed differences in the percent successfully hatching or larval mortality 3 days post hatch in *P. pugio* exposed for 96 hours to 1,000 µg/L. In addition, in 2005, Suffolk County conducted 4-day static renewal toxicity tests on grass shrimp (*Palaemonetes pugio*) using water collected 30 minutes after aerial application of methoprene for mosquito control and observed no toxicity. Similar investigations have been carried out with *Leander tenuicornis*, an estuary shrimp that occurs in Australian intertidal marshes. Methoprene was nontoxic at field application levels in 96-hour toxicity tests (Brown et al. 1996). The LC50 of methoprene for *L tenuicornis* (14,320 µg/L) in these tests was 1,790 times field concentrations when applied at label rates. The authors concluded that methoprene could be safely applied in situations where the shrimp were present and that no mortality of shrimp was likely at the levels applied for mosquito control. Further laboratory work (Brown et al. 2000) found that the dose lethal to mosquitoes (*Culex annulirostris*) was 3,000 times below the LC_{95} for shrimp (*Caradina indistincta)*. Zulkosky et al. (2005) investigated the potential effect of methoprene runoff to larval lobsters (*Homarus americanus*) in continuous flow-through systems for 48 hours: methoprene was not toxic at the highest concentration tested (10 micrograms per liter [µg/L] or 10 µg/L). Laboratory studies with fish demonstrated that methoprene had no effect on the survival of adult and juvenile rainbowfish (*Melanotaenia duboulayi*) (Brown et al. 2002). No effect was observed on swimming performance of rainbowfish when exposed to up to ten times effective field concentrations of applications made for mosquito control (Hurst et al. 2007).

Methoprene does not have adverse effects on amphibians. Tests conducted on various life stages of different amphibian species (*Bufo woodhousei*, *Rana catesbeiana* and *Rana pipiens*) found no adverse effects from acute or chronic exposures at the highest dose tested. Acute studies on *R. catesbeiana* and *R. pipiens* larvae indicate LC50 values >10,000 µg/L and *B. woodhousei* adult LC50 values >1,000 µg/L (highest dose tested). Chronic studies on *B. woodhousei* indicate a 22-day LC50 >1,000 µg/L and LC50 >1,000 µg/L for *R. catesbeiana* and *R. pipiens* (USEPA 2001).

One early field study assessing applications of technical (pure powdered) methoprene on a Louisiana coastal marsh yielded ambiguous results (Breaud et al. 1977). Highly significant declines were observed in the occurrence of 14-invertebrates immediately following the application, including selected life stages and species of amphipods, shrimp, mayflies, dance flies, midges, freshwater snails, damselflies and dragonflies, and water beetles. However, the abundance of five other invertebrates significantly increased including water boatmen, moth flies, two species of crawfish, and predaceous diving beetles. No statistically significant difference was seen between the test and control populations of another 28 aquatic organisms. Interpretation of this study is difficult in part because of the mixed nature of the results, which may simply indicate the complexity of ecosystem dynamics in marshlands. Also, the application rate (28 gm active ingredient/ha technical powder) was at least twice the highest label rate of active ingredient allowed today, and was effectively much higher when the encapsulation and other coatings on modern formulations are considered. The relevance of Breaud et al.'s entire experiment as a legitimate field study may be called into question, as the properties of technical grade methoprene powder render it unfit for any type of direct field application under current label restrictions.

Since the publication of Breaud et al. (1977), there have been numerous field studies using currently available mosquito control products containing methoprene, in which no detectable effect was observed in aquatic invertebrates. For example, no detectable mortality occurred in Talitridae amphipods exposed to aerial applications of Altosid to a Florida mangrove swamp in 1999 (Lawler et al. 1999). A similar study assessed applications of a sustained release formulation of methoprene and a combined liquid formulation of *Bti* and methoprene (duplex) to tidal wetlands of San Francisco Bay. No difference was seen in growth or development of corixid beetles, and no difference in the number of non-target insects inhabiting treated versus untreated plots (Lawler et al. 2000). The authors also monitored brine flies at treated and untreated sites using sentinel cages, and sampled populations with sweep nets. No decline was observed in flies relative to controls collected by sweep nets. Caging of sentinels was unsuccessful at assessing impacts, since none of the caged flies survived at untreated sites or treated ones.

Aerial applications of liquid methoprene on saltmarsh habitat have also been assessed in Australia (Russell et al. 2009). Changes in assemblages of invertebrates through time were observed in both treated and untreated (control) plots. No significant effects were seen on arthropods in ephemeral pools. There was no significant difference in abundance of nonmosquito dipterans (flies), heteropterans (true bugs), and hymenopterans (primarily ants) in treated versus untreated sites. Some differences were observed in copepod populations during the treatment period, but these were short-term or inconsistent between localities or between sampling method. The authors concluded that applications of *Bti* and methoprene to salt marshes do not affect the structure or composition of assemblages of non-target arthropods (Russell et al. 2009).

Published studies on non-target impacts of methoprene for mosquito control were reviewed recently (Davis 2007, Davis and Peterson 2008). The authors also carried out an ecological risk evaluation of mosquito larvicides in a series of ponds at the Benton Lakes National Wildlife Refuge in Montana. *Bti* and methoprene were applied directly to water as liquids, and aquatic arthropods were sampled following the applications. No overall treatment effects were observed on aquatic non-target invertebrates collected in D-shaped net samples. A linear model was then fitted to each of the response variables to determine multivariate treatment effects. Data indicated a possible acute impact on amphipods immediately following application, but no significant effect at 7 to 28 days. No trend was seen across dependent groups of non-target organisms, and there were no persistent biological effects.

Careful review of these and other studies, and the recent reviewers listed above leads to the conclusion that: 1) applications of methoprene (especially technical powder) at rates significantly higher than allowed by the label can adversely impact a number of aquatic animals; 2) animal species are not extirpated (locally eliminated) by repeated methoprene use except at application rates far higher than those used for mosquito control; 3) emergence of adults of some fly species (specifically, some types of midges) can be temporarily reduced at application rates similar to those used for mosquito control; 4) larval flies affected by methoprene are not killed at label application rates, but are prevented from becoming adults; 5) for species that are affected by methoprene, recolonization and reestablishment of populations from neighboring sites is fast once intense control was relaxed; 6) the patchy distribution of mosquito larvae leads to maintenance of untreated refugia for non-targets, speeding recolonization; and 7) no bioaccumulation of methoprene has been seen in animals that have eaten mosquito or midge larvae treated with methoprene.

The concentrations of methoprene applied for mosquito larvae control are unlikely to affect non-target aquatic species, except for some fly species closely related to mosquitos. For species that are affected by methoprene, recolonization and reestablishment of populations from neighboring sites is fast once intense control is relaxed (Table 6.1).

4.3.4.4 Summary of Toxicity and Potential Effects

Methoprene readily degrades in soil and water by a variety of processes. It may exhibit toxicity to fish and aquatic invertebrates, as well as non-target insects including moths, butterflies, and beetles.

Methoprene is longer-lasting than some of the other larvicides on the market and, therefore requires fewer applications of low amounts. Methoprene is effective at much lower concentrations than alternative larvicide products, which correlates with reduced acute exposures to non-target organisms, as well as potential effects to a lower diversity of midges and chironomids. Extended release forms including granular and briquette varieties are also available, including 90-day briquettes. This product may be more residual in the environment, however, the methoprene active ingredient in this formulation has a short half-life in water and does not migrate through soil, significantly reducing the potential for groundwater impacts.

Considered the safest of all larvicide alternatives, methoprene is used prevalently by the nine Districts during each season, including all four quarters of the reporting year. There are 12 methoprene-containing products (0.2 to 8.62% methoprene) that are applied to natural and anthropogenic standing and moving water bodies. Eleven of these products are Altosid formulations (Wellmark) and one is MetaLarv SP-T (Table 3-1). These products were applied several thousand times during the reporting year.

Liquid and granular forms are most prevalently used in residential and ornamental pond application scenarios. Treatments to wetlands including marshes require the granular form (e.g. Altosid XRG with *Bacillus sphaericus*) to penetrate dense aquatic vegetation including cattails and tules. Methoprene is also sometimes co-applied with Bti. Drift is almost irrelevant for hand and aerial (e.g., helicopter) applications since treatments are restricted at moderate to high wind speeds. Methoprene is highly effective against mosquitoes at low concentrations and degrades quickly in the environment, thereby reducing the potential exposure and risk to non-target organisms. When handled and applied using appropriate BMP, methoprene is one of the safest (human and ecological) and most effective mosquito control products used by the Districts. Based on toxicity, environmental fate, and usage patterns, methoprene, using BMP is not likely to result in unwanted adverse impacts

4.3.5 Alcohol Ethoxylated Surfactant (monomolecular film)

The monomolecular film used in California for the control of mosquito larvae is alpha-isooctadecyl-omega-hydroxypoly(oxyethylene). Agnique is the trade name for this recently reissued surface film larvicide. Monomolecular films are alcohol ethoxylated surfactants, which are low-toxicity pesticides that spread a thin film on the surface of the water that makes it difficult for mosquito larvae, pupae, and emerging adults to attach to the water's surface, and cause them to drown (USEPA 2007c). It also disrupts larval respiration of some other classes of air-breathing aquatic insects.

Monomolecular films are used on ornamental ponds, pastures, irrigation systems, drainage systems, drinking water systems, intermittently flooded areas, catch basins, lakes, ponds, reservoirs, tidal areas, marshes, and standing water, industrial waste disposal systems, polluted and stagnant water, and sewage systems (CDPR 2010a).

4.3.5.1 Environmental Fate

Reported half-lives of monomolecular films in water range from 5 to 22 days and Agnique has an average persistence in the environment of 5 to 21 days at label application rates (Oester 2010).

4.3.5.2 Human Toxicity

Because of the mode of action and likely exposure scenarios of these products, there is little to no indication of potential for adverse effects to humans.

4.3.5.3 Ecological Toxicity

A number of efficacy and non-target studies had been conducted on this material when it was registered under the name Aerosurf. Minor proprietary changes in preparation did not apparently change any of the material's potential environmental impacts; therefore, the earlier literature is referenced.

Most published studies conducted with this larvicide tested application rates of 3 to 100 times the maximum label rate. At these rates, no observable effect on mortality or development was noted in tests on green tree frogs, seven species of fresh and salt water fish, two species of shrimp, five species of water beetle, or one species each of fairy shrimp, crayfish, snail, polychaete worm, mayfly naiad, copepod, ostracod, or midge. In addition, no effect was seen on five species of plants. Air (surface) breathing insects were temporarily adversely impacted. Waterboatmen, backswimmers, and one species of water beetle exhibited increased mortality at application rates above label limits. In addition, a clam shrimp, a crab, an amphipod, and one species of isopod exhibited minor to significant increases in mortality at levels several times the highest application rate allowed by the label (Oester 2010).

Although evidence indicates that application of monomolecular films and petroleum distillates may result in reductions to populations of surface-breathing insects at the time of treatment, it is unlikely that overall populations of invertebrate species are affected as populations recover quickly due to recolonization from neighboring sites (Table 6.1).

4.3.5.4 Summary of Toxicity and Potential Effects

Alcohol ethoxylated surfactants exert no lasting or observable effect on most non-target organisms, so that using BMP application practices, these chemicals should not result in unwanted adverse effects.

4.3.6 <u>Aliphatic Solvents (Mineral Oils and Aliphatic Petroleum Hydrocarbons)</u>

Specially-derived aliphatic solvents (e.g., mineral oils and aliphatic petroleum hydrocarbons such as GB-1111) are used to form a coating on top of water to drown larvae, pupae, and emerging adult mosquitoes. These products of petroleum distillations processes have been used for many years nationwide to kill aphids on crops and orchard trees, and to control mosquitoes (USEPA 2007d). They are applied to a wide variety of crops, trees and ornamental plants; to swamps, marshes and intermittently flooded areas; are used as an adjuvant for pesticides; and are applied by mosquito abatement Districts (CDPR 2010a). Dormant oils are widely used in the Central Valley on tree crops.

4.3.6.1 Environmental Fate

Petroleum distillates are effective in many situations in which monomolecular films do not give sufficient control. These materials also break down much more rapidly than monomolecular films (2 to 3 days as opposed to 21 days), which decreases their impact to non-target organisms.

4.3.6.2 Human Toxicity

These chemicals have a low degree of acute toxicity to mammals. There was no mortality in rats at an acute oral dose of 28,000 mg/kg bw. They are virtually nontoxic via dermal and inhalation routes (USEPA 2007d) (Table 6.1).

4.3.6.3 Ecological Toxicity

The safety of petroleum distillates for non-targets has been demonstrated by both laboratory and field studies. Three studies (Tietze et al. 1991, Tietze et al. 1992, Tietze et al. 1994) tested three species of fish (Inland Silversides, Mosquitofish, and Sheepshead Minnows), and a range of microorganisms and concluded that petroleum distillate formulation GB-1111 is not toxic to the tested organisms at label application rates. Mulla and Darwazeh (1981) tested GB-1111 in small experimental ponds and found that benthic invertebrates (including mayflies, dragonflies, and damselflies) were unaffected, while populations of surface-breathing insects were temporarily reduced, following application of this larvicide. Miles et al. (2002) completed an independent study of non-target effects of GB-1111, with financial assistance from the U.S. Fish and Wildlife Service (USFWS), on the tidal marshes of the Don Edwards National Wildlife Refuge in San Francisco Bay near Newark, California, and observed the following effects: 1) surface-breathing insect populations were reduced at the time of treatment; 2) this effect did not persist beyond a few days (no residual pesticide effects); 3) those potentially affected animals with high mobility left the site, while some of those that could not leave died (especially water boatmen [*Corixidae*]); and 4) overall populations of invertebrate species were not affected, apparently because of recolonization from neighboring untreated sites.

Although evidence indicates that application of monomolecular films and petroleum distillates may result in reductions to populations of surface-breathing insects at the time of treatment, it is unlikely that overall populations of invertebrate species are affected as populations recover quickly due to recolonization from neighboring sites (Table 6.1).

4.3.6.4 Summary of Toxicity and Potential Effects

Aliphatic solvents have very low water solubility and high sorption to organic matter. They are practically nontoxic to most non-target organisms and rapidly break down in the environment, reducing their impact on susceptible non-targets so that, using BMP application practices, these products should not result in unwanted adverse effects.

4.4 Other Insecticides

4.4.1 Potassium Salts

Potassium salts of fatty acids are used as insecticides, acaricides, herbicides and algaecides. They are used to control a variety of insects and mosses, algae, lichens, liverworts and other weeds, in or on many food and feed crops, ornamental flower beds, house plants, trees, shrubs, walks and driveways, and on dogs and cats. Potassium salts of fatty acids include potassium laurate, potassium myristate, potassium oleate and potassium ricinoleate. Once applied, however, these salts are degraded quickly in soil by microbes, and do not persist in the environment (USEPA 1992).

4.4.1.1 General Toxicity

Commonly referred to as “soap salts”. They are produced by adding potassium hydroxide to fatty acids found in plant or animal oils. Fatty acids are extracted from palm, coconut, olive, castor, and cottonseed plants (National Pesticide Information Center 2001). Fatty acids penetrate an insect’s body covering and disrupt the cell membranes. The insect dies of dehydration. Soft-bodied insects, such as aphids, are more susceptible as are immature insects.

4.4.1.2 Human Toxicity

Soap salts have low oral and dermal toxicity to mammals but may cause general stomach upset in humans. They may be irritating to the skin and eyes (USEPA 1992). These products are generally considered safe by the FDA. The USEPA classifies soap salts as Category IV (lowest level of toxicity) for acute effects (Table 6.1).

4.4.1.3 Ecological Toxicity

Soap salts are practically nontoxic to birds but slightly toxic to fish and highly toxic to aquatic invertebrates (USEPA 1992). Pesticides containing potassium salts of fatty acids are used in a wide array of outdoor sites; however, the compounds degrade very quickly in soil. Because soap salts are not applied directly to water, they pose little threat to sensitive aquatic invertebrates (USEPA 1992) (Table 6.1).

4.4.1.4 Summary of Toxicity and Potential Effects

Potassium salts degrade quickly in the environment. They are of low toxicity to birds and mammals, but highly toxic to fish aquatic non-target invertebrates. The Districts did not use potassium salt products during the reporting year; therefore, when needed, using BMP application practices, these products should not result in unwanted adverse effects

4.5 Rodenticides

These chemicals are for the control of mammal pests, particularly commensal rats and mice (e.g., Norway rat, roof rat, and house mouse) but also a variety of field rodents.

The anticoagulant rodenticides are typically grouped into “first-generation” (e.g., chlorophacinone, diphacinone) and “second-generation” (e.g., brodifacoum, bromadiolone, difethialone) compounds.

Second-generation anticoagulants tend to be more acutely toxic than are the first-generation anticoagulants, and they are retained much longer in body tissues of primary consumers. In contrast, the first-generation compounds are less acutely toxic and more rapidly metabolized and/or excreted (Housenger and Melendez 2012). Both classes have the same mode of action but second generation anticoagulants have a significantly longer liver half-life than first generation anticoagulants (Hartless and Jones 2011).

4.5.1 Chlorophacinone

Chlorophacinone is used to control a variety of vertebrate pests, mainly rodents, but also jackrabbits (lagomorphs), and moles (insectivores). It is a first-generation anticoagulant and is formulated as tracking powder, as loose-grain bait, paraffinized pellets, rat and mouse bait ready-to-use place packs, and paraffin blocks. Chlorophacinone is currently registered for the control of rodents in and around buildings, households and domestic dwellings, uncultivated agricultural and nonagricultural areas, commercial transportation facilities; industrial areas, and food processing, handling, and storage areas and facilities. Both general use and restricted use chlorophacinone products are currently registered (USEPA 1998e).

4.5.1.1 Environmental Fate

Chlorophacinone is readily degradable by photolysis in the environment. It has low water solubility, is very susceptible to direct photolysis in water and is moderately susceptible to photodegradation on soil (Table 4-16; USEPA, 1998c). Chlorophacinone volatilizes slowly from water and soil and degrades slowly by acid hydrolysis with no measurable hydrolysis at higher pHs. Chlorophacinone is considered to be moderately persistent and immobile in soil. The major route of dissipation in soil appears to be aerobic soil metabolism (USEPA 1998e, Hartless and Jones 2011).

Table 4-16 Degradation of Chlorophacinone

Degradation Method	Half-life	Reference
Hydrolysis, pH 5	232 Days	Hartless & Jones 2011
Hydrolysis, pH 7-9	Stable	USEPA 1998c, Hartless & Jones 2011
Photolysis (water)	37 minutes	USEPA 1998c
Photolysis (soil)	4 Days	USEPA 1998c
Aerobic metabolism (soil)	17 to 47.2 Days	USEPA 1998c, Hartless & Jones 2011

4.5.1.2 Human Toxicity

The USEPA classifies chlorophacinone as Category I (highly toxic) for oral, dermal, and inhalation toxicity to mammals (USEPA 1998e). The oral LD50 of chlorophacinone is 3.15 mg/kg for male rats and 0.329 mg/kg for male rabbits (USEPA 1998e). Human volunteers were able to tolerate a single dose of 20 mg active ingredient with an uneventful recovery and no treatment (EXTOXNET 1985c). The dermal LD50 for rabbits is 200 mg/kg. The inhalation LC50 for male rats is 7.0 µg/L. Chlorophacinone is not known to cause skin or eye irritation (USEPA 1998e) (Table 6.1).

4.5.1.3 Ecological Toxicity

Chlorophacinone is toxic to wildlife and fish. The 96-hr LC50 for rainbow trout is 450 µg/L. The use of food bait (aerial or ground broadcast or hand applied pellets) may present an exposure risk to seed-eating birds (USEPA 1998e). The oral LD50 is 258 mg/kg for bobwhite quail (USEPA 1998e). The oral LD50 for carnivorous mammals, including carnivores (e.g., mountain lions, bobcats, coyotes) is 2.1 to 50 mg/kg (Hosea 2000). Data are lacking to assess potential secondary risks to avian predators and scavengers, which may feed on poisoned rodents. The USEPA presumes high risks to any non-target small mammals. Primary risks to larger mammals are reduced by proper use of bait stations. Secondary risk to predatory mammals such as coyotes has been demonstrated. The USEPA indicates that chlorophacinone poses minimal risk to freshwater organisms (USEPA 1998e) (Table 6.1).

4.5.1.4 Summary of Toxicity and Potential Effects

Chlorophacinone has low water solubility and is moderately persistent in soils. Loose-grain baits may present a risk to non-target foraging animals, including seed-eating birds. This first-generation rodenticide is highly toxic to mammals, including humans, domestic pets, and non-target mammalian wildlife. However, since it is generally applied as solid bait blocks, significant release and environmental impact is not anticipated. In addition, chlorophacinone was not used by the MVCAC Districts during the reporting year. For these reasons, and when needed, using BMP application practices, these products should not result in unwanted adverse effects.

4.5.2 Diphacinone

Diphacinone and diphacinone salt products are first-generation anticoagulants formulated predominantly as food baits (loose bait, feeder boxes, place packs, or paraffinized bait blocks) for control of commensal rats (Norway rat, roof rat) and mice (house mouse). One product is registered as a tracking powder for control of rats and mice indoors and at burrows located along the periphery of buildings. Because diphacinone salt is highly soluble, it is also used to prepare water baits for indoor control of rats and mice. Use sites for rat and mouse food baits are predominantly in and around buildings and similar man-made structures. Some labels include sewers or other wet or damp sites such as dumps, irrigation ditches, along fences, gullies, and other such areas. Diphacinone salt has special local needs registration in California for control of deer mice, jackrabbits, chipmunks, muskrats, woodrats, voles, and commensal rats and mice (USEPA 1998e).

4.5.2.1 Environmental Fate

Diphacinone has low water solubility and volatilizes slowly from water and soil. Diphacinone is stable to hydrolysis at pH 7-9 and stable to photolysis. One clearly established route of transformation for diphacinone is aerobic soil metabolism (Table 4-17). Because diphacinone binds tightly to soil, most of the chemical would remain in the top soil layers and its potential to reach ground water is low (USEPA 1998e, Federoff and Lin 2011).

Table 4-17 Degradation of Diphacinone

Degradation Method	Half-life	Reference
Hydrolysis, pH 5	44 Days	USEPA 1998c
Hydrolysis, pH 7-9	Stable	USEPA 1998c
Photolysis (water)	Stable	Federoff & Lin 2011
Photolysis (soil)	Stable	Federoff & Lin 2011
Aerobic metabolism (water)	180 Days	Federoff & Lin 2011
Aerobic metabolism (soil)	28 to 32 Days	USEPA 1998, Federoff & Lin 2011

4.5.2.2 Human Toxicity

The USEPA has rated diphacinone as Category I for oral, dermal, and inhalation toxicity to mammals. Oral LD50s for rats were 2.3 mg/kg and 7.0 mg/kg in two separate studies (USEPA 1998e). The dermal LD50 for rabbits is 3.6 mg/kg. The inhalation LC50 for rats is <0.6 µg/L (USEPA 1998e). Diphacinone is listed as Category III for eye irritation and Category IV for skin irritation (USEPA 1998e). Given the exclusively nonfood uses of diphacinone, chronic toxicity and carcinogenicity, USEPA has not conducted chronic toxicity and carcinogenicity studies (USEPA 1998e). The use of rodenticides can sometimes pose risks to domestic animals via primary or secondary exposure. The oral LD50 is 0.3 to 7.5 mg/kg for dogs and 14.7 mg/kg for cats. The oral LD50 for swine is 150 mg/kg (EXTOXNET 1993b) (Table 6.1).

4.5.2.3 Ecological Toxicity

Diphacinone is slightly toxic to birds, and the use of food bait (aerial or ground broadcast or hand applied pellets) may present an exposure risk to seed-eating birds (USEPA 1998e). The oral LD50 is 3,158 mg/kg for mallard duck and 1,630 mg/kg for bobwhite quail (EXTOXNET 1993b). There is potential secondary risk to avian predators and scavengers, which may feed on poisoned rodents. The lowest observed lethal single dose to screech owls was 130 mg/kg bw (Rattner et al. 2012). The lowest observed lethal 7-day dose to screech owls was 0.82 mg/kg owl/day (Rattner et al. 2012). Primary risks to larger mammals are reduced by proper use of bait stations. The USEPA expects minimal risk to aquatic organisms from the current uses of diphacinone (USEPA 1998e). However, diphacione is slightly to moderately toxic to fish and invertebrates. The 96-hr LC50 is 7.6 mg/L for bluegill and 2.8 mg/L for trout. The 48-hr LC50 for *Daphnia magna* is 1.8 mg/L (USEPA 1998e). It is not known to bioaccumulate in fish readily (USEPA 1998e) (Table 6.1).

4.5.2.4 Summary of Toxicity and Potential Effects

Diphacinone technical material has low water solubility and is generally applied as food bait blocks; however, diphacinone salt is highly soluble and is used to prepare water baits for indoor applications. Diphacinone salt has special local needs registration in California for control of deer mice, jackrabbits, chipmunks, muskrats, woodrats, voles, and commensal rats and mice (USEPA 1998e). It is highly toxic to mammals, including humans, domestic pets, and non-target mammalian wildlife. However, since it is generally applied as solid bait blocks or in-home water treatments, significant release and environmental impact is not anticipated.

Diphacinone is used by three Districts in tree holes, burrows, creeks, and parks. Districts use two different products. Diphacinone is applied over 80 times a year and application occurs in all four quarters, including during the reporting year. Active ingredient concentrations in these products are 0.2 and 0.005 percent, respectively. Based on the limited use patterns by the Districts and low potential exposure to non-target species, it is not likely that these products would result in adverse effects. For likely future uses, USEPA has released a list of new, more protective rodenticide products, including tamper-resistant and weather-resistant bait stations (http://www.epa.gov/pesticides/mice-and-rats/rodent-bait-station.html).

4.5.3 Brodifacoum

Brodifacoum is a second generation anticoagulant pesticide for rodent control against commensal rats and mice (Housenger and Melendez 2012). It is formulated as meal bait, paraffinized pellets, rat and mouse bait ready-to-use place packs, and paraffin blocks. Brodifacoum is currently registered for the control of rats and mice in and around farm structures, households and domestic dwellings, uncultivated agricultural and nonagricultural areas, inside transport vehicles, commercial transportation facilities, industrial areas, sewage systems, aircraft, ships, boats, railway cars, and food processing, handling, and storage areas and facilities. Only general-use brodifacoum products are currently registered (USEPA 1998e).

4.5.3.1 Environmental Fate

Brodifacoum has low solubility and is nonvolatile. It is stable to hydrolysis at pH 5, 7, and 9, relatively persistent in soil (half-life of 157 days), and immobile in soil columns. Photolysis by sunlight in aqueous media is potentially important, if exposure to aquatic environments occur. Brodifacoum is persistent in soil, but little, if any, contamination of surface and ground waters is expected because of its use pattern and immobility in soil (USEPA 1998e, Housenger and Melendez 2012).

4.5.3.2 Human Toxicity

Brodifacoum is listed as Category I for oral, dermal, and inhalation exposure by the USEPA. The oral LD50 for rats is 0.418 to 0.561 mg/kg. The dermal LD50 for rabbits is 3.16 to 5.21 mg/kg. The inhalation LC50 for rats is 3.05 to 4.86 µg/L. Brodifacoum is listed as Category III for eye irritation and is unlikely to cause skin irritation (USEPA 1998e) (Table 6.1).

4.5.3.3 Ecological Toxicity

Like other common rodenticides, brodifacoum is often found in tissues of wildlife. The LD50 for carnivores such as coyotes, foxes, and mountain lions is 0.27 to 25.0 mg/kg (Stone et al. 1999, Hosea 2000). Eastern gray squirrels, white-tailed deer, raccoons, and red foxes have been recovered and determined to have died from exposure to anticoagulant rodenticides (first or second generation) (Stone et al. 1999). Domestic animals may accidentally ingest bait. The oral LD50 is 100 g of bait for cats and 355 to 1,000 g of bait for dogs (EXTOXNET 1985a).

The LD50 for wild birds, including birds of prey is 2 to 100 mg/kg (Stone et al. 1999, Hosea 2000). The acute oral LD50 for mallard ducks is 2.0 mg/kg (EXTOXNET 1985a). The LD50 for mallard ducks is 0.26 mg/kg (USEPA 1998e). Scavenging birds may also be exposed to brodifacoum. Howald (1997) reported common ravens removed and consumed bait blocks from bait stations on Langara Island during a rat eradication program. Bald eagles captured and tested have also shown blood plasma residues of brodifacoum (Howald et al. 1999). Similar results have been demonstrated for northwestern crows (Howald 1997, Howald et al. 1999) and eastern screech owls (Merson et al. 1984) with some fatalities recorded. The level of concern (LOC) for predatory birds is >100 ng/g ww (hepatic concentration) with >200 ng/g ww considered potentially lethal (Christensen et al. 2012). Brodifacoum (in combination with bromadiolone and difethialone) was indicated in the mortality of three red-tailed hawks in Manhattan in 2012 (New York State Department of Environmental Conservation 2012). In a recent study of raptors and owls in Denmark, 92 percent of all birds contained detectable hepatic concentrations of anticoagulant rodenticides, with second-generation anticoagulants (brodifacoum, bromadiolone, and difenacoum the most prevalent) (Christensen et al. 2012).

The California Department of Fish and Game Pesticide Investigations Unit identified wildlife losses possibly due to pesticide exposure (Hosea 2000). Clinical signs consistent with anticoagulant toxicosis were observed during necropsies of 43 percent of the animals with anticoagulant residues. Of the 74-animals examined in this study, 69 percent had been exposed to anticoagulant rodenticides, indicating that urban use of anticoagulant rodenticides may be important in California. The primary compound identified in this study was brodifacoum (61 percent of mammals and 55 percent of birds). This compound was only registered for use in, or adjacent to, structures. Due to the feeding behaviors of some of the exposed non-target wildlife (i.e., birds of prey do not eat pelletized or grain foods, bobcats and mountain lions are carnivores) the authors concluded that it was unlikely for these species to consume rodenticide baits directly. Raccoons, canids, kangaroo rats, and wild turkeys were thought to have been exposed via the primary route. Acute LD50 data indicated that brodifacoum has the highest toxicity of the four identified rodenticides.

Brodifacoum is also very highly toxic to aquatic organisms, but due to its extremely low solubility, the USEPA does not believe the chemical poses a hazard to non-target aquatic organisms. The 96-hr LC50 is 0.025 mg/L for bluegill and 0.015 mg/L for rainbow trout (USEPA 1998e). Additionally, the USEPA has determined that brodifacoum does not pose a risk to honey bees (USEPA 1998e) (Table 6.1).

4.5.3.4 Summary of Toxicity and Potential Effects

Brodifacoum has low water solubility and is generally applied as food bait blocks or pellets. This second-generation rodenticide is highly toxic to mammals, including humans, domestic pets, and non-target mammalian wildlife. Brodifacoum is often found in the tissues of wildlife, including avian and mammalian predators. Compared to other rodenticides reviewed herein, brodifacoum has the greatest acute toxicity and is one of the most commonly identified poisons in tissues of non-target wildlife. Brodifacoum was not used by the Districts during the reporting year. Due to its limited use by the Districts, brodifacoum does not appear to be an active ingredient of concern, and using BMP application practices, these products should not result in unwanted adverse effects

4.5.4 Bromadiolone

Bromadiolone is an anticoagulant rodenticide that is used to control Norway rats (*Rattus norvegicus*), roof rats (*Rattus rattus*), and house mice (*Mus musculus*) in and around buildings and in transport vehicles (ships, trains, and aircraft), alleys, and sewers. Formulation types include meal bait, pellets, ready-to-use place packs, and paraffinized blocks (USEPA 1998e, Sternberg et al. 2011).

4.5.4.1 Environmental Fate

Bromadiolone is moderately persistent in soil and is immobile in soil with high organic and clay content. Bromadiolone is stable to hydrolysis at pH 5, 7, and 9. The major route of dissipation appears to be aerobic soil metabolism (half-life of 14-days).Two of the major degradates identified in the aerobic soil metabolism study are persistent (USEPA 1998e, Sternberg et al. 2011).

4.5.4.2 Human Toxicity

Bromadiolone is highly toxic to mammals by acute oral, dermal, and inhalation exposure. The oral LD50 is between 0.56 and 0.84-mg/kg for rats. The dermal LD50 is 1.71 mg/kg for rabbits. The inhalation LC50 is 0.43 µg/kg for rats. Bromadiolone is listed as Category III for eye irritation and IV for skin dermal irritation (USEPA 1998e) (Table 6.1).

4.5.4.3 Ecological Toxicity

Because bromadiolone is a rodenticide, risk is presumed for any small mammals that ingest bait containing the chemical (USEPA 1998e). Like other common rodenticides, bromadiolone is often found in tissues of wildlife. The LD50 for carnivores such as coyotes, foxes, and mountain lions is 1.125 to 25.0 mg/kg (Stone et al. 1999, Hosea 2000). Domestic animals may accidentally ingest bait. Acute toxicity for dogs (hemorrhages fatal if not treated) occurs at 10 mg/kg. For a 10 kg dog that would correspond to 100 mg of pure bromadiolone (2 kg bait at a typical application of 0.005 percent) (EXTOXNET 1985b). The maximum tolerated oral dosage for cats is 25 mg/kg (EXTOXNET 1985b).

The LD50 for wild birds, including birds of prey is 16.93 mg/kg (Stone et al. 1999, Hosea 2000). The LD50 is 138 mg/kg for bobwhite quail (USEPA 1998e). Bromadiolone (in combination with brodifacoum and difethialone) was indicated in the mortality of three red-tailed hawks in Manhattan in 2012 (New York State Department of Environmental Conservation 2012). In a recent study of raptors and owls in Denmark, 92 percent of all birds contained detectable hepatic concentrations of anticoagulant rodenticides, with second-generation anticoagulants (brodifacoum, bromadiolone, and difenacoum the most prevalent) (Christensen et al. 2012).

Bromadiolone bioconcentration factors (BCF) of 160X and 1,658X were determined for edible and nonedible tissues in bluegill sunfish, respectively (USEPA 1998e). The 96-hr LC50 is 0.24-mg/L for rainbow trout and 3.0 mg/L for bluegill (USEPA 1998e). The 24-hr LC50 for *Daphnia magna* is 8.8 mg/L (EXTOXNET 1985b). Due to the methods of bromadiolone application, little if any of the chemical is expected in water bodies. Additionally, bromadiolone is extremely insoluble and therefore is not expected to pose a major risk to aquatic organisms (USEPA 1998e) (Table 6.1).

4.5.4.4 Summary of Toxicity and Potential Effects

Bromadiolone is moderately persistent in soils and is generally applied as food bait blocks or pellets. This second-generation rodenticide is highly toxic to mammals, including humans, domestic pets, and non-target mammalian wildlife. Bromadiolone is often found in the tissues of wildlife, including avian and mammalian predators. Mortalities of raptors have been associated with secondary bromadiolone poisoning.

Bromadiolone is being used in and around manmade and natural standing and moving water, including during the reporting year. There are currently four Districts using a total of five products that contain bromadiolone (0.005 percent) for rodent control. These products were applied during all four quarters of the reporting year. One product alone accounts for approximately 0.05 lbs AI applied per year (over 1,000 lbs of product). When deployed in sewers, bromadiolone blocks are sometimes attached to a string and hung below manhole covers. This method of bait deployment reduces the probability of exposure (by multiple routes) to humans and non-target wildlife, especially dietary exposure (ingestion route) to ground-foraging birds and mammals. In addition, this rodenticide causes rapid mortality of targeted rats, therefore poisoned individuals tend to expire in the sewers and not represent prey for secondary consumers in the terrestrial environment. Further, bromadiolone is usually wax-encased (e.g., Contrac Blox) in block form, which has exceptionally low water solubility and low leaching potential.

Outside of sewers, bromadiolone is typically contained in tamper-proof bait stations, which are most frequently deployed at residential locations per the request of homeowners, and not near aquatic systems, open lands, or woodlands. Residential treatments involve bait station deployment generally within 50 feet of homes. Bait stations are anchored to treatment locations (e.g., wires, stakes, etc.) to ensure that they cannot be dragged away by wildlife. In addition, bait stations have small openings that prevent the entrance and exposure to non-rodent mammals (e.g., squirrels, skunks, etc.). Residents are properly educated regarding the location of deployed tamper-proof bait stations and potential risks to children and pets.

Bromadiolone is a single-dose rodenticide that when used properly (such as in the absence of food competition), causes rapid knock-down of rat populations and very limited potential for impacting aquatic systems and resulting in exposure to humans and non-target wildlife. If use is expanded by the Districts in the future or additional issues arise regarding the use of this rodenticide, new, more protective rodenticide bait station alternatives reported by the USEPA could be considered (http://www.epa.gov/pesticides/mice-and-rats/rodent-bait-station.html). Based on toxicity, environmental fate, and usage patterns, bromadiolone, using BMPs is not likely to result in unwanted adverse impacts.

4.5.5 Bromethalin

Bromethalin is often used to exterminate rodents resistant to first generation anticoagulant rodenticides. Bromethalin is easily confused with second generation anticoagulant rodenticides (brodifacoum, bromadiolone) due to naming similarities. After ingestion, bromethalin is rapidly absorbed and undergoes N-demethylation in the liver, forming desmethylbtomethalin, which is thought to be the major toxic metabolite. The plasma half-life of bromethalin is about six days in rats. Excretion occurs mainly in bile and enterohepatic resuspension is suspected. The mode of action is the uncoupling of oxidative phosphorylation, which leads to decreased cellular ATP production and failure of Na^+, K^+-ATPase pumps. The cells lose osmotic control and swell. Cerebral and spinal cord edema elevates cerebrospinal fluid pressures and leads to neurologic dysfunction. Bromethalin toxicosis in dogs manifests as either paralytic or convulsant syndrome. Cats develop paralytic syndrome at all doses (Dunayer 2003).

Some bromethalin products meet the USEPA's new, more protective risk reduction standards. When applied properly, these products present a lower risk of accidental exposure to children, pets, and wildlife. They are applied in tamper-resistant and weather-resistant bait stations (USEPA 2013).

4.5.5.1 Environmental Fate

Bromethalin is stable to hydrolysis and is persistent to aerobic soils. In addition, a major degradate, desnitrobromethalin, also appears to be persistent and its mobility has not been characterized. However, because bromethalin is formulated as pelleted food bait, total usage of the active ingredient is low and ground water leaching and surface runoff is expected to be minimal (USEPA 2011).

Table 4-18 Degradation of Bromethalin

Degradation Method	Half-life	Reference
Hydrolysis	Stable	USEPA 2011
Aerobic metabolism (soil)	178 Days	USEPA 2011

4.5.5.2 Human Toxicity

Bromethalin is classified as very highly toxic to mammals on an acute oral basis. The acute oral (14-day) LD50 of bromethalin is 2.11 mg/kg for rats (USEPA 2011). The oral LD50 is 2.38 to 5.6 mg/kg for dogs and 0.54-mg/kg for cats (USEPA 2011). The minimum lethal oral dose for cats is 0.45 mg/kg (USEPA 2011).

4.5.5.3 Ecological Toxicity

Bromethalin is classified by the USEPA as highly toxic to birds and mammals on an acute oral basis and as highly toxic to birds on a subacute dietary basis. The acute oral (14-day) LD50 for bobwhite quail is 4.56 mg/kg (USEPA 2011). Data are not available to characterize the toxicity of bromethalin to nontarget invertebrates such as honey bees. Very little research has been conducted to directly measure the secondary poisoning hazard of bromethalin. Aquatic exposure is expected to be negligible based on the use patterns of bromethalin and there are currently no data available on the toxicity of this rodenticide to fish or aquatic invertebrates. The USEPA has listed bromethalin as “may affect” and “likely to adversely affect” the federally threatened Alameda whipsnake and the endangered salt marsh harvest mouse in California (USEPA 2011).

4.5.5.4 Summary of Toxicity and Potential Effects

Due to its acute toxicity to rodents and mammals, and the potential for exposure to non-target pets and wildlife, use of bromethalin requires a thorough understanding of possible routes of exposure. Placement and amounts of bromethalin used are critical factors in reducing potential unwanted secondary exposures and effects. Many uses of this product include subterranean placement to poison moles and voles (usually in worm-like commercial products). Some recent bromethalin products meet the USEPA’s new, more protective risk reduction standards and using proper application techniques they can result in a lower risk of accidental exposure to children, pets, and wildlife. They can also be applied in tamper-resistant and weather-resistant bait stations. Use of these products should always include appropriate BMPs and prior evaluation of the potential predators and non-targets that might consume this product.

4.5.6 Difethialone

Difethialone is an anti-coagulant rodenticide that is registered for use only in baits for control of three commensal rodents: the Norway rat (*Rattus norvegicus*), the roof rat (*Rattus rattus*), and the house mouse (*Mus musculus*). Formulation types registered include pellets, pellet packs, blocks, mini blocks, paraffin blocks, meal, packs or pouches, paste and bait stations. Currently, labeled uses of difethialone include in and around homes, and agricultural, industrial and commercial buildings, transport vehicles and associated ports, alleys and sewers (Housenger and Melendez 2011).

Difethialone was introduced as a second-generation rodenticide in 1986 for the control of commensal rats and mice including those resistant to first-generation anticoagulants. Difethialone inhibits the vitamin K-dependent step in the synthesis of a number of blood coagulation factors, disrupts normal blood-clotting mechanisms, and induces capillary damage (Housenger and Melendez 2011).

4.5.6.1 Environmental Fate

Difethialone adsorbs to suspended solids and sediment and is immobile in soil. Difethialone can slowly volatilize from water surfaces. The compound is relatively stable to hydrolysis and aerobic metabolism, but degrades rapidly by photolysis (Table 4-19).

Table 4-19 Degradation of Difethialone

Degradation Method	Half-life	Reference
Hydrolysis, pH 5-9	154 to 211 Days	Housenger & Melendez 2011
Photolysis, pH 5-9 (water)	57 to 62 minutes	Housenger & Melendez 2011
Aerobic metabolism (soil)	204 Days	Housenger & Melendez 2011

4.5.6.2 Human Toxicity

Difethialone is very toxic to mammals by all acute exposure routes. The LD50 for male rats is 0.55 mg/kg bw. The LD50 for mice is 1.29 mg/kg bw. The dermal LD50 is 6.5 mg/kg bw for rats. The inhalation LC50 is ≥ 5.0 µg/L in 4 hrs but ≤19.3 µg/L in 4-hrs for rats (Annex I - Norway 2007). Difethialone is not known to cause skin or eye irritation. No genotoxic or carcinogenic effects have been noted (Annex I - Norway 2007) (Table 6.1).

4.5.6.3 Ecological Toxicity

Difethialone is likely very toxic to most mammals. Domestic animals are somewhat less susceptible than rats and mice. The LD50 is 11.8 mg/kg bw for dogs and ≥ 16 mg/kg bw for cats. A dog would have to ingest 400 g of bait for mortality to occur (Lechevin and Poche 1988). The LD50 for domestic pigs is between 2.0 and 3.0 mg/kg bw (Annex I - Norway 2007). Difethialone is also acutely toxic by dermal and inhalation exposure. The dietary LC50 for ferrets is 97.7 mg active ingredient/kg (Savarie 2005). USEPA studies concluded that, based on the best available information, difethialone is “likely to adversely affect” Alameda whipsnake, salt marsh harvest mouse, and San Joaquin kit fox (Housenger and Melendez 2011, Wagman and Shelby 2012). Risk evaluation indicated that the registered uses of difethialone exceed acute LOCs for the small mammalian weight class of salt marsh harvest mouse. Kit fox are likely to be affected via secondary exposure as well as indirectly from reduced prey availability (small mammals). The whipsnake may be affected as the acute Risk Quotients exceed the LOC for both primary and secondary exposure and habitat modification would also occur (fewer small mammal burrows) (Housenger and Melendez 2011, Wagman and Shelby 2012). The recommended action is that a formal consultation with USFWS under Section 7 of the ESA be initiated.

Difethialone is very highly toxic to birds on an acute oral and subacute dietary exposure basis (Housenger and Melendez 2011). Difethialone is acutely toxic to birds. The LD50 for bobwhite quail is 0.264-mg/kg bw (Annex I - Norway 2007). The dietary LC50 for magpies is 4.48 mg active ingredient/kg diet (Savarie 2005). Secondary exposure of birds of prey has been demonstrated. A study of barn owls gave a low LD100 between 0.27 and 0.39 mg/kg bw (Annex I - Norway 2007). There are no data to characterize chronic toxicity to birds and mammals (Housenger and Melendez 2011). Difethialone is highly toxic to aquatic organisms. The 96-hr LC50 for rainbow trout is 51 µg/L. The 48-hr EC50 for *Daphnia magna* is 4.4-µg/L. There are no data to characterize toxicity of difethialone to the honey bee (Table 6.1).

4.5.6.4 Summary of Toxicity and Potential Effects

Difethialone is persistent in soils and is generally applied as food bait blocks or pellets. This second-generation rodenticide is highly toxic to mammals, including humans, domestic pets, and non-target mammalian wildlife. Difethialone is often found in the tissues of wildlife, including avian and mammalian predators. Difethialone has been categorized as "likely to adversely affect" several species of sensitive California wildlife and registered uses of difethialone exceed the LOC for both primary and secondary exposure. Indirect effects to habitat have been suggested for areas where difethialone is used for pest control (Housenger and Melendez 2011).

One product containing difethialone (0.0025 percent) is used by two Districts for rat control and is applied around creeks, parks, and landscaping. Application typically occurs in the fall, winter, and spring, including 19 applications during the reporting year.

Difethialone is used in areas frequented by humans and domestic animals (parks, landscaped areas) during much of the year. The availability of new, more protective rodenticide bait stations reported by the USEPA should be considered when available. (http://www.epa.gov/pesticides/mice-and-rats/rodent-bait-station.html).

4.5.7 Cholecalciferol

Cholecalciferol is used to control Norway rats (*Rattus norvegicus*), roof rats (*Rattus rattus*), and house mice (*Mus musculus*) in and around homes, industrial buildings and similar man-made structures, in and around agricultural buildings, including swine, poultry, cattle and dairy facilities, warehouses and food storage areas; in transport vehicles (ships, trains and aircraft) and in and around related port and terminal buildings; and in alleys. Formulation types include pellets and blocks (Clock-Rust and Sutton 2011). Cholecalciferol is a sterol (vitamin D3) and its ingestion results in hypercalcemia from mobilization of calcium from bone matrix into blood plasma leading to metastatic calcification of soft tissues (Clock-Rust and Sutton 2011).

4.5.7.1 Environmental Fate

The environmental fate of cholecalciferol is not well described. Based on physical/chemical properties of cholecalciferol, it is expected to be nonvolatile, essentially insoluble in water and immobile in soil (Clock-Rust and Sutton 2011). Information on biotic and abiotic degradation was not available.

4.5.7.2 General Toxicity

The parent compound and metabolites are fat soluble and stored in adipose tissue. Enterohepatic recirculation of cholecalciferol and metabolites occurs. After a massive intake of cholecalciferol, excess calcifediol is produced in the liver. Because of their high lipid solubility, cholecalciferol and its metabolites are eliminated from the body very slowly (primarily through bile and feces). Two mechanisms occur with consumption of large doses of cholecalciferol. First, more calcium is absorbed from the intestines. Second, cholecalciferol metabolites stimulate phosphorus transfer from bone to plasma. The increased plasma calcium concentrations result in vomiting, lethargy, and muscle weakness. Specific organ effects include acute renal tubular necrosis, gastrointestinal stasis, gastric acid secretion, decreased skeletal muscle responsiveness, and decreased neural tissue responsiveness. The increase in plasma calcium causes soft tissue mineralization resulting in loss of functionality of kidneys, cardiac muscle, etc. (Morrow 2001).

4.5.7.3 Human Toxicity

Cholecalciferol is acutely toxic to target rodents. The oral LD50 for cholecalciferol dissolved in corn oil is 42.5 mg/kg for mice and 43.6 mg/kg for rats (Marshall 1984). The dermal LD50 of the finished bait product (0.075 percent cholecalciferol) is 2,000 mg/kg for rabbits (Marshall 1984) (Table 6.1).

4.5.7.4 Ecological Toxicity

Cholecalciferol is considered of low hazard to avian and canine species. The oral LD50 for dogs is 88 mg/kg. The oral LD50 for mallard ducks and bobwhite quail is 2,000 mg/L (Marshall 1984). When used in bait form, cholecalciferol may directly impact sensitive species such as non-target rodents (Clock-Rust and Sutton 2011). Cholecalciferol is not expected to bioconcentrate since it is metabolized in mammals (Clock-Rust and Sutton 2011)

4.5.7.5 *Summary of Toxicity and Potential Effects*

Cholecalciferol is essentially insoluble in water and immobile in soils. It is generally applied as food bait blocks or pellets. The mode of action of cholecalciferol differs from the other rodenticides examined herein in that it is not an anticoagulant. Rather, cholecalciferol baits deliver a toxic dose of vitamin D to pests. Although it is highly toxic to target rodents, cholecalciferol is considered of low hazard to non-targets such as birds or domestic dogs.

Cholecalciferol is used in one product (0.075 percent) by one District. It is used along creeks, parks, and waterfronts in the fall, winter, and spring. Cholecalciferol was used on 26 occasions accounting for total application of 37 ounces of product. Based on the reported usage, using BMP application practices, these products should not result in unwanted adverse effects

4.5.8 Sulfur (fumigant)

Elemental sulfur is a naturally occurring component of the earth's core and crust and is ubiquitous in the environment. Sulfur has been used as a pesticide in the United States since the 1920s, and is currently registered for use as an insecticide and fungicide on a wide range of field and greenhouse-grown food and feed crops, livestock (and livestock quarters), and indoor and outdoor residential sites. Sulfur is also one of the active ingredients in four fumigant (gas-producing) cartridge products, which are used for rodent control on lawns, golf courses, and in gardens. Carbon, sodium and potassium nitrates, sawdust, and sulfur are used in the pyrotechnic fumigant gas producing cartridge products. After the cartridges are ignited, they produce toxic gases that cause asphyxiation of the pests. These toxic gases, not the active ingredients, are the stressors for these products. The gases displace the oxygen in the burrows, creating an un-breathable atmosphere, causing asphyxiation of the target organisms (USEPA 2008d).

Elemental sulfur, when applied as a pesticide, will become incorporated into the natural sulfur cycle. The main processes and dissipation of elemental sulfur are oxidation into sulfate and reduction into sulfide. These processes are mainly mediated by microbes (USEPA 2008d).

4.5.8.1 *Human Toxicity*

Elemental sulfur is known to be of low toxicity and poses little, if any, risk to human health. The USEPA classifies sulfur as Category IV (least toxic) for acute oral toxicity (EXTOXNET 1995b). The oral LD50 for rats is >5,000 mg/kg. The dermal LD50 for rats is also >2,000 mg/kg. Acute inhalation exposure can cause respiratory irritation. The inhalation LC50 for 98 percent sulfur in rats is >2.56 mg/L. Sulfur is not a skin sensitizer. No known risks of oncogenic, teratogenic, or reproductive effects are associated with the use of sulfur (EXTOXNET 1995b) (Table 6.1).

4.5.8.2 *Ecological Toxicity*

Sulfur is nontoxic to birds (EXTOXNET 1995b). The 8-day dietary LC50 for bobwhite quails is >5,620 mg/L for 95 percent sulfur wettable powder. Sulfur is of practically nontoxic to aquatic organisms (EXTOXNET 1995b). The 96-hr LC50 for bluegill and rainbow trout is >180 mg/L using a 99.5 percent sulfur dust formulation. The 48-hr LC50 for *Daphnia magna* is >5,000 mg/L using 90 percent sulfur. Sulfur is considered nontoxic to bees (EXTOXNET 1995b) (Table 6.1).

4.5.8.3 *Summary of Toxicity and Potential Effects*

Sulfur fumigants are of low toxicity prior to activation of sulfur-containing cartridges. Elemental sulfur will become incorporated back into the natural sulfur cycle after deployment. Sulfur fumigant cartridges are placed in pest burrow and produce toxic gases, which will negatively impact any animal in the burrow. Therefore, sulfur fumigants should not be applied when there is evidence of non-target animal presence. Sulfur fumigants were not used by the Districts during the reporting year and risk to non-targets is readily avoided by inspecting application sites thoroughly, therefore; using BMP application practices, these products should not result in unwanted adverse effects.

4.5.9 Sodium Nitrate (fumigant)

Sodium nitrate is used with other components as an active ingredient to control mammals such as woodchucks, ground squirrels, and coyotes in open fields, noncrop areas, rangelands, lawns and golf courses. End-use products containing sodium nitrate are used as fumigant gas cartridges designed to be placed in burrows. The sodium nitrate supports the combustion of charcoal in the formulation of each product. Pyrolysis of these sodium nitrate products results in simple organic and inorganic compounds, mostly in the form of gases such as nitrous oxide and carbon monoxide, which eventually diffuse through burrow openings or into the soil causing organisms to die of asphyxiation (USEPA 1991d).

4.5.9.1 Human Toxicity

Available acute toxicity studies indicate that sodium nitrate may cause eye irritation (Category II) and slight dermal irritation (Category IV) to mammals, but pose relatively low acute oral toxicity (Category III) hazard (USEPA 1991b). The only people exposed to sodium nitrates should be pesticide applicators and they should be exposed only minimally (USEPA 1991b). The USEPA believes that sodium nitrates, when used as indicated, do not present any unreasonable adverse effects to humans (Table 6.1).

4.5.9.2 Ecological Toxicity

Sodium nitrates are naturally occurring substances and exposure of the environment is limited and localized when the products are used as fumigants in burrows (USEPA 1991b). When used as indicated by the product label, any organism inside of a treated burrow would likely be killed by the toxic fumes. The nonselective nature of this pesticide is particularly problematic when protected species are present. Nontarget species such as burrowing owls, black-footed ferrets, kangaroo rats, or desert tortoises often inhabit pest burrows and may be at risk (Keefover-Ring 2009). USEPA recommends that applicators observe signs around burrows indicating the presence of non-target species and use caution (Table 6.1).

4.5.9.3 Summary of Toxicity and Potential Effects

Sodium nitrate fumigants are of low toxicity prior to activation of the cartridges. Sodium nitrates are naturally occurring substances. Sodium nitrate fumigant cartridges are placed in pest burrow and produce toxic gases, which will negatively impact any animal in the burrow. Therefore, sodium nitrate fumigants should not be applied when there is evidence of non-target animal presence. Sodium nitrate fumigants were not used by the Districts during the reporting year and risk to non-targets is readily avoided by inspecting application sites thoroughly; therefore, using BMP application practices, these products should not result in unwanted adverse effects.

4.6 Herbicides

4.6.1 Imazapyr

Imazapyr is part of the imidazolinone chemical class. Imazapyr is a systemic, nonselective, pre- and post-emergent herbicide used for the control of a broad range of terrestrial and aquatic weeds, and controls plant growth by preventing the synthesis of branched-chain amino acids. Imazapyr is applied either as an acid or as the isopropylamine salt. Imazapyr is used for pre- and post-emergence control of a broad range of weeds, including terrestrial annual and perennial grasses, broadleaf herbs, woody species, and riparian and emergent aquatic species. Agricultural uses of imazapyr include field corn and grass. Imazapyr is also registered for use on a variety of commercial and residential use sites, including forestry sites, rights-of-way, fence rows, hedge rows, drainage systems, outdoor industrial areas, outdoor buildings and structures, domestic dwellings, paved areas, driveways, patios, parking areas, walkways, various water bodies (including ponds, lakes, streams, swamps, wetlands, stagnant water, and urban areas) (USEPA 2006b).

4.6.1.1 *Environmental Fate*

Imazapyr is an anionic, organic acid that is nonvolatile and is both persistent and mobile in soil. Commercial formulations contain either imazapyr acid or the imazapyr isopropylamine salt, both of which are dissolved in a water solution. Imazapyr is mainly in ionic form at typical environmental pH levels, and the behavior of the acid and salt forms are similar. Upon direct application, or indirect release into surface water, photolysis is the only identified mechanism for imazapyr degradation in the environment (Table 4-20), with a half-life of approximately 3 to 5 days in surface water. Laboratory studies show imazapyr is essentially stable to hydrolysis, aerobic and anaerobic soil degradation, as well as aerobic and anaerobic aquatic metabolism. Field dissipation study observations are consistent with imazapyr's intrinsic ability to persist in soils and move via runoff to surface water and to leach to groundwater (USEPA 2006b).

Table 4-20 Degradation of Imazapyr

Degradation Method	Half-life	Reference
Hydrolysis	Stable	USEPA 2006a
Photolysis (water)	3 to 5 Days	USEPA 2006a
Aerobic metabolism (water and soil)	Stable	USEPA 2006a
Anaerobic metabolism (water and soil)	Stable	USEPA 2006a

4.6.1.2 *Human Toxicity*

Imazapyr is slightly toxic to mammals via oral, dermal, and inhalation exposure. The oral LD50 for rats is >5,000 mg/kg. The dermal LD50 for rabbits is >2,000 mg/kg. The inhalation LC50 for rats is >1.3 mg/L. There is no evidence that imazapyr is carcinogenic or mutagenic (USDOE-Bonneville Power Administration 2000). The USEPA has determined that the risk to humans of dietary and incidental exposure is below the level of concern (USEPA 2006b). Imazapyr is classified as a Category I primary eye irritant (USEPA 2006b). The oral LD50 for rats is >5,000 mg/kg. The dermal LD50 for rabbits is >2,000 mg/kg. The inhalation LC50 for rats is >1.3 mg/L (USDOE-Bonneville Power Administration 2000) (Table 6.1).

4.6.1.3 *Ecological Toxicity*

Imazapyr is practically nontoxic to birds, fish, *Daphnia*, and honey bees. The oral LD50 for mallard ducks is >2,150 mg/kg. The 96-hr LC50 for rainbow trout is >100 mg/L. The 48-hr LC50 for *Daphnia magna* is >1,000 mg/kg. The LD50 for honey bees is >100 µg/bee (USDOE-Bonneville Power Administration 2000). Although there are no risks of concern to terrestrial birds, mammals, and bees or aquatic invertebrates and fish, imazapyr does pose an ecological risk to non-target terrestrial and aquatic vascular plants (USEPA 2006b). Imazapyr is not expected to bioaccumulate in aquatic organisms because it exists as an anion at typical environmental pHs (USEPA 2006b) (Table 6.1).

4.6.1.4 *Summary of Toxicity and Potential Effects*

Imazapyr is persistent in soil and also tends to leach to groundwater. It is of low acute toxicity to mammals and practically nontoxic to birds, fish, and invertebrates. Non-target plants may be at risk from imazapyr application. Based upon the toxicity and environmental fate of imazapyr, and using BMP application practices, these products should not result in unwanted adverse effects.

4.6.2 Glyphosate

Glyphosate is a nonselective, post-emergent, and systemic herbicide registered for use in agricultural and nonagricultural areas. It is applied to agricultural drainage systems, irrigation systems, sewage systems, forest trees, greenhouses, outside of household/domestic dwellings, and to a variety of feed and food crops. When applied at lower rates, glyphosate is a plant growth regulator (USEPA 1993). It works by inhibiting the synthesis of the enzyme 5-enolpyruvylshikimic acid-3-phosphate synthase (EPSP), which is needed for production of amino acids. These amino acids aid in synthesis of proteins that link primary and secondary metabolism. Glyphosate is not effective on submerged or mostly submerged foliage and therefore is only applied to control emergent foliage (Schuette 1998, Siemering 2005).

4.6.2.1 Environmental Fate

Glyphosate is highly water-soluble. Glyphosate is broken down by microbial degradation to its metabolite aminomethylphosphonic acid (AMPA) and carbon dioxide. The rate of degradation in water is generally slower than the rate in soil because there are fewer microorganisms in water than in most soils. For all aquatic systems, sediment appears to be the major sink for glyphosate residue. Even though glyphosate is highly water soluble it appears that parent glyphosate and AMPA have a low potential to move to groundwater due to their strong soil adsorptive characteristics (USEPA 1993, Schuette 1998, Siemering 2005).

In the soil environment, glyphosate is resistant to chemical degradation, is stable to sunlight, is relatively nonleachable, and has a low tendency to runoff (except as adsorbed to colloidal matter and sediment). It is relatively immobile in most soil environments as a result of its strong adsorption to soil particles and does not move vertically below the 6 inch soil layer. Glyphosate's primary route of decomposition in the environment is through microbial degradation in soil (Table 4-21). The herbicide is inactivated and biodegraded by soil microbes at rates of degradation related to microbial activity in the soil and factors that affect this activity. The biological degradation process is carried out under both aerobic and anaerobic conditions by soil microflora (USEPA 1993, Schuette 1998).

Table 4-21 Degradation of Glyphosate

Degradation Method	Half-life	Reference
Hydrolysis	>35 Days, Stable	USEPA 1993b, Schuette 1998, FAO-WHO 2005a
Photolysis (water)	Stable (pH 5,7 and 9)	USEPA 1993b
Photolysis (soil)	Stable	USEPA 1993b
Aerobic metabolism (water)	7 Days	USEPA 1993b
Aerobic metabolism (soil)	1.85 to 25 Days	USEPA 1993b, FAO-WHO 2005a
Anaerobic metabolism (soil)	8.1 to 22.1 Days	USEPA 1993b, Schuette 1998
Field dissipation (soil)	44 to 60 Days	Schuette 1998
Streams, ponds, natural waters	1.5 to 63 Days	Schuette 1998

4.6.2.2 General Toxicity

Glyphosate is an herbicide designed to specifically affect plants via the shikimic acid pathway. Glyphosate inhibits the enzyme 5-enolpyruvylshikimate 3-phosphate (EPSP) synthase, which is absent in mammals (Miller et al. 2010). The resulting deficiency in EPSP production leads to reductions in aromatic amino acids necessary for plant protein synthesis and growth. Glyphosate is absorbed directly across the leaves and stems and is translocated throughout the plant, concentrating in the meristem (Miller et al. 2010). The effects of the herbicide are generally visible between 4 and 20 days post-application and include stunted growth, loss of pigmentation, malformation or wrinkling of leaves, and ultimately tissue death (Miller et al. 2010). There are several formulations of glyphosate, including an acid, monoammonium salt, diammonium salt, isopropylamine salt, potassium salt, sodium salt, and trimethylsulfonium or trimesium salt. The commonly used Roundup™ products are isopropylamine salt formulations. The salts do not contribute to the weed control activity; therefore, the acid equivalent (ae) of glyphosate acid is the most accurate method of expressing and comparing concentrations (Table 6.1).

4.6.2.3 Human Toxicity

The shikimic acid pathway is specific to plants and some microorganisms; therefore, glyphosate is thought to have very low toxicity to mammals (USEPA 1993). The USEPA classifies glyphosate as Category III for oral and dermal toxicity (USEPA 1993). The oral LD50 for technical grade glyphosate for rats is 4,320 mg/kg (USEPA 1993). The dermal LD50 for technical grade glyphosate in rabbits is ≥2000 mg/kg (USEPA 1993). Technical grade glyphosate is nonvolatile and the LC50 for rats is ≥4.43 mg/L based on a 4-hr, nose-only inhalation study (USEPA 1993, Miller et al. 2010).

The isopropylamine and ammonium salts exhibit low toxicity to mammals via the oral and dermal routes. The oral LD50 for the isopropylamine salt in rats is ≥ 5,000 mg/kg. The oral LD50 for the ammonium salt form in rats is 4,613 mg/kg. The dermal LD50 for rabbits is ≥ 5,000 mg/kg for both salts (Miller et al. 2010). The salt formulations of glyphosate also exhibit low toxicity via the inhalation route. The 4-hr LC50 for rats exposed to the isopropylamine form is >1.3 mg/L air. The LC50 for rats exposed to the ammonium salt form was >1.9 mg/L in a whole-body exposure (Miller et al. 2010).

A one-year feeding study resulted in no chronic effects in beagle dogs at daily doses of 500 mg/kg (USEPA 1993). There is no scientific evidence indicating that glyphosate is carcinogenic or mutagenic (USEPA 1993). Experimental evidence has shown that neither glyphosate nor its major breakdown product (aminomethylphosphonic acid [AMPA]) bioaccumulates in any animal tissue (Williams et al. 2000). Glyphosate is poorly biotransformed in rats and is excreted mostly unchanged in the feces and urine (Williams et al. 2000).

Despite the apparent lack of toxicity to mammals, concerns have been raised about the long-term safety of glyphosate. In one study, glyphosate has been shown to alter the respiratory and hepatic systems of rats and to cause damage to reproductive functions and fetal development (Clair et al. 2012). Additionally, a recent study found significant contamination in all urine samples taken from an urban human population in Germany. The levels of glyphosate in the subjects' urine were 5 to 20 times the maximum allowable limit for drinking water (Brandli and Reinacher 2012). In another study, rats and mice were fed a diet containing glyphosate for 13 weeks. The two highest dose groups of male rats (25,000 and 50,000 mg/kg of 99 percent pure glyphosate) had significant reductions in sperm concentrations (Chan and Mahler 1992). Female rats in the 50,000 mg/kg group had slightly longer estrus cycles than the control group (Chan and Mahler 1992). Although still in review, glyphosate is included in the final list of chemicals for screening under the USEPA Endocrine Disruptor Screening Program (USEPA 2009a), which focuses on pesticide active ingredients and inert ingredients with relatively greater potential for human exposure (Table 6.1).

4.6.2.4 Ecological Toxicity

Glyphosate is practically nontoxic to birds. The oral LD50 for bobwhite quail is >2,000 mg/kg. It is also practically nontoxic to freshwater fish. The 48-hr LC50 for bluegill sunfish is >24-mg/L (USEPA 1993). Maximum bioconcentration factors were 0.52 times for whole fish (USEPA 1993). Technical grade glyphosate is slightly toxic to practically nontoxic to freshwater invertebrates with 48-hr LC50s ranging from 55 to 780 mg/L. LC50 values have also been obtained for several species of frogs and the American toad. The 24-hr LC50 for amphibians ranged from 6.6 to 18.1 mg/L (Howe et al. 2004). No significant acute toxicity to amphibians was observed with the technical material or the products (e.g., Roundup Original). Glyphosate is practically nontoxic to honey bees. The acute oral LD50 is >100 µg/bee (USEPA 1993) (Table 6.1).

4.6.2.5 Summary of Toxicity and Potential Effects

Products currently available containing glyphosate include Roundup, Rodeo, Pondmaster, ProMax, Proud3, Aquamaster and Alligare. Each has a formulation with a slight variation of toxicity and environmental characteristics. This summary is focused on the active ingredient, N-(phosphonomethyl) glycine.

Using BMP approaches, applications of glyphosate can be used safely when an adequate buffer to water sources is maintained. Although there has been some recent concerns expressed about possible sub-lethal effects of glyphosate products, it is virtually nontoxic to mammals and practically nontoxic to birds, fish, and invertebrates. Glyphosate has been identified as a candidate by USEPA for evaluation as a potential endocrine disruptor (USEPA 2009a). Based on these issues, it is likely that USEPA will provide an updated review of its potential risks in 2015, but until then, glyphosate products are effective, generally safe, products used for weed control. (http://gmo-journal.com/2011/11/21/safety-review-of-glyphosate-herbicide-faces-tough-critics)

4.6.3 Triclopyr

Triclopyr is a pyridine-based herbicide used for the control of woody plants and annual and perennial broadleaf weeds. The two registered formulations are triclopyr triethylamine salt (TEA) and triclopyr butoxyethyl ester (TBEE). Triclopyr TEA rapidly dissociates in water to the triclopyr acid/anion and triethanolamine. Triclopyr BEE rapidly hydrolyses in the environment to the triclopyr acid/anion and butoxyethanol. It is the triclopyr acid (known simply as triclopyr) that causes phytotoxicity. Triclopyr is used at railroad or other rights-of-way, for commercial and residential use, and on rice, pasture, and woodlands. Triclopyr is absorbed by leaves and roots and is moved throughout the plant. The triclopyr TEA formulation is also used to control aquatic plant species. Triclopyr is a pyridine-based herbicide that acts as a synthetic auxin, giving a plant an auxin overdose 1,000 times natural levels (Ganapathy 1997). Triclopyr is absorbed by leaves and roots and is moved through the plant into the foliage rapidly. The effects occur at the cellular level first when ethylene and protein production in the plant increases first, followed by epinasty, abnormal leaf formation, and stem swelling, and death. Triclopyr has low phytotoxicity to grasses, but can cause injury to conifers at high application rates (Ganapathy 1997). There are two formulations of triclopyr: the triethylamine salt (TEA) and the butoxyethyl ester (TBEE).

4.6.3.1 Environmental Fate

Triclopyr is nonvolatile and highly soluble. Triclopyr is “slightly mobile” with sorption to soil increasing with time. Triclopyr is moderately persistent, with persistence increasing as it reaches deeper soil levels and anaerobic conditions. The predominant degradation pathway for triclopyr in water is photodegradation and the predominant degradation pathway in soil is microbial degradation (Table 4-22; (Ganapathy 1997, USEPA 1998h).

Table 4-22 Degradation of Triclopyr

Degradation Method	Half-life	Reference
Hydrolysis, pH 5-9	270 Days, Stable	USEPA 1998g, Ganapathy 1997
Photolysis (water)	0.36 to 1.7 Days	USEPA 1998g
Aerobic metabolism (water)	142 Days	USEPA 1998g
Aerobic metabolism (soil)	8 to 18 Days	USEPA 1998g
Anaerobic metabolism (water)	>365 Days	USEPA 1998g
Field dissipation (water)	0.5 to 3.5 Days	USEPA 1998g, Ganapathy 1997
Field dissipation (soil)	10.4 to 33 Days	USEPA 1998g, Ganapathy 1997

4.6.3.2 Human Toxicity

Triclopyr is slightly toxic to mammals by oral and dermal routes and has been classified as Category III by the USEPA (USEPA 1998c). The TBEE formulation is slightly toxic by the oral and dermal route (Category III) and practically nontoxic by inhalation (Category IV) (USEPA 1998c). The oral LD50 for technical triclopyr in rats is 630 mg/kg for females and 729 for males (USEPA 1998c). Triclopyr is not carcinogenic (Table 6.1).

4.6.3.3 Ecological Toxicity

Triclopyr is rapidly absorbed by animals and then excreted by the kidney, primarily in the unmetabolized form. Aquatic organisms are more susceptible to triclopyr. Triclopyr acid is slightly toxic to birds and practically nontoxic to insects, freshwater fish, and aquatic invertebrates. The oral LD50 of triclopyr acid for mallard ducks is 1,698 mg/kg. The 96-hr LC50 for rainbow trout is 117 mg/L. The 96-hr LC50 for *Daphnia magna* is 132 mg/L. The LD50 for honey bees is 60.4-µg/bee (Ganapathy 1997). Triclopyr does not bioaccumulate rapidly (Ganapathy 1997, USEPA 1998c).

The TBEE formulation is slightly toxic to birds, moderately toxic to highly toxic to freshwater fish and slightly to moderately toxic to freshwater invertebrates. The 96-hr LC50 of TBEE to bluegill sunfish is 0.36 mg/L (Ganapathy 1997). The TEA formulation is practically nontoxic to birds and invertebrates and moderately to highly toxic to fish (USEPA 1998c) (Table 6.1).

4.6.3.4 Summary of Toxicity and Potential Effects

Triclopyr is highly soluble and slightly mobile in soil. Technical triclopyr, TEA, and TBEE have similar slight toxicity to mammals, birds, fish, and invertebrates. It also has low toxicity to non-target grasses, but can cause injury to conifers. Based upon the toxicity and environmental fate of triclopyr, and using BMP application practices, these products should not result in unwanted adverse effects.

4.6.4 2,4-Dichlorophenoxy acetic acid (2,4-D)

The compound 2,4-dichlorophenoxyacetic acid (2,4-D) is an herbicide in the phenoxy or phenoxyacetic acid family. Although it is classified as an herbicide, a plant growth regulator, and a fungicide, it is mainly used as a selective postemergence herbicide for the control of broadleaf weed species and aquatic weeds. 2,4-D is registered for use on pasture/rangeland, turf, wheat, corn, soybeans, fallow land, hay other than alfalfa, noncropland (roadways, rights-of-way, ditches, industrial sites, etc.), forestry, rice, sugarcane, pome fruits, stone fruits, nut orchards, filberts, grass grown for seed and sod, aquatic weed control, potatoes, asparagus, strawberries, blueberries, grapes, cranberries, and citrus (USEPA 2005).

2,4-D is generally not applied as the acid, but is applied as one of several formulations, which quickly break down into 2,4-D acid (e.g., chemical formulations of 2,4-D amine salts and 2,4-D esters). 2,4-D mimics the effect of auxins, or other plant growth regulating hormones, and thus stimulates growth, rejuvenates old cells, and overstimulates young cells leading to abnormal growth patterns and death in some plants (Walters 1999). 2,4-D is thought to increase cell-wall plasticity, biosynthesis of proteins and the production of ethylene. The abnormal increase in these processes results in uncontrolled cell division and growth which damages vascular tissue (USEPA 2005).

4.6.4.1 Environmental Fate

In the aqueous environment, 2,4-D is most commonly found as the free anion (the amine salt formulations dissociate to the anion and ester formulations hydrolyze to the anion, usually within 1 day) (Walters 1999). The dissipation of 2,4-D is dependent on oxidative microbial-mediated mineralization, photodegradation in water, and leaching (USEPA 2005). 2,4-D has low persistence in soil, primarily due to degradation by soil microbes, and microorganisms also readily degrade 2,4-D in aquatic environments (Table 4-23). In water, 2,4-D will biodegrade at a rate dependent upon the level of nutrients present, temperature, availability of oxygen, and whether or not the water has been previously contaminated with 2,4-D or other phenoxyacetic acids (Walters 1999, Siemering 2005).

Table 4-23 Degradation of 2,4-D

Degradation Method	Half-life	Reference
Hydrolysis (water)	Stable	USEPA 2005
Hydrolysis (soil)	39 Days	Walters 1999
Photolysis (water)	12.9 to 13 Days	USEPA 2005, Walters 1999
Photolysis (soil)	68 to 393 Days	USEPA 2005, Walters 1999
Aerobic metabolism (water)	15 Days	USEPA 2005, Walters 1999
Aerobic metabolism (soil)	6.2 to 66 Days	USEPA 2005, Walters 1999
Anaerobic metabolism (water)	41 to 333 Days	USEPA 2005, Walters 1999
Field dissipation (soil)	59.3 Days	Walters 1999

4.6.4.2 Human Toxicity

The modes of toxicity to mammals from the acid, ester, and salt forms of 2,4-D are similar, although the acid and salt forms can also be eye irritants. The oral LD50 for rats ranges from 639 to 1,646 mg/kg, depending on the chemical form of 2,4-D used. All forms of 2,4-D are considered of low acute dermal toxicity. The dermal LD50 in rabbits ranges from 1,829 to >2,000 mg/kg. All forms of 2,4,-D are considered of low inhalation toxicity. The inhalation LC50 for rats ranges from 0.78 to >5.4-mg/L, depending on the formulation used (Gervais et al. 2008).

In mammals, 2,4-D is actively secreted by the proximal tubules of the kidney and toxicity appears to result when renal clearance capacity is exceeded. Dose-dependent toxic effects, including damage to the eyes, thyroid, kidney, adrenals, ovaries, and testes, have been observed in rats at 15 mg/kg/day(Charles et al. 1996). Additionally, reproductive toxicity, neurotoxicity, and developmental toxicity have also been observed (Gervais et al. 2008). Because 2,4-D has been associated with effects on the thyroid and gonads following exposure, it has been included in the final list of chemicals for screening under the USEPA Endocrine Disruptor Screening Program (USEPA 2009a) (Table 6.1).

4.6.4.3 Ecological Toxicity

2,4-D is slightly to moderately toxic to birds. The LD50 is 1,000 mg/kg in mallards (EXTOXNET 1996a). The LD50 for acute oral exposure for pheasants is 472 mg/kg (Gervais et al. 2008). Some formulations are highly toxic to fish while others are less toxic. The LC50 for cutthroat trout ranges from 1.0 to 100 mg/L, depending on the formulation tested (EXTOXNET 1996a). The 24-hr LC50 for honey bees has been estimated as between 104 and 115 µg/bee and therefore 2,4-D is considered practically nontoxic to bees (USEPA 2005). 2,4-D has been shown to accumulate in fish at up to 18X the ambient concentrations within two days of exposure (Wang et al. 1994) as cited by (Tu et al. 2001) (Table 6.1).

4.6.4.4 Summary of Toxicity and Potential Effects

2,4-D has low persistence in soil and leaches to groundwater. 2,4-D is of low to moderate toxicity to mammals and birds; however, some formulations are highly toxic to fish and invertebrates. In addition, 2,4-D has been associated with dose-dependent damage to eyes, thyroid, kidneys, adrenals, ovaries, and testes in chronic studies of rats. It has been included in the final list of chemicals for screening under the USEPA Endocrine Disruptor Screening Program (USEPA 2009a).. Although 2,4,D has been characterized as a potential candidate for the banned chemical list (based upon the high toxicity of 2,4-D to some fish, the potential of 2,4-D to runoff, and other factors), USEPA has not yet banned it based on its efficacy and documented need by agriculture and industry   Therefore, the status of 2,4, D should be monitored by the Districts for updates by the regulatory community.

4.6.5 Sulfometuron Methyl

Sulfometuron methyl was originally registered as a pesticide active ingredient in the U.S. in February 1982. Sulfometuron methyl is a broad-spectrum sulfonylurea herbicide recommended for preemergence and postemergence control of annual, biennial, and perennial grasses and broadleaf weeds. The herbicide is used for general weed control on industrial noncrop sites and for selective weed control on turf grasses on industrial sites. It is also used for selective weed control in forest site preparation and in the release of several types of pines and certain hardwoods (O'dell 1999). Similar to other sulfonylurea herbicides, sulfometuron's mode of action involves inhibiting the activity of the enzyme acetolactate synthase, which inhibits the production of amino acids required for cell growth in plants (USEPA 2008c). The result is growth inhibition followed by a decline in plant vigor, discoloration, chlorosis, and terminal bud death. Although seed development is not inhibited, sulfometuron methyl effectively retards or stops root and shoot development (O'dell 1999).

4.6.5.1 Environmental Fate

Hydrolysis, photolysis and microbially-mediated degradation are major routes of transformation of sulfometuron methyl in water, soil, and water-sediment systems (Table 4-24). The degradation in soil and water appears to be enhanced in the presence of an active microbial population (aerobic and anaerobic degradation both proceed more slowly under sterile conditions) (USEPA 2008c). Sulfometuron methyl has a low tendency to sorb to sediments. Partitioning of sulfometuron methyl and its breakdown products between water and sediment is dependent on pH and organic content of the solids (O'dell 1999). Sulfometuron methyl has the potential to leach to ground water and/or reach surface water during runoff events (USEPA 2008c).

Table 4-24 Degradation of Sulfometuron methyl

Degradation Method	Half-life	Reference
Hydrolysis, pH 5	5 to 14 Days	O'dell 1999
Hydrolysis, pH 7	>30 Days	O'dell 1999
Photolysis (water)	12 Days	O'dell 1999
Photolysis (soil)	11 Days	O'dell 1999
Aerobic metabolism (soil)	53 Days	O'dell 1999
Anaerobic metabolism (soil)	283 Days	O'dell 1999
Field dissipation (soil)	14 Days	O'dell 1999

4.6.5.2 Human Toxicity

Sulfometuron methyl is classified as Category IV to mammals for oral and inhalation toxicity and Category III for dermal toxicity by the USEPA (USEPA 2008c). The oral LD50 for rats is >5,000 mg/kg. The dermal LD50 for rabbits is >2,000 mg/kg. The inhalation LC50 for rats is >5.0 mg/L (USEPA 2008c) (Table 6.1).

4.6.5.3 Ecological Toxicity

Sulfometuron methyl is nontoxic to birds, slightly toxic to fish, and practically nontoxic to *Daphnia* and honey bees (EXTOXNET 1996c). The avian oral LD50 is >4,650 mg/kg. No sublethal effects have been observed during acute toxicity studies of birds (USEPA 2008c). The LC50 for fish is >100 mg/L. The LC50 for *Daphnia* *magna* is 125 mg/L (technical material) and >1,000 mg/L (dispersible granule). The 48-hr contact LC50 for honey bees is >100 µg active ingredient/bee (USEPA 2008c). Sulfometuron methyl has low potential to volatilize from soil or water or to bioaccumulate (USEPA 2008c).

Sulfometuron methyl is phytotoxic to duckweed (*Lemna gibba*) at concentrations of ≥ 0.59 µg/L but the effects appear to be reversible given sufficient recovery periods (USEPA 2008c). The chemical is toxic to a broad range of terrestrial plants. EC25 values have been established for sorghum, sugar beets, corn, and soybeans. In all cases, the most sensitive endpoints were seedling emergence and vegetative vigor (USEPA 2008c) (Table 6.1).

4.6.5.4 Summary of Toxicity and Potential Effects

Sulfometuron methyl tends to sorb to soils but has the potential to leach to groundwater. It is of low toxicity to mammals, birds, and bees. It is slightly toxic to fish. The chemical is phytotoxic to non-target aquatic plants such as duckweed. Based upon the toxicity and environmental fate of sulfometuron methyl, and using BMP application practices, these products should not result in unwanted adverse effects.

4.6.6 Bentazon

Bentazon, also known by its trade name Basagran, is a selective herbicide that is used after seedlings have emerged to control broadleaf weeds and sedges among food and feed crops including alfalfa, beans, corn, peanuts, peas, peppers, peppermint, rice, sorghum, soybeans and spearmint. Bentazon also is registered for use on ornamental lawns and turf. Most bentazon used in the U.S. (73 percent) is applied to soybean crops. Based on chemical affinities, bentazon is considered a member of the thiadiazine group, containing nitrogen and sulfur atoms. It is a benzothiadiazinone contact herbicide and photosynthetic electron transport inhibitor. Bentazon is formulated and used as the sodium salt alone or in combination with atrazine (USEPA 1994c). The chemical interferes with the ability of susceptible plants to use sunlight for photosynthesis and visible injury to the plants occurs within 4-to 8 hours of application followed by death of the plant.

4.6.6.1 Environmental Fate

Dissipation of bentazon is dependent on photolysis, microbe-induced degradation, leaching and surface water runoff (Table 4-25). Degradation in aquatic environments is dependent on photolysis. Degradation in soil is controlled by processes involving microbes in the presence of oxygen. Bentazon has a low binding affinity to soil and therefore may leach into ground water and runoff into surface waters. Leaching did not appear to be a major route of dissipation in field studies, however. Bentazon dissipates rapidly under typical use conditions. The soil degradates of bentazon include AIBA, which is very mobile but not persistent (half-life 1-10 days), and N-methylbentazon which is not mobile (USEPA 1994c).

Table 4-25 Degradation of Bentazon

Degradation Method	Half-life	Reference
Hydrolysis, pH 5-9	Stable	USEPA 1994c
Photolysis (water)	2.6 Days	USEPA 1994c
Photolysis (soil)	>39 Days	USEPA 1994c
Aerobic metabolism (water)	Stable	USEPA 1994c
Aerobic metabolism (soil)	24 to 98 Days	USEPA 1994c
Anaerobic metabolism (water)	Stable	USEPA 1994c
Anaerobic metabolism (soil)	89 Days	USEPA 1994c
Field dissipation (soil)	7 to 33 Days	USEPA 1994c

4.6.6.2 Human Toxicity

Bentazon is slightly toxic (Category III) to mammals via the oral, dermal, and inhalation routes and is a skin sensitizer (USEPA 1994a, EXTOXNET 1996b). The oral LD50 for rats is 1,100 mg/kg. The dermal LD50 for rabbits is 4,000 mg/kg. Bentazon has not been associated with carcinogenic effects but causes some developmental toxicity effects in rats and rabbits (USEPA 1994a) (Table 6.1).

4.6.6.3 Ecological Toxicity

Bentazon is slightly toxic to birds on an acute oral and subacute dietary basis and exceeds the level of concern for avian chronic reproductive effects. The risk to birds can be reduced by lowering the maximum seasonal application rate from four to two pounds per acre, as recommended by the USEPA (USEPA 1994a). The oral LD50 for bobwhite quail is 1,171 mg/kg. Bentazon is slightly toxic to small mammals and practically nontoxic to fish and invertebrates. It poses a low risk to aquatic plants but may present a hazard to terrestrial plants (USEPA 1994a) (Table 6.1).

4.6.6.4 Summary of Toxicity and Potential Effects

Bentazon has low binding affinity to soil and leaches to groundwater or tends to runoff. Bentazon is slightly toxic or practically nontoxic to mammals, birds, and bees, fish, aquatic invertebrates, and aquatic plants. Based upon its low toxicity**,** and using BMP application practices, these products should not result in unwanted adverse effects.

4.6.7 Diuron

Diuron is a substituted urea herbicide used for the control of a wide variety of annual and perennial broad leaved and grassy weeds on both crop and noncrop sites. The mechanism of herbicidal action is the inhibition of photosynthesis. It is rapidly translocated into the stems and leaves of plants. Diuron primarily acts by inhibiting the Hill reaction in photosynthesis, limiting the production of high-energy compounds like adenosine triphosphate (ATP) which are necessary for various metabolic processes. Diuron is registered for pre- and post-emergent herbicide treatment of both crop and noncrop areas, as a mildewcide and preservative in paints and stains, and as an algaecide in commercial fish production, residential ponds and aquariums. Products containing diuron are intended for both occupational and residential uses. Occupational uses include agricultural food (such as citrus, berries, asparagus, pineapple, and oranges) and nonfood crops (such as cotton); ornamental trees, flowers, and shrubs; paints and coatings; ornamental fish ponds, and catfish production; rights-of-way and industrial sites. Residential uses include ponds, aquariums, and paints (USEPA 2003b). Diuron is one of the most commonly used pesticides in California. It is often used in rights of way (Moncada 2004).

4.6.7.1 Environmental Fate

The major route of dissipation for diuron in the environment is microbial degradation in water (Table 4-26). Diuron also degrades through photolysis in both water and soil, but at a slower rate. Sorption of diuron to soil is highly correlated with soil organic matter. However, relative to other pesticides diuron is generally considered both mobile and persistent. Diuron has the potential to leach to ground water and to contaminate surface waters (USEPA 2003b, Moncada 2004).

Table 4-26 Degradation of Diuron

Degradation Method	Half-life	Reference
Hydrolysis, pH 5-9	>1,240 Days, Stable	USEPA 2003, Moncada 2004
Photolysis (water)	43 to 2,180 Days	USEPA 2003, Moncada 2004
Photolysis (soil)	173 Days	USEPA 2003, Moncada 2004
Aerobic metabolism (water)	33 Days	USEPA 2003

Table 4-26 Degradation of Diuron

Degradation Method	Half-life	Reference
Aerobic metabolism (soil)	372 Days	USEPA 2003, Moncada 2004
Anaerobic metabolism (water)	5 Days	USEPA 2003
Anaerobic metabolism (soil)	995 Days	USEPA 2003, Moncada 2004
Field dissipation (soil)	73 to 134 Days	USEPA 2003, Moncada 2004

4.6.7.2 Human Toxicity

Diuron has low acute toxicity (Category III or IV) to mammals by the oral, dermal, or inhalation exposure routes. It is not irritating to eyes or skin. Diuron is rapidly absorbed and metabolized by rats and is mostly excreted in the urine (USEPA 2003b). In mammals, metabolism occurs through hydroxylation and dealkylation (Moncada 2004). The oral LD50 for rats is 4,721 mg/kg for males and >5,000 mg/kg for females. The dermal LD50 is >2,000 mg/kg. The inhalation LC50 is >7.1 mg/L. Diuron has been classified as a “known/likely” human carcinogen based on urinary bladder carcinomas in rats. Tumors occurred at doses >600 mg/kg/day (USEPA 2003b) (Table 6.1).

4.6.7.3 Ecological Toxicity

Diuron is slightly to practically nontoxic to birds. The oral LD50 for mallard ducks is >2,000 mg/kg (USEPA 2003b). It is practically nontoxic to honey bees (48-hr LC50 = 145 µg/bee). Diuron is moderately toxic to most aquatic organisms; however, it is highly toxic to cutthroat trout. The 96-hr LC50 for bluegill sunfish is 5.9 mg/L but only 0.71 mg/L for cutthroat (USEPA 2003b). The 48-hr LC50 for *Daphnia magna* is 1.4-mg/L. The bioconcentration factor (BCF) for diuron predicted from its water solubility indicates low bioaccumulation potential (EXTOXNET 1996c) (Table 6.1).

4.6.7.4 Summary of Toxicity and Potential Effects

Diuron is mobile and persistent in soil. It leaches to groundwater and can contaminate surface waters when transported from the application areas. It is of low toxicity to mammals and birds, practically nontoxic to bees, but moderately toxic to fish and aquatic invertebrates. In spite of these specific toxicity issues, Districts, when using BMP application practices for diuron should not encounter unwanted adverse effects when maintaining adequate buffer zones and care in applications.

4.6.8 Benfluralin (Benefin)

Benfluralin is a pre-emergent dinitroaniline herbicide used to control grasses on commercial and residential turf. Benfluralin also has four food/feed use sites that include lettuce, alfalfa, clover, and birdsfoot trefoil. Other nonfood/nonfeed sites include nonbearing fruit and nut trees, nonbearing berries, nonbearing vineyards, turf, ornamentals, rights of way, fence rows/hedgerows, and Christmas tree plantations. Benfluralin works by inhibiting growth (and acts as a mitotic disruptor) (USEPA 2004d).

4.6.8.1 Environmental Fate

Primary degradation pathways for benfluralin include photolysis and anaerobic metabolism in water (Table 4-27). Benfluralin has low mobility in soils. Benfluralin is of variable soil persistence with different mechanisms of degradation. Benfluralin volatilizes rapidly, but application practices and granular formulations are designed to slow volatilization (USEPA 2004d).

Table 4-27 Degradation of Benfluralin

Degradation Method	Half-life	Reference
Hydrolysis, pH 5-9	Stable	USEPA 2004c
Photolysis (water)	5.5 to 9.9 Hours	USEPA 2004c
Photolysis (soil)	12.5 Days	USEPA 2004c
Aerobic metabolism (soil)	20 to 86 Days	USEPA 2004c
Anaerobic metabolism (water)	38 Hours	USEPA 2004c
Anaerobic metabolism (soil)	12 Days	USEPA 2004c
Field dissipation (soil)	22 to 79 Days	USEPA 2004c

4.6.8.2 Human Toxicity

Benfluralin is classified as practically nontoxic (Category IV) to mammals by acute oral and dermal routes and low toxicity (Category III) for skin and eye irritation. The chemical is toxic to the kidneys, liver, and thyroid in longer-term studies. It has not been assessed for carcinogenicity in humans. Benfluralin is included in the final list of chemicals for screening under the USEPA Endocrine Disruptor Screening Program (USEPA 2009a) (Table 6.1).

4.6.8.3 Ecological Toxicity

Benfluralin is practically nontoxic to birds on an acute and sub-acute basis (LD50 >2,000 mg/kg), but has been associated with reproductive effects in chronic studies (USEPA 2004d). It is considered practically nontoxic to small mammals (LD50 >10,000 mg/kg) and honey bees (LD50 >10 µg/bee) but highly toxic to freshwater fish (USEPA 2004d). The LC50 for typical end-use product is <100 µg/L for bluegill sunfish (USEPA 2004d). Preliminary toxicity data indicates that benfluralin is highly toxic to estuarine and marine invertebrates (USEPA 2004b). Benfluralin is considered to be bioaccumulative. The BCF for whole fish is 1580 (USEPA 2004d) (Table 6.1).

4.6.8.4 Summary of Toxicity and Potential Effects

Benfluralin has low mobility and variable persistence in soils. It volatilizes rapidly, but application methods are meant to slow volatilization. Benfluralin is practically nontoxic to mammals, birds, and bees on an acute basis. It is highly toxic to fish and aquatic invertebrates and is bioaccumulative. Additionally, benfluralin has been included in the final list of chemicals for screening under the USEPA Endocrine Disruptor Screening Program (USEPA 2009a). When benfluralin is applied to water bodies, it generally binds to sediments. It also photodegrades when exposed to sunlight, and does not persist in soil and sediments. Benfluralin does not generally leach into groundwater from soil applications due to its low mobility in soil. Benfluralin when used according to label guidelines and BMP application techniques, should not result in unwanted adverse effects.

4.6.9 Oryzalin

Oryzalin is a selective, preemergent surface-applied herbicide used for control of annual grasses and small-seeded broadleaf weeds. Oryzalin is a dinitroaniline herbicide that controls weeds by disrupting the growth process during seed germination by inhibiting cell division in plants; it does not control established weeds. It is used to control annual grasses, broadleaf weeds, woody shrubs and vines in grapes, berries and orchard crops, including both fruits and nuts. It also is used on residential and commercial/industrial lawns and turf, golf course turf, ornamentals and shade trees, Christmas tree plantations, fencerows/hedgerows, nonagricultural rights-of-way, and uncultivated areas including patios, paths, paved areas and power stations. Oryzalin is used most on turf, almond orchards and grapes (USEPA 1994d).

4.6.9.1 Environmental Fate

The primary degradation pathways for oryzalin is photolysis (Table 4-28), otherwise oryzalin biodegrades slowly with a half-life of approximately 2 months. Oryzalin is not mobile under field conditions and most of the applied oryzalin either binds to soil or is fully mineralized. Oryzalin is most mobile in coarse, wet, alkaline soils with little organic matter. However, oryzalin would not be stable if it were to leach to groundwater. Anaerobic conditions below the soil surface would cause the chemical reduction of the compound (USEPA 1994d).

Table 4-28 Degradation of Oryzalin

Degradation Method	Half-life	Reference
Hydrolysis, pH 5-9	Stable	USEPA 1994d
Photolysis (water)	1.4 Hours	USEPA 1994d
Photolysis (soil)	3.9 Days	USEPA 1994d
Aerobic metabolism (water)	Moderate	USEPA 1994d
Aerobic metabolism (soil)	2.1 Months	USEPA 1994d
Anaerobic metabolism (water)	Moderate	USEPA 1994d
Field dissipation (soil)	58 to 146 Days	USEPA 1994d

4.6.9.2 Human Toxicity

Formulations include granular, wettable powder, water dispersible granules, emulsifiable concentrate, flowable concentrate, and liquid. In acute toxicity studies using laboratory animals, oryzalin is practically nontoxic by the oral route (USEPA 1994b). It is of moderate dermal and inhalation toxicity and causes slight eye irritation (USEPA 1994b). Oryzalin is generally of moderate acute toxicity, but is carcinogenic in animal studies; therefore, oryzalin has been classified as a possible human carcinogen. The oral LD50 for rats is >10,000 mg/kg. The dermal LD50 for rabbits is >2,000 mg/kg. The inhalation LC50 is >3.7 mg/L (Table 6.1).

4.6.9.3 Ecological Toxicity

Oryzalin is slightly toxic to practically nontoxic to birds. The oral LD50 for bobwhite quail is 506.7 mg/kg. The dietary LC50 for mallard ducks is >5,000 mg/kg. Oryzalin is moderately toxic to fish and freshwater invertebrates. The 96-hr LC50 for fish is between 2.88 and 3.26 mg/L. The 48-hr LC50 for *D. magna* is 1.4-mg/L. Oryzalin is practically nontoxic to honey bees. The 48-hr contact LD50 for honey bees is >11 µg/bee (USEPA 2004c). Oryzalin does not accumulate significantly in fish. The BCF is 66.1 in whole bluegill sunfish (USEPA 2004c) (Table 6.1).

4.6.9.4 Summary of Toxicity and Potential Effects

Oryzalin is immobile in soils and is not of concern for ground or surface water contamination (USEPA 2004c). It is practically nontoxic to mammals, birds, and bees. It is moderately toxic to fish but does not accumulate in them. Oryzalin is a possible human carcinogen; however, proper personal protective equipment is thought to be sufficient to protect handlers from the chemical. Based upon the low toxicity and environmental fate of oryzalin**,** and using BMP application practices, these products should not result in unwanted adverse effects.

4.6.10 DCPA

DCPA (or chlorthal dimethyl) is a pre-emergent herbicide used to control annual grasses and broadleaf weeds on ornamental turf and plants, strawberries, seeded and transplanted vegetables, cotton, and field beans. Use practice limitations prohibit applying DCPA directly to water or wetlands (swamps, bogs, marshes, and potholes) or through any type of irrigation system (USEPA 1998d). This herbicide kills germinating seeds by disrupting microtubule formation in exposed cells, causing abnormal cell division.

4.6.10.1 Environmental Fate

DCPA is stable to hydrolysis and photolysis. Biodegradation is the primary dissipation process for DCPA (Table 4-29). Under laboratory conditions, the half-life is approximately 15-30 days, but longer half-lives have been reported in the field. DCPA is not especially persistent or mobile. Volatilization from soil is also a major dissipation route for DCPA. Tetrachloroterephthalic acid (TPA or di-acid) is the only significant DCPA metabolite. TPA is unusually mobile and persistent in the field. Data suggest that TPA will leach to groundwater wherever DCPA is used, regardless of soil properties (USEPA 1998d).

Table 4-29 Degradation of DCPA

Degradation Method	Half-life	Reference
Hydrolysis, pH 5-9	Stable	USEPA 1998e
Photolysis (water)	Stable	USEPA 1998e
Photolysis (soil)	Stable	USEPA 1998e
Aerobic metabolism (soil)	18 to 37 Days	USEPA 1998e
Anaerobic metabolism (soil)	37 to 59 Days	USEPA 1998e
Field dissipation (soil)	44 to 126 Days	USEPA 1998e

4.6.10.2 Human Toxicity

DCPA has been classified as practically nontoxic for acute-oral toxicity and dermal irritation. DCPA has been classified as slightly toxic for dermal LD50, inhalation LC50, and eye sensitivity. The chemical has been classified as a possible human carcinogen based on increased incidence of thyroid tumors and liver tumors in rats (USEPA 1998b). The oral LD50 for rats is ≥ 5,000 mg/kg. The oral LD50 for beagle dogs is >10,000 mg/kg. The dermal LD50 for rabbits is >2,000 mg/kg. The 4-hr inhalation LC50 for rats is >4.48 mg/L (USEPA 1998d). DCPA is included in the final list of chemicals for screening under the USEPA Endocrine Disruptor Screening Program (USEPA 2009a) (Table 6.1).

4.6.10.3 Ecological Toxicity

DCPA is more practically nontoxic to birds on an acute basis. The oral LD50 for bobwhite quail is >2,250 mg/kg; however, DCPA is persistent enough to result in chronic exposure to birds (USEPA 1998d). It is practically nontoxic to bees (LD50 >230 µg/bee) (USEPA 1998d). DCPA is slightly toxic to practically nontoxic to fish and aquatic invertebrates. The 96-hr LC50 for rainbow trout is between 30 and >180 mg/L, depending on the study (USEPA 1998d) (Table 6.1).

4.6.10.4 Summary of Toxicity and Potential Effects

DCPA is not mobile in soil and has low persistence; however, the metabolite TPA is unusually mobile and persistent and will leach to groundwater. DCPA is of low acute toxicity to most receptors, but is classified as a possible human carcinogen and a possible endocrine disruptor. Despite the potential for chronic effects from DCPA exposure, its low persistence and low toxicity and using BMP application practices, DCPA applications should not result in unwanted adverse effects.

4.6.11 Dithiopyr

Dithiopyr is a pre-emergent and post-emergent herbicide used for control of annual grasses and broad leaf weeds in established ornamental turf (USEPA 1991a).

4.6.11.1 Environmental Fate

Dithiopyr degrades slowly in water. Hydrolysis is not a significant route of degradation. Dithiopyr is slightly mobile to relatively immobile in soil. Photodegradation is not a significant route of degradation in soil. Volatization contributed more to dissipation than soil aerobic metabolism. Field dissipation for turf grass had a half-life of 17-61 days (USEPA 1991a).

4.6.11.2 Human Toxicity

Dithiopyr has low acute toxicity to mammals. The oral LD50 and 24-hr dermal LD50 for rats is >5,000 mg/kg. The 4-hr inhalation LC50 for rats is 5.98 mg/L (Ward 1993). The NOELs for systemic and reproductive toxicity in rats are 25 and 2,500 mg/L, respectively (Ward 1993). Dithiopyr is not known to have mutagenic or carcinogenic effects(Table 6.1).

4.6.11.3 Ecological Toxicity

No information is readily available on the potential ecological effects of dithiopyr (University of California Agriculture and Natural Resources 2012).

4.6.11.4 Summary of Toxicity and Potential Effects

Dithiopyr degrades slowly in water and is immobile in water. It is of low acute toxicity to mammals and has not been associated with carcinogenic or mutagenic effects. Little is known about the environmental impacts of dithiopyr use. Due to the lack of reported, documented effects of dithiopyr, and using BMP application practices, proper application of dithiopyr should not result in unwanted adverse effects.

4.6.12 Metolachlor

Metolachlor, a broad-spectrum herbicide, was first registered in 1976 for general weed control in noncrop areas. Since first registered for use on turf, it is now also registered for use on corn, cotton, peanuts, pod crops, potatoes, safflowers, sorghum, soybeans, stone fruits, tree nuts, nonbearing citrus, nonbearing grapes, cabbage, peppers (bell, chili, Cubanelle, tabasco), buffalograss, guymon bermudagrass for seed production, nurseries, hedgerows/fencerows and landscape plantings. Metolachlor's major use sites are corn, soybeans, and sorghum. Metolachlor is a chloracetanilide herbicide that inhibits seedling development (USEPA 1995). When absorbed through the roots and shoots just above the seed of the target weeds, it acts as a growth inhibitor by suppressing synthesis of chlorophyll, proteins, fatty acids and lipids, isoprenoids (including gibberellins), and flavonoids (including anthocyanins) (Rivard 2003).

4.6.12.1 Environmental Fate

Metolachlor degradation appears to be dependent on microbially-mediated and abiotic processes (Table 4-30). Metolachlor is stable to hydrolysis under normal environmental conditions, but subject to photolysis in soils (USEPA 1995). Metolachlor ethane sulfonic acid and metolachlor oxanilic acid are the two most common degradates of metolachlor (Rivard 2003). Metolachlor is moderately persistent and mobile. Extensive leaching can occur in soils with low organic carbon content, and is greatest if soil texture is coarse (Rivard 2003). Substantial amounts of metolachlor could be available for runoff to surface water for several months post-application (USEPA 1995).

Table 4-30 Degradation of Metolachlor

Degradation Method	Half-life	Reference
Hydrolysis, pH 5-9	Stable, >30 Days	USEPA 1995
Photolysis (water)	70 Days (natural sunlight), 4 Hours (artificial sunlight)	USEPA 1995
Photolysis (soil)	8 Days (natural sunlight) 37 Days (artificial sunlight)	USEPA 1995, Rivard 2003
Aerobic metabolism (water)	47 Days	USEPA 1995
Aerobic metabolism (soil)	26 to 67 Days	USEPA 1995, Rivard 2003
Anaerobic metabolism (water)	78 Days	USEPA 1995
Anaerobic metabolism (soil)	37 to 81 Days	USEPA 1995, Rivard 2003
Field dissipation (soil)	7 to 292 Days	USEPA 1995, Rivard 2003

4.6.12.2 Human Toxicity

The chemical has displayed low-level toxicity in acute tests. It is slightly toxic (Category III) via the oral, dermal, and inhalation routes but is nonirritating to eyes and skin (Category IV) (USEPA 1995). Metolachlor is included in the final list of chemicals for screening under the USEPA Endocrine Disruptor Screening Program (USEPA 2009a) (Table 6.1).

4.6.12.3 Ecological Toxicity

Metolachlor is practically nontoxic to birds on an acute basis. The oral LD50 for mallard ducks is 4,640 mg/kg (USEPA 1995). Technical metolachlor is moderately toxic to freshwater fish. The LC50s for fish range from 3.9 to 10 mg/L. Metolachlor is slightly toxic to aquatic invertebrates (EC50 = 25.1 mg/L) (USEPA 1995). The chemical has low potential to bioaccumulate in fish with a whole fish BCF of 69X and whole body elimination after 14-days depuration (USEPA 1995) (Table 6.1).

4.6.12.4 Summary of Toxicity and Potential Effects

Metalochlor is moderately persistent in soil and mobile, potentially leaching to groundwater. It is slightly toxic to mammals and a potential endocrine disruptor. It is moderately toxic to fish and has low potential for bioaccumulation. Based upon the low toxicity**,** and using BMP application practices, these products should not result in unwanted adverse effects.

4.6.13 Pendimethalin

Pendimethalin is a selective herbicide registered for control of broadleaf weeds and grassy weed species. It is used on various agricultural and nonagricultural sites in crop and noncrop areas. It is applied to soil pre-plant, pre-emergence, and post-emergence with ground and aerial equipment (USEPA 1997b). It is also used in aquatic rice culture and in nonagricultural, residential outdoor weed controls, such as grounds plantings, ornamentals, and turf grass (e.g., residential, golf course, landscape, sod farms) (CDPR 1994). Pendimethalin acts as a microtubule disruptor (USEPA 1997b).

4.6.13.1 Environmental Fate

Pendimethalin dissipates in the environment by binding to soil, microbially-mediated metabolism, and volatilization (Table 4-31). Persistence decreases with increased temperature, increased moisture and decreased soil organic carbon. Pendimethalin residues are tightly bound to soil and sediment particles. Pendimethalin has a low potential to leach to ground water in most soils (USEPA 1997b).

Table 4-31 Degradation of Pendimethalin

Degradation Method	Half-life	Reference
Hydrolysis, pH 5-9	28 to >30 Days	USEPA 1997, DPR 1999b
Hydrolysis (water with soil fungi)	10 to 11 Days	USEPA 1997
Photolysis (water)	16.5 to 60 Days	USEPA 1997, DPR 1999b
Photolysis (soil)	Stable	USEPA 1997
Aerobic metabolism (soil)	42 to 1,322 Days	USEPA 1997
Anaerobic metabolism (water)	6 to 105 Days	USEPA 1997
Anaerobic metabolism (soil)	>60 Days	USEPA 1997
Field dissipation (soil)	34 Days	USEPA 1997

4.6.13.2 Human Toxicity

Pendimethalin has low acute toxicity to mammals. It is listed as Category III for oral toxicity and Category IV for dermal and inhalation exposure. It is nonirritating to skin and slightly irritating to eyes. The oral LD50 for rats is between 1,050 and 1,250 mg/kg. The dermal LD50 for rabbits is >5,000 mg/kg. The inhalation LC50 for rats is >320 mg/L. The LOEL for reproductive effects in rats is 346 mg/kg/day for male rats and 436 mg/kg/day for female rats (USEPA 1997b). Pendimethalin has been classified as a possible human carcinogen because it has caused thyroid follicular cell adenomas in rats (USEPA 1997b) (Table 6.1).

4.6.13.3 Ecological Toxicity

Pendimethalin is slightly acutely toxic to birds. The oral LD50 for mallard ducks is 1,421 mg/kg. Avian chronic toxicity studies have not yet been completed. Pendimethalin is practically nontoxic to honey bees (LD50 >49.7 µg/bee). It is highly toxic to fish and has high potential to bioaccumulate in fish (USEPA 1997b). The LC50 for rainbow trout is 0.138 mg/L (technical pendimethalin) and 0.52 mg/L (formulated pendimethalin product) (USEPA 1997b). Reproductive effects to fish (reduced egg production, reduced hatch success) occur at exposure >6.3 µg/L. Technical pendimethalin is also highly toxic to aquatic invertebrates (LC50 for *D. magna* is 0.28 µg/L). The formulated product is moderately toxic to these organisms (LC50 for *D. magna* is 5.1 µg/L) (Table 6.1).

4.6.13.4 Summary of Toxicity and Potential Effects

Pendimethalin is of varying persistence in soil, depending on temperature and moisture. It is of low toxicity to mammals, birds, and bees. It is toxic to fish and aquatic invertebrates and has a potential to bioaccumulate. Pendimethalin is classified as a possible human carcinogen; however, the USEPA has determined that all uses of pendimethalin (as prescribed) will not cause unreasonable risks to humans or the environment (USEPA 1997b). Based upon this evaluation and the USEPA literature, using BMP application practices with these products should not result in unwanted adverse effects.

4.7 Adjuvants

An adjuvant is any compound that is added to an herbicide formulation or tank mix to facilitate the mixing, application, or effectiveness of that herbicide. Adjuvants can either enhance activity of an herbicide’s active ingredient (activator adjuvant) or offset any problems associated with spray application, such as adverse water quality or wind (special purpose or utility modifiers). Activator adjuvants include surfactants, wetting agents, sticker-spreaders, and penetrants. Nonionic alkylphenol ethoxylate-based and silicone-based adjuvants are wetter/spreaders. Adjuvants can also be primarily oil-based. Oil additives function to increase herbicide absorption through plant tissues and increase spray retention. Oil adjuvants are made up of either petroleum, vegetable, or methylated vegetable or seed oils plus an emulsifier for dispersion in water (Bakke 2007).

Adjuvants are not under the same registration guidelines as are pesticides. EPA regulates the inclusion of certain ingredients in adjuvant formulations, but it does not stringently test and regulate the manufacture and use of adjuvant products (as they do for pesticides). As such, there is little information on the effects of different adjuvants, other than that provided by the manufacturer or published by the scientific community (Tu et al. 2001, Bakke 2007). DPR does require the registration of adjuvants that are considered to increase the action of the pesticide it is used with (Bakke 2007).

The long-term fates of most adjuvants in soils and elsewhere in the environment are largely unknown, partially because of the lack of long-term monitoring data, but also because the ingredients in most adjuvants are not disclosed (Tu et al. 2001).

4.7.1 Alkylphenol Ethoxylate

Alkylphenol ethoxylates (APEs) can be used as detergents, wetting agents, dispersants, emulsifiers, solubilizers and foaming agents. Alkylphenol ethoxylates are widely in domestic detergents, pesticide formulations and industrial products. Industrial applications include pulp and paper, textiles, coatings, agricultural pesticides, lube oils and fuels, metals and plastics. Primary degradation of alkylphenol ethoxylates in the environment generates more persistent shorter chain alkylphenol ethoxylates and alkylphenols (i.e., nonylphenol, octylphenol, and mono- to triethoxylates), some of which may mimic natural hormones and disrupt endocrine function in wildlife and humans (Ying et al. 2002).

4.7.1.1 Environmental Fate

Alkylphenol ethoxylates degraded faster in the water column than in sediment. Alkylphenol ethoxylates bind strongly to aquatic particles in river and coastal environments and are persistent in sediments. Aerobic conditions further facilitate biotransformation of alkylphenol ethoxylate metabolites as compared to anaerobic conditions (Ying et al. 2002).

4.7.1.2 Human Toxicity

Nonylphenol (NP) is of low acute oral and dermal toxicity but is highly irritation and corrosive to the skin and eyes (USEPA 2010b). Concern exists regarding the estrogen-mimicking behaviors of alkyl phenol ethoxylate (USEPA 2010b). The compounds nonylphenol (NP) and nonylphenol ethoxylate (NPE) are of particular interest and concern to the public and the EPA. NPs and NPEs are produced in large volumes and are widely used (Table 6.1).

4.7.1.3 Ecological Toxicity

NP is persistent in the environment, moderately bioaccumulative, and extremely toxic to aquatic organisms. NPE, though less toxic than NP, is also highly toxic to fish, aquatic invertebrates, and aquatic plants (USEPA 2010b). Toxicity of APEs to aquatic organisms increases with alkyl chain length. The toxicity of a variety of APEs are discussed in detail by Bakke (2003) (Table 6.1).

4.7.1.4 Summary of Toxicity and Potential Effects

APEs include a broad range of chemicals that tend to bind strongly to particulates and persist in sediments. Nonylphenol and short-chain NPEs are moderately bioaccumulative and extremely toxic to aquatic organisms. Aside from use in agricultural herbicide mixtures, APEs are commonly present in detergents, cleaners, food packaging, and cosmetics. The acute toxicity of APEs to mammals is low. They are possible estrogen-mimics. Nonylphenol has been detected in human breast milk, umbilical cord blood, and urine (USEPA 2010b).

The USEPA (USEPA 2010b) has recently recommended that this suite of chemicals be evaluated further due to their wide-spread use (past and present), persistence, and possible estrogen-mimicking behavior.

4.7.2 Polydimethylsiloxane Fluids

Most polydimethylsiloxane (PMDS) fluids are nonvolatile polymeric organosilicon materials consisting of ([CH3]2SiO) structural units. Various polydimethylsiloxane fluids ranging from low to high viscosity are used in a wide range of industrial applications, such as manufacturing textiles, paper, and leather goods and serve as antifoams, softeners, or water repellents. In consumer applications, polydimethylsiloxane fluids can be found in personal-, household- and automotive care products. They are used as softeners in skin care products, conditioners in hair care, additives in polish formulations, and as waterproofers and other surface treatments. Some polydimethylsiloxane materials are also sold as end products (usually in the industrial market), such as transformer dielectric fluids and heat transfer liquids (Dow Corning Corp. 1998).

4.7.2.1 Environmental Fate

Polydimethylsiloxane fluids are insoluble in water and have a high adsorption coefficient. Volatile, low molecular weight dimethyl siloxanes will evaporate into the atmosphere where they undergo indirect photolytic degradation. However, high molecular weight polydimethylsiloxanes typically sorb to particulate matter when in water and become associated with soil and sediments (Griessbach and Lehmann 1999).

Polydimethylsiloxanes degrade into lower molecular weight siloxanols and finally into dimethylsilanediol. Significant degradation to lower molecular weight compounds have been noted after a few weeks' soil contact. The actual rate and extent of degradation vary as a function of soil moisture content and clay type (Dow Corning Corp. 1998). The degradation rate of polydimethylsiloxanes is highly influenced by soil moisture. Degradation is slow on moist soils (3 percent within 6 months) but quite rapid on dry soil (50 percent within several days) (Griessbach and Lehmann 1999).

4.7.2.2 General Toxicity

PMDS appears to be relatively nontoxic to benthic invertebrates and exhibits little bioaccumulation potential (Henry et al. 2001) (Table 6.1).

4.7.2.3 Summary of Toxicity and Potential Effects

Polydimethylsiloxanes are insoluble in water and typically sorb to particulates. Degradation time varies depending on moisture in soils. These chemicals appear to be relatively nontoxic to most organisms, but data is lacking. Although there is a paucity of information regarding the toxicity and environmental fate of polydimethylsiloxanes, using BMP application practices, these products should not result in unwanted adverse effects.

4.7.3 Modified Vegetable Oil and Methylated Seed Oil

Vegetable-derived oils (from soybeans, cottonseeds, etc.) decrease surface tension, but they are not as effective as other surfactants at increasing spreading, sticking, or penetration. Vegetable oils are generally of two types: triglycerides or methylated oils. Triglycerides are essentially oil-surfactant hybrids, and are generally called "seed oils." These seed soils are extracted from plants by pressing or solvent extraction, and tend to have higher viscosities than methylated oils. Methylated seed oils are better solvents than petroleum-based oils. Triglyceride oils usually contain only 5 to 7 percent surfactant emulsifier, while methylated seed oils contain 10 to 20 percent surfactant (Tu et al. 2001). Oil adjuvants can increase the penetration of oil-soluble herbicides into plants. These adjuvants are commonly used in hot, dry conditions (Tu et al. 2001). Attachment of the methanol to the oil alters the hydrophilic/lipophilic balance of the oil to an optimum level (Hartzler 2001).

4.7.3.1 General Toxicity

Modied vegetable and methylated seed oil adjuvants are generally considered inert or essentially nonphytotoxic (Tu et al. 2001).Toxicity information is available for the product, Competitor™ (modified vegetable oil, polyethylene glycol fatty acid ester, polyoxyethylene sorbitan fatty acid ester) (Washington State Department of Agriculture 2009). The 96-hr LC50 for rainbow trout is 95 mg/L (slightly toxic). The 48-hr EC50 for daphnids is >100 mg/L (practically nontoxic) (Table 6.1).

4.7.3.2 Summary of Toxicity and Potential Effects

Modified vegetable oils and methylated seed oils are essentially nontoxic to most organisms, including plants. Little is known of the environmental fate of these adjuvants. Although there is a paucity of toxicity and environmental fate information for these oils, using BMP application practices, these products should not result in unwanted adverse effects.

4.7.4 Lecithin

Lecithin (phosphatidylcholine) is a commonly used amphoteric surfactant, which is derived from soybeans. Amphoteric surfactants contain both a positive and negative charge and typically function similarly to nonionic surfactants. There is little published research on the use and efficacy of amphoteric surfactants (Tu et al. 2001).

4.7.4.1 General Toxicity

Lecithin is a general term used to describe yellow-brownish fatty substances occurring in animal and plant tissues. When used with herbicide applications, lecithin acts as an amphoteric surfactant and functions similarly to nonionic surfactants (Tu et al. 2001). Toxicity information exists for the product, Liberate™ (lecithin, alcohol ethoxylate, modified vegetable oil) (Washington State Department of Agriculture 2009). The 96-hr LC50 for rainbow trout is 17.6 mg/L (slightly toxic) and the 48-hr LC50 for daphnids is 9.3 mg/L (moderately toxic). Little is known about the fate of lecithins in the environment or their effect on non-target organisms (Tu et al. 2001) (Table 6.1).

4.7.4.2 Summary of Toxicity and Potential Effects

Little is known about the toxicity or environmental fate of lecithins. Lecithins are naturally occurring phospholipids in biological cell membranes (Bakke 2007). Although there is a paucity of information on these products, using BMP application practices, use of these products should not result in unwanted adverse effects.

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5 Evaluations of Active Ingredients

While the majority of the active ingredients reviewed do not suggest an unacceptable risk when used properly, some became the focus of additional discussion concerning actual use patterns and BMPs employed. The results of the assessments are based on preliminary assumptions about toxicity and mode of action derived from available information and data published by the manufacturers, researchers, and other published literature.

Using the available information about the active ingredients reviewed, there were several overarching parameters that are known to adversely impact risk. Primary factors considered include the inherent toxicity and mode of action of the chemical that can imply toxicity to non-target species. Other important factors that are considered include the possible transport and fate of the chemical in various media, the reported likely exposure routes, and documented ecological and human studies supporting the toxicity data. Several important parameters, such as the retention time (half-life) in various media are considered, but are based only on available information about regional conditions. Several pesticides received additional discussion during the MVCAC workshop on February 20, 2013.

Using the approach discussed above, select active ingredients were identified (Table 5-1) and discussed during the workshop to supplement the information relevant to the evaluation of potential risk. Each of these pesticides exhibits at least one parameter that appears to drive potential risk.

Table 5-1 Active Ingredients Identified for Discussion

Active Ingredient	Vector	Potential Issue
Methoprene	Mosquitoes	Prevalent use; toxicity to aquatics and insects
Etofenprox	Mosquitoes	Toxicity to aquatic organisms; no synergist required
Bti	Mosquitoes	Prevalent use; public concerns
Pyrethrins	Mosquitoes	Prevalent use; requires synergist (PBO)
Resmethrin	Mosquitoes	Requires synergist (e.g., PBO); potential endocrine disruptor
Vegetable Oil (coconut oil)/mix	Mosquitoes	Contains low percentage of petroleum distillate
Permethrin	Mosquitoes/ yellow jacket wasps	Toxicity to aquatic organisms; potential endocrine disruptor
Lambda-cyhalothrin	Yellow jacket wasp	Toxicity to aquatic organisms; potential to bioaccumulate
Bromadiolone	Rats	Toxicity to non-target organisms including mammals, birds, aquatics
Difethialone	Rats	Toxicity to non-target organisms including mammals, birds, aquatics
Alkylphenol ethoxylates	Weeds	Toxicity to aquatic organisms; Moderately bioaccumulative
Glyphosate	Weeds	Prevalent use; possible endocrine disruptor
Diuron	Weeds	Prevalent use; toxicity to freshwater fish
Benfluralin	Weeds	Toxicity to aquatics; potential for bioaccumulation/endocrine disruption

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6 Toxicity Summary: All Active Ingredients

Toxicity information gathered from the published literature and regulatory sources is included in Table 6.1 below. The table includes information such as LD50, LC50s, USEPA toxicity rating and other relevant toxicity information.

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Table 6-1 Toxicity Values Reported in the Literature for Active Ingredients

Active Ingredient	Mammalian Oral LD50 (mg/kg)[A]	Mammalian Dermal LD50 (mg/kg)[B]	Mammalian Inhalation LC50 (mg/L)[A]	USEPA Tox Rating	Avian LD50 (mg/kg)[C]	Fish LC50 (mg/L)[D]	Aquatic Invert EC50 (µg/L)[E]	Honeybee LD50 (µg/bee)	Other Receptors
Pyrethrins	1400	>2,000	3400	oral and dermal (III), inhalation (IV)	>5,620	0.0051	11.6	no data, likely toxic	no data
Allethrins and *d-trans* allethrin	685 (allethrin, F) 860 (d-trans)	11,332 (allethrin)	no data	no data	>2,000 (allethrin) >5,620 (d-trans)	0.0026 to 0.08	no data	3 to 9	Dog dietary NOEL = 50 mg/kg/Day for 2 years.
Phenothrin (sumithrin or d-phenothrin)	>5,000 (no deaths)	>2,000 (no deaths)	>2.1 (no deaths)	oral and inhalation (IV), dermal (III)	>5,000	0.0158	4.4	no data, likely toxic	no data
Prallethrin	460	>5,000	0.66	no data	1,171	0.012	6.2	0.028	no data
Deltamethrin	>5,000	>2,000	no data	no data	no data	no data	no data	no data	no data
Esfenvalerate	458	2,000	2.93		9,932	0.00026	0.00024	highly toxic	no data
Lambda-cyhalothrin	56 to 144	632 to 696 (rats)	no data	no data	>3,950	0.0021	0.36	0.97	no data
Resmethrin	4,639	>2,000	5.28	no data	75 (blackbird)	.00028	0.063	0.963	no data
Tetramethrin	>5,000	>2,000	no data	oral (III), dermal (IV)	>2,250	0.0037	45	0.155	no data
Permethrin	2280	>2,000	no data	oral and dermal (III), inhalation (IV)	>10,000	0.00079	0.1 (mayfly)	0.13	toxic to cats via dermal route
Etofenprox	>2,000	>2,100	>5.9	no data	>2,000	0.0027	no data	0.27 (oral), 0.13 (contact)	Dog oral LD50 >5,000 mg/kg
Piperonyl butoxide (PBO)	4,570	>2,000	>5.9	oral and dermal (III), inhalation (IV)	>2,250	1.9	510	>25	Tadpole LC50 = 0.21 mg/L
Naled	81 to 85	354	0.19	all acute (II)	52	.087 (lake trout), 2.2 (bluegill)	0.3	0.48	no data
Temephos	444	970	1.3	oral and dermal (II), inhalation (III)	no data	3.49	10	no data	no data
Bacillus sphaericus (Bs)	no data	no data	no data	no data	no data	>15.5	15,500	no data	no data
Bacillus thuringiensis israelensis (Bti)	>4,7x10^{11} spores/kg	>2.67x10^{11} spores/kg	4,7x10^{11} spores/kg	all acute (IV)	no data	no data	50,000 (10 Days)	no data	no data
Spinosad	>5,000	>2,800	>5.18	no data	>2,000	5.9	92,700	11,500	Butterfly/moth LD50 = 0.022 mg/kg. No effect on amphibians.
Methoprene and s-Methoprene	>10,000	>2,000	>210	oral and inhalation (IV), dermal (III)	>2,000	>50	89	no data	Frog LC50 >10,000 µg/L
Alcohol Ethoxylated Surfactant (monomolecular film)	no data	no data	no data	no data	no data	No observable effects	No observable effects to shrimp, snails, worms, or mayfly naiads	no data	No observable effects to amphibians.
Aliphatic solvents (mineral oils, aliphatic hydrocarbons, petroleum distillates)	>28,000 (no deaths observed)	>5,000	3.9	no data	>2,250	no effect	<900	no effect	no data
Potassium Salts (soap salts)	no data	no data	no data	all acute effects (IV)	no data	no data	no data	no data	no data
Chlorophacinone	3.15 (rats)	0.329	.007	all acute effects (II)	258	0.45	640	no data	Carnivorous mammals LD50 = 2.1 to 50 mg/kg

Table 6-1 Toxicity Values Reported in the Literature for Active Ingredients

Active Ingredient	Mammalian Oral LD50 (mg/kg)[A]	Mammalian Dermal LD50 (mg/kg)[B]	Mammalian Inhalation LC50 (mg/L)[A]	USEPA Tox Rating	Avian LD50 (mg/kg)[C]	Fish LC50 (mg/L)[D]	Aquatic Invert EC50 (µg/L)[E]	Honeybee LD50 (µg/bee)	Other Receptors
Diphacinone	2.3 to 7.0	3.6	<0.0006	all acute effects (I)	400 to 2000	2.6	1800	no data	Dog oral LD50 = 7.5 mg/kg
Brodifacoum	0.418 to 0.561	3.16 to 5.21	0.00305 to 0.00486	all acute effects (I)	0.26	0.015	980	no risk	Carnivorous mammals LD50 = 0.27 to 25 mg/kg
Bromadiolone	0.56 to 0.84	1.71	0.00043	all acute effects (I)	138 to 170	0.24	240 to 2000	no data	Carnivorous mammals LD50 = 1.125 to 25 mg/kg
Bromethalin	9.1 to 10.7	2,000	0.024	oral and inhalation (I), dermal (II)	4.6 to 11	0.038 to 0.598	2.0	no data	Dog oral LD50 2.38 to 5.6 mg/kg bw. Cat oral LD50 0.54-mg/kg bw
Difethialone	0.55	6.5 (rats)	.005	no data	0.264	0.051	4.4	no data	Dog oral LD50 = 11.8 mg/kg bw. Cat oral LD50 ≥16 mg/kg bw
Cholecalciferol (vitamin D)	43.6	2,000 (finished bait)	no data	no data	2,000	no data	no data	no data	Dog oral LD50 = 88 mg/kg
Sulfur (fumigant)	>5,000	>2,000	>2.56	no data	>5,620	>180	>5,000,000	nontoxic	no data
Sodium Nitrate (fumigant)	3,700	<2,000	no data	oral (III)	no data	no data	no data	no data	Any non-targets in burrow susceptible.
Imazapyr	>5,000	>2,000	>1.3	no data	>2,150	>100	>1,000,000	>100	no data
Glyphosate	4,320 (technical) ≥5,000 (salt forms)	≥2,000 (tech) ≥5,000 (salts)	≥4.43 (tech) >1.3 (salts)	oral and dermal (III)	>2,000	>24	55,000 to 780,000	>100 (practically nontoxic)	No acute toxicity to frogs.
Triclopyr	630	>2000	>2.6	oral and dermal (III)	1,698 (technical)	117 (technical) 0.36 (TBEE)	132,000	60.4	no data
2,4-D (2,4-dichlorophenoxy acetic acid)	639 to 1,646	1,829 to 2,000	0.78 to >5.4	no data	472 (pheasant)	1 to 100 (cutthroat trout)	132,000	104-to 115	no data
Sulfometuron methyl	>5,000	>2,000	>5.0	oral and inhalation (IV), dermal (III)	>4,650	>100	>100,000	>100	EC25 values available for many non-target plants
Bentazon	1,100	>2500	no data	all acute (III)	1171	practically nontoxic	practically nontoxic	>100	no data
Diuron	4,721	>2,000	>7.1	all acute (III or IV)	>2,000	0.71 (cutthroat trout) 5.9 (bluegill)	1,400	145	no data
Benfluralin (benefin)	>10,000 (small mammals)	>5000	>2.3	all acute (IV)	>2,000 (sub-acute)	<0.1	2180	>10 (practically nontoxic)	no data
Oryzalin	>10,000	>2,000	>3.7	oral (IV), dermal and inhalation (III)	506.7	2.88 to 3.26	1,400	>11 (practically nontoxic)	no data
DCPA (chlorthal dimethyl) [metabolite is tetrachloroterephthalic acid (TPA)]	>5,000	>2,000	>4.48	dermal and inhalation (III), oral (IV)	>2,250	30 to >180	practically nontoxic	>230 (practically nontoxic)	Dog oral LD50 = 10,000 mg/kg

Table 6-1 Toxicity Values Reported in the Literature for Active Ingredients

Active Ingredient	Mammalian Oral LD50 (mg/kg)[A]	Mammalian Dermal LD50 (mg/kg)[B]	Mammalian Inhalation LC50 (mg/L)[A]	USEPA Tox Rating	Avian LD50 (mg/kg)[C]	Fish LC50 (mg/L)[D]	Aquatic Invert EC50 (µg/L)[E]	Honeybee LD50 (µg/bee)	Other Receptors
Dithiopyr	>5,000	>5,000	5.98	no data	no data	no data	no data	no data	no data
Metalochlor	2,780	10,000	1.75	all acute (III)	4,640	3.9 to 10	25,100	no data	no data
Pendimethalin	1,050 to 1,250	>5,000	>320	oral (III), dermal and inhalation (IV)	1,421	0.138 (technical) 0.58 (formulated product)	0.28 (technical) 5.1 (product)	>49.7 (practically nontoxic)	no data
Alkylphenol ethoxylate (APE)	600 to >10,000	>0.22	>2,000	no data	no data	1.5 to 6.4-(differs by chain length)	460 to 740, depending on which AE	no data	No effects on frogs
Polydimethylsiloxane Fluids	no data	no data	no data	no data	no data	no data	no data	no data	Relatively nontoxic to benthic invertebrates.
Modified Vegetable Oils and Methylated Seed Oil	no data	no data	no data	no data	no data	95 (Competitor™)	>100 (Competitor™)	no data	no data
Lecithin	no data	no data	no data	no data	no data	17.6 (Liberate™)	9.3 (Liberate™)	no data	no data

A. Unless otherwise specified, values are for rats.

B. Unless otherwise specified, values are for rabbits.

C. Unless otherwise specified, values are for mallard duck or bobwhite quail.

D. Unless otherwise specified, values are for rainbow trout or bluegill sunfish.

E. Values are for *Daphnia* or similar species.

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Ecological & Human Health Assessment Report

ATTACHMENT

A

CHEMICAL USE DATA SUBMITTED BY DISTRICTS

List of Tables

Table A1. Pesticide Application Data for Summer 2011 – ACMAD

Application Sites:	Agnique MMF - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	VectoBac G - # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit3	VectoBac G Comments	VectoBac 12AS - # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit7	VectoBac 12AS Comments	Altosid Liquid conc. - # Treatments	Total Amount Used11	Total Amount Type12
Canals						8	40.5	Product	Pounds									
Catchbasins						2	15	Product	Pounds		116	6.3	Product	Gallons		2	1	Product
Containers	1	0.5	Product	Ounces (volume)		3	10	Product	Pounds									
Creeks						9	51.6	Product	Pounds									
Ditches						5	12.3	Product	Pounds									
Gutters																		
Leaks						2	0.9	Product	Pounds									
Marshes, fresh						1	3	Product	Pounds									
Marshes, reclaimed						7	64	Product	Pounds									
Marshes, tidal						8	99	Product	Pounds									
Mixed CB/UV/Sumps						15	7.8	Product	Pounds									
Natural Ponds						7	43.5	Product	Pounds									
Ornamental Ponds						21	6.4	Product	Pounds									
Overwatering																		
Rainwater						4	8.1	Product	Pounds									
Sanitary																		
Seepages						14	6.7	Product	Pounds									
Spas																		
Stormdrains																		
Swimming Pools						4	3.6	Product	Pounds									
Tires																		
TreeHoles																		
Under building						1	0.6	Product	Pounds									
Vaults																		
Wells																		
Totals	1	0.5				111	373	Product	Pounds		116	6.3	Product	Gallons		2	1	Product

Table A1.

Application Sites:	Total Amount Unit12	Altosid Liquid conc. Comments	Altosid Briquets - # Treatments	Total Amount Used13	Total Amount Type14	Total Amount Unit14	Altosid Briquets Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18	BVA-2 Comments	VectoLex CG - # Treatments	Total Amount Used19	Total Amount Type20	Total Amount Unit20	VectoLex CG Comments	Pyrenone 25-5 - # Treatments
Canals			5	10.7	Product	Ounces (weight)		13	54.4	Product	Gallons		6	216.5	Product	Pounds		
Catchbasins	Ounces (volume)		11	35.4	Product	Ounces (weight)		33	20.6	Product	Gallons							
Containers													1	0.03				
Creeks			6	13.7	Product	Ounces (weight)		13	2.5	Product	Gallons		14	43.1	Product	Pounds		
Ditches			5	7.2	Product	Ounces (weight)		5	1.1	Product	Gallons		7	43.2	Product	Pounds		1
Gutters																		
Leaks													2	0.9	Product	Pounds		
Marshes, fresh								3	41.3	Product	Gallons		1	3	Product	Pounds		
Marshes, reclaimed								1	2	Product	Gallons		7	72	Product	Pounds		
Marshes, tidal																		
Mixed CB/UV/Sumps			3	4.4	Product	Ounces (weight)		5	2.7	Product	Gallons		14	3.8	Product	Pounds		
Natural Ponds			2	2.1	Product	Ounces (weight)		3	0.7	Product	Gallons		7	40.5	Product	Pounds		
Ornamental Ponds			5	10.9	Product	Ounces (weight)		9	0.2	Product	Gallons		19	6.4	Product	Pounds		
Overwatering								1	0.02	Product	Gallons							
Rainwater			1	0.2	Product	Ounces (weight)		3	4.5	Product	Gallons		4	24.1	Product	Pounds		
Sanitary			1	4.8	Product	Ounces (weight)		7	1.44	Product	Gallons		7	68	Product	Pounds		
Seepages			2	3.8	Product	Ounces (weight)		2	0.69	Product	Gallons		16	9.7	Product	Pounds		
Spas								1	0.004									
Stormdrains			1	3.8	Product	Ounces (weight)							1	5	Product	Pounds		
Swimming Pools								17	0.4	Product	Gallons		2	0.1	Product	Pounds		
Tires																		
TreeHoles																		
Under building													1	0.6	Product	Pounds		
Vaults								2	0.02									
Wells								1	0.02									
Totals	Ounces (volume)		42	97	Product	Ounces (weight)		119	132.594	Product	Gallons		109	536.93	Product	Pounds		1

Table A1.

Application Sites:	Total Amount_Used29	Total Amount_Type30	Total Amount_Unit30	Pyrenone 25-5 Comments	Altosid XR-Briquets - # Treatments	Total Amount_Used37	Total Amount_Type38	Total Amount_Unit38	Altosid XR-Briquets Comments	FourStar 180 Bs - # Treatments	Total Amount Used1315	Total Amount Type1416	Total Amount Unit1417	FourStar 180 Bs Comments	Natular G30 - # Treatments	Total Amount Used1924	Total Amount Type2025	Total Amount Unit2026
Canals					2	3.9	Product	Ounces (weight)		3	1.6	Product	Pounds		3	16	Product	Pounds
Catchbasins					8	37.4	Product	Ounces (weight)		11	4.8	Product	Pounds					
Containers					1	2.6	Product	Ounces (weight)		3	0.4	Product	Pounds					
Creeks					2	21.9	Product	Ounces (weight)		6	4.8	Product	Pounds		1	4	Product	Pounds
Ditches	5	Product	Ounces (volume)							4	3.4	Product	Pounds					
Gutters																		
Leaks																		
Marshes, fresh					1	7.7	Product	Ounces (weight)										
Marshes, reclaimed										2	3.1	Product	Pounds					
Marshes, tidal																		
Mixed CB/UV/Sumps					2	14.2	Product	Ounces (weight)		4	1.2	Product	Pounds					
Natural Ponds										3	1	Product	Pounds		2	21	Product	Pounds
Ornamental Ponds					13	42.5	Product	Ounces (weight)		5	0.9	Product	Pounds					
Overwatering																		
Rainwater																		
Sanitary										1	1.3	Product	Pounds					
Seepages																		
Spas										1	0.1	Product	Pounds					
Stormdrains																		
Swimming Pools					8	119.9	Product	Ounces (weight)		9	4.6	Product	Pounds					
Tires																		
TreeHoles																		
Under building										1	0.1	Product	Pounds					
Vaults					1	1.3	Product	Ounces (weight)										
Wells																		
Totals	5	Product	Ounces (volume)		38	251.4	Product	Ounces (weight)		42	27.3	Product	Pounds		109	41	Product	Pounds

Table A1.

Application Sites:	Natular G30 Comments	Natular XRT - # Treatments	Total Amount Used2127	Total Amount Type2228	Total Amount Unit2229	Natular XRT Comments	VectoLex WDG - # Treatments	Total Amount Used3345	Total Amount Type3446	Total Amount Unit3447	VectoLex WDG Comments	Altosid Pellets - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid Pellets Comments	Golden Bear Oil - # Treatments	Total Amount Used
Canals		2	2.8	Product	Pounds												2	0.3
Catchbasins		69	218	Product	Pounds		168	111.6	Product	Pounds							14	2.4
Containers												4	192	Product	Ounces (weight)		5	0.8
Creeks		7	4.2	Product	Pounds							1	32	Product	Ounces (weight)			
Ditches		4	7.5	Product	Pounds												2	5
Gutters		1	0.5	Product	Pounds												1	0.2
Leaks																		
Marshes, fresh																		
Marshes, reclaimed																		
Marshes, tidal												1	240	Product	Ounces (weight)			
Mixed CB/UV/Sumps		7	3.1	Product	Pounds												4	0.3
Natural Ponds		1	1.1	Product	Pounds													
Ornamental Ponds		10	7.5	Product	Pounds												5	0.3
Overwatering												1	4	Product	Ounces (weight)			
Rainwater		1	1	Product	Pounds												1	0.001
Sanitary		4	13.9	Product	Pounds												2	0.5
Seepages		1	0.7	Product	Pounds							1	48	Product	Ounces (weight)		2	0.02
Spas																		
Stormdrains		1	1.1	Product	Pounds												1	3
Swimming Pools		16	21.1	Product	Pounds												8	0.8
Tires																		
TreeHoles																		
Under building																	4	0.1
Vaults																		
Wells		1	0.4	Product	Pounds													
Totals		125	282.9	Product	Pounds		168	111.6	Product	Pounds		8	516	Product	Ounces (weight)		51	13.721

Table A1.

Application Sites:	Total Amount Type	Total Amount Unit	Golden Bear Oil Comments	Vectolex WSP - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectolex WSP Comments	VectoMAX CG - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	VectoMAX CG Comments
Canals	Product	Gallons		1	1.5	Product	Pounds		3	7	Product	Pounds	
Catchbasins	Product	Gallons		23	6.1	Product	Pounds						
Containers	Product	Gallons		4	0.7	Product	Pounds						
Creeks				3	1.5	Product	Pounds		3	8	Product	Pounds	
Ditches	Product	Gallons							3	10	Product	Pounds	
Gutters	Product	Gallons		1	0.1	Product	Pounds						
Leaks													
Marshes, fresh									3	13	Product	Pounds	
Marshes, reclaimed													
Marshes, tidal													
Mixed CB/UV/Sumps	Product	Gallons		2	0.2	Product	Pounds						
Natural Ponds									1	5	Product	Pounds	
Ornamental Ponds	Product	Gallons		27	2.5	Product	Pounds						
Overwatering				2	0.2	Product	Pounds						
Rainwater				4	0.5	Product	Pounds		1	3	Product	Pounds	
Sanitary	Product	Gallons		4	1.6	Product	Pounds						
Seepages				10	0.8	Product	Pounds						
Spas													
Stormdrains	Product	Gallons		1	0.9	Product	Pounds						
Swimming Pools	Product	Gallons		10	2.4	Product	Pounds						
Tires													
TreeHoles													
Under building	Product	Gallons		3	0.7	Product	Pounds						
Vaults													
Wells													
Totals	Product	Gallons		95	19.7	Product	Pounds		11	46	Product	Pounds	

Table A2. **Pesticide Application Data for Fall 2011 – ACMAD**

Application Sites:	VectoBac G - # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit3	VectoBac G Comments	VectoBac 12AS - # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit7	VectoBac 12AS Comments	Altosid Briquets - # Treatments	Total Amount Used13	Total Amount Type14	Total Amount Unit14	Altosid Briquets Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18
Canals	5	45	Product	Pounds							1	2.7	Product	Ounces (weight)		4	6	Product	Gallons
Catchbasins						16	1.1	Product	Gallons		2	0.8	Product	Ounces (weight)		6	10.2	Product	Gallons
Containers	1	6	Product	Pounds															
Creeks	5	16.5	Product	Pounds												3	5	Product	Gallons
Ditches	6	83	Product	Pounds															
Gutters																			
Leaks																			
Marshes, fresh	1	10	Product	Pounds															
Marshes, reclaimed	17	261	Product	Pounds		1	0.1	Product	Gallons							7	89.1	Product	Gallons
Marshes, tidal	5	25	Product	Pounds															
Mixed CB/UV/Sumps	3	0.8	Product	Pounds															
Natural Ponds	3	9.5	Product	Pounds															
Ornamental Ponds	8	38.2	Product	Pounds							3	1.1	Product	Ounces (weight)					
Overwatering																			
Rainwater	6	48	Product	Pounds												2	2	Product	Gallons
Sanitary																1	0.2	Product	Gallons
Seepages	1	0.25	Product	Pounds							1	2.9	Product	Ounces (weight)					
Spas																			
Stormdrains											1	1	Product	Ounces (weight)					
Swimming Pools	1	0.16	Product	Pounds												1	0.02	Product	Gallons
Tires																			
TreeHoles																			
Under building	2	1	Product	Pounds							2	1.9	Product	Ounces (weight)					
Vaults																			
Wells																			
Totals	64	544.41	Product	Pounds		17	1.2	Product	Gallons		10	10.4	Product	Ounces (weight)		24	112.52	Product	Gallons

Table A2.

Application Sites:	BVA-2 Comments	VectoLex CG - # Treatments	Total Amount Used19	Total Amount Type20	Total Amount Unit20	VectoLex CG Comments	Altosid XR-Briquets - # Treatments	Total Amount Used37	Total Amount Type38	Total Amount Unit38	Altosid XR-Briquets Comments	FourStar 180 Bs - # Treatments	Total Amount Used1315	Total Amount Type1416	Total Amount Unit1417	FourStar 180 Bs Comments	Natular XRT - # Treatments
Canals		1	2	Product	Pounds												
Catchbasins																	1
Containers												1	0.1	Product	Pounds		
Creeks		1	0.5	Product	Pounds		1	2.6	Product	Ounces (weight)		1	0.3	Product	Pounds		3
Ditches		3	53	Product	Pounds												
Gutters																	
Leaks																	
Marshes, fresh		1	10	Product	Pounds												
Marshes, reclaimed		6	169	Product	Pounds												
Marshes, tidal		4	200	Product	Pounds												
Mixed CB/UV/Sumps		3	0.8	Product	Pounds		1	5.2	Product	Ounces (weight)							
Natural Ponds		2	13.5	Product	Pounds												1
Ornamental Ponds		5	4.2	Product	Pounds		3	9	Product	Ounces (weight)		1	0.1	Product	Pounds		1
Overwatering																	
Rainwater		1	9	Product	Pounds		1	2.6	Product	Ounces (weight)		2	0.6	Product	Pounds		
Sanitary		3	35	Product	Pounds												
Seepages		1	0.3	Product	Pounds												
Spas																	
Stormdrains							1	3.9	Product	Ounces (weight)							
Swimming Pools		1	0.2	Product	Pounds		2	20.6	Product	Ounces (weight)		2	0.8	Product	Pounds		4
Tires																	
TreeHoles																	
Under building		2	1	Product	Pounds												
Vaults																	
Wells																	
Totals		34	498.5	Product	Pounds		9	43.9	Product	Ounces (weight)		7	1.9	Product	Pounds		10

Table A2.

Application Sites:	Total Amount Used2127	Total Amount Type2228	Total Amount Unit2229	Natular XRT Comments	VectoLex WDG - # Treatments	Total Amount Used3345	Total Amount Type3446	Total Amount Unit3447	VectoLex WDG Comments	Golden Bear Oil - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Golden Bear Oil Comments	Vectolex WSP - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectolex WSP Comments
Canals															5	2.6	Product	Pounds	
Catchbasins	0.7	Product	Pounds		16	8.7	Product	Pounds		1	0.03	Product	Gallons		10	0.3	Product	Pounds	
Containers										4	0.47	Product	Gallons		3	0.1	Product	Pounds	
Creeks	1.5	Product	Pounds													0.1	Product	Pounds	
Ditches															2	0.2	Product	Pounds	
Gutters																			
Leaks																			
Marshes, fresh																			
Marshes, reclaimed					1	0.5	Product	Pounds		1	1	Product	Gallons		2	1.6	Product	Pounds	
Marshes, tidal																			
Mixed CB/UV/Sumps										4	0.21	Product	Gallons		1	1.2	Product	Pounds	
Natural Ponds	0.1	Product	Pounds																
Ornamental Ponds	0.2	Product	Pounds							5	0.02	Product	Gallons		7	0.9	Product	Pounds	
Overwatering															1	0.2	Product	Pounds	
Rainwater															2	1.2	Product	Pounds	
Sanitary															1	3.3	Product	Pounds	
Seepages																			
Spas																			
Stormdrains										1	0.02	Product	Gallons						
Swimming Pools	5.2	Product	Pounds							3	0.3	Product	Gallons		6	1.7	Product	Pounds	
Tires																			
TreeHoles																			
Under building										1	0.01	Product	Gallons		2	0.1	Product	Pounds	
Vaults																			
Wells																			
Totals	7.7	Product	Pounds		17	9.2	Product	Pounds		20	2.06	Product	Gallons		42	13.5	Product	Pounds	

Table A2.

Application Sites:	VectoMAX CG - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	VectoMAX CG Comments	Skeeter Abate - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Skeeter Abate Comments
Canals	5	5	Product	Pounds		1	10	Product	Pounds	
Catchbasins										
Containers										
Creeks	4	19	Product	Pounds						
Ditches	2	4	Product	Pounds						
Gutters										
Leaks										
Marshes, fresh	1	1	Product	Pounds						
Marshes, reclaimed										
Marshes, tidal										
Mixed CB/UV/Sumps										
Natural Ponds	1	5	Product	Pounds						
Ornamental Ponds	3	1.7	Product	Pounds						
Overwatering										
Rainwater	3	2.8	Product	Pounds		1	7	Product	Pounds	
Sanitary						1	10	Product	Pounds	
Seepages										
Spas										
Stormdrains										
Swimming Pools										
Tires										
TreeHoles										
Under building										
Vaults										
Wells										
Totals	19	38.5	Product	Pounds		3	27	Product	Pounds	

Table A3. **Pesticide Application Data for Winter 2012 – ACMAD**

Application Sites:	Agnique MMF - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	VectoBac G - # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit3	VectoBac G Comments	VectoBac 12AS - # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit7	VectoBac 12AS Comments	Altosid Liquid conc. - # Treatments	Total Amount Used11	Total Amount Type12	Total Amount Unit12
Canals						8	45.8	Product	Pounds										
Catchbasins																			
Containers						2	0.1	Product	Pounds										
Creeks						8	44.5	Product	Pounds										
Ditches						6	36.3	Product	Pounds		1	0.4	Product	Gallons					
Gutters																			
Leaks																			
Marshes, fresh						2	25	Product	Pounds										
Marshes, reclaimed						10	114	Product	Pounds		31	17.5	Product	Gallons		27	123.5	Product	Ounces (volume)
Marshes, tidal						9	118	Product	Pounds										
Mixed CB/UV/Sumps						6	1.6	Product	Pounds										
Natural Ponds						6	50.9	Product	Pounds		3	0.6	Product	Gallons		3	4.9	Product	Ounces (volume)
Ornamental Ponds	1	0.5	Product	Ounces (volume)		8	2.2	Product	Pounds										
Overwatering																			
Rainwater						16	117.2	Product	Pounds										
Sanitary																			
Seepages						2	4.5	Product	Pounds										
Spas																			
Stormdrains																			
Swimming Pools																			
Tires																			
TreeHoles						1	0.1	Product	Pounds										
Under building																			
Vaults																			
Wells																			
Totals	1	0.5	Product	Ounces (volume)		84	560.2	Product	Pounds		35	18.5	Product	Gallons		30	128.4	Product	Ounces (volume)

Table A3.

Application Sites:	Altosid Liquid conc. Comments	Altosid Briquets - # Treatments	Total Amount Used13	Total Amount Type14	Total Amount Unit14	Altosid Briquets Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18	BVA-2 Comments	VectoLex CG - # Treatments	Total Amount Used19	Total Amount Type20	Total Amount Unit20	VectoLex CG Comments	Altosid WSP (pellets) - # Treatments	Total Amount Used23	Total Amount Type24
Canals												7	5.8	Product	Pounds				
Catchbasins							1	0.01	Product	Gallons									
Containers		2	38.3	Product	Ounces (weight)							2	0.1	Product	Pounds				
Creeks		2	13.5	Product	Ounces (weight)		1	3	Product	Gallons		6	19.5	Product	Pounds		1	2.5	Product
Ditches		2	6.5	Product	Ounces (weight)		1	3	Product	Gallons		4	6.3	Product	Pounds		1	8.6	Product
Gutters																			
Leaks																			
Marshes, fresh							1	0.2	Product	Gallons									
Marshes, reclaimed							3	9.2	Product	Gallons		2	45	Product	Pounds				
Marshes, tidal							1	0.1	Product	Gallons		6	50	Product	Pounds		1	61.6	Product
Mixed CB/UV/Sumps		2	0.8	Product	Ounces (weight)							6	1.6	Product	Pounds				
Natural Ponds							1	1	Product	Gallons		5	11	Product	Pounds		1	12.3	Product
Ornamental Ponds		5	1.9	Product	Ounces (weight)		10	0.1	Product	Gallons		9	2.1	Product	Pounds		1	0.2	Product
Overwatering																			
Rainwater							3	9.8	Product	Gallons		11	71.1	Product	Pounds				
Sanitary							1	0.2	Product	Gallons		2	13.5	Product	Pounds				
Seepages							1	0.01	Product	Gallons		2	10.5	Product	Pounds				
Spas																			
Stormdrains																			
Swimming Pools							6	0.2	Product	Gallons									
Tires																			
TreeHoles							8	0.2	Product	Gallons		1	0.1	Product	Pounds				
Under building																			
Vaults																			
Wells																			
Totals		13	61	Product	Ounces (weight)		38	27.02	Product	Gallons		63	236.6	Product	Pounds		5	85.2	Product

Table A3.

Application Sites:	Total Amount Unit24	Altosid WSP (pellets) Commnets	Altosid XR-Briquets - # Treatments	Total Amount Used37	Total Amount Type38	Total Amount Unit38	Altosid XR-Briquets Comments	FourStar 180 Bs - # Treatments	Total Amount Used1315	Total Amount Type1416	Total Amount Unit1417	FourStar 180 Bs Comments	Natular G30 - # Treatments	Total Amount Used1924	Total Amount Type2025	Total Amount Unit2026	Natular G30 Comments
Canals																	
Catchbasins			2	14.2	Product	Ounces (weight)											
Containers			2	16.8	Product	Ounces (weight)		1	0.3	Product	Pounds						
Creeks	Ounces (weight)		1	1.3	Product	Ounces (weight)							1	0.3	Product	Pounds	
Ditches	Ounces (weight)												1	10	Product	Pounds	
Gutters																	
Leaks																	
Marshes, fresh																	
Marshes, reclaimed																	
Marshes, tidal	Ounces (weight)																
Mixed CB/UV/Sumps			1	2.6	Product	Ounces (weight)											
Natural Ponds	Ounces (weight)																
Ornamental Ponds	Ounces (weight)		7	11.6	Product	Ounces (weight)		4	1	Product	Pounds		1	0.5	Product	Pounds	
Overwatering																	
Rainwater								1	0.9	Product	Pounds						
Sanitary																	
Seepages													1	3	Product	Pounds	
Spas																	
Stormdrains																	
Swimming Pools			3	28.4	Product	Ounces (weight)		2	0.9	Product	Pounds						
Tires																	
TreeHoles																	
Under building																	
Vaults																	
Wells																	
Totals	Ounces (weight)		16	74.9	Product	Ounces (weight)		13	61	Product	Pounds		63	236.6	Product	Pounds	

Table A3.

Application Sites:	Natular XRT - # Treatments	Total Amount Used2127	Total Amount Type2228	Total Amount Unit2229	Natular XRT Comments	Altosid Pellets - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid Pellets Comments	Golden Bear Oil - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Golden Bear Oil Comments	Vectolex WSP - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit
Canals																			
Catchbasins	1	0.1	Product	Pounds							1	0.3	Product	Gallons		1	0.04	Product	Pounds
Containers	1	0.4	Product	Pounds		1	0.5	Product	Ounces (weight)							3	0.3	Product	Pounds
Creeks	1	2.9	Product	Pounds		4	157	Product	Ounces (weight)										
Ditches						2	60	Product	Ounces (weight)		1	1.5	Product	Gallons					
Gutters																			
Leaks																			
Marshes, fresh																			
Marshes, reclaimed	1	1.2	Product	Pounds												3	1.3	Product	Pounds
Marshes, tidal											1	0.3	Product	Gallons		2	0.3	Product	Pounds
Mixed CB/UV/Sumps																			
Natural Ponds	1	3.7	Product	Pounds															
Ornamental Ponds	5	1.6	Product	Pounds							2	0.05	Product	Gallons		9	0.9	Product	Pounds
Overwatering																			
Rainwater						1	3	Product	Ounces (weight)							2	1	Product	Pounds
Sanitary											1	0.03	Product	Gallons		1	0.04	Product	Pounds
Seepages																3	0.3	Product	Pounds
Spas																			
Stormdrains																			
Swimming Pools	8	9.2	Product	Pounds		1	15	Product	Ounces (weight)							1	0.04	Product	Pounds
Tires																			
TreeHoles						12	18.5	Product	Ounces (weight)		3	0.7	Product	Gallons		1	0.02	Product	Pounds
Under building																			
Vaults																			
Wells																			
Totals	18	19.1	Product	Pounds		21	254	Product	Ounces (weight)		9	2.88	Product	Gallons		26	4.24	Product	Pounds

Table A3.

Application Sites:	Vectolex WSP Comments	VectoMAX CG - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	VectoMAX CG Comments
Canals		5	9	Product	Pounds	
Catchbasins						
Containers						
Creeks		2	3.5	Product	Pounds	
Ditches		2	2.5	Product	Pounds	
Gutters						
Leaks						
Marshes, fresh						
Marshes, reclaimed						
Marshes, tidal						
Mixed CB/UV/Sumps						
Natural Ponds						
Ornamental Ponds						
Overwatering						
Rainwater		1	14	Product	Pounds	
Sanitary						
Seepages		1	2	Product	Pounds	
Spas						
Stormdrains						
Swimming Pools						
Tires						
TreeHoles						
Under building						
Vaults						
Wells						
Totals		11	31	Product	Pounds	

Table A4. **Pesticide Application Data for Spring 2012 – ACMAD**

Application Sites:	Agnique MMF - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	VectoBac G - # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit3	VectoBac G Comments	VectoBac 12AS - # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit7	VectoBac 12AS Comments	Altosid Liquid conc. - # Treatments	Total Amount Used11	Total Amount Type12
Canals						10	22	Product	Pounds		1	0.6	Product	Gallons		1	4.9	Product
Catchbasins											29	0.9	Product	Gallons				
Containers						6	2.4	Product	Pounds									
Creeks						12	82.6	Product	Pounds									
Ditches						7	31	Product	Pounds		3	0.9	Product	Gallons		1	1	Product
Gutters																		
Leaks																		
Marshes, fresh						4	84.5	Product	Pounds		1	0.2	Product	Gallons				
Marshes, reclaimed						12	104.5	Product	Pounds		21	11.5	Product	Gallons		15	69.7	Product
Marshes, tidal						14	238.5	Product	Pounds		1	0.6	Product	Gallons		1	4.9	Product
Mixed CB/UV/Sumps						5	0.9	Product	Pounds									
Natural Ponds						6	35.5	Product	Pounds									
Ornamental Ponds	1	1	Product	Ounces (volume)		37	8.5	Product	Pounds									
Overwatering																		
Rainwater						18	152.7	Product	Pounds		1	0.6	Product	Gallons		1	4.9	Product
Sanitary						1	2	Product	Pounds									
Seepages						4	5.7	Product	Pounds									
Spas																		
Stormdrains																		
Swimming Pools						6	1.5	Product	Pounds									
Tires																		
TreeHoles																		
Under building																		
Vaults																		
Wells																		
Totals	1	1	Product	Ounces (volume)		142	772.3	Product	Pounds		57	15.3	Product	Gallons		19	85.4	Product

Table A4.

Application Sites:	Total Amount Unit12	Altosid Liquid conc. Comments	Altosid Briquets - # Treatments	Total Amount Used13	Total Amount Type14	Total Amount Unit14	Altosid Briquets Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18	BVA-2 Comments	VectoLex CG - # Treatments	Total Amount Used19	Total Amount Type20	Total Amount Unit20	VectoLex CG Comments	Altosid WSP (pellets) - # Treatments
Canals	Ounces (volume)		1	11	Product	Ounces (weight)		8	3.1	Product	Gallons		9	21	Product	Pounds		
Catchbasins			2	51.4	Product	Ounces (weight)		88	19.6	Product	Gallons							
Containers			1	1	Product	Ounces (weight)		4	0.1	Product	Gallons		5	2.3	Product	Pounds		
Creeks			1	9.5	Product	Ounces (weight)		6	9.4	Product	Gallons		6	21.6	Product	Pounds		
Ditches	Ounces (volume)							4	61	Product	Gallons		7	56	Product	Pounds		1
Gutters																		
Leaks																		
Marshes, fresh								1	0.2	Product	Gallons		1	4.5	Product	Pounds		
Marshes, reclaimed	Ounces (volume)							21	476.3	Product	Gallons		4	25.5	Product	Pounds		
Marshes, tidal	Ounces (volume)							2	6	Product	Gallons		1	10	Product	Pounds		
Mixed CB/UV/Sumps			3	5.9	Product	Ounces (weight)		11	15.6	Product	Gallons		5	0.9	Product	Pounds		
Natural Ponds			1	11.4	Product	Ounces (weight)		5	35.5	Product	Gallons		4	24.5	Product	Pounds		
Ornamental Ponds			4	2.3	Product	Ounces (weight)		25	2.7	Product	Gallons		24	6.3	Product	Pounds		
Overwatering																		
Rainwater	Ounces (volume)		2	5	Product	Ounces (weight)		4	6.8	Product	Gallons		11	50.2	Product	Pounds		
Sanitary								5	0.5	Product	Gallons		6	13.6	Product	Pounds		
Seepages			1	1	Product	Ounces (weight)		2	0.02	Product	Gallons		2	4.5	Product	Pounds		
Spas								2	0.01	Product	Gallons							
Stormdrains								10	0.3	Product	Gallons							
Swimming Pools			2	3.6	Product	Ounces (weight)		31	1	Product	Gallons		4	1.1	Product	Pounds		
Tires																		
TreeHoles													2	0.1	Product	Pounds		
Under building								1	0.03	Product	Gallons							
Vaults								2	0.05	Product	Gallons							
Wells																		
Totals	Ounces (volume)		18	102.1	Product	Ounces (weight)		232	638.21	Product	Gallons		91	242.1	Product	Pounds		1

Table A4.

Application Sites:	Total Amount Used23	Total Amount Type24	Total Amount Unit24	Altosid WSP (pellets) Commnets	Altosid XR-Briquets - # Treatments	Total Amount Used37	Total Amount Type38	Total Amount Unit38	Altosid XR-Briquets Comments	FourStar 180 Bs - # Treatments	Total Amount Used1315	Total Amount Type1416	Total Amount Unit1417	FourStar 180 Bs Comments	Natular G30 - # Treatments	Total Amount Used1924	Total Amount Type2025
Canals															1	12	Product
Catchbasins					17	226.8	Product	Ounces (weight)		6	2	Product	Pounds		1	1.3	Product
Containers					4	33.5	Product	Ounces (weight)									
Creeks					3	55.4	Product	Ounces (weight)							5	11.3	Product
Ditches	7.4	Product	Ounces (weight)														
Gutters																	
Leaks																	
Marshes, fresh																	
Marshes, reclaimed																	
Marshes, tidal					1	58	Product	Ounces (weight)									
Mixed CB/UV/Sumps					1	2.6	Product	Ounces (weight)		7	4.2	Product	Pounds				
Natural Ponds					1	15.5	Product	Ounces (weight)							2	14	Product
Ornamental Ponds					12	19.3	Product	Ounces (weight)		6	0.9	Product	Pounds		1	0.6	Product
Overwatering																	
Rainwater					3	24.5	Product	Ounces (weight)							1	4	Product
Sanitary										1	0.5	Product	Pounds				
Seepages															1	2	Product
Spas																	
Stormdrains					3	41.2	Product	Ounces (weight)		1	0.2	Product	Pounds				
Swimming Pools					2	19.3	Product	Ounces (weight)		4	2.4	Product	Pounds				
Tires																	
TreeHoles																	
Under building																	
Vaults					1	5.2	Product	Ounces (weight)									
Wells																	
Totals	7.4	Product	Ounces (weight)		48	501.3	Product	Ounces (weight)		18	102.1	Product	Pounds		91	242.1	Product

Table A4.

Application Sites:	Total Amount Unit2026	Natular G30 Comments	Natular XRT - # Treatments	Total Amount Used2127	Total Amount Type2228	Total Amount Unit2229	Natular XRT Comments	VectoLex WDG - # Treatments	Total Amount Used3345	Total Amount Type3446	Total Amount Unit3447	VectoLex WDG Comments	Altosid Pellets - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid Pellets Comments	Golden Bear Oil - # Treatments
Canals	Pounds		6	7.7	Product	Pounds							1	48	Product	Ounces (weight)		
Catchbasins	Pounds		86	59.6	Product	Pounds		29	7.3	Product	Pounds							1
Containers			6	3.1	Product	Pounds												
Creeks	Pounds		11	25.8	Product	Pounds							4	272	Product	Ounces (weight)		
Ditches			3	1.2	Product	Pounds							1	16	Product	Ounces (weight)		
Gutters																		
Leaks																		
Marshes, fresh																		
Marshes, reclaimed			1	0.4	Product	Pounds							5	928	Product	Ounces (weight)		
Marshes, tidal													13	2744	Product	Ounces (weight)		
Mixed CB/UV/Sumps			10	12.4	Product	Pounds												
Natural Ponds	Pounds		3	3.3	Product	Pounds												
Ornamental Ponds	Pounds		34	18.3	Product	Pounds												4
Overwatering																		
Rainwater	Pounds		1	1	Product	Pounds												1
Sanitary			3	12.1	Product	Pounds												
Seepages	Pounds		3	0.4	Product	Pounds							3	3.2	Product	Ounces (weight)		
Spas			1	0.1	Product	Pounds												
Stormdrains			9	6.3	Product	Pounds												
Swimming Pools			67	66.8	Product	Pounds												
Tires																		
TreeHoles													1	1.5	Product	Ounces (weight)		1
Under building			2	1	Product	Pounds												
Vaults			2	0.2	Product	Pounds												
Wells																		
Totals	Pounds		248	219.7	Product	Pounds		29	7.3	Product	Pounds		28	4012.7	Product	Ounces (weight)		7

Table A4.

Application Sites:	Total Amount Used	Total Amount Type	Total Amount Unit	Golden Bear Oil Comments	Vectolex WSP - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectolex WSP Comments
Canals					2	0.8	Product	Pounds	
Catchbasins	0.01	Product	Gallons		4	5.1	Product	Pounds	
Containers					2	0.1	Product	Pounds	
Creeks									
Ditches					2	0.2	Product	Pounds	
Gutters									
Leaks									
Marshes, fresh									
Marshes, reclaimed									
Marshes, tidal									
Mixed CB/UV/Sumps					1	0.3	Product	Pounds	
Natural Ponds									
Ornamental Ponds	0.04	Product	Gallons		10	0.4	Product	Pounds	
Overwatering									
Rainwater	0.04	Product	Gallons		1	0.1	Product	Pounds	
Sanitary					1	0.1	Product	Pounds	
Seepages					3	0.2	Product	Pounds	
Spas									
Stormdrains									
Swimming Pools					2	0.3	Product	Pounds	
Tires									
TreeHoles	0.2	Product	Gallons						
Under building									
Vaults									
Wells									
Totals	0.29	Product	Gallons		28	7.6	Product	Pounds	

Table A5. Pesticide Product Key – ACMAD

Product	AI	Vector
Agnique MMF	Biodegradable Alcohol Ethoxylated Surfactant	Mosquito
Altosid Briquets	Methoprene	Mosquito
Altosid Liquid conc.	Methoprene	Mosquito
Altosid Pellets	Methoprene	Mosquito
Altosid WSP (pellets)	Methoprene	Mosquito
Altosid XR-Briquets	Methoprene	Mosquito
BVA 2	Petroleum Distillate	Mosquito
FourStar 180 Bs	Bacillus Sphaericus and Bacillus Thuringiensis Israelensis	Mosquito
Natular G30	Spinosad	Mosquito
Natular XRT	Spinosad	Mosquito
Pyrenone 25-5	Pyrethrins and Piperonyl Butoxide	Mosquito
VectoBac 12AS	Bacillus Thuringiensis Israelensis	Mosquito
VectoBac G	Bacillus Thuringiensis Israelensis	Mosquito
VectoLex CG Biologic	Bacillus Sphaericus	Mosquito
VectoLex WDG	Bacillus Sphaericus	Mosquito
VectoLex WSP	Bacillus Sphaericus	Mosquito
VectoMax CG	Bacillus Sphaericus and Bacillus Thuringiensis Israelensis	Mosquito
Golden Bear	Aliphatic Petroleum Hydrocarbons	Mosquito
Skeeter Abate	Temephos	Mosquito

Table A6. Pesticide Application Data for Summer 2011 – ACVCSD

Application Sites:	Contrac Super Blox - # Treatments	Total Amount Used4	Total Amount Type5	Total Amount Unit5	Contrac Super Blox Comments	Ditrac Tracking Powder - # Treatments	Total Amount Used43	Total Amount Type54	Total Amount Unit55	Ditrac Tracking Powder Comments
Backyard Standing Water Sources										
Rodent Burrows						1	10	Product	Ounces (weight)	
Saintary Sewers	1	246.5	Product	Pounds						
Totals	1	246.5	Product	Pounds		1	10	Product	Ounces (weight)	

Table A7. Pesticide Application Data for Fall 2011 – ACVCSD

Application Sites:	Contrac Super Blox - # Treatments	Total Amount Used4	Total Amount Type5	Total Amount Unit5	Contrac Super Blox Comments	Ditrac Tracking Powder - # Treatments	Total Amount Used43	Total Amount Type54	Total Amount Unit55	Ditrac Tracking Powder Comments
Backyard Standing Water Sources										
Rodent Burrows						1	12	Product	Ounces (weight)	
Saintary Sewers	1	134	Product	Pounds						
Totals	1	134	Product	Pounds		1	12	Product	Ounces (weight)	

Table A8. **Pesticide Application Data for Winter 2012 – ACVCSD**

Application Sites:	Contrac Super Blox - # Treatments	Total Amount Used4	Total Amount Type5	Total Amount Unit5	Contrac Super Blox Comments	Ditrac Tracking Powder - # Treatments	Total Amount Used43	Total Amount Type54	Total Amount Unit55	Ditrac Tracking Powder Comments
Backyard Standing Water Sources										
Rodent Burrows						1	6	Product	Ounces (weight)	
Saintary Sewers	1	15.5	Product	Pounds						
Totals	1	15.5	Product	Pounds	0	1	6	Product	Ounces (weight)	

Table A9. **Pesticide Application Data for Spring 2012 – ACVCSD**

Application Sites:	Altosid XR-Briquets - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid XR-Briquets Comments	Contrac Super Blox - # Treatments	Total Amount Used4	Total Amount Type5	Total Amount Unit5	Contrac Super Blox Comments	Ditrac Tracking Powder - # Treatments	Total Amount Used43	Total Amount Type54	Total Amount Unit55	Ditrac Tracking Powder Comments
Backyard Standing Water Sources	1	3	Product	Ounces (weight)											
Rodent Burrows											1	13	Product	Ounces (weight)	
Saintary Sewers						1	672.5	Product	Pounds						
Totals	1	3	Product	Ounces (weight)		1	672.5	Product	Pounds		1	13	Product	Ounces (weight)	

Table A10. Pesticide Product Key – ACVCSD

Product	AI	Vector
Altosid XR-Briquets	Methoprene	Mosquito
Ditrac Tracking Powder	Diphacinone	Rat
Contrac Super Blox	Bromadiolone	Rat

Table A11. **Pesticide Application Data for Summer 2011 – CCMVCD**

Application Sites:	Agnique MMF - # Treatments	Total Amount_Used	Total Amount Type	Total Amount_Unit	Agnique MMF Comments	VectoBac G - # Treatments	Total Amount_Used2	Total Amount_Type3	Total Amount_Unit3	VectoBac G Comments	VectoBac 12AS - # Treatments	Total Amount_Used6	Total Amount_Type7	Total Amount_Unit7	VectoBac 12AS Comments
Canals															
Containers	6	5.09	Product	Ounces (volume)							26	14.65	Active Ingredient	Ounces (weight)	
Creeks	1	1.16	Product	Ounces (volume)		1	2.5	Product	Pounds		382	88.5	Active Ingredient	Ounces (volume)	
Ditches															
Intermittent	1	0.18	Product	Ounces (volume)							28	1368.37	Active Ingredient	Ounces (volume)	
Marshes						1	12	Product	Pounds		12	624	Active Ingredient	Ounces (volume)	
Natural Ponds						1	10	Product	Pounds		31	27.22	Active Ingredient	Ounces (volume)	
Ornamental Ponds															
Other															
Parks/Landscape															
Rainwater															
Sanitary															
Seepages															
Swimming Pools	22	12.78	Product	Ounces (volume)							46	8.41	Active Ingredient	Ounces (volume)	
Tires															
TreeHoles															
Urban Underground Water	2	5.3	Product	Ounces (volume)							15	2.01	Active Ingredient	Ounces (volume)	
Waterfront															
Wells															
Totals	32	24.51	Product	Ounces (volume)		3	24.5	Product	Pounds		540	2133.16	Active Ingredient	Ounces (volume)	

Table A11.

Application Sites:	Altosid Liquid conc. - # Treatments	Total Amount Used11	Total Amount Type12	Total Amount Unit12	Altosid Liquid conc. Comments	Altosid Briquets - # Treatments	Total Amount Used13	Total Amount Type14	Total Amount Unit14	Altosid Briquets Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18	BVA-2 Comments
Canals															
Containers						28	3.42	Product	Ounces (volume)		45	398.98	Product	Ounces (volume)	
Creeks	11	0.54	Active Ingredient	Ounces (volume)		3	0.33	Product	Ounces (volume)		49	4119.53	Product	Ounces (volume)	
Ditches															
Intermittent	22	141.19	Active Ingredient	Ounces (volume)							51	90039	Product	Ounces (volume)	
Marshes	11	48	Active Ingredient	Ounces (volume)							3	146	Product	Ounces (volume)	
Natural Ponds	4	0.064				4	0.27	Product	Ounces (volume)		11	183	Product	Ounces (volume)	
Ornamental Ponds															
Other															
Parks/Landscape											1	6	Product	Ounces (volume)	
Rainwater															
Sanitary						1	0.03	Product	Ounces (volume)		3	130	Product	Ounces (volume)	
Seepages															
Swimming Pools	10	0.1	Active Ingredient	Ounces (volume)		2	0.27	Product	Ounces (volume)		30	73.25	Product	Ounces (volume)	
Tires															
TreeHoles															
Urban Underground Water	2	0.005				28	10.44	Product	Ounces (volume)		89	4283.49	Product	Ounces (volume)	
Waterfront															
Wells															
Totals	60	189.899	Active Ingredient	Ounces (volume)		66	14.76	Product	Ounces (volume)		282	99379.25	Product	Ounces (volume)	

Table A11.

Application Sites:	VectoLex CG - # Treatments	Total Amount_Used19	Total Amount_Type20	Total Amount_Unit20	VectoLex CG Comments	Altosid WSP (pellets) - # Treatments	Total Amount_Used23	Total Amount_Type24	Total Amount_Unit24	Altosid WSP (pellets) Commnets	FourStar SR Briquet - # Treatments	Total Amount_Used27	Total Amount_Type28	Total Amount_Unit28
Canals														
Containers	21	563.73	Product	Ounces (volume)		10	9.12	Product	Ounces (volume)		8	18	Product	Ounces (volume)
Creeks	67	1404.98	Product	Ounces (volume)		8	3.36	Product	Ounces (volume)		6	12.9	Product	Ounces (volume)
Ditches														
Intermittent	7	880.18	Product	Ounces (volume)							1	1.1	Product	Ounces (volume)
Marshes	2	288	Product	Ounces (volume)										
Natural Ponds	34	2866.1	Product	Ounces (volume)		1	1.44	Product	Ounces (volume)		2	8.8	Product	Ounces (volume)
Ornamental Ponds														
Other														
Parks/Landscape														
Rainwater														
Sanitary											1	9.9	Product	Ounces (volume)
Seepages														
Swimming Pools	42	38.92	Product	Ounces (volume)										
Tires														
TreeHoles														
Urban Underground Water						8	3.36	Product	Ounces (volume)		31	549.4	Product	Ounces (volume)
Waterfront														
Wells														
Totals	173	6041.91	Product	Ounces (volume)		27	17.28	Product	Ounces (volume)		49	600.1	Product	Ounces (volume)

Table A11.

Application Sites:	FourStar SR Briquet Comments	Bell Contrac Super-Size Blox - # Treatments	Total Amount_Used35	Total Amount_Type36	Total Amount_Unit36	Bell Contrac Super-Size Blox Comments	Altosid XR-Briquets - # Treatments	Total Amount_Used37	Total Amount_Type38	Total Amount_Unit38	Altosid XR-Briquets Comments	Drione - # Treatments	Total Amount_Used1112
Canals													
Containers							27	156	Product	Ounces (volume)		2	1.5
Creeks		43	344	Product	Ounces (volume)		6	21	Product	Ounces (volume)			
Ditches													
Intermittent							1	3	Product	Ounces (volume)			
Marshes													
Natural Ponds							12	27	Product	Ounces (volume)			
Ornamental Ponds													
Other													
Parks/Landscape		23	184	Product	Ounces (volume)							682	855.55
Rainwater													
Sanitary		84	1360	Product	Ounces (volume)								
Seepages													
Swimming Pools							17	37.5	Product	Ounces (volume)			
Tires													
TreeHoles													
Urban Underground Water							133	2365.5	Product	Ounces (volume)			
Waterfront		10	88	Product	Ounces (volume)								
Wells													
Totals		160	1976	Product	Ounces (volume)		196	2610	Product	Ounces (volume)		684	857.05

Table A11.

Application Sites:	Total Amount_Type1213	Total Amount_Unit1214	Drione Comments	Natular 2EC - # Treatments	Total Amount_Used1721	Total Amount_Type1822	Total Amount_Unit1823	Natular 2EC Comments	Pyrocide 7396 - # Treatments	Total Amount_Used2939	Total Amount_Type3040	Total Amount_Unit3041	Pyrocide 7396 Comments	VectoLex CG Biologic - # Treatments
Canals														
Containers	Product	Ounces (volume)												21
Creeks														67
Ditches														
Intermittent														7
Marshes				5	360	Product	Ounces (volume)							2
Natural Ponds														34
Ornamental Ponds														
Other									28	1871.18	Product	Ounces (volume)		
Parks/Landscape	Product	Ounces (volume)												
Rainwater														
Sanitary														
Seepages														
Swimming Pools														42
Tires														
TreeHoles														
Urban Underground Water														
Waterfront														
Wells														
Totals	Product	Ounces (volume)		5	360	Product	Ounces (volume)		28	1871.18	Product	Ounces (volume)		173

Table A11.

Application Sites:	Total Amount Used3142	Total Amount Type3243	Total Amount Unit3244	VectoLex CG Biologic Comments	VectoLex WDG - # Treatments	Total Amount Used3345	Total Amount Type3446	Total Amount Unit3447	VectoLex WDG Comments	Ditrac Blox - # Treatments	Total Amount Used3	Total Amount Type	Total Amount Unit4	Ditrac Blox Comments	Vectolex WSP - # Treatments
Canals															
Containers	563.73	Product	Ounces (volume)												3
Creeks	1404.98	Product	Ounces (volume)		3	1.5	Active Ingredient	Ounces (volume)		28	448	Product	Ounces (volume)		7
Ditches															
Intermittent	880.18	Product	Ounces (volume)		1	160	Active Ingredient	Ounces (volume)							
Marshes	288	Product	Ounces (volume)												
Natural Ponds	2866.1	Product	Ounces (volume)												2
Ornamental Ponds															
Other															
Parks/Landscape										12	192	Product	Ounces (volume)		
Rainwater															
Sanitary															
Seepages															
Swimming Pools	38.92	Product	Ounces (volume)												3
Tires															
TreeHoles															
Urban Underground Water					43	94.27	Product	Ounces (volume)							8
Waterfront															
Wells															
Totals	6041.91	Product	Ounces (volume)		47	255.77	Product	Ounces (volume)		40	640	Product	Ounces (volume)		23

Table A11.

Application Sites:	Total Amount_Used5	Total Amount_Type6	Total Amount_Unit8	Vectolex WSP Comments	Altosid Pellets - # Treatments	Total Amount Used	Total Amount Type9	Total Amount Unit	Altosid Pellets - Comments
Canals									
Containers	17.48	Product	Ounces (volume)		4	40.36	Product	Ounces (volume)	
Creeks	12.16	Product	Ounces (volume)		38	1307.82	Product	Ounces (volume)	
Ditches									
Intermittent					60	6919.61	Product	Ounces (volume)	
Marshes					33	1632	Product	Ounces (volume)	
Natural Ponds	2.28	Product	Ounces (volume)		16	768	Product	Ounces (volume)	
Ornamental Ponds									
Other									
Parks/Landscape					2	9	Product	Ounces (volume)	
Rainwater									
Sanitary					2	56	Product	Ounces (volume)	
Seepages									
Swimming Pools	7.6	Product	Ounces (volume)						
Tires									
TreeHoles									
Urban Underground Water	225.72	Product	Ounces (volume)		1	0.55	Active Ingredient	Ounces (volume)	
Waterfront									
Wells									
Totals	265.24	Product	Ounces (volume)		156	10733.34	Mix	Ounces (volume)	

Table A12. **Pesticide Application Data for Fall 2011 – CCMVCD**

Application Sites:	Agnique MMF - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	VectoBac G - # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit3	VectoBac G Comments	VectoBac 12AS - # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit7	VectoBac 12AS Comments
Canals															
Containers	5	14.72	Product	Ounces (volume)		2	28	Product	Ounces (volume)		11	2.51	Active Ingredient	Ounces (volume)	
Creeks	2	1	Product	Ounces (volume)		2	64	Product	Ounces (volume)		81	8.48	Active Ingredient	Ounces (volume)	
Ditches															
Intermittent	1	5	Product	Ounces (volume)							4	209.34	Active Ingredient	Ounces (volume)	
Marshes															
Natural Ponds						3	272	Product	Ounces (volume)		6	5.28	Active Ingredient	Ounces (volume)	
Ornamental Ponds															
Other															
Park/Landscape	1	0.25	Product	Ounces (volume)											
Rainwater															
Sanitary	1	15	Product	Ounces (volume)											
Seepages															
Swimming Pools	10	7.35	Product	Ounces (volume)							17	2.93	Active Ingredient	Ounces (volume)	
Tires															
TreeHoles															
Urban Underground Water											6	1.05	Active Ingredient	Ounces (volume)	
Waterfront															
Wells															
Totals	20	43.32	Product	Ounces (volume)		7	364	Product	Ounces (volume)		125	229.59	Active Ingredient	Ounces (volume)	

Table A12.

Application Sites:	Altosid Liquid conc. - # Treatments	Total Amount Used11	Total Amount Type12	Total Amount Unit12	Altosid Liquid conc. Comments	Altosid Briquets - # Treatments	Total Amount Used13	Total Amount Type14	Total Amount Unit14	Altosid Briquets Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18
Canals														
Containers	1	0.0023	Active Ingredient	Ounces (volume)		8	1.77	Product	Ounces (volume)		16	193.09	Product	Ounces (volume)
Creeks	9	0.1	Active Ingredient	Ounces (volume)		1	0.06	Product	Ounces (volume)		16	2431	Product	Ounces (volume)
Ditches														
Intermittent	4	21.66	Active Ingredient	Ounces (volume)							6	9354	Product	Ounces (volume)
Marshes											3	5121	Product	Ounces (volume)
Natural Ponds	1	0.007	Active Ingredient	Ounces (volume)		2	0.12	Product	Ounces (volume)		8	439.8	Product	Ounces (volume)
Ornamental Ponds														
Other														
Park/Landscape						2	0.93	Product	Ounces (volume)					
Rainwater														
Sanitary											1	384	Product	Ounces (volume)
Seepages														
Swimming Pools	8	0.06	Active Ingredient	Ounces (volume)		9	0.72	Product	Ounces (volume)		7	25	Product	Ounces (volume)
Tires														
TreeHoles														
Urban Underground Water						7	6.72	Product	Ounces (volume)		22	1024.1	Product	Ounces (volume)
Waterfront														
Wells														
Totals	23	21.8293	Active Ingredient	Ounces (volume)		29	10.32	Product	Ounces (volume)		79	18971.99	Product	Ounces (volume)

Table A12.

Application Sites:	BVA-2 Comments	VectoLex CG - # Treatments	Total Amount Used19	Total Amount Type20	Total Amount Unit20	VectoLex CG Comments	Altosid WSP (pellets) - # Treatments	Total Amount Used23	Total Amount Type24	Total Amount Unit24	Altosid WSP (pellets) Commnets	FourStar SR Briquet - # Treatments	Total Amount Used27	Total Amount Type28
Canals														
Containers		20	352.93	Product	Ounces (volume)		9	9.84	Product	Ounces (volume)		2	2.2	Product
Creeks		24	428.94	Product	Ounces (volume)		1	0.24	Product	Ounces (volume)		1	1.1	Product
Ditches														
Intermittent		3	176.36	Product	Ounces (volume)									
Marshes														
Natural Ponds		17	1266.82	Product	Ounces (volume)		2	3.84	Product	Ounces (volume)				
Ornamental Ponds														
Other														
Park/Landscape														
Rainwater														
Sanitary														
Seepages														
Swimming Pools		33	23.75	Product	Ounces (volume)		1	0.48	Product	Ounces (volume)		1	1.1	Product
Tires														
TreeHoles														
Urban Underground Water		1	1.85	Product	Ounces (volume)		2	0.96	Product	Ounces (volume)		17	317.9	Product
Waterfront														
Wells														
Totals		98	2250.65	Product	Ounces (volume)		15	15.36	Product	Ounces (volume)		21	322.3	Product

Table A12.

Application Sites:	Total Amount Unit28	FourStar SR Briquet Comments	Bell Contrac Super-Size Blox - # Treatments	Total Amount Used35	Total Amount Type36	Total Amount Unit36	Bell Contrac Super-Size Blox Comments	Altosid XR-Briquets - # Treatments	Total Amount Used37	Total Amount Type38	Total Amount Unit38	Bell Contrac Small Blox - # Treatments
Canals												
Containers	Ounces (volume)							15	60	Product	Ounces (volume)	
Creeks	Ounces (volume)		30	248	Product	Ounces (volume)						15
Ditches												
Intermittent												
Marshes												
Natural Ponds								2	9	Product	Ounces (volume)	
Ornamental Ponds												
Other												
Park/Landscape			24	192	Product	Ounces (volume)						7
Rainwater												
Sanitary			43	528	Product	Ounces (volume)						
Seepages												
Swimming Pools	Ounces (volume)							24	54	Product	Ounces (volume)	
Tires												
TreeHoles												
Urban Underground Water	Ounces (volume)							12	180	Product	Ounces (volume)	
Waterfront			11	88	Product	Ounces (volume)						2
Wells												
Totals	Ounces (volume)		108	1056	Product	Ounces (volume)		53	303	Product	Ounces (volume)	24

Table A12.

Application Sites:	Total Amount Used69	Total Amount Type710	Total Amount Unit711	Bell Contrac Small Blox Comments	Drione - # Treatments	Total Amount Used1112	Total Amount Type1213	Total Amount Unit1214	Drione Comments	Bell Terad 3 Blox - # Treatments	Total Amount Used1315	Total Amount Type1416	Total Amount Unit1417	Bell Terad 3 Blox Comments
Canals														
Containers														
Creeks	16	Product	Ounces (volume)							8	8	Product	Ounces (volume)	
Ditches														
Intermittent														
Marshes														
Natural Ponds														
Ornamental Ponds														
Other														
Park/Landscape	7	Product	Ounces (volume)		107	146.75	Product	Ounces (volume)		5	5	Product	Ounces (volume)	
Rainwater														
Sanitary														
Seepages														
Swimming Pools														
Tires														
TreeHoles														
Urban Underground Water														
Waterfront	2	Product	Ounces (volume)							2	2	Product	Ounces (volume)	
Wells														
Totals	25	Product	Ounces (volume)		107	146.75	Product	Ounces (volume)		15	15	Product	Ounces (volume)	

Table A12.

Application Sites:	First Strike - # Treatments	Total Amount Used1518	Total Amount Type1619	Total Amount Unit1620	First Strike Comments	Natular 2EC - # Treatments	Total Amount Used1721	Total Amount Type1822	Total Amount Unit1823	Natular 2EC Comments	Pyrocide 7396 - # Treatments	Total Amount Used2939	Total Amount Type3040	Total Amount Unit3041
Canals														
Containers														
Creeks	6	6	Product	Ounces (volume)										
Ditches														
Intermittent														
Marshes														
Natural Ponds														
Ornamental Ponds														
Other											1	6	Product	Ounces (volume)
Park/Landscape	5	5.6	Product	Ounces (volume)										
Rainwater														
Sanitary														
Seepages														
Swimming Pools						1	0.027	Product	Ounces (volume)					
Tires														
TreeHoles														
Urban Underground Water														
Waterfront														
Wells														
Totals	11	11.6	Product	Ounces (volume)		1	0.027	Product	Ounces (volume)		1	6	Product	Ounces (volume)

Table A12.

Application Sites:	Pyrocide 7396 Comments	VectoLex CG Biologic - # Treatments	Total Amount Used3142	Total Amount Type3243	Total Amount Unit3244	VectoLex CG Biologic Comments	VectoLex WDG - # Treatments	Total Amount Used3345	Total Amount Type3446	Total Amount Unit3447	VectoLex WDG Comments	Ditrac Blox - # Treatments	Total Amount Used3	Total Amount Type
Canals														
Containers		20	352.93	Product	Ounces (volume)									
Creeks		24	428.94	Product	Ounces (volume)							20	320	Product
Ditches														
Intermittent		3	176.36	Product	Ounces (volume)		3	480	Active Ingredient	Ounces (volume)				
Marshes														
Natural Ponds		17	1266.82	Product	Ounces (volume)									
Ornamental Ponds														
Other														
Park/Landscape												5	80	Product
Rainwater														
Sanitary														
Seepages														
Swimming Pools		33	23.75	Product	Ounces (volume)									
Tires														
TreeHoles														
Urban Underground Water		1	1.85	Product	Ounces (volume)									
Waterfront														
Wells														
Totals		98	2250.65	Product	Ounces (volume)		3	480	Active Ingredient	Ounces (volume)		25	400	Product

Table A12.

Application Sites:	Total Amount Unit4	Ditrac Blox Comments	Vectolex WSP - # Treatments	Total Amount Used5	Total Amount Type6	Total Amount Unit8	Vectolex WSP Comments	Altosid Pellets - # Treatments	Total Amount Used	Total Amount Type9	Total Amount Unit	Altosid Pellets - Comments
Canals												
Containers			10	55.48	Product	Ounces (volume)		1	10	Product	Ounces (volume)	
Creeks	Ounces (volume)		2	3.04	Product	Ounces (volume)		5	102	Product	Ounces (volume)	
Ditches												
Intermittent								7	165	Product	Ounces (volume)	
Marshes								2	32	Product	Ounces (volume)	
Natural Ponds								3	57	Product	Ounces (volume)	
Ornamental Ponds												
Other												
Park/Landscape	Ounces (volume)											
Rainwater												
Sanitary												
Seepages												
Swimming Pools			2	3.8	Product	Ounces (volume)						
Tires												
TreeHoles												
Urban Underground Water			8	23.56	Product	Ounces (volume)		1	1	Product	Ounces (volume)	
Waterfront												
Wells												
Totals	Ounces (volume)		22	85.88	Product	Ounces (volume)		19	367	Product	Ounces (volume)	

Table A13. Pesticide Application Data for Winter 2012 – CCMVCD

Application Sites:	Agnique MMF - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	VectoBac G - # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit3	VectoBac G Comments	Agnique MMF G - # Treatments	Total Amount Used4	Total Amount Type5	Total Amount Unit5	Agnique MMF G Comments
Canals															
Containers															
Creeks						2	80	Product	Ounces (volume)						
Ditches															
Intermittent															
Marshes															
Natural Ponds						2	512	Product	Ounces (volume)		1	56	Product	Ounces (volume)	
Ornamental Ponds															
Park/Landscape															
Rainwater															
Sanitary															
Seepages															
Swimming Pools	9	5.06	Product	Ounces (volume)											
Tires															
TreeHoles															
Urban Underground Water															
Waterfront															
Wells															
Totals	9	5.06	Product	Ounces (volume)		4	592	Product	Ounces (volume)		1	56	Product	Ounces (volume)	

Table A13.

Application Sites:	VectoBac 12AS - # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit7	VectoBac 12AS Comments	Altosid Liquid conc. - # Treatments	Total Amount Used11	Total Amount Type12	Total Amount Unit12	Altosid Liquid conc. Comments	Altosid Briquets - # Treatments	Total Amount Used13	Total Amount Type14	Total Amount Unit14	Altosid Briquets Comments
Canals															
Containers	3	0.63	Active Ingredient	Ounces (volume)		3	0.066	Active Ingredient	Ounces (volume)		7	0.48	Product	Ounces (volume)	
Creeks	15	52.51	Active Ingredient	Ounces (volume)		12	5.04	Active Ingredient	Ounces (volume)		1	0.09	Product	Ounces (volume)	
Ditches															
Intermittent	11	360.1	Active Ingredient	Ounces (volume)		9	37.13	Active Ingredient	Ounces (volume)						
Marshes	7	158.03	Active Ingredient	Ounces (volume)		7	16.38	Active Ingredient	Ounces (volume)						
Natural Ponds	31	64.68	Active Ingredient	Ounces (volume)		22	4.38	Active Ingredient	Ounces (volume)		2	0.12	Product	Ounces (volume)	
Ornamental Ponds															
Park/Landscape															
Rainwater															
Sanitary															
Seepages															
Swimming Pools	31	3.44	Active Ingredient	Ounces (volume)		25	0.25	Active Ingredient	Ounces (volume)		7	0.72	Product	Ounces (volume)	
Tires															
TreeHoles											1	0.03	Product	Ounces (volume)	
Urban Underground Water															
Waterfront															
Wells															
Totals	98	639.39	Active Ingredient	Ounces (volume)		78	63.246	Active Ingredient	Ounces (volume)		18	1.44	Product	Ounces (volume)	

Table A13.

Application Sites:	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18	BVA-2 Comments	VectoLex CG - # Treatments	Total Amount Used19	Total Amount Type20	Total Amount Unit20	VectoLex CG Comments	VectoMax WSP - # Treatments	Total Amount Used21	Total Amount Type22	Total Amount Unit22	VectoMax WSP Comments
Canals															
Containers	2	15.5	Product	Ounces (volume)		1	0.18	Product	Ounces (volume)						
Creeks	1	4	Product	Ounces (volume)											
Ditches															
Intermittent															
Marshes	1	12	Product	Ounces (volume)		1	48	Product	Ounces (volume)		3	608	Product	Ounces (volume)	
Natural Ponds	1	15	Product	Ounces (volume)		4	208	Product	Ounces (volume)		1	80	Product	Ounces (volume)	
Ornamental Ponds															
Park/Landscape															
Rainwater															
Sanitary															
Seepages															
Swimming Pools	3	6	Product	Ounces (volume)		4	2.35	Product	Ounces (volume)		2	0.85	Product	Ounces (volume)	
Tires															
TreeHoles															
Urban Underground Water															
Waterfront															
Wells															
Totals	8	52.5	Product	Ounces (volume)		10	258.53	Product	Ounces (volume)		6	688.85	Product	Ounces (volume)	

Table A13.

Application Sites:	Altosid WSP (pellets) - # Treatments	Total Amount Used23	Total Amount Type24	Total Amount Unit24	Altosid WSP (pellets) Commnets	Bell Contrac Super-Size Blox - # Treatments	Total Amount Used35	Total Amount Type36	Total Amount Unit36	Bell Contrac Super-Size Blox Comments	Altosid XR-Briquets - # Treatments	Total Amount Used37	Total Amount Type38
Canals													
Containers	3	2.64	Product	Ounces (volume)							4	61.5	Product
Creeks	1	1.68	Product	Ounces (volume)		24	208	Product	Ounces (volume)		2	6	Product
Ditches													
Intermittent													
Marshes	1	1.68	Product	Ounces (volume)									
Natural Ponds	7	8.88	Product	Ounces (volume)							1	1.5	Product
Ornamental Ponds													
Park/Landscape						8	64	Product	Ounces (volume)				
Rainwater													
Sanitary						22	336	Product	Ounces (volume)				
Seepages													
Swimming Pools	2	1.92	Product	Ounces (volume)							24	46.5	Product
Tires													
TreeHoles													
Urban Underground Water											2	15	Product
Waterfront						8	64	Product	Ounces (volume)				
Wells													
Totals	14	16.8	Product	Ounces (volume)		62	672	Product	Ounces (volume)		33	130.5	Product

Table A13.

Application Sites:	Total Amount Unit38	Altosid XR-Briquets Comments	Bell Contrac Small Blox - # Treatments	Total Amount Used69	Total Amount Type710	Total Amount Unit711	Bell Contrac Small Blox Comments	Drione - # Treatments	Total Amount Used1112	Total Amount Type1213	Total Amount Unit1214	Drione Comments	Bell Terad 3 Blox - # Treatments	Total Amount Used1315
Canals														
Containers	Ounces (volume)													
Creeks	Ounces (volume)		5	5	Product	Ounces (volume)							3	3
Ditches														
Intermittent														
Marshes														
Natural Ponds	Ounces (volume)													
Ornamental Ponds														
Park/Landscape			2	2	Product	Ounces (volume)		1	1.5	Product	Ounces (volume)		5	12
Rainwater														
Sanitary														
Seepages														
Swimming Pools	Ounces (volume)													
Tires														
TreeHoles														
Urban Underground Water	Ounces (volume)													
Waterfront														
Wells														
Totals	Ounces (volume)		7	7	Product	Ounces (volume)		1	1.5	Product	Ounces (volume)		8	15

Table A13.

Application Sites:	Total Amount Type1416	Total Amount Unit1417	Bell Terad 3 Blox Comments	First Strike - # Treatments	Total Amount Used1518	Total Amount Type1619	Total Amount Unit1620	First Strike Comments	VectoLex CG Biologic - # Treatments	Total Amount Used3142	Total Amount Type3243	Total Amount Unit3244	VectoLex CG Biologic Comments	VectoLex WDG - # Treatments
Canals														
Containers									1	0.18	Product	Ounces (volume)		
Creeks	Product	Ounces (volume)		2	1.41	Product	Ounces (volume)							6
Ditches														
Intermittent														6
Marshes									1	48	Product	Ounces (volume)		
Natural Ponds									4	208	Product	Ounces (volume)		
Ornamental Ponds														
Park/Landscape	Product	Ounces (volume)		2	3.88	Product	Ounces (volume)							
Rainwater														
Sanitary														
Seepages														
Swimming Pools									4	2.35	Product	Ounces (volume)		
Tires														
TreeHoles														
Urban Underground Water														
Waterfront														
Wells														
Totals	Product	Ounces (volume)		4	5.29	Product	Ounces (volume)		10	258.53	Product	Ounces (volume)		12

Table A13.

Application Sites:	Total Amount Used3345	Total Amount Type3446	Total Amount Unit3447	VectoLex WDG Comments	Ditrac Blox - # Treatments	Total Amount Used3	Total Amount Type	Total Amount Unit4	Ditrac Blox Comments	Vectolex WSP - # Treatments	Total Amount Used5	Total Amount Type6	Total Amount Unit8	Vectolex WSP Comments	Altosid Pellets - # Treatments
Canals															
Containers										1	3.04	Product	Ounces (volume)		2
Creeks	96	Active Ingredient	Ounces (volume)		8	128	Product	Ounces (volume)							3
Ditches															
Intermittent	672	Active Ingredient	Ounces (volume)												1
Marshes										1	5.32	Product	Ounces (volume)		4
Natural Ponds															12
Ornamental Ponds															
Park/Landscape					1	16	Product	Ounces (volume)							
Rainwater															
Sanitary															
Seepages															
Swimming Pools										6	25.84	Product	Ounces (volume)		
Tires															
TreeHoles															
Urban Underground Water										1	0.76	Product	Ounces (volume)		
Waterfront															
Wells															
Totals	768	Active Ingredient	Ounces (volume)		9	144	Product	Ounces (volume)		9	34.96	Product	Ounces (volume)		22

Table A13.

Application Sites:	Total Amount Used	Total Amount Type9	Total Amount Unit	Altosid Pellets - Comments
Canals				
Containers	32	Product	Ounces (volume)	
Creeks	36	Product	Ounces (volume)	
Ditches				
Intermittent	8	Product	Ounces (volume)	
Marshes	100	Product	Ounces (volume)	
Natural Ponds	424	Product	Ounces (volume)	
Ornamental Ponds				
Park/Landscape				
Rainwater				
Sanitary				
Seepages				
Swimming Pools				
Tires				
TreeHoles				
Urban Underground Water				
Waterfront				
Wells				
Totals	600	Product	Ounces (volume)	

Table A14. **Pesticide Application Data for Spring 2012 – CCMVCD**

Application Sites:	Agnique MMF - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	VectoBac G - # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit3	VectoBac G Comments	VectoBac 12AS - # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit7	VectoBac 12AS Comments
Canals															
Containers	6	27.41	Product	Ounces (volume)		3	34.29	Product	Ounces (volume)		13	4.03	Active Ingredient	Ounces (volume)	
Creeks	1	2.56	Product	Ounces (volume)		14	894.87	Product	Ounces (volume)		183	214.85	Active Ingredient	Ounces (volume)	
Ditches															
Intermittent						1	128	Product	Ounces (volume)		21	406.4	Active Ingredient	Ounces (volume)	
Marshes						3	264	Product	Ounces (volume)		26	853.77	Active Ingredient	Ounces (volume)	
Natural Ponds	2	0.51	Product	Ounces (volume)		11	496	Product	Ounces (volume)		83	344.37	Active Ingredient	Ounces (volume)	
Ornamental Ponds															
Other															
Park/Landscape															
Rainwater															
Sanitary	1	1.5	Product	Ounces (volume)											
Seepages															
Swimming Pools	21	11.26	Product	Ounces (volume)		2	3.59	Product	Ounces (volume)		66	7.85	Active Ingredient	Ounces (volume)	
Tires															
TreeHoles															
Urban Underground Water											3	0.44	Active Ingredient	Ounces (volume)	
Waterfront															
Wells															
Totals	31	43.24	Product	Ounces (volume)		34	1820.75	Product	Ounces (volume)		395	1831.71	Active Ingredient	Ounces (volume)	

Table A14.

Application Sites:	Altosid Liquid conc. - # Treatments	Total Amount Used11	Total Amount Type12	Total Amount Unit12	Altosid Liquid conc. Comments	Altosid Briquets - # Treatments	Total Amount Used13	Total Amount Type14	Total Amount Unit14	Altosid Briquets Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18
Canals														
Containers	3	0.13	Active Ingredient	Ounces (volume)		21	2.7	Product	Ounces (volume)		21	66	Product	Ounces (volume)
Creeks	16	15.5	Active Ingredient	Ounces (volume)							16	123	Product	Ounces (volume)
Ditches														
Intermittent	11	41.32	Active Ingredient	Ounces (volume)		1	0.3	Product	Ounces (volume)		22	20744	Product	Ounces (volume)
Marshes	18	85.57	Active Ingredient	Ounces (volume)							3	52	Product	Ounces (volume)
Natural Ponds	50	33.94	Active Ingredient	Ounces (volume)		3	0.12	Product	Ounces (volume)		15	2713.5	Product	Ounces (volume)
Ornamental Ponds														
Other														
Park/Landscape											2	2	Product	Ounces (volume)
Rainwater														
Sanitary														
Seepages														
Swimming Pools	29	0.23	Active Ingredient	Ounces (volume)		10	1.83	Product	Ounces (volume)		31	53	Product	Ounces (volume)
Tires														
TreeHoles														
Urban Underground Water						19	4.77	Product	Ounces (volume)		110	1639.25	Product	Ounces (volume)
Waterfront														
Wells														
Totals	127	176.69	Active Ingredient	Ounces (volume)		54	9.72	Product	Ounces (volume)		220	25392.75	Product	Ounces (volume)

Table A14.

Application Sites:	BVA-2 Comments	VectoLex CG - # Treatments	Total Amount Used19	Total Amount Type20	Total Amount Unit20	VectoLex CG Comments	VectoMax WSP - # Treatments	Total Amount Used21	Total Amount Type22	Total Amount Unit22	VectoMax WSP Comments	Altosid WSP (pellets) - # Treatments	Total Amount Used23	Total Amount Type24
Canals														
Containers		12	304.76	Product	Ounces (volume)							7	9.36	Product
Creeks		56	2001.27	Product	Ounces (volume)		1	16	Product	Ounces (volume)		7	3.36	Product
Ditches														
Intermittent		5	160.18	Product	Ounces (volume)									
Marshes		5	368	Product	Ounces (volume)							1	1.68	Product
Natural Ponds		58	4325.69	Product	Ounces (volume)		2	162	Product	Ounces (volume)		2	1.44	Product
Ornamental Ponds														
Other		1	0.36	Product	Ounces (volume)									
Park/Landscape														
Rainwater														
Sanitary		1	1	Product	Ounces (volume)									
Seepages														
Swimming Pools		27	20.23	Product	Ounces (volume)							1	0.96	Product
Tires														
TreeHoles														
Urban Underground Water		1	40	Product	Ounces (volume)							5	1.92	Product
Waterfront														
Wells														
Totals		166	7221.49	Product	Ounces (volume)		3	178	Product	Ounces (volume)		23	18.72	Product

Table A14.

Application Sites:	Total Amount Unit24	Altosid WSP (pellets) Commnets	MetaLarv SP-T - # Treatments	Total Amount Used25	Total Amount Type26	Total Amount Unit26	MetaLarv SP-T Comments	FourStar SR Briquet - # Treatments	Total Amount Used27	Total Amount Type28	Total Amount Unit28	FourStar SR Briquet Comments	Bell Contrac Super-Size Blox - # Treatments
Canals													
Containers	Ounces (volume)							6	8.8	Product	Ounces (volume)		
Creeks	Ounces (volume)												21
Ditches													
Intermittent			2	3072	Product	Ounces (volume)							
Marshes	Ounces (volume)												
Natural Ponds	Ounces (volume)							1	1.1	Product	Ounces (volume)		1
Ornamental Ponds													
Other													
Park/Landscape													20
Rainwater													
Sanitary													40
Seepages													
Swimming Pools	Ounces (volume)							11	22	Product	Ounces (volume)		
Tires													
TreeHoles													
Urban Underground Water	Ounces (volume)							179	3388	Product	Ounces (volume)		
Waterfront													20
Wells													
Totals	Ounces (volume)		2	3072	Product	Ounces (volume)		197	3419.9	Product	Ounces (volume)		102

Table A14.

Application Sites:	Total Amount Used35	Total Amount Type36	Total Amount Unit36	Bell Contrac Super-Size Blox Comments	Altosid XR-Briquets - # Treatments	Total Amount Used37	Total Amount Type38	Total Amount Unit38	Altosid XR-Briquets Comments	Bell Contrac Small Blox - # Treatments	Total Amount Used69	Total Amount Type710	Total Amount Unit711
Canals													
Containers					35	244.5	Product	Ounces (volume)					
Creeks	184	Product	Ounces (volume)		16	88.5	Product	Ounces (volume)		4	10	Product	Ounces (volume)
Ditches													
Intermittent					2	31.5	Product	Ounces (volume)					
Marshes					4	24	Product	Ounces (volume)					
Natural Ponds	24	Product	Ounces (volume)		14	42	Product	Ounces (volume)		2	21	Product	Ounces (volume)
Ornamental Ponds													
Other										1	1	Product	Ounces (volume)
Park/Landscape	160	Product	Ounces (volume)							1	3	Product	Ounces (volume)
Rainwater													
Sanitary	472	Product	Ounces (volume)										
Seepages													
Swimming Pools					27	58.5	Product	Ounces (volume)					
Tires													
TreeHoles													
Urban Underground Water					177	4824	Product	Ounces (volume)					
Waterfront	160	Product	Ounces (volume)							1	8	Product	Ounces (volume)
Wells													
Totals	1000	Product	Ounces (volume)		275	5313	Product	Ounces (volume)		9	43	Product	Ounces (volume)

Table A14.

Application Sites:	Bell Contrac Small Blox Comments	Drione - # Treatments	Total Amount Used1112	Total Amount Type1213	Total Amount Unit1214	Drione Comments	Bell Terad 3 Blox - # Treatments	Total Amount Used1315	Total Amount Type1416	Total Amount Unit1417	Bell Terad 3 Blox Comments	First Strike - # Treatments	Total Amount Used1518	Total Amount Type1619
Canals														
Containers		1	0.5	Product	Ounces (volume)									
Creeks							3	7	Product	Ounces (volume)		2	2.12	Product
Ditches														
Intermittent														
Marshes														
Natural Ponds														
Ornamental Ponds														
Other														
Park/Landscape		46	26.55	Product	Ounces (volume)							2	4.94	Product
Rainwater														
Sanitary														
Seepages														
Swimming Pools														
Tires														
TreeHoles														
Urban Underground Water														
Waterfront														
Wells														
Totals		47	27.05	Product	Ounces (volume)		3	7	Product	Ounces (volume)		4	7.06	Product

Table A14.

Application Sites:	Total Amount Unit1620	First Strike Comments	Pyrocide 7396 - # Treatments	Total Amount Used2939	Total Amount Type3040	Total Amount Unit3041	Pyrocide 7396 Comments	VectoLex CG Biologic - # Treatments	Total Amount Used3142	Total Amount Type3243	Total Amount Unit3244	VectoLex CG Biologic Comments	VectoLex WDG - # Treatments
Canals													
Containers								12	304.76	Product	Ounces (volume)		
Creeks	Ounces (volume)							56	2001.27	Product	Ounces (volume)		
Ditches													
Intermittent			12	193.39	Product	Ounces (volume)		5	160.18	Product	Ounces (volume)		13
Marshes								5	368	Product	Ounces (volume)		
Natural Ponds								58	4325.69	Product	Ounces (volume)		2
Ornamental Ponds													
Other								1	0.36	Product	Ounces (volume)		
Park/Landscape	Ounces (volume)		2	15.75	Product	Ounces (volume)							
Rainwater													
Sanitary								1	1	Product	Ounces (volume)		
Seepages													
Swimming Pools								27	20.23	Product	Ounces (volume)		
Tires													
TreeHoles													
Urban Underground Water								1	40	Product	Ounces (volume)		3
Waterfront													
Wells													
Totals	Ounces (volume)		14	209.14	Product	Ounces (volume)		166	7221.49	Product	Ounces (volume)		18

Table A14.

Application Sites:	Total Amount Used3345	Total Amount Type3446	Total Amount Unit3447	VectoLex WDG Comments	Ditrac Blox - # Treatments	Total Amount Used3	Total Amount Type	Total Amount Unit4	Ditrac Blox Comments	Vectolex WSP - # Treatments	Total Amount Used5	Total Amount Type6	Total Amount Unit8	Vectolex WSP Comments	Altosid Pellets - # Treatments
Canals															
Containers										5	15.2	Product	Ounces (volume)		3
Creeks					14	224	Product	Ounces (volume)		4	8.36	Product	Ounces (volume)		32
Ditches															
Intermittent	1168	Active Ingredient	Ounces (volume)												52
Marshes															28
Natural Ponds	24	Active Ingredient	Ounces (volume)												22
Ornamental Ponds															
Other															
Park/Landscape					4	64	Product	Ounces (volume)							
Rainwater															
Sanitary															1
Seepages															
Swimming Pools										3	13.68	Product	Ounces (volume)		
Tires															
TreeHoles															
Urban Underground Water	3.31	Product	Ounces (volume)							1	1.52	Product	Ounces (volume)		1
Waterfront															
Wells															
Totals	1195.31	Product	Ounces (volume)		18	288	Product	Ounces (volume)		13	38.76	Product	Ounces (volume)		139

Table A14.

Application Sites:	Total Amount Used	Total Amount Type9	Total Amount Unit	Altosid Pellets - Comments
Canals				
Containers	17.15	Product	Ounces (volume)	
Creeks	766	Product	Ounces (volume)	
Ditches				
Intermittent	10209.5	Product	Ounces (volume)	
Marshes	1144	Product	Ounces (volume)	
Natural Ponds	531	Product	Ounces (volume)	
Ornamental Ponds				
Other				
Park/Landscape				
Rainwater				
Sanitary	10	Product	Ounces (volume)	
Seepages				
Swimming Pools				
Tires				
TreeHoles				
Urban Underground Water	1	Product	Ounces (volume)	
Waterfront				
Wells				
Totals	12678.65	Product	Ounces (volume)	

Table A15. Pesticide Product Key CCMVCD

Product	AI	Vector
Agnique MMF	Biodegradable Alcohol Ethoxylated Surfactant	Mosquito
Agnique MMF G	Biodegradable Alcohol Ethoxylated Surfactant	Mosquito
Altosid Briquets	Methoprene	Mosquito
Altosid Liquid conc.	Methoprene	Mosquito
Altosid Pellets	Methoprene	Mosquito
Altosid WSP (pellets)	Methoprene	Mosquito
Altosid XR-Briquets	Methoprene	Mosquito
Bell Contrac Small Blox	Bromadiolone	Rat
Bell Contrac Super-Size Blox	Bromadiolone	Rat
Bell Terad 3 Blox	Cholecalciferol	Rat
BVA 2	Petroleum Distillate	Mosquito
Drione	Pyrethrin and Piperonyl Butroxide and Amorphous Silica Gel	Yellow Jacket / Wasp
First Strike	Difethialone	Rat
FourStar SR Briquet 180-90-45	Bacillus Sphaericus and Bacillus Thuringiensis Israelensis	Mosquito
MetaLarv SP-T	Methoprene	Mosquito
Natular 2EC	Spinosad	Mosquito
Pyrocide 7396	Pyrethrins and Piperonyl Butoxide	Mosquito
VectoBac 12AS	Bacillus Thuringiensis Israelensis	Mosquito
VectoBac G	Bacillus Thuringiensis Israelensis	Mosquito
VectoLex CG Biologic	Bacillus Sphaericus	Mosquito
VectoLex WDG	Bacillus Sphaericus	Mosquito
VectoLex WSP	Bacillus Sphaericus	Mosquito
VectoMax WSP	Bacillus Sphaericus and Bacillus Thuringiensis Israelensis	Mosquito
Ditrac Blox	Difethialone	Rat

Table A16. **Pesticide Application Data for Summer 2011 – MSMVCD**

Application Sites:	Agnique MMF - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	Agnique MMF G - # Treatments	Total Amount Used4	Total Amount Type5	Total Amount Unit5	Agnique MMF G Comments	VectoBac 12AS - # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit7	VectoBac 12AS Comments
Anthropogenic Sources	120	0.736	Product	Gallons											
Drainage Ditch Man Made	8	0.024	Product	Gallons											
Manmade Wetlands	1	0.01	Product	Gallons											
Manmade Wetlands Seasonal	1	0.012	Product	Gallons							4	32.754	Product	Gallons	
Wetland Permanent Treated Effluent															
Natural Wetlands															
Natural Wetlands Seasonal											2	16.5	Product	Gallons	
Vernal Pool															
Vernal Pool Manmade															
Mitigated Wetlands Seasonal															
Wildlife Refuge															
Pond	60	0.144	Product	Gallons							5	1.315	Product	Gallons	
Wildlife Pond															
Rain Pond	3	0.153	Product	Gallons											
Natural Spring	3	0.006	Product	Gallons											
Low Area	10	0.217	Product	Gallons							14	2.72	Product	Gallons	
Waterways															
Creeks	11	0.048	Product	Gallons							7	0.493	Product	Gallons	
Treehole															
Culvert	1	0.001	Product	Gallons											
Natural Ditch	2	0.112	Product	Gallons							3	98.512	Product	Gallons	
Flood Control Ditch											1	0.008	Product	Gallons	
Marshes (Fresh Water)											1	0.75	Product	Gallons	
Marsh - Seasonal											5	27.284	Product	Gallons	
Marsh - Tidal	2	0.024	Product	Gallons							8	190.943	Product	Gallons	
Residential Areas															
Industrial Areas															
Recreational Areas															
Agricultural Areas															
Aeration Pond															
Waste Pond	19	1.074	Product	Gallons							2	1	Product	Gallons	
Reservoir											1	0.125	Product	Gallons	
Settling Pond	6	0.03	Product	Gallons											
Hayfield Ditch											3	3	Product	Gallons	
Pastures															
Irrigated Reservoir	1	0.014	Product	Gallons											
Swamps															
Overgrown Waste Areas															
Roadsides															
Roadside Ditch	16	0.086	Product	Gallons											
Woodlands															
Gardens															
Playgrounds															
Campsites															
Athletic Fields															
Municipalities															
Catch Basin	14	0.033	Product	Gallons											
Waste Treatment Plant	7	0.419	Product	Gallons		4	1980	Product	Pounds		1	3.626	Product	Gallons	
Water Treatment Plant	2	0.017	Product	Gallons											
Wildlife Refuge Treated Effluent											6	7.751	Product	Gallons	
Overland Flow															
Waste Water Irrigation (e.g. pastures)															
Storm Sewer Line															
Storm Water BMP															
Retention Basin	1	0.002	Product	Gallons											
Sewer Pond	2	0.545	Product	Gallons							6	2.373	Product	Gallons	
Indoors															
Total	290	3.707	Product	Gallons		4	1980	Product	Pounds		69	389.154	Product	Gallons	

Application Sites:	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18	BVA-2 Comments	VectoBac Technical Powder - # Treatments	Total Amount Used19	Total Amount Type20	Total Amount Unit20	VectoBac Technical Powder Comments	Delta Dust - # Treatments	Total Amount Used31	Total Amount Type32	Total Amount Unit32
Anthropogenic Sources	71	4.506	Product	Gallons		1	0.0035	Product	Pounds		1	0.063	Product	Pounds
Drainage Ditch Man Made	4	2.127	Product	Gallons		1	0.0017	Product	Pounds					
Manmade Wetlands														
Manmade Wetlands Seasonal														
Wetland Permanent Treated Effluent														
Natural Wetlands														
Natural Wetlands Seasonal														
Vernal Pool														
Vernal Pool Manmade														
Mitigated Wetlands Seasonal														
Wildlife Refuge														
Pond	19	3.101	Product	Gallons		5	0.253	Product	Pounds					
Wildlife Pond														
Rain Pond														
Natural Spring	1	0.025	Product	Gallons										
Low Area	3	0.034	Product	Gallons		1	0.002	Product	Pounds					
Waterways														
Creeks	1	0.0012	Product	Gallons		10	0.106	Product	Pounds					
Treehole														
Culvert						1	0.005	Product	Pounds					
Natural Ditch	5	0.897	Product	Gallons							1	0.063	Product	Pounds
Flood Control Ditch	1	0.001	Product	Gallons										
Marshes (Fresh Water)														
Marsh - Seasonal	1	1	Product	Gallons										
Marsh - Tidal	2	0.075	Product	Gallons		1	0.006	Product	Pounds					
Residential Areas														
Industrial Areas														
Recreational Areas														
Agricultural Areas														
Aeration Pond	3	0.9	Product	Gallons										
Waste Pond	36	219.271	Product	Gallons										
Reservoir														
Settling Pond	1	1	Product	Gallons										
Hayfield Ditch														
Pastures														
Irrigated Reservoir														
Swamps														
Overgrown Waste Areas														
Roadsides														
Roadside Ditch	12	4.42	Product	Gallons		3	0.003	Product	Pounds					
Woodlands														
Gardens														
Playgrounds														
Campsites														
Athletic Fields														
Municipalities														
Catch Basin	117	5.86	Product	Gallons		5	0.006	Product	Pounds					
Waste Treatment Plant	12	0.769	Product	Gallons										
Water Treatment Plant	23	61.16	Product	Gallons										
Wildlife Refuge Treated Effluent														
Overland Flow														
Waste Water Irrigation (e.g. pastures)	2	1.422	Product	Gallons										
Storm Sewer Line														
Storm Water BMP														
Retention Basin						1	0.006	Product	Pounds					
Sewer Pond	9	6.961	Product	Gallons										
Indoors														
Total	323	313.5302	Product	Gallons		29	0.3922	Product	Pounds		2	0.126	Product	Pounds

Table A16.

Application Sites:	Delta Dust Comments	Wasp Freeze - # Treatments	Total Amount Used33	Total Amount Type34	Total Amount Unit34	Wasp Freeze Comments	Drione - # Treatments	Total Amount Used1112	Total Amount Type1213	Total Amount Unit1214	Drione Comments	FourStar 45 - # Treatments	Total Amount Used2127	Total Amount Type2228	Total Amount Unit2229	FourStar 45 Comments	VectoLex WDG - # Treatments	Total Amount Used3345	Total Amount Type3446	Total Amount Unit3447	VectoLex WDG Comments	Zenivex - # Treatments	Total Amount Used3548	Total Amount Type3649	Total Amount Unit3650	Zenivex Comments	Pyrocide fogging concentrate 7396 - # Treatments	Total Amount Used3144	Total Amount Type3245
Anthropogenic Sources		1	0.016	Product	Gallons		14	1.377	Product	Pounds							3	0.037	Product	Pounds							17	0.325	Product
Drainage Ditch Man Made																	5	1.199	Product	Pounds									
Manmade Wetlands																													
Manmade Wetlands Seasonal																	5	4.3	Product	Pounds									
Wetland Permanent Treated Effluent																													
Natural Wetlands																													
Natural Wetlands Seasonal																	1	1	Product	Pounds									
Vernal Pool																													
Vernal Pool Manmade																													
Mitigated Wetlands Seasonal																													
Wildlife Refuge																													
Pond							11	1.25	Product	Pounds		1	0.21	Active Ingredient	Pounds		6	6.45	Product	Pounds							5	0.304	Product
Wildlife Pond																													
Rain Pond																													
Natural Spring																													
Low Area																	7	10.753	Product	Pounds									
Waterways																													
Creeks							1	0.063	Product	Pounds							1	0.2	Product	Pounds							5	0.313	Product
Treehole																											1	2.078	Product
Culvert																													
Natural Ditch							2	0.438	Product	Pounds							6	9.8	Product	Pounds									
Flood Control Ditch																													
Marshes (Fresh Water)																	1	3	Product	Pounds									
Marsh - Seasonal																	1	5	Product	Pounds									
Marsh - Tidal																													
Residential Areas																													
Industrial Areas																													
Recreational Areas																													
Agricultural Areas																													
Aeration Pond																													
Waste Pond																	9	3.938	Product	Pounds									
Reservoir																	1	0.5	Product	Pounds									
Settling Pond																													
Hayfield Ditch																	15	30.127	Product	Pounds									
Pastures																													
Irrigated Reservoir							3	1	Product	Pounds																			
Swamps																													
Overgrown Waste Areas																													
Roadsides																													
Roadside Ditch																	1	0.2	Product	Pounds									
Woodlands																													
Gardens																													
Playgrounds																													
Campsites																													
Athletic Fields																													
Municipalities																													
Catch Basin							1	0.063	Product	Pounds							1	0.007	Product	Pounds								0.004	Product
Waste Treatment Plant							1	0.063	Product	Pounds							2	0.01	Product	Pounds		1	0.266	Product	Gallons		7	0.035	Product
Water Treatment Plant																													
Wildlife Refuge Treated Effluent																	6	31	Product	Pounds									
Overland Flow																													
Waste Water Irrigation (e.g. pastures)																	8	2.75	Product	Pounds									
Storm Sewer Line																													
Storm Water BMP																													
Retention Basin																													
Sewer Pond																	5	8.6	Product	Pounds									
Indoors																													
Total		1	0.016	Product	Gallons		33	4.254	Product	Pounds		1	0.21	Active Ingredient	Pounds		84	118.871	Product	Pounds		1	0.266	Product	Gallons		35	3.059	Product

Table A16.

Application Sites:	Total Amount Unit3246	Pyrocide fogging concentrate 7396 Comments	VectoBac GS - # Treatments	Total Amount Used3347	Total Amount Type3448	Total Amount Unit3449	VectoBac GS Comments	Altosid Liquid Concentrate - # Treatments	Total Amount Used6966	Total Amount Type71067	Total Amount Unit71168	Altosid Liquid Concentrate Comments	Altosid Pellets - # Treatments	Total Amount Used111269	Total Amount Type121370	Total Amount Unit121471	Altosid Pellets Comments	Altosid SBG - # Treatments	Total Amount Used131572	Total Amount Type141673	Total Amount Unit141774	Altosid SBG Comments	Altosid XR Briquets - # Treatments	Total Amount Used151875	Total Amount Type161976	Total Amount Unit162077	Altosid XR Briquets Comments	Altosid Briquettes (Standard) -# Treatments
Anthropogenic Sources	Gallons												95	32.217	Product	Pounds							332	111.218	Product	Pounds	each	25
Drainage Ditch Man Made													4	0.159	Product	Pounds							4	1	Product	Pounds	each	2
Manmade Wetlands																												
Manmade Wetlands Seasonal																												
Wetland Permanent Treated Effluent																												
Natural Wetlands																												
Natural Wetlands Seasonal																												
Vernal Pool																												
Vernal Pool Manmade																												
Mitigated Wetlands Seasonal																												
Wildlife Refuge																												
Pond	Gallons		1	0.034	Product	Pounds							13	1.958	Product	Pounds							199	35.333	Active Ingredient	Pounds	each	6
Wildlife Pond													1	0.01	Product	Pounds												
Rain Pond			1	2.25	Product	Pounds							1	0.028	Product	Pounds							1	0.444	Product	Pounds	each	
Natural Spring													1	0.2	Product	Pounds							2	0.889	Product	Pounds	each	
Low Area													12	3.669	Product	Pounds							3	0.667	Product	Pounds	each	1
Waterways																												
Creeks	Gallons												44	7.877	Product	Pounds							6	1.222	Product	Pounds	each	3
Treehole	Gallons																						1	0.111	Product	Pounds	each	
Culvert													1	0.007	Product	Pounds							1	0.111	Product	Pounds	each	
Natural Ditch													7	0.948	Product	Pounds							4	1.222	Product	Pounds	each	
Flood Control Ditch													3	0.062	Product	Pounds												
Marshes (Fresh Water)																												
Marsh - Seasonal								3	1.692	Product	Gallons		5	108.14	Product	Pounds												
Marsh - Tidal			3	10.011	Product	Pounds		4	12.713	Product	Gallons		31	223.782	Product	Pounds												
Residential Areas																												
Industrial Areas																												
Recreational Areas																												
Agricultural Areas																												
Aeration Pond																												
Waste Pond			2	1.092	Product	Pounds							1	4.5	Product	Pounds												
Reservoir													1	0.01	Product	Pounds												
Settling Pond																							1	0.222	Product	Pounds	each	
Hayfield Ditch													1	1	Product	Pounds												
Pastures																												
Irrigated Reservoir																												
Swamps																												
Overgrown Waste Areas																												
Roadsides																												
Roadside Ditch			1	0.625	Product	Pounds																	1	0.111	Product	Pounds	each	6
Woodlands																												
Gardens																												
Playgrounds																												
Campsites																												
Athletic Fields																												
Municipalities																												
Catch Basin	Gallons												7	0.012	Product	Pounds							327	7,104.37	Product	Pounds	each	19
Waste Treatment Plant	Gallons							1	0.242	Product	Gallons		3	1.12	Product	Pounds							3	0.444	Product	Pounds	each	
Water Treatment Plant																							2	2.111	Product	Pounds	each	
Wildlife Refuge Treated Effluent																												
Overland Flow																												
Waste Water Irrigation (e.g. pastures)													1	0.009	Product	Pounds							2	1.333	Product	Pounds	each	
Storm Sewer Line																												
Storm Water BMP																												
Retention Basin													1	0.003	Product	Pounds		1	0.48	Product	Pounds							
Sewer Pond													3	0.758	Product	Pounds												
Indoors																												
Total	Gallons		8	14.012	Product	Pounds		8	14.647	Product	Gallons		236	386.469	Product	Pounds		1	0.48	Product	Pounds		889	7260.812	Product	Pounds	each	62

Table A16.

Application Sites:	Total Amount Used	Total Amount Type2	Total Amount Unit	Altosid Briquettes Comments	Vectolex CG - # Treatments	Total Amount Used3	Total Amount Type4	Total Amount Unit5	Vectolex CG Comments	Vectomax CG - # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit8	Vectomax CG Comments	VectoLex WSP - # Treatments	Total Amount Used5	Total Amount Type6	Total Amount Unit7	VectoLex WSP Comments	Altosid Liquid (non-concentrate) - # Treatments	Total Amount Used8	Total Amount Type9	Total Amount Unit10	Altosid Liquid (non-concentrate) comments
Anthropogenic Sources	1.63	Product	Pounds	each	28	6.767	Product	Pounds		18	3.934	Product	Pounds		23	0.858	Product	Pounds	each					
Drainage Ditch Man Made	0.029	Product	Pounds	each	8	53.919	Product	Pounds		6	13.057	Product	Pounds		1	0.088	Product	Pounds	each					
Manmade Wetlands																								
Manmade Wetlands Seasonal					2	38	Product	Pounds												4	4.09	Product	Gallons	
Wetland Permanent Treated Effluent										5	45	Product	Pounds											
Natural Wetlands																				1	0.062	Product	Gallons	
Natural Wetlands Seasonal										1	1200	Product	Pounds											
Vernal Pool																								
Vernal Pool Manmade																								
Mitigated Wetlands Seasonal																								
Wildlife Refuge																								
Pond	0.186	Product	Pounds	each	16	63.027	Product	Pounds		14	82.525	Product	Pounds		12	0.308	Product	Pounds	each					
Wildlife Pond										1	160	Product	Pounds											
Rain Pond					3	10.1	Product	Pounds		7	95.114	Product	Pounds											
Natural Spring					1	0.45	Product	Pounds		2	0.206	Product	Pounds											
Low Area	0.014	Product	Pounds	each	5	108.05	Product	Pounds		8	20.524	Product	Pounds		1	0.022	Product	Pounds	each					
Waterways																								
Creeks	0.186	Product	Pounds	each						2	13	Product	Pounds											
Treehole																								
Culvert					2	0.041	Product	Pounds																
Natural Ditch					9	57.96	Product	Pounds		1	0.5	Product	Pounds							1	11.988	Product	Gallons	
Flood Control Ditch					5	20.771	Product	Grams		1	2	Product	Pounds											
Marshes (Fresh Water)					2	1.2	Product	Pounds																
Marsh - Seasonal					1	20	Product	Pounds																
Marsh - Tidal					2	0.207	Product	Pounds		7	17.092	Product	Pounds											
Residential Areas																								
Industrial Areas																								
Recreational Areas																								
Agricultural Areas																								
Aeration Pond										4	12.404	Product	Pounds											
Waste Pond					14	185.15	Product	Pounds		36	142.387		Pounds		2	0.198	Product	Pounds	each					
Reservoir					1	60	Product	Pounds																
Settling Pond																								
Hayfield Ditch					8	115.97	Product	Pounds												1	0.187	Product	Gallons	
Pastures																								
Irrigated Reservoir					2	20	Product	Pounds																
Swamps																								
Overgrown Waste Areas																								
Roadsides																								
Roadside Ditch	0.143	Product	Pounds	each	1	0.037	Product	Pounds		10	3.151	Product	Pounds		2	0.066	Product	Pounds	each					
Woodlands																								
Gardens																								
Playgrounds																								
Campsites																								
Athletic Fields																								
Municipalities																								
Catch Basin	0.557	Product	Pounds	each	3	0.018	Product	Pounds		3	0.011	Product	Pounds		109	6.622	Product	Pounds	each					
Waste Treatment Plant					3	0.638	Product	Pounds		3	2360	Product	Pounds		8	0.418	Product	Pounds	each					
Water Treatment Plant															1	0.022	Product	Pounds	each					
Wildlife Refuge Treated Effluent					4	600	Product	Pounds												5	0.656	Product	Gallons	
Overland Flow																								
Waste Water Irrigation (e.g. pastures)					70	1748.723	Product	Pounds		20	211.4	Product	Pounds		3	0.176	Active Ingredient	Pounds	each					
Storm Sewer Line																								
Storm Water BMP																								
Retention Basin					3	11.3	Product	Pounds		1	0.8	Product	Pounds											
Sewer Pond					5	32	Product	Pounds		11	382.1	Product	Pounds											
Indoors																								
Total	2.745	Product	Pounds	each	198	3154.328	Product	Pounds		161	4765.205	Product	Pounds		162	8.778	Mix	Pounds	each	12	16.983	Product	Gallons	

Table A17. Pesticide Application Data for Fall 2011 – MSMVCD

Application Sites:	Agnique MMF - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	VectoBac 12AS - # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit7	VectoBac 12AS Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18	BVA-2 Comments	VectoBac Technical Powder - # Treatments	Total Amount Used19	Total Amount Type20	Total Amount Unit20	VectoBac Technical Powder Comments	Drione - # Treatments	Total Amount Used1112	Total Amount Type1213	Total Amount Unit1214	Drione Comments	VectoLex WDG - # Treatments
Anthropogenic Sources	72	0.738	Product	Gallons							24	3.448	Product	Gallons		2	0.011	Product	Pounds		7	0.69	Product	Pounds		1
Drainage Ditch Man Made						1	0.004	Product	Gallons		3	0.824	Product	Gallons		4	0.041	Product	Pounds							
Manmade Wetlands																										
Manmade Wetlands Seasonal																										
Wetlands Permanent Treated Effluent																										
Natural Wetlands																										
Natural Wetlands Seasonal																										
Vernal Pool																										
Vernal Pool Manmade																										
Mitigated Wetlands Seasonal																										
Wildlife Refuge																										
Pond	34	0.074	Product	Gallons							5	1.039									1	0.063	Product	Pounds		2
Wildlife Pond											1	0.018	Product	Gallons												
Rain Pond	1	0.007	Product	Gallons							1	0.012	Product	Gallons												
Natural Spring	1	0.005	Product	Gallons																						
Low Area	5	0.505	Product	Gallons							1	0.164	Product	Gallons		1	0.001	Product	Pounds							
Waterways																										
Creeks	8	0.047	Product	Gallons												10	0.253	Product	Pounds		2	0.125	Product	Pounds		
Treehole																										
Culvert	2	0.002	Product	Gallons							1	0.014	Product	Gallons												
Natural Ditch	7	0.105	Product	Gallons							3	0.524	Product	Gallons							1	0.063	Product	Pounds		2
Flood Control Ditch																										
Marshes (Fresh Water)						1	0.5	Product	Gallons																	
Marsh - Seasonal						3	7	Product	Gallons																	
Marsh - Tidal	2	0.014	Product	Gallons		2	0.109	Product	Gallons		1	0.046	Product	Gallons		5	0.226	Product	Pounds							
Cracked Ground																										
Residential Areas																										
Industrial Areas																										
Recreational Areas																										
Agricultural Areas																										
Aeration Pond											4	2.149	Product	Gallons												
Waste Pond	7	2.807	Product	Gallons							19	30.305	Product	Gallons							1	0.063	Product	Pounds		6
Reservoir																										
Settling Pond											6	1.844	Product	Gallons												
Hayfield Ditch	1	0.01	Product	Gallons																						
Pastures																										1
Irrigated Reservoir																					1	0.063	Product	Pounds		
Swamps																										
Overgrown Waste Areas																										
Roadsides																										
Roadside Ditch	5	0.044	Product	Gallons		1	0.005	Product	Gallons		10	1.233	Product	Gallons		4	0.083	Product	Pounds		1	0.063	Product	Pounds		
Woodlands																										
Gardens																										
Playgrounds																										
Campsites																										
Athletic Fields																										
Municipalities																										
Catch Basin	6	0.008	Product	Gallons							35	0.633	Product	Gallons		1	0.002	Product	Pounds							
Waste Treatment Plant											1	0.002	Product	Gallons												
Water Treatment Plant											30	52.823	Product	Gallons												
Wildlife Refuge Treated Effluent																										
Overland Flow																										
Waste Water Irrigation (e.g. pastures)	1	0.25	Product	Gallons		3	16.25	Product	Gallons		3	6.3	Product	Gallons												7
Storm Sewer Line											1	0.012	Product	Gallons												
Storm Water BMP																										
Retention Basin	1	0.01	Active Ingredient	Gallons																						
Sewer Pond	4	1.163	Product	Gallons		1	0.25	Product	Gallons		3	6	Product	Gallons												1
Indoors																										
Total																										
Totals	157	5.789	Mix	Gallons		12	24.118	Product	Gallons		152	107.39	Product	Gallons		27	0.617	Product	Pounds		14	1.13	Product	Pounds		20

Table A17.

Application Sites:	Total Amount Used3345	Total Amount Type3446	Total Amount Unit3447	VectoLex WDG Comments	Zenivex - # Treatments	Total Amount Used3548	Total Amount Type3649	Total Amount Unit3650	Zenivex Comments	Pyrocide fogging concentrate 7396 - # Treatments	Total Amount Used3144	Total Amount Type3245	Total Amount Unit3246	Pyrocide fogging concentrate 7396 Comments	VectoBac GS - # Treatments	Total Amount Used3347	Total Amount Type3448	Total Amount Unit3449	VectoBac GS Comments	Altosid Pellets - # Treatments	Total Amount Used111269	Total Amount Type121370	Total Amount Unit121471	Altosid Pellets Comments	Altosid XR Briquets - # Treatments
Anthropogenic Sources	0.063	Product	Pounds							13	0.012	Product	Gallons							55	24.506	Product	Pounds		199
Drainage Ditch Man Made															1	0.2	Product	Gallons		2	0.026	Product	Pounds		1
Manmade Wetlands																									
Manmade Wetlands Seasonal																									
Wetlands Permanent Treated Effluent																									
Natural Wetlands																									
Natural Wetlands Seasonal																									
Vernal Pool																									
Vernal Pool Manmade																									
Mitigated Wetlands Seasonal																									
Wildlife Refuge																									
Pond	0.225	Product	Pounds																	4	0.029	Product	Pounds		103
Wildlife Pond																									
Rain Pond																									
Natural Spring																				2	0.029	Product	Pounds		
Low Area																				5	0.749	Product	Pounds		4
Waterways																									
Creeks																				8	5.469	Product	Pounds		1
Treehole																									
Culvert																									
Natural Ditch	0.813	Product	Pounds																	3	2.39	Product	Pounds		2
Flood Control Ditch																									
Marshes (Fresh Water)																									
Marsh - Seasonal																				1	4.5	Product	Pounds		
Marsh - Tidal															4	2.845	Product	Pounds		5	30.554	Product	Pounds		
Cracked Ground																									
Residential Areas																									
Industrial Areas																									
Recreational Areas																									
Agricultural Areas																									
Aeration Pond																									
Waste Pond	1.25	Product	Pounds												1	0.069	Product	Pounds		2	0.178	Product	Pounds		
Reservoir																									
Settling Pond																									1
Hayfield Ditch																									
Pastures	0.188	Product	Pounds																						
Irrigated Reservoir																									
Swamps																									
Overgrown Waste Areas																									
Roadsides																									
Roadside Ditch																				4	0.35	Product	Pounds		2
Woodlands																									
Gardens																									
Playgrounds																									
Campsites																									
Athletic Fields																									
Municipalities																									
Catch Basin																				6	0.104	Product	Pounds		17
Waste Treatment Plant					1	0.295	Product	Gallons		5	1.173	Product	Gallons							1	0.15	Product	Pounds		2
Water Treatment Plant																									
Wildlife Refuge Treated Effluent																									
Overland Flow																									
Waste Water Irrigation (e.g. pastures)	1.5	Product	Pounds																						1
Storm Sewer Line																									
Storm Water BMP																									1
Retention Basin																				1	0.007	Product	Pounds		1
Sewer Pond	0.86	Product	Pounds																	1	0.415	Product	Pounds		1
Indoors																									
Total																									
Totals	4.899	Product	Pounds		1	0.295	Product	Gallons		18	1.185	Product	Gallons		6	3.114	Product	Pounds		100	69.456	Product	Pounds		336

Table A17.

Application Sites:	Total Amount Used151875	Total Amount Type161976	Total Amount Unit162077	Altosid XR Briquets Comments	Altosid Briquettes (Standard) -# Treatments	Total Amount Used	Total Amount Type2	Total Amount Unit	Altosid Briquettes Comments	Vectolex CG - # Treatments	Total Amount Used3	Total Amount Type4	Total Amount Unit5	Vectolex CG Comments	Vectomax CG - # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit8	Vectomax CG Comments	VectoLex WSP - # Treatments	Total Amount Used5	Total Amount Type6	Total Amount Unit7	VectoLex WSP Comments
Anthropogenic Sources	69.547	Product	Pounds	each	24	1.841	Product	Pounds	each	6	0.8	Product	Pounds		10	0.785	Product	Pounds		16	1.034	Product	Pounds	each
Drainage Ditch Man Made	0.111	Product	Pounds	each	1	0.029	Product	Pounds	each	2	0.095	Product	Pounds		1	5	Product	Pounds		1	0.132	Product	Pounds	each
Manmade Wetlands																								
Manmade Wetlands Seasonal																								
Wetlands Permanent Treated Effluent															2	11.6	Product	Pounds						
Natural Wetlands																								
Natural Wetlands Seasonal																								
Vernal Pool																								
Vernal Pool Manmade																								
Mitigated Wetlands Seasonal																								
Wildlife Refuge																								
Pond	18.111	Product	Pounds	each	4	0.086	Product	Pounds	each	4	23.367	Product	Pounds		11	5.304	Product	Pounds		8	0.308	Product	Pounds	each
Wildlife Pond																								
Rain Pond										1	0.5	Product	Pounds		1	1.25	Product	Pounds						
Natural Spring										1	0.8	Product	Pounds											
Low Area	0.667	Product	Pounds	each						1	0.04	Product	Pounds		3	23	Product	Pounds		3	0.066	Product	Pounds	each
Waterways																								
Creeks	0.111	Product	Pounds	each	1	0.029	Product	Pounds	each	3	1.3	Product	Pounds		7	45.93	Product	Pounds		1	0.044	Product	Pounds	each
Treehole																								
Culvert																								
Natural Ditch	0.556	Product	Pounds	each	1	0.014	Product	Pounds	each	1	2	Product	Grams											
Flood Control Ditch																								
Marshes (Fresh Water)																								
Marsh - Seasonal										2	160.5	Product	Pounds		1	1	Product	Pounds						
Marsh - Tidal										1	0.009	Product	Pounds		5	24.75	Product	Pounds						
Cracked Ground																								
Residential Areas																								
Industrial Areas																								
Recreational Areas																								
Agricultural Areas																								
Aeration Pond															1	1.2	Product	Pounds						
Waste Pond										2	22.5	Product	Pounds		21	160.262	Product	Pounds						
Reservoir																								
Settling Pond	0.222	Product	Pounds	each																				
Hayfield Ditch										1	0.5	Product	Pounds											
Pastures										1	5	Product	Pounds											
Irrigated Reservoir																								
Swamps																								
Overgrown Waste Areas																								
Roadsides																								
Roadside Ditch	1	Product	Pounds	each	3	0.057	Product	Pounds	each	3	0.145	Product	Pounds		1	0.046	Product	Pounds		5	0.22	Product	Pounds	each
Woodlands																								
Gardens																								
Playgrounds																								
Campsites																								
Athletic Fields																								
Municipalities																								
Catch Basin	4.611	Product	Pounds	each	30	1.4	Product	Pounds	each	2	0.2	Product	Pounds							28	2.728	Product	Pounds	each
Waste Treatment Plant	0.889	Product	Pounds	each	1	0.014	Product	Pounds	each						2	980.069	Product	Pounds		1	0.022	Product	Pounds	each
Water Treatment Plant																								
Wildlife Refuge Treated Effluent										1	320	Product	Pounds											
Overland Flow																								
Waste Water Irrigation (e.g. pastures)	1.111	Product	Pounds	each						10	197.5	Product	Pounds		1	10	Product	Pounds		1	0.022	Product	Pounds	each
Storm Sewer Line																								
Storm Water BMP	0.111	Product	Pounds	each	1	0.014	Product	Pounds	each															
Retention Basin	0.444	Product	Pounds	each						4	15.772	Product	Pounds		1	0.48	Product	Pounds		1	0.022	Product	Pounds	each
Sewer Pond	0.444	Product	Pounds	each											2	7	Product	Pounds						
Indoors																								
Total																								
Totals	97.935	Product	Pounds	each	66	3.484	Product	Pounds	each	46	751.028	Product	Pounds		70	1277.676	Product	Pounds		65	4.598	Product	Pounds	each

Table A18. **Pesticide Application Data for Winter 2012 – MSMVCD**

Application Sites:	Agnique MMF - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	VectoBac G - # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit3	VectoBac G Comments	VectoBac 12AS - # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit7	VectoBac 12AS Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18	BVA-2 Comments	VectoBac Technical Powder - # Treatments	Total Amount Used19	Total Amount Type20	Total Amount Unit20
Anthropogenic Sources	93	2.381	Product	Gallons							40	11.166	Product	Gallons		9	0.151	Product	Gallons					
Drainage Ditch Man Made	1	0.003	Product	Gallons							12	5.663	Product	Gallons										
Manmade Wetlands																								
Manmade Wetlands Seasonal	1	0.05	Product	Gallons							1	0.031	Product	Gallons										
Wetlands Permanent Treated Effluent											1	1.25	Product	Gallons										
Natural Wetlands																								
Natural Wetlands Seasonal											2	7.75	Product	Gallons		1	25	Product	Gallons					
Vernal Pool	1	0.05	Product	Gallons							4	0.844	Product	Gallons										
Vernal Pool Manmade											3	0.75	Product	Gallons										
Mitigated Wetlands - Seasonal											5	7.925	Product	Gallons										
Wildlife Refuge											1	0.75	Product	Gallons										
Pond	31	0.247	Product	Gallons							17	8.602	Product	Gallons		1	0.25	Product	Gallons					
Dredge Pond											1	1.25	Product	Gallons										
Wildlife Pond																								
Rain Pond	5	0.106	Product	Gallons							23	14.025	Product	Gallons										
Natural Spring	3	0.114	Product	Gallons							1	0.25	Product	Gallons										
Low Area	20	5.114	Product	Gallons							121	80.573	Product	Gallons		4	3.555	Product	Gallons					
Waterways																								
Creeks	5	0.085	Product	Gallons																				
Treehole																								
Culvert											1	0.004	Product	Gallons										
Natural Ditch	2	0.089	Product	Gallons		1	0.18	Product	Pounds		17	8.637	Product	Gallons										
Flood Control Ditch																								
Marshes (Fresh Water)											7	3.779	Product	Gallons										
Marsh - Seasonal											36	93.909	Product	Gallons		2	0.077	Product	Gallons					
Marsh - Tidal	3	0.129	Product	Gallons							15	19.937	Product	Gallons										
Cracked Ground											4	10.001	Product	Gallons										
Residential Areas	661	21.355		0		0	0		0		170	522.089		0		257	98.639				28	0.573		
Industrial Areas																								
Recreational Areas																								
Agricultural Areas																								
Aeration Pond																								
Waste Pond	10	0.324	Product	Gallons							1	0.05	Product	Gallons		2	0.395	Product	Gallons					
Reservoir	1	0.031	Product	Gallons																				
Settling Pond																								
Hayfield Ditch											24	22.5	Product	Gallons										
Pastures																								
Irrigated Reservoir																								
Swamps																								
Overgrown Waste Areas																								
Roadsides																								
Roadside Ditch	11	0.091	Product	Gallons							25	3.704	Product	Gallons		3	0.545	Product	Gallons					
Woodlands																								
Gardens																								
Playgrounds																								
Campsites																								
Athletic Fields																								
Municipalities																								
Catch Basin	1	0.001																						
Waste Treatment Plant	12	0.171	Product	Gallons							3	0.25	Product	Gallons							2	0.645	Product	Pounds
Water Treatment Plant																								
Wildlife Refuge Treated Effluent											1	5.001	Product	Gallons										
Overland Flow																								
Waste Water Irrigation (e.g. pastures)											6	0.422	Product	Gallons										
Storm Sewer Line																								
Storm Water BMP																								
Retention Basin											4	0.519	Product	Gallons										
Sewer Pond																1	2.5	Product	Gallons					
Indoors																								
Total	200	8.986	Product	Gallons		1	0.18	Product	Pounds		376	309.542	Product	Gallons		23	32.473	Product	Gallons		2	0.645	Product	Pounds

Table A18.

Application Sites:	VectoBac Technical Powder Comments	VectoLex WDG - # Treatments	Total Amount Used3345	Total Amount Type3446	Total Amount Unit3447	VectoLex WDG Comments	Pyrocide fogging concentrate 7396 - # Treatments	Total Amount Used3144	Total Amount Type3245	Total Amount Unit3246	Pyrocide fogging concentrate 7396 Comments	VectoBac GS - # Treatments	Total Amount Used3347	Total Amount Type3448	Total Amount Unit3449	VectoBac GS Comments	Altosid Liquid Concentrate - # Treatments	Total Amount Used6966	Total Amount Type71067	Total Amount Unit71168	Altosid Liquid Concentrate Comments	Altosid Pellets - # Treatments
Anthropogenic Sources		4	1.1	Product	Pounds		9	0.027	Product	Gallons		1	0.17	Product	Pounds							24
Drainage Ditch Man Made		1	0.198	Product	Pounds							1	0.028	Product	Pounds							2
Manmade Wetlands																						
Manmade Wetlands Seasonal																						2
Wetlands Permanent Treated Effluent																						
Natural Wetlands																						
Natural Wetlands Seasonal																						
Vernal Pool		1	0.188	Product	Pounds																	
Vernal Pool Manmade		2	1.12	Product	Pounds							1	30	Product	Pounds							
Mitigated Wetlands - Seasonal																						
Wildlife Refuge																						
Pond		1	1.25	Product	Pounds																	3
Dredge Pond																						
Wildlife Pond																						
Rain Pond												1	0.092	Product	Pounds							1
Natural Spring												1	0.068	Product	Pounds							
Low Area		5	4.938	Product	Pounds							6	23.01	Product	Pounds							17
Waterways																						
Creeks																						5
Treehole																						
Culvert																						
Natural Ditch												1	0.092	Product	Pounds							3
Flood Control Ditch																						1
Marshes (Fresh Water)																						1
Marsh - Seasonal																						1
Marsh - Tidal																						10
Cracked Ground																						1
Residential Areas		2	0.133				0	0				2	0.133				5	660		0		170
Industrial Areas																						
Recreational Areas																						
Agricultural Areas																						
Aeration Pond																						
Waste Pond		4	0.54	Product	Pounds																	1
Reservoir																						
Settling Pond																						
Hayfield Ditch		3	13	Product	Pounds												16	2.045	Product	Gallons		2
Pastures																						1
Irrigated Reservoir																						
Swamps																						
Overgrown Waste Areas																						
Roadsides																						
Roadside Ditch												1	0.057	Product	Pounds		2	0.101	Product	Gallons		9
Woodlands																						
Gardens																						
Playgrounds																						
Campsites																						
Athletic Fields																						
Municipalities																						
Catch Basin																						
Waste Treatment Plant																						
Water Treatment Plant																						
Wildlife Refuge Treated Effluent																	1	0.624	Product	Gallons		
Overland Flow																						
Waste Water Irrigation (e.g. pastures)		10	1.469	Product	Pounds																	
Storm Sewer Line																						
Storm Water BMP																						
Retention Basin																						
Sewer Pond																						
Indoors																						
Total		31	23.803	Product	Pounds		9	0.027	Product	Gallons		13	53.517	Product	Pounds		19	2.77	Product	Gallons		84

Table A18.

Application Sites:	Total Amount Used111269	Total Amount Type121370	Total Amount Unit121471	Altosid Pellets Comments	Altosid XR Briquets - # Treatments	Total Amount Used151875	Total Amount Type161976	Total Amount Unit162077	Altosid XR Briquets Comments	Altosid XR-G - # Treatments	Total Amount Used172178	Total Amount Type182279	Total Amount Unit182380	Altosid XR-G Comments	Altosid Briquettes (Standard) -# Treatments	Total Amount Used	Total Amount Type2	Total Amount Unit	Altosid Briquettes Comments	Vectolex CG - # Treatments	Total Amount Used3	Total Amount Type4	Total Amount Unit5	Vectolex CG Comments
Anthropogenic Sources	26.411	Product	Pounds		182	49.769	Product	Pounds	each	1	0.05	Product	Pounds		1	0.014	Product	Pounds	each	4	3.83	Product	Pounds	
Drainage Ditch Man Made	0.206	Product	Pounds																	1	5	Product	Pounds	
Manmade Wetlands																								
Manmade Wetlands Seasonal	0.052	Product	Pounds																	1	50	Product	Pounds	
Wetlands Permanent Treated Effluent																								
Natural Wetlands																								
Natural Wetlands Seasonal																								
Vernal Pool																				7	159.25	Product	Pounds	
Vernal Pool Manmade																				8	309.968	Product	Pounds	
Mitigated Wetlands - Seasonal																				3	112	Product	Pounds	
Wildlife Refuge																								
Pond	1.018	Product	Pounds		73	14.111	Product	Pounds	each											10	146.24	Product	Pounds	
Dredge Pond																								
Wildlife Pond																								
Rain Pond	1.5	Product	Pounds		5	2	Product	Pounds	each											3	90	Product	Pounds	
Natural Spring					1	0.333	Product	Pounds	each															
Low Area	10.064	Product	Pounds		3	1.111	Product	Pounds	each											24	231.205	Product	Pounds	
Waterways							Product	Pounds	each															
Creeks	22.267	Product	Pounds		2	0.222	Product	Pounds	each															
Treehole					1	0.111	Product	Pounds	each															
Culvert																								
Natural Ditch	0.208	Product	Pounds																	2	2.203	Product	Pounds	
Flood Control Ditch	0.113	Product	Pounds																					
Marshes (Fresh Water)	3	Product	Pounds																	2	60	Product	Pounds	
Marsh - Seasonal	44	Product	Pounds																					
Marsh - Tidal	47.868	Product	Pounds																					
Cracked Ground	0.09	Product	Pounds																					
Residential Areas	522.089		0		0	0		0		0	0													
Industrial Areas																								
Recreational Areas																								
Agricultural Areas																								
Aeration Pond																								
Waste Pond	0.3	Product	Pounds																	2	17.9	Product	Pounds	
Reservoir																								
Settling Pond																								
Hayfield Ditch	0.117	Product	Pounds																					
Pastures	0.034	Product	Pounds																					
Irrigated Reservoir																								
Swamps																								
Overgrown Waste Areas																								
Roadsides																								
Roadside Ditch	0.405	Product	Pounds																	8	15.065	Product	Pounds	
Woodlands																								
Gardens																								
Playgrounds																								
Campsites																								
Athletic Fields																								
Municipalities																								
Catch Basin					13	2.556	Active Ingredient	Pounds																
Waste Treatment Plant																								
Water Treatment Plant																								
Wildlife Refuge Treated Effluent																								
Overland Flow																								
Waste Water Irrigation (e.g. pastures)																								
Storm Sewer Line																								
Storm Water BMP																								
Retention Basin																								
Sewer Pond					1	0.222	Active Ingredient	Pounds																
Indoors																								
Total	157.653	Product	Pounds		281	70.435	Active Ingredient	Pounds		1	0.05	Product	Pounds		1	0.014	Product	Pounds		75	1202.661	Product	Pounds	

Table A18.

Application Sites:	Vectomax CG - # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit8	Vectomax CG Comments	VectoBac WDG - # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit4	VectoBac WDG comments	VectoLex WSP - # Treatments	Total Amount Used5	Total Amount Type6	Total Amount Unit7	VectoLex WSP Comments	Altosid Liquid (non-concentrate) - # Treatments	Total Amount Used8	Total Amount Type9	Total Amount Unit10	Altosid Liquid (non-concentrate) comments
Anthropogenic Sources	1	0.12	Product	Pounds												3	0.788	Product	Gallons	
Drainage Ditch Man Made	4	16.255	Product	Pounds												5	0.531	Active Ingredient	Gallons	
Manmade Wetlands																				
Manmade Wetlands Seasonal	1	10	Product	Pounds							3	0.22	Product	Pounds	each					
Wetlands Permanent Treated Effluent	1	10	Product	Pounds												1	0.156	Product	Gallons	
Natural Wetlands																				
Natural Wetlands Seasonal																				
Vernal Pool	1	10	Product	Pounds																
Vernal Pool Manmade	3	70	Product	Pounds																
Mitigated Wetlands - Seasonal																				
Wildlife Refuge																				
Pond	4	3.748	Product	Pounds							2	0.154	Product	Pounds	each	3	0.765	Product	Gallons	
Dredge Pond																				
Wildlife Pond	1	0.688	Product	Pounds																
Rain Pond	8	69.175	Product	Pounds												5	1.353	Product	Gallons	
Natural Spring	1	0.023	Product	Pounds																
Low Area	45	342.341	Product	Pounds		3	3.565	Product	Pounds							25	5.15	Product	Gallons	
Waterways																				
Creeks																				
Treehole																				
Culvert	1	0.045	Product	Pounds																
Natural Ditch	2	0.2	Product	Pounds												3	0.273	Product	Gallons	
Flood Control Ditch																				
Marshes (Fresh Water)	6	132.05	Product	Pounds												4	0.406	Product	Gallons	
Marsh - Seasonal																6	2.314	Product	Gallons	
Marsh - Tidal	16	163.219	Product	Pounds												7	1.936	Product	Gallons	
Cracked Ground																				
Residential Areas																				
Industrial Areas																				
Recreational Areas																				
Agricultural Areas																				
Aeration Pond																				
Waste Pond	8	24.75	Product	Pounds																
Reservoir																				
Settling Pond	1	0.7	Product	Pounds																
Hayfield Ditch																16	2.045	Product	Gallons	
Pastures																				
Irrigated Reservoir	1	0.1	Product	Pounds																
Swamps																				
Overgrown Waste Areas																				
Roadsides																				
Roadside Ditch	10	21.68	Product	Pounds												2	0.101	Product	Gallons	
Woodlands																				
Gardens																				
Playgrounds																				
Campsites																				
Athletic Fields																				
Municipalities																				
Catch Basin											1	0.198	Product	Pounds	each					
Waste Treatment Plant																				
Water Treatment Plant																				
Wildlife Refuge Treated Effluent																1	0.624	Product	Gallons	
Overland Flow																				
Waste Water Irrigation (e.g. pastures)	4	5.6	product	pounds																
Storm Sewer Line																				
Storm Water BMP																				
Retention Basin																				
Sewer Pond	5	56.25	Product	pounds																
Indoors																				
Total	124	936.944	Product	Pounds		3	3.565	Product	Pounds		6	0.572	Product	Pounds	each	81	16.442	Product	Gallons	

Table A19. **Pesticide Application Data for Spring2012 – MSMVCD**

Application Sites:	Agnique MMF - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	Agnique MMF G - # Treatments	Total Amount Used4	Total Amount Type5	Total Amount Unit5	Agnique MMF G Comments	VectoBac 12AS - # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit7	VectoBac 12AS Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18	BVA-2 Comments	VectoBac Technical Powder - # Treatments	Total Amount Used19	Total Amount Type20	Total Amount Unit20
Anthropogenic Sources	212	1.434	Product	Gallons							9	11.952	Product	Gallons		44	1.758	Product	Gallons		2	0.025	Product	Pounds
Drainage Ditch Man Made	9	0.24	Product	Gallons							7	40.625	Product	Gallons		6	0.21	Product	Gallons		2	0.001	Product	Pounds
Manmade Wetlands																								
Manmade Wetlands Seasonal											5	4.925	Product	Gallons										
Wetlands Permanent Treated Effluent						4	399	Product	Pounds		1	1.25	Product	Gallons										
Natural Wetlands																								
Natural Wetlands Seasonal																								
Vernal Pool											1	0.063	Product	Gallons										
Vernal Pool Manmade	1	0.009									2	0.896	Product	Gallons		1	5	Product	Gallons					
Mitigated Wetlands Seasonal																								
Wildlife Refuge											2	4.367	Product	Gallons										
Pond	225	4.985	Product	Gallons							6	5.666	Product	Gallons		5	5.018	Product	Gallons					
Dredge Pond																								
Wildlife Pond																								
Rain Pond	6	0.628	Product	Gallons							11	27.484	Product	Gallons		1	1	Product	Gallons		1	0.059	Product	Pounds
Natural Spring	3	0.04	Product	Gallons																				
Low Area	35	8.908	Product	Gallons							53	147.205	Product	Gallons		13	14.807	Product	Gallons		2	0.004	Product	Pounds
Waterways																								
Creeks	22	0.753	Product	Gallons							8	0.568	Product	Gallons		4	0.188	Product	Gallons		6	0.089	Product	Pounds
Treehole	1	0.005	Product	Gallons																				
Culvert	1	0.001	Product	Gallons												1	0.035	Product	Gallons					
Natural Ditch	10	0.533	Product	Gallons							8	2.854	Product	Gallons		10	5.966	Product	Gallons					
Flood Control Ditch																1	0.006	Product	Gallons					
Marshes (Fresh Water)	3	0.033	Product	Gallons							5	2.41	Product	Gallons							1	0.086	Product	Pounds
Marsh - Seasonal											17	105.89	Product	Gallons		1	0.469	Product	Gallons		2	0.215	Product	Pounds
Marsh - Tidal	4	0.059	Product	Gallons							8	156.029	Product	Gallons							4	0.035	Product	Pounds
Cracked Ground																								
Residential Areas																								
Industrial Areas																								
Recreational Areas																								
Agricultural Areas																								
Aeration Pond	2	0.002	Product	Gallons																				
Waste Pond	31	1.758	Product	Gallons							1	0.031	Product	Gallons		22	44.661	Product	Gallons					
Reservoir																								
Settling Pond	2	0.11	Product	Gallons												1	0.023	Product	Gallons					
Hayfield Ditch											11	6.25	Product	Gallons										
Pastures																								
Irrigated Reservoir																								
Swamps																								
Overgrown Waste Areas																								
Roadsides																								
Roadside Ditch	25	0.473	Product	Gallons							8	1.323	Product	Gallons		26	2.755	Product	Gallons		8	0.059	Product	Pounds
Woodlands																								
Gardens																								
Playgrounds																								
Campsites																								
Athletic Fields																								
Municipalities																								
Catch Basin	28	0.048	Product	Gallons							2	0.001	Product	Gallons		110	4.835	Product	Gallons					
Waste Treatment Plant	35	0.709	Product	Gallons												2	0.163	Product	Gallons					
Water Treatment Plant																6	10.62	Product	Gallons					
Wildlife Refuge Treated Effluent																								
Overland Flow																								
Waste Water Irrigation (e.g. pastures)	2	0.007	Product	Gallons							2	0.2	Product	Gallons										
Storm Sewer Line																								
Storm Water BMP																								
Retention Basin											2	1.35	Product	Gallons										
Sewer Pond	4	0.62	Product	Gallons		1	261	Product	Pounds		1	0.75	Product	Gallons		3	1.125	Product	Gallons					
Indoors																								
Totals	661	21.355	Product	Gallons		5	660	Product	Pounds		170	522.089	Product	Gallons		257	98.639	Product	Gallons		28	0.573	Product	Pounds

Table A19.

Application Sites:	VectoBac Technical Powder Comments	Wasp Freeze - # Treatments	Total Amount Used33	Total Amount Type34	Total Amount Unit34	Wasp Freeze Comments	Drione - # Treatments	Total Amount Used1112	Total Amount Type1213	Total Amount Unit1214	Drione Comments	FourStar 45 - # Treatments	Total Amount Used2127	Total Amount Type2228	Total Amount Unit2229	FourStar 45 Comments	VectoLex WDG - # Treatments	Total Amount Used3345	Total Amount Type3446	Total Amount Unit3447	VectoLex WDG Comments	Pyrocide fogging concentrate 7067 - # Treatments	Total Amount Used2535	Total Amount Type2636
Anthropogenic Sources		1	0.008	Product	Pounds							1	0.21	Active Ingredient	Pounds		5	3.5	Product	Pounds		9	0.22	Product
Drainage Ditch Man Made																	3	0.255	Product	Pounds		2	0.328	Product
Manmade Wetlands																								
Manmade Wetlands Seasonal																								
Wetlands Permanent Treated Effluent																						8	0.938	Product
Natural Wetlands																								
Natural Wetlands Seasonal																								
Vernal Pool																	2	0.563	Product	Pounds				
Vernal Pool Manmade																	3	3.725	Product	Pounds				
Mitigated Wetlands Seasonal																								
Wildlife Refuge																								
Pond							2	0.125	Product	Pounds												7	0.375	Product
Dredge Pond																								
Wildlife Pond																								
Rain Pond																								
Natural Spring																								
Low Area																	1	0.325	Product	Pounds		10	0.483	Product
Waterways																								
Creeks																	8	1.506	Product	Pounds		2	0.288	Product
Treehole																						1	2.082	Product
Culvert																	1	0.01	Product	Pounds				
Natural Ditch																								
Flood Control Ditch																	1	0.015	Product	Pounds				
Marshes (Fresh Water)																	1	2	Product	Pounds				
Marsh - Seasonal		1	0.125	Product	Pounds												1	0.5	Product	Pounds				
Marsh - Tidal																								
Cracked Ground																								
Residential Areas																								
Industrial Areas																								
Recreational Areas																								
Agricultural Areas																								
Aeration Pond																								
Waste Pond																	4	2.838	Product	Pounds				
Reservoir																								
Settling Pond																								
Hayfield Ditch																	3	32	Product	Pounds		1	0.563	Product
Pastures																								
Irrigated Reservoir																								
Swamps																								
Overgrown Waste Areas																								
Roadsides																								
Roadside Ditch																								
Woodlands																								
Gardens																								
Playgrounds																								
Campsites																								
Athletic Fields																								
Municipalities																								
Catch Basin																								
Waste Treatment Plant																						4	0.859	Product
Water Treatment Plant																								
Wildlife Refuge Treated Effluent																								
Overland Flow																								
Waste Water Irrigation (e.g. pastures)																	10	1.625	Product	Pounds				
Storm Sewer Line																								
Storm Water BMP																								
Retention Basin																								
Sewer Pond																	2	3.248	Product	Pounds		4	0.656	Product
Indoors																								
Totals		2	0.133	Product	Pounds		2	0.125	Product	Pounds		1	0.21	Active Ingredient	Pounds		45	52.11	Product	Pounds		48	6.792	Product

Table A19.

Application Sites:	Total Amount Unit2637	Pyrocide fogging concentrate 7067 Comments	VectoBac GS - # Treatments	Total Amount Used3347	Total Amount Type3448	Total Amount Unit3449	VectoBac GS Comments	Altosid Liquid Concentrate - # Treatments	Total Amount Used6966	Total Amount Type71067	Total Amount Unit71168	Altosid Liquid Concentrate Comments	Altosid Pellets - # Treatments	Total Amount Used111269	Total Amount Type121370	Total Amount Unit121471	Altosid Pellets Comments	Altosid SBG - # Treatments	Total Amount Used131572	Total Amount Type141673	Total Amount Unit141774	Altosid SBG Comments	Altosid XR Briquets - # Treatments	Total Amount Used151875
Anthropogenic Sources	Gallons												73	37.604	Product	Pounds							484	127.783
Drainage Ditch Man Made	Gallons							1	2.465	Product	Gallons												5	1.222
Manmade Wetlands																								
Manmade Wetlands Seasonal													1	0.103	Product	Pounds								
Wetlands Permanent Treated Effluent	Gallons																							
Natural Wetlands																								
Natural Wetlands Seasonal			1	800	Product	Pounds																		
Vernal Pool																								
Vernal Pool Manmade																								
Mitigated Wetlands Seasonal													1	2.5	Product	Pounds								
Wildlife Refuge																								
Pond	Gallons							1	0.322	Product	Gallons		14	0.52	Product	Pounds							414	76.777
Dredge Pond																								
Wildlife Pond																								
Rain Pond			2	6.5	Product	Pounds		2	1.013	Product	Gallons		6	3.359	Product	Pounds							4	1.333
Natural Spring													2	1.046	Active Ingredient	Pounds							1	0.222
Low Area	Gallons		4	22.557	Product	Gallons		2	4.366	Product	Gallons		36	101.037	Product	Pounds		1	40	Product	Pounds			
Waterways																								
Creeks	Gallons		1	1.25	Product	Pounds							47	33.522	Product	Pounds							11	3.778
Treehole	Gallons																						1	0.111
Culvert													3	0.042	Product	Pounds							1	0.222
Natural Ditch			2	1.046	Product	Pounds							5	1.196	Product	Pounds							3	0.667
Flood Control Ditch			2	1.7									3	0.246	Product	Pounds								
Marshes (Fresh Water)			1	14	Product	Pounds							5	6.25	Product	Pounds								
Marsh - Seasonal			4	12.5	Product	Pounds		5	5.799	Product	Gallons		8	436.75	Product	Pounds		1	120	Product	Pounds			
Marsh - Tidal			2	10	Product	Pounds		3	5.059	Product	Gallons		40	1243.028	Product	Pounds								
Cracked Ground													1	9	Product	Pounds		1	40	Product	Pounds			
Residential Areas																								
Industrial Areas																								
Recreational Areas																								
Agricultural Areas																								
Aeration Pond																								
Waste Pond													3	1.055	Product	Pounds							1	0.222
Reservoir													2	0.135	Product	Pounds								
Settling Pond																								
Hayfield Ditch	Gallons																							
Pastures																								
Irrigated Reservoir																								
Swamps																								
Overgrown Waste Areas																								
Roadsides																								
Roadside Ditch			2	0.16	Product	Pounds							21	2.873	Product	Pounds							3	0.333
Woodlands																								
Gardens																								
Playgrounds																								
Campsites																								
Athletic Fields																								
Municipalities																								
Catch Basin													10	0.055	Product	Pounds							529	186.465
Waste Treatment Plant	Gallons												2	0.75	Product	Pounds							1	0.778
Water Treatment Plant																								
Wildlife Refuge Treated Effluent																								
Overland Flow																								
Waste Water Irrigation (e.g. pastures)													3	6.45	Product	Pounds								
Storm Sewer Line																								
Storm Water BMP																								
Retention Basin			1	5	Product	Pounds							1	0.2	Product	Pounds								
Sewer Pond	Gallons		2	8.3	Product	Pounds							4	4.05	Product	Pounds							1	0.667
Indoors																								
Totals	Gallons		24	883.013	Product	Pounds		14	19.024	Product	Gallons		291	1891.771	Product	Pounds		3	200	Product	Pounds		1459	400.58

Table A19.

Application Sites:	Total Amount Type161976	Total Amount Unit162077	Altosid XR Briquets Comments	Altosid XR-G - # Treatments	Total Amount Used172178	Total Amount Type182279	Total Amount Unit182380	Altosid XR-G Comments	Altosid Briquettes (Standard) -# Treatments	Total Amount Used	Total Amount Type2	Total Amount Unit	Altosid Briquettes Comments	Vectolex CG - # Treatments	Total Amount Used3	Total Amount Type4	Total Amount Unit5	Vectolex CG Comments	Vectomax CG - # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit8	Vectomax CG Comments	VectoBac WDG - # Treatments
Anthropogenic Sources	Product	Pounds	each						9	0.172	Product	Pounds	each	13	40.11	Product	Pounds		18	32.151	Product	Pounds		
Drainage Ditch Man Made	Product	Pounds	each						1	0.014	Product	Pounds	each	8	23.991	Product	Pounds		5	425.04	Product	Pounds		2
Manmade Wetlands																								
Manmade Wetlands Seasonal									8	1.8	Product	Pounds	each	18	440.5	Product	Pounds		1	60	Product	Pounds		
Wetlands Permanent Treated Effluent																			17	897.6	Product	Pounds		
Natural Wetlands																								
Natural Wetlands Seasonal														5	1092.5	Product	Pounds		3	1560	Product	Pounds		
Vernal Pool														9	184	Product	Pounds		2	60	Product	Pounds		
Vernal Pool Manmade														29	1422.5	Product	Pounds		1	30	Product	Pounds		
Mitigated Wetlands Seasonal														2	190	Product	Pounds		1	2.5	Product	Pounds		
Wildlife Refuge																			1	160	Product	Pounds		
Pond	Product	Pounds	each	1	0.001	Product	Pounds		14	0.286	Product	Pounds	each	10	23.086	Product	Pounds		9	4.951	Product	Pounds		
Dredge Pond																								
Wildlife Pond																								
Rain Pond	Product	Pounds	each											5	89.75	Product	Pounds		4	33.046	Product	Pounds		
Natural Spring	Product	Pounds	each											2	20	Product	Pounds		4	0.318	Product	Pounds		
Low Area														59	808.762	Product	Pounds		29	319.209	Product	Pounds		
Waterways																								
Creeks	Product	Pounds	each						2	0.057	Product	Pounds	each	6	34.213	Product	Pounds		9	22.7	Product	Pounds		
Treehole	Product	Pounds	each																					
Culvert	Product	Pounds	each																					
Natural Ditch	Product	Pounds	each											9	78.637	Product	Pounds		6	31.004	Product	Pounds		
Flood Control Ditch																								
Marshes (Fresh Water)														6	250	Product	Pounds		1	2.3	Product	Pounds		
Marsh - Seasonal														2	20	Product	Pounds		1	0.04	Product	Pounds		
Marsh - Tidal														1	10	Product	Pounds		6	85.758	Product	Pounds		
Cracked Ground																								
Residential Areas																								
Industrial Areas																								
Recreational Areas																								
Agricultural Areas																								
Aeration Pond																								
Waste Pond	Product	Pounds	each											7	45.956	Product	Pounds		22	124.3	Product	Pounds		3
Reservoir																								
Settling Pond														1	2.5	Product	Pounds							
Hayfield Ditch														1	15	Product	Pounds		2	40	Product	Pounds		
Pastures														1	15	Product	Pounds							
Irrigated Reservoir														3	20.013	Product	Pounds							
Swamps																								
Overgrown Waste Areas																								
Roadsides																								
Roadside Ditch	Product	Pounds	each						2	0.043	Product	Pounds	each	8	4.416	Product	Pounds		10	0.943	Product	Pounds		
Woodlands																								
Gardens																								
Playgrounds																								
Campsites																								
Athletic Fields																								
Municipalities																								
Catch Basin	Product	Pounds	each						9	0.457	Product	Pounds	each	1	0.01	Product	Pounds							
Waste Treatment Plant	Product	Pounds	each											3	22.5	Product	Pounds							
Water Treatment Plant																								
Wildlife Refuge Treated Effluent																								
Overland Flow																								
Waste Water Irrigation (e.g. pastures)														15	107.9	Product	Pounds		27	125.3	Product	Pounds		
Storm Sewer Line																								
Storm Water BMP																								
Retention Basin														4	26.48	Product	pounds		2	45.04	Product	pounds		
Sewer Pond	Product	Pounds	each																10	1918	Product	Pounds		
Indoors																								
Totals	Product	Pounds	each	1	0.001	Product	Pounds		45	2.829	Product	Pounds		228	4987.824	Product	Pounds		191	5980.2	Product	Pounds		5

Table A19.

Application Sites:	Total Amount Used2	Total Amount Type3	Total Amount Unit4	VectoBac WDG comments	VectoLex WSP - # Treatments	Total Amount Used5	Total Amount Type6	Total Amount Unit7	VectoLex WSP Comments	Altosid Liquid (non-concentrate) - # Treatments	Total Amount Used8	Total Amount Type9	Total Amount Unit10	Altosid Liquid (non-concentrate) comments	FourStar SBG - # Treatments	Total Amount Used11	Total Amount Type12	Total Amount Unit13	FourStar SBG comments
Anthropogenic Sources					22	1.122	Product	Pounds	each	1	1.369	Product	Gallons						
Drainage Ditch Man Made	0.188	Product	Pounds		1	0.0025	Product	Pounds	each	1	0.203	Product	Gallons						
Manmade Wetlands																			
Manmade Wetlands Seasonal										1	0.053	Product	Gallons						
Wetlands Permanent Treated Effluent										1	0.156	Product	Gallons						
Natural Wetlands																			
Natural Wetlands Seasonal																			
Vernal Pool																			
Vernal Pool Manmade										1	0.018	Product	Gallons						
Mitigated Wetlands Seasonal																			
Wildlife Refuge										2	0.545	Product	Gallons						
Pond					15	0.385	Product	Pounds	each	1	0.008	Product	Gallons						
Dredge Pond																			
Wildlife Pond																			
Rain Pond										7	1.454	Product	Gallons						
Natural Spring																			
Low Area					1	0.022	Product	Pounds	each	33	9.133	Product	Gallons						
Waterways																			
Creeks					2	0.154	Product	Pounds	each	2	0.031	Product	Gallons						
Treehole																			
Culvert																			
Natural Ditch										5	0.437	Product	Gallons						
Flood Control Ditch					1	0.044	Product	Pounds	each										
Marshes (Fresh Water)										3	0.254	Product	Gallons						
Marsh - Seasonal										6	1.267	Product	Gallons		3	120	Product	Pounds	
Marsh - Tidal										3	1.717	Product	Gallons						
Cracked Ground										1	0.156	Product	Gallons						
Residential Areas																			
Industrial Areas																			
Recreational Areas																			
Agricultural Areas																			
Aeration Pond																			
Waste Pond	0.613	Product	Pounds																
Reservoir																			
Settling Pond																			
Hayfield Ditch										11	101.144	Product	Pounds						
Pastures																			
Irrigated Reservoir																			
Swamps																			
Overgrown Waste Areas																			
Roadsides																			
Roadside Ditch					1	0.022	Product	Pounds	each	2	0.156	Product	Gallons						
Woodlands																			
Gardens																			
Playgrounds																			
Campsites																			
Athletic Fields																			
Municipalities																			
Catch Basin					24	1.958	Product	Pounds	each										
Waste Treatment Plant																			
Water Treatment Plant																			
Wildlife Refuge Treated Effluent										1	0.078	Product	Gallons						
Overland Flow																			
Waste Water Irrigation (e.g. pastures)																			
Storm Sewer Line																			
Storm Water BMP																			
Retention Basin										1	0.156	Product	Gallons						
Sewer Pond										1	0.094	Product	Gallons						
Indoors																			
Totals	0.801	Product	Pounds		67	3.7095	Product	Pounds	each	84	118.429	Product	Gallons		3	120	Product	Pounds	

Table A20. Pesticide Product Key – MSMVCD

Product	AI
Agnique MMF G	Biodegradable Alcohol Ethoxylated Surfactant
Agnique MMF Mosquito Larvicide & Pupicide	Biodegradable Alcohol Ethoxylated Surfactant
BVA 2 Mosquito Larvicide Oil	Petroleum Distillate
Delta Dust Insecticide	Deltamethrin
Drione Insecticide	Pyrethrin and Piperonyl Butroxide and Amorphous Silica Gel
FourStar 45	Bacillus Sphaericus and Bacillus Thuringiensis Israelensis
FourStar SBG	Bacillus Thuringiensis Israelensis
Pyrocide Mosquito Adulticiding Concentrate for ULV Fogging 7067	Pyrethrin and Piperonyl Butoxide
Pyrocide Mosquito Adulticiding Concentrate for ULV Fogging 7396	Pyrethrin and Piperonyl Butoxide
VectoBac 12AS Biological Larvicide	Bacillus Thuringiensis Israelensis
VectoBac G Biological Larvicide	Bacillus Thuringiensis Israelensis
VectoBac GS Biological Larvicide	Bacillus Thuringiensis Israelensis
VectoBac Technical Powder Biological Larvicide	Bacillus Thuringiensis Israelensis
VectoBac WDG Biological Larvicide	Bacillus Thuringiensis Israelensis
VectoLex WDG Biological Larvicide	Bacillus Sphaericus
VectoLex WSP Biological Larvicide	Bacillus Sphaericus
VectoMax CG Biological Larvicide	Bacillus Sphaericus and Bacillus Thuringiensis Israelensis
Wasp Freeze	Phenothrin and Trans Allethrin
Zenivex E20	Etofenprox
Zoecon Altosid Briquets	Methoprene
Zoecon Altosid Liquid Larvicide Concentrate	Methoprene
Zoecon Altosid Liquid Larvicide Mosquito Growth Regulator	Methoprene
Zoecon Altosid Pellets	Methoprene
Zoecon Altosid SBG Single Brood Granule	Methoprene
Zoecon Altosid XR Entended Residual Briquets	Methoprene
Zoecon Altosid XR-G	Methoprene

Table A21. **Pesticide Application Data for Summer 2011 – NCMAD**

Application Sites:	5% Skeeter Abate - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	5% Skeeter Abate Comments	Teknar HP-D - # Treatments	Total Amount Used4	Total Amount Type5	Total Amount Unit5	Teknar HP-D Comments	Altosid Liquid SR5 - # Treatments	Total Amount Used11	Total Amount Type12	Total Amount Unit12	Altosid Liquid SR5 Comments	Altosid Pellets - # Treatments	Total Amount Used15	Total Amount Type16
1. Tidal marsh						4	800	Product	Ounces (volume)		4	200	Product	Ounces (volume)				
2. Fresh water marsh	3	360	Product	Ounces (weight)		3	320	Product	Ounces (volume)		3	80	Product	Ounces (volume)		2	400	Product
2A. Reclaimed Marsh						3	560	Product	Ounces (volume)		3	140	Product	Ounces (volume)				
3. Diked marsh																		
4. Seasonal wetland	5	109	Product	Ounces (weight)		4	240	Product	Ounces (volume)		4	60	Product	Ounces (volume)		4	141	Product
4A. Seasonal Vineyard Water/Pothole																		
5. Natural seep																		
6. River margin																		
7. Creek																		
8. Seasonal creek pools	2	6	Product	Ounces (weight)														
9. Channel (unlined)	16	176	Product	Ounces (weight)		13	880	Product	Ounces (volume)		13	220	Product	Ounces (volume)		11	174	Product
10. Ditch																		
10A. Agricultural Ditch						1	160	Product	Ounces (volume)		1	40	Product	Ounces (volume)		2	176	Product
11. Vernal pool																		
12. Flooded/irrigated pasture	1	4	Product	Ounces (weight)														
13. Storm drain/catch basin	15	44	Product	Ounces (weight)		22	1166	Product	Ounces (volume)		22	296	Product	Ounces (volume)		7	21	Product
14. Waste water pond	3	181	Product	Ounces (weight)							1	4	Product	Ounces (volume)		1	32	Product
14A. Waste Water Spray Field/Marsh						3	240	Product	Ounces (volume)		4	70	Product	Ounces (volume)		4	624	Product
15. Winery waste pond																		
16. Stock pond																		
17. Irrigation pond/Vineyard Pond																		
18. Storm water detention basin																2	56	Product
19. Sump	6	40	Product	Ounces (weight)												3	365	Product
20. Septic tank	6	36	Product	Ounces (weight)												7	65	Product
21. Ornamental water garden/fish pond	1	10	Product	Ounces (weight)														
22. Swimming pool																		
23. Spa/hot tub																		
24. Man-made container (e.g. buckets, tires, cemetery urns, wading pools, wheel barrow, etc)	22	147	Product	Ounces (weight)												9	126	Product
24A. Agrcultural Containers (e.g. bins, etc.)																		
25. Tree holes																		
26. Horse/livestock watering troughs																		
27. Water under buildings	2	13	Product	Ounces (weight)														
28. Utility vaults																		
29. Dredge Disposal Pond																		
30. Wells/Water Storage Tanks/Pumps																		
31. Water Main Leaks	1	80	Product	Ounces (weight)														
32. Other Natural Water Sources	1	10	Product	Ounces (weight)														
33. Other Commercial Sources																		
34. Other																		
35. Fresh Water Pond (Natural)	6	704	Product	Ounces (weight)												1	8	Product
36. Cess Pool																		
Total	90	1920	Product	Ounces (weight)		53	4366	Product	Ounces (volume)		55	1110	Product	Ounces (volume)		53	2188	Product

Table A21.

Application Sites:	Total Amount Unit16	Altosid Pellets Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18	BVA-2 Comments	VectoLex CG - # Treatments	Total Amount Used19	Total Amount Type20	Total Amount Unit20	VectoLex CG Comments	VectoMax WSP - # Treatments	Total Amount Used21	Total Amount Type22	Total Amount Unit22	VectoMax WSP Comments	Altosid Briquets 30-day - # Treatments
1. Tidal marsh																		
2. Fresh water marsh	Ounces (weight)																	
2A. Reclaimed Marsh																		
3. Diked marsh																		
4. Seasonal wetland	Ounces (weight)																	
4A. Seasonal Vineyard Water/Pothole																		
5. Natural seep																		
6. River margin																		
7. Creek																		
8. Seasonal creek pools																		
9. Channel (unlined)	Ounces (weight)							3	21	Product	Ounces (weight)		5	18	Product	her (specify in comments secti	Each	1
10. Ditch																		
10A. Agricultural Ditch	Ounces (weight)																	
11. Vernal pool																		
12. Flooded/irrigated pasture																		
13. Storm drain/catch basin	Ounces (weight)		3	16	Product	Ounces (volume)							43	2261	Product	her (specify in comments secti	Each	25
14. Waste water pond	Ounces (weight)		1	128	Product	Ounces (volume)							2	24	Product	her (specify in comments secti	Each	
14A. Waste Water Spray Field/Marsh	Ounces (weight)		1	1280	Product	Ounces (volume)												
15. Winery waste pond																		
16. Stock pond																		
17. Irrigation pond/Vineyard Pond																		
18. Storm water detention basin	Ounces (weight)																	1
19. Sump	Ounces (weight)												1	15	Product	her (specify in comments secti	Each	1
20. Septic tank	Ounces (weight)												3	1	Product	her (specify in comments secti	Each	1
21. Ornamental water garden/fish pond													1	1	Product	her (specify in comments secti	Each	
22. Swimming pool													1	16	Product	her (specify in comments secti	Each	
23. Spa/hot tub			2	18	Product	Ounces (volume)												
24. Man-made container (e.g. buckets, tires, cemetery urns, wading pools, wheel barrow, etc)	Ounces (weight)		2	5	Product	Ounces (volume)							13	106	Product	her (specify in comments secti	Each	13
24A. Agrcultural Containers (e.g. bins, etc.)																		
25. Tree holes																		
26. Horse/livestock watering troughs																		
27. Water under buildings			2	28	Product	Ounces (volume)												
28. Utility vaults																		1
29. Dredge Disposal Pond																		
30. Wells/Water Storage Tanks/Pumps																		
31. Water Main Leaks																		
32. Other Natural Water Sources																		6
33. Other Commercial Sources																		7
34. Other																		
35. Fresh Water Pond (Natural)	Ounces (weight)																	
36. Cess Pool			2	134	Product	Ounces (volume)							1	1	Product	her (specify in comments secti	Each	
Total	Ounces (weight)		13	1609	Product	Ounces (volume)		3	21	Product	Ounces (weight)		70	2443	Product	her (specify in comments secti	Each	56

Table A21.

Application Sites:	Total Amount Used23	Total Amount Type24	Total Amount Unit24	Altosid Briquets 30 Day Commnets	Permanone - # Treatments	Total Amount Used25	Total Amount Type26	Total Amount Unit26	Permanone Comments	MGK Pyrocide 7396 - # Treatments	Total Amount Used27	Total Amount Type28	Total Amount Unit28	MGK Pyrocide 7396 Comments	Pyrenone 25-5 - # Treatments	Total Amount Used29	Total Amount Type30	Total Amount Unit30
1. Tidal marsh																		
2. Fresh water marsh																		
2A. Reclaimed Marsh					1	375	Product	Ounces (volume)										
3. Diked marsh																		
4. Seasonal wetland																		
4A. Seasonal Vineyard Water/Pothole																		
5. Natural seep																		
6. River margin																		
7. Creek																		
8. Seasonal creek pools																		
9. Channel (unlined)	5	Product	er (specify in comments sect	Each														
10. Ditch																		
10A. Agricultural Ditch																		
11. Vernal pool																		
12. Flooded/irrigated pasture																		
13. Storm drain/catch basin	4092	Product	er (specify in comments sect	Each														
14. Waste water pond																		
14A. Waste Water Spray Field/Marsh																		
15. Winery waste pond																		
16. Stock pond																		
17. Irrigation pond/Vineyard Pond																		
18. Storm water detention basin	10	Product	er (specify in comments sect	Each														
19. Sump	4	Product	er (specify in comments sect	Each														
20. Septic tank	6	Product	er (specify in comments sect	Each														
21. Ornamental water garden/fish pond																		
22. Swimming pool																		
23. Spa/hot tub																		
24. Man-made container (e.g. buckets, tires, cemetery urns, wading pools, wheel barrow, etc)	69	Product	er (specify in comments sect	Each														
24A. Agrcultural Containers (e.g. bins, etc.)																		
25. Tree holes										38	2140	Product	Ounces (volume)		2	80	Product	Ounces (volume)
26. Horse/livestock watering troughs																		
27. Water under buildings															2	2	Product	Ounces (volume)
28. Utility vaults	5	Product	er (specify in comments sect	Each														
29. Dredge Disposal Pond																		
30. Wells/Water Storage Tanks/Pumps																		
31. Water Main Leaks																		
32. Other Natural Water Sources	17	Product	er (specify in comments sect	Each														
33. Other Commercial Sources	55	Product	er (specify in comments sect	Each														
34. Other																		
35. Fresh Water Pond (Natural)																		
36. Cess Pool																		
Total	4263	Product	er (specify in comments sect	Each	1	375	Product	Ounces (volume)		38	2140	Product	Ounces (volume)		4	82	Product	Ounces (volume)

Table A21.

Application Sites:	Pyrenone 25-5 Comments	Wasp Freeze - # Treatments	Total Amount Used33	Total Amount Type34	Total Amount Unit34	Wasp Freeze Comments	Drione Insecticide - # Treatments	Total Amount Used35	Total Amount Type36	Total Amount Unit36	Drione Comments	Contrac All-Weather Blox - # Treatments	Total Amount Used39	Total Amount Type40	Total Amount Unit40	Contrac Blox Comments	GB1111 Larv. Oil # Treatments	Total Amount Used
1. Tidal marsh																		
2. Fresh water marsh																		
2A. Reclaimed Marsh																		
3. Diked marsh																		
4. Seasonal wetland																		
4A. Seasonal Vineyard Water/Pothole																		
5. Natural seep																		
6. River margin																		
7. Creek																		
8. Seasonal creek pools																		
9. Channel (unlined)																	2	33
10. Ditch																		
10A. Agricultural Ditch																		
11. Vernal pool																		
12. Flooded/irrigated pasture																		
13. Storm drain/catch basin																	4	16
14. Waste water pond																	7	1200
14A. Waste Water Spray Field/Marsh																	3	2304
15. Winery waste pond																		
16. Stock pond																		
17. Irrigation pond/Vineyard Pond																		
18. Storm water detention basin																	2	25
19. Sump																	1	3
20. Septic tank																	4	22
21. Ornamental water garden/fish pond																	1	6
22. Swimming pool																	2	13
23. Spa/hot tub																		
24. Man-made container (e.g. buckets, tires, cemetery urns, wading pools, wheel barrow, etc)																	7	21
24A. Agrcultural Containers (e.g. bins, etc.)																		
25. Tree holes																		
26. Horse/livestock watering troughs																		
27. Water under buildings																		
28. Utility vaults																		
29. Dredge Disposal Pond																		
30. Wells/Water Storage Tanks/Pumps																		
31. Water Main Leaks																		
32. Other Natural Water Sources																		
33. Other Commercial Sources												1	50	Product	er (specify in comments secti	Each		
34. Other		7	34	Product	Ounces (volume)		233	465	Product	Ounces (weight)		22	288	Product	er (specify in comments secti	Each		
35. Fresh Water Pond (Natural)																		
36. Cess Pool																		
Total		7	34	Product	Ounces (volume)		233	465	Product	Ounces (weight)		23	338	Product	er (specify in comments secti	Each	33	3643

Table A21.

Application Sites:	Total Amount Type2	Total Amount Unit	GB1111 Larv Oil. Comments
1. Tidal marsh			
2. Fresh water marsh			
2A. Reclaimed Marsh			
3. Diked marsh			
4. Seasonal wetland			
4A. Seasonal Vineyard Water/Pothole			
5. Natural seep			
6. River margin			
7. Creek			
8. Seasonal creek pools			
9. Channel (unlined)	Product	Ounces (volume)	
10. Ditch			
10A. Agricultural Ditch			
11. Vernal pool			
12. Flooded/irrigated pasture			
13. Storm drain/catch basin	Product	Ounces (volume)	
14. Waste water pond	Product	Ounces (volume)	
14A. Waste Water Spray Field/Marsh	Product	Ounces (volume)	
15. Winery waste pond			
16. Stock pond			
17. Irrigation pond/Vineyard Pond			
18. Storm water detention basin	Product	Ounces (volume)	
19. Sump	Product	Ounces (volume)	
20. Septic tank	Product	Ounces (volume)	
21. Ornamental water garden/fish pond	Product	Ounces (volume)	
22. Swimming pool	Product	Ounces (volume)	
23. Spa/hot tub			
24. Man-made container (e.g. buckets, tires, cemetery urns, wading pools, wheel barrow, etc)	Product	Ounces (volume)	
24A. Agrcultural Containers (e.g. bins, etc.)			
25. Tree holes			
26. Horse/livestock watering troughs			
27. Water under buildings			
28. Utility vaults			
29. Dredge Disposal Pond			
30. Wells/Water Storage Tanks/Pumps			
31. Water Main Leaks			
32. Other Natural Water Sources			
33. Other Commercial Sources			
34. Other			
35. Fresh Water Pond (Natural)			
36. Cess Pool			
Total	Product	Ounces (volume)	

Table A22. **Pesticide Application Data for Fall 2011 – NCMAD**

Application Sites:	5% Skeeter Abate - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	5% Skeeter Abate - Comments	Teknar HP-D - # Treatments	Total Amount Used4	Total Amount Type4	Total Amount Unit5	Teknar HP-D - Comments	Altosid Liquid SR5 - # Treatments	Total Amount Used11	Total Amount Type11	Total Amount Unit12	Altosid Liquid SR5 - Comments	Altosid Pellets - # Treatments	Total Amount Used15	Total Amount Type15	Total Amount Unit16
1. Tidal marsh																			
2. Fresh water marsh	5	1072	Product	Ounces (weight)															
2A. Reclaimed Marsh																			
3. Diked marsh																			
4. Seasonal wetland																			
4A. Seasonal Vineyard Water/Pothole																			
5. Natural seep																			
6. River margin																			
7. Creek																			
8. Seasonal creek pools																			
9. Channel (unlined)	4	82	Product	Ounces (weight)		2	208	Product	Ounces (volume)		1	52	Product	Ounces (volume)		1	4	Product	Ounces (weight)
10. Ditch																			
11. Vernal pool																			
12. Flooded/irrigated pasture	1	16	Product	Ounces (weight)															
13. Storm drain/catch basin	2	22	Product	Ounces (weight)															
14. Waste water pond	2	48	Product	Ounces (weight)															
14A. Waste Water Spray Field/Marsh																			
15. Winery waste pond																			
16. Stock pond																			
17. Irrigation pond/Vineyard Pond																			
18. Storm water detention basin																			
19. Sump	1	6	Product	Ounces (weight)												1	2	Product	Ounces (weight)
20. Septic tank																			
21. Ornamental water garden/fish pond																			
22. Swimming pool																			
23. Spa/hot tub																			
24. Man-made container (e.g. buckets, tires, cemetery urns, wading pools, wheel barrow, etc)	8	36	Product	Ounces (weight)															
24A. Agricultural Containers (e.g. bins, etc.)																			
25. Tree holes																			
26. Horse/livestock watering troughs																			
27. Water under buildings																			
28. Utility vaults																			
29. Dredge Disposal Pond																			
30. Wells/Water Storage Tanks/Pumps																			
31. Water Main Leaks	2	12	Product	Ounces (weight)												1	24	Product	Ounces (weight)
32. Other Natural Water Sources	4	38	Product	Ounces (weight)															
33. Other Commercial Sources																			
34. Other																			
Total	29	1332	Product	Ounces (weight)		2	208	Product	Ounces (volume)		1	52	Product	Ounces (volume)		3	30	Product	Ounces (weight)

Table A22.

Application Sites:	Altosid Pellets - Comments	VectoLex CG - # Treatments	Total Amount Used19	Total Amount Type19	Total Amount Unit20	VectoLex CG - Comments	VectoMax WSP - # Treatments	Total Amount Used21	Total Amount Type21	Total Amount Unit22	VectoMax WSP - Comments	Altosid Briquets 30-day - # Treatments	Total Amount Used23	Total Amount Type23	Total Amount Unit24	Altosid Briquets 30-day - Comments	Drione Insecticide - # Treatments	Total Amount Used35	Total Amount Type35
1. Tidal marsh																			
2. Fresh water marsh																			
2A. Reclaimed Marsh																			
3. Diked marsh																			
4. Seasonal wetland																			
4A. Seasonal Vineyard Water/Pothole																			
5. Natural seep																			
6. River margin																			
7. Creek																			
8. Seasonal creek pools																			
9. Channel (unlined)																			
10. Ditch																			
11. Vernal pool																			
12. Flooded/irrigated pasture																			
13. Storm drain/catch basin																			
14. Waste water pond																			
14A. Waste Water Spray Field/Marsh																			
15. Winery waste pond																			
16. Stock pond																			
17. Irrigation pond/Vineyard Pond																			
18. Storm water detention basin																			
19. Sump																			
20. Septic tank							2	14	Product	(specify in comments s	Each								
21. Ornamental water garden/fish pond																			
22. Swimming pool																			
23. Spa/hot tub																			
24. Man-made container (e.g. buckets, tires, cemetery urns, wading pools, wheel barrow, etc)		1	3	Product	Ounces (weight)		3	10	Product	(specify in comments s	Each	1	3	Product	(specify in comments s	Each			
24A. Agricultural Containers (e.g. bins, etc.)																			
25. Tree holes																			
26. Horse/livestock watering troughs																			
27. Water under buildings																			
28. Utility vaults							1	5	Product	(specify in comments s	Each								
29. Dredge Disposal Pond																			
30. Wells/Water Storage Tanks/Pumps																			
31. Water Main Leaks							1	11	Product	(specify in comments s	Each								
32. Other Natural Water Sources																			
33. Other Commercial Sources																			
34. Other																	54	112	Product
Total		1	3	Product	Ounces (weight)		7	40	Product	(specify in comments s	Each	1	3	Product	(specify in comments s	Each	54	112	Product

Table A22.

Application Sites:	Total Amount Unit36	Drione Insecticide - Comments	Contrac All-Weather Blox - # Treatments	Total Amount Used39	Total Amount Type39	Total Amount Unit40	Contrac All-Weather Blox - Comments	GB1111 Larv. Oil # Treatment	Total Amount Used	Total Amount Type2	Total Amount Unit	GB1111 Larv. Oil Comments
1. Tidal marsh												
2. Fresh water marsh												
2A. Reclaimed Marsh												
3. Diked marsh												
4. Seasonal wetland												
4A. Seasonal Vineyard Water/Pothole												
5. Natural seep												
6. River margin												
7. Creek												
8. Seasonal creek pools												
9. Channel (unlined)												
10. Ditch												
11. Vernal pool												
12. Flooded/irrigated pasture												
13. Storm drain/catch basin												
14. Waste water pond								5	75	Product	Ounces (volume)	
14A. Waste Water Spray Field/Marsh												
15. Winery waste pond								1	16	Product	Ounces (volume)	
16. Stock pond												
17. Irrigation pond/Vineyard Pond												
18. Storm water detention basin												
19. Sump								1	2	Product	Ounces (volume)	
20. Septic tank								2	18	Product	Ounces (volume)	
21. Ornamental water garden/fish pond												
22. Swimming pool												
23. Spa/hot tub												
24. Man-made container (e.g. buckets, tires, cemetery urns, wading pools, wheel barrow, etc)								2	6	Product	Ounces (volume)	
24A. Agricultural Containers (e.g. bins, etc.)												
25. Tree holes												
26. Horse/livestock watering troughs												
27. Water under buildings												
28. Utility vaults												
29. Dredge Disposal Pond												
30. Wells/Water Storage Tanks/Pumps												
31. Water Main Leaks												
32. Other Natural Water Sources												
33. Other Commercial Sources			2	20	Product	(specify in comments s	Each					
34. Other	Ounces (weight)		16	142	Product	(specify in comments s	Each					
Total	Ounces (weight)		18	162	Product	(specify in comments s	Each	11	117	Product	Ounces (volume)	

Table A23. **Pesticide Application Data for Winter 2012 – NCMAD**

Application Sites:	5% Skeeter Abate - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	5% Skeeter Abate - Comments	Teknar HP-D - # Treatments	Total Amount Used4	Total Amount Type4	Total Amount Unit5	Teknar HP-D - Comments	Altosid Liquid SR5 - # Treatments	Total Amount Used11	Total Amount Type11	Total Amount Unit12	Altosid Liquid SR5 - Comments	Altosid Pellets - # Treatments	Total Amount Used15	Total Amount Type15	Total Amount Unit16
1. Tidal marsh						2	176	Product	Ounces (volume)		2	44	Product	Ounces (volume)		1	352	Product	Ounces (weight)
2. Fresh water marsh	3	832	Product	Ounces (weight)		4	520	Product	Ounces (volume)		4	130	Product	Ounces (volume)		1	352	Product	Ounces (weight)
2A. Reclaimed Marsh	1	704	Product	Ounces (weight)												1	704	Product	Ounces (weight)
3. Diked marsh																			
4. Seasonal wetland	20	1332	Product	Ounces (weight)		4	240	Product	Ounces (volume)		3	40	Product	Ounces (volume)		16	1584	Product	Ounces (weight)
4A. Seasonal Vineyard Water/Pothole																			
5. Natural seep																			
6. River margin																			
7. Creek																			
8. Seasonal creek pools																			
9. Channel (unlined)	4	148	Product	Ounces (weight)		4	560	Product	Ounces (volume)		5	160	Product	Ounces (volume)		5	224	Product	Ounces (weight)
10. Ditch																			
11. Vernal pool																			
12. Flooded/irrigated pasture	1	16	Product	Ounces (weight)															
13. Storm drain/catch basin	1	3	Product	Ounces (weight)															
14. Waste water pond																			
14A. Waste Water Spray Field/Marsh						1	320	Product	Ounces (volume)		1	80	Product	Ounces (volume)		1	704	Product	Ounces (weight)
15. Winery waste pond																			
16. Stock pond																			
17. Irrigation pond/Vineyard Pond																			
18. Storm water detention basin						2	400	Product	Ounces (volume)		2	100	Product	Ounces (volume)		3	728	Product	Ounces (weight)
19. Sump	2	7	Product	Ounces (weight)															
20. Septic tank																			
21. Ornamental water garden/fish pond																			
22. Swimming pool																1	4	Product	Ounces (weight)
23. Spa/hot tub																			
24. Man-made container (e.g. buckets, tires, cemetery urns, wading pools, wheel barrow, etc)	11	91	Product	Ounces (weight)												1	3	Product	Ounces (weight)
24A. Agricultural Containers (e.g. bins, etc.)																			
25. Tree holes	1	16	Product	Ounces (weight)												1	16	Product	Ounces (weight)
26. Horse/livestock watering troughs																			
27. Water under buildings																			
28. Utility vaults																			
29. Dredge Disposal Ponds																			
30. Wells/Water Storage Tanks/Pumps																			
31. Water Main Leaks	1	160	Product	Ounces (weight)															
32. Other Natural Water Sources																			
33. Other Commercial Sources																			
34. Other																			
35. Fresh Water Pond (Natural)																1	352	Product	Ounces (weight)
36. Fish Pond/Water Garden																			
Total	45	3309	Product	Ounces (weight)		17	2216	Product	Ounces (volume)		17	554	Product	Ounces (volume)		32	5023	Product	Ounces (weight)

Table A23.

Application Sites:	Altosid Pellets - Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type17	Total Amount Unit18	BVA-2 - Comments	VectoLex CG - # Treatments	Total Amount Used19	Total Amount Type19	Total Amount Unit20	VectoLex CG - Comments	VectoMax WSP - # Treatments	Total Amount Used21	Total Amount Type21	Total Amount Unit22	VectoMax WSP - Comments	Altosid Briquets 30-day - # Treatments	Total Amount Used23	Total Amount Type23
1. Tidal marsh																			
2. Fresh water marsh												1	14	Product	(specify in comments s	Each			
2A. Reclaimed Marsh																			
3. Diked marsh																			
4. Seasonal wetland		7	1084	Product	Ounces (volume)		1	8	Product	Ounces (weight)		9	122	Product	(specify in comments s	Each	5	93	Product
4A. Seasonal Vineyard Water/Pothole																			
5. Natural seep																			
6. River margin																			
7. Creek																			
8. Seasonal creek pools		1	384	Product	Ounces (volume)														
9. Channel (unlined)		3	928	Product	Ounces (volume)							2	28	Product	(specify in comments s	Each	2	10	Product
10. Ditch																			
11. Vernal pool																			
12. Flooded/irrigated pasture																			
13. Storm drain/catch basin		1	384	Product	Ounces (volume)							1	2	Product	(specify in comments s	Each			
14. Waste water pond																			
14A. Waste Water Spray Field/Marsh		2	2560	Product	Ounces (volume)							1	5	Product	(specify in comments s	Each			
15. Winery waste pond																			
16. Stock pond																			
17. Irrigation pond/Vineyard Pond																			
18. Storm water detention basin		1	256	Product	Ounces (volume)		1	32	Product	Ounces (weight)							1	15	Product
19. Sump																			
20. Septic tank												1	4	Product	(specify in comments s	Each			
21. Ornamental water garden/fish pond																			
22. Swimming pool																			
23. Spa/hot tub																			
24. Man-made container (e.g. buckets, tires, cemetery urns, wading pools, wheel barrow, etc)		6	12	Product	Ounces (volume)		1	4	Product	Ounces (weight)		7	86	Product	(specify in comments s	Each	5	82	Product
24A. Agricultural Containers (e.g. bins, etc.)																			
25. Tree holes																			
26. Horse/livestock watering troughs																			
27. Water under buildings																			
28. Utility vaults												2	20	Product	(specify in comments s	Each	1	10	Product
29. Dredge Disposal Ponds																			
30. Wells/Water Storage Tanks/Pumps																			
31. Water Main Leaks																			
32. Other Natural Water Sources																			
33. Other Commercial Sources																			
34. Other																			
35. Fresh Water Pond (Natural)																			
36. Fish Pond/Water Garden												1	4	Product	(specify in comments s	Each			
Total		21	5608	Product	Ounces (volume)		3	44	Product	Ounces (weight)		25	285	Product	(specify in comments s	Each	14	210	Product

Table A23.

Application Sites:	Total Amount Unit24	Altosid Briquets 30-day - Comments	Contrac All-Weather Blox - # Treatments	Total Amount Used39	Total Amount Type39	Total Amount Unit40	Contrac All-Weather Blox - Comments	GB1111 Larv. Oil # Treatments	Total Amount Used	Total Amount Type3	Total Amount Unit	GB1111 Larv. Oil Comments
1. Tidal marsh												
2. Fresh water marsh												
2A. Reclaimed Marsh												
3. Diked marsh												
4. Seasonal wetland	(specify in comments s	Each						4	640	Product	Ounces (volume)	
4A. Seasonal Vineyard Water/Pothole												
5. Natural seep												
6. River margin												
7. Creek												
8. Seasonal creek pools												
9. Channel (unlined)	(specify in comments s	Each						1	32	Product	Ounces (volume)	
10. Ditch												
11. Vernal pool												
12. Flooded/irrigated pasture												
13. Storm drain/catch basin												
14. Waste water pond												
14A. Waste Water Spray Field/Marsh								1	128	Product	Ounces (volume)	
15. Winery waste pond												
16. Stock pond												
17. Irrigation pond/Vineyard Pond												
18. Storm water detention basin	(specify in comments s	Each						3	768	Product	Ounces (volume)	
19. Sump												
20. Septic tank												
21. Ornamental water garden/fish pond												
22. Swimming pool												
23. Spa/hot tub												
24. Man-made container (e.g. buckets, tires, cemetery urns, wading pools, wheel barrow, etc)	(specify in comments s	Each						2	12	Product	Ounces (volume)	
24A. Agricultural Containers (e.g. bins, etc.)												
25. Tree holes												
26. Horse/livestock watering troughs												
27. Water under buildings												
28. Utility vaults	(specify in comments s	Each										
29. Dredge Disposal Ponds												
30. Wells/Water Storage Tanks/Pumps												
31. Water Main Leaks												
32. Other Natural Water Sources												
33. Other Commercial Sources			2	110	Product	(specify in comments s	Each					
34. Other			29	351	Product	(specify in comments s	Each					
35. Fresh Water Pond (Natural)												
36. Fish Pond/Water Garden												
Total	(specify in comments s	Each	31	461	Product	(specify in comments s	Each	11	1580	Product	Ounces (volume)	

Table A24. Pesticide Application Data for Spring 2012 – NCMAD

Application Sites:	5% Skeeter Abate - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	5% Skeeter Abate - Comments	Teknar HP-D - # Treatments	Total Amount Used4	Total Amount Type4	Total Amount Unit5	Teknar HP-D - Comments	Altosid Liquid SR5 - # Treatments	Total Amount Used11	Total Amount Type11	Total Amount Unit12	Altosid Liquid SR5 - Comments	Altosid Pellets - # Treatments	Total Amount Used15	Total Amount Type15	Total Amount Unit16
1. Tidal marsh	1	96	Product	Ounces (weight)		6	2480	Product	Ounces (volume)		5	320	Product	Ounces (volume)		1	1408	Product	Ounces (weight)
2. Fresh water marsh						7	2480	Product	Ounces (volume)		7	620	Product	Ounces (volume)		2	992	Product	Ounces (weight)
2A. Reclaimed Marsh											4	44	Product	Ounces (volume)					
3. Diked marsh	1	160	Product	Ounces (weight)															
4. Seasonal wetland/Rain Water	30	1657	Product	Ounces (weight)		23	1538	Product	Ounces (volume)		22	344	Product	Ounces (volume)		24	1660	Product	Ounces (weight)
4A. Seasonal Vineyard Water/Pothole						2	800	Product	Ounces (volume)							1	704	Product	Ounces (weight)
5. Natural seep	1	15	Product	Ounces (weight)															
6. River margin																			
7. Creek						1	32	Product	Ounces (volume)		1	8	Product	Ounces (volume)					
8. Seasonal creek pools																			
9. Channel (unlined)	14	487	Product	Ounces (weight)		22	1056	Product	Ounces (volume)		18	202	Product	Ounces (volume)		7	466	Product	Ounces (weight)
10. Ditch																			
11. Vernal pool																			
12. Flooded/irrigated pasture	1	64	Product	Ounces (weight)												1	32	Product	Ounces (weight)
13. Storm drain/catch basin	1	13	Product	Ounces (weight)		6	408	Product	Ounces (volume)		6	102	Product	Ounces (volume)		1	6	Product	Ounces (weight)
14. Waste water pond																			
14A. Waste Water Spray Field/Marsh						2	200	Product	Ounces (volume)		2	50	Product	Ounces (volume)					
15. Winery waste pond											5	188	Product	Ounces (volume)					
16. Stock pond																			
17. Irrigation pond/Vineyard Pond																			
18. Storm water detention basin						4	480	Product	Ounces (volume)		4	120	Product	Ounces (volume)		2	80	Product	Ounces (weight)
19. Sump																2	4	Product	Ounces (weight)
20. Septic tank	2	10	Product	Ounces (weight)															
21. Ornamental water garden/fish pond																			
22. Swimming pool	1	3	Product	Ounces (weight)															
23. Spa/hot tub																			
24. Man-made container (e.g. buckets, tires, cemetery urns, wading pools, wheel barrow, etc)	15	134	Product	Ounces (weight)												3	8	Product	Ounces (weight)
24A. Agricultural Containers (e.g. bins, etc)											1	40	Product	Ounces (volume)					
25. Tree holes																			
26. Horse/livestock watering troughs																			
27. Water under buildings																			
28. Utility vaults																			
29. Dredge Disposal Pond	1	160	Product	Ounces (weight)												1	160	Product	Ounces (weight)
30. Wells/Water Storage Tanks/Pumps																			
31. Water Main Leaks																			
32. Other Natural Water Sources											1	40	Product	Ounces (volume)		1	64	Product	Ounces (weight)
33. Other Commercial Sources																			
34. Other																			
Total	68	2799	Product	Ounces (weight)		73	9474	Product	Ounces (volume)		76	2078	Product	Ounces (volume)		46	5584	Product	Ounces (weight)

Table A24.

Application Sites:	Altosid Pellets - Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type17	Total Amount Unit18	BVA-2 - Comments	VectoLex CG - # Treatments	Total Amount Used19	Total Amount Type19	Total Amount Unit20	VectoLex CG - Comments	VectoMax WSP - # Treatments	Total Amount Used21	Total Amount Type21	Total Amount Unit22	VectoMax WSP - Comments	Altosid Briquets 30-day - # Treatments	Total Amount Used23	Total Amount Type23
1. Tidal marsh																			
2. Fresh water marsh		2	1280	Product	Ounces (volume)														
2A. Reclaimed Marsh																			
3. Diked marsh																			
4. Seasonal wetland/Rain Water		24	2538	Product	Ounces (volume)		18	1092	Product	Ounces (weight)		11	204	Product	(specify in comments s	Each	4	114	Product
4A. Seasonal Vineyard Water/Pothole		2	2176	Product	Ounces (volume)		5	672	Product	Ounces (weight)									
5. Natural seep		3	520	Product	Ounces (volume)														
6. River margin																			
7. Creek												1	2	Product	(specify in comments s	Each			
8. Seasonal creek pools		1	2	Product	Ounces (volume)														
9. Channel (unlined)		3	1600	Product	Ounces (volume)		1	13	Product	Ounces (weight)		5	0	Product	(specify in comments s	Each	3	16	Product
10. Ditch																			
11. Vernal pool																			
12. Flooded/irrigated pasture																			
13. Storm drain/catch basin		3	386	Product	Ounces (volume)		2	14	Product	Ounces (weight)		31	1263	Product	(specify in comments s	Each	5	2246	Product
14. Waste water pond		1	256	Product	Ounces (volume)		1	64	Product	Ounces (weight)		1	12	Product	(specify in comments s	Each			
14A. Waste Water Spray Field/Marsh		1	256	Product	Ounces (volume)														
15. Winery waste pond																			
16. Stock pond																			
17. Irrigation pond/Vineyard Pond		1	6	Product	Ounces (volume)		2	320	Product	Ounces (weight)		1	18	Product	(specify in comments s	Each			
18. Storm water detention basin		2	640	Product	Ounces (volume)														
19. Sump		3	21	Product	Ounces (volume)							3	1	Product	(specify in comments s	Each	2	54	Product
20. Septic tank		2	12	Product	Ounces (volume)		1	4	Product	Ounces (weight)		1	5	Product	(specify in comments s	Each			
21. Ornamental water garden/fish pond																			
22. Swimming pool												1	8	Product	(specify in comments s	Each			
23. Spa/hot tub																			
24. Man-made container (e.g. buckets, tires, cemetery urns, wading pools, wheel barrow, etc)		16	107	Product	Ounces (volume)		6	75	Product	Ounces (weight)		30	249	Product	(specify in comments s	Each	14	138	Product
24A. Agricultural Containers (e.g. bins, etc)		1	32	Product	Ounces (volume)														
25. Tree holes												1	2	Product	(specify in comments s	Each			
26. Horse/livestock watering troughs												1	4	Product	(specify in comments s	Each			
27. Water under buildings																			
28. Utility vaults		1	128	Product	Ounces (volume)							3	46	Product	(specify in comments s	Each			
29. Dredge Disposal Pond																			
30. Wells/Water Storage Tanks/Pumps		1	6	Product	Ounces (volume)														
31. Water Main Leaks												1	10	Product	(specify in comments s	Each			
32. Other Natural Water Sources												1	48	Product	(specify in comments s	Each			
33. Other Commercial Sources																			
34. Other																			
Total		67	9966	Product	Ounces (volume)		36	2254	Product	Ounces (weight)		92	1872	Product	(specify in comments s	Each	28	2568	Product

Table A24.

Application Sites:	Total Amount Unit24	Altosid Briquets 30-day - Commments	MGK Pyrocide 7396 - # Treatments	Total Amount Used27	Total Amount Type27	Total Amount Unit28	MGK Pyrocide 7396 - Comments	Drione Insecticide - # Treatments	Total Amount Used35	Total Amount Type35	Total Amount Unit36	Drione Insecticide - Comments	Contrac All-Weather Blox - # Treatments	Total Amount Used39	Total Amount Type39	Total Amount Unit40	Contrac All-Weather Blox -Comments
1. Tidal marsh																	
2. Fresh water marsh																	
2A. Reclaimed Marsh																	
3. Diked marsh																	
4. Seasonal wetland/Rain Water	(specify in comments s	Each															
4A. Seasonal Vineyard Water/Pothole																	
5. Natural seep																	
6. River margin																	
7. Creek																	
8. Seasonal creek pools																	
9. Channel (unlined)	(specify in comments s	Each															
10. Ditch																	
11. Vernal pool																	
12. Flooded/irrigated pasture																	
13. Storm drain/catch basin	(specify in comments s	Each															
14. Waste water pond																	
14A. Waste Water Spray Field/Marsh																	
15. Winery waste pond																	
16. Stock pond																	
17. Irrigation pond/Vineyard Pond																	
18. Storm water detention basin																	
19. Sump	(specify in comments s	Each															
20. Septic tank																	
21. Ornamental water garden/fish pond																	
22. Swimming pool																	
23. Spa/hot tub																	
24. Man-made container (e.g. buckets, tires, cemetery urns, wading pools, wheel barrow, etc)	(specify in comments s	Each															
24A. Agricultural Containers (e.g. bins, etc)																	
25. Tree holes			132	7879	Product	Ounces (volume)											
26. Horse/livestock watering troughs																	
27. Water under buildings																	
28. Utility vaults																	
29. Dredge Disposal Pond																	
30. Wells/Water Storage Tanks/Pumps																	
31. Water Main Leaks																	
32. Other Natural Water Sources																	
33. Other Commercial Sources																	
34. Other								12	24	Product	Ounces (weight)		21	295	Product	(specify in comments s	Each
Total	(specify in comments s	Each	132	7879	Product	Ounces (volume)		12	24	Product	Ounces (weight)		21	295	Product	(specify in comments s	Each

Table A25. Pesticide Product Key – NCMAD

Product	AI	Vector
5% Skeeter Abate	Temephos	Mosquito
Altosid Briquets 30-day	Methoprene	Mosquito
Altosid Liquid SR5	Methoprene	Mosquito
Altosid Pellets	Methoprene	Mosquito
BVA-2	Petroleum Distillate	Mosquito
Contrac All-Weather Blox	Bromadiolone	Rat
Drione Insecticide	Pyrethrin and Piperonyl Butroxide and Amorphous Silica Gel	Yellow Jacket / Wasp
MGK Pyrocide 7396	Pyrethrins and Piperonyl Butoxide	Mosquito
Permanone	Permethrin and Piperonyl Butoxide	Mosquito
Pyrenone 25-5	Pyrethrins and Piperonyl Butoxide	Mosquito
Teknar HP-D	Bacillus Thuringiensis Israelensis	Mosquito
VectoLex CG	Bacillus Sphaericus	Mosquito
VectoMax WSP	Bacillus Sphaericus and Bacillus Thuringiensis Israelensis	Mosquito
Wasp Freeze	Phenothrin and Trans Allethrin	Yellow Jacket / Wasp

Table A26. Pesticide Application Data for Summer 2011 – NSVMAD

Application Sites:	Agnique MMF - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	VectoBac G - # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit3	VectoBac G Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18	BVA-2 Comments
Storm Drains			Product	Ounces (volume)				Product	Pounds		500	20	Product	Gallons	
Catch Basins			Product	Ounces (volume)				Product	Pounds		500	20	Product	Gallons	
Troughs			Product	Ounces (volume)				Product	Pounds						
Water Features	3	6	Product	Ounces (volume)	Swimming pools			Product	Pounds						
Containers			Product	Ounces (volume)				Product	Pounds						
Standing / Flood Water			Product	Ounces (volume)		3	800	Product	Pounds						
Pastures			Product	Ounces (volume)				Product	Pounds						
Salt Marsh			Product	Ounces (volume)		5	2000	Product	Pounds						
Estuaries			Product	Ounces (volume)		5	1000	Product	Pounds						
Tidal / Woodland Pools			Product	Ounces (volume)		5	1000	Product	Pounds						
Wastewater			Product	Ounces (volume)		3	300	Product	Pounds		1	50	Product	Gallons	
Ditches			Product	Ounces (volume)		2	300	Product	Pounds		1	50	Product	Gallons	
Sewer / Dairy lagoons			Product	Ounces (volume)				Product	Pounds						
Retention / Detention Ponds			Product	Ounces (volume)				Product	Pounds		1	50	Product	Gallons	
Rural / Urban Residences			Product	Ounces (volume)				Product	Pounds						
Totals	3	6	Product	Ounces (volume)		23	5400	Product	Pounds		1003	190	Product	Gallons	

Table A26.

Application Sites:	VectoLex CG - # Treatments	Total Amount Used19	Total Amount Type20	Total Amount Unit20	VectoLex CG Comments	Natular G30 - # Treatments	Total Amount Used1924	Total Amount Type2025	Total Amount Unit2026	Natular G30 Comments
Storm Drains			Product	Pounds						
Catch Basins			Product	Pounds						
Troughs			Product	Pounds						
Water Features			Product	Pounds						
Containers			Product	Pounds						
Standing / Flood Water			Product	Pounds						
Pastures			Product	Pounds						
Salt Marsh	1	120	Product	Pounds		1	300	Product	Pounds	works well in colder temps
Estuaries			Product	Pounds						
Tidal / Woodland Pools			Product	Pounds						
Wastewater	1	80	Product	Pounds						
Ditches	1	80	Product	Pounds						
Sewer / Dairy lagoons			Product	Pounds						
Retention / Detention Ponds			Product	Pounds						
Rural / Urban Residences			Product	Pounds						
Totals	3	280	Product	Pounds		1	300	Product	Pounds	

Table A27. Pesticide Application Data for Fall 2011 – NSVMAD

Application Sites:	Agnique MMF - # Treatments	Total Amount_Used	Total Amount_Type	Total Amount_Unit	Agnique MMF Comments	VectoBac G - # Treatments	Total Amount_Used2	Total Amount_Type3	Total Amount_Unit3	VectoBac G Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount_Unit18	BVA-2 Comments
Storm Drains															
Catch Basins															
Troughs															
Water Features	1	1	Product	Ounces (weight)	swimming pool										
Containers															
Standing / Flood Water															
Pastures															
Salt Marsh															
Estuaries															
Tidal / Woodland Pools															
Wastewater						1	40	Product	Pounds		2	10	Product	Gallons	
Ditches											2	10	Product	Gallons	
Sewer / Dairy lagoons											2	10	Product	Gallons	
Retention / Detention Ponds											1	20	Product	Gallons	
Rural / Urban Residences															
Totals	1	1	Product	Ounces (weight)		1	40	Product	Pounds		7	50	Product	Gallons	

Table A27.

Application Sites:	Altosid XR-G (granules)- # Treatments	Total Amount Used39	Total Amount Type40	Total Amount Unit40	Altosid XR-G (granules) Blox Comments	Kontrol 4-4 - # Treatments	Total Amount Used1315	Total Amount Type1416	Total Amount Unit1417	Kontrol 4-4 Comments
Storm Drains	1	2	Product	Ounces (weight)						
Catch Basins										
Troughs										
Water Features										
Containers										
Standing / Flood Water										
Pastures										
Salt Marsh										
Estuaries										
Tidal / Woodland Pools										
Wastewater										
Ditches										
Sewer / Dairy lagoons										
Retention / Detention Ponds										
Rural / Urban Residences						1	78	Product	Ounces (weight)	
Totals	1	2	Product	Ounces (weight)		1	78	Product	Ounces (weight)	

Table A28. Pesticide Application Data for Winter 2012 – NSVMAD

Application Sites:	Agnique MMF - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	VectoBac G - # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit3	VectoBac G Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18	BVA-2 Comments
Storm Drains											500	20	Product	Gallons	
Catch Basins											500	20	Product	Gallons	
Troughs															
Water Features															
Containers															
Standing / Flood Water															
Pastures															
Salt Marsh						2	300	Product	Pounds						
Estuaries						1	40	Product	Pounds						
Tidal / Woodland Pools															
Wastewater											1	10	Product	Gallons	
Ditches															
Sewer / Dairy lagoons															
Retention / Detention Ponds		8													
Rural / Urban Residences	9														
Totals	9	8		0		3	340	Product	Pounds		1001	50			

Table A28.

Application Sites:	Natular 2EC - # Treatments	Total Amount Used1721	Total Amount Type1822	Total Amount Unit1823	Natular 2EC Comments	Natular G30 - # Treatments	Total Amount Used1924	Total Amount Type2025	Total Amount Unit2026	Natular G30 Comments
Storm Drains										
Catch Basins										
Troughs										
Water Features										
Containers										
Standing / Flood Water										
Pastures										
Salt Marsh	2	3	Active Ingredient	Gallons	mixed @ 10oz/gal	1	40	Product	Pounds	
Estuaries	3	5	Active Ingredient	Gallons	mixed @ 10oz/gal	5	1000	Product	Pounds	
Tidal / Woodland Pools	2	3	Active Ingredient	Gallons	mixed @ 10oz/gal	3	500	Product	Pounds	
Wastewater										
Ditches										
Sewer / Dairy lagoons										
Retention / Detention Ponds										
Rural / Urban Residences										
Totals	7	11	Active Ingredient	Gallons	mixed @ 10oz/gal	9	1540	Product	Pounds	

Table A29. Pesticide Application Data for Spring 2012 – NSVMAD

Application Sites:	VectoBac G - # Treatments	Total Amount_Used2	Total Amount_Type3	Total Amount_Unit3	VectoBac G Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount_Unit18	BVA-2 Comments	Teknar HP-D - # Treatments	Total Amount Used27	Total Amount Type28	Total Amount_Unit28	Teknar HP-D Comments
Storm Drains						1500	50	Product	Gallons						
Catch Basins						1500	50	Product	Gallons						
Troughs															
Water Features															
Containers															
Standing / Flood Water						5	35	Product	Gallons		5	3	Active Ingredient	Gallons	16 oz / gallon water
Pastures															
Salt Marsh	2	120	Product			5	40	Product	Gallons		3	10	Active Ingredient	Gallons	16 oz / gallon water
Estuaries	2	120	Product			5	50	Product	Gallons		3	10	Active Ingredient	Gallons	16 oz / gallon water
Tidal / Woodland Pools	2	120	Product			5	50	Product	Gallons						
Wastewater															
Ditches											5	3	Active Ingredient	Gallons	16 oz / gallon water
Sewer / Dairy lagoons											5	3	Active Ingredient	Gallons	16 oz / gallon water
Retention / Detention Ponds	2	40	Product								5	3	Active Ingredient	Gallons	16 oz / gallon water
Rural / Urban Residences															
Totals	8	400	Product	0		3020	275	Product	Gallons		26	32	Active Ingredient	Gallons	16 oz / gallon water

Table A29.

Application Sites:	FourStar 45 Bti - # Treatments	Total Amount Used35	Total Amount Type36	Total Amount Unit36	FourStar 45 Bti Comments	Natular G30 - # Treatments	Total Amount Used1924	Total Amount Type2025	Total Amount Unit2026	Natular G30 Comments
Storm Drains										
Catch Basins										
Troughs										
Water Features										
Containers										
Standing / Flood Water						3	250	Product	Pounds	
Pastures										
Salt Marsh	10	5000				3	250	Product	Pounds	
Estuaries	10	5000				3	250	Product	Pounds	
Tidal / Woodland Pools	5	3000				3	250	Product	Pounds	
Wastewater	10	1000				5	100	Product	Pounds	
Ditches										
Sewer / Dairy lagoons	5	1000								
Retention / Detention Ponds										
Rural / Urban Residences										
Totals	40	15000				17	1100	Product	Pounds	

Table A30. Pesticide Product Key – NSVMAD

Product	AI	Vector
VectoLex CG Biologic	Bacillus Sphaericus	Mosquito
FourStar 45 Bti	Bacillus Sphaericus and Bacillus Thuringiensis Israelensis	Mosquito
Teknar HP-D	Bacillus Thuringiensis Israelensis	Mosquito
VectoBac G	Bacillus Thuringiensis Israelensis	Mosquito
Agnique MMF	Biodegradable Alcohol Ethoxylated Surfactant	Mosquito
Altosid XR-G (granules)	Methoprene	Mosquito
Kontrol 4-4	Permethrin and Piperonyl Butoxide	Mosquito
BVA 2	Petroleum Distillate	Mosquito
Natular G30	Spinosad	Mosquito
Natular 2EC	Spinosad	Mosquito

Table A31. Pesticide Application Data for Summer 2011 – SCCVCD

Application Sites:	Agnique MMF-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	AGNIQUE MMF G-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	AGNIQUE MMF G Comments	Altosid Briquets 30-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid Briquets 30 Comments
	7	0.03998	Product	Gallons		1	0.6916	Product	Pounds		2	0.045	Product	Pounds	
Bird Bath			Product	Gallons				Product	Pounds		1	0.03	Product	Pounds	
Catch Basin	5	0.008035	Product	Gallons				Product	Pounds				Product	Pounds	
Cemetery vases	4	0.004591	Product	Gallons				Product	Pounds				Product	Pounds	
Channel	2	0.092961	Product	Gallons		1	0.8398	Product	Pounds				Product	Pounds	
Clean Pool	3	0.022507	Product	Gallons				Product	Pounds				Product	Pounds	
Commercial			Product	Gallons				Product	Pounds				Product	Pounds	
Container			Product	Gallons				Product	Pounds				Product	Pounds	
Creek	16	0.914632	Product	Gallons		15	33.341	Product	Pounds		1	0.33	Product	Pounds	
Curbs	51	0.850476	Product	Gallons		10	43.918875	Product	Pounds				Product	Pounds	
Dairy Drain	1	0.001148	Product	Gallons				Product	Pounds				Product	Pounds	
Diked Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Drain			Product	Gallons				Product	Pounds				Product	Pounds	
Fish Pond			Product	Gallons				Product	Pounds				Product	Pounds	
Flooded Area	2	0.002525	Product	Gallons				Product	Pounds				Product	Pounds	
FW Marsh			Product	Gallons		1	0.1	Product	Pounds				Product	Pounds	
Impound			Product	Gallons		1	0.4199	Product	Pounds				Product	Pounds	
Lake			Product	Gallons				Product	Pounds				Product	Pounds	
Lift Station			Product	Gallons				Product	Pounds				Product	Pounds	
Neglected Pool	84	0.431675	Product	Gallons		9	0.8022	Product	Pounds				Product	Pounds	
Ornamental Pond	5	0.01033	Product	Gallons		1	0.07	Product	Pounds				Product	Pounds	
Park			Product	Gallons				Product	Pounds				Product	Pounds	
Parking garage			Product	Gallons				Product	Pounds				Product	Pounds	
Pond	5	0.401396	Product	Gallons		3	3.9026	Product	Pounds				Product	Pounds	
Residential	2	0.014357	Product	Gallons				Product	Pounds				Product	Pounds	
Salt Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Seepage			Product	Gallons				Product	Pounds				Product	Pounds	
Sewer Pond	66	0.422688	Product	Gallons		20	4.3892	Product	Pounds				Product	Pounds	
Tires			Product	Gallons				Product	Pounds				Product	Pounds	
Utility Vault			Product	Gallons				Product	Pounds				Product	Pounds	
Watering Trough	1	0.00023	Product	Gallons				Product	Pounds				Product	Pounds	
Totals	254	3.217531	Product	Gallons		62	88.475175	Product	Pounds		4	0.405	Product	Pounds	

Table A31.

Application Sites:	Altosid XR Briquets-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid XR Briquets Comments	Altosid XR-G-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid XR-G Comments	BVA 2 Mosquito Larvi-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	BVA 2 Mosquito Larvi Comments
			Product	Pounds				Product	Pounds				Product	Gallons	
Bird Bath			Product	Pounds				Product	Pounds		1	0.00825	Product	Gallons	
Catch Basin	1	1.2075	Product	Pounds				Product	Pounds		42	0.34625	Product	Gallons	
Cemetery vases	2	1.127	Product	Pounds				Product	Pounds		7	0.681875	Product	Gallons	
Channel	1	0.0805	Product	Pounds				Product	Pounds		3	0.018375	Product	Gallons	
Clean Pool			Product	Pounds				Product	Pounds		7	0.099609	Product	Gallons	
Commercial			Product	Pounds				Product	Pounds		1	0.0055	Product	Gallons	
Container			Product	Pounds				Product	Pounds		1	0.003906	Product	Gallons	
Creek	6	1.932	Product	Pounds		5	16.138	Product	Pounds		56	4.28474	Product	Gallons	
Curbs	10	2.9785	Product	Pounds		1	0.046	Product	Pounds		150	2.041118	Product	Gallons	
Dairy Drain			Product	Pounds				Product	Pounds				Product	Gallons	
Diked Marsh			Product	Pounds				Product	Pounds				Product	Gallons	
Drain			Product	Pounds				Product	Pounds		1	0.003906	Product	Gallons	
Fish Pond			Product	Pounds				Product	Pounds				Product	Gallons	
Flooded Area			Product	Pounds				Product	Pounds		10	0.476295	Product	Gallons	
FW Marsh			Product	Pounds				Product	Pounds				Product	Gallons	
Impound			Product	Pounds				Product	Pounds		4	0.111563	Product	Gallons	
Lake			Product	Pounds				Product	Pounds				Product	Gallons	
Lift Station			Product	Pounds				Product	Pounds				Product	Gallons	
Neglected Pool			Product	Pounds				Product	Pounds		31	0.170385	Product	Gallons	
Ornamental Pond			Product	Pounds				Product	Pounds				Product	Gallons	
Park			Product	Pounds				Product	Pounds				Product	Gallons	
Parking garage			Product	Pounds				Product	Pounds				Product	Gallons	
Pond			Product	Pounds		1	0.15	Product	Pounds		4	0.889188	Product	Gallons	
Residential			Product	Pounds				Product	Pounds		3	0.041313	Product	Gallons	
Salt Marsh			Product	Pounds				Product	Pounds		1	0.020625	Product	Gallons	
Seepage			Product	Pounds				Product	Pounds				Product	Gallons	
Sewer Pond			Product	Pounds				Product	Pounds		31	0.469939	Product	Gallons	
Tires			Product	Pounds				Product	Pounds				Product	Gallons	
Utility Vault			Product	Pounds				Product	Pounds		4	0.070313	Product	Gallons	
Watering Trough			Product	Pounds				Product	Pounds				Product	Gallons	
Totals	20	7.3255	Product	Pounds		7	16.334	Product	Pounds		357	9.74315	Product	Gallons	

Table A31.

Application Sites:	Drione Insecticide-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Drione Insecticide Comments	EcoExempt IC2-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	EcoExempt IC2 Comments	Fourstar 180 briq-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Fourstar 180 briq Comments
			Product	Pounds				Product	Gallons		1	0.125	Product	Pounds	
Bird Bath			Product	Pounds				Product	Gallons		1	0.0625	Product	Pounds	
Catch Basin			Product	Pounds				Product	Gallons		2	0.4375	Product	Pounds	
Cemetery vases			Product	Pounds				Product	Gallons				Product	Pounds	
Channel			Product	Pounds				Product	Gallons		3	0.5625	Product	Pounds	
Clean Pool			Product	Pounds				Product	Gallons		3	1.0625	Product	Pounds	
Commercial			Product	Pounds				Product	Gallons				Product	Pounds	
Container			Product	Pounds				Product	Gallons		2	0.875	Product	Pounds	
Creek			Product	Pounds				Product	Gallons		19	5.3125	Product	Pounds	
Curbs			Product	Pounds				Product	Gallons		5	0.8125	Product	Pounds	
Dairy Drain			Product	Pounds				Product	Gallons				Product	Pounds	
Diked Marsh			Product	Pounds				Product	Gallons				Product	Pounds	
Drain			Product	Pounds				Product	Gallons				Product	Pounds	
Fish Pond			Product	Pounds				Product	Gallons				Product	Pounds	
Flooded Area			Product	Pounds				Product	Gallons		2	0.1875	Product	Pounds	
FW Marsh			Product	Pounds				Product	Gallons				Product	Pounds	
Impound			Product	Pounds				Product	Gallons				Product	Pounds	
Lake			Product	Pounds				Product	Gallons				Product	Pounds	
Lift Station			Product	Pounds				Product	Gallons		1	0.125	Product	Pounds	
Neglected Pool			Product	Pounds				Product	Gallons		64	8.5625	Product	Pounds	
Ornamental Pond			Product	Pounds				Product	Gallons				Product	Pounds	
Park	2	0.04375	Product	Pounds				Product	Gallons				Product	Pounds	
Parking garage	1	0.0125	Product	Pounds				Product	Gallons				Product	Pounds	
Pond			Product	Pounds				Product	Gallons		1	0.125	Product	Pounds	
Residential			Product	Pounds				Product	Gallons		1	0.0625	Product	Pounds	
Salt Marsh			Product	Pounds				Product	Gallons				Product	Pounds	
Seepage			Product	Pounds				Product	Gallons				Product	Pounds	
Sewer Pond			Product	Pounds		4	0.070314	Product	Gallons		16	9.5625	Product	Pounds	
Tires			Product	Pounds				Product	Gallons		1	0.25	Product	Pounds	
Utility Vault			Product	Pounds				Product	Gallons				Product	Pounds	
Watering Trough			Product	Pounds				Product	Gallons				Product	Pounds	
Totals	3	0.05625	Product	Pounds		4	0.070314	Product	Gallons		122	28.125	Product	Pounds	

Table A31.

Application Sites:	Fourstar 45 briq-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Fourstar 45 briq Comments	Fourstar 90 briq-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Fourstar 90 briq Comments	Golden Bear 1111 Oil-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Golden Bear 1111 Oil Comments
			Product	Pounds				Product	Pounds				Product	Gallons	
Bird Bath			Product	Pounds				Product	Pounds				Product	Gallons	
Catch Basin			Product	Pounds				Product	Pounds				Product	Gallons	
Cemetery vases	2	0.210938	Product	Pounds				Product	Pounds				Product	Gallons	
Channel	1	0.28125	Product	Pounds				Product	Pounds				Product	Gallons	
Clean Pool			Product	Pounds				Product	Pounds				Product	Gallons	
Commercial			Product	Pounds				Product	Pounds				Product	Gallons	
Container			Product	Pounds				Product	Pounds		1	0.011719	Product	Gallons	
Creek	23	2.828127	Product	Pounds		4	1.375	Product	Pounds				Product	Gallons	
Curbs	2	0.03125	Product	Pounds				Product	Pounds		22	0.0825	Product	Gallons	
Dairy Drain			Product	Pounds				Product	Pounds				Product	Gallons	
Diked Marsh			Product	Pounds				Product	Pounds				Product	Gallons	
Drain			Product	Pounds				Product	Pounds				Product	Gallons	
Fish Pond			Product	Pounds				Product	Pounds				Product	Gallons	
Flooded Area			Product	Pounds				Product	Pounds		1	0.25	Product	Gallons	
FW Marsh			Product	Pounds				Product	Pounds				Product	Gallons	
Impound			Product	Pounds				Product	Pounds				Product	Gallons	
Lake	1	0.15625	Product	Pounds				Product	Pounds				Product	Gallons	
Lift Station			Product	Pounds				Product	Pounds				Product	Gallons	
Neglected Pool	3	0.019532	Product	Pounds		7	0.289063	Product	Pounds		5	0.154219	Product	Gallons	
Ornamental Pond	1	0.015625	Product	Pounds				Product	Pounds				Product	Gallons	
Park			Product	Pounds				Product	Pounds				Product	Gallons	
Parking garage			Product	Pounds				Product	Pounds				Product	Gallons	
Pond	1	0.0625	Product	Pounds				Product	Pounds				Product	Gallons	
Residential			Product	Pounds		2	0.09375	Product	Pounds				Product	Gallons	
Salt Marsh			Product	Pounds				Product	Pounds				Product	Gallons	
Seepage			Product	Pounds				Product	Pounds				Product	Gallons	
Sewer Pond			Product	Pounds				Product	Pounds				Product	Gallons	
Tires			Product	Pounds				Product	Pounds				Product	Gallons	
Utility Vault			Product	Pounds				Product	Pounds				Product	Gallons	
Watering Trough			Product	Pounds				Product	Pounds				Product	Gallons	
Totals	34	3.605472	Product	Pounds		13	1.757813	Product	Pounds		29	0.498438	Product	Gallons	

Table A31.

Application Sites:	Pyrenone 25-5-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Pyrenone 25-5 Comments	Vectobac 12AS-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectobac 12AS Comments	Vectobac G-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectobac G Comments
	13	77.58	Product	Gallons		1	0.000287	Product	Gallons		1	0.23	Product	Pounds	
Bird Bath			Product	Gallons				Product	Gallons				Product	Pounds	
Catch Basin			Product	Gallons				Product	Gallons		4	0.207	Product	Pounds	
Cemetery vases			Product	Gallons				Product	Gallons		4	0.92	Product	Pounds	
Channel			Product	Gallons		3	0.252294	Product	Gallons		16	34.548	Product	Pounds	
Clean Pool			Product	Gallons		4	0.051122	Product	Gallons				Product	Pounds	
Commercial	1	7.5	Product	Gallons		2	2.138189	Product	Gallons				Product	Pounds	
Container			Product	Gallons		1	0.000313	Product	Gallons		2	1.175	Product	Pounds	
Creek			Product	Gallons		61	3.602547	Product	Gallons		172	382.6285	Product	Pounds	
Curbs			Product	Gallons		11	2.929331	Product	Gallons		14	21.311313	Product	Pounds	
Dairy Drain			Product	Gallons				Product	Gallons		4	0.115	Product	Pounds	
Diked Marsh			Product	Gallons				Product	Gallons		1	25	Product	Pounds	
Drain			Product	Gallons				Product	Gallons				Product	Pounds	
Fish Pond			Product	Gallons		1	0.00172	Product	Gallons				Product	Pounds	
Flooded Area			Product	Gallons		5	0.205854	Product	Gallons		7	11.132	Product	Pounds	
FW Marsh			Product	Gallons				Product	Gallons		3	41	Product	Pounds	
Impound			Product	Gallons				Product	Gallons		2	0.5405	Product	Pounds	
Lake			Product	Gallons		1	0.019784	Product	Gallons				Product	Pounds	
Lift Station			Product	Gallons		3	0.026092	Product	Gallons				Product	Pounds	
Neglected Pool			Product	Gallons		15	1.103133	Product	Gallons		4	1.555	Product	Pounds	
Ornamental Pond			Product	Gallons		2	0.001798	Product	Gallons		2	0.09	Product	Pounds	
Park			Product	Gallons				Product	Gallons				Product	Pounds	
Parking garage			Product	Gallons				Product	Gallons				Product	Pounds	
Pond			Product	Gallons		7	0.237349	Product	Gallons		7	53.826	Product	Pounds	
Residential	4	19.8	Product	Gallons		1	0.00172	Product	Gallons		1	0.138	Product	Pounds	
Salt Marsh			Product	Gallons		4	11	Product	Gallons		16	104.203	Product	Pounds	
Seepage			Product	Gallons				Product	Gallons		1	0.23	Product	Pounds	
Sewer Pond			Product	Gallons		18	0.021757	Product	Gallons		15	11.408	Product	Pounds	
Tires			Product	Gallons				Product	Gallons				Product	Pounds	
Utility Vault			Product	Gallons				Product	Gallons				Product	Pounds	
Watering Trough			Product	Gallons				Product	Gallons				Product	Pounds	
Totals	18	104.88	Product	Gallons		140	21.59329	Product	Gallons		276	690.257313	Product	Pounds	

Table A31.

Application Sites:	Vectolex CG-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectolex CG Comments	Vectolex WSP-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectolex WSP Comments	Vectomax CG-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectomax CG Comments
	1	0.23	Product	Pounds				Product	Pounds				Product	Pounds	
Bird Bath			Product	Pounds				Product	Pounds				Product	Pounds	
Catch Basin			Product	Pounds				Product	Pounds				Product	Pounds	
Cemetery vases			Product	Pounds				Product	Pounds				Product	Pounds	
Channel	2	8.5	Product	Pounds				Product	Pounds				Product	Pounds	
Clean Pool			Product	Pounds				Product	Pounds				Product	Pounds	
Commercial			Product	Pounds				Product	Pounds				Product	Pounds	
Container			Product	Pounds				Product	Pounds				Product	Pounds	
Creek	86	116.5627	Product	Pounds				Product	Pounds				Product	Pounds	
Curbs	2	0.0345	Product	Pounds				Product	Pounds				Product	Pounds	
Dairy Drain			Product	Pounds				Product	Pounds				Product	Pounds	
Diked Marsh			Product	Pounds				Product	Pounds				Product	Pounds	
Drain			Product	Pounds				Product	Pounds				Product	Pounds	
Fish Pond			Product	Pounds				Product	Pounds				Product	Pounds	
Flooded Area	2	3.1004	Product	Pounds		1	0.5	Product	Pounds				Product	Pounds	
FW Marsh			Product	Pounds				Product	Pounds				Product	Pounds	
Impound	1	0.0115	Product	Pounds				Product	Pounds				Product	Pounds	
Lake			Product	Pounds				Product	Pounds				Product	Pounds	
Lift Station			Product	Pounds				Product	Pounds				Product	Pounds	
Neglected Pool	9	1.886	Product	Pounds		1	0.12	Product	Pounds		1	0.09	Product	Pounds	
Ornamental Pond	2	0.046	Product	Pounds				Product	Pounds				Product	Pounds	
Park			Product	Pounds				Product	Pounds				Product	Pounds	
Parking garage			Product	Pounds				Product	Pounds				Product	Pounds	
Pond	1	0.529	Product	Pounds				Product	Pounds				Product	Pounds	
Residential			Product	Pounds				Product	Pounds				Product	Pounds	
Salt Marsh			Product	Pounds				Product	Pounds				Product	Pounds	
Seepage	1	10	Product	Pounds				Product	Pounds				Product	Pounds	
Sewer Pond	2	0.046	Product	Pounds				Product	Pounds				Product	Pounds	
Tires			Product	Pounds				Product	Pounds				Product	Pounds	
Utility Vault			Product	Pounds				Product	Pounds				Product	Pounds	
Watering Trough			Product	Pounds				Product	Pounds				Product	Pounds	
Totals	109	140.9461	Product	Pounds		2	0.62	Product	Pounds		1	0.09	Product	Pounds	

Table A32. **Pesticide Application Data for Fall 2011 – SCCVCD**

Application Sites:	Agnique MMF-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	AGNIQUE MMF G-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	AGNIQUE MMF G Comments	Altosid Briquets 30-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid Briquets 30 Comments
	1	0.009766	Product	Gallons				Product	Pounds				Product	Pounds	
Catch Basin	1	0.002295	Product	Gallons				Product	Pounds				Product	Pounds	
Cemetery vases	1	0.001148	Product	Gallons				Product	Pounds				Product	Pounds	
Channel			Product	Gallons				Product	Pounds				Product	Pounds	
Clean Pool			Product	Gallons				Product	Pounds				Product	Pounds	
Commercial			Product	Gallons				Product	Pounds				Product	Pounds	
Container	1	0.004591	Product	Gallons				Product	Pounds				Product	Pounds	
Creek	7	0.209313	Product	Gallons		4	1.2817	Product	Pounds		3	0.165	Product	Pounds	
Curbs	4	0.17554	Product	Gallons		2	3.1996	Product	Pounds		1	0.045	Product	Pounds	
Dairy Drain			Product	Gallons				Product	Pounds				Product	Pounds	
Diked Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Drain			Product	Gallons		1	0.0247	Product	Pounds				Product	Pounds	
Duck Pond			Product	Gallons				Product	Pounds				Product	Pounds	
Flooded Area	3	0.079189	Product	Gallons		2	0.4486	Product	Pounds				Product	Pounds	
FW Marsh			Product	Gallons		1	0.1976	Product	Pounds				Product	Pounds	
Impound			Product	Gallons				Product	Pounds				Product	Pounds	
Lake			Product	Gallons				Product	Pounds				Product	Pounds	
Lift Station			Product	Gallons				Product	Pounds				Product	Pounds	
Neglected Pool	3	0.025686	Product	Gallons		1	0.09	Product	Pounds				Product	Pounds	
Ornamental Pond	1	0.002289	Product	Gallons				Product	Pounds				Product	Pounds	
Pond	1	0.001148	Product	Gallons		1	5.928	Product	Pounds				Product	Pounds	
Residential	1	0.001148	Product	Gallons				Product	Pounds				Product	Pounds	
Salt Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Sewer Pond	7	0.018227	Product	Gallons		1	1.1856	Product	Pounds				Product	Pounds	
Tires	1	0.000156	Product	Gallons				Product	Pounds				Product	Pounds	
Treehole			Product	Gallons				Product	Pounds				Product	Pounds	
Utility Vault			Product	Gallons				Product	Pounds				Product	Pounds	
Watering Trough			Product	Gallons				Product	Pounds				Product	Pounds	
Totals	32	0.530496	Product	Gallons		13	12.3558	Product	Pounds		4	0.21	Product	Pounds	

Table A32.

Application Sites:	Altosid Pellets-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid Pellets Comments	Altosid XR Briquets-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid XR Briquets Comments	Altosid XR-G-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid XR-G Comments
			Product	Pounds				Product	Pounds				Product	Pounds	
Catch Basin			Product	Pounds		2	0.4025	Product	Pounds				Product	Pounds	
Cemetery vases			Product	Pounds				Product	Pounds				Product	Pounds	
Channel			Product	Pounds				Product	Pounds				Product	Pounds	
Clean Pool			Product	Pounds				Product	Pounds				Product	Pounds	
Commercial			Product	Pounds				Product	Pounds				Product	Pounds	
Container			Product	Pounds				Product	Pounds				Product	Pounds	
Creek	1	8	Product	Pounds		2	0.253575	Product	Pounds		5	1.725	Product	Pounds	
Curbs			Product	Pounds		2	0.161	Product	Pounds				Product	Pounds	
Dairy Drain			Product	Pounds				Product	Pounds				Product	Pounds	
Diked Marsh			Product	Pounds				Product	Pounds				Product	Pounds	
Drain			Product	Pounds				Product	Pounds				Product	Pounds	
Duck Pond			Product	Pounds				Product	Pounds				Product	Pounds	
Flooded Area			Product	Pounds				Product	Pounds				Product	Pounds	
FW Marsh			Product	Pounds				Product	Pounds				Product	Pounds	
Impound			Product	Pounds				Product	Pounds				Product	Pounds	
Lake			Product	Pounds				Product	Pounds				Product	Pounds	
Lift Station			Product	Pounds				Product	Pounds				Product	Pounds	
Neglected Pool			Product	Pounds		2	0.322	Product	Pounds				Product	Pounds	
Ornamental Pond			Product	Pounds				Product	Pounds				Product	Pounds	
Pond			Product	Pounds				Product	Pounds				Product	Pounds	
Residential			Product	Pounds		1	0.161	Product	Pounds				Product	Pounds	
Salt Marsh			Product	Pounds				Product	Pounds				Product	Pounds	
Sewer Pond			Product	Pounds				Product	Pounds				Product	Pounds	
Tires			Product	Pounds				Product	Pounds				Product	Pounds	
Treehole			Product	Pounds				Product	Pounds				Product	Pounds	
Utility Vault			Product	Pounds				Product	Pounds				Product	Pounds	
Watering Trough			Product	Pounds				Product	Pounds				Product	Pounds	
Totals	1	8	Product	Pounds		9	1.300075	Product	Pounds		5	1.725	Product	Pounds	

Table A32.

Application Sites:	BVA 2 Mosquito Larvi-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	BVA 2 Mosquito Larvi Comments	Contrac 8oz blk-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Contrac 8oz blk Comments	Diphacinone-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Diphacinone Comments
			Product	Gallons				Product					Product	Pounds	
Catch Basin	2	0.054875	Product	Gallons				Product					Product	Pounds	
Cemetery vases	3	0.148875	Product	Gallons				Product					Product	Pounds	
Channel	2	0.013313	Product	Gallons				Product					Product	Pounds	
Clean Pool	4	0.035157	Product	Gallons				Product					Product	Pounds	
Commercial	1	0.006875	Product	Gallons				Product					Product	Pounds	
Container			Product	Gallons				Product					Product	Pounds	
Creek	24	0.53222	Product	Gallons				Product					Product	Pounds	
Curbs	18	1.219219	Product	Gallons				Product					Product	Pounds	
Dairy Drain	1	0.004125	Product	Gallons				Product					Product	Pounds	
Diked Marsh			Product	Gallons				Product					Product	Pounds	
Drain			Product	Gallons				Product					Product	Pounds	
Duck Pond			Product	Gallons				Product					Product	Pounds	
Flooded Area	5	0.29975	Product	Gallons				Product					Product	Pounds	
FW Marsh	2	0.011	Product	Gallons				Product					Product	Pounds	
Impound	2	0.03675	Product	Gallons				Product					Product	Pounds	
Lake			Product	Gallons				Product					Product	Pounds	
Lift Station			Product	Gallons				Product					Product	Pounds	
Neglected Pool	8	0.099126	Product	Gallons				Product					Product	Pounds	
Ornamental Pond	1	0.006875	Product	Gallons				Product					Product	Pounds	
Pond			Product	Gallons				Product					Product	Pounds	
Residential			Product	Gallons		2		Product			1		Product	Pounds	
Salt Marsh	2	3.5825	Product	Gallons				Product					Product	Pounds	
Sewer Pond	2	0.221375	Product	Gallons				Product					Product	Pounds	
Tires			Product	Gallons				Product					Product	Pounds	
Treehole			Product	Gallons				Product					Product	Pounds	
Utility Vault	1	0.015625	Product	Gallons				Product					Product	Pounds	
Watering Trough			Product	Gallons				Product					Product	Pounds	
Totals	78	6.28766	Product	Gallons		2		Product			1		Product	Pounds	

Table A32.

Application Sites:	Drione Insecticide-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Drione Insecticide Comments	FirstStrike Soft Bai-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	FirstStrike Soft Bai Comments	Fourstar 180 briq-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Fourstar 180 briq Comments
			Product	Pounds				Product			1	0.0625	Product	Pounds	
Catch Basin			Product	Pounds				Product			1	1.5	Product	Pounds	
Cemetery vases			Product	Pounds				Product					Product	Pounds	
Channel			Product	Pounds				Product			1	0.625	Product	Pounds	
Clean Pool			Product	Pounds				Product					Product	Pounds	
Commercial			Product	Pounds		1		Product			1	0.125	Product	Pounds	
Container			Product	Pounds				Product					Product	Pounds	
Creek			Product	Pounds				Product			32	9.625	Product	Pounds	
Curbs			Product	Pounds				Product			3	0.75	Product	Pounds	
Dairy Drain			Product	Pounds				Product					Product	Pounds	
Diked Marsh			Product	Pounds				Product					Product	Pounds	
Drain			Product	Pounds				Product					Product	Pounds	
Duck Pond			Product	Pounds				Product					Product	Pounds	
Flooded Area			Product	Pounds				Product			1	0.0625	Product	Pounds	
FW Marsh			Product	Pounds				Product			1	0.25	Product	Pounds	
Impound			Product	Pounds				Product					Product	Pounds	
Lake			Product	Pounds				Product					Product	Pounds	
Lift Station			Product	Pounds				Product					Product	Pounds	
Neglected Pool			Product	Pounds				Product					Product	Pounds	
Ornamental Pond			Product	Pounds				Product			2	0.125	Product	Pounds	
Pond			Product	Pounds				Product			3	0.375	Product	Pounds	
Residential	2	0.0625	Product	Pounds		1		Product					Product	Pounds	
Salt Marsh			Product	Pounds				Product					Product	Pounds	
Sewer Pond			Product	Pounds				Product			1	0.0625	Product	Pounds	
Tires			Product	Pounds				Product					Product	Pounds	
Treehole	1	0.015625	Product	Pounds				Product					Product	Pounds	
Utility Vault			Product	Pounds				Product					Product	Pounds	
Watering Trough			Product	Pounds				Product			1	0.3125	Product	Pounds	
Totals	3	0.078125	Product	Pounds		2		Product			48	13.875	Product	Pounds	

Table A32.

Application Sites:	Fourstar 45 briq-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Fourstar 45 briq Comments	Fourstar 90 briq-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Fourstar 90 briq Comments	Golden Bear 1111 Oil-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Golden Bear 1111 Oil Comments
			Product	Pounds				Product	Pounds				Product	Gallons	
Catch Basin	1	0.03125	Product	Pounds				Product	Pounds				Product	Gallons	
Cemetery vases			Product	Pounds				Product	Pounds				Product	Gallons	
Channel			Product	Pounds		1	0.1875	Product	Pounds				Product	Gallons	
Clean Pool			Product	Pounds				Product	Pounds				Product	Gallons	
Commercial			Product	Pounds				Product	Pounds				Product	Gallons	
Container			Product	Pounds				Product	Pounds				Product	Gallons	
Creek	4	0.320313	Product	Pounds		2	0.1875	Product	Pounds		2	0.028875	Product	Gallons	
Curbs	1	0.007813	Product	Pounds		2	0.09375	Product	Pounds				Product	Gallons	
Dairy Drain			Product	Pounds				Product	Pounds				Product	Gallons	
Diked Marsh			Product	Pounds				Product	Pounds				Product	Gallons	
Drain			Product	Pounds				Product	Pounds				Product	Gallons	
Duck Pond			Product	Pounds				Product	Pounds				Product	Gallons	
Flooded Area			Product	Pounds				Product	Pounds				Product	Gallons	
FW Marsh			Product	Pounds		1	0.03125	Product	Pounds				Product	Gallons	
Impound			Product	Pounds				Product	Pounds				Product	Gallons	
Lake			Product	Pounds				Product	Pounds				Product	Gallons	
Lift Station	1	0.015625	Product	Pounds				Product	Pounds				Product	Gallons	
Neglected Pool			Product	Pounds				Product	Pounds				Product	Gallons	
Ornamental Pond			Product	Pounds				Product	Pounds				Product	Gallons	
Pond			Product	Pounds				Product	Pounds				Product	Gallons	
Residential			Product	Pounds				Product	Pounds				Product	Gallons	
Salt Marsh			Product	Pounds				Product	Pounds				Product	Gallons	
Sewer Pond	6	0.703127	Product	Pounds				Product	Pounds				Product	Gallons	
Tires			Product	Pounds				Product	Pounds				Product	Gallons	
Treehole			Product	Pounds				Product	Pounds				Product	Gallons	
Utility Vault			Product	Pounds				Product	Pounds				Product	Gallons	
Watering Trough			Product	Pounds				Product	Pounds				Product	Gallons	
Totals	13	1.078128	Product	Pounds		6	0.5	Product	Pounds		2	0.028875	Product	Gallons	

Table A32.

Application Sites:	Vectobac 12AS-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectobac 12AS Comments	Vectobac G-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectobac G Comments	Vectolex CG-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectolex CG Comments
			Product	Gallons		1	0.15	Product	Pounds				Product	Pounds	
Catch Basin	1	0.004014	Product	Gallons				Product	Pounds				Product	Pounds	
Cemetery vases			Product	Gallons		2	0.598	Product	Pounds				Product	Pounds	
Channel	3	0.094783	Product	Gallons		4	12.788	Product	Pounds				Product	Pounds	
Clean Pool			Product	Gallons				Product	Pounds				Product	Pounds	
Commercial	1	0.000287	Product	Gallons				Product	Pounds				Product	Pounds	
Container			Product	Gallons				Product	Pounds				Product	Pounds	
Creek	25	0.970037	Product	Gallons		58	71.9533	Product	Pounds		22	19.3485	Product	Pounds	
Curbs	7	51.349999	Product	Gallons		4	47.107	Product	Pounds		1	40	Product	Pounds	
Dairy Drain			Product	Gallons				Product	Pounds				Product	Pounds	
Diked Marsh	5	0.802525	Product	Gallons				Product	Pounds				Product	Pounds	
Drain			Product	Gallons				Product	Pounds				Product	Pounds	
Duck Pond	2	0.15	Product	Gallons				Product	Pounds				Product	Pounds	
Flooded Area	1	0.014623	Product	Gallons		6	5.236	Product	Pounds				Product	Pounds	
FW Marsh			Product	Gallons		5	146.58	Product	Pounds		2	16	Product	Pounds	
Impound			Product	Gallons		1	0.092	Product	Pounds				Product	Pounds	
Lake	1	0.011755	Product	Gallons				Product	Pounds				Product	Pounds	
Lift Station	1	0.00172	Product	Gallons		1	0.138	Product	Pounds				Product	Pounds	
Neglected Pool	1	0.001094	Product	Gallons		2	0.98	Product	Pounds		1	0.253	Product	Pounds	
Ornamental Pond			Product	Gallons		2	0.0276	Product	Pounds		2	0.0276	Product	Pounds	
Pond	1	0.000573	Product	Gallons				Product	Pounds				Product	Pounds	
Residential			Product	Gallons		1	0.092	Product	Pounds				Product	Pounds	
Salt Marsh	1	0.03928	Product	Gallons		5	12.65	Product	Pounds		2	0.46	Product	Pounds	
Sewer Pond	6	3.085915	Product	Gallons		1	4.002	Product	Pounds				Product	Pounds	
Tires			Product	Gallons				Product	Pounds				Product	Pounds	
Treehole			Product	Gallons				Product	Pounds				Product	Pounds	
Utility Vault			Product	Gallons				Product	Pounds				Product	Pounds	
Watering Trough			Product	Gallons				Product	Pounds				Product	Pounds	
Totals	56	56.526605	Product	Gallons		93	302.3939	Product	Pounds		30	76.0891	Product	Pounds	

Table A32.

Application Sites:	Vectomax CG-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectomax CG Comments
			Product	Pounds	
Catch Basin			Product	Pounds	
Cemetery vases			Product	Pounds	
Channel			Product	Pounds	
Clean Pool			Product	Pounds	
Commercial			Product	Pounds	
Container			Product	Pounds	
Creek			Product	Pounds	
Curbs	1	1.311	Product	Pounds	
Dairy Drain			Product	Pounds	
Diked Marsh			Product	Pounds	
Drain			Product	Pounds	
Duck Pond			Product	Pounds	
Flooded Area			Product	Pounds	
FW Marsh			Product	Pounds	
Impound			Product	Pounds	
Lake			Product	Pounds	
Lift Station			Product	Pounds	
Neglected Pool			Product	Pounds	
Ornamental Pond			Product	Pounds	
Pond			Product	Pounds	
Residential			Product	Pounds	
Salt Marsh			Product	Pounds	
Sewer Pond	3	1.541	Product	Pounds	
Tires			Product	Pounds	
Treehole			Product	Pounds	
Utility Vault			Product	Pounds	
Watering Trough			Product	Pounds	
Totals	4	2.852	Product	Pounds	

Table A33. Pesticide Application Data for Winter 2012 – SCCVCD

Application Sites:	Agnique MMF-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	AGNIQUE MMF G-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	AGNIQUE MMF G Comments	Altosid Briquets 30-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid Briquets 30 Comments
			Product	Gallons				Product	Pounds				Product	Pounds	
Channel			Product	Gallons				Product	Pounds				Product	Pounds	
Clean Pool			Product	Gallons				Product	Pounds				Product	Pounds	
Commercial			Product	Gallons				Product	Pounds				Product	Pounds	
Container	1	0.004591	Product	Gallons		1	0.0494	Product	Pounds				Product	Pounds	
Creek			Product	Gallons		3	2.2477	Product	Pounds		1	0.075	Product	Pounds	
Curbs	1	0.001148	Product	Gallons		3	0.3705	Product	Pounds				Product	Pounds	
Diked Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Fish Pond	1	0.001148	Product	Gallons				Product	Pounds				Product	Pounds	
Flooded Area	1	0.036725	Product	Gallons				Product	Pounds				Product	Pounds	
FW Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Impound	1	0.040168	Product	Gallons				Product	Pounds				Product	Pounds	
Lift Station			Product	Gallons				Product	Pounds				Product	Pounds	
Neglected Pool	3	0.029839	Product	Gallons				Product	Pounds				Product	Pounds	
Ornamental Pond			Product	Gallons				Product	Pounds				Product	Pounds	
Pond	2	0.004591	Product	Gallons		1	0.0247	Product	Pounds				Product	Pounds	
Residential			Product	Gallons				Product	Pounds				Product	Pounds	
Salt Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Seepage			Product	Gallons				Product	Pounds				Product	Pounds	
Sewer Pond			Product	Gallons				Product	Pounds				Product	Pounds	
Watering Trough			Product	Gallons				Product	Pounds				Product	Pounds	
Totals	10	0.11821	Product	Gallons		8	2.6923	Product	Pounds		1	0.075	Product	Pounds	

Table A33.

Application Sites:	Altosid Liquid SR5-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid Liquid SR5 Comments	Altosid XR Briquets-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid XR Briquets Comments	Altosid XR-G-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid XR-G Comments
			Product	Gallons				Product	Pounds				Product	Pounds	
Channel			Product	Gallons		2	0.7245	Product	Pounds				Product	Pounds	
Clean Pool			Product	Gallons				Product	Pounds				Product	Pounds	
Commercial			Product	Gallons				Product	Pounds				Product	Pounds	
Container			Product	Gallons		1	0.2415	Product	Pounds				Product	Pounds	
Creek			Product	Gallons		4	0.8855	Product	Pounds		2	0.851	Product	Pounds	
Curbs			Product	Gallons		1	0.161	Product	Pounds		4	0.943	Product	Pounds	
Diked Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Fish Pond			Product	Gallons				Product	Pounds				Product	Pounds	
Flooded Area			Product	Gallons				Product	Pounds		1	0.184	Product	Pounds	
FW Marsh	1	0.3125	Product	Gallons				Product	Pounds				Product	Pounds	
Impound			Product	Gallons				Product	Pounds				Product	Pounds	
Lift Station			Product	Gallons				Product	Pounds				Product	Pounds	
Neglected Pool			Product	Gallons		2	0.161	Product	Pounds				Product	Pounds	
Ornamental Pond			Product	Gallons		1	0.0805	Product	Pounds				Product	Pounds	
Pond			Product	Gallons				Product	Pounds				Product	Pounds	
Residential			Product	Gallons				Product	Pounds				Product	Pounds	
Salt Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Seepage			Product	Gallons				Product	Pounds				Product	Pounds	
Sewer Pond			Product	Gallons				Product	Pounds				Product	Pounds	
Watering Trough			Product	Gallons				Product	Pounds				Product	Pounds	
Totals	1	0.3125	Product	Gallons		11	2.254	Product	Pounds		7	1.978	Product	Pounds	

Table A33.

Application Sites:	BVA 2 Mosquito Larvi-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	BVA 2 Mosquito Larvi Comments	Fourstar 180 briq-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Fourstar 180 briq Comments	Fourstar 45 briq-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Fourstar 45 briq Comments
			Product	Gallons				Product	Pounds		1	0.101563	Product	Pounds	
Channel	3	0.132813	Product	Gallons				Product	Pounds		4	0.468751	Product	Pounds	
Clean Pool			Product	Gallons		1	0.0625	Product	Pounds				Product	Pounds	
Commercial			Product	Gallons				Product	Pounds				Product	Pounds	
Container	2	0.0165	Product	Gallons		1	0.1875	Product	Pounds				Product	Pounds	
Creek	15	0.829595	Product	Gallons		13	5.25	Product	Pounds		21	14.76563	Product	Pounds	
Curbs	4	0.197063	Product	Gallons		4	0.5625	Product	Pounds		9	0.656252	Product	Pounds	
Diked Marsh	1	1.375	Product	Gallons				Product	Pounds				Product	Pounds	
Fish Pond			Product	Gallons		2	0.125	Product	Pounds				Product	Pounds	
Flooded Area	2	0.188375	Product	Gallons		1	1	Product	Pounds				Product	Pounds	
FW Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Impound	1	0.041323	Product	Gallons				Product	Pounds				Product	Pounds	
Lift Station			Product	Gallons				Product	Pounds				Product	Pounds	
Neglected Pool	4	0.198125	Product	Gallons				Product	Pounds		2	0.054688	Product	Pounds	
Ornamental Pond	1	0.001375	Product	Gallons		2	0.125	Product	Pounds		1	0.03125	Product	Pounds	
Pond			Product	Gallons				Product	Pounds		2	0.031251	Product	Pounds	
Residential			Product	Gallons				Product	Pounds				Product	Pounds	
Salt Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Seepage			Product	Gallons				Product	Pounds				Product	Pounds	
Sewer Pond			Product	Gallons				Product	Pounds		1	0.15625	Product	Pounds	
Watering Trough			Product	Gallons				Product	Pounds				Product	Pounds	
Totals	33	2.980169	Product	Gallons		24	7.3125	Product	Pounds		41	16.265635	Product	Pounds	

Table A33.

Application Sites:	Fourstar 90 briq-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Fourstar 90 briq Comments	Golden Bear 1111 Oil-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Golden Bear 1111 Oil Comments	Vectobac 12AS-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectobac 12AS Comments
			Product	Pounds				Product	Gallons		1	0.023438	Product	Gallons	
Channel			Product	Pounds				Product	Gallons		1	0.006021	Product	Gallons	
Clean Pool			Product	Pounds				Product	Gallons				Product	Gallons	
Commercial			Product	Pounds				Product	Gallons		1	0.072827	Product	Gallons	
Container	1	0.03125	Product	Pounds		1	0.000156	Product	Gallons		1	0.000016	Product	Gallons	
Creek	2	0.15625	Product	Pounds				Product	Gallons		20	0.656871	Product	Gallons	
Curbs			Product	Pounds				Product	Gallons		2	0.036987	Product	Gallons	
Diked Marsh			Product	Pounds		1	0.776875	Product	Gallons		10	1.138848	Product	Gallons	
Fish Pond			Product	Pounds				Product	Gallons				Product	Gallons	
Flooded Area			Product	Pounds				Product	Gallons		3	1.250578	Product	Gallons	
FW Marsh			Product	Pounds				Product	Gallons		1	2.5	Product	Gallons	
Impound			Product	Pounds				Product	Gallons				Product	Gallons	
Lift Station			Product	Pounds				Product	Gallons		1	0.00172	Product	Gallons	
Neglected Pool	1	0.0625	Product	Pounds				Product	Gallons				Product	Gallons	
Ornamental Pond			Product	Pounds				Product	Gallons		1	0.000573	Product	Gallons	
Pond			Product	Pounds				Product	Gallons		4	0.332021	Product	Gallons	
Residential			Product	Pounds				Product	Gallons				Product	Gallons	
Salt Marsh			Product	Pounds				Product	Gallons		22	34.329229	Product	Gallons	
Seepage			Product	Pounds				Product	Gallons				Product	Gallons	
Sewer Pond			Product	Pounds				Product	Gallons		6	0.524981	Product	Gallons	
Watering Trough	1	0.15625	Product	Pounds				Product	Gallons				Product	Gallons	
Totals	5	0.40625	Product	Pounds		2	0.777031	Product	Gallons		74	40.87411	Product	Gallons	

Table A33.

Application Sites:	Vectobac G-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectobac G Comments	Vectolex CG-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectolex CG Comments	Vectomax CG-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectomax CG Comments
	1	1.012	Product	Pounds				Product	Pounds				Product	Pounds	
Channel			Product	Pounds				Product	Pounds				Product	Pounds	
Clean Pool			Product	Pounds				Product	Pounds				Product	Pounds	
Commercial			Product	Pounds				Product	Pounds				Product	Pounds	
Container	1	0.046	Product	Pounds				Product	Pounds				Product	Pounds	
Creek	3	2.047	Product	Pounds				Product	Pounds				Product	Pounds	
Curbs	2	0.207	Product	Pounds				Product	Pounds				Product	Pounds	
Diked Marsh	1	38	Product	Pounds				Product	Pounds				Product	Pounds	
Fish Pond			Product	Pounds				Product	Pounds				Product	Pounds	
Flooded Area	6	5.865	Product	Pounds				Product	Pounds				Product	Pounds	
FW Marsh	5	25.98	Product	Pounds		5	25.98	Product	Pounds				Product	Pounds	
Impound	1	1.1433	Product	Pounds				Product	Pounds				Product	Pounds	
Lift Station	2	25	Product	Pounds				Product	Pounds				Product	Pounds	
Neglected Pool	1	0.23	Product	Pounds				Product	Pounds				Product	Pounds	
Ornamental Pond	1	0.069	Product	Pounds				Product	Pounds				Product	Pounds	
Pond	4	5.497	Product	Pounds				Product	Pounds				Product	Pounds	
Residential	1	0.046	Product	Pounds				Product	Pounds				Product	Pounds	
Salt Marsh	21	164.855	Product	Pounds		5	7.427	Product	Pounds		2	26	Product	Pounds	
Seepage	1	0.506	Product	Pounds				Product	Pounds				Product	Pounds	
Sewer Pond	2	9.085	Product	Pounds				Product	Pounds				Product	Pounds	
Watering Trough			Product	Pounds				Product	Pounds				Product	Pounds	
Totals	53	279.5883	Product	Pounds		10	33.407	Product	Pounds		2	26	Product	Pounds	

Table A34. Pesticide Application Data for Spring 2012 – SCCVCD

Application Sites:	Agnique MMF-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	AGNIQUE MMF G-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	AGNIQUE MMF G Comments	Altosid Briquets 30-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid Briquets 30 Comments
			Product	Gallons				Product	Pounds				Product	Pounds	
Channel			Product	Gallons				Product	Pounds				Product	Pounds	
Clean Pool			Product	Gallons				Product	Pounds				Product	Pounds	
Commercial			Product	Gallons				Product	Pounds				Product	Pounds	
Container	1	0.004591	Product	Gallons		1	0.0494	Product	Pounds				Product	Pounds	
Creek			Product	Gallons		3	2.2477	Product	Pounds		1	0.075	Product	Pounds	
Curbs	1	0.001148	Product	Gallons		3	0.3705	Product	Pounds				Product	Pounds	
Diked Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Fish Pond	1	0.001148	Product	Gallons				Product	Pounds				Product	Pounds	
Flooded Area	1	0.036725	Product	Gallons				Product	Pounds				Product	Pounds	
FW Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Impound	1	0.040168	Product	Gallons				Product	Pounds				Product	Pounds	
Lift Station			Product	Gallons				Product	Pounds				Product	Pounds	
Neglected Pool	3	0.029839	Product	Gallons				Product	Pounds				Product	Pounds	
Ornamental Pond			Product	Gallons				Product	Pounds				Product	Pounds	
Pond	2	0.004591	Product	Gallons		1	0.0247	Product	Pounds				Product	Pounds	
Residential			Product	Gallons				Product	Pounds				Product	Pounds	
Salt Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Seepage			Product	Gallons				Product	Pounds				Product	Pounds	
Sewer Pond			Product	Gallons				Product	Pounds				Product	Pounds	
Watering Trough			Product	Gallons				Product	Pounds				Product	Pounds	
Totals	10	0.11821	Product	Gallons		8	2.6923	Product	Pounds		1	0.075	Product	Pounds	

Table A34.

Application Sites:	Altosid Liquid SR5-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid Liquid SR5 Comments	Altosid XR Briquets-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid XR Briquets Comments	Altosid XR-G-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Altosid XR-G Comments
			Product	Gallons				Product	Pounds				Product	Pounds	
Channel			Product	Gallons		2	0.7245	Product	Pounds				Product	Pounds	
Clean Pool			Product	Gallons				Product	Pounds				Product	Pounds	
Commercial			Product	Gallons				Product	Pounds				Product	Pounds	
Container			Product	Gallons		1	0.2415	Product	Pounds				Product	Pounds	
Creek			Product	Gallons		4	0.8855	Product	Pounds		2	0.851	Product	Pounds	
Curbs			Product	Gallons		1	0.161	Product	Pounds		4	0.943	Product	Pounds	
Diked Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Fish Pond			Product	Gallons				Product	Pounds				Product	Pounds	
Flooded Area			Product	Gallons				Product	Pounds		1	0.184	Product	Pounds	
FW Marsh	1	0.3125	Product	Gallons				Product	Pounds				Product	Pounds	
Impound			Product	Gallons				Product	Pounds				Product	Pounds	
Lift Station			Product	Gallons				Product	Pounds				Product	Pounds	
Neglected Pool			Product	Gallons		2	0.161	Product	Pounds				Product	Pounds	
Ornamental Pond			Product	Gallons		1	0.0805	Product	Pounds				Product	Pounds	
Pond			Product	Gallons				Product	Pounds				Product	Pounds	
Residential			Product	Gallons				Product	Pounds				Product	Pounds	
Salt Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Seepage			Product	Gallons				Product	Pounds				Product	Pounds	
Sewer Pond			Product	Gallons				Product	Pounds				Product	Pounds	
Watering Trough			Product	Gallons				Product	Pounds				Product	Pounds	
Totals	1	0.3125	Product	Gallons		11	2.254	Product	Pounds		7	1.978	Product	Pounds	

Table A34.

Application Sites:	BVA 2 Mosquito Larvi-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	BVA 2 Mosquito Larvi Comments	Fourstar 180 briq-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Fourstar 180 briq Comments	Fourstar 45 briq-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Fourstar 45 briq Comments
			Product	Gallons				Product	Pounds		1	0.101563	Product	Pounds	
Channel	3	0.132813	Product	Gallons				Product	Pounds		4	0.468751	Product	Pounds	
Clean Pool			Product	Gallons		1	0.0625	Product	Pounds				Product	Pounds	
Commercial			Product	Gallons				Product	Pounds				Product	Pounds	
Container	2	0.0165	Product	Gallons		1	0.1875	Product	Pounds				Product	Pounds	
Creek	15	0.829595	Product	Gallons		13	5.25	Product	Pounds		21	14.76563	Product	Pounds	
Curbs	4	0.197063	Product	Gallons		4	0.5625	Product	Pounds		9	0.656252	Product	Pounds	
Diked Marsh	1	1.375	Product	Gallons				Product	Pounds				Product	Pounds	
Fish Pond			Product	Gallons		2	0.125	Product	Pounds				Product	Pounds	
Flooded Area	2	0.188375	Product	Gallons		1	1	Product	Pounds				Product	Pounds	
FW Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Impound	1	0.041323	Product	Gallons				Product	Pounds				Product	Pounds	
Lift Station			Product	Gallons				Product	Pounds				Product	Pounds	
Neglected Pool	4	0.198125	Product	Gallons				Product	Pounds		2	0.054688	Product	Pounds	
Ornamental Pond	1	0.001375	Product	Gallons		2	0.125	Product	Pounds		1	0.03125	Product	Pounds	
Pond			Product	Gallons				Product	Pounds		2	0.031251	Product	Pounds	
Residential			Product	Gallons				Product	Pounds				Product	Pounds	
Salt Marsh			Product	Gallons				Product	Pounds				Product	Pounds	
Seepage			Product	Gallons				Product	Pounds				Product	Pounds	
Sewer Pond			Product	Gallons				Product	Pounds		1	0.15625	Product	Pounds	
Watering Trough			Product	Gallons				Product	Pounds				Product	Pounds	
Totals	33	2.980169	Product	Gallons		24	7.3125	Product	Pounds		41	16.265635	Product	Pounds	

Table A34.

Application Sites:	Fourstar 90 briq-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Fourstar 90 briq Comments	Golden Bear 1111 Oil-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Golden Bear 1111 Oil Comments	Vectobac 12AS-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectobac 12AS Comments
			Product	Pounds				Product	Gallons		1	0.023438	Product	Gallons	
Channel			Product	Pounds				Product	Gallons		1	0.006021	Product	Gallons	
Clean Pool			Product	Pounds				Product	Gallons				Product	Gallons	
Commercial			Product	Pounds				Product	Gallons		1	0.072827	Product	Gallons	
Container	1	0.03125	Product	Pounds		1	0.000156	Product	Gallons		1	0.000016	Product	Gallons	
Creek	2	0.15625	Product	Pounds				Product	Gallons		20	0.656871	Product	Gallons	
Curbs			Product	Pounds				Product	Gallons		2	0.036987	Product	Gallons	
Diked Marsh			Product	Pounds		1	0.776875	Product	Gallons		10	1.138848	Product	Gallons	
Fish Pond			Product	Pounds				Product	Gallons				Product	Gallons	
Flooded Area			Product	Pounds				Product	Gallons		3	1.250578	Product	Gallons	
FW Marsh			Product	Pounds				Product	Gallons		1	2.5	Product	Gallons	
Impound			Product	Pounds				Product	Gallons				Product	Gallons	
Lift Station			Product	Pounds				Product	Gallons		1	0.00172	Product	Gallons	
Neglected Pool	1	0.0625	Product	Pounds				Product	Gallons				Product	Gallons	
Ornamental Pond			Product	Pounds				Product	Gallons		1	0.000573	Product	Gallons	
Pond			Product	Pounds				Product	Gallons		4	0.332021	Product	Gallons	
Residential			Product	Pounds				Product	Gallons				Product	Gallons	
Salt Marsh			Product	Pounds				Product	Gallons		22	34.329229	Product	Gallons	
Seepage			Product	Pounds				Product	Gallons				Product	Gallons	
Sewer Pond			Product	Pounds				Product	Gallons		6	0.524981	Product	Gallons	
Watering Trough	1	0.15625	Product	Pounds				Product	Gallons				Product	Gallons	
Totals	5	0.40625	Product	Pounds		2	0.777031	Product	Gallons		74	40.87411	Product	Gallons	

Table A34.

Application Sites:	Vectobac G-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectobac G Comments	Vectolex CG-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectolex CG Comments	Vectomax CG-# Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Vectomax CG Comments
	1	1.012	Product	Pounds				Product	Pounds				Product	Pounds	
Channel			Product	Pounds				Product	Pounds				Product	Pounds	
Clean Pool			Product	Pounds				Product	Pounds				Product	Pounds	
Commercial			Product	Pounds				Product	Pounds				Product	Pounds	
Container	1	0.046	Product	Pounds				Product	Pounds				Product	Pounds	
Creek	3	2.047	Product	Pounds				Product	Pounds				Product	Pounds	
Curbs	2	0.207	Product	Pounds				Product	Pounds				Product	Pounds	
Diked Marsh	1	38	Product	Pounds				Product	Pounds				Product	Pounds	
Fish Pond			Product	Pounds				Product	Pounds				Product	Pounds	
Flooded Area	6	5.865	Product	Pounds				Product	Pounds				Product	Pounds	
FW Marsh	5	25.98	Product	Pounds		5	25.98	Product	Pounds				Product	Pounds	
Impound	1	1.1433	Product	Pounds				Product	Pounds				Product	Pounds	
Lift Station	2	25	Product	Pounds				Product	Pounds				Product	Pounds	
Neglected Pool	1	0.23	Product	Pounds				Product	Pounds				Product	Pounds	
Ornamental Pond	1	0.069	Product	Pounds				Product	Pounds				Product	Pounds	
Pond	4	5.497	Product	Pounds				Product	Pounds				Product	Pounds	
Residential	1	0.046	Product	Pounds				Product	Pounds				Product	Pounds	
Salt Marsh	21	164.855	Product	Pounds		5	7.427	Product	Pounds		2	26	Product	Pounds	
Seepage	1	0.506	Product	Pounds				Product	Pounds				Product	Pounds	
Sewer Pond	2	9.085	Product	Pounds				Product	Pounds				Product	Pounds	
Watering Trough			Product	Pounds				Product	Pounds				Product	Pounds	
Totals	53	279.5883	Product	Pounds		10	33.407	Product	Pounds		2	26	Product	Pounds	

Table A35. Pesticide Product Key – SCCVCD

Product	AI	Vector
Agnique MMF	Biodegradable Alcohol Ethoxylated Surfactant	Mosquito
Agnique MMF G	Biodegradable Alcohol Ethoxylated Surfactant	Mosquito
Altosid Briquets 30	Methoprene	Mosquito
Altosid Liquid SR5	Methoprene	Mosquito
Altosid Pellets	Methoprene	Mosquito
Altosid XR Briquets	Methoprene	Mosquito
Altosid XR-G	Methoprene	Mosquito
BVA 2	Petroleum Distillate	Mosquito
Contrac 8 oz blk	Bromadiolone	Rat
Drione Insecticide	Pyrethrin	Yellow Jacket / Wasp
FirstStrike Soft Bait	Difethialone	Rat
FourStar 180 Bs	Bacillus Sphaericus and Bacillus Thuringiensis Israelensis	Mosquito
FourStar 45 Bti	Bacillus Sphaericus and Bacillus Thuringiensis Israelensis	Mosquito
FourStar 90 briq	Bacillus Sphaericus and Bacillus Thuringiensis Israelensis	Mosquito
Pyrenone 25-5	Pyrethrins and Piperonyl Butoxide	Mosquito
VectoBac 12AS	Bacillus Thuringiensis Israelensis	Mosquito
VectoBac G	Bacillus Thuringiensis Israelensis	Mosquito
VectoLex CG Biologic	Bacillus Sphaericus	Mosquito
VectoLex WSP	Bacillus Sphaericus	Mosquito
VectoMax CG	Bacillus Sphaericus and Bacillus Thuringiensis Israelensis	Mosquito
Diphacinone	Active Ingredient in Ditrac blox for rats	
EcoExempt IC2	Rosemary Oil	Mosquito
Golden Bear 1111	Aliphatic Petroleum Hydrocarbons	Mosquito

Table A36. **Pesticide Application Data for Summer 2011 – SCMAD**

Application Sites:	Altosid Liquid SR5 - # Treatments	Total Amount Used4	Total Amount Type5	Total Amount Unit5	Altosid Liquid SR5 Comments	Altosid XR Extended Residual - # Treatments	Total Amount Used13	Total Amount Type14	Total Amount Unit14	Altosid XR Extended Residual Comments	Altosid SBG - # Treatments	Total Amount Used15	Total Amount Type16	Total Amount Unit16	Altosid SBG Comments	Scourge 18%+12% - # Treatments	Total Amount Used25	Total Amount Type26	Total Amount Unit26	Scourge 18%+54% Comments	FourStar 180 Bs/Bti - # Treatments	Total Amount Used35	Total Amount Type36	Total Amount Unit36	FourStar 180 Bs/Bti Comments	MGK Pyrocide Fogging Concentrate 7396 - # Treatments
1. Swimming pool **(00100)**						41	41.770	Product	Pounds												2	0.727	Product	Pounds		
2. Ponds **(00385)**						1	0.960	Product	Pounds																	
3. Water trough **(00390)**																										
4. Retention basin **(00400)**																										
5. Manmade pond **(00480)**																										
6. Fish pond **(01096)**																										
7. Dredge spoil pond **(01276)**																										
8. Permanent pond **(03240)**																										
9. Alfalfa **(00020)**																										3
10. Row crop **(00050)**																										
11. Contour pasture **(00435)**																										7
12. Pasture ditch **(00440)**																										
13. Flooded pasture **(00470)**																										55
14. Strip check pasture **(00495)**																										4
15. Sump (**00500)**																					1	0.132	Product	Pounds		
16. Tail water drain **(00505)**																										
17. Septic tank **(01038)**																										
18. Container **(01045)**																										
19. Tires **(01060)**																										
20. Waterline leak **(01288)**																										2
21. Electrical box **(01624)**																										
22. Catch basin **(01699)**																					1	0.132	Product	Pounds		
23. Valve box **(02460)**																										
24. Waste/sewer pond **(02480)**																										
25. Roadside ditch **(01705)**																										
26. Depression/swale **(03120)**																										2
27. Duck Club/seasonal waterfowl habitat **(00700)**	13	31.4375	Product	Gallons							2	840.000	Product	Pounds												65
28. Tidal marsh **(03130)**	1	5.9375	Product	Gallons																						
29. Reclaimed marsh **(03230)**																										
30A. Reclaimed marsh/other **(03231)**																										
31. Streams/creeks **(03440)**																										
32. Treehole **(03480)**																										3
33. Vernal pools																										
34A. Upland/other **(03330)**																										
35A. Residential/other **(00200)**																										
36A. Industrial/other **(02500)**																3	1.379	Product	Gallons							
Totals	14	37.375	Product	Gallons		42	42.73	Product	Pounds		2	840	Product	Pounds		3	1.379	Product	Gallons		4	0.991	Product	Pounds		141

Table A36.

Application Sites:	Total Amount Used1518	Total Amount Type1619	Total Amount Unit1620	MGK Pyrocide Fogging Concentrate 7396 Comments	VectoLex WSP # Treatments	Total Amount Used	Total Amount Type2	Total Amount Unit	VectoLex WSP Comments	Altosid Pellets # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit2	Altosid Pellets Comments	Mosquito Larvicide GB1111 # Treatments	Total Amount Used3	Total Amount Type4	Total Amount Type Unit
1. Swimming pool **(00100)**										1	6.000	Product	Pounds		2	0.102	Product	Gallons
2. Ponds **(00385)**															1	0.030	Product	Gallons
3. Water trough **(00390)**																		
4. Retention basin **(00400)**																		
5. Manmade pond **(00480)**																		
6. Fish pond **(01096)**										1	15.000	Product	Pounds					
7. Dredge spoil pond **(01276)**																		
8. Permanent pond **(03240)**																		
9. Alfalfa **(00020)**	0.803	Product	Gallons															
10. Row crop **(00050)**																		
11. Contour pasture **(00435)**	3.859	Product	Pounds												4	35.000	Product	Gallons
12. Pasture ditch **(00440)**										1	0.150	Product	Pounds					
13. Flooded pasture **(00470)**	14.037	Product	Gallons							3	228.000	Product	Pounds					
14. Strip check pasture **(00495)**	1.99	Product	Gallons															
15. Sump (**00500)**																		
16. Tail water drain **(00505)**																		
17. Septic tank **(01038)**																		
18. Container **(01045)**																		
19. Tires **(01060)**																		
20. Waterline leak **(01288)**	0.003	Product	Gallons							1	0.003	Product	Pounds					
21. Electrical box **(01624)**																		
22. Catch basin **(01699)**					4	52	Product	Other	52 Pouches	2	0.330	Product	Pounds					
23. Valve box **(02460)**																		
24. Waste/sewer pond **(02480)**																		
25. Roadside ditch **(01705)**															1	5.000	Product	Gallons
26. Depression/swale **(03120)**	0.042	Product	Gallons		1	80	Product	Other	80 Pouches	2	2.400	Product	Pounds					
27. Duck Club/seasonal waterfowl habitat **(00700)**	46.559	Product	Gallons							2	99.000	Product	Pounds		2	15.000	Product	Gallons
28. Tidal marsh **(03130)**										7	179.500	Product	Pounds					
29. Reclaimed marsh **(03230)**																		
30A. Reclaimed marsh/other **(03231)**																		
31. Streams/creeks **(03440)**																		
32. Treehole **(03480)**	0.528	Product	Gallons															
33. Vernal pools																		
34A. Upland/other **(03330)**																		
35A. Residential/other **(00200)**																		
36A. Industrial/other **(02500)**																		
Totals	67.821	Product	Gallons		5	132	Product	Other	Pouches	20	530.383	Product	Pounds		10	55.132	Product	Gallons

Table A37. **Pesticide Application Data for Fall 2011 – SCMAD**

Application Sites:	Altosid Liquid SR5 - # Treatments	Total Amount Used4	Total Amount Type5	Total Amount Unit5	Altosid Liquid SR5 Comments	Altosid XR Extended Residual - # Treatments	Total Amount Used13	Total Amount Type14	Total Amount Unit14	Altosid XR Extended Residual Comments	Altosid SBG - # Treatments	Total Amount Used15	Total Amount Type16	Total Amount Unit16	Altosid SBG Comments	Pyrenone 25-5 - # Treatments	Total Amount Used29	Total Amount Type30	Total Amount Unit30	Pyrenone 25-5 Comments	FourStar 180 Bs/Bti - # Treatments	Total Amount Used35	Total Amount Type36	Total Amount Unit36
1. Swimming pool **(00100)**						14	13.840	Product	Pounds															
2. Ponds **(00385)**																								
3. Water trough **(00390)**																								
4. Retention basin **(00400)**																								
5. Manmade pond **(00480)**																								
6. Fish pond **(01096)**																								
7. Dredge spoil pond **(01276)**																								
8. Permanent pond **(03240)**																								
9. Alfalfa **(00020)**																								
10. Row crop **(00050)**																								
11. Contour pasture **(00435)**																								
12. Pasture ditch **(00440)**																								
13. Flooded pasture **(00470)**																								
14. Strip check pasture **(00495)**																								
15. Sump (**00500)**																								
16. Tail water drain **(00505)**																								
17. Septic tank **(01038)**																								
18. Container **(01045)**																								
19. Tires **(01060)**																								
20. Waterline leak **(01288)**																								
21. Electrical box **(01624)**																								
22. Catch basin **(01699)**																					1	0.0661	Product	Pounds
23. Valve box **(02460)**																								
24. Waste/sewer pond **(02480)**																								
25. Roadside ditch **(01705)**																								
26. Depression/swale **(03120)**																								
27. Duck Club/seasonal waterfowl habitat **(00700)**	33	135.625	Product	Gallons							2	1,316.00	Product	Pounds		12	10.156	Product	Gallons					
28. Tidal marsh **(03130)**																								
29. Reclaimed marsh **(03230)**																								
30A. Reclaimed marsh/other **(03231)**																								
31. Streams/creeks **(03440)**																								
32. Treehole **(03480)**																								
33. Vernal pools																								
34A. Upland/other **(03330)**																								
35A. Residential/other **(00200)**																								
36A. Industrial/other **(02500)**																								
Totals	33	135.625	Product	Gallons		14	13.84	Product	Pounds		2	1316	Product	Pounds		12	10.156	Product	Gallons		1	0.0661	Product	Pounds

Table A37.

Application Sites:	FourStar 180 Bs/Bti Comments	MGK Pyrocide Fogging Concentrate 7396 - # Treatments	Total Amount Used1518	Total Amount Type1619	Total Amount Unit1620	MGK Pyrocide Fogging Concentrate 7396 Comments	Altosid Pellets # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit2	Altosid Pellets Comments	Mosquito Larvicide GB-1111 # Treatments	Total Amount Used3	Total Amount Type4	Total Amount Unit3	Mosquito Larvicide GB-1111 Comments
1. Swimming pool **(00100)**												1	0.119	Product	Gallons	
2. Ponds **(00385)**																
3. Water trough **(00390)**																
4. Retention basin **(00400)**																
5. Manmade pond **(00480)**																
6. Fish pond **(01096)**																
7. Dredge spoil pond **(01276)**																
8. Permanent pond **(03240)**																
9. Alfalfa **(00020)**																
10. Row crop **(00050)**																
11. Contour pasture **(00435)**																
12. Pasture ditch **(00440)**																
13. Flooded pasture **(00470)**		2	1.462	Product	Gallons											
14. Strip check pasture **(00495)**																
15. Sump **(00500)**							2	9.000	Product	Pounds						
16. Tail water drain **(00505)**																
17. Septic tank **(01038)**																
18. Container **(01045)**																
19. Tires **(01060)**																
20. Waterline leak **(01288)**																
21. Electrical box **(01624)**																
22. Catch basin **(01699)**																
23. Valve box **(02460)**																
24. Waste/sewer pond **(02480)**																
25. Roadside ditch **(01705)**												1	5.000	Product	Gallons	
26. Depression/swale **(03120)**		1	0.650	Product	Gallons											
27. Duck Club/seasonal waterfowl habitat **(00700)**		80	41.139	Product	Gallons											
28. Tidal marsh **(03130)**																
29. Reclaimed marsh **(03230)**																
30A. Reclaimed marsh/other **(03231)**																
31. Streams/creeks **(03440)**																
32. Treehole **(03480)**																
33. Vernal pools																
34A. Upland/other **(03330)**																
35A. Residential/other **(00200)**																
36A. Industrial/other **(02500)**																
Totals		83	43.251	Product	Gallons		2	9	Product	Pounds		2	5.119	Product	Gallons	

Table A38. **Pesticide Application Data for Winter 2012 – SCMAD**

Application Sites:	Agnique MMF - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	Altosid Liquid SR5 - # Treatments	Total Amount Used4	Total Amount Type5	Total Amount Unit5	Altosid Liquid SR5 Comments	Altosid XR Extended Residual - # Treatments	Total Amount Used13	Total Amount Type14	Total Amount Unit14	Altosid XR Extended Residual Comments	FourStar 180 Bs/Bti - # Treatments	Total Amount Used35	Total Amount Type36	Total Amount Unit36	FourStar 180 Bs/Bti Comments	VectoLex WSP # Treatments	Total Amount Used	Total Amount Type2	Total Amount Unit
1. Swimming pool **(00100)**	3	0.170	Product	Gallons							49	45.490	Product	Pounds		1	1.322	Product	Pounds		1	5	Product	Other
2. Ponds **(00385)**											1	0.240	Product	Pounds										
3. Water trough **(00390)**																								
4. Retention basin **(00400)**																								
5. Manmade pond **(00480)**											3	1.440	Product	Pounds										
6. Fish pond **(01096)**																								
7. Dredge spoil pond **(01276)**																								
8. Permanent pond **(03240)**																								
9. Alfalfa **(00020)**																								
10. Row crop **(00050)**																								
11. Contour pasture **(00435)**																								
12. Pasture ditch **(00440)**																								
13. Flooded pasture **(00470)**																								
14. Strip check pasture **(00495)**																								
15. Sump (**00500)**																								
16. Tail water drain **(00505)**																								
17. Septic tank **(01038)**																								
18. Container **(01045)**																								
19. Tires **(01060)**																								
20. Waterline leak **(01288)**																								
21. Electrical box **(01624)**																								
22. Catch basin **(01699)**											22	30.960	Product	Pounds										
23. Valve box **(02460)**																								
24. Waste/sewer pond **(02480)**											1	1.760	Product	Pounds										
25. Roadside ditch **(01705)**																								
26. All Other Drains **(01702)**																								
26. Depression/swale **(03120)**																								
27. Duck Club/seasonal waterfowl habitat **(00700)**																								
28. Tidal marsh **(03130)**						5	23.125	Product	Gallons															
29. Reclaimed marsh **(03230)**																								
30A. Reclaimed marsh/other **(03231)**																								
31. Streams/creeks **(03440)**																								
32. Treehole **(03480)**																								
33. Vernal pools																								
34A. Upland/other **(03330)**																								
35A. Residential/other **(00200)**																								
36A. Industrial/other **(02500)**																								
Totals	3	0.17	Product	Gallons		5	23.125	Product	Gallons		76	79.89	Product	Pounds		1	1.322	Product	Pounds		1	5	Product	Other

Table A38.

Application Sites:	VectoLex WSP Comments	Altosid Pellets # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit2	Altosid Pellets Comments	Mosquito Larvicide GB-1111 # Treatments	Total Amount Used3	Total Amount Type4	Total Amount Unit3	Mosquito Larvicide GB-1111 Comments
1. Swimming pool **(00100)**	Pouches						1	0.090	Product	Gallons	
2. Ponds **(00385)**		3	9.810	Product	Pounds						
3. Water trough **(00390)**											
4. Retention basin **(00400)**											
5. Manmade pond **(00480)**											
6. Fish pond **(01096)**											
7. Dredge spoil pond **(01276)**											
8. Permanent pond **(03240)**											
9. Alfalfa **(00020)**											
10. Row crop **(00050)**											
11. Contour pasture **(00435)**											
12. Pasture ditch **(00440)**		1	6.000	Product	Pounds						
13. Flooded pasture **(00470)**											
14. Strip check pasture **(00495)**											
15. Sump (**00500)**											
16. Tail water drain **(00505)**											
17. Septic tank **(01038)**											
18. Container **(01045)**											
19. Tires **(01060)**											
20. Waterline leak **(01288)**											
21. Electrical box **(01624)**											
22. Catch basin **(01699)**											
23. Valve box **(02460)**											
24. Waste/sewer pond **(02480)**											
25. Roadside ditch **(01705)**											
26. All Other Drains **(01702)**		3	1.003	Product	Pounds						
26. Depression/swale **(03120)**		4	60.000	Product	Pounds						
27. Duck Club/seasonal waterfowl habitat **(00700)**											
28. Tidal marsh **(03130)**		8	199.000	Product	Pounds						
29. Reclaimed marsh **(03230)**		1	15.000	Product	Pounds						
30A. Reclaimed marsh/other **(03231)**											
31. Streams/creeks **(03440)**		1	0.041	Product	Pounds						
32. Treehole **(03480)**											
33. Vernal pools											
34A. Upland/other **(03330)**											
35A. Residential/other **(00200)**											
36A. Industrial/other **(02500)**											
Totals	Pouches	21	290.854	Product	Pounds		1	0.09	Product	Gallons	

Table A39. **Pesticide Application Data for Spring 2012 – SCMAD**

Application Sites:	Agnique MMF - # Treatments	Total Amount Used	Total Amount Type	Total Amount Unit	Agnique MMF Comments	Altosid Liquid SR5 - # Treatments	Total Amount Used4	Total Amount Type5	Total Amount Unit5	Altosid Liquid SR5 Comments	Altosid XR Extended Residual - # Treatments	Total Amount Used13	Total Amount Type14	Total Amount Unit14	Altosid XR Extended Residual Comments	Scourge 18%+12% - # Treatments	Total Amount Used25	Total Amount Type26	Total Amount Unit26	Scourge 18%+12% Comments	FourStar 180 Bs/Bti - # Treatments	Total Amount Used35	Total Amount Type36	Total Amount Unit36
1. Swimming pool **(00100)**	1	0.010	Product	Gallons							60	61.050	Product	Pounds							1	1.322	Product	Pounds
2. Ponds **(00385)**	2	0.001	Product	Gallons							4	0.480	Product	Pounds										
3. Water trough **(00390)**																								
4. Retention basin **(00400)**																								
5. Manmade pond **(00480)**																								
6. Fish pond **(01096)**																								
7. Dredge spoil pond **(01276)**						2																		
8. Permanent pond **(03240)**																								
9. Alfalfa **(00020)**																								
10. Row crop **(00050)**																								
11. Contour pasture **(00435)**																								
12. Pasture ditch **(00440)**																								
13. Flooded pasture **(00470)**																								
14. Strip check pasture **(00495)**																								
15. Sump (**00500)**																								
16. Tail water drain **(00505)**																								
17. Septic tank **(01038)**																								
18. Container **(01045)**																								
19. Tires **(01060)**																								
20. Waterline leak **(01288)**																								
21. Electrical box **(01624)**																								
22. Catch basin **(01699)**											3	1.280	Product	Pounds										
23. Valve box **(02460)**																								
24. Waste/sewer pond **(02480)**											1	2.400	Product	Pounds										
25. Roadside ditch **(01705)**	1	0.001	Product	Gallons																				
26. All Other Drains **(01702)**																								
26. Depression/swale **(03120)**						2	0.593	Product	Gallons		1	1.680	Product	Pounds										
27. Duck Club/seasonal waterfowl habitat **(00700)**						1	4.687	Product	Gallons		1	3.200	Product	Pounds										
28. Tidal marsh **(03130)**						5	35.468	Product	Gallons															
29 A. Upland within vicinity of Tidal Marsh **(03131)**																								
30.A Residential within vicinity of Tidal Marsh **(03132)**																								
31 A. Industrial within vicinity of Tidal Marsh **(02500)**																								
32. Reclaimed marsh **(03230)**						10	3.062	Product	Gallons															
33A. Residential within vicinity of Reclaimed marsh **(03231)**																2	0.976	Product	Gallons					
34 A.Upland within vicinity of Reclaimed marsh **(03232)**																								
35.A. Residential/other **(02200)**																								
35. Streams/creeks **(03440)**																								
36. Treehole **(03480)**																2	0.585	Product	Gallons					
Totals	4	0.012	Product	Gallons		20	43.81	Product	Gallons		70	70.09	Product	Pounds		4	1.561	Product	Gallons		1	1.322	Product	Pounds

Table A39.

Application Sites:	FourStar 180 Bs/Bti Comments	Biomist 4+12 ULV - # Treatments	Total Amount Used22	Total Amount Type33	Total Amount Unit35	Biomist 4+12 ULV Comments	MGK Pyrocide Fogging Concentrate 7396 - # Treatments	Total Amount Used1518	Total Amount Type1619	Total Amount Unit1620	MGK Pyrocide Fogging Concentrate 7396 Comments	VectoLex WSP # Treatments	Total Amount Used	Total Amount Type2	Total Amount Unit	VectoLex WSP Comments	Altosid Pellets # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit2	Altosid Pellets Comments	Mosquito Larvicide GB-1111 # Treatments	Total Amount Used3	Total Amount Type4	Total Amount Unit3
1. Swimming pool **(00100)**												1	5	Product	Other	Pouches						2	0.001	Product	Gallons
2. Ponds **(00385)**																	3	9.810	Product	Pounds					
3. Water trough **(00390)**																									
4. Retention basin **(00400)**																									
5. Manmade pond **(00480)**																									
6. Fish pond **(01096)**																									
7. Dredge spoil pond **(01276)**																									
8. Permanent pond **(03240)**																									
9. Alfalfa **(00020)**																									
10. Row crop **(00050)**																									
11. Contour pasture **(00435)**							5	2.559	Product	Gallons												1	10.000	Product	Gallons
12. Pasture ditch **(00440)**																	1	6.000	Product	Pounds					
13. Flooded pasture **(00470)**							9	1.669	Product	Gallons															
14. Strip check pasture **(00495)**							11	5.118	Product	Gallons															
15. Sump **(00500)**							2	0.771	Product	Gallons															
16. Tail water drain **(00505)**																									
17. Septic tank **(01038)**																									
18. Container **(01045)**																									
19. Tires **(01060)**																									
20. Waterline leak **(01288)**																									
21. Electrical box **(01624)**																									
22. Catch basin **(01699)**							1	0.126	Product	Gallons															
23. Valve box **(02460)**																									
24. Waste/sewer pond **(02480)**																						5	4.750	Product	Gallons
25. Roadside ditch **(01705)**																						1	0.500	Product	Gallons
26. All Other Drains **(01702)**																	3	1.003	Product	Pounds					
26. Depression/swale **(03120)**							5	0.694	Product	Gallons							4	60.000	Product	Pounds					
27. Duck Club/seasonal waterfowl habitat **(00700)**																									
28. Tidal marsh **(03130)**																	8	199.000	Product	Pounds					
29 A. Upland within vicinity of Tidal Marsh **(03131)**																									
30.A Residential within vicinity of Tidal Marsh **(03132)**		1	0.004	Product	Gallons		3	0.880	Product	Gallons															
31 A. Industrial within vicinity of Tidal Marsh **(02500)**							1	0.334	Product	Gallons															
32. Reclaimed marsh **(03230)**																	1	15.000	Product	Pounds					
33A. Residential within vicinity of Reclaimed marsh **(03231)**																									
34 A.Upland within vicinity of Reclaimed marsh **(03232)**							13	7.518	Product	Gallons															
35.A. Residential/other **(02200)**							2	0.023	Product	Gallons															
35. Streams/creeks **(03440)**																	1	0.041	Product	Pounds					
36. Treehole **(03480)**																									
Totals		1	0.004	Product	Gallons		52	19.692	Product	Gallons		1	5	Product	Other	Pouches	21	290.854	Product	Pounds		9	15.251	Product	Gallons

Table A40. Pesticide Product Key – SCMAD

Product	AI	Vector
Agnique MMF	Biodegradable Alcohol Ethoxylated Surfactant	Mosquito
Altosid Liquid SR5	Methoprene	Mosquito
Altosid Pellets	Methoprene	Mosquito
Altosid SBG Single Brood Granule	Methoprene	Mosquito
Altosid XR Extended Residual	Methoprene	Mosquito
Bayer Pyrenone 25-5 Public Health Insecticide	Pyrethrins and Piperonyl Butoxide	Mosquito
Clarke Biomist 4 + 12 ULV	Permethrin and Piperonyl Butoxide	Mosquito
FourStar 180 Bs/Bti	Bacillus Sphaericus and Bacillus Thuringiensis Israelensis	Mosquito
MGK Pyrocide Mosquito Adulticiding Concentrate for ULV Fogging 7396	Pyrethrins and Piperonyl Butoxide	Mosquito
Scourge 18% + 12%*	Resmethrin and Piperonyl Butoxide	Mosquito
VectoLex WSP Bs	Bacillus Sphaericus	Mosquito
GB-1111	Aliphatic Petroleum Hydrocarbons	Mosquito

Table A41. Pesticide Application Data for Summer 2011 – SMCMVCD

Application Sites:	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18	BVA-2 Comments	VectoLex CG - # Treatments	Total Amount Used19	Total Amount Type20	Total Amount Unit20	VectoLex CG Comments	Astro, Ortho, Bonide, Tengard, etc. Products - # Treatments	Total Amount Used23	Total Amount Type24	Total Amount Unit24	Astro, Ortho, Bonide, Tengard, etc. Products Commnets	Delta Dust - # Treatments	Total Amount Used31	Total Amount Type32	Total Amount Unit32
Aerial yellowjacket nest																			
Bird Bath	7	1.75	Product			2	0.5	Product	Ounces (weight)										
Catch Basin	675	214012	Product	Ounces (volume)		5	1.25	Product	Ounces (weight)										
Creek	9	159.75	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Culvert	5	3.5	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Ditch	36	3318.5	Product	Ounces (volume)		5	5.25	Product	Ounces (weight)										
Drain Line	12	37	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Drain Pipes	4	500.75	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Fish Pond	325	154	Product	Ounces (volume)		42	15	Product	Ounces (weight)										
Fountain	142	50.75	Product	Ounces (volume)		23	5.75	Product	Ounces (weight)										
Fresh H2O Marsh	0	0	Product	Ounces (volume)		4	47680	Product	Ounces (weight)										
Ground yellowjacket nest			Product	Ounces (volume)		0	0	Product	Ounces (weight)		4	67.5	Product	Ounces (volume)		263	224.75	Product	Ounces (weight)
H20 under Bldg	22	1401.75	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Horse Trough	1	0.25	Product	Ounces (volume)		3	0.75	Product	Ounces (weight)										
Hot tub	20	7.25	Product	Ounces (volume)		2	0.5	Product	Ounces (weight)										
Imp H2O	44	133.5	Product	Ounces (volume)		2	5.25	Product	Ounces (weight)										
Misc container	43	13.75	Product	Ounces (volume)		6	1.5	Product	Ounces (weight)										
Multiple			Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Pond (natural)	5	2.25	Product	Ounces (volume)		2	0.5	Product	Ounces (weight)										
Pothole	2	10.25	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Reservoir	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Salt Marsh	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Seepage	4	2.25	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Septic Seepage	1	10	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Septic Tank	4	2.5	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Sewage Treatment Plant	35	17572	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Slough	2	1600	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Spring	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Storm Drain	1	0.25	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Street Gutter	22	238.5	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Sump	39	13.5	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Swim Pool	32	115.5	Product	Ounces (volume)		3	8	Product	Ounces (weight)										
Swim pool cover	2	1.5	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Swim Pool Drain	1	0.25	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Tank	3	20.75	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Tire	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Treehole	1	0.25	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Vault	16	163	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Water meter box	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)										
Waterfall	22	9.25	Product	Ounces (volume)		2	0.5	Product	Ounces (weight)										
Well	2	0.5	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)										
Total	1539	239557	Product	Ounces (volume)		102	47725	Product	Ounces (weight)		4	67.5	Product	Ounces (volume)		263	224.75	Product	Ounces (weight)

Table A41.

Application Sites:	Delta Dust Comments	Wasp Freeze - # Treatments	Total Amount Used33	Total Amount Type34	Total Amount Unit34	Wasp Freeze Comments	Drione - # Treatments	Total Amount Used1112	Total Amount Type1213	Total Amount Unit1214	Drione Comments	VectoLex WDG - # Treatments	Total Amount Used3345	Total Amount Type3446	Total Amount Unit3447	VectoLex WDG Comments	Spectracide - # Treatments	Total Amount Used33452
Aerial yellowjacket nest		1	0.5	Product	Other (specify in comments section)	per can											2	7.5
Bird Bath												0	0					
Catch Basin												0	0					
Creek												0	0					
Culvert												0	0					
Ditch												0	0					
Drain Line												4	368	Product	Ounces (weight)			
Drain Pipes												0	0					
Fish Pond												0	0					
Fountain												0	0					
Fresh H2O Marsh												0	0					
Ground yellowjacket nest		4	3	Product	Other (specify in comments section)	per can	4	1.75	Product	Ounces (weight)		0	0				93	1545
H20 under Bldg												0	0					
Horse Trough												0	0					
Hot tub												0	0					
Imp H2O												0	0					
Misc container												0	0					
Multiple												0	0					
Pond (natural)												0	0					
Pothole												0	0					
Reservoir												0	0					
Salt Marsh												0	0					
Seepage												0	0					
Septic Seepage												0	0					
Septic Tank												0	0					
Sewage Treatment Plant												0	0					
Slough												0	0					
Spring												0	0					
Storm Drain												0	0					
Street Gutter												0	0					
Sump												0	0					
Swim Pool												0	0					
Swim pool cover												0	0					
Swim Pool Drain												0	0					
Tank												0	0					
Tire												0	0					
Treehole												0	0					
Vault												0	0					
Water meter box												0	0					
Waterfall												0	0					
Well												0	0					
Total		5	3.5	Product	Other (specify in comments section)	per can	4	1.75	Product	Ounces (weight)		4	368	Product	Ounces (weight)		95	1552.5

Table A41.

Application Sites:	Total Amount Type34463	Total Amount Unit34474	Spectracide Comments	Larvicide GB-1111 - # Treatments	Total Amount Used611	Total Amount Type712	Total Amount Unit713	Larvicide GB-1111 Comments	Natular G30 - # Treatments	Total Amount Used1317	Total Amount Type1418	Total Amount Unit1419	Natular G30 Comments	Spectracide Pro # Treatments	Total Amount Used1723	Total Amount Type1824	Total Amount Unit1825	Spectracide Pro Comments	Teknar SC - # Treatments
Aerial yellowjacket nest	Product	Ounces (volume)																	
Bird Bath				0	0	Product	Ounces (volume)		3	0.75	Product	Ounces (weight)							
Catch Basin				4	1	Product	Ounces (volume)		96	80.5	Product	Ounces (weight)							
Creek				1	1.5	Product	Ounces (volume)		47	2439.75	Product	Ounces (weight)							
Culvert				0	0	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)							
Ditch				3	6.5	Product	Ounces (volume)		27	27.75	Product	Ounces (weight)							
Drain Line				1	0.25	Product	Ounces (volume)		3	1	Product	Ounces (weight)							
Drain Pipes				0	0	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)							
Fish Pond				4	1	Product	Ounces (volume)		40	10	Product	Ounces (weight)							
Fountain				2	0.5	Product	Ounces (volume)		32	11.75	Product	Ounces (weight)							
Fresh H2O Marsh				0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)							
Ground yellowjacket nest	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)		63	1436.25	Product	Ounces (volume)		
H20 under Bldg				0	0	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)							
Horse Trough				1	0.25	Product	Ounces (volume)		0	0	Product	Ounces (weight)							
Hot tub				0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)							
Imp H2O				2	50.25	Product	Ounces (volume)		26	369.5	Product	Ounces (weight)							1
Misc container				0	0	Product	Ounces (volume)		23	6	Product	Ounces (weight)							
Multiple				0	0	Product	Ounces (volume)		2	0.5	Product	Ounces (weight)							
Pond (natural)				0	0	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)							
Pothole				0	0	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)							
Reservoir				0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)							
Salt Marsh				0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)							
Seepage				0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)							
Septic Seepage				0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)							
Septic Tank				0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)							
Sewage Treatment Plant				0	0	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)							
Slough				0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)							
Spring				0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)							
Storm Drain				0	0	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)							
Street Gutter				0	0	Product	Ounces (volume)		39	10.25	Product	Ounces (weight)							
Sump				0	0	Product	Ounces (volume)		34	8.5	Product	Ounces (weight)							
Swim Pool				0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)							
Swim pool cover				0	0	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)							
Swim Pool Drain				0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)							
Tank				0	0	Product	Ounces (volume)		1	4	Product	Ounces (weight)							
Tire				1	0.25	Product	Ounces (volume)		0	0	Product	Ounces (weight)							
Treehole				0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)							
Vault				0	0	Product	Ounces (volume)		42	12	Product	Ounces (weight)							
Water meter box				0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)							
Waterfall				0	0	Product	Ounces (volume)		12	3	Product	Ounces (weight)							
Well				0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)							
Total	Product	Ounces (volume)		19	61.5	Product	Ounces (volume)		435	2987.25	Product	Ounces (weight)		63	1436.25	Product	Ounces (volume)		1

Table A41.

Application Sites:	Total Amount Used3144	Total Amount Type3245	Total Amount Unit3246	Teknar SC Comments	Altosid Briquets - # Treatments	Total Amount Used4663	Total Amount Type5764	Total Amount Unit5865	Atlosid Briquets Comments	Altosid Liquid Concentrate - # Treatments	Total Amount Used6966	Total Amount Type71067	Total Amount Unit71168	Altosid Liquid Concentrate Comments	Altosid Pellets - # Treatments	Total Amount Used111269
Aerial yellowjacket nest																
Bird Bath					16	16	Product	her (specify in comments secti	per briq						2	0.5
Catch Basin					381	880	Product	her (specify in comments section)							42	584.75
Creek					5	127	Product	her (specify in comments section)							11	44.25
Culvert					4	7	Product	her (specify in comments section)							0	0
Ditch					14	31	Product	her (specify in comments section)							27	12
Drain Line					8	18	Product	her (specify in comments section)							3	0.75
Drain Pipes					0	0	Product	her (specify in comments section)							0	0
Fish Pond					624	942	Product	her (specify in comments section)							7	2
Fountain					375	598	Product	her (specify in comments section)							7	4.25
Fresh H2O Marsh					0	0	Product	her (specify in comments section)							0	0
Ground yellowjacket nest					0	0	Product	her (specify in comments section)								
H20 under Bldg					5	22	Product	her (specify in comments section)							1	2
Horse Trough					6	30	Product	her (specify in comments section)							0	0
Hot tub					26	27	Product	her (specify in comments section)							0	0
Imp H2O	8	Product	Ounces (volume)	Our product was Teknar HPD	34	57	Product	her (specify in comments section)		1	1	Product	Ounces (volume)	5%	20	5.25
Misc container					93	147	Product	her (specify in comments section)							8	6.75
Multiple							Product	her (specify in comments section)							0	0
Pond (natural)					10	24	Product	her (specify in comments section)							0	0
Pothole					0	0	Product	her (specify in comments section)							0	0
Reservoir					0	0	Product	her (specify in comments section)							0	0
Salt Marsh					0	0	Product	her (specify in comments section)							2	200
Seepage					0	0	Product	her (specify in comments section)							1	0.25
Septic Seepage					0	0	Product	her (specify in comments section)							0	0
Septic Tank					2	8	Product	her (specify in comments section)							0	0
Sewage Treatment Plant					1	1	Product	her (specify in comments section)							0	0
Slough					0	0	Product	her (specify in comments section)							0	0
Spring					0	0	Product	her (specify in comments section)							0	0
Storm Drain					1	1	Product	her (specify in comments section)							0	0
Street Gutter					1	1	Product	her (specify in comments section)							15	3.75
Sump					94	128	Product	her (specify in comments section)							5	1.25
Swim Pool					34	130	Product	her (specify in comments section)							2	0.5
Swim pool cover					0	0	Product	her (specify in comments section)							0	0
Swim Pool Drain					2	3	Product	her (specify in comments section)							0	0
Tank					10	31	Product	her (specify in comments section)							1	10
Tire					0	0	Product	her (specify in comments section)							1	0.25
Treehole					0	0	Product	her (specify in comments section)							7	1.75
Vault					66	161	Product	her (specify in comments section)							0	0
Water meter box					1	1	Product	her (specify in comments section)							0	0
Waterfall					40	89	Product	her (specify in comments section)							0	0
Well					12	16	Product	her (specify in comments section)							0	0
Total	8	Product	Ounces (volume)		1865	3496	Product	her (specify in comments secti	per briq	1	1	Product	Ounces (volume)		162	880.25

Table A41.

Application Sites:	Total Amount Type121370	Total Amount Unit121471	Altosid Pellets Comments	Altosid XR Briquets - # Treatments	Total Amount Used151875	Total Amount Type161976	Total Amount Unit162077	Altosid XR Briquets Comments	Altosid XR-G - # Treatments	Total Amount Used172178	Total Amount Type182279	Total Amount Unit182380	Altosid XR-G Comments	Pyrenone 25-5 # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit8
Aerial yellowjacket nest																	
Bird Bath				3	1.5	Product	Other (specify in comments section)		1	0.25	Product	Other (specify in comments section)		0	0		
Catch Basin				67	99	Product	Other (specify in comments section)		70	25.5	Product	Other (specify in comments section)		0	0		
Creek				0	0	Product	Other (specify in comments section)		39	927.25	Product	Other (specify in comments section)		0	0		
Culvert				1	1	Product	Other (specify in comments section)		6	1.75	Product	Other (specify in comments section)		0	0		
Ditch				16	17	Product	Other (specify in comments section)		171	1786.75	Product	Other (specify in comments section)		0	0		
Drain Line				4	9.5	Product	Other (specify in comments section)		8	2.25	Product	Other (specify in comments section)		0	0		
Drain Pipes				1	1	Product	Other (specify in comments section)		0	0	Product	Other (specify in comments section)		0	0		
Fish Pond				126	139	Product	Other (specify in comments section)		37	10.75	Product	Other (specify in comments section)		0	0		
Fountain				49	48	Product	Other (specify in comments section)		30	7.5	Product	Other (specify in comments section)		0	0		
Fresh H2O Marsh				0	0	Product	Other (specify in comments section)		9	70883	Product	Other (specify in comments section)		0	0		
Ground yellowjacket nest						Product	Other (specify in comments section)				Product	Other (specify in comments section)		0	0		
H20 under Bldg				6	17	Product	Other (specify in comments section)		1	20	Product	Other (specify in comments section)		6	12.5	Product	Ounces (volume)
Horse Trough				10	15.5	Product	Other (specify in comments section)		13	3.25	Product	Other (specify in comments section)		0	0		
Hot tub				7	5.5	Product	Other (specify in comments section)		5	1.25	Product	Other (specify in comments section)		0	0		
Imp H2O				5	6.5	Product	Other (specify in comments section)		61	350.75	Product	Other (specify in comments section)		0	0		
Misc container				15	12	Product	Other (specify in comments section)		40	11	Product	Other (specify in comments section)		0	0		
Multiple				0		Product	Other (specify in comments section)				Product	Other (specify in comments section)		0	0		
Pond (natural)				1	1	Product	Other (specify in comments section)		2	4	Product	Other (specify in comments section)		0	0		
Pothole				2	8	Product	Other (specify in comments section)		3	0.75	Product	Other (specify in comments section)		0	0		
Reservoir				0	0	Product	Other (specify in comments section)		2	20	Product	Other (specify in comments section)		0	0		
Salt Marsh				0	0	Product	Other (specify in comments section)		3	220	Product	Other (specify in comments section)		0	0		
Seepage				0	0	Product	Other (specify in comments section)		7	1.75	Product	Other (specify in comments section)		0	0		
Septic Seepage				1	4	Product	Other (specify in comments section)		0	0	Product	Other (specify in comments section)		0	0		
Septic Tank				2	4.5	Product	Other (specify in comments section)		0	0	Product	Other (specify in comments section)		0	0		
Sewage Treatment Plant				0	0	Product	Other (specify in comments section)		0	0	Product	Other (specify in comments section)		0	0		
Slough				0	0	Product	Other (specify in comments section)		1	40	Product	Other (specify in comments section)		0	0		
Spring				2	2.5	Product	Other (specify in comments section)		0	0	Product	Other (specify in comments section)		0	0		
Storm Drain				0	0	Product	Other (specify in comments section)		0	0	Product	Other (specify in comments section)		0	0		
Street Gutter				2	2	Product	Other (specify in comments section)		27	8	Product	Other (specify in comments section)		0	0		
Sump				20	20	Product	Other (specify in comments section)		15	3.75	Product	Other (specify in comments section)		0	0		
Swim Pool				14	42	Product	Other (specify in comments section)		2	1.25	Product	Other (specify in comments section)		0	0		
Swim pool cover				1	2	Product	Other (specify in comments section)		0	0	Product	Other (specify in comments section)		0	0		
Swim Pool Drain				0	0	Product	Other (specify in comments section)		0	0	Product	Other (specify in comments section)		0	0		
Tank				5	11	Product	Other (specify in comments section)		1	4	Product	Other (specify in comments section)		0	0		
Tire				0	0	Product	Other (specify in comments section)		1	0.25	Product	Other (specify in comments section)		0	0		
Treehole				1	0.5	Product	Other (specify in comments section)		0	0	Product	Other (specify in comments section)		0	0		
Vault				16	2505.5	Product	Other (specify in comments section)		31	9	Product	Other (specify in comments section)		0	0		
Water meter box				0	0	Product	Other (specify in comments section)		0	0	Product	Other (specify in comments section)		0	0		
Waterfall				7	15.5	Product	Other (specify in comments section)		7	1.75	Product	Other (specify in comments section)		0	0		
Well				3	3	Product	Other (specify in comments section)		1	0.25	Product	Other (specify in comments section)		0	0		
Total		0		387	2994	Product	Other (specify in comments section)		594	74346	Product	Other (specify in comments section)		6	12.5	Product	Ounces (volume)

Table A41.

Application Sites:	Pyrenone 25-5 Comments	VectoLex WSP - # Treatments	Total Amount Used16	Total Amount Type17	Total Amount Unit18	VectoLex WSP Comments
Aerial yellowjacket nest						
Bird Bath		0	0	Product	Other (specify in comments section)	per packet
Catch Basin		0	0	Product	Other (specify in comments section)	
Creek		0	0	Product	Other (specify in comments section)	
Culvert		0	0	Product	Other (specify in comments section)	
Ditch		1	1	Product	Other (specify in comments section)	
Drain Line		0	0	Product	Other (specify in comments section)	
Drain Pipes		0	0	Product	Other (specify in comments section)	
Fish Pond		6	8.25	Product	Other (specify in comments section)	
Fountain		1	1	Product	Other (specify in comments section)	
Fresh H2O Marsh		0	0	Product	Other (specify in comments section)	
Ground yellowjacket nest		0	0	Product	Other (specify in comments section)	
H20 under Bldg		0	0	Product	Other (specify in comments section)	
Horse Trough		1	1	Product	Other (specify in comments section)	
Hot tub		0	0	Product	Other (specify in comments section)	
Imp H2O		0	0	Product	Other (specify in comments section)	
Misc container		0	0	Product	Other (specify in comments section)	
Multiple		0	0	Product	Other (specify in comments section)	
Pond (natural)		0	0	Product	Other (specify in comments section)	
Pothole		0	0	Product	Other (specify in comments section)	
Reservoir		0	0	Product	Other (specify in comments section)	
Salt Marsh		0	0	Product	Other (specify in comments section)	
Seepage		0	0	Product	Other (specify in comments section)	
Septic Seepage		0	0	Product	Other (specify in comments section)	
Septic Tank		0	0	Product	Other (specify in comments section)	
Sewage Treatment Plant		0	0	Product	Other (specify in comments section)	
Slough		0	0	Product	Other (specify in comments section)	
Spring		1	1	Product	Other (specify in comments section)	
Storm Drain		0	0	Product	Other (specify in comments section)	
Street Gutter		0	0	Product	Other (specify in comments section)	
Sump		1	1	Product	Other (specify in comments section)	
Swim Pool		0	0	Product	Other (specify in comments section)	
Swim pool cover		0	0	Product	Other (specify in comments section)	
Swim Pool Drain		0	0	Product	Other (specify in comments section)	
Tank		1	1	Product	Other (specify in comments section)	
Tire		0	0	Product	Other (specify in comments section)	
Treehole		0	0	Product	Other (specify in comments section)	
Vault		1	5	Product	Other (specify in comments section)	
Water meter box		0	0	Product	Other (specify in comments section)	
Waterfall		0	0	Product	Other (specify in comments section)	
Well		0	0	Product	Other (specify in comments section)	
Total		13	19.25	Product	Other (specify in comments section)	per packet

Table A42. **Pesticide Application Data for Fall 2011 – SMCMVCD**

Application Sites:	Altosid Pellets WSP - # Treatments	Total Amount Used11	Total Amount Type12	Total Amount Unit12	Altosid Pellets WSP Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18	BVA-2 Comments	VectoLex CG - # Treatments	Total Amount Used19	Total Amount Type20	Total Amount Unit20	VectoLex CG Comments	Delta Dust - # Treatments	Total Amount Used31	Total Amount Type32
Aerial yellowjacket nest						0												
Bird Bath	0	0	Product	Other (specify in comments section)	packet	4	1	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Catch Basin	2	2		Other (specify in comments section)	packet	215	47661	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)				
Creek	0	0		Other (specify in comments section)	packet	3	9.25	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Culvert	0	0		Other (specify in comments section)	packet	3	1.5	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Ditch	6	6		Other (specify in comments section)	packet	12	60	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Drain Line	0	0		Other (specify in comments section)	packet	5	20.75	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Drain Pipes	0	0		Other (specify in comments section)	packet	2	0.5	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Fish Pond	0	0		Other (specify in comments section)	packet	360	170.5	Product	Ounces (volume)		45	14.25	Product	Ounces (weight)				
Fountain	5	5		Other (specify in comments section)	packet	157	43.5	Product	Ounces (volume)		33	8.25	Product	Ounces (weight)				
Fresh H2O Marsh	0	0		Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Ground yellowjacket nest	0	0		Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)		26	18.25	Product
H20 under Bldg	0	0		Other (specify in comments section)	packet	31	905	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Horse Trough	1	6		Other (specify in comments section)	packet	2	0.5	Product	Ounces (volume)		6	1.5	Product	Ounces (weight)				
Hot tub	1	1		Other (specify in comments section)	packet	19	6.5	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)				
Imp H2O	2	2		Other (specify in comments section)	packet	22	18.5	Product	Ounces (volume)		3	15.25	Product	Ounces (weight)				
Misc container	1	1		Other (specify in comments section)	packet	53	14.25	Product	Ounces (volume)		12	3	Product	Ounces (weight)				
Multiple	0	0		Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Pond (natural)	0	0		Other (specify in comments section)	packet	5	2	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Pothole	0	0		Other (specify in comments section)	packet	1	10	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Reservoir	0	0		Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Salt Marsh	0	0		Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Seepage	0	0		Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Septic Seepage	0	0		Other (specify in comments section)	packet	2	20	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Septic Tank	0	0		Other (specify in comments section)	packet	3	2	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Sewage Treatment Plant	0	0		Other (specify in comments section)	packet	13	7552	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Slough	0	0		Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Spring	0	0		Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Storm Drain	0	0		Other (specify in comments section)	packet	1	0.25	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Street Gutter	0	0		Other (specify in comments section)	packet	3	1.75	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)				
Sump	0	0		Other (specify in comments section)	packet	27	9	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)				
Swim Pool	1	1		Other (specify in comments section)	packet	33	103.25	Product	Ounces (volume)		2	2	Product	Ounces (weight)				
Swim pool cover	0	0		Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Swim Pool Drain	0	0		Other (specify in comments section)	packet	3	0.75	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)				
Tank	0	0		Other (specify in comments section)	packet	2	2.25	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Tire	0	0		Other (specify in comments section)	packet	2	0.5	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Treehole	0	0		Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)				
Vault	2	7		Other (specify in comments section)	packet	10	34.5	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Water meter box	0	0		Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Waterfall	0	0		Other (specify in comments section)	packet	22	7.75	Product	Ounces (volume)		4	1.5	Product	Ounces (weight)				
Well	0	0		Other (specify in comments section)	packet	4	1.25	Product	Ounces (volume)									
Paper Wasp Nest																		
Total	21	31	Product	Other (specify in comments section)	packet	1019	56660	Product	Ounces (volume)		111	47.25	Product	Ounces (weight)		26	18.25	Product

Table A42.

Application Sites:	Total Amount Unit32	Delta Dust Comments	VectoLex WDG - # Treatments	Total Amount Used3345	Total Amount Type3446	Total Amount Unit3447	VectoLex WDG Comments	Spectracide - # Treatments	Total Amount Used33452	Total Amount Type34463	Total Amount Unit34474	Spectracide Comments	Larvicide GB-1111 - # Treatments	Total Amount Used611	Total Amount Type712	Total Amount Unit713	Larvicide GB-1111 Comments	Natular G30 - # Treatments
Aerial yellowjacket nest																		
Bird Bath																		2
Catch Basin																		35
Creek																		2
Culvert																		4
Ditch																		12
Drain Line			3	160	Product	Ounces (weight)												6
Drain Pipes																		1
Fish Pond																		21
Fountain																		14
Fresh H2O Marsh																		0
Ground yellowjacket nest	Ounces (weight)							36	420	Product	Ounces (volume)							0
H20 under Bldg																		1
Horse Trough																		0
Hot tub																		0
Imp H2O																		25
Misc container																		25
Multiple																		0
Pond (natural)																		2
Pothole																		0
Reservoir																		0
Salt Marsh																		0
Seepage																		0
Septic Seepage																		0
Septic Tank																		0
Sewage Treatment Plant													2	178	Product	Ounces (volume)		0
Slough																		0
Spring																		0
Storm Drain																		0
Street Gutter																		16
Sump																		19
Swim Pool																		0
Swim pool cover																		0
Swim Pool Drain																		0
Tank																		1
Tire																		3
Treehole																		0
Vault																		24
Water meter box																		0
Waterfall																		5
Well																		0
Paper Wasp Nest								2	18.75	Product	Ounces (volume)							0
Total	Ounces (weight)		3	160	Product	Ounces (weight)		38	438.75	Product	Ounces (volume)		2	178	Product	Ounces (volume)		218

Table A42.

Application Sites:	Total Amount Used1317	Total Amount Type1418	Total Amount Unit1419	Natular G30 Comments	Spectracide Pro # Treatments	Total Amount Used1723	Total Amount Type1824	Total Amount Unit1825	Spectracide Pro Comments	Teknar SC - # Treatments	Total Amount Used3144	Total Amount Type3245	Total Amount Unit3246	Teknar SC Comments	Altosid Briquets - # Treatments	Total Amount Used4663	Total Amount Type5764
Aerial yellowjacket nest															0	0	Product
Bird Bath	0.5	Product	Ounces (weight)							0	0	Product	Ounces (volume)		22	22	Product
Catch Basin	12.5	Product	Ounces (weight)							0	0	Product	Ounces (volume)		321	722	Product
Creek	4.5	Product	Ounces (weight)							0	0	Product	Ounces (volume)		5	11	Product
Culvert	1	Product	Ounces (weight)							0	0	Product	Ounces (volume)		3	3	Product
Ditch	17.25	Product	Ounces (weight)							2	392	Product	Ounces (volume)		12	18	Product
Drain Line	1.75	Product	Ounces (weight)							0	0	Product	Ounces (volume)		11	20	Product
Drain Pipes	0.25	Product	Ounces (weight)							0	0	Product	Ounces (volume)		4	6	Product
Fish Pond	10.5	Product	Ounces (weight)							0	0	Product	Ounces (volume)		929	1335	Product
Fountain	3.5	Product	Ounces (weight)							0	0	Product	Ounces (volume)		529	828	Product
Fresh H2O Marsh	0	Product	Ounces (weight)							1	12	Product	Ounces (volume)		0	0	Product
Ground yellowjacket nest	0	Product	Ounces (weight)		11	277.5	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0	Product
H20 under Bldg	2	Product	Ounces (weight)							0	0	Product	Ounces (volume)		3	11	Product
Horse Trough	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		9	61	Product
Hot tub	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		46	47	Product
Imp H2O	10.75	Product	Ounces (weight)							2	33	Product	Ounces (volume)		32	37	Product
Misc container	6.25	Product	Ounces (weight)							0	0	Product	Ounces (volume)		146	246	Product
Multiple	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		0	0	Product
Pond (natural)	0.5	Product	Ounces (weight)							0	0	Product	Ounces (volume)		12	32	Product
Pothole	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		3	8	Product
Reservoir	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		1	1	Product
Salt Marsh	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		0	0	Product
Seepage	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		0	0	Product
Septic Seepage	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		0	0	Product
Septic Tank	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		1	4	Product
Sewage Treatment Plant	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		0	0	Product
Slough	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		0	0	Product
Spring	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		0	0	Product
Storm Drain	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		2	2	Product
Street Gutter	4.25	Product	Ounces (weight)							0	0	Product	Ounces (volume)		3	3	Product
Sump	4.75	Product	Ounces (weight)							0	0	Product	Ounces (volume)		114	145	Product
Swim Pool	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		63	232	Product
Swim pool cover	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		0	0	Product
Swim Pool Drain	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		6	7	Product
Tank	4	Product	Ounces (weight)							0	0	Product	Ounces (volume)		12	27	Product
Tire	0.75	Product	Ounces (weight)							0	0	Product	Ounces (volume)		2	2	Product
Treehole	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		4	4	Product
Vault	6.25	Product	Ounces (weight)							0	0	Product	Ounces (volume)		71	126	Product
Water meter box	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		1	1	Product
Waterfall	1.25	Product	Ounces (weight)							0	0	Product	Ounces (volume)		60	150	Product
Well	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		14	16	Product
Paper Wasp Nest	0	Product	Ounces (weight)							0	0	Product	Ounces (volume)		0	0	Product
Total	92.5	Product	Ounces (weight)		11	277.5	Product	Ounces (volume)		5	437	Product	Ounces (volume)		2441	4127	Product

Table A42.

Application Sites:	Total Amount Unit5865	Atlosid Briquets Comments	Altosid Pellets - # Treatments	Total Amount Used111269	Total Amount Type121370	Total Amount Unit121471	Altosid Pellets Comments	Altosid XR Briquets - # Treatments	Total Amount Used151875	Total Amount Type161976	Total Amount Unit162077	Altosid XR Briquets Comments	Altosid XR-G - # Treatments	Total Amount Used172178	Total Amount Type182279	Total Amount Unit182380
Aerial yellowjacket nest	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)
Bird Bath	Other (specify in comments section)	briquet	3	0.75	Product	Ounces (weight)		2	2.5	Product	Other (specify in comments section)	briquet	5	1.25	Product	Ounces (weight)
Catch Basin	Other (specify in comments section)	briquet	34	489.25	Product	Ounces (weight)		16	29	Product	Other (specify in comments section)	briquet	24	6	Product	Ounces (weight)
Creek	Other (specify in comments section)	briquet	4	1.5	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	4	22.75	Product	Ounces (weight)
Culvert	Other (specify in comments section)	briquet	1	0.25	Product	Ounces (weight)		1	1	Product	Other (specify in comments section)	briquet	5	1.25	Product	Ounces (weight)
Ditch	Other (specify in comments section)	briquet	24	80	Product	Ounces (weight)		1	7	Product	Other (specify in comments section)	briquet	59	668.25	Product	Ounces (weight)
Drain Line	Other (specify in comments section)	briquet	4	1	Product	Ounces (weight)		1	5	Product	Other (specify in comments section)	briquet	8	2.25	Product	Ounces (weight)
Drain Pipes	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)
Fish Pond	Other (specify in comments section)	briquet	22	5.5	Product	Ounces (weight)		81	111	Product	Other (specify in comments section)	briquet	70	19.25	Product	Ounces (weight)
Fountain	Other (specify in comments section)	briquet	13	3.25	Product	Ounces (weight)		31	54.5	Product	Other (specify in comments section)	briquet	71	17.75	Product	Ounces (weight)
Fresh H2O Marsh	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	5	35208	Product	Ounces (weight)
Ground yellowjacket nest	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)
H20 under Bldg	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		5	13	Product	Other (specify in comments section)	briquet	1	0.25	Product	Ounces (weight)
Horse Trough	Other (specify in comments section)	briquet	1	0.25	Product	Ounces (weight)		9	20	Product	Other (specify in comments section)	briquet	7	1.75	Product	Ounces (weight)
Hot tub	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		9	9	Product	Other (specify in comments section)	briquet	1	0.25	Product	Ounces (weight)
Imp H2O	Other (specify in comments section)	briquet	44	27	Product	Ounces (weight)		3	16	Product	Other (specify in comments section)	briquet	65	164.25	Product	Ounces (weight)
Misc container	Other (specify in comments section)	briquet	27	7.75	Product	Ounces (weight)		11	15	Product	Other (specify in comments section)	briquet	93	27.75	Product	Ounces (weight)
Multiple	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)
Pond (natural)	Other (specify in comments section)	briquet	1	0.25	Product	Ounces (weight)		2	6	Product	Other (specify in comments section)	briquet	3	0.75	Product	Ounces (weight)
Pothole	Other (specify in comments section)	briquet	1	0.5	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)
Reservoir	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	1	0.25	Product	Ounces (weight)
Salt Marsh	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		1	1	Product	Other (specify in comments section)	briquet	7	784	Product	Ounces (weight)
Seepage	Other (specify in comments section)	briquet	1	0.25	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	4	1	Product	Ounces (weight)
Septic Seepage	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		1	3	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)
Septic Tank	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		2	3	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)
Sewage Treatment Plant	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)
Slough	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)
Spring	Other (specify in comments section)	briquet	2	0.75	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)
Storm Drain	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)
Street Gutter	Other (specify in comments section)	briquet	13	3.25	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	15	3.75	Product	Ounces (weight)
Sump	Other (specify in comments section)	briquet	4	1	Product	Ounces (weight)		7	7	Product	Other (specify in comments section)	briquet	29	7.5	Product	Ounces (weight)
Swim Pool	Other (specify in comments section)	briquet	3	0.75	Product	Ounces (weight)		12	30	Product	Other (specify in comments section)	briquet	3	1	Product	Ounces (weight)
Swim pool cover	Other (specify in comments section)	briquet	4	2	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	1	0.25	Product	Ounces (weight)
Swim Pool Drain	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		2	2	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)
Tank	Other (specify in comments section)	briquet	1	1	Product	Ounces (weight)		2	4	Product	Other (specify in comments section)	briquet	1	4	Product	Ounces (weight)
Tire	Other (specify in comments section)	briquet	4	1	Product	Ounces (weight)		1	1	Product	Other (specify in comments section)	briquet	7	1.75	Product	Ounces (weight)
Treehole	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		2	3	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)
Vault	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		3	7	Product	Other (specify in comments section)	briquet	55	14.25	Product	Ounces (weight)
Water meter box	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)
Waterfall	Other (specify in comments section)	briquet	3	0.75	Product	Ounces (weight)		2	5	Product	Other (specify in comments section)	briquet	18	4.5	Product	Ounces (weight)
Well	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		5	6	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)
Paper Wasp Nest	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)
Total	Other (specify in comments section)	briquet	214	628	Product	Ounces (weight)		212	361	Product	Other (specify in comments section)	briquet	562	36964	Product	Ounces (weight)

Table A42.

Application Sites:	Altosid XR-G Comments	Altosid Liquid (Not-conentrate) # Treatments	Total Amount Used	Total Amount Type2	Total Amount Unit	Altosid Liquid (not-concentrate) Comments	Pyrenone 25-5 # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit8	Pyrenone 25-5 Comments	VectoLex WSP - # Treatments	Total Amount Used2	Total Amount Type17	Total Amount Unit18	VectoLex WSP Comments
Aerial yellowjacket nest		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Bird Bath		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Catch Basin		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Creek		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Culvert		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Ditch		2	40	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Drain Line		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Drain Pipes		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Fish Pond		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		1	1	Product	Other (specify in comments section)	packet
Fountain		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Fresh H2O Marsh		1	3	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Ground yellowjacket nest		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
H20 under Bldg		0	0	Product	Ounces (volume)		7	69.25	Product	Ounces (volume)		0	0			
Horse Trough		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Hot tub		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Imp H2O		2	2.25	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Misc container		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Multiple		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Pond (natural)		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Pothole		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Reservoir		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Salt Marsh		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Seepage		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Septic Seepage		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Septic Tank		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Sewage Treatment Plant		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Slough		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Spring		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Storm Drain		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Street Gutter		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Sump		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Swim Pool		1	5	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Swim pool cover		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Swim Pool Drain		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Tank		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Tire		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Treehole		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Vault		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Water meter box		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Waterfall		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Well		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Paper Wasp Nest		0	0	Product	Ounces (volume)		0	0	Product	Ounces (volume)		0	0			
Total		6	50.25	Product	Ounces (volume)		7	69.25	Product	Ounces (volume)		1	1	Product	Other (specify in comments section)	packet

Table A43. **Pesticide Application Data for Winter 2012 – SMCMVCD**

Application Sites:	Altosid Pellets WSP - # Treatments	Total Amount Used11	Total Amount Type12	Total Amount Unit12	Altosid Pellets WSP Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18	BVA-2 Comments	VectoLex CG - # Treatments	Total Amount Used19	Total Amount Type20	Total Amount Unit20	VectoLex CG Comments	Delta Dust - # Treatments	Total Amount Used31	Total Amount Type32
Bird Bath	0	0	Product	Other (specify in comments section)	packet	1	0.25	Product	Ounces (volume)		2	0.5	Product	Ounces (weight)				
Catch Basin	24	32	Product	Other (specify in comments section)	packet	45	104.75	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Creek	0	0	Product	Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Culvert	0	0	Product	Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Ditch	4	8	Product	Other (specify in comments section)	packet	7	3208	Product	Ounces (volume)		6	5	Product	Ounces (weight)				
Drain Line	0	0	Product	Other (specify in comments section)	packet	5	150.25	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Drain Pipes	0	0	Product	Other (specify in comments section)	packet	1	0.25	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Fish Pond	12	15	Product	Other (specify in comments section)	packet	279	130	Product	Ounces (volume)		63	17.25	Product	Ounces (weight)				
Fountain	20	24	Product	Other (specify in comments section)	packet	103	29.75	Product	Ounces (volume)		39	9.75	Product	Ounces (weight)				
Fresh H2O Marsh	1	2	Product	Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Ground yellowjacket nest	0	0	Product	Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)		1	0.5	Product
H20 under Bldg	0	0	Product	Other (specify in comments section)	packet	20	935.75	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Horse Trough	0	0	Product	Other (specify in comments section)	packet	2	0.75	Product	Ounces (volume)		6	1.5	Product	Ounces (weight)				
Hot tub	1	1	Product	Other (specify in comments section)	packet	11	3.75	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)				
Imp H2O	10	24	Product	Other (specify in comments section)	packet	23	36	Product	Ounces (volume)		4	17.25	Product	Ounces (weight)				
Misc container	5	7	Product	Other (specify in comments section)	packet	47	12.25	Product	Ounces (volume)		12	3	Product	Ounces (weight)				
Multiple	0	0	Product	Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Paper Wasp Nest	0	0	Product	Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Pond (natural)	0	0	Product	Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Pothole	1	1	Product	Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Reservoir	0	0	Product	Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Salt Marsh	0	0	Product	Other (specify in comments section)	packet	1	3200	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Seepage	0	0	Product	Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Septic Seepage	0	0	Product	Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Septic Tank	0	0	Product	Other (specify in comments section)	packet	4	2.5	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Sewage Treatment Plant	0	0	Product	Other (specify in comments section)	packet	11	4242	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Spring	0	0	Product	Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Storm Drain	0	0	Product	Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Street Gutter	0	0	Product	Other (specify in comments section)	packet	4	1.25	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)				
Sump	8	8	Product	Other (specify in comments section)	packet	15	3.75	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Swim Pool	1	2	Product	Other (specify in comments section)	packet	29	100.25	Product	Ounces (volume)		2	7.5	Product	Ounces (weight)				
Swim pool cover	0	0	Product	Other (specify in comments section)	packet	4	6	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Swim Pool Drain	0	0	Product	Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Tank	0	0	Product	Other (specify in comments section)	packet	4	21.75	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Tire	0	0	Product	Other (specify in comments section)	packet	3	15.75	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Treehole	1	1	Product	Other (specify in comments section)	packet	1	0.25	Product	Ounces (volume)		3	0.75	Product	Ounces (weight)				
Vault	7	14	Product	Other (specify in comments section)	packet	1	2.5	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Water meter box	0	0	Product	Other (specify in comments section)	packet	0	0	Product	Ounces (volume)		0	0	Product	Ounces (weight)				
Waterfall	1	3	Product	Other (specify in comments section)	packet	15	4.5	Product	Ounces (volume)		4	1.25	Product	Ounces (weight)				
Well	1	1	Product	Other (specify in comments section)	packet	4	3	Product	Ounces (volume)		2	0.5	Product	Ounces (weight)				
Total	97	143	Product	Other (specify in comments section)	packet	640	12215.25	Product	Ounces (volume)		145	64.75	Product	Ounces (weight)		1	0.5	Product

Table A43.

Application Sites:	Total Amount Unit32	Delta Dust Comments	VectoLex WDG - # Treatments	Total Amount Used3345	Total Amount Type3446	Total Amount Unit3447	VectoLex WDG Comments	Spectracide - # Treatments	Total Amount Used33452	Total Amount Type34463	Total Amount Unit34474	Spectracide Comments	Natular G30 - # Treatments	Total Amount Used1317	Total Amount Type1418	Total Amount Unit1419	Natular G30 Comments	Teknar SC - # Treatments
Bird Bath													0	0	Product	Ounces (weight)		0
Catch Basin													6	1.5	Product	Ounces (weight)		0
Creek													0	0	Product	Ounces (weight)		0
Culvert													2	0.5	Product	Ounces (weight)		0
Ditch													5	203.75	Product	Ounces (weight)		3
Drain Line			2	156	Product	Ounces (weight)							0	0	Product	Ounces (weight)		0
Drain Pipes													1	0.25	Product	Ounces (weight)		0
Fish Pond													3	1	Product	Ounces (weight)		0
Fountain													2	0.5	Product	Ounces (weight)		0
Fresh H2O Marsh													1	25	Product	Ounces (weight)		0
Ground yellowjacket nest	Ounces (weight)							3	22.5	Product	Ounces (volume)		0	0	Product	Ounces (weight)		0
H20 under Bldg													0	0	Product	Ounces (weight)		0
Horse Trough													0	0	Product	Ounces (weight)		0
Hot tub													0	0	Product	Ounces (weight)		0
Imp H2O													22	31.25	Product	Ounces (weight)		17
Misc container													5	1.25	Product	Ounces (weight)		0
Multiple													0	0	Product	Ounces (weight)		0
Paper Wasp Nest								2	7.5	Product	Ounces (volume)		0	0	Product	Ounces (weight)		0
Pond (natural)													0	0	Product	Ounces (weight)		1
Pothole													0	0	Product	Ounces (weight)		0
Reservoir													0	0	Product	Ounces (weight)		0
Salt Marsh													1	1	Product	Ounces (weight)		1
Seepage													0	0	Product	Ounces (weight)		0
Septic Seepage													0	0	Product	Ounces (weight)		0
Septic Tank													0	0	Product	Ounces (weight)		0
Sewage Treatment Plant													0	0	Product	Ounces (weight)		0
Spring													0	0	Product	Ounces (weight)		0
Storm Drain													0	0	Product	Ounces (weight)		0
Street Gutter													1	0.25	Product	Ounces (weight)		0
Sump													1	0.25	Product	Ounces (weight)		0
Swim Pool													2	0.75	Product	Ounces (weight)		0
Swim pool cover													1	1	Product	Ounces (weight)		0
Swim Pool Drain													0	0	Product	Ounces (weight)		0
Tank													0	0	Product	Ounces (weight)		0
Tire													0	0	Product	Ounces (weight)		0
Treehole													1	0.25	Product	Ounces (weight)		4
Vault													0	0	Product	Ounces (weight)		0
Water meter box													0	0	Product	Ounces (weight)		0
Waterfall													0	0	Product	Ounces (weight)		0
Well													0	0	Product	Ounces (weight)		0
Total	Ounces (weight)		2	156	Product	Ounces (weight)		5	30	Product	Ounces (volume)		54	268.5	Product	Ounces (weight)		26

Table A43.

Application Sites:	Total Amount Used3144	Total Amount Type3245	Total Amount Unit3246	Teknar SC Comments	Altosid Briquets - # Treatments	Total Amount Used4663	Total Amount Type5764	Total Amount Unit5865	Atlosid Briquets Comments	Altosid Liquid Concentrate - # Treatments	Total Amount Used6966	Total Amount Type71067	Total Amount Unit71168	Altosid Liquid Concentrate Comments	Altosid Pellets - # Treatments	Total Amount Used111269
Bird Bath	0	Product	Ounces (volume)		25	28	Product	Other (specify in comments section)	briquet						2	0.5
Catch Basin	0	Product	Ounces (volume)		319	571	Product	Other (specify in comments section)	briquet						49	86
Creek	0	Product	Ounces (volume)		1	2	Product	Other (specify in comments section)	briquet						0	0
Culvert	0	Product	Ounces (volume)		4	9	Product	Other (specify in comments section)	briquet						4	1
Ditch	5.5	Product	Ounces (volume)		11	12	Product	Other (specify in comments section)	briquet						32	18.5
Drain Line	0	Product	Ounces (volume)		4	11	Product	Other (specify in comments section)	briquet						14	5.5
Drain Pipes	0	Product	Ounces (volume)		1	1	Product	Other (specify in comments section)	briquet						0	0
Fish Pond	0	Product	Ounces (volume)		1153	1695	Product	Other (specify in comments section)	briquet						32	8.75
Fountain	0	Product	Ounces (volume)		631	1006	Product	Other (specify in comments section)	briquet						36	11.5
Fresh H2O Marsh	0	Product	Ounces (volume)		0	0	Product	Other (specify in comments section)	briquet						0	0
Ground yellowjacket nest	0	Product	Ounces (volume)		0	0	Product	Other (specify in comments section)	briquet						0	0
H20 under Bldg	0	Product	Ounces (volume)		4	17	Product	Other (specify in comments section)	briquet						2	1.25
Horse Trough	0	Product	Ounces (volume)		11	25	Product	Other (specify in comments section)	briquet						0	0
Hot tub	0	Product	Ounces (volume)		53	54	Product	Other (specify in comments section)	briquet						2	0.5
Imp H2O	491.25	Product	Ounces (volume)		36	70	Product	Other (specify in comments section)	briquet	1	5	Product	Ounces (volume)		76	32.75
Misc container	0	Product	Ounces (volume)		179	354	Product	Other (specify in comments section)	briquet						39	12.25
Multiple	0	Product	Ounces (volume)		0	0	Product	Other (specify in comments section)	briquet						0	0
Paper Wasp Nest	0	Product	Ounces (volume)		0	0	Product	Other (specify in comments section)	briquet						0	0
Pond (natural)	8	Product	Ounces (volume)		3	6	Product	Other (specify in comments section)	briquet						1	2
Pothole	0	Product	Ounces (volume)		0	0	Product	Other (specify in comments section)	briquet						0	0
Reservoir	0	Product	Ounces (volume)		0	0	Product	Other (specify in comments section)	briquet						1	0.25
Salt Marsh	320	Product	Ounces (volume)		1	1	Product	Other (specify in comments section)	briquet						0	0
Seepage	0	Product	Ounces (volume)		0	0	Product	Other (specify in comments section)	briquet						1	0.25
Septic Seepage	0	Product	Ounces (volume)		0	0	Product	Other (specify in comments section)	briquet						0	0
Septic Tank	0	Product	Ounces (volume)		0	0	Product	Other (specify in comments section)	briquet						0	0
Sewage Treatment Plant	0	Product	Ounces (volume)		3	12	Product	Other (specify in comments section)	briquet						0	0
Spring	0	Product	Ounces (volume)		0	0	Product	Other (specify in comments section)	briquet						2	1.5
Storm Drain	0	Product	Ounces (volume)		2	2	Product	Other (specify in comments section)	briquet						0	0
Street Gutter	0	Product	Ounces (volume)		4	6	Product	Other (specify in comments section)	briquet						20	5.25
Sump	0	Product	Ounces (volume)		127	181	Product	Other (specify in comments section)	briquet						13	9.75
Swim Pool	0	Product	Ounces (volume)		70	255	Product	Other (specify in comments section)	briquet						3	1.5
Swim pool cover	0	Product	Ounces (volume)		4	11	Product	Other (specify in comments section)	briquet						4	1.75
Swim Pool Drain	0	Product	Ounces (volume)		4	4	Product	Other (specify in comments section)	briquet						0	0
Tank	0	Product	Ounces (volume)		17	41	Product	Other (specify in comments section)	briquet						1	10
Tire	0	Product	Ounces (volume)		3	4	Product	Other (specify in comments section)	briquet						9	2.5
Treehole	1	Product	Ounces (volume)		22	39	Product	Other (specify in comments section)	briquet						7	1.75
Vault	0	Product	Ounces (volume)		91	187	Product	Other (specify in comments section)	briquet						9	3
Water meter box	0	Product	Ounces (volume)		1	1	Product	Other (specify in comments section)	briquet						0	0
Waterfall	0	Product	Ounces (volume)		66	138	Product	Other (specify in comments section)	briquet						2	0.5
Well	0	Product	Ounces (volume)		18	24	Product	Other (specify in comments section)	briquet						0	0
Total	825.75	Product	Ounces (volume)		2868	4767	Product	Other (specify in comments section)		1	5	Product	Ounces (volume)		361	218.5

Table A43.

Application Sites:	Total Amount Type121370	Total Amount Unit121471	Altosid Pellets Comments	Altosid XR Briquets - # Treatments	Total Amount Used151875	Total Amount Type161976	Total Amount Unit162077	Altosid XR Briquets Comments	Altosid XR-G - # Treatments	Total Amount Used172178	Total Amount Type182279	Total Amount Unit182380	Altosid XR-G Comments	Altosid Liquid (Not-conentrate) # Treatments	Total Amount Used	Total Amount Type2	Total Amount Unit	Altosid Liquid (not-concentrate) Comments
Bird Bath	Product	Ounces (weight)		2	2	Product	Other (specify in comments section)	briquet	3	0.75	Product	Ounces (weight)						
Catch Basin	Product	Ounces (weight)		13	36	Product	Other (specify in comments section)	briquet	33	51.5	Product	Ounces (weight)						
Creek	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)						
Culvert	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	2	0.75	Product	Ounces (weight)						
Ditch	Product	Ounces (weight)		1	2	Product	Other (specify in comments section)	briquet	63	369.5	Product	Ounces (weight)		3	1.5	Product	Ounces (weight)	
Drain Line	Product	Ounces (weight)		2	3	Product	Other (specify in comments section)	briquet	5	1.25	Product	Ounces (weight)						
Drain Pipes	Product	Ounces (weight)		2	2	Product	Other (specify in comments section)	briquet	1	0.25	Product	Ounces (weight)						
Fish Pond	Product	Ounces (weight)		98	151	Product	Other (specify in comments section)	briquet	89	23.75	Product	Ounces (weight)						
Fountain	Product	Ounces (weight)		42	68	Product	Other (specify in comments section)	briquet	97	24.25	Product	Ounces (weight)						
Fresh H2O Marsh	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	4	190	Product	Ounces (weight)						
Ground yellowjacket nest	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)						
H20 under Bldg	Product	Ounces (weight)		1	1	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)						
Horse Trough	Product	Ounces (weight)		7	37	Product	Other (specify in comments section)	briquet	7	1.75	Product	Ounces (weight)						
Hot tub	Product	Ounces (weight)		7	7	Product	Other (specify in comments section)	briquet	1	0.25	Product	Ounces (weight)						
Imp H2O	Product	Ounces (weight)		4	13	Product	Other (specify in comments section)	briquet	109	665.5	Product	Ounces (weight)		15	46.25	Product	Ounces (weight)	
Misc container	Product	Ounces (weight)		11	22	Product	Other (specify in comments section)	briquet	160	46	Product	Ounces (weight)						
Multiple	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)						
Paper Wasp Nest	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)						
Pond (natural)	Product	Ounces (weight)		1	1	Product	Other (specify in comments section)	briquet	2	40.25	Product	Ounces (weight)		1	2	Product	Ounces (weight)	
Pothole	Product	Ounces (weight)		1	1	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)						
Reservoir	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	3	0.75	Product	Ounces (weight)		1	40	Product	Ounces (weight)	
Salt Marsh	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	5	720.75	Product	Ounces (weight)						
Seepage	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)						
Septic Seepage	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)						
Septic Tank	Product	Ounces (weight)		2	3	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)						
Sewage Treatment Plant	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	1	0.25	Product	Ounces (weight)						
Spring	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)						
Storm Drain	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)						
Street Gutter	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	35	8.75	Product	Ounces (weight)						
Sump	Product	Ounces (weight)		8	8	Product	Other (specify in comments section)	briquet	50	12.5	Product	Ounces (weight)						
Swim Pool	Product	Ounces (weight)		20	68	Product	Other (specify in comments section)	briquet	1	3	Product	Ounces (weight)						
Swim pool cover	Product	Ounces (weight)		1	1	Product	Other (specify in comments section)	briquet	1	1	Product	Ounces (weight)						
Swim Pool Drain	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)						
Tank	Product	Ounces (weight)		2	4	Product	Other (specify in comments section)	briquet	2	8	Product	Ounces (weight)						
Tire	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	18	4.5	Product	Ounces (weight)						
Treehole	Product	Ounces (weight)		1	1	Product	Other (specify in comments section)	briquet	2	0.5	Product	Ounces (weight)						
Vault	Product	Ounces (weight)		3	12	Product	Other (specify in comments section)	briquet	54	19.5	Product	Ounces (weight)						
Water meter box	Product	Ounces (weight)		0	0	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)						
Waterfall	Product	Ounces (weight)		7	12	Product	Other (specify in comments section)	briquet	30	7.5	Product	Ounces (weight)						
Well	Product	Ounces (weight)		3	3	Product	Other (specify in comments section)	briquet	0	0	Product	Ounces (weight)						
Total	Product	Ounces (weight)		239	458	Product	Other (specify in comments section)	briquet	778	2202.75	Product	Ounces (weight)		20	89.75	Product	Ounces (weight)	

Table A43.

Application Sites:	VectoLex WSP - # Treatments	Total Amount Used16	Total Amount Type17	Total Amount Unit18	VectoLex WSP Comments
Bird Bath					
Catch Basin					
Creek					
Culvert					
Ditch					
Drain Line					
Drain Pipes					
Fish Pond					
Fountain					
Fresh H2O Marsh					
Ground yellowjacket nest					
H20 under Bldg					
Horse Trough					
Hot tub					
Imp H2O					
Misc container					
Multiple					
Paper Wasp Nest					
Pond (natural)					
Pothole					
Reservoir					
Salt Marsh					
Seepage					
Septic Seepage					
Septic Tank					
Sewage Treatment Plant					
Spring					
Storm Drain					
Street Gutter					
Sump					
Swim Pool	1	6	Product	Ounces (weight)	
Swim pool cover					
Swim Pool Drain					
Tank					
Tire					
Treehole					
Vault					
Water meter box					
Waterfall					
Well					
Total	1	6	Product	Ounces (weight)	

Table A44. Pesticide Application Data for Spring 2012 – SMCMVCD

Application Sites:	VectoBac 12AS - # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit7	VectoBac 12AS Comments	Altosid Pellets WSP - # Treatments	Total Amount Used11	Total Amount Type12	Total Amount Unit12	Altosid Pellets WSP Comments	BVA-2 - # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit18	BVA-2 Comments	VectoLex CG - # Treatments	Total Amount Used19	Total Amount Type20	Total Amount Unit20
Aerial yellowjacket nest																			
Bird Bath											4	1	Product	Ounces (volume)		2	0.5	Product	Ounces (weight)
Catch Basin						19	25	Product	Other (specify in comments section)	packet	296	64276.9	Product	Ounces (volume)		8	24.25	Product	Ounces (weight)
Creek											6	37.5	Product	Ounces (volume)		2	12.25	Product	Ounces (weight)
Culvert											4	1.75	Product	Ounces (volume)					
Ditch						3	12	Product	Other (specify in comments section)	packet	23	49.5	Product	Ounces (volume)		10	15	Product	Ounces (weight)
Drain Line											6	30.75	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)
Drain Pipes											2	0.5	Product	Ounces (volume)					
Fish Pond	1	1	Product	Ounces (volume)		12	17	Product	Other (specify in comments section)	packet	345	177.5	Product	Ounces (volume)		38	10.25	Product	Ounces (weight)
Fountain						5	7	Product	Other (specify in comments section)	packet	141	45.25	Product	Ounces (volume)		24	6	Product	Ounces (weight)
Fresh H2O Marsh																			
Ground yellowjacket nest																			
H20 under Bldg											17	882.25	Product	Ounces (volume)					
Horse Trough											1	0.25	Product	Ounces (volume)		2	0.5	Product	Ounces (weight)
Hot tub						1	1	Product	Other (specify in comments section)	packet	19	8.25	Product	Ounces (volume)		2	0.5	Product	Ounces (weight)
Imp H2O	3	80	Product	Ounces (volume)		3	7	Product	Other (specify in comments section)	packet	40	131.25	Product	Ounces (volume)		4	6.5	Product	Ounces (weight)
Misc container						2	2	Product	Other (specify in comments section)	packet	42	238.75	Product	Ounces (volume)		6	1.5	Product	Ounces (weight)
Multiple																			
Pond (natural)											2	4.25	Product	Ounces (volume)					
Pothole											2	1.25	Product	Ounces (volume)					
Reservoir																			
Salt Marsh																			
Seepage											1	0.25	Product	Ounces (volume)					
Septic Seepage																			
Septic Tank											1	1	Product	Ounces (volume)					
Sewage Treatment Plant											16	7122	Product	Ounces (volume)					
Slough																			
Spring																			
Storm Drain																			
Street Gutter						1	1	Product	Other (specify in comments section)	packet	6	4.25	Product	Ounces (volume)					
Sump						4	4	Product	Other (specify in comments section)	packet	27	9.5	Product	Ounces (volume)					
Swim Pool											38	130	Product	Ounces (volume)		3	6.5	Product	Ounces (weight)
Swim pool cover											2	3.25	Product	Ounces (volume)					
Swim Pool Drain											1	0.25	Product	Ounces (volume)					
Tank											4	22.75	Product	Ounces (volume)					
Tire											1	0.25	Product	Ounces (volume)					
Treehole											3	0.75	Product	Ounces (volume)					
Vault											16	224.25	Product	Ounces (volume)		1	0.25	Product	Ounces (weight)
Water meter box																			
Waterfall											14	4.5	Product	Ounces (volume)		3	0.75	Product	Ounces (weight)
Well											5	2	Product	Ounces (volume)					
Paper wasp nest																			
Total	4	81	Product	Ounces (volume)		50	76	Product	Other (specify in comments section)	packet	1085	73411.9	Product	Ounces (volume)		106	85	Product	Ounces (weight)

Table A44.

Application Sites:	VectoLex CG Comments	Spheratax SPH (50G) WSP - # Treatments	Total Amount Used29	Total Amount Type30	Total Amount Unit30	Spheratax SPH (50G) WSP Comments	Delta Dust - # Treatments	Total Amount Used31	Total Amount Type32	Total Amount Unit32	Delta Dust Comments	VectoLex WDG - # Treatments	Total Amount Used3345	Total Amount Type3446	Total Amount Unit3447	VectoLex WDG Comments	Spectracide - # Treatments	Total Amount Used33452
Aerial yellowjacket nest																	5	30
Bird Bath																		
Catch Basin																		
Creek																		
Culvert																		
Ditch		1	1	Product	Other (specify in comments section)													
Drain Line												4	172	Product	Ounces (volume)			
Drain Pipes																		
Fish Pond		1	1	Product	Other (specify in comments section)													
Fountain																		
Fresh H2O Marsh																		
Ground yellowjacket nest							18	11.25	Product	Ounces (weight)							18	172.5
H20 under Bldg																		
Horse Trough																		
Hot tub																		
Imp H2O		1	8	Product	Other (specify in comments section)													
Misc container																		
Multiple																		
Pond (natural)																		
Pothole																		
Reservoir																		
Salt Marsh																		
Seepage																		
Septic Seepage																		
Septic Tank																		
Sewage Treatment Plant																		
Slough																		
Spring																		
Storm Drain																		
Street Gutter																		
Sump																		
Swim Pool																		
Swim pool cover																		
Swim Pool Drain																		
Tank																		
Tire																		
Treehole																		
Vault																		
Water meter box																		
Waterfall																		
Well																		
Paper wasp nest																	11	108.75
Total		3	10	Product	Other (specify in comments section)		18	11.25	Product	Ounces (weight)		4	172	Product	Ounces (volume)		34	311.25

Table A44.

Application Sites:	Total Amount Type34463	Total Amount Unit34474	Spectracide Comments	Natular G30 - # Treatments	Total Amount Used1317	Total Amount Type1418	Total Amount Unit1419	Natular G30 Comments	Spectracide Pro # Treatments	Total Amount Used1723	Total Amount Type1824	Total Amount Unit1825	Spectracide Pro Comments	Teknar SC - # Treatments	Total Amount Used3144	Total Amount Type3245	Total Amount Unit3246	Teknar SC Comments	Altosid Briquets - # Treatments
Aerial yellowjacket nest	Product	Ounces (volume)																	
Bird Bath																			18
Catch Basin				4	11.5	Product	Ounces (weight)												302
Creek				4	320	Product	Ounces (weight)												2
Culvert																			9
Ditch				2	4	Product	Ounces (weight)							4	48	Product	Ounces (volume)		18
Drain Line																			3
Drain Pipes																			2
Fish Pond																			633
Fountain				1	0.25	Product	Ounces (weight)												442
Fresh H2O Marsh				1	0.5	Product	Ounces (weight)							2	16	Product	Ounces (volume)		
Ground yellowjacket nest	Product	Ounces (volume)							10	303.75	Product	Ounces (volume)							
H20 under Bldg																			3
Horse Trough																			6
Hot tub																			25
Imp H2O				5	60.5	Product	Ounces (weight)							17	888	Product	Ounces (volume)		30
Misc container																			122
Multiple																			
Pond (natural)																			2
Pothole																			
Reservoir																			
Salt Marsh														1	480	Product	Ounces (volume)		
Seepage																			
Septic Seepage																			
Septic Tank																			1
Sewage Treatment Plant																			
Slough																			
Spring																			1
Storm Drain																			1
Street Gutter																			4
Sump																			75
Swim Pool																			38
Swim pool cover																			1
Swim Pool Drain																			1
Tank																			13
Tire																			2
Treehole														4	1	Product	Ounces (volume)		9
Vault																			52
Water meter box																			
Waterfall																			32
Well																			12
Paper wasp nest	Product	Ounces (volume)							3	105	Product	Ounces (volume)							
Total	Product	Ounces (volume)		17	396.75	Product	Ounces (weight)		13	408.75	Product	Ounces (volume)		28	1433	Product	Ounces (volume)		1859

Table A44.

Application Sites:	Total Amount Used4663	Total Amount Type5764	Total Amount Unit5865	Atlosid Briquets Comments	Altosid Liquid Concentrate - # Treatments	Total Amount Used6966	Total Amount Type71067	Total Amount Unit71168	Altosid Liquid Concentrate Comments	Altosid Pellets - # Treatments	Total Amount Used111269	Total Amount Type121370	Total Amount Unit121471	Altosid Pellets Comments	Altosid XR Briquets - # Treatments	Total Amount Used151875	Total Amount Type161976
Aerial yellowjacket nest																	
Bird Bath	18	Product	Other (specify in comments section)	briquet						1	0.25	Product	Ounces (weight)		2	2	Product
Catch Basin	779	Product	Other (specify in comments section)	briquet						73	268	Product	Ounces (weight)		77	136	Product
Creek	4	Product	Other (specify in comments section)	briquet						30	1351	Product	Ounces (weight)		4	5	Product
Culvert	12	Product	Other (specify in comments section)	briquet						5	2.25	Product	Ounces (weight)		1	1	Product
Ditch	29	Product	Other (specify in comments section)	briquet	1	1	Product	Ounces (volume)		56	282	Product	Ounces (weight)		8	13	Product
Drain Line	5	Product	Other (specify in comments section)	briquet						5	1.25	Product	Ounces (weight)				
Drain Pipes	2	Product	Other (specify in comments section)	briquet													
Fish Pond	951	Product	Other (specify in comments section)	briquet						52	24	Product	Ounces (weight)		176	250.5	Product
Fountain	703	Product	Other (specify in comments section)	briquet						37	9.25	Product	Ounces (weight)		69	93.5	Product
Fresh H2O Marsh																	
Ground yellowjacket nest																	
H20 under Bldg	12	Product	Other (specify in comments section)	briquet						1	8	Product	Ounces (weight)				
Horse Trough	7	Product	Other (specify in comments section)	briquet						1	0.5	Product	Ounces (weight)		3	6	Product
Hot tub	26	Product	Other (specify in comments section)	briquet						4	1	Product	Ounces (weight)		8	8	Product
Imp H2O	54	Product	Other (specify in comments section)	briquet	2	1.5	Product	Ounces (volume)		82	221.75	Product	Ounces (weight)		6	8	Product
Misc container	229	Product	Other (specify in comments section)	briquet						42	11.5	Product	Ounces (weight)		15	21	Product
Multiple																	
Pond (natural)	5	Product	Other (specify in comments section)	briquet											1	8	Product
Pothole															2	2	Product
Reservoir										1	0.25	Product	Ounces (weight)				
Salt Marsh																	
Seepage										1	0.25	Product	Ounces (weight)				
Septic Seepage																	
Septic Tank	4	Product	Other (specify in comments section)	briquet													
Sewage Treatment Plant																	
Slough																	
Spring	1	Product	Other (specify in comments section)	briquet											1	1	Product
Storm Drain	1	Product	Other (specify in comments section)	briquet											1	1	Product
Street Gutter	6	Product	Other (specify in comments section)	briquet						22	5.5	Product	Ounces (weight)		1	1	Product
Sump	107	Product	Other (specify in comments section)	briquet						24	6.25	Product	Ounces (weight)		24	27.5	Product
Swim Pool	163	Product	Other (specify in comments section)	briquet						4	1.75	Product	Ounces (weight)		16	40.5	Product
Swim pool cover	3	Product	Other (specify in comments section)	briquet						2	1.5	Product	Ounces (weight)				
Swim Pool Drain	1	Product	Other (specify in comments section)	briquet													
Tank	34	Product	Other (specify in comments section)	briquet						2	6	Product	Ounces (weight)		1	2	Product
Tire	3	Product	Other (specify in comments section)	briquet						3	0.75	Product	Ounces (weight)				
Treehole	9	Product	Other (specify in comments section)	briquet						3	0.75	Product	Ounces (weight)		1	1	Product
Vault	98	Product	Other (specify in comments section)	briquet						41	11.25	Product	Ounces (weight)		21	1094	Product
Water meter box																	
Waterfall	67	Product	Other (specify in comments section)	briquet						9	2.25	Product	Ounces (weight)		6	12	Product
Well	14	Product	Other (specify in comments section)	briquet						1	0.25	Product	Ounces (weight)		3	4	Product
Paper wasp nest																	
Total	3347	Product	Other (specify in comments section)	briquet	3	2.5	Product	Ounces (volume)		502	2217.5	Product	Ounces (weight)		447	1738	Product

Table A44.

Application Sites:	Total Amount Unit162077	Altosid XR Briquets Comments	Altosid XR-G - # Treatments	Total Amount Used172178	Total Amount Type182279	Total Amount Unit182380	Altosid XR-G Comments	Altosid Liquid (Not-conentrate) # Treatments	Total Amount Used	Total Amount Type2	Total Amount Unit	Altosid Liquid (not-concentrate) Comments	Pyrenone 25-5 # Treatments	Total Amount Used6	Total Amount Type7	Total Amount Unit8	Pyrenone 25-5 Comments
Aerial yellowjacket nest																	
Bird Bath	Other (specify in comments section)	briquet	17	5.5	Product	Ounces (weight)											
Catch Basin	Other (specify in comments section)	briquet	1	6	Product	Ounces (weight)											
Creek	Other (specify in comments section)	briquet															
Culvert	Other (specify in comments section)	briquet	1	0.25	Product	Ounces (weight)											
Ditch	Other (specify in comments section)	briquet	65	266.75	Product	Ounces (weight)		3	5	Product	Ounces (volume)						
Drain Line			2	0.5	Product	Ounces (weight)											
Drain Pipes																	
Fish Pond	Other (specify in comments section)	briquet	13	3.25	Product	Ounces (weight)											
Fountain	Other (specify in comments section)	briquet	20	5	Product	Ounces (weight)											
Fresh H2O Marsh			2	322.5	Product	Ounces (weight)		2	3	Product	Ounces (volume)						
Ground yellowjacket nest																	
H20 under Bldg													1	4.5	Product	Ounces (volume)	
Horse Trough	Other (specify in comments section)	briquet	8	2	Product	Ounces (weight)											
Hot tub	Other (specify in comments section)	briquet	1	0.25	Product	Ounces (weight)											
Imp H2O	Other (specify in comments section)	briquet	81	1808.5	Product	Ounces (weight)		18	130.5	Product	Ounces (volume)						
Misc container	Other (specify in comments section)	briquet	43	12.25	Product	Ounces (weight)											
Multiple																	
Pond (natural)	Other (specify in comments section)	briquet	2	44	Product	Ounces (weight)											
Pothole	Other (specify in comments section)	briquet															
Reservoir			3	40.25	Product	Ounces (weight)											
Salt Marsh			19	2586	Product	Ounces (weight)		1	60	Product	Ounces (volume)						
Seepage			2	0.5	Product	Ounces (weight)											
Septic Seepage																	
Septic Tank																	
Sewage Treatment Plant																	
Slough																	
Spring	Other (specify in comments section)	briquet															
Storm Drain	Other (specify in comments section)	briquet															
Street Gutter	Other (specify in comments section)	briquet	8	2	Product	Ounces (weight)											
Sump	Other (specify in comments section)	briquet	15	3.75	Product	Ounces (weight)											
Swim Pool	Other (specify in comments section)	briquet	1	0.25	Product	Ounces (weight)											
Swim pool cover			1	0.25	Product	Ounces (weight)											
Swim Pool Drain																	
Tank	Other (specify in comments section)	briquet	2	3	Product	Ounces (weight)											
Tire			9	7	Product	Ounces (weight)											
Treehole	Other (specify in comments section)	briquet															
Vault	Other (specify in comments section)	briquet	18	12	Product	Ounces (weight)											
Water meter box																	
Waterfall	Other (specify in comments section)	briquet	3	0.75	Product	Ounces (weight)											
Well	Other (specify in comments section)	briquet															
Paper wasp nest																	
Total	Other (specify in comments section)	briquet	337	5132.5	Product	Ounces (weight)		24	198.5	Product	Ounces (volume)		1	4.5	Product	Ounces (volume)	

Table A45. Pesticide Product Key – SMCMVCD

Product	Active Ingredient	Vector
Altosid Briquets	Methoprene	Mosquito
Altosid Liquid Larvicide	Methoprene	Mosquito
Altosid Liquid Larvicide Concentrate	Methoprene	Mosquito
Altosid Pellets	Methoprene	Mosquito
Altosid Pellets WSP	Methoprene	Mosquito
Altosid XR-Briquets	Methoprene	Mosquito
Altosid XR-G (granules)	Methoprene	Mosquito
Astro®, Ortho® products, Bonide® products, Tengard® products, etc.	Permethrin	Yellow Jacket / Wasp
Bayer Pyrenone 25-5	Pyrethrins and Piperonyl Butoxide	Mosquito
BVA 2	Petroleum Distillate	Mosquito
Delta Dust	Deltamethrin	Yellow Jacket / Wasp
Drione	Pyrethrin and Piperonyl Butroxide and Amorphous Silica Gel	Yellow Jacket / Wasp
Mosquito Larvicide GB-1111	Aliphatic Petroleum Hydrocarbons	Mosquito
Natular G30	Spinosad	Mosquito
Spectracide Pro®	Tetramethrin and Permethrin and Piperonyl Butoxide	Yellow Jacket / Wasp
Spectracide®	Prallethrin and Lambda-cyhalothrin	Yellow Jacket / Wasp
Teknar SC	Bacillus Thuringiensis Israelensis	Mosquito
VectoBac 12AS	Bacillus Thuringiensis Israelensis	Mosquito
VectoLex CG Biologic	Bacillus Sphaericus	Mosquito
VectoLex WDG	Bacillus Sphaericus	Mosquito
VectoLex WSP	Bacillus Sphaericus	Mosquito
Wasp-Freeze	Phenothrin and Trans Allethrin	Yellow Jacket / Wasp

Table A46. **Herbicide Application Data for Summer 2011 – NCMAD**

Application Sites	Aquamaster # Treatmens	Total Amount Used	Total Amount Type	Total Amount Unit	Aquamaster Comments	Blazon Pattern Indicator # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit4	Blazon Pattern Indicator Comments	BullsEye Pattern Idicator # Treatments	Total Amount Used5
Access Roads	15	883.5	Product	Ounces (volume)		6	160	Product	Ounces (volume)		14	103.7
Pond Levees												
Top and Exterior Slopes of Waste Water Ponds	17	1783.5	Product	Ounces (volume)		3	64	Product	Ounces (volume)		17	222.3
Interior Margins/Slopes of Waste Water Ponds	14	975.6	Product	Ounces (volume)		3	80	Product	Ounces (volume)		13	107.2
Napa River Islands/Embankments												
Waste Water Spray Fields	2	64	Product	Ounces (volume)		3	96	Product	Ounces (volume)		5	28.4
Ditches/Channels	2	384	Product	Ounces (volume)							1	16
Empty Lots/Fields	4	93.4	Product	Ounces (volume)							3	127.2
Total	54	4184	Product	Ounces (volume)		15	400	Product	Ounces (volume)		53	604.8

Table A46.

Application Sites	Total Amount Type6	Total Amount Unit7	BullsEye Pattern Idicator Comments	No Foam A # Treatments	Total Amount Used20	Total Amount Type21	Total Amount Unit22	No Foam A Comments	Pro-Spreader Activator # Treatments	Total Amount Used29	Total Amount Type30	Total Amount Unit31
Access Roads	Product	Ounces (volume)		1	1.5	Product	Ounces (volume)		3	18.6	Product	Ounces (volume)
Pond Levees												
Top and Exterior Slopes of Waste Water Ponds	Product	Ounces (volume)		1	15	Product	Ounces (volume)		5	33.8	Product	Ounces (volume)
Interior Margins/Slopes of Waste Water Ponds	Product	Ounces (volume)		1	13.5	Product	Ounces (volume)		5	24.6	Product	Ounces (volume)
Napa River Islands/Embankments												
Waste Water Spray Fields	Product	Ounces (volume)										
Ditches/Channels	Product	Ounces (volume)										
Empty Lots/Fields	Product	Ounces (volume)										
Total	Product	Ounces (volume)		3	30	Product	Ounces (volume)		13	77	Product	Ounces (volume)

Table A46.

Application Sites	Pro-Spreader Activator Comments	R-11 Spreader Activator # Treatments	Total Amount Used32	Total Amount Type33	Total Amount Unit34	R-11 Spreader Activator Comments	Roundup Pro # Treaments	Total Amount Used35	Total Amount Type36	Total Amount Unit37	Roundup Pro Comments	Roundup Pro Max # Treatments
Access Roads		13	529.85	Product	Ounces (volume)		2	51.2	Product	Ounces (volume)		1
Pond Levees												
Top and Exterior Slopes of Waste Water Ponds		10	667.95	Product	Ounces (volume)		2	301.4	Product	Ounces (volume)		
Interior Margins/Slopes of Waste Water Ponds		8	350.1	Product	Ounces (volume)		2	70.4	Product	Ounces (volume)		
Napa River Islands/Embankments												
Waste Water Spray Fields		4	273.7	Product	Ounces (volume)							
Ditches/Channels		2	96	Product	Ounces (volume)							
Empty Lots/Fields		4	49.1	Product	Ounces (volume)		2	189	Product	Ounces (volume)		1
Total		41	1966.7	Product	Ounces (volume)		8	612	Product	Ounces (volume)		2

Table A46.

Application Sites	Total Amount Used38	Total Amount Type39	Total Amount Unit40	Roundup Pro Max Comments	Buccaneer # Treatments	Total Amount Used47	Total Amount Type48	Total Amount Unit49	Buccaneer Comments
Access Roads	102.4	Product	Ounces (volume)		3	588.8	Product	Ounces (volume)	
Pond Levees									
Top and Exterior Slopes of Waste Water Ponds					1	204.8	Product	Ounces (volume)	
Interior Margins/Slopes of Waste Water Ponds					1	256	Product	Ounces (volume)	
Napa River Islands/Embankments									
Waste Water Spray Fields					2	358.4	Product	Ounces (volume)	
Ditches/Channels									
Empty Lots/Fields	921.6	Product	Ounces (volume)						
Total	1024	Product	Ounces (volume)		7	1408	Product	Ounces (volume)	

Table A47. **Herbicide Application Data for Fall 2011 – NCMAD**

Application Sites	Aquamaster # Treatmens	Total Amount Used	Total Amount Type	Total Amount Unit	Aquamaster Comments	Blazon Pattern Indicator # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit4	Blazon Pattern Indicator Comments	BullsEye Pattern Idicator # Treatments	Total Amount Used5
Access Roads	26	3437.4	Product	Ounces (volume)		14	1169	Product	Ounces (volume)		49	933.7
Pond Levees												
Top and Exterior Slopes of Waste Water Ponds	24	7456.3	Product	Ounces (volume)		7	1408.6	Product	Ounces (volume)		65	2612.1
Interior Margins/Slopes of Waste Water Ponds	21	4150.4	Product	Ounces (volume)		7	1544	Product	Ounces (volume)		61	1502.8
Napa River Islands/Embankments	11	11240	Product	Ounces (volume)							9	282
Waste Water Spray Fields	1	51.2	Product	Ounces (volume)		4	467.2	Product	Ounces (volume)		5	81
Ditches/Channels	3	768	Product	Ounces (volume)								
Empty Lots/Fields	1	42.3	Product	Ounces (volume)							4	120
Total	87	27145.6	Product	Ounces (volume)		32	4588.8	Product	Ounces (volume)		193	5531.6

Table A47.

Application Sites	Total Amount Type6	Total Amount Unit7	BullsEye Pattern Idicator Comments	Competitor # Treatments	Total Amount Used8	Total Amount Type9	Total Amount Unit10	Competitor Comments	Karmex XP # Treatments	Total Amount Used14	Total Amount Type15	Total Amount Unit16
Access Roads	Product	Ounces (volume)							45	7907.2	Product	Ounces (weight)
Pond Levees												
Top and Exterior Slopes of Waste Water Ponds	Product	Ounces (volume)							57	26949.6	Product	Ounces (weight)
Interior Margins/Slopes of Waste Water Ponds	Product	Ounces (volume)							53	18132	Product	Ounces (weight)
Napa River Islands/Embankments	Product	Ounces (volume)		12	1264	Product	Ounces (volume)					
Waste Water Spray Fields	Product	Ounces (volume)							1	32	Product	Ounces (weight)
Ditches/Channels									3	1120	Product	Ounces (weight)
Empty Lots/Fields	Product	Ounces (volume)							3	195.2	Product	Ounces (weight)
Total	Product	Ounces (volume)		12	1264	Product	Ounces (volume)		162	54336	Product	Ounces (weight)

Table A47.

Application Sites	Karmex XP Comments	Oust XP # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit19	Oust XP Comments	No Foam A # Treatments	Total Amount Used20	Total Amount Type21	Total Amount Unit22	No Foam A Comments	Polaris # Treatments	Total Amount Used26
Access Roads		63	383.69	Product	Ounces (weight)		10	45.6	Product	Ounces (volume)			
Pond Levees													
Top and Exterior Slopes of Waste Water Ponds		74	865.09	Product	Ounces (weight)		11	605.6	Product	Ounces (volume)			
Interior Margins/Slopes of Waste Water Ponds		67	580	Product	Ounces (weight)		10	276.8	Product	Ounces (volume)			
Napa River Islands/Embankments		7	68	Product	Ounces (weight)							11	9216
Waste Water Spray Fields		1	4.8	Product	Ounces (weight)								
Ditches/Channels		1	8	Product	Ounces (weight)								
Empty Lots/Fields		3	5.88	Product	Ounces (weight)								
Total		216	1915.46	Product	Ounces (weight)		31	928	Product	Ounces (volume)		11	9216

Table A47.

Application Sites	Total Amount Type27	Total Amount Unit28	Polaris Comments	Pro-Spreader Activator # Treatments	Total Amount Used29	Total Amount Type30	Total Amount Unit31	Pro-Spreader Activator Comments	R-11 Spreader Activator # Treatments	Total Amount Used32	Total Amount Type33	Total Amount Unit34
Access Roads				32	2585.2	Product	Ounces (volume)		24	1086.8	Product	Ounces (volume)
Pond Levees												
Top and Exterior Slopes of Waste Water Ponds				31	2840.89	Product	Ounces (volume)		34	3177.7	Product	Ounces (volume)
Interior Margins/Slopes of Waste Water Ponds				28	3042.9	Product	Ounces (volume)		29	1690.6	Product	Ounces (volume)
Napa River Islands/Embankments	Product	Ounces (volume)		11	311	Product	Ounces (volume)					
Waste Water Spray Fields				8	889.6	Product	Ounces (volume)					
Ditches/Channels									3	224	Product	Ounces (volume)
Empty Lots/Fields									4	40.8	Product	Ounces (volume)
Total	Product	Ounces (volume)		110	9669.59	Product	Ounces (volume)		94	6219.9	Product	Ounces (volume)

Table A47.

Application Sites	R-11 Spreader Activator Comments	Diuron 80 # Treatments	Toal Amount Used	Total Amount Type2	Total Amount Unit2	Diuron 80 Comments
Access Roads		18	8343	Product	Ounces (weight)	
Pond Levees						
Top and Exterior Slopes of Waste Water Ponds		17	6372.8	Product	Ounces (weight)	
Interior Margins/Slopes of Waste Water Ponds		15	5318.6	Product	Ounces (weight)	
Napa River Islands/Embankments						
Waste Water Spray Fields		8	3289.6	Product	Ounces (weight)	
Ditches/Channels						
Empty Lots/Fields						
Total		58	23324	Product	Ounces (weight)	

Table A48. **Herbicide Application Data for Winter 2012 – NCMAD**

Application Sites	Aquamaster # Treatmens	Total Amount Used	Total Amount Type	Total Amount Unit	Aquamaster Comments	BullsEye Pattern Idicator # Treatments	Total Amount Used5	Total Amount Type6	Total Amount Unit7	BullsEye Pattern Idicator Comments	Karmex XP # Treatments	Total Amount Used14
Access Roads	4	375.9	Product	Ounces (volume)		5	70	Product	Ounces (volume)		5	700.8
Pond Levees												
Top and Exterior Slopes of Waste Water Ponds	4	824.2	Product	Ounces (volume)		5	157.4	Product	Ounces (volume)		5	1574.4
Interior Margins/Slopes of Waste Water Ponds	3	342	Product	Ounces (volume)		3	72.8	Product	Ounces (volume)		4	742.4
Napa River Islands/Embankments											2	864
Waste Water Spray Fields	2	403.2	Product	Ounces (volume)		2	86.4	Product	Ounces (volume)			
Ditches/Channels												
Empty Lots/Fields	1	30.7	Product	Ounces (volume)		2	5.4	Product	Ounces (volume)		1	38.4
Total	14	1976	Product	Ounces (volume)		17	392	Product	Ounces (volume)		17	3920

Table A48.

Application Sites	Total Amount Type15	Total Amount Unit16	Karmex XP Comments	Oust XP # Treatments	Total Amount Used17	Total Amount Type18	Total Amount Unit19	Oust XP Comments	No Foam A # Treatments	Total Amount Used20	Total Amount Type21	Total Amount Unit22	No Foam A Comments
Access Roads	Product	Ounces (weight)		5	17.52	Product	Ounces (weight)		1	4.8	Product	Ounces (volume)	
Pond Levees													
Top and Exterior Slopes of Waste Water Ponds	Product	Ounces (weight)		5	39.36	Product	Ounces (weight)		1	4.8	Product	Ounces (volume)	
Interior Margins/Slopes of Waste Water Ponds	Product	Ounces (weight)		3	18.2	Product	Ounces (weight)		1	6.4	Product	Ounces (volume)	
Napa River Islands/Embankments	Product	Ounces (weight)											
Waste Water Spray Fields				2	21.6	Product	Ounces (weight)						
Ditches/Channels													
Empty Lots/Fields	Product	Ounces (weight)											
Total	Product	Ounces (weight)		15	96.68	Product	Ounces (weight)		3	16	Product	Ounces (volume)	

Table A48.

Application Sites	R-11 Spreader Activator # Treatments	Total Amount Used32	Total Amount Type33	Total Amount Unit34	R-11 Spreader Activator Comments
Access Roads	4	138.6	Product	Ounces (volume)	
Pond Levees					
Top and Exterior Slopes of Waste Water Ponds	4	134.8	Product	Ounces (volume)	
Interior Margins/Slopes of Waste Water Ponds	2	144	Product	Ounces (volume)	
Napa River Islands/Embankments					
Waste Water Spray Fields	2	172.8	Product	Ounces (volume)	
Ditches/Channels					
Empty Lots/Fields	2	10.6	Product	Ounces (volume)	
Total	14	600.8	Product	Ounces (volume)	

Table A49. **Herbicide Application Data for Spring 2012 – NCMAD**

Application Sites	Aquamaster # Treatmens	Total Amount Used	Total Amount Type	Total Amount Unit	Aquamaster Comments	Blazon Pattern Indicator # Treatments	Total Amount Used2	Total Amount Type3	Total Amount Unit4	Blazon Pattern Indicator Comments	BullsEye Pattern Idicator # Treatments	Total Amount Used5
Access Roads	13	646.9	Product	Ounces (volume)		4	89.6	Product	Ounces (volume)		13	94.4
Pond Levees												
Top and Exterior Slopes of Waste Water Ponds	15	1931.8	Product	Ounces (volume)		3	102.4	Product	Ounces (volume)		15	252
Interior Margins/Slopes of Waste Water Ponds	14	1104.3	Product	Ounces (volume)		3	128	Product	Ounces (volume)		14	149.6
Napa River Islands/Embankments												
Waste Water Spray Fields												
Ditches/Channels												
Empty Lots/Fields	1	256	Product	Ounces (volume)							2	32
Total	43	3939	Product	Ounces (volume)		10	320	Product	Ounces (volume)		44	528

Table A49.

Application Sites	Total Amount Type6	Total Amount Unit7	BullsEye Pattern Idicator Comments	Competitor # Treatments	Total Amount Used8	Total Amount Type9	Total Amount Unit10	Competitor Comments	No Foam A # Treatments	Total Amount Used20	Total Amount Type21	Total Amount Unit22
Access Roads	Product	Ounces (volume)							10	35.1	Product	Ounces (volume)
Pond Levees												
Top and Exterior Slopes of Waste Water Ponds	Product	Ounces (volume)							12	173.2	Product	Ounces (volume)
Interior Margins/Slopes of Waste Water Ponds	Product	Ounces (volume)							11	173.7	Product	Ounces (volume)
Napa River Islands/Embankments				9	288	Product	Ounces (volume)					
Waste Water Spray Fields												
Ditches/Channels												
Empty Lots/Fields	Product	Ounces (volume)										
Total	Product	Ounces (volume)		9	288	Product	Ounces (volume)		33	382	Product	Ounces (volume)

Table A49.

Application Sites	No Foam A Comments	Polaris # Treatments	Total Amount Used26	Total Amount Type27	Total Amount Unit28	Polaris Comments	Pro-Spreader Activator # Treatments	Total Amount Used29	Total Amount Type30	Total Amount Unit31	Pro-Spreader Activator Comments	R-11 Spreader Activator # Treatments
Access Roads							1	6.4	Product	Ounces (volume)		3
Pond Levees												
Top and Exterior Slopes of Waste Water Ponds		1	72	Product	Ounces (volume)		1	25.6	Product	Ounces (volume)		2
Interior Margins/Slopes of Waste Water Ponds							1	32	Product	Ounces (volume)		2
Napa River Islands/Embankments		4	432	Product	Ounces (volume)							
Waste Water Spray Fields												
Ditches/Channels												
Empty Lots/Fields												1
Total		5	504	Product	Ounces (volume)		3	64	Product	Ounces (volume)		8

Table A49.

Application Sites	Total Amount Used32	Total Amount Type33	Total Amount Unit34	R-11 Spreader Activator Comments	Roundup Pro # Treaments	Total Amount Used35	Total Amount Type36	Total Amount Unit37	Roundup Pro Comments
Access Roads	204.8	Product	Ounces (volume)		2	460.8	Product	Ounces (volume)	
Pond Levees									
Top and Exterior Slopes of Waste Water Ponds	332.8	Product	Ounces (volume)		2	537.6	Product	Ounces (volume)	
Interior Margins/Slopes of Waste Water Ponds	102.4	Product	Ounces (volume)		2	537.6	Product	Ounces (volume)	
Napa River Islands/Embankments									
Waste Water Spray Fields									
Ditches/Channels									
Empty Lots/Fields	128	Product	Ounces (volume)						
Total	768	Product	Ounces (volume)		6	1536	Product	Ounces (volume)	

Table A50. Herbicide Product Key – NCMAD

Product	Active Ingredient	Vector
Aquamaster	Glyphosate	Weed
Blazon Pattern Indicator	Polymetric Colorant (proprietary)	Weed
BullsEye Pattern Indicator	Proprietary Colorant	Weed
Competitor	Modified Vegetable Oil	Weed
Karmex XP	Diuron	Weed
Oust XP	Sulfometuron Methyl	Weed
No Foam A	Alkyl Phenol Ethoxylate / Isopropanol	Weed
Polaris	Imazapyr	Weed
Pro-Spreader Activator	Alkyl Phenol Ethoxylate / Isopropanol	Weed
R-11 Spreader Activator		Weed
Roundup Pro	Glyphosate	Weed
Buccaneer	Glyphosate	Weed

Ecological & Human Health Assessment Report

ATTACHMENT

B

REVIEW OF ADDITIONAL LITERATURE FOR METHOPRENE, BTI AND BACILLUS SPHAERICUS

B.1 Introduction

This attachment serves as an update and supplement to the information about chemical toxicity provided in Appendix B, Ecological & Human Health Assessment Report (June 2013). In that document, approximately 46 active ingredients and numerous products were reviewed, including dozens of papers and documents that provide supporting information about the toxicity for each chemical. While the information provided in the original report was developed using the information available at the time, this attachment is a follow-up review of additional information not included previously in Appendix B for three of the 46 chemicals: 1) methoprene; 2) Bti (*Bacillus thuringiensis israelensis*) and 3) *B. sphaericus* (*Bacillus sphaericus*).

Fifty-one additional publications and reports about these three pesticides were identified and evaluated for consistency with the original assessment conclusions in Appendix B and subsequently in the Districts' Draft PEIRs. This attachment addresses several publications that will be included to supplement Appendix B. Most of these additional articles report using pesticide exposures that are generally longer, or at higher concentrations, than those used by the Districts. Several other factors are presented that may confound their reported results. Based on the information in these reviews, and comparisons of their reported exposure rates, the finding is that in general, the exposures are not relevant to District application scenarios. None of the additional reports contain information that would substantially change the impact assessments in the Draft PEIRs, i.e., would not change a conclusion of no impact or less-than-significant impact to potentially significant impact.

B.2 Approach to the Current Reviews

The objective of Appendix B was to review all active ingredients in use (or proposed for future use) and then to identify those active ingredients that may pose potential human health or ecological health concerns when used by the Districts. Extensive literature reviews were conducted to document the relevant reported toxicity and environmental fate of the pesticides of interest to the Districts. Following the examination in 2012 and 2013 of the reports on the Districts' pesticides, it was determined that three pesticides are of special interest as key methods of mosquito control and additional literature should be reviewed. The reports cited in this attachment are, therefore, focused on the three pesticides: 1) methoprene; 2) Bti; and 3) *B. sphaericus*. These pesticides are detailed and summarized in Chapter 4 of Appendix B (especially Table 4-1). Documented effects of each of these pesticides are presented in Tables 3-1, 3-2, and 3-3 of Chapter 3 of Appendix B. The reports evaluated for this attachment are supplemental to the original reports and generally include and publications not previously evaluated in Appendix B.

B.3 Conclusions

The additional reports listed in this attachment suggest that no modifications to the hazard assessments and conclusions provided in each District's Draft PEIR or Appendix B should be necessary for methoprene, Bti, or *B. sphaericus.*

Additional Methoprene Publications Reviewed

Publication Authors	Summary of Reported Findings
Ali, A., R.J. Lobinske, R.J. Leckel, N. Carandang and A. Mazumdar. 2008. Population Survey and Control of Chironomidae (Diptera) in Wetlands in Northeastern Florida, USA. Florida Entomologist 91(3):446-452.	Two species of Chironomids, *Glyptotendipes paripes* and *Goeldichironomus carus* in Florida wetlands were evaluated for sensitivity to Temephos, Bti, and s-methoprene. This paper reviews the comparison of these larvicides both for efficacy and in cost. The summary of the paper suggests that Bti and S methoprene be used in rotation with Tim FR's for Midge control. The authors suggest that this approach in an IPM technique would have only temporary and reversible impact on nontarget biota. However, the study did not actually evaluate nontargets in the field as part of the study. Note: label rate is 5 to 10 lbs/acre for midges in wastewater ponds and systems. This study used methoprene pellets at a rate of 7.7 to 15 lbs/ acre to achieve 80 and 90% reduction of adult emergence in experimental field plots. Lab bioassys used rates that exceeded 18 or more times what would occur with exposure to maximum label rates.
Anonymous. 2007. Canadian Water Quality Guidelines for the Protection of Aquatic Life. Methoprene. Canadian Council of Ministers of the Environment. 11pp	Listing of Methoprene freshwater target levels for acceptable risk…..0.09 µg/L target organism, and 0.53 µg/L management value considered as target thresholds. These are values of water concentrations safe to non-target species.
Brown, M., D. Thomas, P. Mason, J.G. Greenwood and B.H. Kay. 1998. Laboratory and Field Evaluation of the Efficacy of Four Insecticides for *Aedes vigilax* (Diptera: Culicidae) and Toxicity to the Nontarget Shrimp *Leander tenuicornis* (Decapoda: Palaemonidae). J. Econ. Ent. 92(5):1045-1051.	This report describes laboratory and field tests of the toxicity of two organophosphate compounds (temephos and pirimiphosmethyl) and s-methoprene and *Bacillus thuringiensis ssp. israelensis* (Bti) to a saltwater mosquito (*Aedes vigilax*) including an evaluation of the selectivity for the mosquito and possible toxicity to a non-target shrimp *Leander tenuicornis* (a Decapod). In addition to developing LC 50 values the report includes measures of selectivity of each pesticide for the target organisms versus nontarget. The methoprene applications were highly toxic to the saltwater mosquito while not affecting survival of the shrimp that inhabit the same saltwater marsh areas. In addition, s-methoprene did not affect water quality. The authors suggest that methoprene is an "ideal pesticide for continued control of *Ae. vigilax* in Australian saltwater ponds.
Butler, M., H.S. Ginsburg, R.A. LeBrun and A. Gettman. 2010. Evaluation of Nontarget Effects of Methoprene Applied to Catch Basins for Mosquito Control. J. Vector Ecology. 35(2):372-384.	Measurements of methoprene concentrations were made from water in catch basins that were treated with methoprene and from an adjoining salt pond near where the catch basins emptied. Concentrations of methoprene in catch basins and at drainage outlets, after application at mosquito control label rates, were 0.5 ppb and lower, which was below levels determined to be detrimental to organisms other than mosquitoes. Effects of methoprene on communities of organisms that live in catch basins (lab simulated as well as field) were also evaluated. No evidence of declines in abundance of any taxa or consistent change in community level parameters (e.g. species richness, dominance-diversity relationships) was found.
Craggs, R., L. Golding, S. Clearwater, L. Susaria and W. Donovan. 2005. Control of Chironomid Midge Larvae in Wastewater Stabilization Ponds: Comparison of Five Compounds. Water Sci. Tech. 51(12):191-199.	The efficacy of Maldison, an organophosphate insecticide, was compared to *Bacillus thuringiensis* var. *israelensis* (Bti), methoprene, pyriproxyfen, and diflubenzuron. During 21-day small-scale trials, Bti, diflubenzuron and Maldison reduced live larval numbers by 80-89% compared to controls and adult emergence was markedly reduced by all compounds (72-96%). Large-scale trials with methoprene (Prolink XRG granules) at 32 kg total ingredient/ha (to give a final field concentration in the water column of 50 µg/L) reduced midge emergence by approximately 80% over 25 days. It should be noted that the rate of methoprene used in the large-scale field trials was significantly higher than maximum labels rates allowed for mosquito control applications.

Additional Methoprene Publications Reviewed

Publication Authors	Summary of Reported Findings
Csondes, A. 2004. Environmental Fate of Methoprene. 6 pp whitepaper prepared by Cal. DPR.	Review of methoprene characteristics, physiochemical etc., includes tables of reported and verified toxicity and fate and transport properties. Methoprene is an insect growth regulator, used to control a variety of insect species, and is considered a biochemical pesticide. Rather than direct toxicity, methoprene disrupts the insects' metamorphosis and life cycle, thus hindering their ability to reach adulthood and successful reproduction. This paper provides an overview of the uses of Methoprene and descriptions of some special formulations used for mosquito control, especially in floodwater sites, rice cultivations, storm drains, ponds and water treatment works
Davis, R.S. and R. Peterson. 2008. Effects of Single and Multiple Applications of Mosquito Insecticides on Nontarget Arthropods. J. Amer. Mosq. Cont. Assoc. 24(2):270-280.	Experiments were conducted to assess the acute impacts of mosquito adulticides (permethrin and d-phenothrin) and larvicides (*Bacillus thuringiensis israelensis* and methoprene) on nontarget aquatic and terrestrial arthropods after a single application. This experiment was conducted in 2004 and 2005 with methoprene on nontarget terrestrial arthropods using a single application. For aquatic non-target species, no adverse treatment effects were observed. In general, nearly all of the responses evaluated for either study indicated few, if any, clear adverse effects from methoprene applications. Methoprene was used at near maximum label rate (93% of maximum which was 0.20 oz. AI per acre)
Degitz, S., E.J. Durhan, J.E. Tietge, P.A. Koslan, G.W. Holcombe and G.T. Ankley. 2003. Developmental Toxicity of Methoprene and Several Degradation Products in *Xenopus laevis*. Aquatic Toxicol. 64:97-105.	Methoprene is an insect juvenile growth hormone mimic, which inhibits pupation and is used for the control of emergent insect pests such as mosquitoes. Researchers have hypothesized that methoprene use in US may be a contributing factor to the recent increase in malformed amphibians. However, little is known concerning the developmental toxicity of methoprene and its degradation products in amphibians. In these studies, the aqueous stability and developmental toxicity of methoprene and several degradation products (methoprene acid, methoprene epoxide, 7-methoxycitronellal, and 7-methoxycitronellic acid) were examined. *Xenopus laevis* embryos (stage 8) were exposed to the test chemicals (aquatic test chambers with total immersion) for 96 h. Assays were conducted under static renewal (24 h) conditions and chemical concentrations in water were measured at the beginning and end of the renewal periods. Methoprene exposure did not result in developmental toxicity at concentrations up to 2 mg/l (equivalent to 2000 ppb which is 400 times max label application rate for mosquito control), which is slightly higher than its water solubility. Methoprene acid, a relatively minor degradation product, produced developmental toxicity when concentrations exceeded 1.25 mg/l. Methoprene epoxide and 7-methoxycitronellal caused developmental toxicity at concentrations of 2.5 mg/l and higher. 7-Methoxycitronellic acid was not developmentally toxic at a test concentration as high as 30 mg/l. These data indicate that methoprene and its degradation products are not potent development toxicants in *X. laevis*. This, in combination with the fact that field applications of sustained-release formulations of methoprene result in methoprene concentrations that do not typically exceed 0.01 mg/l, suggests that concerns for methoprene-mediated developmental toxicity to amphibians may be unwarranted.

Additional Methoprene Publications Reviewed

Publication Authors	Summary of Reported Findings
Glare, T. and M. O'Callaghan. 2005. A Review and Update of the Report "Environmental and Health Impacts of the Insect Juvenile Hormone Analogue, S-Methoprene" 1999. Report for the New Zealand Ministry of Health. 32pp.	Conclusions of this report were: 1) although methoprene is toxic to 12 orders of insects and may have effects on other nontarget organisms, particularly other nontarget arthropods, methoprene is one of the least environmentally damaging mosquito control agents and poses little risk to human and animal health; 2) concentrations of methoprene necessary to control mosquitoes (1 ppb) are much lower than the concentrations necessary to cause damage to populations of most nontarget organisms. Short half-life in the environment unlikely to accumulate in various environmental compartments. Although new literature has been published showing declines in insect biomass due to long-term use of methoprene and Bti in freshwater wetlands in Minnesota, USA, no evidence for permanent damage to ecosystem function has been found. The causal agent(s) of frog deformities in the USA has still not been clearly elucidated. Some believe these deformities are caused by a parasitic trematode, UV radiation and chemicals synergistically. Authors recommend that methoprene be the first choice for control and eradication of introduced mosquito species
Miyakawa, H., T.K. Hirakawa, O.Y. and Miyagawa, O.S. Tatarazako, T. Miura, J.K. Colbourne and T. Iguchi. 2013. A Mutation in the Receptor Methoprene-Tolerant Alters Juvenile Hormone Response in Insects and Crustaceans. Nature Communications 4, Article number: 1856doi:10.1038/14.	Most of the insects use juvenile hormone III as the innate juvenile hormone ligand. By contrast, crustaceans use methyl farnesoate. Despite this difference, the process of this ligand transition is unknown. A single amino-acid substitution in the receptor. Juvenile hormone-binding pockets of the orthologous genes differ by only two amino acids, yet a single substitution within Daphnia metabolic pathways appears to enhance the receptor's responsiveness to juvenile hormone III. These results suggest that this mutation within an ancestral insect lineage contributed to the evolution of a juvenile hormone III receptor system. This is a theoretical study and has no strong correlative response to the toxicity of methoprene.
Hurst, T.F., B.H. Kay, P.A. Ryan and M.D. Brown. 2007. Sublethal Effects of Mosquito Larvicides on Swimming Performance of Larvivorous Fish *Melanotaenia duboulayi* (Atherinoformes: Melanotaeniidae). J. Econ. Ent. 100(1):61-65.	Laboratory studies were conducted to determine the sublethal effects of exposure to the mosquito larvicides temephos, primiphos-methyl, Bti, *Bacillus sphaericus*, and methoprene. Methoprene exposures of 10 times the effective field concentration had no effect on the Australian Crimson-Spotted Rainbowfish (*Melanotaenia duboulayi*) swimming speed.

Additional Methoprene Publications Reviewed

Publication Authors	Summary of Reported Findings
Kenyon, S. and G. Kennedy. 2001. Methoprene: A Review of the Impacts of the Insect Growth Regulator Methoprene on Nontarget Aquatic Organisms in Fish Bearing Waters (ver. 2.0). Prepared for the Massachusetts Pesticide Board Subcommittee.	Although this paper includes no new data generated by these authors, this paper is a comprehensive overview of the reported effects of methoprene on non-target organisms, especially aquatic species, including a review of the reported effects of methoprene on amphibians. The authors report several critical findings and responses based on their reviews of existing publications: 1. Results reported in most published papers do not support the contention that methoprene applications for midge and mosquito control can lead to amphibian malformations. 2. Although some reports suggest that methoprene can adversely affect crustaceans, studies indicate that impacts to crustaceans may be variable in magnitude but are not likely to adversely impact crustaceans at expected environmental concentrations. 3. The use of methoprene at appropriate application levels would be less harmful to aquatic communities than other available mosquito pesticides for mosquito control. 4. Detailed physiochemical information on methoprene, including its short half-life in the environment, challenges reports of potentially irreversible harm to the aquatic ecosystem. 5. Regulatory issues pertaining to potential uses of methoprene for mosquito control are included that are relevant for several locations and states. The reviews in this report include critiques of many of the publications that have reported adverse impacts to non-target species and the ecosystem. 6. Summaries of methoprene publications are focused on plausible and reasonable confounding factors in each study that might account for the reported effects. Several special exposure conditions are discussed that may have played a role in reported effects, such as possible salinity toxicity and additive effects of solvents and media contaminants. This report provides extensive and realistic critiques of methoprene as a pesticide for mosquito control.
Lawler, S.P., D. Dritz and T. Jensen. 2000. Effects of Sustained Release Methoprene and a Combined Formulation of Liquid Methoprene and *Bacillus thuringiensis israelensis* on Insects in Salt Marshes. Arch. Environ. Contam. Toxicol. 39:177-182.	Applications of Bti liquid (Vectobac 12AS) and the methoprene products Altosid Liquid Larvicide and Altosid Pellets near maximum label rates in a salt marsh found no detectable effects of Bti, Bti and methoprene (duplex), or methoprene pellets on nontarget saltmarsh insects. Rates used were 13.68 oz. Bti/acre, 6.09 oz. liquid methoprene/acre, and 9.28 lb methoprene pellets per acre. All pesticides effectively controlled the salt marsh mosquito *Aedes dorsalis*.

Additional Methoprene Publications Reviewed

Publication Authors	Summary of Reported Findings
McKenney, C.L. 2005. The Influence of Insect Juvenile Hormone Agonists on Metamorphosis and Reproduction in Estuarine Crustaceans. Integr. Comp. Biol. 45:97-105.	Comparative developmental and reproductive studies were performed on several species of estuarine crustaceans in response to three juvenile hormone agonists (pyriproxyfen, methoprene and fenoxycarb). Claims that larval development of the grass shrimp, *Palaemonetes pugio*, was greater than two orders of magnitude more sensitive to disruption by methoprene and fenoxycarb than was embryonic development. Developing larvae of the mud crab, *Rhithropanopeus harrisii*, exhibited reduced metamorphic success at lower concentrations of methoprene (100 ppb) and pyriproxyfen (50 ppb) than grass shrimp larvae (1000 ppb and 100 ppb respectively). The final crab larval stage, the megalopa, was more sensitive to methoprene and fenoxycarb exposure than earlier zoeal stages. Juvenile mysids (*Americamysis bahia*) released by exposed adults and reared through maturation without further exposure produced fewer young and had altered sex ratios (lower percentages of males) at lower parental-exposure concentrations than directly affected parental reproduction. These findings support a recommendation to use a functional approach (expanding the test base) as an appropriate screening procedure to evaluate potential environmental endocrine-disrupting chemicals in aquatic environments.
Olmstead, A. and G. LeBlanc. 2003. Insecticidal Juvenile Hormone Analogs Stimulate the Production of Male Offspring in the Crustacean *Daphnia magna*. Environ. Health Perspect. 111(7):919-924.	Juvenile hormone analogs (JHAs) represent a class of insecticides that were designed specifically to disrupt endocrine-regulated processes relatively unique to insects. Earlier report by these authors suggested that the crustacean juvenoid hormone methyl farnesoate (MF) at high levels (50 ppb) can initiate development of oocytes of crustacean Daphnia magna to develop into males. Authors suggest that insecticidal JHAs might mimic the action of MF to produce altered sex ratios of offspring. Daphnids were exposed continuously (3 weeks) to sublethal concentrations of MF, the JHA pyriproxyfen, and several non juvenoid chemicals to discern whether excess male offspring production is a generic response to stress or a specific response to juvenoid hormones. This response was not elicited by methoprene exposure.

Additional Methoprene Publications Reviewed

Publication Authors	**Summary of Reported Findings**
Olmstead, A. and G. LeBlanc. 2001. Temporal and Quantitative Changes in Sexual Reproductive Cycling of the Cladoceran *Daphnia magna* by a Juvenile Hormone Analog. J. Exp. Zool. 290:148-155.	Cyclic parthenogens, such as the cladoceran, *Daphnia magna*, utilize both asexual (parthenogenetic) and sexual reproduction. Experiments were conducted with the juvenile hormone analog methoprene to test the hypothesis that members of the insect juvenile hormone/vertebrate retinoic acid family of transcription factors are involved in the regulation of sexual reproduction in daphnids. Neither methoprene food reduction, nor crowding independently stimulated entry into the sexual reproductive phase of the daphnids. However, the combination of food deprivation and crowding stimulated entry into the sexual reproductive phase characterized by an initial high production of males and the subsequent intermittent production of haploid egg-containing ephippia. Exposure to 160 nM methoprene (50 ppb) along with food deprivation and crowding caused a significant reduction in the percentage of males produced during the early phase of the sexual cycle and significantly increased the percentage of males produced during the later stages of the cycle. Methoprene concentrations as low as 6.4 nM (2 ppb) reduced the number of resting eggs produced and proportionately increased the production of parthenogenetically-produced neonates. These experiments demonstrate that methoprene may uncouple the coordinated production of males and resting eggs during the sexual reproductive period of *D. magna* at the levels tested Methoprene, at these concentrations, which are higher than typical application rates is said to stimulate male offspring production and defers their production to latter stages of the sexual reproductive period, while inhibiting the production of resting eggs and promoting the continuance of parthenogenetic reproduction
Olmstead, A. and G. LeBlanc. 2001. Low Exposure Concentration Effects of Methoprene on Endocrine Regulated Processes in the Crustacean *Daphnia magna*. Toxicol. Sciences. 62:268-273.	Methoprene may exert toxicity to crustaceans by mimicking or interfering with methyl farnesoate, a crustacean juvenoid. The authors suggest that methoprene interferes with endocrine-regulated processes in crustaceans by several mechanisms involving agonism or antagonism of juvenoid receptor complexes. In this present study, characterizing response curves for methoprene for endpoints related to development and reproduction of the crustacean *Daphnia magna* resulted in response thresholds at approximately 4 ppb, considerably higher than would be used in actual field scenarios. Molt frequency was reduced by methoprene in a concentration-dependent manner, at 4.2 nM (1.3 ppb) and a NOEC of 32 nM (9.9 ppb). Results in the study suggest that methoprene may elicit some toxicity to endocrine-related processes in the 5–50 nM (6 to 16 ppb) concentration range.

Additional Methoprene Publications Reviewed

Publication Authors	Summary of Reported Findings
Rexrode, M., I. Abdel-Saheb and J. Andersen. 2008. Potential Risks of Labeled S-Methoprene Uses to the Federally Listed California Red-Legged Frog. Pesticide Effects Determination. U.S. EPA Biopesticide and Pollution Prevention Division. 77pp.	Based on the results of this reported assessment, the following hypotheses can be **rejected**: > The labeled use of S-methoprene impacts growth and viability of juvenile and adult CRLFs. causing mortality or by adversely affecting growth or fecundity: > indirect effects occur by reducing or changing the composition of food supply; > indirectly affects critical habitat by reducing or changing the composition of the aquatic plant community in the ponds and streams comprising the species' current range and designated critical habitat, thus affecting primary productivity and/or cover; > indirectly affects critical habitat by reducing or changing the composition of the terrestrial plant community (i.e., riparian habitat) and habitat in the ponds and streams comprising the species' current range and designated critical habitat; > modifies critical habitat changing breeding and non-breeding aquatic habitat (via modification of water quality parameters, habitat morphology, and/or sedimentation); > modifies the designated critical habitat of the CRLF by reducing the food supply required for normal growth and viability of juvenile and adult CRLFs; > modifies the designated critical habitat of the CRLF by reducing or changing upland habitat within 200 ft of the edge of the riparian vegetation necessary for shelter, foraging, and predator avoidance. > modifies the designated critical habitat of the CRLF by reducing or changing dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites that do not contain barriers to dispersal. > modifies the designated critical habitat of the CRLF by altering chemical characteristics necessary for normal response line, having a threshold of 12.6 nM (4 ppb). The conclusion is that there is a "may affect", but "not likely to adversely affect" determination for the CRLF from exposures to S-methoprene at levels above 4ppb (much higher than actual exposure when s-methoprene is used per the label for mosquito control.

Additional Methoprene Publications Reviewed

Publication Authors	**Summary of Reported Findings**
Russell, T., B. Kay and G. Skilleter. 2009. Environmental Affects of Mosquito Insecticides on Saltmarsh Invertebrate Fauna. Aquatic Biology 6:77-90.	The effects of Bti and s-methoprene on nontarget aquatic and terrestrial fauna in 2 subtropical saltmarshes approximately 30 km apart are reported. Application rates used were 16.42 oz. Bti per acre and 4.93 oz. methoprene (Altosid Liquid Larvicide) which is slightly in excess of the maximum label rate. The main taxa collected from ephemeral pools were copepods and from terrestrial plots were springtails (*Collembola*), mites (*Acariformes*) and ants (*Hymenoptera*), with smaller numbers of beetles (*Coleoptera*), true bugs (*Heteroptera*) and flies (*Diptera*). Following applications of both products, inconsistent short-term (<20 d) differences in the composition of the arthropod community were noted. After applications of Bti to ephemeral pools, smaller numbers of copepods were recorded at only one locality and the difference was not significant. There were no significant effects of s-methoprene on the arthropods in ephemeral pools at either locality. There were few significant effects on any other taxa and these effects were also localized and short-lived. These results suggest that *applications of s-methoprene do not impact the abundance and composition of nontarget arthropod assemblages in typical subtropical saltmarshes*,
Sparling, D. 2000. Effects of Altosid and Abate-4E on Deformities and Survival in Southern Leopard Frogs Under Semi-Natural Conditions. J. Iowa Acad Sci. 107(3):90-91.	Experimental wetlands were sprayed with Abate-4E (a.i. temephos) and Altosid (a.i. methoprene) through the summer “following label directions" Tadpoles captured from ponds sprayed with Altosid had a 15% deformity rate mostly involving total or partially missing hind limbs. Tadpoles from control ponds had a 5% rate of deformities. The difference was statistically significant. The relative abundance of tadpoles from ponds sprayed with Abate-4E was significantly lower than those from Altosid-sprayed or control wetlands. This project was conducted with high concentrations of methoprene products to illicit these responses. Comparison of temephos and methoprene indicate that methoprene exposure at label rate did not illicit adverse effects.
Stueckle, T.A., J. Likens and C.M. Foran. 2009. Limb Regeneration and Molting Processes Under Chronic Methoprene Exposure in the Mud Fiddler Crab, *Uca pugnax.* Comp. Biochem. Physiol. Part C. 147:366-377.	This study evaluated the effect chronic methoprene exposure would have on male and female fiddler crab, *Uca pugnax*, limb regeneration and molting. Crabs were chronically exposed to methoprene (dissolved in acetone) concentrations of 0, 0.1, 1.0, 10, 100 and 1000 µg/L (0-1000 ppb). The authors found male crabs lost more weight per body volume than females, took longer to proceed through proecdysis when exposed to 0.1 µg/L methoprene, and exhibited elevated frequency for abnormal limb formation at 1.0 µg/L. Female crabs displayed no such trend. Methoprene also did not significantly alter extractable exoskeleton protein or chitin content, although variable water-soluble protein expression increased with exposure at 1.0 µg/L. The authors suggest that adult male *Uca pugnax* possess greater sensitivity to chronic methoprene exposure during limb regeneration and molting. The authors also point out that the daily pulsed methoprene exposure used in this study may over estimate real world exposure rates since known slow-release methoprene applications result in pulse frequencies ranging every 2-19 days with low to negligible levels between pulses.

Additional Methoprene Publications Reviewed

Publication Authors	**Summary of Reported Findings**
Stueckle, T.A. 2008. An Evaluation of the Non-Target Effects of Mosquito Control Pesticides on *Uca pugnax* Physiology, Limb Regeneration and Molting Processes. Dissertation submitted to Eberly College of Arts and Sciences at West Virginia University.	This study addresses the potential effects of methoprene and permethrin on physiology, limb regeneration and molting ability of a crustacean species, *Uca pugnax*. The author claims that chronic methoprene exposure at environmental concentrations may cause increased male abnormal regenerative limbs and delays in proecdysis. Both male and female crabs displayed increased variability in water-soluble exoskeleton protein. Results presented link both chemical and salinity regimes to potential harmful effects. The study also focuses on some of the possible additive effects of chemicals and media salinity as additive stressors (permethrin, methoprene and salinity). Concentrations of methoprene used in this study were between label rates for mosquito control to approximately 2.5 to 3X possible exposures based on label rates. The author reports that “most observations were no effect for methoprene alone. The study revealed no significant effects until the other test stressors (permethrin and salinity) were added and tested, suggesting that exposure of *Uca pugnax* to methoprene alone did not result in any significant adverse effects. In addition, males displayed some minor methoprene and permethrin non-additive effects on total exoskeleton protein content, reduced body mass gain, reduced carapace width gain and overall body condition loss. Females displayed only reduced carapace size gain and increased respiration rate, possibly due to increased metabolic and biotransformation of both pesticides. This report suggests that these results, although not significant, indicate that insect growth regulators, pyrethroid insecticides or their mixture into coastal wetland environments may pose a potential risk to crustaceans.
Walker, A., P. Bush, J. Puritz, T. Wilson, E.S. Chang, T. Miller, K. Halloway and M.N. Horst. 2005. Bioaccumulation and Metabolic Effects of the Endocrine Disruptor Methoprene in the Lobster, *Homarus americanus*. Integr. Comp. Biol. 45(1):118-126.	Methoprene has *suspected* toxic effects on larval and adult crustaceans reported recently for lobsters. These studies report the effects of continuous exposures of methoprene on larvae and adults. Low levels of methoprene had adverse effects on stage II lobster larvae at 1 ppb. Stage IV larvae were more resistant, but did exhibit increases in molt frequency beginning at exposures of 5 ppb. Juvenile lobsters exhibited variations in tissue susceptibility to methoprene pathway of lobster cuticle synthesis and the quality of the post-molt shell. It is likely that a combination of factors led to the reported reduced lobster population.

Additional Bti Publications Reviewed

Publication Authors	**Summary of Reported Findings**
Ali, A., R.J. Lobinske, R.J. Leckel, N Carandang, and A. Mazumdar. 2008. Population Survey and Control of Chironomidae (Diptera) in Wetlands in Northeastern Florida, USA. Florida Entomologist 91(3):446-452.	Two species of Chironomids, *Glyptotendipes paripes* and *Goeldichironomus carus* in Florida wetlands were evaluated for sensitivity to Temephos and Bti and s-methoprene. This paper reviews the comparison of these larvicides both for efficacy and in cost. The summary of the paper suggests that Bti and s-methoprene be used in rotation with Tim FR's for Midge control. The authors suggest that this rotation approach in an IPM technique would have only temporary and reversible impact on nontarget biota. However, the study did not actually evaluate nontargets in the field as part of the study. Rates of Bti used were 2.07 and 4.14 times maximum mosquito control label rates and achieved 52% and 88% reduction of adult emergence in experimental field plots.
Becker, N. 1998. The Use of *Bacillus thuringiensis* subsp. *israelensis* (Bti) Against Mosquitoes, With Special Emphasis on the Ecological Impact. Israel Journal of Entomology. 32:63-69.	Overview report on the use of Bti *Bacillus thuringiensis israelensis* products in Germany and information about the lack of adverse effects resulting from treatments. The author indicates that more than 200 tons of Bti is used annually worldwide without any evidence of harmful impact on the environment. In Germany, 97 cities and municipalities along a 310 kilometer stretch of the Upper Rhine River, with a total population of 2.5 million people, have treated areas to control mosquitoes, mainly the flood-water mosquito *Aedes vexans*, over a breeding area of some 600 km^2 of the Rhine's flood-plain. The control of Aedes mosquitoes in Germany is based solely on the use of Bti products. Precise mapping of the breeding sites accounts not only for the mosquito population but also wide ecological considerations. For instance, from 1981 to 1996 approximately 37 tons of Bti powder or almost 1,000 tons of Bti granules as well as 29 tons of Bti liquid concentrates have been used in Germany, treating over 1,000 km2 of breeding area, resulting in a reduction of the mosquito population by more than 90%. In an extensive monitoring program the environmental safety of Bti treatments is confirmed for each routine treatment. All investigations have shown that the numbers of *Aedes* mosquitoes are drastically reduced but that all other insects continue to develop in the water and provide, as winged adults, a food resource for birds, amphibians and bats.
Boissvert, M. and J. Boisvert. 2000. Effects of *Bacillus thuringiensis* var. *israelensis* on Target and Nontarget Organisms: A Review of Laboratory and Field Experiments. Biocontrol Science and Technology 10:517-561.	An extensive review of the literature was conducted concerning toxicity, mode of action, environmental fate, factors affecting efficacy, and effects on nontarget organisms for the biopesticide Bti (*Bacillus thuringiensis* var. *israelensis*). The majority of this review emphasizes nontarget impacts, analyzing the results of 75 studies covering 125 families, 300 genera and 400 species of target and nontarget organisms. Overall, formulations of Bti used at the label rates for mosquito control do not have a significant impact on most other animals o plants. It was however suggested that under different application conditions, the effects of Bti may be hard to predict. It was further suggested that high frequencies of application and/or over dosages of Bti against mosquitoes may result in some persistence of the toxic crystals, which could have potential adverse effects on the food web. It was recommended that more long-term and controlled studies be performed to better ascertain any potential food web effects that may occur with prolonged use and repeated applications of Bti.

Additional Bti Publications Reviewed

Publication Authors	Summary of Reported Findings
Brown, M., D. Thomas, P. Mason, J.G. Greenwood and B.H. Kay 1998. Laboratory and Field Evaluation of the Efficacy of Four Insecticides for *Aedes vigilax* (Diptera: Culicidae) and Toxicity to the Nontarget Shrimp *Leander tenuicornis* (Decapoda: Palaemonidae). J. Econ. Ent. 92(5):1045-1051.	This report describes laboratory and field tests of the toxicity of two organophosphate compounds (temephos and pirimiphosmethyl) and methoprene and *Bacillus thuringiensis* ssp*. israelensis*.to a saltwater mosquito (*Aedes vigilax*) including an evaluation of the selectivity for the mosquito and possible toxicity to a non-target shrimp *Leander tenuicornis* (a Decapod). In addition to developing LC 50 values the report includes measures of selectivity of each pesticide for the target organisms versus nontarget. The Bti applications were highly toxic to the saltwater mosquito while not affecting survival of the shrimp that inhabit the same saltwater marsh areas in the study. In addition, Bti did not affect water quality. The authors suggest that Bti is "ideal for continued control of *Ae. vigilax* in Australian saltwater ponds".
Cao, C., L. Sun, R. Wen, X. Li, H. Qu and Z. Wang. 2012. Toxicity and Affecting Factors of *Bacillus thuringiensis* var. *israelensis* on *Chironomus kiiensis* Larvae. J. Insect Sci. 12(article 126):1-8.	*Bacillus thuringiensis* var. *israelensis* (Bti). Laboratory bioassays were used to study toxicity and affecting factors of Bti on *Chironomus kiiensis* larvae using three commercial Bti formulations (oil miscible suspension, 1,200 ITU/mL (1gm); wettable powder, 1,200 ITU/mg (1gm); technical material, 5,000 ITU/mg, (4 gm) of Bti). The toxicity of Bti formulations to third and fourth instar *C. kiiensis* larvae was in decreasing order of technical material, oil miscible suspension, and wettable powder, based on the 12 and 24 hour LC50 values. Increasing larval densities (from 10 to 30 per bioassay cup) increased the LC50 values for fourth instar *C. kiiensis* larvae. The LC50 values for fourth instar larvae reared in sand substrate were higher than those from soil substrate, and autoclaved substrates significantly increased the LC50 values. The technical material of Bti at 12 and 24 hours responded similarly to changes in temperature between 30°C and 15°C, but the LC50 values at a range of tested temperatures showed distinct differences in time points. Study provided a comparison of efficacy of Bti formulations but no report on non-target effects in this article.
Caquet, T., M. Roucaute, P. Le Goff and L. Lagadic. 2011. Effects of Repeated Field Applications of Two Formulations of *Bacillus thuringiensis* var. *israelensis* on Nontarget Saltmarsh Invertebrates in Atlantic Coastal Wetlands. Ecotoxicology and Env. Safety. 74(5):1122-1130.	A 2-year controlled study on French Atlantic coastal saltmarsh wetlands was conducted to evaluate the effects of multiple applications of Bti. No adverse effects of the treatments were shown on the abundance of midge larvae, suggesting that the availability of these food sources for birds was not negatively affected by Bti applications. It was concluded that, as currently performed in Western France coastal wetlands, land-based treatments of saltmarsh pools for larval mosquito control with *Bti did not adversely impact nontarget aquatic invertebrate communities*. Near minimum mosquito control label rates for the Bti products Vectobac 12AS and Vectobac WG were utilized in this study.
Craggs, R., L. Golding, S. Clearwater, L. Susaria and W. Donovan. 2005. Control of Chironomid Midge Larvae in Wastewater Stabilization Ponds: Comparison of Five Compounds. Water Sci. Tech. 51(12):191-199.	The efficacy of Maldison, an organophosphate insecticide, was compared to *Bacillus thuringiensis* var. *israelensis* (Bti), methoprene, pyriproxyfen, and diflubenzuron. During 21-day small-scale trials, Bti, diflubenzuron and Maldison reduced live larval numbers by 80-89% compared to controls and adult emergence was markedly reduced by all compounds (72-96%). Large-scale trials with Bti (Vectobac WG) powder at 10 kg total ingredient/ha (to give a final concentration in the water column of 1000 µg/L) resulted in a slight reduction in midge larval numbers compared to controls and had little effect on adult emergence.
Davis, R.S. and R.K.D. Peterson. 2008. Effects of Single and Multiple Applications of Mosquito Insecticides on Nontarget Arthropods. J. Amer. Mosq. Cont. Assoc. 24(2):270-280.	Experiments were conducted to assess the acute impacts of mosquito adulticides (permethrin and d-phenothrin) and larvicides (*Bacillus thuringiensis israelensis* and methoprene) on nontarget aquatic and terrestrial arthropods after a single application. The first experiment was conducted in 2004 and 2005 with Bti on nontarget terrestrial arthropods after a single application. For aquatic samples, no overall treatment effects of Bti were observed. In general, nearly all of the responses evaluated in this study indicated few, if any, deleterious effects from Bti application.

Additional Bti Publications Reviewed

Publication Authors	**Summary of Reported Findings**
Duchet, C., M. Coutellec, E. Franquet, C. Lagneau and L. Lagadic. 2010. Population-Level Effects of Spinosad and *Bacillus thuringiensis israelensis* in *Daphnia pulex* and *Daphnia magna*: Comparison of Laboratory and Field Microcosm Exposure Conditions. Ecotoxicology, 19(7):1224-1237.	Use of a life table response approach to assess population-level effects of two insecticides used against mosquito larvae, spinosad (8 µg/l) and *Bacillus thuringiensis* var. *israelensis* (Bti, 0.5 µg/l), on two nontarget species, *Daphnia pulex* and *Daphnia magna* (Crustacea: Cladocera), under laboratory versus field microcosms conditions. In laboratory conditions, these theoretical calculations and analyses performed for each species suggests a negative effect of spinosad on survival, mean time at death, and fecundity as compared to controls and Bti-treated groups; for both species, population growth rate λ was lower under exposure to spinosad. In field microcosms, 2 days after larvicide application, differences in population growth rates were observed between spinosad exposure conditions, and control and Bti exposure conditions. Simulations performed on spinosad-exposed organisms led to population "extinction. *D. magna* was shown to be more sensitive than *D. pulex* to spinosad in the laboratory, and the effects were also detectable through field population demographic simulations.
Eder, E. and I. Schönbrunner, 2010. Toxicity of *Bacillus thuringiensis israelensis* on the Nontarget Organisms *Triops cancriformis*, *Branchipus schaefferi*, *Leptestheria dahalacensis* (*Crustacea*: *Branchiopoda*: *Notostraca*, *Anostraca*, *Spinicaudata*). The Open Environmental Pollution & Toxicology Journal. 2:16-20.	Authors report that in a blind and randomized study, early post-larval stages of the tadpole shrimp *Triops cancriformis*, the fairy shrimp *Branchipus schaefferi*, and the clam shrimp *Leptestheria dahalacensis* were exposed to different concentrations of a commonly available Bti suspension, equivalent to 0, 4.5 (recommended treatment concentration), 45, 450, and 4500x (related to the recommended level). No statistically significant correlations were found between Bti concentration and mortality or longevity of the examined organisms at any of the exposure levels studied.
Frouz, J., R.J. Lobinske, A. Yaqub and A. Ali. 2007. Larval Gut pH Profile in *Pestiferous Chironomus crassicaudatus* and *Glyptotendipes paripes* (Chironomidae: Diptera) in Reference to the Toxicity of *Bacillus thuringiensis serovar israelensis*. J. Amer. Mosq. Cont. Assoc. 23(3):355-358.	Gut pH was measured in the 4th-stage larvae of two chironomid species, *Chironomus crassicaudatus* and *Glyptotendipes paripes*. The gut pH in both species was close to neutral, varying from 6.7 to 7.4 and 6.9 to 7.6 pH units for *C. crassicaudatus* and *G paripes*, respectively. The gut pH in both chironomid species remained between pH values of 5.5 and 7. The pH profiles in these 2 species of chironomids are lower than for mosquitoes or Lepidoptera larvae. The authors suggest that this could be the reason for the relatively lower susceptibility of chironomid larvae to *Bacillus thuringiensis serovar israelensis* toxin proteins than some other nematoceran Diptera, specifically mosquitoes.
Glare, T. and M. O'Callaghan. 2005. A Review and Update of the Report "Environmental and Health Impacts of *Bacillus thuringiensis israelensis*" 1998. Report for the New Zealand Ministry of Health. 32pp.	Much of the new literature on nontarget effects still indicates that Bti is one of the least environmentally damaging pesticides used for mosquito control. Some reports have shown that large declines in insect biomass can occur after long-term use of Bti in freshwater wetlands. However, the authors indicate that no evidence for permanent damage to ecosystem function has been found. Organisms that utilized insects for food, adapted to the declines and either switched to other food sources or travelled (birds) outside of the treated zones to acquire insects. The authors suggest that the conclusions reached by Glare and O'Callaghan in 1998 (no significant impact of Bti on critical food sources) are valid and that Bti be used for control and eradication of introduced mosquito species (with rotation of methoprene). The authors justify their recommendation because they argue that alternative control agents, other than *Bacillus sphaericus*, are OP insecticides that are broad-spectrum neurotoxins that may pose a higher risk to the environment, human, and animal health than Bti.

Additional Bti Publications Reviewed

Publication Authors	Summary of Reported Findings
Hurst, T.P., B.H. Kay, P.A. Ryan, and M.D. Brown. 2007. Sublethal Effects of Mosquito Larvicides on Swimming Performance of Larvivorous Fish *Melanotaenia duboulayi* (Atheriniformes: Melanotaeniidae). J. Econ. Ent. 100(1):61-65.	Laboratory studies were conducted to determine the sublethal effects of exposure to the mosquito larvicides temephos, primiphos-methyl, Bti, *Bacillus sphaericus*, and methoprene. Bti exposures of 10 times the effective field concentration had no effect on the Australian Crimson-Spotted Rainbowfish (*Melanotaenia duboulayi*) swimming speed.
Lagadic. L. M. Roucaute and T. Caquet. 2014. Bti Sprays do not Adversely Affect Nontarget Aquatic Invertebrates in French Atlantic Coastal Wetlands. J. Applied Ecology. 51(1):102-113	This was a 6-year study sampling invertebrates in the water and sediment of control and Bti treated saltmarsh pools. Taxa abundance was the metric used along with physicochemical parameters in the same pools so that homogeneity of environmental conditions between the control and treated areas could be tested*. It was concluded that long-term use of Bti in coastal wetlands had no influence on the temporal evolution of the taxonomic structure and taxa abundance of nontarget aquatic invertebrate communities*, *(which is highly driven by abiotic factors).* In addition, over the long term, the amount of invertebrates that could be used as food resources by birds was maintained in Bti-treated areas. Subtle differences in the range of variation of abiotic factors result in discrepancies between control and treated area in terms of invertebrate abundance, which could be wrongly attributed to Bti.
Laurence, D., L. Christophe and F. Roger. 2012. Using the Bio-Insecticide *Bacillus thuringiensis israelensis* in Mosquito Control. www.intechopen.	This article provides an extensive and comprehensive review of the Bti formulations and use scenarios over the last few decades. Excellent source of the Bti background papers. General overview of several issues and information such as environmental factors affecting efficacy, effects on nontarget organisms, effects on ecosystems, managing mosquito resistance, and use with other bio-insecticides.
Lawler, S.P., D. Dritz and T. Jensen. 2000. Effects of Sustained Release Methoprene and a Combined Formulation of Liquid Methoprene and *Bacillus thuringiensis israelensis* on Insects in Salt Marshes. Arch. Environ. Contam. Toxicol. 39:177-182	Applications of Bti liquid (Vectobac 12AS and the methoprene products Altosid Liquid Larvicide and Altosid Pellets near maximum label rates in a salt marsh found no detectable effects of Bti, Bti and methoprene (duplex), or methoprene pellets on nontarget saltmarsh insects. The rate of Bti used was 13.68 oz./acre, which was also an effective for controlling the salt marsh mosquito *Aedes dorsalis*.
Liber, K., K.L. Schmude and D. Rau. 1998. Toxicity of *Bacillus thuringiensis* var. *israelensis* to Chironomids in Pond Mesocosms. Ecotox. 7(6):343-354.	A pond mesocosm wetland study was conducted to evaluate the potential toxicity of *Bacillus thuringiensis* var. *israelensis* to chironomids. Bti was applied to three replicate mesocosms for each of five applications rates (2.4, 8, 20, 40 and 80 lbs/acre), with the base application rate being 8 lbs/acre. The abundance of Chironomid larvae was significantly reduced at the 10x base rate treatment at 4 d. Chironomid abundance was reduced after a second application with 10x base rate, but recovered within 32 d. The abundance of Orthocladiinae larvae was significantly reduced at both the 10x and 5x base rate treatments, whereas the Tanypodinae appeared unaffected by all treatments, but no reductions were statistically significant. Emergence of adult Chironomidae was significantly reduced at the 10x base rate. Emergence of Ceratopogonidae and Chaoboridae was unaffected by all Bti treatments. The maximum mosquito control label rate for the formulation of Bti granules used in this study is 20 lb/acre.

Additional Bti Publications Reviewed

Publication Authors	**Summary of Reported Findings**
Lundstrom, J.O., Y. Brodin, M.L. Schafer, T.Z.P. Vinnersten and O. Ostman. 2010. High Species Richness of Chironomidae (Diptera) in Temporary Flooded Wetlands Associated with High Species Turnover Rates. Bull. Ent. Res. 100(4):433-444.	Species richness and species turnover of Chironomidae was studied in irregularly flooded wetlands of the River Dalälven flood-plains in central Sweden. Recurrent irregular floods may have induced high chironomid species richness. Half of the wetlands were treated with *Bacillus thuringiensis* var. *israelensis* (Bti) against larvae of the flood-water mosquito *Aedes sticticus*. These treatments had no significant effect on chironomid species richness, but there was a higher species turn-over between years of primarily low abundance species in the treated wetlands. The cumulative number of species was also higher in the Bti-treated experimental wetlands than in the untreated reference wetlands. Bti treatment appeared to have only small effects on chironomid species richness possibly due to a compensatory increase of the colonization-extinction dynamics.
Lundstrom, J.O., M.L. Schafer, E. Peterssen, T.Z.P. Vinnersten, J. Landin and Y. Brodin. 2009. Production of Wetland Chironomidae (Diptera) and the Effects of Using *Bacillus thuringiensis israelensis* for Mosquito Control. Bull. Ent. Res. 100(1):117-125.	*Bacillus thuringiensis* var. *israelensis* (Bti) is used to control immature mosquitoes in Sweden. Six years of monitoring Chironomidae, a nontarget organism, was conducted in three wetlands with Bti-treatment against mosquitoes and in three wetlands without treatment. Moderately high label rates (11.6 to 13.4 lbs/acre of the product Vectobac G (a corncob granule) were used. Emergence traps were used for continuous insect sampling. A total of 21,394 chironomids of 135 species were collected. No reduced production of chironomids was found, neither family nor subfamily level, in Bti-treated as compared to untreated wetlands. Four species had higher and one species had lower production in treated areas. Bti-based control of floodwater mosquitoes does not cause any major direct negative effects on chironomid production, and therefore does not induce any risk for indirect negative effects on birds, bats or any other predators feeding on chironomids.
Mezzomo, B.P., A.L. Miranda-Vilela, I.S. Freira, L.C.P. Barbosa, F.A. Portilho, Z.G.M. Lacava and C.K. Grisolia. 2013 Hematotoxicity of *Bacillus thuringiensis* as Spore-crystal Strains Cry1Aa, Cry1Ab, Cry1Ac or Cry2Aa in Swiss Albino Mice. J. Hematol. Thromb. Dis. 1:104 doi: 10.4172/2329-8790.1000104	Albino mice blood parameters were evaluated after gavage with a single dose of prepared Bt proteins as 27 mg/ Kg, 136 mg/Kg or 270 mg/Kg, 24 h, 72 h or 7 days before euthanasia. Binary combinations of these four spore-crystal proteins were also assayed at 270 mg/Kg with a single administration 24 h before euthanasia. Hematotoxicity evaluations of blood samples were conducted using an automated hematology analyzer and with a micronucleus test for genotoxicity analysis in mice bone marrow cells. Spore-crystal administrations provoked selective hematotoxicity for erythroid lineage. Reduction in bone marrow cell proliferation was seen but no genotoxic effects. Similar results were observed for binary combinations at 24 h, suggesting that further studies are required to clarify the mechanism involved in the hematotoxicity found in mice, and to establish the toxicological risks to nontarget organisms, especially mammals.

Additional Bti Publications Reviewed

Publication Authors	Summary of Reported Findings
Negri, A.P., R. M. Soo, F. Flores, N. S. Webster. 2009. *Bacillus* insecticides are not Acutely Harmful to Corals and Sponges. Mar. Ecol. Prog. Ser. 381:157-165.	*Bacillus thuringiensis* is widely considered an environmentally safe insecticide to control mosquitoes and a number of agriculture pests. Bacteria closely related to *B. thuringiensis* have recently been discovered in association with diseased sponges, which has raised concerns that *Bacillus* insecticides may be harmful to tropical marine invertebrates. Coral larvae and juvenile corals were exposed to the insecticides VectoBac® G (containing *B. thuringiensis israelensis*) and VectoLex® G (containing *B. sphaericus*) at concentrations up to 100 fold higher than concentrations that affect target immature mosquitoes. VectoBac G and VectoLex G had no effect on the survival and metamorphosis of *Acropora millepora* and *A. tenuis* larvae *at very high concentrations (5000 µg l^{-1}*). The juvenile corals of the same species were also unaffected after four sequential 48 h exposures to *B. thuringiensis israelensis* and *B. sphaericus* at different stages of development. Adult corals (*A. millepora*) and sponges (*Ianthella basta*) were exposed to a single 6 h pulse of 1000 µg l^{-1} VectoBac G. No evidence of coral or sponge disease was observed during the following 2 wk. These results indicate that insecticides containing *Bacillus* spp. are unlikely to be acutely pathogenic to corals and sponges.
Ostman, O., J.O. Lundstrom, and T.Z.P. Vinnersten. 2008. Effects of Mosquito Larvae Removal with *Bacillus thuringiensis israelensis* (Bti) on Natural Protozoan Communities. Hydrobiologia 607(1):231-235.	Mosquito larvae are considered important predators on protozoans and bacteria, and this study addresses a result of a reduction of mosquito larvae density in natural wetlands caused by application of Bti may indirectly affect these microbial communities. Six natural wetlands were used to illustrate that the densities of heterotrophic protozoans was on an average 4.5 times higher in wetland areas treated with Bti than in control areas. In addition, the taxonomic richness of heterotrophic protozoans increased on an average of 60% in areas with Bti application compared to control areas. The increase in protozoan density and richness was fairly consistent among sites of different wetland habitats, indicating a potential positive, but indirect effect of treatments.
Poopathi, S. and S. Abidha. 2010. Mosquitocidal Bacterial Toxins (*Bacillus sphaericus* and *Bacillus thuringiensis serovar israelensis*): Mode of Action, Cytopathological Effects and Mechanism of Resistance. J. Physiol. Pathophysiol. 1(3):22-38.	This paper provides a general overview and test data discussing the use of Bs and Bti (*Bacillus sphaericus* and *Bacillus thuringiensis* serovar *israelensis*): to provide effective alternatives to broad spectrum larvicides in many situations with little or no environmental impact. New recombinant bacteria are as potent as many synthetic chemical insecticides yet are less prone to resistance, as they typically contain a mixture of endotoxins with different modes of action.
Poulin, B. 2012. Indirect Effects of Bioinsecticides on the Nontarget Fauna: The Camargue Experiment Calls for Future Research. Acta Oecologia 44:28-32.	Birds from natural and human-inhabited areas were used as model species to assess trophic impacts that may have been caused by three years of Bti applications to a monitoring region. The author reports some significant effects of Bti spraying on abundance of reed-dwelling invertebrates serving as food to passerines, as well as on the diet and breeding success of house martins nesting in rural estates and small towns. This report supports several other studies that have reported adverse food web impacts (indirect effects) as a result of the Bt applications. Although these field studies are impacted by several confounding (non-chemical) impacts, the author suggests that these results are important in the context of indirect effects of spray applications.

Additional Bti Publications Reviewed

Publication Authors	**Summary of Reported Findings**
Poulin, B., G. Lefebvre and L. Paz. 2010. Red Flag for Green Spray: Adverse Trophic Effects of Bti on Breeding Birds. J. Applied Ecology 47(4):884-889.	Study of food web interactions in the field with *Bacillus thuringiensis israelensis* (Bti) applications at 34.21 oz. per acre, which is slightly above maximum label rates for mosquito control. Breeding house martins *Delichon urbicum* were used as a model species to test the effect of Bti spraying on foraging rates and chick diet prior to and during 3 years of Bti spraying in the Camargue, France. Intake of Nematocera (Diptera sub-order including midges and mosquitoes) and their predators (spiders and dragonflies) were reported to be decreased significantly at treated sites, concurrently with increased flying ant intake. Clutch size and fledgling survival were lower at treated sites relative to control. Breeding success was positively correlated with intake of Nematocera and their predators at the nest level. No previous study has provided compelling evidence of Bti affecting vertebrate populations following the suppression of prey species. Indirect effects caused by repeated application of Bti through food web interactions warrant more attention.
Russell, T., B. Kay and G. Skilleter. 2009. Environmental Affects of Mosquito Insecticides on Saltmarsh Invertebrate Fauna. Aquatic Biology 6:77-90.	The effects of Bti and s-methoprene on nontarget aquatic and terrestrial fauna in 2 subtropical saltmarshes approximately 30 km apart are reported. Application rates used were 16.42 oz. Bti per acre and 4.93 oz. methoprene (Altosid Liquid Larvicide) which is slightly in excess of the maximum label rate. The main taxa collected from ephemeral pools were copepods and from terrestrial plots were springtails (*Collembola*), mites (*Acariformes*) and ants (*Hymenoptera*), with smaller numbers of beetles (*Coleoptera*), true bugs (*Heteroptera*) and flies (*Diptera*). Following applications of both products, inconsistent short-term (<20 d) differences in the composition of the arthropod community were noted. After applications of Bti to ephemeral pools, smaller numbers of copepods were recorded, but at only one locality, and the difference was not significant. There were few significant effects on any other taxa and these effects were also localized and short-lived. These results suggest that applications of Bti and s-methoprene do not impact the abundance and composition of nontarget arthropod assemblages in subtropical saltmarshes, although more work is needed on potential sub-lethal effects on the communities studied.
Siegel, J.P. 2001. The Mammalian Safety of *Bacillus thuringiensis* Based Insecticides. J. Invert. Pathol. 77:13-21.	This is a short review paper. Numerous laboratory studies have demonstrated that *Bt* and *Bt* products are noninfectious and are toxic to mammals only at high doses. Only two literature reports of Bt infection in man suggest an adverse effect of *Bt* infection and all infected individuals had experienced either extensive burns or a blast injury, which predisposed them to infection. Two epidemiology studies conducted during large-scale aerial *Bt* serovar *kurstaki* spray campaigns reported no increased incidence of illness. Laboratory studies found no evidence of illness in rats and sheep fed *Bt* products, nor have epidemiology studies found increased incidence of diarrhea during *Bt* aerial spray campaigns. Increases in human antibody levels following exposure to Bt products have been reported but there was no increased incidence in asthma or other illness. Based on laboratory studies and field experience, *Bt* insecticides have an excellent safety record.

Additional Bti Publications Reviewed

Publication Authors	Summary of Reported Findings
Stevens, M., S. Helliwell and P.A. Hughes. 2005. Toxicity of *Bacillus thuringiensis* var. *israelensis* Formulations, Spinosad and Selected Synthetic Insecticides to *Chironomus tepperi Larvae*. J. Amer. Mosq. Cont. Assoc. 21(4):446-450.	Three *Bacillus thuringiensis* var. *israelensis* (Bti) formulations, the bacterial metabolite spinosad, and 7 synthetic insecticides were bioassayed against 4th instars of *Chironomus tepperi*. LC_{50} values were adjusted to reflect nominal ITU values of the 3 products, but there was still substantial variation in the calculated toxicity (LC50 values ranging from 1,200 ITU/L (1gm) to 2,580 ITU/L (2.2 gm). The differential activity between formulations observed may be a beneficial characteristic when controlling benthic species such as *C. tepperi*. Spinosad and the synthetic insecticides evaluated were all substantially more active than Bti.
Stevens, M., R.J. Akhurst, M.A. Clifton, and P.A. Hughes. 2004. Factors Affecting the Toxicity of *Bacillus thuringiensis* var. *israelensis* and *Bacillus sphaericus* to Fourth Instar Larvae of *Chironomus tepperi* (Diptera: Chironomidae). J. Invert. Pathology 86(3):104-110.	Laboratory bioassays were used to determine the toxicity of commercial products of strains of *Bacillus thuringiensis* var. *israelensis*, VectoBac WDG, 3000ITU/mg (2.5 gm in 1 ml) and *Bacillus sphaericus* to fourth instar larvae of *Chironomus tepperi*. Bioassays were conducted using different temperatures and combinations of larval ages and densities to determine if these factors affected toxicity. Bti exposures of 20-46 mg/L was toxic to fourth instar *C. tepperi* in bioassays using a sand substrate, with age and density increasing LC50 values. The results suggest that the product VectoBac WDG has the potential to provide selective control of this rice pest at economically viable application rates. The proposed effective application rates are 1.78-2.48 lbs/acre. The maximum label rate for mosquito control is 0.89 lb/acre.
Tilquin, M. M. Paris, S. Reynaud, L. Despres, P. Ravanel, R.A. Geremia and J. Gury. 2008. Long Lasting Persistence of *Bacillus thuringiensis* subsp. *israelensis* in Mosquito Natural Habitats. PLoS ONE 3(10):1-10.	These studies address the issue of the persistence, potential proliferation and environmental accumulation of Bti in natural mosquito habitats. The authors contend that Bti environmental persistence may lengthen the exposure time of insects to Bti and could increase the risk of development of resistance and negative impact to nontarget insects. *The exposures used in these studies are unrealistic, irrelevant to actual purposeful applications of Bti*, based on the theory that if one exposes anything to anything long enough results (positive or negative) MAY occur. The authors contend that Bti (a soil microorganism) is already present in most areas so that applications should be considered additive and residual" toxicity" of Bti in the environment is problematic.
Vaughn, I., C. Newberry, D.J. Hall, J.S. Ligget and S.J. Omerod. 2008. Evaluating Large Scale Effects of *Bacillus thuringiensis* var. *israelensis* on Non-Biting Midges (Chironomidae) in a Eutrophic Urban Lake. Freshwater Biol. 53:2117-2128.	Bti effects on larval chironomids from eight experimental treatments, over 3 years, on a eutrophic, urban lake of 200 ha were assessed. Vectobac 12AS (liquid Bti) was applied at a rate of 6.07 liters/ acre which is 1.6 times the maximum label rate for midge control and 6.42 times the maximum label rate for mosquito control. The first two experimental years provided limited evidence of Bti effects, with chironomid densities reduced by up to 14%. Increased scale of application and altered experimental design in the third year revealed reductions in chironomid larval densities of around 35% following Bti treatment, with suppression lasting several months. Results suggest that near-neutral buoyancy formulations of Bti can reduce chironomid numbers in large lakes exceeding 3 m depth where treatment methods avoid over-dispersion. Further studies are recommended to evaluate whether chironomids can be suppressed over longer periods using whole-lake application without long-term ecological implications.
Waalwijk, C., A. Dullemans, G. Wiegers and P. Smits. 1992. Toxicity of *Bacillus thuringiensis* variety *israelensis* Against Tipulid Larvae. J. Appl. Ent. 114:415-420.	Tests with cultures of *Bacillus thuringiensis* were conducted for toxicity to both laboratory and field collected tipulid larvae (leatherjackets). Observed toxicity was shown to be primarily from the parasporal crystals. High pH in the midgut of the tipulid larva was required for the primary step in the pathogenesis of *B. thuringiensis* var. *israelensis*. The authors suggest that the toxicity of one of the Bti crystal proteins is a likely toxin to tipulid larvae. Additional bioassays suggested that *Escherichia coli* recombinants carrying this gene were toxic for L1 larvae of *Tipula oleracea*.

Additional Bti Publications Reviewed

Publication Authors	Summary of Reported Findings
Wirth, M. 2010. Mosquito Resistance to Bacterial Larvicidal Toxins. Open Toxicology Journal. 3:126-140.	Study of possible development of cross-resistance of *Bacillus thuringiensis*. *Bacillus sphaericus* (Bs) is at higher risk for resistance due to its single site action. Cross-resistance is reported among the various Bs isolates. Field and lab evolved resistant populations consistently show recessive and monofactorial inheritance of resistance. Recommended resistance management strategies include application rotations and using mixtures of Bti and Bs. The authors suggest that promising new strategies include genetic engineering to increase the toxin complexity targeted toward mosquito larvae, to enhance the host range of the mosquito control product, and to avoid the evolution of insecticide resistance.

Additional *B. sphaericus* Publications Reviewed

Publication Authors	Summary of Report Findings
Brown, M.D., T.M. Watson, J. Carter, D.M. Purdie and B.H. Kay. 2004. Toxicity of VectoLex (*Bacillus sphaericus*) Products to Selected Australian Mosquito and Nontarget Species. J. Econ. Ent. 97(1):51-58.	Laboratory and field bioassay (efficacy) studies were conducted in southeast Queensland, Australia, on the efficacy of VectoLex Control Granule (CG; active ingredient [AI]:50 *Bacillus sphaericus* [*Bs*] International Toxic Units [ITU]/mg, 50gm product/mg) and VectoLex Water Dispersible Granule (WDG) (AI: 650 *Bs* ITU/mg, 650 gm product/mg) formulations against third-instar larvae of *Culex annulirostris* Skuse, *Culex quinquefasciatus* Say, *Culex sitiens* Wiedemann, *Ochlerotatus rigilax* (Skuse), *Ochlerotatus*. *notoscriptus* (Skuse), and *Aedes aegypti* (L.). Laboratory 48-h LC95 values were determined. The *Bs* formulations were most effective against *Culex* spp., with the WDG 10-100 times more effective than the CG on an ITU/mosquito basis. Weekly cohorts of caged third-instar *Cx. annulirostris* were exposed to replicated low (250 g/ha), medium (500 g/ha), and high (1,000 g/ha) dosages of WDG. Concurrent assessment of *Cx. quinquefasciatus* mortality outside the cages was also conducted. In water with high organic content, the low rate produced > 99% *Cx. annulirostris* mortality at 48 h, decreasing to 79% at week 3 and no control at week 4. The medium and high rates resulted in 100% *Cx. annulirostris* mortality for 2 wk post treatment, decreasing to 95% at week 3, and no control at week 4. The WDG was equally effective against *Cx. quinquefasciatus*. *Treatment did not affect water quality or nontarget shrimp and fish species survival*.
Hurst, T.P., B.H. Kay, P.A. Ryan and M.D. Brown. 2007. Sublethal Effects of Mosquito Larvicides on Swimming Performance of Larvivorous Fish *Melanotaenia duboulayi* (Atheriniformes: Melantaeniidae). J. Econ. Ent. 100(1):61-65.	Laboratory studies were conducted to determine the sublethal effects of exposure to the mosquito larvicides temephos, primiphos-methyl, Bti, Bacillus sphaericus, and methoprene. *Bacillus sphaericus* exposures of 10 times the effective field concentration had no effect on the Australian Crimson-Spotted Rainbowfish (*Melanotaenia duboulayi*) swimming speed.
Merritt, R.W., J.L. Lessard, K.J. Wessell, O. Hernandez, M.B. Berg, J.R. Wallace, J.A. Novak, J. Ryan and B.W. Merritt. 2005. Lack of Effects of *Bacillus sphaericus* (VectoLex) on Nontarget Organisms in a Mosquito-Control Program in Southeastern Wisconsin: A 3 Year Study. J. Amer. Mosq. Cont. Assoc. 21(2):201-212.	A 3-year study (2000-2002) in southeastern Wisconsin was conducted to assess the effects of *Bacillus sphaericus* applied for mosquito control on nontarget wetland invertebrates. The experimental design consisted of control and treatment sites (that were applied by helicopter with VectoLex CG), each in 2 vegetation habitat types: reed canary grass marsh (*Phalaris arundinacea*) and cattail marsh (*Typha* spp.). In each of these areas, a predetermined number of timed (30-sec) D-frame aquatic net samples containing vegetation, detritus, and invertebrates were collected 1 day before spraying and 72 h after spraying to detect for effects. We examined and compared 5 bioassessment measures to determine if there was an effect of *B. sphaericus* on nontarget organisms during each of the sampling years. The metrics tested were (1) mean taxa richness (the mean number of all taxa), (2) mean diversity (combines taxa richness and abundances in a summary statistic; i.e., Shannon Index [H'I]), (3) Diptera richness (minus mosquitoes) as a proportion of all other taxa richness (Diptera/others richness), (4) Diptera abundance (minus mosquitoes) as a proportion of all other invertebrate abundance (Diptera/others abundance), and (5) functional group changes in percent collector-gatherers, collector-filterers, scrapers, shredders, and predators. When VectoLex was applied during *6 treatments at the labeled dosage*, no detrimental effects to nontarget organisms could be attributed to this microbial insecticide. Variation in the control vs. treatment and pre vs. post plots was attributed to factors other than the effects of *B. sphaericus* on nontarget organisms, (time of sampling, natural variation that occurs in such diverse habitats as canary grass and cattail marshes, and water depth, which varied among years).

Additional *B. sphaericus* Publications Reviewed

Publication Authors	**Summary of Report Findings**
Negri, A.P., R.M. Soo, F. Flores and N.S. Webster. 2009. Bacillus Insecticides are not Acutely Harmful to Corals and Sponges. Mar. Ecol. Prog. Ser. 381:157-165.	Bacteria closely related to *B. thuringiensis* have recently been discovered in association with diseased sponges, which has raised concerns that *Bacillus* insecticides may be harmful to tropical marine invertebrates. Coral larvae and juvenile corals were exposed to the insecticides VectoBac® G (containing *B. thuringiensis israelensis*) and VectoLex® G (containing *B. sphaericus*) at concentrations up to 100 fold higher than concentrations that affect immature mosquitoes. VectoBac G and VectoLex G had no effect on the survival and metamorphosis of *Acropora millepora* and *A. tenuis* larvae *at very high concentrations (5000 µg l^{-1}*). The juvenile corals of the same species were also unaffected after 4 sequential 48 h exposures to *B. thuringiensis israelensis* and *B. sphaericus* at different stages of development. These results indicate that insecticides containing *Bacillus* spp. are unlikely to be acutely pathogenic to corals and sponges.
Poopathi, S. and S. Abidha. 2010. Mosquitocidal Bacterial Toxins (*Bacillus sphaericus* and *Bacillus thuringiensis* serovar *israelensis*): Mode of Action, Cytopathological Effects and Mechanism of Resistance. J. Physiol. Pathophysiol. 1(3):22-38.	This paper provides a general overview and test data discussing the use of Bs and Bti (*Bacillus sphaericus* and *Bacillus thuringiensis* serovar *israelensis*) to provide effective alternatives to broad spectrum larvicides in many situations with little or no environmental impact. New recombinant bacteria are as potent as many synthetic chemical insecticides yet are less prone to resistance, as they typically contain a mixture of endotoxins with different modes of action.
Stevens, M.M., et al., 2004. Factors Affecting the Toxicity of *Bacillus thuringienss* var. *israelensis* and *Bacillus sphaericus* to Fourth Instar Larvae of *Chironomus tepperi* (Diptera: Chironomidae). J. Invert. Pathology. 86(3):104-110.	Laboratory bioassays were used to determine the toxicity of commercial products of strains of *Bacillus thuringiensis* var. *israelensis* Vectobac WDG, 3000 ITU/mg (2.5 gm in 1 ml) and *Bacillus sphaericus*, VectoLex WDG, 650 ITU/mg, to fourth instar larvae of *Chironomus tepperi*. Bioassays were conducted using different temperatures and combinations of larval ages and densities to determine if these factors affected toxicity. VectoLex WDG showed very low toxicity to *C. tepperi* larvae, and the overall impact of larval age and density was relatively minor (LC50 values 1062-1340 mg/L). VectoLex WDG was determined to be ineffective against the Australian rice pest *C. tepperi*.

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Integrated Mosquito and Vector Management Programs

APPENDIX C

AIR QUALITY AND GHG TECHNICAL REPORT

Air Quality and Greenhouse Gases Technical Report

Project Name	Integrated Mosquito and Vector Management Programs for Nine Districts
Date	June 2013

Prepared for:

Alameda County Mosquito Abatement District
Alameda County Vector Control Services District
Contra Costa Mosquito and Vector Control District
Marin/Sonoma Mosquito Vector Control District
Napa County Mosquito Abatement District
Northern Salinas Valley Mosquito Abatement District
San Mateo County Mosquito and Vector Control District
Santa Clara County Vector Control District
Solano County Mosquito Abatement District

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Table of Contents

Attachments

Attachment A Criteria Pollutant and Greenhouse Gas Emissions Calculations

Tables

Acronyms

°C	degrees Celsius
°F	degrees Fahrenheit
AB	Assembly Bill
ACMAD	Alameda County Mosquito Abatement District
ACVCSD	Alameda County Vector Control Services District
ATCM	Airborne Toxic Control Measure
BAAQMD	Bay Area Air Quality Management District
CAA	Clean Air Act of 1970
CAAQS	California Ambient Air Quality Standards
CARB	California Air Resources Board
CCMVCD	Contra Costa Mosquito and Vector Control District
CCR	California Code of Regulations
CDFA	California Department of Food and Agriculture
CDFG	California Department of Fish and Game
CDPH	California Department of Public Health
CDPR	California Department of Pesticide Regulation
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
DPM	Diesel particulate matter
GHG	greenhouse gas
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
MBUAPCD	Monterey Bay Unified Air Pollution Control District
MEI	Maximally Exposed Individual
MSMVCD	Marin/Sonoma Mosquito Vector Control District
MVC	mosquito and vector control
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NCMAD	Napa County Mosquito Abatement District
NMFS	National Marine Fisheries Service

NO	nitric oxide
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
NSCAPCD	Northern Sonoma County Air Pollution Control District
NSVMAD	Northern Salinas Valley Mosquito Abatement District
O_3	ozone
PERP	Portable Equipment Registration Program
PM_{10}	respirable particulate matter
$PM_{2.5}$	fine particulate matter
ppm	part(s) per million
ROCs	reactive organic compounds
ROGs	reactive organic gases
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SCAQMD	South Coast Air Quality Management District
SCCVCD	Santa Clara County Vector Control District
SCMAD	Solano County Mosquito and Vector Control District
SFBAAB	San Francisco Bay Area Air Basin
SJVAPCD	San Joaquin Valley Air Pollution Control District
SMCMVCD	San Mateo County Mosquito and Vector Control District
SO_2	sulfur dioxide
SWRCB	State Water Resources Control Board
UNFCCC	United Nations Framework Convention on Climate Change
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VOCs	volatile organic compounds
YSAQMD	Yolo-Solano Air Quality Management District

1 Introduction

This report provides a description of the air quality and climate change environmental setting for and impacts of the Integrated Mosquito and Vector Management Programs (Programs) for nine mosquito abatement and/or vector control districts in northern California. The nine districts are: Alameda County Mosquito Abatement District (ACMAD), Alameda County Vector Control Services District (ACVCSD), Contra Costa Mosquito and Vector Control District (CCMVCD), Marin/Sonoma Mosquito Vector Control District (MSMVCD), Napa County Mosquito Abatement District (NCMAD), Northern Salinas Valley Mosquito Abatement District (NSVMAD), San Mateo County Mosquito and Vector Control District (SMCMVCD), Santa Clara County Vector Control District (SCCVCD), and the Solano County Mosquito Abatement District (SCMAD).The Programs provide for mosquito and/or vector control activities within each District’s Program Area. The nine District Program Areas include both the areas within the Districts (their individual Service Areas) and the surrounding counties where the Districts may provide mosquito and/or other vector management services when requested.

The immediate nine District Service Areas are located in the following nine counties of the state: Alameda, Contra Costa, Marin, Monterey, Napa, San Mateo, Santa Clara, Solano, and Sonoma. Control activities may also be provided in areas adjacent to the District Service Areas upon request of the adjacent jurisdictions to protect the health and safety of residents in adjacent jurisdictions. Actions that would be taken outside of the nine Districts’ Service Areas are the same types of actions undertaken within the Districts’ Service Areas and in similar types of habitats or sites. Therefore, the nine District Program Areas addressed in this report also include the ten surrounding counties: Mendocino, Merced, Lake, Sacramento, San Benito, San Francisco, San Joaquin, Santa Cruz, Stanislaus, Yolo, and the portion of Monterey County south of the NSVMAD.

The bulk of criteria pollutant and greenhouse gas emissions resulting from Program activities would occur in the San Francisco Bay Area, and minor amounts would occur in northern Sonoma, Yolo, Solano, and northern Monterey counties. The following chapters characterize and quantify Program emissions on a year-round basis. Chapter 2 addresses air quality, and Chapter 3 covers greenhouse gases.

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2 Air Quality

2.1 Introduction

State and Federal law defines criteria emissions to include the following: reactive or volatile organic compounds (ROCs or VOCs), nitrogen oxides (NO and NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), respirable particulate matter (PM_{10}), and fine particulate matter ($PM_{2.5}$). Elimination of tetraethyl lead in motor gasoline has eliminated emissions of lead (Pb) from vehicles and portable equipment, although tetraethyl lead is still used in some types of aviation gasoline.

During applicable mosquito and/or vector control activities, the Programs would cause criteria emissions from the combustion of fossil fuels (i.e., gasoline, diesel, jet fuel) used to operate portable equipment, vehicles, and aircraft primarily across the nine-county region comprising the MVCAC Nine Districts' Service Areas. Control activities would also cause emissions of greenhouse gases, which is addressed in the next chapter. This report evaluates Program emissions to determine individual and combined effects in relation to established thresholds of significance.

2.2 Environmental Setting

The Service Areas comprise Alameda, Contra Costa, Marin, Sonoma, Napa, Solano, San Mateo, and Santa Clara counties, and the northern portion of Monterey County. These counties are predominantly in the San Francisco Bay Area Air Basin (SFBAAB), under the jurisdiction of the Bay Area Air Quality Management District (BAAQMD), along with the Northern Sonoma County Air Pollution Control District (NSCAPCD), the Yolo-Solano Air Quality Management District (YSAQMD), and the Monterey Bay Unified Air Pollution Control District (MBUAPCD) in adjacent areas.

Air districts in California are required to monitor air pollutant levels to assure that National Ambient Air Quality Standards (NAAQS) and California Ambient Air Quality Standards (CAAQS) are met and, in the event that they are not, to develop strategies to meet these standards. If the standards are met, the local air basin is classified as being in "attainment"; if the standards are exceeded, it is classified as "nonattainment." Where insufficient data exist to make a determination, an area is deemed "unclassified."

The SFBAAB is designated as nonattainment for the state 1-hour, state 8-hour, and Federal 8-hour ozone ($O_{3)}$ standards, and nonattainment for all state PM_{10} and $PM_{2.5}$ (i.e., respirable particulate matter with an aerodynamic diameter of 10 and 2.5 micrometers or less) standards. The SFBAAB is also designated unclassified for the 24-hour Federal PM_{10} standard, and nonattainment and attainment for the Federal 24-hour and annual $PM_{2.5}$ standards, respectively. For all other pollutants and standards, the SFBAAB is designated as either attainment or unclassified status (BAAQMD 2012a, CARB 2012b, EPA 2012a, see Table 2-2 below).

Northern Sonoma County is designated transitional/uncharacterized for the state 1-hour ozone standard. Monterey County is "Moderate" nonattainment for state 1-hour ozone standard and nonattainment for the state PM_{10} standard. Yolo and Solano counties are "Serious" nonattainment for the state 1-hour O_3 standard, nonattainment for the state and federal 8-hour O_3 standards, nonattainment for the state 24-hour and annual PM_{10} standards, and partial nonattainment for the Federal 24-hour $PM_{2.5}$ standard. For all other pollutants and standards northern Sonoma, Yolo, Solano, and Monterey counties are designated either attainment or unclassified status. (CARB 2012b, EPA 2012a, YSAQMD 2013)

2.2.1 <u>Meteorology and Climate</u>

The Program Area climate is characterized by moderately wet winters and dry summers. About 90 percent of the annual total rainfall is received in the November through April period. Between June and

September, normal rainfall is typically less than 0.6 inch (1.5 centimeters). Temperatures in the Program Area average about 60°F (15°C) annually, with average summer highs in the 70 to 80°F (21 to 27°C) range and average winter lows in the 40 to 50°F (4 to 10°C) range. Precipitation averages about 23 inches (58 centimeters) per year, although annual precipitation can vary significantly from year-to-year. Annual average wind speeds in the Program Area are about 8 miles per hour (3.6 meters per second). The predominant direction of air pollution transport in the Program Area is inland from the coastal areas (BAAQMD 2010a, WC 2012, NOAA 2008).

2.2.2 Criteria Air Pollutants

A criteria or regulated air pollutant is any air pollutant for which ambient air quality standards have been set by the U.S. Environmental Protection Agency (EPA) or the California Air Resources Board (CARB). Primary air quality standards are established to protect human (public) health. Secondary air quality standards are designed to protect public welfare from effects such as diminished production and quality of agricultural crops, reduced visibility, degraded soils, materials and infrastructure damage, and damaged vegetation. Criteria pollutants include O_3, NO_2, CO, SO_2, PM_{10}, and $PM_{2.5}$. The six most prevalent criteria pollutants and their potential health effects are described below.

Ozone

Ground-level O_3 is a secondary pollutant formed in the atmosphere by a series of complex chemical reactions and transformations in the presence of sunlight above urban areas due to the mixing effects of temperature inversions. Nitrogen oxides (NO_X) and reactive organic gases (ROGs)[1] are the principal constituents in these reactions. NO_X and ROG emissions are predominantly attributed to mobile sources (on-road motor vehicles and other mobile sources). Thus, regulation and control of NO_X and ROGs from these sources is essential to reduce the formation of ground-level O_3.

O_3 is a strong irritating gas that can chemically burn and cause narrowing of airways, forcing the lungs and heart to work harder to provide oxygen to the body. A powerful oxidant, O_3 is capable of destroying organic matter, including human lung and airway tissue; it essentially burns through cell walls. O_3 damages cells in the lungs, making the passages inflamed and swollen. O_3 also causes shortness of breath, nasal congestion, coughing, eye irritation, sore throat, headache, chest discomfort, breathing pain, throat dryness, wheezing, fatigue, and nausea. It can damage alveoli, the individual air sacs in the lungs where oxygen and carbon dioxide are exchanged. O_3 has been associated with a decrease in resistance to infections. People most likely to be affected by O_3 include the elderly, the young, and athletes. O_3 may pose its worst health threat to people who already suffer from respiratory diseases such as asthma, emphysema, and chronic bronchitis (VCAPCD 2003).

Nitrogen Dioxide

NO_2 is formed in the atmosphere primarily by the rapid reaction of the colorless gas nitric oxide (NO) with atmospheric oxygen. It is a reddish brown gas with an odor similar to that of bleach. NO_2 participates in the photochemical reactions that result in O_3. The greatest source of NO, and subsequently NO_2, is the high-temperature combustion of fossil fuels such as in motor vehicle engines and power plant boilers. NO_2 and NO are referred to collectively as NO_X. NO_2 can irritate and damage the lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections such as influenza. Researchers have identified harmful effects, similar to those caused by O_3, with progressive changes over four hours of exposure causing impaired pulmonary function, increased incidence of acute respiratory disease, and difficult breathing for both bronchitis sufferers and healthy persons (VCAPCD 2003).

[1] Also referred to as reactive organic compounds (ROCs) or volatile organic compounds (VOCs).

Carbon Monoxide

CO is a common, colorless, odorless, highly toxic gas. It is produced by natural and anthropogenic (caused by human activity) combustion processes. The major source of CO in urban areas is incomplete combustion of carbon-containing fuels (primarily gasoline, diesel fuel, and natural gas). However, it also results from combustion processes including forest fires and agricultural burning. Ambient CO concentrations are generally higher in the winter, usually on cold, clear days and nights with little or no wind. Low wind speeds inhibit horizontal dispersion, and surface inversions inhibit vertical mixing. Traffic-congested intersections have the potential to result in localized high CO levels.

When inhaled, CO does not directly harm the lungs. The impact from CO is on oxygenation of the entire body. CO combines chemically with hemoglobin, the oxygen-transporting component of blood. This diminishes the ability of blood to carry oxygen to the brain, heart, and other vital organs. Red blood cells have 220 times the attraction for CO as for oxygen. This affinity interferes with movement of oxygen to the body's tissues. Effects from CO exposure include headaches, nausea, and death. People with heart ailments are at risk from low-level exposure to CO. Also sensitive are people with chronic respiratory disease, the elderly, infants and fetuses, and people suffering from anemia and other conditions that affect the oxygen-carrying capacity of blood. High CO levels in a concentrated area can result in asphyxiation. Studies show a synergistic effect when CO and O_3 are combined (VCAPCD 2003).

Sulfur Dioxide

SO_2 is a colorless gas with a sharp, irritating odor. It can react in the atmosphere to produce sulfuric acid and sulfates, which contribute to acid deposition and atmospheric visibility reduction. It also contributes to the formation of PM_{10}. Most of the SO_2 emitted into the atmosphere is from burning sulfur-containing fossil fuels by mobile sources such as marine vessels and farm equipment and stationary fuel combustion. SO_2 irritates the mucous membranes of the eyes and nose and may also affect the mouth, trachea, and lungs. Healthy people may experience sore throats, coughing, and breathing difficulties when exposed to high concentrations. SO_2 causes constriction of the airways and poses a health hazard to asthmatics, which are very sensitive to SO_2. Children often experience more respiratory tract infections when they are exposed to SO_2 (VCAPCD 2003).

Respirable Particulate Matter, 10 Microns

PM_{10} consists of particulate matter, fine dusts and aerosols, 10 microns or smaller in diameter. When inhaled, particles larger than 10 microns generally are caught in the nose and throat and do not enter the lungs. PM_{10} can enter the large upper branches of the lungs just below the throat, where they are caught and removed (by coughing, spitting, or swallowing).

The primary sources of PM_{10} include dust from paved and unpaved roads and construction and demolition operations. Lesser sources of PM_{10} include wind erosion, agricultural operations, residential wood combustion, smoke, tailpipe emissions, and industrial sources. These sources have different constituents, and, therefore, varying effects on health. Road dust is composed of many particles other than soil dust. It also includes engine exhaust, tire rubber, oil, and truck load spills. Diesel particulate matter (DPM) contains many toxic particle and elemental carbon (soot), and is considered a toxic air contaminant in California. Airborne particles absorb and adsorb toxic substances and can be inhaled and lodge in the lungs. Once in the lungs, the toxic substances can be absorbed into the bloodstream and carried throughout the body. PM_{10} concentrations tend to be lower during the winter months because weather greatly affects PM_{10} concentrations. During rain, concentrations are relatively low, and on windy days, PM_{10} levels can be high. Photochemical aerosols, formed by chemical reactions with manmade emissions, may also influence PM_{10} concentrations.

Elevated ambient particulate levels are associated with premature death, an increased number of asthma attacks, reduced lung function, aggravation of bronchitis, respiratory disease, cancer, and other serious health effects. Short-term exposure to particulates can lead to coughing, minor throat irritation, and a reduction in lung function. Long-term exposure can be more harmful. EPA estimates that 8 percent of urban nonsmoker-lung-cancer-risk is due to PM_{10} in soot from diesel trucks, buses, and cars. Additional studies by EPA and the Harvard School of Public Health estimate that 50,000 to 60,000 deaths per year in the United States are caused by particulates. PM_{10} particles collect in the upper portion of the respiratory system, affecting the bronchial tubes, nose, and throat. They contribute to aggravation of asthma, premature death, increased number of asthma attacks, bronchitis, reduced lung function, respiratory disease, aggravation of respiratory and cardiovascular disease, alteration of lung tissue and structure, changes in respiratory defense mechanisms, and cancer (VCAPCD 2003).

Fine Particulate Matter, 2.5 Microns

$PM_{2.5}$ is a mixture of particulate matter fine dusts and aerosols 2.5 microns or smaller in aerodynamic diameter. $PM_{2.5}$ can enter the deepest portions of the lungs where gas exchange occurs between the air and the blood stream. These are the most dangerous particles because the lungs have no efficient mechanisms for removing them. If these particles are soluble in water, they pass directly into the blood stream within minutes. If they are not soluble in water, they are retained deep in the lungs and can remain there permanently. This increases the risks of long-term disease including chronic respiratory disease, cancer, and increased and premature death. Other effects include increased respiratory stress and disease, decreased lung function, alterations in lung tissue and structure, and alterations in respiratory tract defense mechanisms.

$PM_{2.5}$ particles are emitted from activities such as industrial and residential combustion processes, wood burning, and from diesel and gasoline-powered vehicles. They are also formed in the atmosphere from gases such as SO_2, NO_X, ammonia, and VOCs that are emitted from combustion activities and then become particles as a result of chemical transformations in the air (secondary particles) (VCAPCD 2003).

2.2.3 Sources of Air Pollutants

The most significant regional sources of O_3, NO_2, and CO in ambient air are automobiles, trucks, and other on-road vehicles, along with trains, vessels, and aircraft. O_3 is not directly emitted; rather, photochemical O_3 is formed by the atmospheric reaction of VOCs and NO_X in sunlight. Gasoline and diesel engines emit VOCs and NO_X as combustion products, as does natural gas fired equipment (stationary sources) such as pump engines, gas turbine generators, process heaters, and steam boilers.

Local emissions of PM_{10} are primarily the result of fugitive dust from travel on unpaved roads, as well as construction and agricultural activities. Coarser particles also may be emitted from activities that disturb the topsoil. Other sources include wind-blown dust, pollen, salts, brake dust, and tire wear. Although $PM_{2.5}$ is a subset of PM_{10}, it differs from the rest of PM_{10}. While most of the ambient PM_{10} results from direct emissions of the pollutant, a significant amount of the ambient $PM_{2.5}$ results from transformation of precursors and condensing of gaseous pollutants in the atmosphere. Other than direct $PM_{2.5}$ emissions, the key pollutants contributing to $PM_{2.5}$ concentrations in the atmosphere are SO_2, NO_X, VOCs, and ammonia (CARB 2005).

Mobile sources used in mosquito and vector control (MVC) activities include onroad fleet vehicles (light- and medium-duty trucks, vans, passenger cars), offroad all-terrain vehicles (ATVs), watercraft (motorboats, airboats), aircraft (helicopters and fixed-wing), portable equipment (pumps, sprayers, generators), and small equipment (hand-held sprayers, foggers, dusters). Except for 2-stroke engines used in small lightweight equipment (spark ignition, 50:1 gas/oil mix), engines are 4-stroke gasoline (spark ignition) or diesel fuel (compression ignition). The dominant fuel used for these mobile sources is motor gasoline along with some diesel fuel (larger trucks) , aviation gasoline (fixed-wing aircraft), and jet fuel (turbine-powered helicopters). Light trucks, vans, and passenger cars are normally used for responding to public service requests and disease surveillance.

2.2.4 Ambient Air Quality

Air quality is affected by a variety of sources in the vicinity of the Program Areas. Large stationary sources such as oil refineries and power plants emit substantial amounts of NO_X and ROCs, along with PM_{10} and $PM_{2.5}$. Light motor vehicles, diesel powered construction equipment, and commercial trucks used in the Program Area are another source of these pollutants. Noncombustion sources of PM_{10} and $PM_{2.5}$ include fugitive dust from roads, construction, demolition, and earthmoving. Finally, commercial and general aviation aircraft generate emissions that affect air quality.

O_3 is a secondary pollutant that is not emitted directly by sources, but rather is formed by a reaction between NO_X and ROCs in the presence of sunlight. Reductions in O_3 concentrations are dependent upon reducing emissions of these precursors. The major sources of O_3 precursors in the Bay Area are motor vehicles and other mobile equipment (including agricultural equipment), solvent use, petroleum industry activities, nonelectric agricultural water pumping, and electric utilities operation.

BAAQMD, NSCAPCD, and SJVAPCD operate extensive regional air monitoring networks comprised of monitoring stations (sites) that collectively measure the ambient concentrations of six criteria air pollutants: ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), respirable particulates (PM_{10}), and fine particulates ($PM_{2.5}$). Not all monitoring stations are fully instrumented for these pollutants, while some sites have not been operating for adequate periods of time to provide representative data for characterization of attainment status.

2.2.5 Sensitive Receptors

Certain population groups are considered more sensitive to air pollution and odors than others; in particular, children, elderly, and acutely ill and chronically ill persons, especially those with cardio respiratory diseases such as asthma and bronchitis. Sensitive receptors (land uses) indicate locations where such individuals are typically found, namely schools, daycare centers, hospitals, convalescent homes, residences of sensitive persons, and parks with active recreational uses, such as youth sports.

Persons engaged in strenuous work or physical exercise also have increased sensitivity to poor air quality. Residential areas are considered more sensitive to air quality conditions than commercial and industrial areas, because people generally spend longer periods of time at their residences, resulting in greater exposure to ambient air quality conditions. Recreational uses such as parks are also considered sensitive, due to the greater exposure to ambient air quality conditions and because the presence of pollution detracts from the recreational experience.

Due to the very wide geographic dispersion of the nine MVCAC Districts' activities and their short-term temporary nature at any particular location, no quantifiable risk to sensitive receptors or the general public would be posed by Program-related engine exhaust.

2.3 Regulatory Setting

The following paragraphs describe the Federal, state, and local agencies and the laws and regulations governing air quality. *It is the practice of the nine MVCAC Districts to work with Service Area jurisdictions and agencies during Program planning to reasonably consider the local environmental protection policies and to conform to the extent required.*

2.3.1 Standards and Attainment Status

The Clean Air Act of 1970 (CAA, amended 1977 and 1990, 42 United States Code 7401 et seq.) established NAAQS, and individual states retained the option to adopt more stringent standards and to include other pollution sources. California had already established its own air quality standards when Federal standards were established, and because of the unique meteorological problems in the state, there is considerable diversity between the Federal and the state standards currently in effect in

California, as shown in Table 2-1 below. CAAQS tend to be at least as protective as national standards and are often more stringent.

Table 2-1 Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards		Federal Standards	
		ppmv	µg/m³	ppmv	µg/m³
Ozone (O_3)	1-hour	0.09	177	—	—
	8-hour	0.07	137	0.075	147
Nitrogen Dioxide (NO_2)	1-hour	0.18	338	0.100	188
	Annual	0.03	56	0.053	100
Sulfur Dioxide (SO_2)	1-hour	0.25	655	0.075	196
	3-hour Secondary	—	—	0.50	1,309
	24-hour	0.04	105	—	—
Carbon Monoxide (CO)	1-hour	20	22,898	35	40,071
	8-hour	9	10,304	9	10,304
	Lake Tahoe (8-hr)	6	6,869	—	—
Particulates (as PM_{10})	24-hour	—	50	—	150
	Annual	—	20	—	—
Particulates (as $PM_{2.5}$)	24-hour	—	—	—	35
	Annual Primary	—	12	—	12
	Annual Secondary	—	—	—	15
Lead (Pb)	30-day	—	1.5	—	—
	3-month (rolling)	—	—	—	0.15
Sulfates (as SO_4)	24-hour	—	25	—	—
Hydrogen Sulfide (H_2S)	1-hour	0.03	42	—	—
Vinyl Chloride (C_2H_3Cl)	24-hour	0.01	26	—	—
Visibility Reducing Particles	8-hour	Extinction coefficient of 0.23 per km; visibility of 10 miles or more (0.07 to 30 miles or more for Lake Tahoe) due to particles when relative humidity is less than 70%.		—	—

Sources: CARB 2012a, EPA 2011a

Notes:

ppmv = parts per million by volume

µg/m³ = micrograms per cubic meter

The 1.5 µg/m³ Federal quarterly lead standard applied until 2008; 0.15 µg/m³ rolling 3-month average thereafter

For gases, µg /m³ calculated from ppmv based on molecular weight and standard conditions

Standard Temperature 25°C

Standard Molar Volume 24.465 liter/g-mole

The ambient air quality standards shown in Table 2-1 are intended to protect the public health and welfare and specify the concentration of pollutants (with an adequate margin of safety) to which the public may be exposed without adverse health effects. The standards are designed to protect those segments of the public most susceptible to respiratory distress (known as sensitive receptors), including asthmatics, the very young, the elderly, people weak from other illness or disease, or persons engaged in strenuous work or exercise. Healthy adults can tolerate occasional exposure to air pollution levels somewhat above the ambient air quality standards before adverse health effects are observed.

As previously described, air districts in California are required to monitor air pollutant levels to assure that NAAQS and CAAQS are met and, in the event that they are not, to develop strategies to meet these standards. Depending on whether the standards are met or exceeded, the local air basin is classified as being in “attainment” or “nonattainment.” Where insufficient data exist to make a determination, an area is deemed “unclassified.”

In general, the San Francisco Bay Area experiences low concentrations of most pollutants when compared to state and Federal standards, except for O_3 and particulate matter, for which standards are exceeded periodically. Portions of Sonoma and Monterey counties also experience mildly elevated concentrations of ozone, resulting in state-level transitional and moderate nonattainment designations, respectively. Monterey County is also nonattainment for the state PM_{10} standard (MBUAPCD 2009, CARB 2012b). The attainment status of the main Bay Area region is shown in Table 2-2.

Table 2-2 Attainment Status Summary - Bay Area Region

Criteria Pollutant	**State Designation**	**Federal Designation**
Ozone (O_3) (1-hour)	Nonattainment	—
Ozone (O_3) (8-hour)	Nonattainment	Nonattainment(1)
Nitrogen Dioxide (NO_2) (1-hour)	Attainment	Unclassified(2)
Nitrogen Dioxide (NO_2) (annual)	Attainment	Attainment
Sulfur Dioxide (SO_2)	Attainment	Attainment
Carbon Monoxide (CO)	Attainment	Attainment
Resp. Particulates (as PM_{10}) (24-hour)	Nonattainment	Unclassified(2)
Resp. Particulates (as PM_{10}) (annual)	Nonattainment	—
Fine Particulates (as $PM_{2.5}$) (24-hour)	—	Nonattainment
Fine Particulates (as $PM_{2.5}$) (annual)	Nonattainment	Attainment
Lead (Pb)	Attainment	Attainment
Sulfates (as SO_4)	Attainment	—
Hydrogen Sulfide (H_2S)	Unclassified(2)	—
Vinyl Chloride (C_2H_3Cl)	n/d	—
Visibility	Unclassified(2)	—

Source: BAAQMD 2012a

Notes:

(1) The 0.08 ppmv Federal 8-hour ozone standard applied until 2008; 0.075 ppmv thereafter

(2) At the time of designation, if the available data does not support a designation of attainment or nonattainment, the area is designated as unclassified.

n/d = no data/information available

2.3.2 Federal Authority

The 1977 CAA amendments required that regional planning and air pollution control agencies prepare regional air quality plans to outline the measures by which both stationary and mobile sources of pollutants can be controlled to achieve all standards by the deadlines specified in the act.

For the SFBAAB, the Association of Bay Area Governments, the Metropolitan Transportation Commission, and BAAQMD jointly prepared the *2005 Bay Area Ozone Strategy,* which provided inputs to the most recent *2010 Clean Air Plan* issued by BAAQMD (2012a). These plans contain control strategies that demonstrate attainment with NAAQS by the deadlines established in the Federal CAA and become part of the State Implementation Plan (SIP) administered by CARB and submitted to EPA. Similarly, NSCAPCD and MBUAPCD are also required to prepare and submit tailored clean air implementation plans to state and Federal regulators.

Under the 1990 CAA amendments, areas that did not meet the original Federal 1-hour O_3 standard were classified according to the severity of each area's respective O_3 problem. The 1-hour classifications were Marginal, Moderate, Serious, Severe, and Extreme. Marginal areas were closest to meeting the 1-hour O_3 standard. Extreme areas had the worst air quality problems. Areas with severe O_3 problems had progressively more stringent control requirements to meet under the Act. An area's classification determined how long the area had to attain the O_3 standard. Marginal areas had 3 years; Moderate areas had 6 years; Serious areas had 9 years; Severe areas had either 15 or 17 years, depending on the magnitude of their O_3 problem; and Extreme areas had 20 years. Under the Act, the Bay Area Air Basin is a "Serious" Federal nonattainment area for O_3 and a Federal nonattainment area for $PM_{2.5}$.

2.3.3 State Authority

Pursuant to the Federal CAA, states have the right to establish and enforce their own air quality standards; state standards may be equal to or more stringent, but not less stringent than Federal standards. In 1988, the state legislature passed the California CAA (California Health and Safety Code Section 39600 et seq.), which, like its Federal counterpart, called for designations of areas as attainment or nonattainment based on state rather than Federal standards.

Similar to the Federal CAA, the California CAA also classifies areas according to pollution levels. Under the Act, the Bay Area is a "Serious" O_3 nonattainment area and state PM_{10} and $PM_{2.5}$ nonattainment areas. In addition, localized CO concentrations, also known as CO "hotspots," may occur at heavily traveled roadways, particularly at intersections or other locations where the traffic is congested and vehicles idle for prolonged periods. CO concentrations exceeding the existing standard may occur at intersections that operate at a Level of Service D or worse.

CARB is the state agency responsible for regulating air quality, and its responsibilities include establishing state ambient air quality standards, emissions standards, and regulations for mobile emissions sources (e.g., autos, trucks, etc.) as well as overseeing the efforts of countywide and multicounty air pollution control districts, which have primary responsibility over stationary sources. The emission standards most relevant to the Programs are those related to automobiles, light- and medium-duty trucks, and California heavy-duty truck and construction equipment engines. CARB also regulates vehicle fuels with the intent to reduce emissions; to this end, the CARB has set emission reduction performance requirements for gasoline (California reformulated gasoline) and has stringently limited the sulfur and aromatic content of diesel fuel to make it burn cleaner. CARB also sets the standards used to pass or fail vehicles in smog check and heavy-duty truck inspection programs.

2.3.4 Local Authority

BAAQMD is the regional agency responsible for air quality regulation within the San Francisco Bay Area, along with NSCAPCD and MBUAPCD in their respective jurisdictions. These districts regulate air quality through planning, monitoring, rulemaking, permitting, and enforcement activities. Districts have permit authority over most types of stationary emission sources and can require stationary sources to obtain permits; they can also impose emission limits, set fuel or material specifications, or establish operational limits to reduce air emissions. BAAQMD also regulates new or expanding stationary sources of toxic air contaminants. For state air quality planning purposes, the Bay Area is classified by the California CAA as a nonattainment area for O_3. The "Serious" classification triggers various plan submittal requirements and transportation performance standards. One such requirement is that each district update its air quality attainment plan every three years (triennially) to reflect progress in meeting the air quality standards and to incorporate new information regarding the feasibility of control measures and new emission inventory data. Districts indirectly regulate construction projects that use mobile sources via the statewide Portable Equipment Registration Program discussed below. Since the Programs do not meet the definition of permanent stationary sources, no permits would be required from the BAAQMD, NSCAPCD, or MBUAPCD.

2.4 Source-Specific Regulations

Non-road Engine Standards

CARB regulates mobile sources of air pollution in the State of California. Self-propelled nonroad construction equipment is considered a vehicle, as defined by the California Vehicle Code. A vehicle may have an engine that both propels the vehicle and powers equipment mounted on the vehicle. As such, vehicles are generally exempt from regulation by the air districts. However, not included in exemption provisions is any equipment mounted on a vehicle that would otherwise require a permit under air district rules and regulations.

Federal Tier 1 standards for off-road diesel engines were adopted as part of the California requirements for 1995. Federal Tier 2 and Tier 3 standards were adopted in 2000 and selectively apply to the full range of diesel off-road engine power categories. Both Tier 2 and Tier 3 standards include durability requirements to ensure compliance with the standards throughout the useful life of the engine (40 Code of Federal Regulations [CFR] 89.112, 13 California Code of Regulations [CCR] 2423).

On May 11, 2004, the EPA signed the final rule implementing Tier 4 emission standards which are to be phased-in over the period of 2008-2015 (69 Federal Register [FR] 38957-39273, 29 June 2004). The Tier 4 standards require that emissions of PM and NO_X be further reduced by about 90 percent. Such emission reductions can be achieved through the use of advanced control technologies – including advanced exhaust gas after treatment similar to those required by the 2007-2010 standards for highway diesel engines.

The Code of Federal Regulations (CFR) Title 40 is divided into parts to address specific EPA programs. Regulations initiated by the Office of Air and Radiation (OAR) have historically all been located together in Parts 49 through 99. Within OAR, the Office of Transportation and Air Quality (OTAQ) has adopted emission standards for various types of highway and nonroad engines, which are generally in Parts 85 through 94. To address the need for more regulatory parts for new programs and write them in plain language, EPA has reserved a new set of parts – 1000 through 1299 – for future use. The first 100 of these parts are reserved for engine emission control programs from the OTAQ, with the intended distribution as follows (EPA 2012d):

> Part 1027 specifies certification fees for all engines, vehicles, and equipment.

> Part 1033 is the standard for locomotives.

> Part 1036 is the standard for heavy-duty highway engines.

> Part 1037 is the standard for heavy-duty highway vehicles.

> Part 1039 is the standard for land-based nonroad diesel engines.

> Part 1042 is the standard for marine diesel engines.

> Part 1043 describes the requirements that apply under MARPOL Annex VI for marine diesel engines, including in-use fuel requirements.

> Part 1045 is the standard for marine spark-ignition engines.

> Part 1048 is the standard for nonroad spark-ignition engines over 19 kilowatts that are not used in recreational vehicles.

> Part 1051 is the standard for recreational vehicles, including snowmobiles, all-terrain vehicles, and off-highway motorcycles.

> Part 1054 is the standard for nonroad spark-ignition engines at or below 19 kilowatts.

> Part 1060 specifies emission standards and test procedures for all types of nonroad engines.

> Part 1065 describes general provisions related to procedures for testing engines.

> Part 1066 describes general provisions related to procedures for testing vehicles.

> Part 1068 includes general compliance provisions.

> Part 1074 describes provisions related to preemption of state regulations.

Portable Equipment Registration Program (PERP)

The statewide PERP establishes a uniform program to regulate portable engines and portable engine-driven equipment units. Once registered in PERP, engines and equipment units may operate throughout the State of California without the need to obtain individual permits from local air districts such as BAAQMD, NSCAPCD, and MBUAPCD. Owners or operators of portable engines and certain types of equipment can register their units under the PERP in order to operate their equipment anywhere in the state. (CARB 2012c)

BAAQMD operates stipulated enforcement programs for owners and operators of portable equipment which does not comply with CARB's Portable Diesel Airborne Toxic Control Measure (ATCM) regulation. Under this rule, any portable diesel engine not registered in the PERP prior to January 1, 2006, is illegal, and may not be operated in California unless it meets the ATCM Tier requirements or has an operating permit issued by an air district.

BAAQMD Regulation 2, Sections 2-1-105 and 2-1-114 list types of portable equipment commonly used in construction as exempt from stationary source rule requirements provided that the equipment complies with all applicable requirements of the statewide PERP pursuant to 13 CCR, Division 3, Chapter 3, Article 5. The nine MVCAC District Programs are not subject to BAAQMD permitting requirements because the Programs would not involve any stationary air pollution sources that are subject to BAAQMD review, including engine-driven pumps, generators, and air compressors.

Air Toxics Control Measures

On July 26, 2007, CARB adopted a regulation to reduce DPM and NO_X emissions from in use (existing) off-road heavy-duty diesel vehicles in California. Such vehicles are used in construction, mining, and industrial operations. Not included in this category are locomotives, commercial marine vessels, marine engines over 50 horsepower, or recreational vehicles. The ATCM regulation supplements existing tiered emission standards for nonroad diesel engines in California (CARB 2012d).

Senate Bill 656

Senate Bill 656 is a planning requirement that calls for a plan and strategy for reducing $PM_{2.5}$ and PM_{10}. This bill requires CARB to identify, develop, and adopt a list of control measures to reduce the emissions of $PM_{2.5}$ and PM_{10} from new and existing stationary, mobile, and area sources. BAAQMD has developed particulate matter control measures and submitted plans to CARB that include lists of measures to reduce particulate matter. Under the plans, air districts are required to continue to assess $PM_{2.5}$ and PM_{10} emissions and their impacts.

For construction emissions of fugitive PM_{10}, California air districts have adopted a number of feasible control measures that can be reasonably implemented to significantly reduce fugitive PM_{10} emissions from construction. In general, most districts' approach to CEQA (California Environmental Quality Act) analyses of construction impacts is to emphasize implementation of effective and comprehensive control measures rather than detailed quantification of emissions.

Nuisance (Odors)

BAAQMD and MBUAPCD CEQA Air Quality Guidelines (BAAQMD 1999, MBUAPCD 2008), require an assessment of a project's potential to cause a public nuisance by subjecting surrounding land uses (receptors) to objectionable odors. Due to proximity, NSCAPCD generally follows the BAAQMD guidelines (NSCAPCD 2012).

Nuisance is a fundamental air pollution control rule across the state in all air districts, including NSCAPCD Rule 400 and MBUAPCD Rule 402, and typically contain the same language as BAAQMD Regulation 1, Rule 301 which states that "No person shall discharge from any source whatsoever such quantities of air contaminants or other material which cause injury, detriment, nuisance or annoyance to any considerable number of persons or the public; or which endangers the comfort, repose, health or safety of any such persons or the public, or which causes, or has a natural tendency to cause, injury or damage to business or property."

An objectionable odor problem is defined by BAAQMD Regulation 7, Rule 102 as when the Air Pollution Control Officer "receives odor complaints from ten or more complainants within a 90-day period, alleging that a person has caused odors perceived at or beyond the property line of such person and deemed to be objectionable by the complainants in the normal course of their work, travel, or residence." The assessment protocol includes projects that have the potential to cause odors or projects that may subject potential sensitive receptors to nearby existing or proposed land uses that emit objectionable odors.

Toxic Air Contaminants

A project with the potential to expose sensitive receptors (including residential areas) or the general public to substantial levels of toxic air contaminants, as designated by CARB under 17 CCR Section 93001, listed in BAAQMD's Toxic Air Contaminants Inventory (BAAQMD 2004), would be deemed to have a significant impact. This includes projects that would locate receptors near existing sources of toxic air contaminants, as well as projects that would place sources of toxic air contaminants near existing receptors.

Projects that have the potential to expose the public to toxic air contaminants in excess of the following thresholds would be considered to have a significant air quality impact for receptors within 1,000 feet of a source boundary. These thresholds, which are based on the 1999 BAAQMD CEQA Air Quality Guidelines, are as follows:

- Probability of contracting cancer for the Maximally Exposed Individual (MEI) which exceeds 10 in 1 million. The MEI is a hypothetical person exposed for 70 years continuously (24 hours per day, 365 days per year).

> Ground-level concentrations of chronic or acute noncarcinogenic toxic air contaminants which result in a Hazard Index greater than one for the MEI.

DPM is considered a toxic air contaminant in California (BAAQMD 2004). Due to the limited use of diesel-powered vehicles and equipment and wide geographic scope of the Programs, emissions of DPM would not be sufficient to pose a significant risk to sensitive receptors from MVC equipment operations.

General Conformity

A General Conformity determination is required for Federally sponsored, permitted, or funded actions in NAAQS nonattainment areas or in certain maintenance areas when the total direct and indirect net emissions of nonattainment pollutants (or their precursors) exceed specified thresholds (Clean Air Act Amendments of 1990 Section 176[c]). This regulation ensures that Federal actions conform to State Implementation Plans (SIPs) and agency NAAQS attainment plans.

As discussed in Section 2.3.1 and shown in Table 2-2, the Bay Area region is in federal nonattainment $PM_{2.5}$ and ozone. Thus, the emissions of nonattainment pollutants NO_X, VOCs, PM_{10}, and $PM_{2.5}$ would be subject to the Rule if the Programs were Federal actions. However, since the Programs are local actions and not Federally sponsored, permitted, or funded actions, General Conformity does not apply.

2.5 Standards of Significance

The programmatic environmental impact report (PEIR) addresses the following standards of significance as based on CEQA Guidelines Appendix G. Would the project:

> Conflict with or obstruct implementation of the applicable Air Quality Attainment Plan or Congestion Management Plan?

> Violate any stationary source air quality standard or contribute to an existing or projected air quality violation?

> Result in a net increase of any criteria pollutant for which the project region is nonattainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?

> Expose sensitive receptors to substantial pollutant concentrations?

> Create objectionable odors affecting a substantial number of people?

For this Program, determinations made with respect to significance criteria are documented in the PEIR.

BAAQMD CEQA Guidelines

On June 2, 2010, the Bay Area Air Quality Management District (BAAQMD) adopted new CEQA Air Quality Guidelines (BAAQMD 2012b) for consideration by lead agencies tasked with evaluating the air quality and climate change impacts of proposed new projects. The proposed guidelines superseded the December 1999 Guidelines. As guidelines, they did not comprise enforceable rules or regulations per se, nevertheless, the guidelines established new quantitative thresholds of significance for criteria and greenhouse gas emissions.

However, on March 5, 2012, the Alameda County Superior Court issued a judgment finding that the BAAQMD had failed to comply with CEQA when it adopted the thresholds of significance. The court did not determine whether the thresholds were valid on the merits, but found that the adoption of the thresholds was a project under CEQA. The court issued a writ of mandate ordering the BAAQMD to set aside the 2010 thresholds and cease dissemination of them until it had complied with CEQA. The BAAQMD is no longer recommending that the 2010 thresholds be used as a generally applicable measure of a project’s significance. Lead agencies may continue to rely on the 1999 CEQA thresholds and may continue to make determinations regarding the significance of an individual project's air quality impacts based on the substantial evidence in the record for that project.

For the PEIR, air quality impacts will be quantitatively assessed using significance thresholds established by BAAQMD in its 1999 CEQA Guidelines for nonattainment pollutants and USEPA for attainment pollutants, which are listed in Table 2-3. MBUAPCD thresholds are the same or higher than BAAQMD thresholds (MBUAPCD 2008), and Federal Prevention of Significant Deterioration (PSD) thresholds contained in 40 CFR 51.166(b)(23)(i) applicable to NSCAPCD are also higher than BAAQMD thresholds. Thus, the 1999 BAAQMD thresholds are the most stringent (lowest) quantitative criteria for assessing the potential for all Program impacts under CEQA.

2.6 Methodology

As described in Section 2.2.3, operation of onroad fleet vehicles, offroad all-terrain vehicles, watercraft, aircraft, portable equipment, and small equipment would result in emissions of criteria pollutants (NO_X, VOC, CO, SO_X, PM_{10}, $PM_{2.5}$) in engine exhaust. Detailed lists of equipment, estimated usage, and emission calculations are provided in Attachment A. Equipment lists and annual activity schedules were provided by the nine participating MVC Districts. Emission calculations were performed using the most recent and applicable emission factors published by CARB (2008a) and EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c).

Table 2-4 shows alternatives applicability by percentage as selected by the nine MVC Districts: surveillance, physical control, vegetation management, biological control, chemical control, or other non-chemical control tapping. Table 2-5 shows land uses associated with selected alternatives: residential, commercial, industrial, agricultural, and open space. As shown in Tables 2-4 and 2-5, not all alternatives or land uses are applicable in all Districts, nor are all options or activities under any applicable alternative.

2.7 Estimated Emissions

Tables 2-6 through 2-11 show estimated ongoing annual criteria emissions by alternative and District. Table 2-12 shows estimated combined annual emissions across all nine Districts. Table 2-13 shows estimated peak daily criteria emissions for applicable alternatives assuming simultaneous operations as a hypothetical and highly unlikely "worst case" scenario. Table 2-14 shows estimated highest quarterly and average daily criteria emissions for applicable alternatives assuming concurrent operations as "typical case", which is a more likely and realistic scenario.

As shown in Table 2-12, no annual thresholds (Table 2-3) would be exceeded by the Programs, either individually or collectively. As shown in Table 2-13, no individual MVC District would exceed "worst case" daily thresholds. As shown in Table 2-14, no "typical case" daily thresholds would likely be exceeded by the Programs, either individually or collectively. Due to the very wide spatial and temporal dispersion of the mobile emissions sources across the nine Service Area counties, no ambient air quality standards for any pollutant would be violated solely by MVC activities. Since the combined annual or average daily emissions of the nine Districts would not be significant, neither would the incremental contribution of each District.

Table 2-3 CEQA Significance Thresholds - BAAQMD (1999)

Applicability	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$
Operation, tons/year	15	CAAQS[1]	15	40[2]	15	10[2]
Operation, pounds/year	30,000	CAAQS[1]	30,000	80,000	30,000	20,000
Operation, pounds/day	80	CAAQS[1]	80	—	80	—
Construction, pounds/day	80	CAAQS[1]	80	—	80[3]	—

Sources: BAAQMD 1999, 2012b (see note 4), 40 CFR 51.166. On March 5, 2012 the Alameda County Superior Court issued a judgment finding that the District had failed to comply with CEQA when it adopted the thresholds of significance. The court did not determine whether the thresholds were valid on the merits, but found that the adoption of the thresholds was a project under CEQA. The court issued a writ of mandate ordering the District to set aside the 2010 thresholds and cease dissemination of them until the District had complied with CEQA. The District is no longer recommending that the 2010 thresholds be used as a generally applicable measure of a project's significance. Lead Districts may continue to rely on the District's 1999 thresholds and may continue to make determinations regarding the significance of an individual project's air quality impacts based on the substantial evidence in the record for that project.

Notes:

(1) No violation of CAAQS for CO (9 ppmv for 1 hour, 20 ppmv for 8 hours)

(2) Prevention of Significant Deterioration (PSD), annual only

(3) For construction projects, applies to exhaust emissions only, not fugitive dusts

Table 2-4 Districts' Selected Alternatives Applicability

Districts	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control	Other Non-Chemical Control
Alameda County MAD	12%	7%	—	1%	64%	16%
Alameda County VCSD	100%	—	—	—	—	—
Contra Costa County MVCD	16%	0.07%	0.13%	0.07%	61%	23%
Marin-Sonoma Counties MVCD	20%	5%	13%	21%	25%	15%
Napa County MAD	11%	13%	7%	2%	64%	4%
Northern Salinas Valley MAD	3%	6%	29%	7%	39%	15%
San Mateo County MVCD	11%	0%	30%	21%	13%	24%
Santa Clara County VCD	47%	3%	—	13%	37%	—
Solano County MAD	24%	—	—	0.03%	46%	30%
Nine Districts Composite	**27%**	**4%**	**9%**	**7%**	**39%**	**14%**

Sources: Nine Districts

Table 2-5 Land Uses Associated with Selected Alternatives

Districts	Residential	Commercial	Industrial	Agricultural	Open Space
Alameda County MAD	●	●	●	●	●
Alameda County VCSD	●	●			
Contra Costa County MVCD	●	●	●	●	●
Marin-Sonoma Counties MVCD	●	●	●	●	●
Napa County MAD	●	●	●	●	●
Northern Salinas Valley MAD	●	●	●	●	●
San Mateo County MVCD	●	●	●		●
Santa Clara County VCD	●	●	●	●	●
Solano County MAD	●	●	●	●	●

Sources: Nine Districts

Table 2-6 Estimated Annual Criteria Emissions for Surveillance Alternative

Districts	VOC lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
Alameda County MAD	44	1,051	44	1.4	4.1	2.7
Alameda County VCSD	148	1,392	138	2.3	19.4	12.5
Contra Costa County MVCD	38	521	35	0.7	4.8	3.1
Marin-Sonoma Counties MVCD	132	2,515	298	3.5	19.5	13.9
Napa County MAD	21	718	40	0.8	2.6	1.7
Northern Salinas Valley MAD	3	57	18	0.1	0.8	0.6
San Mateo County MVCD	365	7,550	321	10.2	38.5	24.9
Santa Clara County VCD	240	2,300	226	3.7	31.3	20.3
Solano County MAD	73	1,710	225	2.6	9.0	5.9
Nine Districts Totals	**1,065**	**17,813**	**1,345**	**25.2**	**130.1**	**85.6**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

Notes:

SCCVCD = Emissions for equipment use associated with rodent and wildlife trapping are reported under Surveillance

Table 2-7 Estimated Annual Criteria Emissions for Physical Control Alternative

Districts	VOC lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
Alameda County MAD	25	606	25	0.8	2.4	1.5
Alameda County VCSD	0	0	0	0.0	0.0	0.0
Contra Costa County MVCD	0	2	0	0.0	0.0	0.0
Marin-Sonoma Counties MVCD	36	689	82	1.0	5.3	3.8
Napa County MAD	25	841	47	1.0	3.1	2.0
Northern Salinas Valley MAD	7	120	38	0.2	1.7	1.3
San Mateo County MVCD	8	170	7	0.2	0.9	0.6
Santa Clara County VCD	16	149	15	0.2	2.0	1.3
Solano County MAD	0	0	0	0.0	0.0	0.0
Nine Districts Totals	**117**	**2,577**	**214**	**3.4**	**15.4**	**10.5**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

Table 2-8 Estimated Annual Criteria Emissions for Vegetation Management Alternative

Districts	VOC lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
Alameda County MAD	0	0	0	0.0	0.0	0.0
Alameda County VCSD	0	0	0	0.0	0.0	0.0
Contra Costa County MVCD	0	4	0	0.0	0.0	0.0
Marin-Sonoma Counties MVCD	89	1,700	201	2.4	13.2	9.4
Napa County MAD	14	456	26	0.5	1.7	1.1
Northern Salinas Valley MAD	30	540	173	0.7	7.4	5.9
San Mateo County MVCD	973	20,105	855	27.0	102.6	66.4
Santa Clara County VCD	0	0	0	0.0	0.0	0.0
Solano County MAD	0	0	0	0.0	0.0	0.0
Nine Districts Totals	**1,106**	**22,805**	**1,255**	**30.7**	**124.9**	**82.9**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

Table 2-9 Estimated Annual Criteria Emissions for Biological Control Alternative

Districts	VOC lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
Alameda County MAD	3	67	3	0.1	0.3	0.2
Alameda County VCSD	0	0	0	0.0	0.0	0.0
Contra Costa County MVCD	0	2	0	0.0	0.0	0.0
Marin-Sonoma Counties MVCD	141	2,683	318	3.7	20.8	14.8
Napa County MAD	3	109	6	0.1	0.4	0.3
Northern Salinas Valley MAD	7	130	42	0.2	1.8	1.4
San Mateo County MVCD	669	13,828	588	18.6	70.5	45.7
Santa Clara County VCD	66	636	62	1.0	8.7	5.6
Solano County MAD	0	2	0	0.0	0.0	0.0
Nine Districts Totals	**890**	**17,458**	**1,019**	**23.7**	**102.5**	**68.0**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

Table 2-10 Estimated Annual Criteria Emissions for Chemical Control Alternative

Districts	VOC lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
Alameda County MAD	231	5,523	229	7.4	21.6	14.0
Alameda County VCSD	0	0	0	0.0	0.0	0.0
Contra Costa County MVCD	146	2,013	136	2.9	18.6	12.1
Marin-Sonoma Counties MVCD	167	3,168	375	4.4	24.5	17.5
Napa County MAD	127	4,244	238	4.9	15.6	10.1
Northern Salinas Valley MAD	41	737	236	1.0	10.2	8.1
San Mateo County MVCD	431	8,907	379	12.0	45.4	29.4
Santa Clara County VCD	186	1,786	175	2.9	24.3	15.7
Solano County MAD	138	3,235	426	4.8	17.1	11.1
Nine Districts Totals	**1,467**	**29,613**	**2,194**	**40.2**	**177.4**	**118.0**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

Table 2-11 Estimated Annual Criteria Emissions for Other Non-Chemical Control/Trapping Alternative

Districts	VOC lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
Alameda County MAD	58	1,374	57	1.8	5.4	3.5
Alameda County VCSD	0	0	0	0.0	0.0	0.0
Contra Costa County MVCD	56	774	52	1.1	7.2	4.6
Marin-Sonoma Counties MVCD	99	1,873	222	2.6	14.5	10.3
Napa County MAD	7	236	13	0.3	0.9	0.6
Northern Salinas Valley MAD	16	284	91	0.4	3.9	3.1
San Mateo County MVCD	755	15,609	664	21.0	79.6	51.6
Santa Clara County VCD	0	0	0	0.0	0.0	0.0
Solano County MAD	92	2,151	283	3.2	11.4	7.4
Nine Districts Totals	**1,082**	**22,300**	**1,382**	**30.4**	**122.8**	**81.1**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

Notes:

ACMAD = Emissions associated with ongoing District office administration and grounds maintenance activities are reported under this alternative.

SCCVCD = Emissions for equipment use associated with rodent and wildlife trapping are reported under Surveillance.

SCMAD = Emissions referenced in the “Other Non-Chemical” category emanate from vehicles and equipment used in connection with district activities not directly related to mosquito control, such as transportation to various meetings and facilities maintenance.

Table 2-12 Estimated Combined Annual Criteria Emissions Across Nine Districts

Alternatives	VOC tons/yr	CO tons/yr	NO_X tons/yr	SO_X tons/yr	PM_{10} tons/yr	$PM_{2.5}$ tons/yr
Surveillance	0.53	8.91	0.67	0.01	0.07	0.04
Physical Control	0.06	1.29	0.11	0.00	0.01	0.01
Vegetation Management	0.55	11.40	0.63	0.02	0.06	0.04
Biological Control	0.45	8.73	0.51	0.01	0.05	0.03
Chemical Control	0.73	14.81	1.10	0.02	0.09	0.06
Other Non-Chemical	0.54	11.15	0.69	0.02	0.06	0.04
All Alternatives Totals	**2.86**	**56.28**	**3.70**	**0.08**	**0.34**	**0.22**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

Table 2-13 Estimated Peak Daily Criteria Emissions for Applicable Alternatives - Simultaneous Operations

Districts	VOC lbs/day	CO lbs/day	NO_X lbs/day	SO_X lbs/day	PM_{10} lbs/day	$PM_{2.5}$ lbs/day
Alameda County MAD	5.8	177.5	39.9	0.3	0.9	0.6
Alameda County VCSD	0.6	5.5	0.6	0.0	0.1	0.0
Contra Costa County MVCD	7.8	152.7	23.7	0.2	1.2	0.8
Marin-Sonoma Counties MVCD	15.3	394.0	44.1	0.5	2.1	1.5
Napa County MAD	6.6	255.0	31.2	0.3	0.9	0.6
Northern Salinas Valley MAD	1.7	31.1	10.0	0.0	0.4	0.3
San Mateo County MVCD	25.3	810.2	31.8	1.0	2.1	1.4
Santa Clara County VCD	2.7	26.9	3.0	0.0	0.4	0.2
Solano County MAD	9.2	283.7	43.8	0.4	1.2	0.8
Peak Total Daily Emissions	**75**	**2,137**	**228**	**3**	**9**	**6**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

Table 2-14 Estimated Highest Quarterly Criteria Emissions for Applicable Alternatives - Concurrent Operations

Districts	VOC lbs/qtr	CO lbs/qtr	NO_X lbs/qtr	SO_X lbs/qtr	PM_{10} lbs/qtr	$PM_{2.5}$ lbs/qtr
Alameda County MAD	184	5,215	197	7	15	10
Alameda County VCSD	38	355	35	1	5	3
Contra Costa County MVCD	105	1,627	105	2	13	9
Marin-Sonoma Counties MVCD	223	4,369	485	6	33	23
Napa County MAD	79	3,114	168	3	10	6
Northern Salinas Valley MAD	30	493	177	1	8	6
San Mateo County MVCD	1,329	28,290	1,125	38	140	91
Santa Clara County VCD	145	1,383	136	2	19	12
Solano County MAD	136	3,702	413	5	15	10
Nine Districts Totals	**2,268**	**48,549**	**2,841**	**65**	**258**	**170**
Average Total Daily Emissions	**35**	**747**	**44**	**1**	**4**	**3**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

3 Greenhouse Gases and Climate Change

3.1 Introduction

Climate change refers to any significant change in the measures of climate lasting for an extended period of time, and includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer. The average temperature of the Earth has increased about 1.4°F (0.8°C) over the past century, and is projected to rise another 2 degrees to 11.5°F (1.1 to 6.4°C) over the next 100 years. Small changes in the average temperature of the planet can translate to large and potentially hazardous shifts in climate and weather. Climate change is suspected as the cause of changes in rainfall, resulting in more floods, droughts, or intense rain, as well as more frequent and severe heat waves. Also, oceans are warming and becoming more acidic, polar ice caps are melting, glaciers are receding, and sea levels are rising due to thermal expansion and ice loss. As climate change progresses in the coming decades, it will likely present challenges to society and the environment. (EPA 2012e)

Over the past century, human activities have released large amounts of carbon dioxide and other greenhouse gases (GHGs) into the atmosphere. The majority of greenhouse gases are the byproduct of burning fossil fuels to release energy in the form of heat, although deforestation, industrial processes, and some agricultural practices also emit greenhouse gases into the atmosphere. Greenhouse gases trap solar energy in the atmosphere and cause it to warm. This phenomenon is called the greenhouse effect and is necessary to support life on Earth, however, excessive buildup of greenhouse gases can change Earth's climate and result in undesirable effects on ecosystems, which affects human health and welfare. (EPA 2012e)

3.2 Environmental Setting

3.2.1 The Atmosphere

Air is a mixture of constituent gases and its composition varies slightly with location and altitude. For 20th century scientific and engineering purposes, it became necessary to define a standard composition known as the U.S. Standard Atmosphere. In addition to the common gases (nitrogen, oxygen, carbon dioxide, methane, hydrogen, nitrous oxide), the atmosphere contains noble or inert gases (argon, neon, helium, krypton, xenon). Radon (Rn) is also present in low concentrations near ground level in limited geographic areas where it is naturally emitted from certain types of rock and soil. Table 3-1 shows the typical composition of dry standard air, which is over 99 percent nitrogen and oxygen (UIG 2008; EPA 2012b). The apparent molecular weight of dry standard air is 28.966 grams per mole (Jennings 1970; du Pont 1971).

The atmosphere consists of five basic altitude zones: troposphere (sea level to 8 miles); stratosphere (8 to 32 miles); mesosphere (32 to 50 miles); thermosphere (50 to 350 miles); and exosphere (350 to 500 miles). Within the stratosphere is the ozone layer (9 to 22 miles) which absorbs ultraviolet wavelengths; and within the mesosphere is the ionosphere (62 to 190 miles) which reflects shortwave radio signals and produces auroras. These approximate altitude ranges vary with latitude, season, solar activity, and turbulence. Greenhouse gases persist mainly in the troposphere and stratosphere – some in the mesosphere – for different lengths of time, ranging from less than 5 years to over 50,000 years, long enough to become well-mixed, meaning that atmospheric concentrations are about the same all over the world, regardless of source locations (EPA 2012f). Thus, the homogeneous composition of the lower atmosphere is the global setting for climate change.

Table 3-1 Standard Composition of Dry Air

Principal Gas	Chemical Symbol	Gas MW g/mole	Concentration ppmv	Fraction percent	Fraction MW g/mole
Nitrogen	N_2	28.014	780,805.00	78.080500	21.873471
Oxygen	O_2	31.998	209,440.00	20.944000	6.701661
Argon	Ar	39.948	9,340.00	0.934000	0.373114
Carbon Dioxide	CO_2	44.009	387.69	0.038769	0.017062
Neon	Ne	20.183	18.21	0.001821	0.000368
Helium	He	4.003	5.24	0.000524	0.000021
Methane	CH_4	16.043	1.81	0.000181	0.000029
Krypton	Kr	83.800	1.14	0.000114	0.000096
Hydrogen	H_2	2.016	0.50	0.000050	0.000001
Nitrous Oxide	N_2O	44.013	0.32	0.000032	0.000014
Xenon	Xe	31.300	0.09	0.000009	0.000003
Totals			**1,000,000.00**	**100.000**	**28.966**

Sources: UIG 2008, EPA 2012b, du Pont 1971, Jennings 1970

Notes:

MW = molecular weight, g/mole

ppmv = parts per million by volume (10^{-6})

3.2.2 Area Climate

The Program Areas' climate is characterized by moderately wet winters and dry summers. About 90 percent of the annual total rainfall is received in the November through April period. Between June and September, normal rainfall is typically less than 0.6 inch (1.5 centimeters). Temperatures in the Program Area average about 60°F (15°C) annually, with average summer highs in the 70 to 80°F (21 to 27°C) range and average winter lows in the 40 to 50°F (4 to 10°C) range. Precipitation averages about 23 inches (58 centimeters) per year, although annual precipitation can vary significantly from year-to-year. Annual average wind speeds in the Program Areas are about 8 miles per hour (3.6 meters per second). The predominant direction of air pollution transport in the Program Areas is inland from the coastal areas (BAAQMD 2010a, WC 2012, NOAA 2008).

3.3 Greenhouse Gases

3.3.1 Principal GHGs

Gases that trap heat in the atmosphere are called greenhouse gases or GHGs. Principal GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and other fluorinated gases including nitrogen trifluoride and hydrofluorinated ethers. Greenhouse gases occur naturally because of volcanoes, forest fires, and biological processes such as enteric fermentation and aerobic decomposition. They are also produced by combustion of fuels, industrial processes, agricultural operations, waste management, and land use changes such as loss of farmland to urbanization. The most common GHG from human activity (fuel combustion) is CO_2, followed by CH_4 and N_2O. (EPA 2012f)

Concentration, or abundance, is the amount of a particular gas in the air. Larger emissions of greenhouse gases lead to higher concentrations in the atmosphere. Greenhouse gas concentrations are measured in units of parts per million (ppm), parts per billion (ppb), and parts per trillion (ppt). One part per million is equivalent to one cubic centimeter (cc) of pure gas diluted in one cubic meter of air. Similarly, one part per billion is one cc diluted in 1,000 cubic meters, and one part per trillion is one cc diluted in 1,000,000 cubic meters. (EPA 2012f)

Carbon Dioxide

Carbon dioxide (CO_2) enters the atmosphere through burning fossil fuels (coal, natural gas, and petroleum products), decomposition of solid waste, trees and wood products, fermentation, and also as a result of certain chemical reactions, such as manufacture of cement. Carbon dioxide is removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biologic carbon cycle. In the carbon cycle, carbon in various molecular forms is cycled among atmospheric, oceanic, land biotic, marine biotic, and mineral reservoirs. Atmospheric carbon dioxide is part of this global carbon cycle. Carbon dioxide concentrations in the atmosphere have increased from about 280 ppm in pre-industrial times to about 390 ppm today, a 39 percent increase. The Intergovernmental Panel on Climate Change (IPCC), notes that "this concentration has not been exceeded during the past 420,000 years, and likely not during the past 20 million years. The rate of increase over the past century is unprecedented, at least during the past 20,000 years." The IPCC definitively states that "the present atmospheric CO_2 increase is caused by anthropogenic emissions of CO_2". (EPA 2012f, IPCC 2007)

Global Warming Potential (GWP) is a quantified measure of the globally averaged relative radiative forcing impacts of a particular GHG. It is defined as the cumulative radiative forcing both direct and indirect effects integrated over a period of time from the emission of a unit mass of gas relative to a reference gas. Carbon dioxide is the reference gas with a GWP of unity (1). Carbon dioxide equivalents (CO_2e) are calculated by summing the products of mass GHG emissions by species times their respective U.S. Environmental Protection Agency (EPA) official GWP coefficients. The persistence of CO_2 in the atmosphere is estimated to be in the range of 50 to 200 years, depending on variations in the carbon cycle. (EPA 2012b, EPA 2012f)

Methane

Methane (CH_4) is primarily produced through anaerobic decomposition of organic matter in biological systems. Agricultural processes such as wetland rice cultivation, enteric fermentation in ruminant animals (e.g., cows), and the decomposition of animal wastes emit methane, as does the decomposition of municipal solid wastes. Methane is also fugitively emitted during the production and distribution of natural gas and petroleum, and is released as a by-product of coal mining and incomplete fossil fuel combustion. Pipeline-quality natural gas is over 90 percent methane by volume and is considered a "clean fuel" by industry with carbon dioxide and water vapor as its main combustion byproducts. Atmospheric concentrations of methane have increased by about 160 percent since pre-industrial times, although the rate of increase has been declining. The IPCC has estimated that slightly more than half of the current methane flux to the atmosphere is anthropogenic, from human activities such as agriculture, fossil fuel use, and waste disposal. The EPA's official GWP coefficient of CH_4 is 21, and its persistence in the atmosphere is estimated to be about 9 to 15 years. (EPA 2012b, EPA 2012f)

Nitrous Oxide

Nitrous oxide (N_2O) is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste. Anthropogenic sources of nitrous oxide emissions include agricultural soils, especially the use of synthetic and manure fertilizers; fossil fuel combustion, especially from mobile combustion; adipic (nylon) and nitric acid production; wastewater treatment and waste combustion; and biomass burning. The atmospheric concentration of N_2O has increased by about 19 percent since 1750, from a pre-industrial value of about 270 ppb to about 320 ppb today, a concentration that has not been exceeded during the last thousand years. The EPA's official GWP coefficient of N_2O is 310, and its persistence in the atmosphere is estimated to be about 110 to 120 years. (EPA 2012b, EPA 2012f)

Fluorinated gases

Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for ozone-depleting substances (e.g., chlorofluorocarbons, hydrochlorofluorocarbons, and halons). In the electric utility industry, sulfur hexafluoride (SF_6) is used as a dielectric gas in high-voltage equipment, such as switchgear and circuit breakers. As man-made gas, SF_6 in the atmosphere has increased from 0 to about 7 ppt in modern times. Due to their expense, all of these fluorinated gases are typically emitted (lost) in small quantities relative to combustion byproducts, but because they are potent greenhouse gases, they are sometimes referred to as "High GWP gases" with estimated persistence in the atmosphere ranging from 1.5 to 50,000 years. Of these, SF_6 is the most potent, with an EPA official GWP of 23,900 and an estimated persistence of about 3,200 years. (EPA 2012b, EPA 2012f)

3.3.2 Emission Sources

The EPA tracks greenhouse gas emissions in the United States and publishes the *Inventory of U.S. Greenhouse Gas Emissions and Sinks*, which is updated annually (EPA 2012d). This detailed report contains estimates of the total national greenhouse gas emissions and removals associated with human activities in all 50 states. From the current report, the main sources of greenhouse gas emissions in the United States are identified below (EPA 2012f):

- Electric power generation accounts for 34 percent of GHG emissions nationwide. Over 70 percent of electric power is generated by burning fossil fuels, mainly coal and natural gas. Greenhouse gas emissions from electric power generation in the United States have increased by about 24 percent since 1990 as demand for electric power has grown and fossil fuels have remained the dominant energy source for generation due to their low cost and high reliability.
- Transportation accounts for 27 percent of GHG emissions nationwide. Greenhouse gas emissions from transportation result from burning fossil fuels in automobiles, trucks, trains, ships, and aircraft. About 90 percent of the fuel used for transportation is petroleum-based, which includes gasoline, diesel, and jet fuel.
- Industry accounts for 21 percent of GHG emissions nationwide. Greenhouse gas emissions from industry are associated mainly with burning fossil fuels (coal, natural gas) for heat energy as well as emissions from certain chemical reactions necessary to produce goods from raw materials.
- Commercial and Residential uses account for 11 percent of GHG emissions nationwide. Greenhouse gas emissions from businesses and homes result primarily from fossil fuels burned for heat, the use of certain products that contain GHGs, and the handling and disposal of domestic wastes.
- Agriculture accounts for 7 percent of GHG emissions nationwide. Greenhouse gas emissions from agriculture are caused by livestock such as cows (enteric fermentation), soil management practices, and rice farming.
- Land Use and Forestry offsets (absorbs or sequesters) about 15 percent of GHG emissions nationwide. Land areas can act as GHG sinks (absorbing CO_2 from the atmosphere) or GHG sources. Since 1990, well-managed forests and other lands have absorbed more CO_2 from the atmosphere than they emit.

3.3.3 Emission Trends

Annual GHG emission inventories provide the basis for establishing historical emission trends. Trends are useful in tracking progress towards a specific goal or target. There are many factors affecting GHG emissions, including the state of the economy, changes in demography, improved efficiency, and changes in environmental conditions such as drought.

From 2000 to 2009, California's gross GHG emissions decreased by 1.5 percent overall from 464 to 457 million metric tonnes (MMT) CO_2e, with a maximum of 489 MMT CO_2 e in 2007. During the same period, California's population grew by 9.7 percent from 33.9 to 37.2 million, therefore, per capita GHG emissions decreased from 13.7 to 12.3 metric tonnes of CO_2 e per person. From 2008 to 2009, overall GHG emissions decreased by about 6 percent. This reflects the effect of the economic recession and higher fuel prices, with marked declines in on-road transportation, cement production, and electric power consumption. As the economy recovers, emissions are likely to rise again until GHG reduction measures begin to take effect. (CARB 2011a)

Since 1990, greenhouse gas emissions in the United States have increased by about 10 percent. however, from year-to-year emissions can increase or decrease due to changes in the economy, the price of fuel, weather, and other factors. In 2010, national GHG emissions increased about 3 percent from 2009 levels. This increase was primarily due to the improving economy which increased energy consumption across all sectors. In addition, a hot summer caused an increase in electric power demand for air conditioning that was generated mainly by burning coal and natural gas in existing power plants. (EPA 2012f)

3.3.4 Mobile Sources

While stationary sources such as power plants and oil refineries emit large quantities of greenhouse gases, mobile sources, due their sheer numbers nationwide, also emit significant amounts. Mobile sources include onroad vehicles (e.g., automobiles, trucks, motorcycles), offroad equipment (e.g., earthmovers, cranes, portable pumps and generators), trains (e.g., freight, passenger, light rail), vessels (e.g., boats, ships, watercraft), and aircraft (e.g., general aviation, commercial, military). Mobile source fuels include gasoline, diesel, heavy fuel oil (large marine vessels), and jet fuel, all of which emit GHGs when combusted.

Mobile sources used in mosquito and vector control (MVC) activities include onroad fleet vehicles (light- and medium-duty trucks, vans, passenger cars), offroad all-terrain vehicles (ATVs), watercraft (motorboats, airboats), aircraft (helicopters and fixed-wing), portable equipment (pumps, sprayers, generators), and small equipment (hand-held sprayers, foggers, dusters). Except for 2-stroke engines used in small lightweight equipment (spark ignition, 50:1 gas/oil mix), engines are 4-stroke gasoline (spark ignition) or diesel fuel (compression ignition). The dominant fuel used for these mobile sources is motor gasoline along with some diesel fuel (larger trucks) , aviation gasoline (fixed-wing aircraft), and jet fuel (turbine-powered helicopters). Light trucks, vans, and passenger cars are normally used for responding to public service requests and disease surveillance. Typical GHG contents of common fuels are presented in Table 3-2.

Table 3-2 Typical GHG Contents of Common Fuels

Fuel	CO_2 kg/mmBTU	CH_4 kg/mmBTU	N_2O kg/mmBTU	CO_2e lb/mmBTU	Energy BTU/gal	CO_2e lb/gal
Diesel Fuel No. 2	73.96	0.0105	0.0006	163.97	138,300	22.68
Kerosene	73.19	0.0105	0.0006	162.27	138,700	22.51
Jet Fuel	72.23	0.0105	0.0006	160.17	135,000	21.62
Motor Gasoline	71.35	0.0105	0.0006	158.23	122,600	19.40
Aviation Gasoline	69.15	0.0105	0.0006	153.38	120,200	18.44
Propane	62.22	0.0053	0.0001	137.49	91,300	12.55
Pipeline Natural Gas	53.02	0.0053	0.0001	117.20	—	—

Sources: EPA 2012b, EPA 2011b

Notes:

kg/mmBTU = kilograms per million British Thermal Units

lb/mmBTU = pounds per million British Thermal Units

BTU = the amount of energy (heat) required to raise 1 pound of liquid water 1 degree Fahrenheit from 39 to 40°F

3.3.5 Sensitive Receptors

Certain population groups are considered more sensitive to air pollution and odors than others; in particular, children, elderly, and acutely ill and chronically ill persons, especially those with cardio respiratory diseases such as asthma and bronchitis. Sensitive receptors (land uses) indicate locations where such individuals are typically found, namely schools, daycare centers, hospitals, convalescent homes, residences of sensitive persons, and parks with active recreational uses, such as youth sports.

Persons engaged in strenuous work or physical exercise also have increased sensitivity to poor air quality. Residential areas are considered more sensitive to air quality conditions than commercial and industrial areas, because people generally spend longer periods of time at their residences, resulting in greater exposure to ambient air quality conditions. Recreational uses such as parks are also considered sensitive, due to the greater exposure to ambient air quality conditions and because the presence of pollution detracts from the recreational experience.

None of the greenhouse gases described in Section 3.3.1 are considered toxic, however, all are classified as asphyxiants. Thus, in high enough concentrations in confined spaces they can displace the oxygen in air and present hazards to industrial workers, however, GHG concentrations in ambient air (see Table 3-1) are far below any danger levels. Therefore, no risk to sensitive receptors or the general public is posed by greenhouse gases emitted to outdoor air, either from stationary or mobile sources.

3.4 Climate Change

3.4.1 National and International Assessments

The American Meteorological Society refers to climate change as any systematic change in the long-term statistics of climate elements (such as temperature, pressure, or winds) sustained over several decades or longer. The Society also indicates that climate change may be due to natural external forcings, such as changes in solar emission or slow changes in the Earth’s orbital elements; natural internal processes of the climate system; or anthropogenic forcing (AMS 2012). The climate system can be influenced by changes in the concentration of various GHGs in the atmosphere that affect the Earth’s absorption of radiation.

In its *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2011* (EPA 2012b), the EPA provides summary information on the work of the United Nations Framework Convention on Climate Change (UNFCCC, 2009) and the Intergovernmental Panel on Climate Control (IPCC, 1990-2007); key information from that report is summarized below – more details may be found in the cited source documents.

The UNFCCC defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (UNFCCC 2009). In its *Second Assessment Report* of the science of climate change, the IPCC concluded "human activities are changing the atmospheric concentrations and distributions of greenhouse gases and aerosols" (IPCC 1995). These changes can produce a radiative forcing by changing either the reflection or absorption of solar radiation, or the emission and absorption of terrestrial radiation." Building on this conclusion, the IPCC *Third Assessment Report* (IPCC 2001) asserted "concentrations of atmospheric greenhouse gases and their radiative forcing have continued to increase as a result of human activities."

The IPCC reports the global average surface temperature of the Earth has increased by 1.1 ±0.4°F (0.6 ±0.2°C) over the 20th century. This value is about 0.27°F (0.15°C) larger than that estimated by the Second Assessment Report, which reported for the period up to 1994, "owing to the relatively high temperatures of the additional years (1995 to 2000) and improved methods of processing the data."

While the *Second Assessment Report* concluded, "the balance of evidence suggests there is a discernible human influence on global climate," the *Third Assessment Report* more directly connects the influence of human activities on climate. IPCC concluded, "In light of new evidence and taking into account the remaining uncertainties, most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations."

In its most recent *Fourth Assessment Report*, IPCC stated warming of Earth's climate is unequivocal, and that warming is very likely attributable to increases in atmospheric greenhouse gases caused by human activities (IPCC 2007). IPCC further stated changes in many physical and biological systems, such as increases in global temperatures, more frequent heat waves, rising sea levels, coastal flooding, loss of wildlife habitat, spread of infectious disease, and other potential environmental impacts, are linked to changes in the climate system, and some changes might be irreversible.

The mobile sources used in MVC activities emit greenhouse gases and therefore contribute incrementally to climate change; however, as described in Section 3.8, these emissions comprise a very small fraction of the Bay Area, California, and U.S. GHG inventories. This fact precludes any meaningful analysis of quantitative effects that MVC operations may specifically have on climate, although taken together with regional, national, and worldwide GHG emissions, global effects are as described above.

3.4.2 State Policies

The Global Warming Solutions Act of 2006 (AB 32) (see Section 3.5.2 below) required the California Air Resources Board (CARB) to prepare a Scoping Plan to achieve substantial GHG emissions reductions, both from within the state and from "exported" emissions, such as importing electric power generated at coal-fired power plants located in neighboring western states. The 2008 Scoping Plan outlines a wide range of strategies for reducing statewide GHG emissions to 1990 levels by 2020. This will be achieved by cutting about 30 percent from business-as-usual emission levels projected for 2020, or about 15 percent from 2008 levels. Allowing for population growth, the goal is to reduce annual per capita emissions from 14 metric tonnes (MT) of CO_2e down to about 10 MT CO_2e per capita by 2020. (CARB 2008b)

3.4.3 Emissions Inventories

The bulk of MVC activity emissions would occur in the Bay Area, and only minor amounts would occur in northern Sonoma, Yolo, Solano, and northern Monterey counties. Therefore, the comprehensive 2007 Bay Area GHG inventory is used as the regional benchmark for comparison purposes.

Table 3-3 shows aggregated national, state, and regional GHG emissions for all sources on a gross basis, i.e., CO_2e emissions only, not including CO_2 sinks such as forestry and agriculture. As shown, California accounts for about 7 percent of gross CO_2e emissions in the U.S. annually, and the Bay Area accounts for about 20 percent of gross CO_2e emissions in California.

Tables 3-4, 3-5, 3-6, and 3-7 present progressively focused Bay Area GHG emissions inventory data for 2007 broken down by sectors, counties, and applicable sub-sectors. This information will be used as a basis for comparisons with estimated MVC activity emissions for the nine Districts presented in Section 3.8.

Table 3-3 Greenhouse Gas Emissions Inventories - Gross Basis

Summary Year	National MMT CO_2e	California MMT CO_2e	Bay Area MMT CO_2e
2005	7,204	482.5	—
2006	7,159	481.9	—
2007	7,253	488.8	95.8
2008	7,048	484.7	—
2009	6,608	456.8	—
5-Year Average	**7,054**	**478.9**	—
Average Annual Variation	**2.6%**	**1.8%**	—

Sources: EPA 2012b, CARB 2011b, BAAQMD 2010b

Notes:

MMT - million metric tonnes (annual)

1 metric tonne = 1,000 kilograms or 2,204.6 pounds

2009 is most recent CARB published data; Bay Area for 2007 only

Table 3-4 Bay Area GHG Emissions by Sector

End-Use Sector	District Emissions	
	Percent	**MMT CO_2e**
Industrial / Commercial	36.4%	34.9
Residential Fuel Use	7.1%	6.8
Local Electric Power Generation	8.5%	8.1
Imported Electric Power Generation	7.4%	7.1
Offroad Equipment	3.0%	2.9
Transportation	36.4%	34.9
Agriculture / Farming	1.2%	1.1
Totals	**100.0%**	**95.8**

Source: BAAQMD 2010b

Notes:

MMT - million metric tonnes (annual)

1 metric tonne = 1,000 kilograms or 2,204.6 pounds

Table 3-5 Bay Area GHG Emissions by County

County	District Emissions	
	Percent	**MMT CO_2e**
Alameda	16.4%	15.7
Contra Costa	32.9%	31.5
Marin	2.8%	2.7
Napa	1.8%	1.7
San Francisco	7.4%	7.1
San Mateo	8.9%	8.5
Santa Clara	19.6%	18.8
Solano (within BAAQMD)	5.9%	5.7
Sonoma (within BAAQMD)	4.3%	4.1
Totals	**100.0%**	**95.8**

Source: BAAQMD 2010b

Notes:

MMT = million metric tonnes (annual)

1 metric tonne = 1,000 kilograms or 2,204.6 pounds

Table 3-6 Mobile Sectors GHG Emissions by County

County	Offroad MT CO_2e	Transportation MT CO_2e
Alameda	569,000	8,351,000
Contra Costa	406,000	4,998,000
Marin	99,000	1,286,000
Napa	50,000	917,000
San Francisco	415,000	2,673,000
San Mateo	270,000	4,850,000
Santa Clara	790,000	7,859,000
Solano (within BAAQMD)	147,000	1,834,000
Sonoma (within BAAQMD)	175,000	2,103,000
Totals	**2,921,000**	**34,871,000**

Source: BAAQMD 2010b

Notes:

MT = metric tonnes (annual)

1 metric tonne = 1,000 kilograms or 2,204.6 pounds

Values rounded to nearest 1,000 tonnes

“Offroad” is offroad equipment category

Table 3-7 Offroad Sub-Sectors GHG Emissions by County

County	Utility MT CO_2e	Commercial MT CO_2e	Combined MT CO_2e
Alameda	29,800	49,900	79,700
Contra Costa	20,300	26,900	47,200
Marin	7,900	12,300	20,200
Napa	2,900	4,300	7,200
San Francisco	14,200	43,900	58,100
San Mateo	14,200	27,200	41,400
Santa Clara	32,900	56,500	89,400
Solano (within BAAQMD)	3,900	6,800	10,700
Sonoma (within BAAQMD)	7,800	13,500	21,300
Totals	**133,900**	**241,300**	**375,200**

Source: BAAQMD 2010b

Notes:

MT= metric tonnes (annual)

1 metric tonne = 1,000 kilograms or 2,204.6 pounds

Values rounded to nearest 100 tonnes

“Utility” is small landscaping equipment selected for comparisons to Districts' activities

“Commercial” is light commercial equipment selected for comparisons to Districts' activities

3.5 Regulatory Setting

Currently, no local, state, or Federal regulatory standards directly apply to GHG emissions from temporary or intermittent mobile sources such as MVC activities. However, in the context of the Scoping Plan discussed in Section 3.4.2, implementation of Low Carbon Fuel Standard (Executive Order S-1-07, below) would indirectly apply to MVC activities via fuel usage. Summaries of principal Federal, state, and local GHG statutes, regulations, and programs which affect other types of sources are presented below.

3.5.1 Federal

40 CFR Part 98 – Greenhouse Gas Reporting

On October 30, 2009 the EPA issued the Mandatory Reporting of Greenhouse Gases rule (74 FR 56260, 40 CFR 98, effective December 29, 2009) which requires reporting of GHG data and other relevant information from large sources and suppliers in the United States pursuant to Fiscal Year 2008 Consolidated Appropriations Act (HR 2764; Public Law 110-161).

The new rule facilitates collection of accurate and comprehensive emissions data to provide a basis for future EPA policy decisions and regulatory initiatives. The rule requires specified industrial source categories and facilities with an aggregated heat input of 30 mmBTU or more per hour or that emit 25,000 metric tons or more per year of GHG to submit annual reports to the EPA. The gases covered by the rule are CO_2, CH_4, N_2O, and HFCs, PFCs, SF_6, and other fluorinated gases including nitrogen trifluoride and hydrofluorinated ethers. Since the Programs do not meet the definition of an affected stationary source (i.e., mobile sources only), the GHG reporting rule does not apply.

Notwithstanding the GHG reporting rule, no Federal regulations currently limit or curtail GHG emissions of carbon dioxide and methane, and EPA cap-and-trade programs currently apply only to acid rain precursors sulfur dioxide (SO_2) and nitrogen oxides (NO_X) (EPA 2012g). However, emissions of N_2O are regulated, albeit indirectly, through limitation of NO_X emissions as a criteria pollutant under New Source Performance Standards (NSPS) and Federal, state, and local operating permits.

General Conformity

A General Conformity determination is required for Federally sponsored, permitted, or funded actions in NAAQS nonattainment areas or in certain maintenance areas when the total direct and indirect net emissions of nonattainment pollutants (or their precursors) exceed specified thresholds (Clean Air Act Amendments of 1990 Section 176[c]). This regulation ensures that Federal actions conform to State Implementation Plans (SIPs) and agency NAAQS attainment plans. Since greenhouse gases are not regulated criteria air pollutants and the Programs are not Federally sponsored, permitted, or funded actions, General Conformity does not apply.

3.5.2 State

Global Warming Solutions Act

The Global Warming Solutions Act of 2006 (Assembly Bill [AB] 32) codifies California's goal of reducing statewide emissions of GHGs to 1990 levels by 2020. This reduction will be accomplished through an enforceable statewide cap on global warming emissions that will be phased in starting in 2012 to achieve maximum technologically feasible and cost-effective GHG emission reductions. In order to effectively implement the cap, AB 32 directs the California Air Resources Board (CARB) to develop appropriate regulations and establish a mandatory reporting system to track and monitor global warming emissions levels.

On September 25, 2009, CARB adopted the AB 32 Cost of Implementation Fee Regulation (Health and Safety Code 38597). The regulation was approved by the Office of Administrative Law on June 17, 2010, and became effective on July 19, 2010. For the first year of the fee program, CARB will administratively provide compliance flexibility and will not enforce reporting and fee requirements until after the passage of the state budget for fiscal year 2010-11. Until the budget is enacted and CARB provides detailed compliance criteria, facilities subject to the regulation do not need to pay fees or report information required by the regulation. However, since the Programs are not affected stationary sources, the AB 32 fee regulation does not apply.

Cap and Trade

The California Air Resources Board's new "Cap and Trade" regulation (Subchapter 10, Article 5, Sections 95800 to 96023, Title 17, California Code of Regulations) is a set of rules (effective September 1, 2012) that establishes a limit on GHG emissions from the largest sources of GHGs in the state. The purpose of *California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms* is to reduce emissions of GHGs from affected stationary sources through the establishment, administration, and enforcement of an aggregate GHG allowance budget and to provide a trading mechanism for compliance instruments (i.e., "GHG allowances" or "carbon credits"). Since the Programs are not affected stationary sources under the rule, Cap and Trade does not apply. No other statewide quantitative standards of significance for GHG impacts have been established for nonaffected sources under CEQA.

Assembly Bill 939

California AB 939, known as the Integrated Waste Management Act of 1989, was enacted due to increasing waste stream volumes and decreasing landfill capacities in the state. As a result of AB 939, the California Integrated Waste Management Board was created. A disposal reporting system with its oversight was established, and facility and program planning was required. AB 939 mandated that sanitation districts (jurisdictions) meet diversion goals of 25 percent by 1995 and 50 percent by 2000, primarily through recyclables collection and green waste compositing. AB 939 also established an integrated framework for program implementation, solid waste planning, and solid waste facility and landfill compliance.

Senate Bill 1368

California Senate Bill (SB) 1368 adds sections 8340 and 8341 to the Public Utilities Code (effective January 1, 2007) with the intent "to prevent long-term investments in power plants with GHG emissions in excess of those produced by a combined-cycle natural gas power plant" with the aim of "reducing emissions of GHGs from the state's electricity consumption, not just the state's electricity production." SB 1368 provides a mechanism for reducing the GHG emissions of electricity providers, both in-state and out-of-state, thereby assisting CARB in meeting its mandate under AB 32, the Global Warming Solutions Act of 2006.

Senate Bill 97

California SB 97 directs the Office of Planning and Research to prepare, develop, and transmit to the Resources Agency CEQA guidelines for the feasible mitigation of GHG emissions or their effects by July 1, 2009. The Resources Agency is required to certify or adopt those guidelines by January 1, 2010. SB 97 also protects, for a short time, certain projects funded by the Highway Safety, Traffic Reduction, Air Quality and Port Security Bond Act of 2006, or the Disaster Preparedness and Flood Protection Bond Act of 2006 (Proposition 1B or 1E) from claims of inadequate analysis of GHG as a legitimate cause of action. This latter provision was repealed on January 1, 2010.

Senate Bill 375

California SB 375 aims to reduce GHG emissions by curbing sprawl, because the largest sources of GHG emissions in California are passenger vehicles and light trucks. SB 375 provides emission reduction goals for which regions can plan, integrates disjointed planning activities, and provides incentives for local governments and developers to follow new conscientiously-planned growth patterns. SB 375 enhances CARB's ability to reach AB 32 goals by requiring metropolitan planning organizations to include defined sustainable community strategies in their regional transportation plans for the purpose of reducing GHG emissions, aligns planning for transportation and housing, and creates specified incentives for the implementation of the strategies.

Senate Bills 1078 and 10

California SB 1078 was signed into legislation in 2002 and required California load serving entities (electric utilities) to procure 20 percent of their retail customer load with renewable energy by the year 2017. Four years later (2006), SB 10 accelerated the 20 percent renewable deadline to 2010.

Executive Order S-20-04

On July 27, 2004, Executive Order S-20-04 was issued committing the state to aggressive action to reduce state-owned building electricity usage by retrofitting, building and operating the most energy and resource efficient buildings by taking all cost-effective measures described in the Green Building Action Plan with the goal of reducing grid-based energy purchases by 20 percent by 2015. This order also directed the California Public Utilities Commission to support a campaign to improve commercial building energy efficiency in order to help achieve the 20 percent goal and to develop a benchmarking methodology.

Executive Order S-3-05

On June 1, 2005, Executive Order S-3-05 was issued establishing GHG emission reduction targets: by 2010, reduce GHG emissions to 2000 levels; by 2020, reduce GHG emissions to 1990 levels; and by 2050, reduce GHG emissions to 80 percent below 1990 levels.

Executive Order S-1-07

On January 18, 2007, the Low Carbon Fuel Standard (LCFS) was issued mandating a reduction of at least 10 percent in the carbon intensity of California's transportation fuels by 2020. It instructed the California Environmental Protection Agency to coordinate activities among the University of California, the California Energy Commission, and other state agencies to develop and propose a draft compliance schedule to meet the 2020 target. Furthermore, it directed CARB to consider initiating regulatory proceedings to establish and implement the LCFS. In response, CARB identified the LCFS as an early action item with a regulation to be adopted and implemented by 2010.

Executive Order S-13-08

On November 14, 2008, Executive Order S-20-04 was issued directing the California Resources Agency, in cooperation with the Department of Water Resources, the California Energy Commission, California's coastal management agencies, and the Ocean Protection Council to request that the National Academy of Sciences convene an independent panel to complete the first California Sea Level Rise Assessment Report by December 1, 2010. As part of this effort, the Resources Agency is to create an independent sea level rise science and policy committee made up of state, national, and international experts and to hold public workshops to gather policy-relevant information.

3.5.3 Local

BAAQMD CEQA Guidelines

On June 2, 2010, the Bay Area Air Quality Management District (BAAQMD) adopted new CEQA Air Quality Guidelines (BAAQMD 2012b) for consideration by lead agencies tasked with evaluating the air quality and climate change impacts of proposed new projects. The proposed Guidelines superseded the December 1999 Guidelines. As guidelines, they did not comprise enforceable rules or regulations per se, nevertheless, the guidelines established the following quantitative thresholds of significance for GHG emissions (MT = metric tonne, 1,000 kilograms or 2,204.6 pounds; SP = Service Population, residents + employees):

> Stationary Sources: 10,000 MT CO_2e per year

> Other than Stationary Sources: 1,100 MT CO_2e per year or 4.6 MT CO_2e per SP per year

> Plans: 6.6 MT CO_2e per SP per year

However, on March 5, 2012, the Alameda County Superior Court issued a judgment finding that the BAAQMD had failed to comply with CEQA when it adopted the thresholds of significance. The court did not determine whether the thresholds were valid on the merits, but found that the adoption of the thresholds was a project under CEQA. The court issued a writ of mandate ordering the BAAQMD to set aside the 2010 thresholds and cease dissemination of them until it had complied with CEQA. The BAAQMD is no longer recommending that the 2010 thresholds be used as a generally applicable measure of a project's significance. Lead agencies may continue to rely on the 1999 CEQA thresholds and may continue to make determinations regarding the significance of an individual project's air quality impacts based on the substantial evidence in the record for that project.

Neither Northern Sonoma County APCD nor Monterey Bay Unified APCD have applicable CEQA thresholds for greenhouse gases. Since the 1999 BAAQMD thresholds apply only to criteria pollutants, not greenhouse gases, no GHG thresholds currently apply (BAAQMD 1999, 2012b). Notwithstanding the writ of mandate, Program status would have been as follows under the 2010 Bay Area CEQA Guidelines:

> MVC activities do not meet the regulatory definition of a stationary source of air contaminants; therefore, the 10,000 metric tonne CO_2e per year stationary source GHG threshold would not apply.

> For nonstationary source land use development projects, BAAQMD's adopted "bright-line" threshold of significance differs from other proposed GHG thresholds currently under consideration in California. Under this threshold, in order to conclude that a project's GHG impacts are less than significant, a project would need to be in compliance with a "Qualified Greenhouse Gas Reduction Strategy," emit less than 1,100 metric tonnes CO_2e per year, or emit less than 4.6 metric tonnes CO_2e per year per capita service population (residents + employees). However, the Programs do not qualify as land use development projects; therefore, these GHG thresholds would not apply.

> There are no GHG thresholds for temporary construction emissions from mobile and portable sources, neither daily nor annual, whether for stationary or nonstationary source projects. Since MVC activities comprise mobile and portable sources similar to construction, no quantitative GHG significance thresholds would apply to the Programs since activities such as MVC are not specified, defined, or addressed in the guidelines.

3.6 Standards of Significance

The programmatic environmental impact report (PEIR) addresses the following qualitative standards of significance as based on CEQA Guidelines Appendix G. Would the project:

> Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?

> Conflict with any applicable plan, policy or regulation of an agency adopted for the purpose of reducing the emissions of greenhouse gases?

For the nine Programs, determinations made with respect to significance criteria are documented in the PEIR.

3.7 Quantification Methodology

As described in Section 3.3.4, operation of onroad fleet vehicles, offroad all-terrain vehicles, watercraft, aircraft, portable equipment, and small equipment would result in emissions of GHGs in engine exhaust. Detailed lists of equipment, estimated usage, and emission calculations are provided in Attachment A. Equipment lists and annual activity schedules were provided by the nine participating Districts. Emission calculations were performed using the most recent and applicable emission factors published by CARB (2008a) and EPA (2011b, 2012b).

Table 3-8 shows alternatives applicability by percentage as selected by the nine MVC Districts: surveillance, physical control, vegetation management, biological control, chemical control, or other non-chemical control. Table 3-9 shows land uses associated with selected alternatives: residential, commercial, industrial, agricultural, and open space. As shown in Tables 3-8 and 3-9, not all alternatives or land uses are applicable in all Districts, nor are all options or activities under any applicable alternative.

3.8 Estimated Emissions

Tables 3-10 through 3-15 show estimated ongoing annual GHG emissions as CO_2e by alternative and district. Table 3-16 shows estimated combined annual emissions across all nine Districts. On the local level, the combined "grand total" of 2,600 metric tonnes CO_2e per year comprises only 0.7 percent of the 375,200 metric tonnes CO_2e per year in the utility and commercial offroad sub-sectors (see Table 3-7); this is within EPA limits of precision of -2 to +5 percent for fossil fuel combustion (EPA 2012b). On the regional level, this is less than 0.003 percent of aggregate GHG emissions from the Bay Area (see Table 3-4). At the state and national levels, these emissions are negligible: 0.0005 and 0.00004 percent, respectively (see Table 3-3). Since the combined emissions of the nine Districts would not be substantial, neither would the incremental contribution of each District.

Table 3-8 Districts' Selected Alternatives Applicability

Districts	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control	Other Non-Chemical
Alameda County MAD	12%	7%	—	1%	64%	16%
Alameda County VCSD	100%	—	—	—	—	—
Contra Costa County MVCD	16%	0.07%	0.13%	0.07%	61%	23%
Marin-Sonoma Counties MVCD	20%	5%	13%	21%	25%	15%
Napa County MAD	11%	13%	7%	2%	64%	4%
Northern Salinas Valley MAD	3%	6%	29%	7%	39%	15%
San Mateo County MVCD	11%	0%	30%	21%	13%	24%
Santa Clara County VCD	47%	3%	—	13%	37%	—
Solano County MAD	24%	—	—	0.03%	46%	30%
Nine Districts Composite	**27%**	**4%**	**9%**	**7%**	**39%**	**14%**

Sources: Nine Districts

Table 3-9 Land Uses Associated with Selected Alternatives

Districts	Residential	Commercial	Industrial	Agricultural	Open Space
Alameda County MAD	●	●	●	●	●
Alameda County VCSD	●	●			
Contra Costa County MVCD	●	●	●	●	●
Marin-Sonoma Counties MVCD	●	●	●	●	●
Napa County MAD	●	●	●	●	●
Northern Salinas Valley MAD	●	●	●	●	●
San Mateo County MVCD	●	●	●		●
Santa Clara County VCD	●	●	●	●	●
Solano County MAD	●	●	●	●	●

Sources: Nine Districts

Table 3-10 Estimated Annual GHG Emissions for Surveillance Alternative

Districts	CO_2 MT/yr	CH_4 MT/yr	N_2O MT/yr	CO_2e MT/yr
Alameda County MAD	16.3	0.0009	0.0004	16.4
Alameda County VCSD	105.4	0.0060	0.0024	106.3
Contra Costa County MVCD	21.1	0.0012	0.0005	21.3
Marin-Sonoma Counties MVCD	51.0	0.0024	0.0016	51.6
Napa County MAD	8.9	0.0004	0.0002	8.9
Northern Salinas Valley MAD	1.6	0.0001	0.0001	1.6
San Mateo County MVCD	147.6	0.0084	0.0034	148.9
Santa Clara County VCD	169.7	0.0097	0.0039	171.2
Solano County MAD	35.5	0.0016	0.0009	35.8
Nine Districts Totals	**557.2**	**0.0309**	**0.0135**	**562.0**

Sources: CARB 2008a, EPA (2011b, 2012b)

SCCVCD = Emissions for equipment use associated with rodent and wildlife trapping are reported under Surveillance.

Table 3-11 Estimated Annual GHG Emissions for Physical Control Alternative

Districts	CO_2 MT/yr	CH_4 MT/yr	N_2O MT/yr	CO_2e MT/yr
Alameda County MAD	9.4	0.0005	0.0002	9.5
Alameda County VCSD	0.0	0.0000	0.0000	0.0
Contra Costa County MVCD	0.1	0.0000	0.0000	0.1
Marin-Sonoma Counties MVCD	14.0	0.0007	0.0004	14.1
Napa County MAD	10.4	0.0005	0.0003	10.5
Northern Salinas Valley MAD	3.4	0.0002	0.0001	3.4
San Mateo County MVCD	3.3	0.0002	0.0001	3.3
Santa Clara County VCD	11.0	0.0006	0.0003	11.1
Solano County MAD	0.0	0.0000	0.0000	0.0
Nine Districts Totals	**51.5**	**0.0027**	**0.0014**	**52.0**

Sources: CARB 2008a, EPA (2011b, 2012b)

Table 3-12 Estimated Annual GHG Emissions for Vegetation Management Alternative

Districts	CO_2 MT/yr	CH_4 MT/yr	N_2O MT/yr	CO_2e MT/yr
Alameda County MAD	0.0	0.0000	0.0000	0.0
Alameda County VCSD	0.0	0.0000	0.0000	0.0
Contra Costa County MVCD	0.2	0.0000	0.0000	0.2
Marin-Sonoma Counties MVCD	34.5	0.0016	0.0011	34.8
Napa County MAD	5.6	0.0003	0.0001	5.7
Northern Salinas Valley MAD	15.3	0.0007	0.0005	15.5
San Mateo County MVCD	393.2	0.0224	0.0092	396.5
Santa Clara County VCD	0.0	0.0000	0.0000	0.0
Solano County MAD	0.0	0.0000	0.0000	0.0
Nine Districts Totals	**448.8**	**0.0251**	**0.0109**	**452.7**

Sources: CARB 2008a, EPA (2011b, 2012b)

Table 3-13 Estimated Annual GHG Emissions for Biological Control Alternative

Districts	CO_2 MT/yr	CH_4 MT/yr	N_2O MT/yr	CO_2e MT/yr
Alameda County MAD	1.0	0.0001	0.0000	1.1
Alameda County VCSD	0.0	0.0000	0.0000	0.0
Contra Costa County MVCD	0.1	0.0000	0.0000	0.1
Marin-Sonoma Counties MVCD	54.4	0.0026	0.0017	55.0
Napa County MAD	1.3	0.0001	0.0000	1.4
Northern Salinas Valley MAD	3.7	0.0002	0.0001	3.7
San Mateo County MVCD	270.4	0.0154	0.0063	272.7
Santa Clara County VCD	46.9	0.0027	0.0011	47.3
Solano County MAD	0.0	0.0000	0.0000	0.0
Nine Districts Totals	**378.0**	**0.0210**	**0.0093**	**381.3**

Sources: CARB 2008a, EPA (2011b, 2012b)

Table 3-14 Estimated Annual GHG Emissions for Chemical Control Alternative

Districts	CO_2 MT/yr	CH_4 MT/yr	N_2O MT/yr	CO_2e MT/yr
Alameda County MAD	85.4	0.0048	0.0020	86.2
Alameda County VCSD	0.0	0.0000	0.0000	0.0
Contra Costa County MVCD	81.8	0.0046	0.0019	82.4
Marin-Sonoma Counties MVCD	64.2	0.0030	0.0020	64.9
Napa County MAD	52.3	0.0027	0.0013	52.8
Northern Salinas Valley MAD	20.9	0.0009	0.0007	21.1
San Mateo County MVCD	174.2	0.0099	0.0041	175.7
Santa Clara County VCD	131.8	0.0075	0.0031	132.9
Solano County MAD	67.1	0.0031	0.0018	67.7
Nine Districts Totals	**677.7**	**0.0367**	**0.0168**	**683.7**

Sources: CARB 2008a, EPA (2011b, 2012b)

Table 3-15 Estimated Annual GHG Emissions for Other Non-Chemical Control/Trapping Alternative

Districts	CO_2 MT/yr	CH_4 MT/yr	N_2O MT/yr	CO_2e MT/yr
Alameda County MAD	21.3	0.0012	0.0005	21.4
Alameda County VCSD	0.0	0.0000	0.0000	0.0
Contra Costa County MVCD	31.4	0.0018	0.0007	31.7
Marin-Sonoma Counties MVCD	38.0	0.0018	0.0012	38.4
Napa County MAD	2.9	0.0001	0.0001	2.9
Northern Salinas Valley MAD	8.0	0.0004	0.0003	8.1
San Mateo County MVCD	305.3	0.0174	0.0071	307.8
Santa Clara County VCD	0.0	0.0000	0.0000	0.0
Solano County MAD	44.6	0.0020	0.0012	45.0
Nine Districts Totals	**451.5**	**0.0248**	**0.0111**	**455.4**

Sources: CARB 2008a, EPA (2011b, 2012b)

Notes:

ACMAD = Emissions associated with ongoing District office administration and grounds maintenance activities are reported under this alternative.

SCCVCD = Emissions for equipment use associated with rodent and wildlife trapping are reported under Surveillance.

SCMAD = Emissions referenced in the “Other Non-Chemical” category emanate from vehicles and equipment used in connection with district activities not directly related to mosquito control, such as transportation to various meetings and facilities maintenance.

Table 3-16 Estimated Combined Annual GHG Emissions Across Nine Districts

Alternatives	CO_2 MT/yr	CH_4 MT/yr	N_2O MT/yr	CO_2e MT/yr
Surveillance	557	0.0309	0.0135	562
Physical Control	52	0.0027	0.0014	52
Vegetation Management	449	0.0251	0.0109	453
Biological Control	378	0.0210	0.0093	381
Chemical Control	678	0.0367	0.0168	684
Other Non-Chemical	451	0.0248	0.0111	455
All Alternatives Totals	**2,565**	**0.1410**	**0.0630**	**2,587**

Sources: CARB 2008a, EPA (2011b, 2012b)

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Integrated Mosquito and Vector Management Programs

ATTACHMENT A

CRITERIA POLLUTANT AND GREENHOUSE GAS EMISSIONS CALCULATIONS

A-1 Ambient Air Standards

Table 2-1 Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards		Federal Standards	
		ppmv	μg/m^3	ppmv	μg/m^3
Ozone (O_3)	1-hour	0.09	177	—	—
	8-hour	0.07	137	0.075	147
Nitrogen Dioxide (NO_2)	1-hour	0.18	338	0.100	188
	Annual	0.03	56	0.053	100
Sulfur Dioxide (SO_2)	1-hour	0.25	655	0.075	196
	3-hour Secondary	—	—	0.50	1,309
	24-hour	0.04	105	—	—
Carbon Monoxide (CO)	1-hour	20	22,898	35	40,071
	8-hour	9	10,304	9	10,304
	Lake Tahoe (8-hr)	6	6,869	—	—
Particulates (as PM_{10})	24-hour	—	50	—	150
	Annual	—	20	—	—
Particulates (as $PM_{2.5}$)	24-hour	—	—	—	35
	Annual Primary	—	12	—	12
	Annual Secondary	—	—	—	15
Lead (Pb)	30-day	—	1.5	—	—
	3-month (rolling)	—	—	—	0.15
Sulfates (as SO_4)	24-hour	—	25	—	—
Hydrogen Sulfide (H_2S)	1-hour	0.03	42	—	—
Vinyl Chloride (C_2H_3Cl)	24-hour	0.01	26	—	—
Visibility Reducing Particles	8-hour	Extinction coefficient of 0.23 per km; visibility of 10 miles or more (0.07 to 30 miles or more for Lake Tahoe) due to particles when relative humidity is less than 70%.		—	—

Sources: CARB 2012a, EPA 2011a

Notes:

ppmv = parts per million by volume

μg/m^3 = micrograms per cubic meter

The 1.5 μg/m^3 federal quarterly lead standard applied until 2008; 0.15 μg/m^3 rolling 3-month average thereafter

For gases, ug/m^3 calculated from ppmv based on molecular weight and standard conditions

Standard Temperature	25	deg C
Standard Molar Volume	24.465	liter/g-mole

A-2 Attainment Status

Table 2-2 Attainment Status Summary - Bay Area Region

Criteria Pollutant	State Designation	Federal Designation
Ozone (O_3) (1-hour)	Nonattainment	—
Ozone (O_3) (8-hour)	Nonattainment	Nonattainment(1)
Nitrogen Dioxide (NO_2) (1-hour)	Attainment	Unclassified(2)
Nitrogen Dioxide (NO_2) (annual)	Attainment	Attainment
Sulfur Dioxide (SO_2)	Attainment	Attainment
Carbon Monoxide (CO)	Attainment	Attainment
Resp. Particulates (as PM_{10}) (24-hour)	Nonattainment	Unclassified(2)
Resp. Particulates (as PM_{10}) (annual)	Nonattainment	—
Fine Particulates (as $PM_{2.5}$) (24-hour)	—	Nonattainment
Fine Particulates (as $PM_{2.5}$) (annual)	Nonattainment	Attainment
Lead (Pb)	Attainment	Attainment
Sulfates (as SO_4)	Attainment	—
Hydrogen Sulfide (H_2S)	Unclassified(2)	—
Vinyl Chloride (C_2H_3Cl)	n/d	—
Visibility	Unclassified(2)	—

Source: BAAQMD 2012a

Notes:

(1) The 0.08 ppmv federal 8-hour ozone standard applied until 2008; 0.075 ppmv thereafter

(2) At the time of designation, if the available data does not support a designation of attainment or nonattainment, the area is designated as unclassified.

n/d - no data/information available

Table 2-3 CEQA Significance Thresholds - BAAQMD (1999)

Applicability	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$
Operation, tons/year	15	CAAQS	15	40(2)	15	10(2)
Operation, pounds/year	30,000	CAAQS	30,000	80,000	30,000	20,000
Operation, pounds/day	80	CAAQS	80	—	80	—
Construction, pounds/day	80	CAAQS	80	—	80(3)	—

Sources: BAAQMD 1999, 2012b (see note 4), 40 CFR 51.166

Notes:

(1) No violation of CAAQS for CO (9 ppmv for 1 hour, 20 ppmv for 8 hours)

(2) Prevention of Significant Deterioration (PSD), annual only

(3) For construction projects, applies to exhaust emissions only, not fugitive dusts

(4) On March 5, 2012 the Alameda County Superior Court issued a judgment finding that the District had failed to comply with CEQA when it adopted the thresholds of significance. The court did not determine whether the thresholds were valid on the merits, but found that the adoption of the thresholds was a project under CEQA. The court issued a writ of mandate ordering the District to set aside the 2010 thresholds and cease dissemination of them until the District had complied with CEQA. The District is no longer recommending that the 2010 thresholds be used as a generally applicable measure of a project's significance. Lead Districts may continue to rely on the District's 1999 thresholds and may continue to make determinations regarding the significance of an individual project's air quality impacts based on the substantial evidence in the record for that project.

Table 2-4, 3-8 Districts' Selected Alternatives Applicability

Districts	Surveillance	Physical Control	Vegetation Management	Biological Control	Chemical Control	Other Non-Chemical
Alameda County MAD	12%	7%	—	1%	64%	16%
Alameda County VCSD	100%	—	—	—	—	—
Contra Costa County MVCD	16%	0.07%	0.13%	0.07%	61%	23%
Marin-Sonoma Counties MVCD	20%	5%	13%	21%	25%	15%
Napa County MAD	11%	13%	7%	2%	64%	4%
Northern Salinas Valley MAD	3%	6%	29%	7%	39%	15%
San Mateo County MVCD	11%	0%	30%	21%	13%	24%
Santa Clara County VCD	47%	3%	—	13%	37%	—
Solano County MAD	24%	—	—	0.03%	46%	30%
Nine Districts Composite	**27%**	**4%**	**9%**	**7%**	**39%**	**14%**

Sources: Nine Districts

Table 2-5, 3-9 Land Uses Associated with Selected Alternatives

Districts	Residential	Commercial	Industrial	Agricultural	Open Space
Alameda County MAD	■	■	■	■	■
Alameda County VCSD	■	■			
Contra Costa County MVCD	■	■	■	■	■
Marin-Sonoma Counties MVCD	■	■	■	■	■
Napa County MAD	■	■	■	■	■
Northern Salinas Valley MAD	■	■	■	■	■
San Mateo County MVCD	■	■	■		■
Santa Clara County VCD	■	■	■	■	■
Solano County MAD	■	■	■	■	■

Sources: Nine Districts

Table 2-6 Estimated Annual Criteria Emissions for Surveillance Alternative

Districts	VOC lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
Alameda County MAD	44	1,051	44	1.4	4.1	2.7
Alameda County VCSD	148	1,392	138	2.3	19.4	12.5
Contra Costa County MVCD	38	521	35	0.7	4.8	3.1
Marin-Sonoma Counties MVCD	132	2,515	298	3.5	19.5	13.9
Napa County MAD	21	718	40	0.8	2.6	1.7
Northern Salinas Valley MAD	3	57	18	0.1	0.8	0.6
San Mateo County MVCD	365	7,550	321	10.2	38.5	24.9
Santa Clara County VCD	240	2,300	226	3.7	31.3	20.3
Solano County MAD	73	1,710	225	2.6	9.0	5.9
Nine Districts Totals	**1,065**	**17,813**	**1,345**	**25.2**	**130.1**	**85.6**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

Table 2-7 Estimated Annual Criteria Emissions for Physical Control Alternative

Districts	VOC lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
Alameda County MAD	25	606	25	0.8	2.4	1.5
Alameda County VCSD	0	0	0	0.0	0.0	0.0
Contra Costa County MVCD	0	2	0	0.0	0.0	0.0
Marin-Sonoma Counties MVCD	36	689	82	1.0	5.3	3.8
Napa County MAD	25	841	47	1.0	3.1	2.0
Northern Salinas Valley MAD	7	120	38	0.2	1.7	1.3
San Mateo County MVCD	8	170	7	0.2	0.9	0.6
Santa Clara County VCD	16	149	15	0.2	2.0	1.3
Solano County MAD	0	0	0	0.0	0.0	0.0
Nine Districts Totals	**117**	**2,577**	**214**	**3.4**	**15.4**	**10.5**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

Table 2-8 Estimated Annual Criteria Emissions for Vegetation Management Alternative

Districts	VOC lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
Alameda County MAD	0	0	0	0.0	0.0	0.0
Alameda County VCSD	0	0	0	0.0	0.0	0.0
Contra Costa County MVCD	0	4	0	0.0	0.0	0.0
Marin-Sonoma Counties MVCD	89	1,700	201	2.4	13.2	9.4
Napa County MAD	14	456	26	0.5	1.7	1.1
Northern Salinas Valley MAD	30	540	173	0.7	7.4	5.9
San Mateo County MVCD	973	20,105	855	27.0	102.6	66.4
Santa Clara County VCD	0	0	0	0.0	0.0	0.0
Solano County MAD	0	0	0	0.0	0.0	0.0
Nine Districts Totals	**1,106**	**22,805**	**1,255**	**30.7**	**124.9**	**82.9**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

Table 2-9 Estimated Annual Criteria Emissions for Biological Control Alternative

Districts	VOC lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
Alameda County MAD	3	67	3	0.1	0.3	0.2
Alameda County VCSD	0	0	0	0.0	0.0	0.0
Contra Costa County MVCD	0	2	0	0.0	0.0	0.0
Marin-Sonoma Counties MVCD	141	2,683	318	3.7	20.8	14.8
Napa County MAD	3	109	6	0.1	0.4	0.3
Northern Salinas Valley MAD	7	130	42	0.2	1.8	1.4
San Mateo County MVCD	669	13,828	588	18.6	70.5	45.7
Santa Clara County VCD	66	636	62	1.0	8.7	5.6
Solano County MAD	0	2	0	0.0	0.0	0.0
Nine Districts Totals	**890**	**17,458**	**1,019**	**23.7**	**102.5**	**68.0**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

Table 2-10 Estimated Annual Criteria Emissions for Chemical Control Alternative

Districts	VOC lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
Alameda County MAD	231	5,523	229	7.4	21.6	14.0
Alameda County VCSD	0	0	0	0.0	0.0	0.0
Contra Costa County MVCD	146	2,013	136	2.9	18.6	12.1
Marin-Sonoma Counties MVCD	167	3,168	375	4.4	24.5	17.5
Napa County MAD	127	4,244	238	4.9	15.6	10.1
Northern Salinas Valley MAD	41	737	236	1.0	10.2	8.1
San Mateo County MVCD	431	8,907	379	12.0	45.4	29.4
Santa Clara County VCD	186	1,786	175	2.9	24.3	15.7
Solano County MAD	138	3,235	426	4.8	17.1	11.1
Nine Districts Totals	**1,467**	**29,613**	**2,194**	**40.2**	**177.4**	**118.0**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

Table 2-11 Estimated Annual Criteria Emissions for Other Non-Chemical Alternative

Districts	VOC lbs/year	CO lbs/year	NO_X lbs/year	SO_X lbs/year	PM_{10} lbs/year	$PM_{2.5}$ lbs/year
Alameda County MAD	58	1,374	57	1.8	5.4	3.5
Alameda County VCSD	0	0	0	0.0	0.0	0.0
Contra Costa County MVCD	56	774	52	1.1	7.2	4.6
Marin-Sonoma Counties MVCD	99	1,873	222	2.6	14.5	10.3
Napa County MAD	7	236	13	0.3	0.9	0.6
Northern Salinas Valley MAD	16	284	91	0.4	3.9	3.1
San Mateo County MVCD	755	15,609	664	21.0	79.6	51.6
Santa Clara County VCD	0	0	0	0.0	0.0	0.0
Solano County MAD	92	2,151	283	3.2	11.4	7.4
Nine Districts Totals	**1,082**	**22,300**	**1,382**	**30.4**	**122.8**	**81.1**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

Table 2-12 Estimated Combined Annual Criteria Emissions Across Nine Districts

Alternatives	VOC tons/yr	CO tons/yr	NO_X tons/yr	SO_X tons/yr	PM_{10} tons/yr	$PM_{2.5}$ tons/yr
Surveillance	0.53	8.91	0.67	0.01	0.07	0.04
Physical Control	0.06	1.29	0.11	0.00	0.01	0.01
Vegetation Management	0.55	11.40	0.63	0.02	0.06	0.04
Biological Control	0.45	8.73	0.51	0.01	0.05	0.03
Chemical Control	0.73	14.81	1.10	0.02	0.09	0.06
Other Non-Chemical	0.54	11.15	0.69	0.02	0.06	0.04
All Alternatives Totals	**2.86**	**56.28**	**3.70**	**0.08**	**0.34**	**0.22**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

Table 2-13 Estimated Peak Daily Criteria Emissions for Applicable Alternatives - Simultaneous Operations

Districts	VOC lbs/day	CO lbs/day	NO_X lbs/day	SO_X lbs/day	PM_{10} lbs/day	$PM_{2.5}$ lbs/day
Alameda County MAD	5.8	177.5	39.9	0.3	0.9	0.6
Alameda County VCSD	0.6	5.5	0.6	0.0	0.1	0.0
Contra Costa County MVCD	7.8	152.7	23.7	0.2	1.2	0.8
Marin-Sonoma Counties MVCD	15.3	394.0	44.1	0.5	2.1	1.5
Napa County MAD	6.6	255.0	31.2	0.3	0.9	0.6
Northern Salinas Valley MAD	1.7	31.1	10.0	0.0	0.4	0.3
San Mateo County MVCD	25.3	810.2	31.8	1.0	2.1	1.4
Santa Clara County VCD	2.7	26.9	3.0	0.0	0.4	0.2
Solano County MAD	9.2	283.7	43.8	0.4	1.2	0.8
Peak Total Daily Emissions	**75**	**2,137**	**228**	**3**	**9**	**6**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

Table 2-14 Estimated Highest Quarterly Criteria Emissions for Applicable Alternatives - Concurrent Operations

Districts	VOC lbs/qtr	CO lbs/qtr	NO_X lbs/qtr	SO_X lbs/qtr	PM_{10} lbs/qtr	$PM_{2.5}$ lbs/qtr
Alameda County MAD	184	5,215	197	7	15	10
Alameda County VCSD	38	355	35	1	5	3
Contra Costa County MVCD	105	1,627	105	2	13	9
Marin-Sonoma Counties MVCD	223	4,369	485	6	33	23
Napa County MAD	79	3,114	168	3	10	6
Northern Salinas Valley MAD	30	493	177	1	8	6
San Mateo County MVCD	1,329	28,290	1,125	38	140	91
Santa Clara County VCD	145	1,383	136	2	19	12
Solano County MAD	136	3,702	413	5	15	10
Nine Districts Totals	**2,268**	**48,549**	**2,841**	**65**	**258**	**170**
Average Total Daily Emissions	**35**	**747**	**44**	**1**	**4**	**3**

Sources: CARB 2008a, EPA (1973, 1991a, 1991b, 2011b, 2011c, 2012c)

Table 3-10 Estimated Annual GHG Emissions for Surveillance Alternative

Districts	CO_2 MT/yr	CH_4 MT/yr	N_2O MT/yr	CO_2e MT/yr
Alameda County MAD	16.3	0.0009	0.0004	16.4
Alameda County VCSD	105.4	0.0060	0.0024	106.3
Contra Costa County MVCD	21.1	0.0012	0.0005	21.3
Marin-Sonoma Counties MVCD	51.0	0.0024	0.0016	51.6
Napa County MAD	8.9	0.0004	0.0002	8.9
Northern Salinas Valley MAD	1.6	0.0001	0.0001	1.6
San Mateo County MVCD	147.6	0.0084	0.0034	148.9
Santa Clara County VCD	169.7	0.0097	0.0039	171.2
Solano County MAD	35.5	0.0016	0.0009	35.8
Nine Districts Totals	**557.2**	**0.0309**	**0.0135**	**562.0**

Sources: CARB 2008a, EPA (2011b, 2012b)

Table 3-11 Estimated Annual GHG Emissions for Physical Control Alternative

Districts	CO_2 MT/yr	CH_4 MT/yr	N_2O MT/yr	CO_2e MT/yr
Alameda County MAD	9.4	0.0005	0.0002	9.5
Alameda County VCSD	0.0	0.0000	0.0000	0.0
Contra Costa County MVCD	0.1	0.0000	0.0000	0.1
Marin-Sonoma Counties MVCD	14.0	0.0007	0.0004	14.1
Napa County MAD	10.4	0.0005	0.0003	10.5
Northern Salinas Valley MAD	3.4	0.0002	0.0001	3.4
San Mateo County MVCD	3.3	0.0002	0.0001	3.3
Santa Clara County VCD	11.0	0.0006	0.0003	11.1
Solano County MAD	0.0	0.0000	0.0000	0.0
Nine Districts Totals	**51.5**	**0.0027**	**0.0014**	**52.0**

Sources: CARB 2008a, EPA (2011b, 2012b)

Table 3-12 Estimated Annual GHG Emissions for Vegetation Management Alternativ

Districts	CO_2 MT/yr	CH_4 MT/yr	N_2O MT/yr	CO_2e MT/yr
Alameda County MAD	0.0	0.0000	0.0000	0.0
Alameda County VCSD	0.0	0.0000	0.0000	0.0
Contra Costa County MVCD	0.2	0.0000	0.0000	0.2
Marin-Sonoma Counties MVCD	34.5	0.0016	0.0011	34.8
Napa County MAD	5.6	0.0003	0.0001	5.7
Northern Salinas Valley MAD	15.3	0.0007	0.0005	15.5
San Mateo County MVCD	393.2	0.0224	0.0092	396.5
Santa Clara County VCD	0.0	0.0000	0.0000	0.0
Solano County MAD	0.0	0.0000	0.0000	0.0
Nine Districts Totals	**448.8**	**0.0251**	**0.0109**	**452.7**

Sources: CARB 2008a, EPA (2011b, 2012b)

Table 3-13 Estimated Annual GHG Emissions for Biological Control Alternative

Districts	CO_2 MT/yr	CH_4 MT/yr	N_2O MT/yr	CO_2e MT/yr
Alameda County MAD	1.0	0.0001	0.0000	1.1
Alameda County VCSD	0.0	0.0000	0.0000	0.0
Contra Costa County MVCD	0.1	0.0000	0.0000	0.1
Marin-Sonoma Counties MVCD	54.4	0.0026	0.0017	55.0
Napa County MAD	1.3	0.0001	0.0000	1.4
Northern Salinas Valley MAD	3.7	0.0002	0.0001	3.7
San Mateo County MVCD	270.4	0.0154	0.0063	272.7
Santa Clara County VCD	46.9	0.0027	0.0011	47.3
Solano County MAD	0.0	0.0000	0.0000	0.0
Nine Districts Totals	**378.0**	**0.0210**	**0.0093**	**381.3**

Sources: CARB 2008a, EPA (2011b, 2012b)

Table 3-14 Estimated Annual GHG Emissions for Chemical Control Alternative

Districts	CO_2 MT/yr	CH_4 MT/yr	N_2O MT/yr	CO_2e MT/yr
Alameda County MAD	85.4	0.0048	0.0020	86.2
Alameda County VCSD	0.0	0.0000	0.0000	0.0
Contra Costa County MVCD	81.8	0.0046	0.0019	82.4
Marin-Sonoma Counties MVCD	64.2	0.0030	0.0020	64.9
Napa County MAD	52.3	0.0027	0.0013	52.8
Northern Salinas Valley MAD	20.9	0.0009	0.0007	21.1
San Mateo County MVCD	174.2	0.0099	0.0041	175.7
Santa Clara County VCD	131.8	0.0075	0.0031	132.9
Solano County MAD	67.1	0.0031	0.0018	67.7
Nine Districts Totals	**677.7**	**0.0367**	**0.0168**	**683.7**

Sources: CARB 2008a, EPA (2011b, 2012b)

Table 3-15 Estimated Annual GHG Emissions for Other Non-Chemical Alternative

Districts	CO_2 MT/yr	CH_4 MT/yr	N_2O MT/yr	CO_2e MT/yr
Alameda County MAD	21.3	0.0012	0.0005	21.4
Alameda County VCSD	0.0	0.0000	0.0000	0.0
Contra Costa County MVCD	31.4	0.0018	0.0007	31.7
Marin-Sonoma Counties MVCD	38.0	0.0018	0.0012	38.4
Napa County MAD	2.9	0.0001	0.0001	2.9
Northern Salinas Valley MAD	8.0	0.0004	0.0003	8.1
San Mateo County MVCD	305.3	0.0174	0.0071	307.8
Santa Clara County VCD	0.0	0.0000	0.0000	0.0
Solano County MAD	44.6	0.0020	0.0012	45.0
Nine Districts Totals	**451.5**	**0.0248**	**0.0111**	**455.4**

Sources: CARB 2008a, EPA (2011b, 2012b)

Table 3-16 Estimated Combined Annual GHG Emissions Across Nine Districts

Alternatives	CO_2 MT/yr	CH_4 MT/yr	N_2O MT/yr	CO_2e MT/yr
Surveillance	557	0.0309	0.0135	562
Physical Control	52	0.0027	0.0014	52
Vegetation Management	449	0.0251	0.0109	453
Biological Control	378	0.0210	0.0093	381
Chemical Control	678	0.0367	0.0168	684
Other Non-Chemical	451	0.0248	0.0111	455
All Alternatives Totals	**2,565**	**0.1410**	**0.0630**	**2,587**

Sources: CARB 2008a, EPA (2011b, 2012b)

A-4 Dry Air Composition

Table 3-1 Standard Composition of Dry Air

Principal Gas	Chemical Symbol	Gas MW g/mole	Concentration ppmv	Fraction percent	Fraction MW g/mole
Nitrogen	N_2	28.014	780,805.00	78.080500	21.873471
Oxygen	O_2	31.998	209,440.00	20.944000	6.701661
Argon	Ar	39.948	9,340.00	0.934000	0.373114
Carbon Dioxide	CO_2	44.009	387.69	0.038769	0.017062
Neon	Ne	20.183	18.21	0.001821	0.000368
Helium	He	4.003	5.24	0.000524	0.000021
Methane	CH_4	16.043	1.81	0.000181	0.000029
Krypton	Kr	83.800	1.14	0.000114	0.000096
Hydrogen	H_2	2.016	0.50	0.000050	0.000001
Nitrous Oxide	N_2O	44.013	0.32	0.000032	0.000014
Xenon	Xe	31.300	0.09	0.000009	0.000003
Totals			**1,000,000.00**	**100.000**	**28.966**

Sources: UIG 2008, EPA 2012b, du Pont 1971, Jennings 1970

<u>Notes:</u>

MW = molecular weight, g/mole

ppmv = parts per million by volume (10^{-6})

A-5 Fuels

Table 3-2 Typical GHG Contents of Common Fuels

Fuel	CO_2 kg/mmBTU	CH_4 kg/mmBTU	N_2O kg/mmBTU	CO_2 e lb/mmBTU	Energy BTU/gal	CO_2 e lb/gal
Diesel Fuel No. 2	73.96	0.0105	0.0006	163.97	138,300	22.68
Kerosene	73.19	0.0105	0.0006	162.27	138,700	22.51
Jet Fuel	72.23	0.0105	0.0006	160.17	135,000	21.62
Motor Gasoline	71.35	0.0105	0.0006	158.23	122,600	19.40
Aviation Gasoline	69.15	0.0105	0.0006	153.38	120,200	18.44
Propane	62.22	0.0053	0.0001	137.49	91,300	12.55
Pipeline Natural Gas	53.02	0.0053	0.0001	117.20	—	—

Sources: EPA 2012b, EPA 2011b

Notes:

kg/mmBTU - kilograms per million British Thermal Units

lb/mmBTU - pounds per million British Thermal Units

BTU - the amount of energy (heat) required to raise 1 pound of liquid water 1 degree Fahrenheit from 39 to 40 °F

A-6 GHG Inventories

Table 3-3 Greenhouse Gas Emissions Inventories - Gross Basis

Summary Year	National MMT CO_2 e	California MMT CO_2 e	Bay Area MMT CO_2 e
2005	7,204	482.5	—
2006	7,159	481.9	—
2007	7,253	488.8	95.8
2008	7,048	484.7	—
2009	6,608	456.8	—
5-Year Average	**7,054**	**478.9**	—
Average Annual Variation	**2.6%**	**1.8%**	—

Sources: EPA 2012b, CARB 2011b, BAAQMD 2010b

Notes:

MMT - million metric tonnes (annual)

1 metric tonne = 1,000 kilograms or 2,204.6 pounds

2009 is most recent CARB published data; Bay Area for 2007 only

Table 3-4 Bay Area GHG Emissions by Sector

End-Use Sector	District Emissions	
	Percent	MMT CO_2 e
Industrial / Commercial	36.4%	34.9
Residential Fuel Use	7.1%	6.8
Local Electric Power Generation	8.5%	8.1
Imported Electric Power Generation	7.4%	7.1
Offroad Equipment	3.0%	2.9
Transportation	36.4%	34.9
Agriculture / Farming	1.2%	1.1
Totals	**100.0%**	**95.8**

Source: BAAQMD 2010b

Notes:

MMT - million metric tonnes (annual)

1 metric tonne = 1,000 kilograms or 2,204.6 pounds

A-6 GHG Inventories

Table 3-5 Bay Area GHG Emissions by County

County	District Emissions	
	Percent	MMT CO_2 e
Alameda	16.4%	15.7
Contra Costa	32.9%	31.5
Marin	2.8%	2.7
Napa	1.8%	1.7
San Francisco	7.4%	7.1
San Mateo	8.9%	8.5
Santa Clara	19.6%	18.8
Solano (within BAAQMD)	5.9%	5.7
Sonoma (within BAAQMD)	4.3%	4.1
Totals	**100.0%**	**95.8**

Source: BAAQMD 2010b

Notes:

MMT - million metric tonnes (annual)

1 metric tonne = 1,000 kilograms or 2,204.6 pounds

Table 3-6 Mobile Sectors GHG Emissions by County

County	Offroad MT CO_2 e	Transportation MT CO_2 e
Alameda	569,000	8,351,000
Contra Costa	406,000	4,998,000
Marin	99,000	1,286,000
Napa	50,000	917,000
San Francisco	415,000	2,673,000
San Mateo	270,000	4,850,000
Santa Clara	790,000	7,859,000
Solano (within BAAQMD)	147,000	1,834,000
Sonoma (within BAAQMD)	175,000	2,103,000
Totals	**2,921,000**	**34,871,000**

Source: BAAQMD 2010b

Notes:

MT - metric tonnes (annual)

1 metric tonne = 1,000 kilograms or 2,204.6 pounds

Values rounded to nearest 1,000 tonnes

"Offroad" is offroad equipment category

Table 3-7 Offroad Sub-Sectors GHG Emissions by County

County	Utility MT CO_2 e	Commercial MT CO_2 e	Combined MT CO_2 e
Alameda	29,800	49,900	79,700
Contra Costa	20,300	26,900	47,200
Marin	7,900	12,300	20,200
Napa	2,900	4,300	7,200
San Francisco	14,200	43,900	58,100
San Mateo	14,200	27,200	41,400
Santa Clara	32,900	56,500	89,400
Solano (within BAAQMD)	3,900	6,800	10,700
Sonoma (within BAAQMD)	7,800	13,500	21,300
Totals	**133,900**	**241,300**	**375,200**

Source: BAAQMD 2010b

Notes:

MT - metric tonnes (annual)

1 metric tonne = 1,000 kilograms or 2,204.6 pounds

Values rounded to nearest 100 tonnes

"Utility" is small landscaping equipment selected for comparisons to Districts' activities

"Commercial" is light commercial equipment selected for comparisons to Districts' activities

Alameda County Mosquito Abatement District Vehicles and Equipments

Land Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
2001 6x6 Polaris ATV	500cc, liquid cooled, 4 stroke	20%				80%		100%	Gasoline
Birchmeier Flox 2.5 gal backpack sprayer	N/A					100%		100%	Zero
Birchmeier Flox 5 gal backpack sprayer	N/A					100%		100%	Zero
Brush Cutter	Kawasaki 33.33cc, 2cycle		100%					100%	50:1 gas/oil mix
Cargo Van	4.2L V6						100%	100%	Gasoline
Chainsaw	59cc, 2cycle		100%					100%	50:1 gas/oil mix
Chapin Premier Pro+ 2 gal sprayer Model 21220	N/A					100%		100%	Zero
Chapin Premier Series 3 gal polyethylene sprayer Model 2123	N/A					100%		100%	Zero
Electric Spray Rig	SHURflow electric pumps					100%		100%	Zero
Gas Spray Rig	Honda HX120, 4 stroke					100%		100%	Gasoline
Hudson X-Pert Stainless Steel 3 gal. sprayer	N/A					100%		100%	Zero
Jeep	4.0L Inline V6	10%				80%	10%	100%	Gasoline
Leaf Blower	Type #135R, 2cycle						100%	100%	50:1 gas/oil mix
Maruyama Mist Duster MD155DX	Kawasaki 40.2cc, 2cycle					100%		100%	50:1 gas/oil mix
Pickup Truck	5.4L V8	100%						100%	Gasoline
Pickup Truck	5.0L V8	40%	5%		5%	10%	40%	100%	Gasoline
Pickup Truck	4.6L V8	40%	5%		5%	10%	40%	100%	Gasoline
Pickup Truck	4.3L V6	40%	5%		5%	10%	40%	100%	Gasoline
Pickup Truck	4.0L V6	40%	5%		5%	10%	40%	100%	Gasoline
Pickup Truck	3.0L V6	40%	5%		5%	10%	40%	100%	Gasoline
SUV	4.0L V6						100%	100%	Gasoline

Water Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
2005 Hydro Traxx 6/wheel	1100cc, liquid cooled, 4cycle, 4 stroke	20%				80%		100%	Gasoline
2008 ARGO 8/Wheel Avenger	674cc, liquid cooled, 4 stroke carburetor	20%				80%		100%	Gasoline
2010/2012 ARGO 8/Wheel 750 HDI EFI	747cc, liquid cooled, 4 stroke EFI	20%				80%		100%	Gasoline
Gas Spray Rig	Honda HX120, 4 stroke					100%		100%	Gasoline
Hydro centrifugal hydraulic spray pump	N/A					100%		100%	Zero

Aerial Applications	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
1960 Hiller Soloy helicopter (Alpine) 120 gal material tank	Allison 250-C20J turboshaft, 420 shp					100%		100%	Jet A
1968 Bell 206 Jet Ranger helicopter (Alpine) 120 gal material tank	Allison 250-C20J turboshaft, 420 shp					100%		100%	Jet A
1989 Bell 206 Jet Ranger helicopter (Alpine) 120 gal material tank	Allison 250-C20J turboshaft, 420 shp					100%		100%	Jet A
Isolair 4400 bucket system (helicopter-mounted)	N/A					100%		100%	Zero
Isolair 4500 broadcaster (helicopter-mounted)	N/A					100%		100%	Zero
Isolair Air spray system model 3900 (helicopter-mounted)	N/A					100%		100%	Zero
	100.00%	**12%**	**7%**	**0%**	**1%**	**64%**	**16%**	**3200%**	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Sport	500	30.5	0.86	26.0	1	1	2	0	0	2	
None				0	1	0	0	0	0		
None				0	1	0	0	0	0		
2-stroke	33	2.0	0.92	1.9	1	0	0	0	1	0.5	
Onroad LD				LD	1	8	15	6	5		60
2-stroke	59	3.6	0.92	3.3	1	0	0	0	1	0.5	
None				0	1	0	0	0	0		
None				0	1	0	0	0	0		
Electric				0	6	0	10	20	1	0.15	
Utility	120	7.3	0.56	4.1	2	30	15	0	0	0.25	
None				0	1	0	0	0	0		
Onroad LD				LD	2	0	33	62	22		180
2-stroke	17	1.0	0.92	1.0	1	1	0	0	0	0.25	
2-stroke	40	2.4	0.92	2.2	1	8	5	7	0	0.75	
Onroad LD				LD	1	0	43	62	22		180
Onroad LD				LD	4	55	60	55	40		90
Onroad LD				LD	1	0	0	1	0		120
Onroad LD				LD	2	58	60	58	55		75
Onroad LD				LD	2	53	60	55	50		90
Onroad LD				LD	1	50	57	55	45		120
Onroad LD				LD	1	20	15	20	15		60

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Sport	1100	67.1	0.86	58.0	1	30	15	0	0	4	
Sport	674	41.1	0.86	35.0	1	30	15	0	0	4	
Sport	747	45.6	0.86	39.0	2	30	15	0	0	4	
Utility	120	7.3	0.56	4.1	3	30	15	0	0	4	
None				0	1	30	15	0	0	4	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Turbine				420	1	0	1	0	0	4	
Turbine				420	1	0	1	0	0	4	
Turbine				420	1	0	1	0	0	4	
None				0	1	0	1	0	0	4	
None				0	1	0	1	0	0	4	
None				0	1	0	1	0	0	4	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
2		4		6	
0.5		0.5		0.5	
	60		900		2040
0.5		0.5		0.5	
0.9		18		27.9	
0.5		15		22.5	
	360		22320		42120
0.25		0.25		0.25	
0.75		6		15	
	180		11160		22860
	360		21600		75600
	120		120		120
	150		9000		34650
	180		10800		39240
	120		6840		24840
	60		1200		4200

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
4		120		180	
4		120		180	
8		240		360	
12		360		540	
4		120		180	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
4		4		4	
4		4		4	
4		4		4	
4		4		4	
4		4		4	
4		4		4	

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.14742	4.89060	0.12714	0.00655	0.00780	0.00507	12.26940	0.00069	0.00030	12.37828
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.07028	1.25727	0.00781	0.00113	0.01487	0.00967	1.94266	0.00011	0.00005	1.95989
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.17578	1.63572	0.01953	0.00196	0.02583	0.01679	3.11454	0.00018	0.00008	3.14218
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.02057	2.05585	0.01752	0.00176	0.00199	0.00129	3.54712	0.00020	0.00009	3.57859
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.03699	0.66172	0.00411	0.00060	0.00783	0.00509	1.02245	0.00006	0.00003	1.03152
0.08138	1.45578	0.00904	0.00131	0.01722	0.01119	2.24939	0.00013	0.00006	2.26935
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.32886	10.90980	0.28362	0.01462	0.01740	0.01131	27.37020	0.00155	0.00068	27.61309
0.19845	6.58350	0.17115	0.00882	0.01050	0.00683	16.51650	0.00093	0.00041	16.66307
0.22113	7.33590	0.19071	0.00983	0.01170	0.00761	18.40410	0.00104	0.00046	18.56742
0.02057	2.05585	0.01752	0.00176	0.00199	0.00129	3.54712	0.00020	0.00009	3.57859
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Surveillance	12%
Physical Control	7%
Vegetation Management	0%
Biological Control	1%
Chemical Control	64%
Other Non-Chemical	16%
CHECKSUM	**100%**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
0.29	9.78	0.25	0.01	0.02	0.01	24.54	0.00	0.00	24.76
0.04	0.63	0.00	0.00	0.01	0.00	0.97	0.00	0.00	0.98
0.04	0.40	0.04	0.00	0.01	0.00	66.15	0.00	0.00	66.71
0.09	0.82	0.01	0.00	0.01	0.01	1.56	0.00	0.00	1.57
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.01	1.03	0.01	0.00	0.00	0.00	1.77	0.00	0.00	1.79
0.25	2.38	0.24	0.00	0.03	0.02	396.93	0.02	0.01	400.26
0.01	0.17	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.26
0.06	1.09	0.01	0.00	0.01	0.01	1.69	0.00	0.00	1.70
0.13	1.19	0.12	0.00	0.02	0.01	198.46	0.01	0.00	200.13
0.25	2.38	0.24	0.00	0.03	0.02	396.93	0.02	0.01	400.26
0.08	0.79	0.08	0.00	0.01	0.01	132.31	0.01	0.00	133.42
0.11	0.99	0.10	0.00	0.01	0.01	165.39	0.01	0.00	166.77
0.13	1.19	0.12	0.00	0.02	0.01	198.46	0.01	0.00	200.13
0.08	0.79	0.08	0.00	0.01	0.01	132.31	0.01	0.00	133.42
0.04	0.40	0.04	0.00	0.01	0.00	66.15	0.00	0.00	66.71
1.62	**24.01**	**1.33**	**0.03**	**0.20**	**0.13**	**1783.87**	**0.10**	**0.04**	**1798.85**
VOC	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
lbs/day	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**
1.32	43.64	1.13	0.06	0.07	0.05	109.48	0.01	0.00	110.45
0.79	26.33	0.68	0.04	0.04	0.03	66.07	0.00	0.00	66.65
1.77	58.69	1.53	0.08	0.09	0.06	147.23	0.01	0.00	148.54
0.25	24.67	0.21	0.02	0.02	0.02	42.57	0.00	0.00	42.94
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.13	**153.33**	**3.55**	**0.19**	**0.23**	**0.15**	**365.34**	**0.02**	**0.01**	**368.59**
VOC	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
lbs/day	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**
0.01	0.04	11.67	0.02	0.16	0.10	2166.39	0.06	0.07	2189.17
0.01	0.04	11.67	0.02	0.16	0.10	2166.39	0.06	0.07	2189.17
0.01	0.04	11.67	0.02	0.16	0.10	2166.39	0.06	0.07	2189.17
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.02	**0.13**	**35.02**	**0.06**	**0.48**	**0.31**	**6499.18**	**0.18**	**0.21**	**6567.50**
5.76	**177.47**	**39.90**	**0.29**	**0.90**	**0.59**	**8648.40**	**0.30**	**0.26**	**8734.93**
0.70	21.63	4.86	0.04	0.11	0.07	1054.02	0.04	0.03	1064.57
0.40	12.48	2.81	0.02	0.06	0.04	608.09	0.02	0.02	614.17
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.04	1.39	0.31	0.00	0.01	0.00	67.57	0.00	0.00	68.24
3.69	113.69	25.56	0.19	0.58	0.38	5540.38	0.19	0.17	5595.82
0.92	28.28	6.36	0.05	0.14	0.09	1378.34	0.05	0.04	1392.13
5.76	**177.47**	**39.90**	**0.29**	**0.90**	**0.59**	**8648.40**	**0.30**	**0.26**	**8734.93**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
0.6	19.6	0.5	0.0	0.0	0.0	49.1	0.0	0.0	49.5
0.0	0.6	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0
0.6	5.9	0.6	0.0	0.1	0.1	992.3	0.1	0.0	1000.6
0.1	0.8	0.0	0.0	0.0	0.0	1.6	0.0	0.0	1.6
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.3	30.8	0.3	0.0	0.0	0.0	53.2	0.0	0.0	53.7
15.7	147.4	14.6	0.2	2.1	1.3	24609.4	1.4	0.6	24815.8
0.0	0.2	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3
0.5	8.7	0.1	0.0	0.1	0.1	13.5	0.0	0.0	13.6
7.8	73.7	7.3	0.1	1.0	0.7	12304.7	0.7	0.3	12407.9
15.2	142.6	14.1	0.2	2.0	1.3	23815.6	1.4	0.6	24015.3
0.1	0.8	0.1	0.0	0.0	0.0	132.3	0.0	0.0	133.4
6.3	59.4	5.9	0.1	0.8	0.5	9923.1	0.6	0.2	10006.4
7.6	71.3	7.1	0.1	1.0	0.6	11907.8	0.7	0.3	12007.7
4.8	45.2	4.5	0.1	0.6	0.4	7541.6	0.4	0.2	7604.8
0.8	7.9	0.8	0.0	0.1	0.1	1323.1	0.1	0.0	1334.2
60.47	**615.05**	**55.81**	**0.96**	**7.90**	**5.11**	**92668.46**	**5.30**	**2.15**	**93445.77**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
39.46	1309.18	34.03	1.75	2.09	1.36	3284.42	0.19	0.08	3313.57
23.81	790.02	20.54	1.06	1.26	0.82	1981.98	0.11	0.05	1999.57
53.07	1760.62	45.77	2.36	2.81	1.83	4416.98	0.25	0.11	4456.18
7.40	740.11	6.31	0.63	0.72	0.47	1276.96	0.07	0.03	1288.29
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
123.75	**4599.92**	**106.65**	**5.81**	**6.87**	**4.47**	**10960.35**	**0.62**	**0.27**	**11057.61**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
0.01	0.04	11.67	0.02	0.16	0.10	2166.39	0.06	0.07	2189.17
0.01	0.04	11.67	0.02	0.16	0.10	2166.39	0.06	0.07	2189.17
0.01	0.04	11.67	0.02	0.16	0.10	2166.39	0.06	0.07	2189.17
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.02	**0.13**	**35.02**	**0.06**	**0.48**	**0.31**	**6499.18**	**0.18**	**0.21**	**6567.50**
184.24	**5215.10**	**197.48**	**6.83**	**15.25**	**9.88**	**110127.99**	**6.10**	**2.63**	**111070.88**
22.45	635.59	24.07	0.83	1.86	1.20	13421.85	0.74	0.32	13536.76
12.95	366.69	13.88	0.48	1.07	0.69	7743.37	0.43	0.18	7809.67
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.44	40.74	1.54	0.05	0.12	0.08	860.37	0.05	0.02	867.74
118.03	3340.92	126.51	4.37	9.77	6.33	70550.75	3.91	1.68	71154.78
29.36	831.16	31.47	1.09	2.43	1.58	17551.65	0.97	0.42	17701.92
184.24	**5215.10**	**197.48**	**6.83**	**15.25**	**9.88**	**110127.99**	**6.10**	**2.63**	**111070.88**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
0.9	29.3	0.8	0.0	0.0	0.0	73.6	0.0	0.0	74.3
0.0	0.6	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0
1.4	13.5	1.3	0.0	0.2	0.1	2249.2	0.1	0.1	2268.1
0.1	0.8	0.0	0.0	0.0	0.0	1.6	0.0	0.0	1.6
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.5	46.3	0.4	0.0	0.0	0.0	79.8	0.0	0.0	80.5
29.6	278.1	27.6	0.5	3.9	2.5	46440.3	2.7	1.1	46829.9
0.0	0.2	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3
1.2	21.8	0.1	0.0	0.3	0.2	33.7	0.0	0.0	34.0
16.1	151.0	15.0	0.2	2.1	1.4	25204.8	1.4	0.6	25416.2
53.1	499.2	49.5	0.8	6.9	4.5	83354.4	4.8	1.9	84053.6
0.1	0.8	0.1	0.0	0.0	0.0	132.3	0.0	0.0	133.4
24.3	228.8	22.7	0.4	3.2	2.1	38204.1	2.2	0.9	38524.6
27.6	259.1	25.7	0.4	3.6	2.3	43264.9	2.5	1.0	43627.8
17.4	164.0	16.3	0.3	2.3	1.5	27387.9	1.6	0.6	27617.6
2.9	27.7	2.8	0.0	0.4	0.2	4630.8	0.3	0.1	4669.6
175.23	**1721.34**	**162.18**	**2.73**	**22.94**	**14.83**	**271058.83**	**15.52**	**6.28**	**273332.41**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
59.19	1963.76	51.05	2.63	3.13	2.04	4926.64	0.28	0.12	4970.36
35.72	1185.03	30.81	1.59	1.89	1.23	2972.97	0.17	0.07	2999.35
79.61	2640.92	68.66	3.54	4.21	2.74	6625.48	0.37	0.16	6684.27
11.11	1110.16	9.46	0.95	1.07	0.70	1915.44	0.11	0.05	1932.44
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
185.63	**6899.88**	**159.97**	**8.71**	**10.31**	**6.70**	**16440.52**	**0.93**	**0.41**	**16586.42**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
0.01	0.04	11.67	0.02	0.16	0.10	2166.39	0.06	0.07	2189.17
0.01	0.04	11.67	0.02	0.16	0.10	2166.39	0.06	0.07	2189.17
0.01	0.04	11.67	0.02	0.16	0.10	2166.39	0.06	0.07	2189.17
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.02	**0.13**	**35.02**	**0.06**	**0.48**	**0.31**	**6499.18**	**0.18**	**0.21**	**6567.50**
360.87	**8621.35**	**357.17**	**11.50**	**33.72**	**21.84**	**293998.53**	**16.63**	**6.90**	**296486.32**
43.98	1050.73	43.53	1.40	4.11	2.66	35831.07	2.03	0.84	36134.27
25.37	606.19	25.11	0.81	2.37	1.54	20671.77	1.17	0.49	20846.69
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.82	67.35	2.79	0.09	0.26	0.17	2296.86	0.13	0.05	2316.30
231.18	5523.05	228.81	7.37	21.60	13.99	188342.81	10.65	4.42	189936.55
57.51	1374.03	56.92	1.83	5.37	3.48	46856.02	2.65	1.10	47252.51
360.87	**8621.35**	**357.17**	**11.50**	**33.72**	**21.84**	**293998.53**	**16.63**	**6.90**	**296486.32**

Alameda County Vector Control Services District Vehicles and Equipments

Land Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
GMC Pickup Truck (3)	V-8	100%						100%	Gasoline
Ford Pickup Truck (1)	V-8	100%						100%	Gasoline
Dodge Pickup Truck (8)	V-8	100%						100%	Gasoline
Nissan Pickup Truck (2)	V-8	100%						100%	Gasoline

Water Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel

Aerial Applications	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel

100.00%	100%	0%	0%	0%	0%	0%	400%	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Onroad LD				LD	3	62	64	63	62		60
Onroad LD				LD	1	62	64	63	62		60
Onroad LD				LD	8	62	64	63	62		60
Onroad LD				LD	2	62	64	63	62		60

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
	180		11520		45180
	60		3840		15060
	480		30720		120480
	120		7680		30120

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit

Surveillance	100%
Physical Control	0%
Vegetation Management	0%
Biological Control	0%
Chemical Control	0%
Other Non-Chemical	0%
CHECKSUM	**100%**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
0.13	1.19	0.12	0.00	0.02	0.01	198.46	0.01	0.00	200.13
0.04	0.40	0.04	0.00	0.01	0.00	66.15	0.00	0.00	66.71
0.34	3.17	0.31	0.01	0.04	0.03	529.23	0.03	0.01	533.67
0.08	0.79	0.08	0.00	0.01	0.01	132.31	0.01	0.00	133.42
0.59	**5.55**	**0.55**	**0.01**	**0.08**	**0.05**	**926.16**	**0.05**	**0.02**	**933.93**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
0.59	**5.55**	**0.55**	**0.01**	**0.08**	**0.05**	**926.16**	**0.05**	**0.02**	**933.93**

0.59	5.55	0.55	0.01	0.08	0.05	926.16	0.05	0.02	933.93
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.59	**5.55**	**0.55**	**0.01**	**0.08**	**0.05**	**926.16**	**0.05**	**0.02**	**933.93**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
8.1	76.1	7.5	0.1	1.1	0.7	12701.6	0.7	0.3	12808.2
2.7	25.4	2.5	0.0	0.4	0.2	4233.9	0.2	0.1	4269.4
21.6	202.9	20.1	0.3	2.8	1.8	33871.0	1.9	0.8	34155.1
5.4	50.7	5.0	0.1	0.7	0.5	8467.8	0.5	0.2	8538.8
37.75	**355.01**	**35.20**	**0.57**	**4.94**	**3.19**	**59274.27**	**3.39**	**1.37**	**59771.43**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
37.75	**355.01**	**35.20**	**0.57**	**4.94**	**3.19**	**59274.27**	**3.39**	**1.37**	**59771.43**

37.75	355.01	35.20	0.57	4.94	3.19	59274.27	3.39	1.37	59771.43
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37.75	**355.01**	**35.20**	**0.57**	**4.94**	**3.19**	**59274.27**	**3.39**	**1.37**	**59771.43**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
31.7	298.3	29.6	0.5	4.1	2.7	49814.2	2.9	1.2	50232.0
10.6	99.4	9.9	0.2	1.4	0.9	16604.7	1.0	0.4	16744.0
84.6	795.6	78.9	1.3	11.1	7.2	132837.9	7.6	3.1	133952.0
21.2	198.9	19.7	0.3	2.8	1.8	33209.5	1.9	0.8	33488.0
148.07	**1392.29**	**138.07**	**2.25**	**19.37**	**12.52**	**232466.29**	**13.31**	**5.39**	**234416.09**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
148.07	**1392.29**	**138.07**	**2.25**	**19.37**	**12.52**	**232466.29**	**13.31**	**5.39**	**234416.09**

148.07	1392.29	138.07	2.25	19.37	12.52	232466.29	13.31	5.39	234416.09
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
148.07	**1392.29**	**138.07**	**2.25**	**19.37**	**12.52**	**232466.29**	**13.31**	**5.39**	**234416.09**

Contra Costa County Mosquito and Vector Control District Vehicles and Equipments

Land Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
A-1 Mist Blower	Honda GX160					100%		100%	Gasoline
Chevy Pickup Truck	4.8 L	68%	1%	2%	1%	28%		100%	Gasoline
Chevy Pickup Truck	5.3 L	68%	1%	2%	1%	28%		100%	Gasoline
Chevy Pickup Truck	5.7 L						100%	100%	Gasoline
Chevy Pickup Truck	6.0 L						100%	100%	Gasoline
Chevy Pickup Truck	7.4 L						100%	100%	Gasoline
Chevy Sedan	4.3 L						100%	100%	Gasoline
Chevy Van	4.3 L						100%	100%	Gasoline
Clarke-Cougar ULV	Briggs and Stratton					100%		100%	Gasoline
Colt-T ULV	Tecumseh TCII					100%		100%	50:1 gas/oil mix
Hand Sprayer – LECO ULV Model 800	Briggs and Stratton					100%		100%	Gasoline
Hand Sprayer – Mozzie ULV Model 250	Electric					100%		100%	Zero
LECO P-1 ULV	Robin Eco25					100%		100%	50:1 gas/oil mix
Maruyama Mist Duster MD155DX	Kawasaki					100%		100%	50:1 gas/oil mix
MicroGen ED2-20	Briggs and Stratton					100%		100%	Gasoline
Stihl SR420	Stihl					100%		100%	50:1 gas/oil mix
Storm Mister	Honda GX390					100%		100%	Gasoline
Toyota SUV	2.4 L						100%	100%	Gasoline
Transfer Tank Rears 200SS	Honda GX160						100%	100%	Gasoline

Water Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
Argo ATV	Kawasaki 26 hp	25%				75%		100%	Gasoline
Gregor Boat	Johnson 15 hp 4 stroke	100%						100%	Gasoline
Honda ATV	Honda 475cc 4 stroke	80%				20%		100%	Gasoline
Kvichak Conquest Boat	Johnson 115 hp 2 stroke	50%				50%		100%	50:1 gas/oil mix
Polaris ATV	Polaris 300cc 4 stroke	80%				20%		100%	Gasoline

Aerial Applications	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
1960 Hiller Soloy helicopter	Allison 250-C20J turboshaft 420 shp					100%		100%	Jet A
1968 Bell 206 Jet Ranger helicopter	Allison 250-C20J turboshaft 420 shp					100%		100%	Jet A
1982 Eagle DW-1	Lycoming 300hp (IO-540-M1B5D)					100%		100%	Jet A
1987 Air Tractor AT-501	Pratt & Whitney 600 shp					100%		100%	Jet A
1989 Bell 206 Jet Ranger helicopter	Allison 250-C20J turboshaft 420 shp					100%		100%	Jet A
1992 Air Tractor AT-502 Turbine (PT6A series turboprop)	507 kW (680shp) Pratt & Whitney Canada					100%		100%	Jet A
	100.00%	16%	0%	0%	0%	61%	23%	3000%	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Utility	160	9.8	0.56	5.5	1		1	8		1.2	
Onroad LD				LD	15	30	65	65	30		60
Onroad LD				LD	3	15	30	30	15		45
Onroad LD				LD	6	0	5	5	0		15
Onroad LD				LD	6	0	5	5	0		15
Onroad LD				LD	7	0	65	65	0		83
Onroad LD				LD	1	12	12	12	12		15
Onroad LD				LD	1	2	0	0	2		30
Utility	146	8.9	0.56	5.0	1			9		2.5	
2-stroke	49	3.0	0.92	2.8	1		6	8		0.75	
Utility	146	8.9	0.56	5.0	1		1	7		2	
Electric				0	2		1	7		2	
2-stroke	25	1.5	0.92	1.4	2		1			1	
2-stroke	40	2.4	0.92	2.2	3	4	22	15		1.75	
Utility	146	8.9	0.56	5.0	1		1			0.5	
2-stroke	59	3.6	0.92	3.3	1		1			0.5	
Utility	390	23.8	0.56	13.0	1		1			0.5	
Onroad LD				LD	2	8	8	8	8		30
Utility	160	9.8	0.56	5.5	1		1	1		0.5	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Sport	495	30.2	0.86	26.0	7	2	7.5	3.5		2	
Sport	285	17.4	0.86	15.0	1		1			0.5	
Sport	475	29.0	0.86	25.0	1		8	10		1	
2-stroke	2049	125.0	0.92	115.0	1		1			0.5	
Sport	300	18.3	0.86	16.0	2		8	10		1	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Turbine				420	1		1			1	
Turbine				420	1		1			1	
Turbine				300	1		1			1	
Turbine				600	1		1			1	
Turbine				420	1		1			1	
Turbine				680	1		1			1	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
1.2		9.6		10.8	
	900		58500		171000
	135		4050		12150
	90		450		900
	90		450		900
	577.5		37537.5		75075
	15		180		720
	30		60		120
2.5		22.5		22.5	
0.75		6		10.5	
2		14		16	
4		28		32	
2		2		2	
5.25		115.5		215.25	
0.5		0.5		0.5	
0.5		0.5		0.5	
0.5		0.5		0.5	
	60		480		1920
0.5		0.5		1	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
14		105		182	
0.5		0.5		0.5	
1		10		18	
0.5		0.5		0.5	
2		20		36	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
1		1		1	
1		1		1	
1		1		1	
1		1		1	
1		1		1	
1		1		1	

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.02759	2.75785	0.02350	0.00236	0.00267	0.00173	4.75833	0.00027	0.00012	4.80055
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.02508	2.50713	0.02136	0.00215	0.00243	0.00158	4.32575	0.00024	0.00011	4.36414
0.10357	1.85281	0.01151	0.00167	0.02191	0.01424	2.86286	0.00016	0.00007	2.88827
0.02508	2.50713	0.02136	0.00215	0.00243	0.00158	4.32575	0.00024	0.00011	4.36414
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.05179	0.92641	0.00575	0.00083	0.01096	0.00712	1.43143	0.00008	0.00004	1.44413
0.08138	1.45578	0.00904	0.00131	0.01722	0.01119	2.24939	0.00013	0.00006	2.26935
0.02508	2.50713	0.02136	0.00215	0.00243	0.00158	4.32575	0.00024	0.00011	4.36414
0.17578	1.63572	0.01953	0.00196	0.02583	0.01679	3.11454	0.00018	0.00008	3.14218
0.12285	4.07550	0.10595	0.00546	0.00650	0.00423	10.22450	0.00058	0.00025	10.31523
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.02759	2.75785	0.02350	0.00236	0.00267	0.00173	4.75833	0.00027	0.00012	4.80055

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.14742	4.89060	0.12714	0.00655	0.00780	0.00507	12.26940	0.00069	0.00030	12.37828
0.08505	2.82150	0.07335	0.00378	0.00450	0.00293	7.07850	0.00040	0.00018	7.14132
0.14175	4.70250	0.12225	0.00630	0.00750	0.00488	11.79750	0.00067	0.00029	11.90219
6.12563	57.00237	0.68063	0.06845	0.90004	0.58503	90.44750	0.00512	0.00224	91.25014
0.09072	3.00960	0.07824	0.00403	0.00480	0.00312	7.55040	0.00043	0.00019	7.61740

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131
0.00097	0.00782	2.08440	0.00368	0.02842	0.01848	386.85600	0.01069	0.01239	390.92236
0.00194	0.01563	4.16880	0.00736	0.05685	0.03695	773.71200	0.02138	0.02479	781.84472
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131
0.00220	0.01772	4.72464	0.00835	0.06443	0.04188	876.87360	0.02424	0.02809	886.09069

Surveillance	16%
Physical Control	0%
Vegetation Management	0%
Biological Control	0%
Chemical Control	61%
Other Non-Chemical	23%
CHECKSUM	**100%**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
0.03	3.31	0.03	0.00	0.00	0.00	5.71	0.00	0.00	5.76
0.63	5.94	0.59	0.01	0.08	0.05	992.31	0.06	0.02	1000.64
0.09	0.89	0.09	0.00	0.01	0.01	148.85	0.01	0.00	150.10
0.06	0.59	0.06	0.00	0.01	0.01	99.23	0.01	0.00	100.06
0.06	0.59	0.06	0.00	0.01	0.01	99.23	0.01	0.00	100.06
0.41	3.81	0.38	0.01	0.05	0.03	636.74	0.04	0.01	642.08
0.01	0.10	0.01	0.00	0.00	0.00	16.54	0.00	0.00	16.68
0.02	0.20	0.02	0.00	0.00	0.00	33.08	0.00	0.00	33.35
0.06	6.27	0.05	0.01	0.01	0.00	10.81	0.00	0.00	10.91
0.08	1.39	0.01	0.00	0.02	0.01	2.15	0.00	0.00	2.17
0.05	5.01	0.04	0.00	0.00	0.00	8.65	0.00	0.00	8.73
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.10	1.85	0.01	0.00	0.02	0.01	2.86	0.00	0.00	2.89
0.43	7.64	0.05	0.01	0.09	0.06	11.81	0.00	0.00	11.91
0.01	1.25	0.01	0.00	0.00	0.00	2.16	0.00	0.00	2.18
0.09	0.82	0.01	0.00	0.01	0.01	1.56	0.00	0.00	1.57
0.06	2.04	0.05	0.00	0.00	0.00	5.11	0.00	0.00	5.16
0.04	0.40	0.04	0.00	0.01	0.00	66.15	0.00	0.00	66.71
0.01	1.38	0.01	0.00	0.00	0.00	2.38	0.00	0.00	2.40
2.26	**43.50**	**1.52**	**0.05**	**0.34**	**0.22**	**2145.34**	**0.12**	**0.05**	**2163.36**
VOC	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
lbs/day	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**
2.06	68.47	1.78	0.09	0.11	0.07	171.77	0.01	0.00	173.30
0.04	1.41	0.04	0.00	0.00	0.00	3.54	0.00	0.00	3.57
0.14	4.70	0.12	0.01	0.01	0.00	11.80	0.00	0.00	11.90
3.06	28.50	0.34	0.03	0.45	0.29	45.22	0.00	0.00	45.63
0.18	6.02	0.16	0.01	0.01	0.01	15.10	0.00	0.00	15.23
5.49	**109.10**	**2.44**	**0.14**	**0.58**	**0.38**	**247.43**	**0.01**	**0.01**	**249.63**
VOC	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
lbs/day	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**
0.00	0.01	2.92	0.01	0.04	0.03	541.60	0.01	0.02	547.29
0.00	0.01	2.92	0.01	0.04	0.03	541.60	0.01	0.02	547.29
0.00	0.01	2.08	0.00	0.03	0.02	386.86	0.01	0.01	390.92
0.00	0.02	4.17	0.01	0.06	0.04	773.71	0.02	0.02	781.84
0.00	0.01	2.92	0.01	0.04	0.03	541.60	0.01	0.02	547.29
0.00	0.02	4.72	0.01	0.06	0.04	876.87	0.02	0.03	886.09
0.01	**0.07**	**19.73**	**0.03**	**0.27**	**0.17**	**3662.24**	**0.10**	**0.12**	**3700.73**

7.76	**152.67**	**23.69**	**0.23**	**1.18**	**0.77**	**6055.01**	**0.24**	**0.17**	**6113.72**

1.22	23.97	3.72	0.04	0.19	0.12	950.64	0.04	0.03	959.85
0.01	0.10	0.02	0.00	0.00	0.00	4.04	0.00	0.00	4.08
0.01	0.20	0.03	0.00	0.00	0.00	8.07	0.00	0.00	8.15
0.01	0.10	0.02	0.00	0.00	0.00	4.04	0.00	0.00	4.08
4.71	92.67	14.38	0.14	0.72	0.47	3675.39	0.14	0.11	3711.03
1.81	35.62	5.53	0.05	0.28	0.18	1412.83	0.06	0.04	1426.53
7.76	**152.67**	**23.69**	**0.23**	**1.18**	**0.77**	**6055.01**	**0.24**	**0.17**	**6113.72**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
0.3	26.5	0.2	0.0	0.0	0.0	45.7	0.0	0.0	46.1
41.1	386.3	38.3	0.6	5.4	3.5	64500.5	3.7	1.5	65041.5
2.8	26.7	2.7	0.0	0.4	0.2	4465.4	0.3	0.1	4502.9
0.3	3.0	0.3	0.0	0.0	0.0	496.2	0.0	0.0	500.3
0.3	3.0	0.3	0.0	0.0	0.0	496.2	0.0	0.0	500.3
26.4	247.9	24.6	0.4	3.4	2.2	41387.8	2.4	1.0	41734.9
0.1	1.2	0.1	0.0	0.0	0.0	198.5	0.0	0.0	200.1
0.0	0.4	0.0	0.0	0.0	0.0	66.2	0.0	0.0	66.7
0.6	56.4	0.5	0.0	0.1	0.0	97.3	0.0	0.0	98.2
0.6	11.1	0.1	0.0	0.1	0.1	17.2	0.0	0.0	17.3
0.4	35.1	0.3	0.0	0.0	0.0	60.6	0.0	0.0	61.1
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.1	1.9	0.0	0.0	0.0	0.0	2.9	0.0	0.0	2.9
9.4	168.1	1.0	0.2	2.0	1.3	259.8	0.0	0.0	262.1
0.0	1.3	0.0	0.0	0.0	0.0	2.2	0.0	0.0	2.2
0.1	0.8	0.0	0.0	0.0	0.0	1.6	0.0	0.0	1.6
0.1	2.0	0.1	0.0	0.0	0.0	5.1	0.0	0.0	5.2
0.3	3.2	0.3	0.0	0.0	0.0	529.2	0.0	0.0	533.7
0.0	1.4	0.0	0.0	0.0	0.0	2.4	0.0	0.0	2.4
82.91	**976.22**	**68.82**	**1.36**	**11.62**	**7.52**	**112634.47**	**6.45**	**2.61**	**113579.43**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
15.5	513.5	13.3	0.7	0.8	0.5	1288.3	0.1	0.0	1299.7
0.0	1.4	0.0	0.0	0.0	0.0	3.5	0.0	0.0	3.6
1.4	47.0	1.2	0.1	0.1	0.0	118.0	0.0	0.0	119.0
3.1	28.5	0.3	0.0	0.5	0.3	45.2	0.0	0.0	45.6
1.8	60.2	1.6	0.1	0.1	0.1	151.0	0.0	0.0	152.3
21.82	**650.64**	**16.51**	**0.87**	**1.44**	**0.94**	**1606.03**	**0.09**	**0.04**	**1620.29**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
0.0	0.0	2.9	0.0	0.0	0.0	541.6	0.0	0.0	547.3
0.0	0.0	2.9	0.0	0.0	0.0	541.6	0.0	0.0	547.3
0.0	0.0	2.1	0.0	0.0	0.0	386.9	0.0	0.0	390.9
0.0	0.0	4.2	0.0	0.1	0.0	773.7	0.0	0.0	781.8
0.0	0.0	2.9	0.0	0.0	0.0	541.6	0.0	0.0	547.3
0.0	0.0	4.7	0.0	0.1	0.0	876.9	0.0	0.0	886.1
0.01	**0.07**	**19.73**	**0.03**	**0.27**	**0.17**	**3662.24**	**0.10**	**0.12**	**3700.73**
104.73	**1626.93**	**105.06**	**2.26**	**13.33**	**8.63**	**117902.74**	**6.64**	**2.77**	**118900.44**
16.44	255.43	16.50	0.35	2.09	1.36	18510.73	1.04	0.43	18667.37
0.07	1.08	0.07	0.00	0.01	0.01	78.60	0.00	0.00	79.27
0.14	2.17	0.14	0.00	0.02	0.01	157.20	0.01	0.00	158.53
0.07	1.08	0.07	0.00	0.01	0.01	78.60	0.00	0.00	79.27
63.57	987.55	63.77	1.37	8.09	5.24	71566.96	4.03	1.68	72172.57
24.44	379.62	24.51	0.53	3.11	2.01	27510.64	1.55	0.65	27743.44
104.73	**1626.93**	**105.06**	**2.26**	**13.33**	**8.63**	**117902.74**	**6.64**	**2.77**	**118900.44**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
0.3	29.8	0.3	0.0	0.0	0.0	51.4	0.0	0.0	51.8
120.1	1129.2	112.0	1.8	15.7	10.2	188539.8	10.8	4.4	190121.2
8.5	80.2	8.0	0.1	1.1	0.7	13396.3	0.8	0.3	13508.6
0.6	5.9	0.6	0.0	0.1	0.1	992.3	0.1	0.0	1000.6
0.6	5.9	0.6	0.0	0.1	0.1	992.3	0.1	0.0	1000.6
52.7	495.8	49.2	0.8	6.9	4.5	82775.6	4.7	1.9	83469.9
0.5	4.8	0.5	0.0	0.1	0.0	793.9	0.0	0.0	800.5
0.1	0.8	0.1	0.0	0.0	0.0	132.3	0.0	0.0	133.4
0.6	56.4	0.5	0.0	0.1	0.0	97.3	0.0	0.0	98.2
1.1	19.5	0.1	0.0	0.2	0.1	30.1	0.0	0.0	30.3
0.4	40.1	0.3	0.0	0.0	0.0	69.2	0.0	0.0	69.8
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.1	1.9	0.0	0.0	0.0	0.0	2.9	0.0	0.0	2.9
17.5	313.4	1.9	0.3	3.7	2.4	484.2	0.0	0.0	488.5
0.0	1.3	0.0	0.0	0.0	0.0	2.2	0.0	0.0	2.2
0.1	0.8	0.0	0.0	0.0	0.0	1.6	0.0	0.0	1.6
0.1	2.0	0.1	0.0	0.0	0.0	5.1	0.0	0.0	5.2
1.3	12.7	1.3	0.0	0.2	0.1	2116.9	0.1	0.0	2134.7
0.0	2.8	0.0	0.0	0.0	0.0	4.8	0.0	0.0	4.8
204.71	**2203.15**	**175.33**	**3.23**	**28.24**	**18.27**	**290488.02**	**16.63**	**6.73**	**292924.84**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
26.8	890.1	23.1	1.2	1.4	0.9	2233.0	0.1	0.1	2252.8
0.0	1.4	0.0	0.0	0.0	0.0	3.5	0.0	0.0	3.6
2.6	84.6	2.2	0.1	0.1	0.1	212.4	0.0	0.0	214.2
3.1	28.5	0.3	0.0	0.5	0.3	45.2	0.0	0.0	45.6
3.3	108.3	2.8	0.1	0.2	0.1	271.8	0.0	0.0	274.2
35.75	**1112.99**	**28.53**	**1.49**	**2.18**	**1.42**	**2765.96**	**0.16**	**0.07**	**2790.51**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
0.0	0.0	2.9	0.0	0.0	0.0	541.6	0.0	0.0	547.3
0.0	0.0	2.9	0.0	0.0	0.0	541.6	0.0	0.0	547.3
0.0	0.0	2.1	0.0	0.0	0.0	386.9	0.0	0.0	390.9
0.0	0.0	4.2	0.0	0.1	0.0	773.7	0.0	0.0	781.8
0.0	0.0	2.9	0.0	0.0	0.0	541.6	0.0	0.0	547.3
0.0	0.0	4.7	0.0	0.1	0.0	876.9	0.0	0.0	886.1
0.01	**0.07**	**19.73**	**0.03**	**0.27**	**0.17**	**3662.24**	**0.10**	**0.12**	**3700.73**
240.47	**3316.22**	**223.60**	**4.75**	**30.69**	**19.86**	**296916.22**	**16.89**	**6.92**	**299416.08**
37.75	520.65	35.11	0.75	4.82	3.12	46615.85	2.65	1.09	47008.32
0.16	2.21	0.15	0.00	0.02	0.01	197.94	0.01	0.00	199.61
0.32	4.42	0.30	0.01	0.04	0.03	395.89	0.02	0.01	399.22
0.16	2.21	0.15	0.00	0.02	0.01	197.94	0.01	0.00	199.61
145.97	2012.94	135.73	2.88	18.63	12.06	180228.15	10.25	4.20	181745.56
56.11	773.78	52.17	1.11	7.16	4.63	69280.45	3.94	1.61	69863.75
240.47	**3316.22**	**223.60**	**4.75**	**30.69**	**19.86**	**296916.22**	**16.89**	**6.92**	**299416.08**

Marin-Sonoma Counties Mosquito and Vector Control District Vehicles and Equipments

Land Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
05 Dodge 2500 4X4 truck	5.9 liter				50%	50%		100%	Diesel
1 gal back can sprayer	N/A							0%	Zero
12v Argo tank	Electric 12v							0%	Zero
12v Spray tank for bike	Electric 12v							0%	Zero
2000 Gal Water truck 97 Ford Louisville (Alpine) GW 33,000lbs	7.9 liter				50%	50%		100%	Diesel
2000 Gal Water truck 99 Int 4700 (Alpine) GW 33,000lbs	7.6 liter				50%	50%		100%	Diesel
2500 Gal Water Truck 01 Int 8000 (Alpine) GW 52,000lbs	10.3 liter				50%	50%		100%	Diesel
3 gal back can sprayer	N/A							0%	Zero
30-gallon sprayer	Electric 12v							0%	Zero
40 foot portable lift (Ameriquip)	Electric (battery operated)							0%	Zero
5 x 8 trailer	N/A							0%	Zero
50-gallon sprayer	Electric 12v							0%	Zero
6 x 10 trailer	N/A							0%	Zero
6 x 12 GO-4 trailer	N/A							0%	Zero
7 x 14 Flatbed trailer	N/A							0%	Zero
99 Ford F550 Flat Bed 4X4 truck	7.3 liter				50%	50%		100%	Diesel
Agnique spray bottle	N/A							0%	Zero
Arctic Cat 500 TBX (off road)	30.5 cubic inches 31hp	50%			40%	10%		100%	Gasoline
Argo Avenger (off road)	41.1 cubic inches 26 hp	60%	5%	5%	15%	15%		100%	Gasoline
Argo Conquest (off road)	37.8 cubic inches 21 hp	60%	5%	5%	15%	15%		100%	Gasoline
Argo seeder	Electric 12v							0%	Zero
Backpack fogger (Curtis Dynaflow)	40 cc					100%		100%	50:1 gas/oil mix
Ball Mix Trailer 1000 Gal Tank	N/A							0%	Zero
Becomist Fogger	Electric 12v					100%		100%	Zero
Big Mix Trailer 800 Gal Tank	N/A							0%	Zero
Bike seeder	Electric 12v							0%	Zero
Bike Sprayer	Electric 12v							0%	Zero
Boat trailer	N/A							0%	Zero
Chevy 1500 truck	3.6 liter	60%	5%	10%	15%	10%		100%	Gasoline
Chevy 3500 truck	454 cu in						100%	100%	Diesel
Chevy HD 2500 truck	6.0 liter	50%	5%	10%	20%	15%		100%	Diesel
Chevy Traverse	3.6 liter						100%	100%	Gasoline
Chevy W4500	6.0 liter						100%	100%	Diesel
Dondi Rotary Ditcher DMR 35-B	N/A		100%					100%	Zero
Dump Truck 5 ton	390 cu in						100%	100%	Diesel
Echo backpack blower	40.2 cc							0%	50:1 gas/oil mix
Echo Chainsaw	30.1 cc			100%				100%	50:1 gas/oil mix
Echo hand held blower	17 cc							0%	50:1 gas/oil mix
Echo hedge trimmer	21.2 cc			100%				100%	50:1 gas/oil mix
Electramist fogger	Electric 12v					100%		100%	Zero
EVS Mosquito Trap	Electric 6v							0%	Zero
Faye Mosquito Trap	N/A							0%	Zero
Ford E-150 Van	4.2 liter						100%	100%	Gasoline
Ford Explorer	4.0 liter						100%	100%	Gasoline
Ford Explorer 4x4	4.0 liter						100%	100%	Gasoline
Ford F-150 truck 4x4	4.6 liter	65%	5%	10%	10%	10%		100%	Gasoline
Ford F-250 truck	Varied 5.4 liter to 6.2 liter	50%	5%	10%	20%	15%		100%	Gasoline
Ford F-250 truck 4x4	Varied 5.4 liter to 6.2 liter	50%	5%	10%	20%	15%		100%	Gasoline
Ford F-350 truck	460 cu in	50%	5%	10%	25%	10%		100%	Diesel
Ford F-550 4x4	6.0 liter		25%	25%	25%	25%		100%	Diesel
Ford Ranger truck 2x4	3.0 liter	70%			15%	15%		100%	Gasoline
Ford Ranger truck 4x4	3.0 liter	80%					20%	100%	Gasoline
Gator (off road)	37.7 cubic inches 18hp	70%	10%	10%	5%	5%		100%	Gasoline
GO-4 Catch Basin Rig	60.9 cubic inches 55hp	50%			20%	30%		100%	Gasoline
GO-4 Spray tank	Electric 12v							0%	Zero
Hand fogger	3.0 cu in					100%		100%	50:1 gas/oil mix
High Pressure sprayer	41.9 cu in 21 hp				60%	40%		100%	Gasoline
Horn seeder	N/A							0%	Zero
Husqavarna Chainsaw	55.5 cc			100%				100%	50:1 gas/oil mix
Husqavarna Weedeater	21.7 cc			100%				100%	50:1 gas/oil mix
Intelli sprayer 150	14.8 cu in 9 hp				60%	40%		100%	Gasoline
Intelli sprayer 50	14.8 cu in 9 hp				60%	40%		100%	Gasoline
Intelli Truck 3500	5.7 liter				50%	50%		100%	Diesel
John Deere Tractor	41.5 cubic inches: output 43.7hp			100%				100%	Diesel
Kawasaki 400 (off road)	23.8 cubic inches 26.5hp	50%			40%	10%		100%	Gasoline
Kawasaki 650 (off road)	36.8 cubic inches 42hp	50%	3%	3%	35%	10%		100%	Gasoline
Kelly seeder	N/A							0%	Zero
Komatsu (off road)	Komatsu 3D94-2 35hp		50%	50%				100%	Gasoline
Lite Foot Sprayer	hydraulic							0%	Zero
Lite Foot trailer	N/A							0%	Zero
Mozzie Fog Fogger	10.1 cu in 5.5 hp					100%		100%	Gasoline
Mozzie granular applicator	Electric 12v				50%	50%		100%	Zero
New Jersey Light Mosquito Trap	Electric 110v							0%	Zero
Nifty-Fifty	5.5 cu in 3 hp							0%	Gasoline
Nifty-Fifty with Intelli reel	5.5 cu in 3 hp	10%		50%	40%			100%	Gasoline
Old Suzuki tank	Electric 12v							0%	Zero
Pistenbully Mower 72F-H (off road)	N/A			100%				100%	Zero
Pistenbully PB100 (off road)	242.3 cubic inches: 170hp		100%					100%	Diesel
Solo MD 150 DX	40.2 cc				70%	30%		100%	50:1 gas/oil mix
Solo MD 155DX	40.2 cc				70%	30%		100%	50:1 gas/oil mix
Spryte (off road)	300 cubic inches 132 hp							0%	Gasoline
Spryte seeder	19.4 cu in							0%	Gasoline

Spryte tank	N/A							0%	Zero
Spryte/Komatsu trailer	N/A							0%	Zero
Suzuki trailer	N/A							0%	Zero
Tilt trailer	N/A							0%	Zero
Toyota Prius HB Three	1.8 liter hybrid						100%	100%	Gasoline
Trailer for Airboat	N/A							0%	Zero
Yellowjacket Duster	N/A							0%	Zero

Water Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
Airboat	502 cubic inches: output 500hp	50%			40%	10%		100%	Gasoline
Airboat spray tank	7.4 cu in				50%	50%		100%	Gasoline
Boat trailer	N/A							0%	Zero
Flat bottom boat	123 cc 4 hp	100%						100%	Gasoline
Grizzly 17 ft. Boat	60.8 cu in	100%						100%	Gasoline
Klamath Boat	100 cc 9.9 hp	70%			15%	15%		100%	50:1 gas/oil mix

Aerial Applications	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
1960 Hiller Soloy helicopter (Alpine) 120 gal material tank	Allison 250-C20J turboshaft, 420 shp					70%	30%	100%	Jet A
1968 Bell 206 Jet Ranger helicopter (Alpine) 120 gal material tank	Allison 250-C20J turboshaft, 420 shp				70%	30%		100%	Jet A
1989 Bell 206 Jet Ranger helicopter (Alpine) 120 gal material tank	Allison 250-C20J turboshaft, 420 shp				70%	30%		100%	Jet A
800 gallon mix trailer	Transfer pump					60%	40%	100%	Gasoline
Isolair 4400 bucket system (helicopter-mounted)	N/A							0%	Zero
Isolair 4500 broadcaster (helicopter-mounted)	N/A							0%	Zero
Isolair Air spray system model 3900 (helicopter-mounted)	N/A							0%	Zero
	100.00%	20%	5%	13%	21%	25%	15%	6000%	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Onroad MD				MD	1	3	3	3	2		30
None				0	1						
Electric				0	1						
Electric				0	1						
Onroad HD				HD	1	1	1	1	1		30
Onroad HD				HD	1	1	2	2	1		30
Onroad HD				HD	1	2	2	2	1		60
None				0	1						
Electric				0	1						
Electric				0	1						
None				0	1						
Electric				0	1						
None				0	1						
None				0	1						
None				0	1						
Onroad MD				MD	1	1	2	2	1		30
None				0	1						
Sport				31	2	5	5	5	1	1	
Sport				26	5	20	20	20	10	1	
Sport				21	4	20	20	20	10	1	
Electric				0	1						
2-stroke	40	2.4	0.92	2.2	5	2	20	10	1	0.5	
None				0	1						
Electric				0	3	2	15	10	2		
None				0	1						
Electric				0	1						
Electric				0	1						
None				0	1						
Onroad LD				LD	2	35	50	50	30		45
Onroad MD				MD	1	4	15	15	2		30
Onroad MD				MD	3	50	66	66	45		60
Onroad LD				LD	1	6	6	6	3		45
Onroad MD				MD	1	0	1	3	0		30
None				0	1	1	0	0	1		
Onroad HD				HD	1	0	0	0	2		30
2-stroke	40	2.4	0.92	2.2	1					0.5	
2-stroke	30	1.8	0.92	1.7	1	10	0	0	10	0.5	
2-stroke	17	1.0	0.92	1.0	1					1	
2-stroke	21	1.3	0.92	1.2	1	5	0	0	5	1	
Electric				0	1	1	3	3	2		
Electric				0	1						
None				0	1						
Onroad LD				LD	1	0	7	7	1		30
Onroad LD				LD	3	32	48	48	32		30
Onroad LD				LD	1	0	2	2	1		30
Onroad LD				LD	5	10	15	15	5		15
Onroad LD				LD	12	50	60	60	40		45
Onroad LD				LD	9	45	60	60	40		60
Onroad MD				MD	3	10	15	15	5		90
Onroad MD				MD	2	5	15	15	2		90
Onroad LD				LD	3	15	40	40	5		90
Onroad LD				LD	1	3	5	5	1		45
Sport				18	1	0	1	1	0	0.5	
Sport				55	1	1	5	5	5	1	
Electric				0	1						
2-stroke	49	3.0	0.92	2.8	21	2	15	10	5	0.5	
Utility	615	37.5	0.56	21.0	1	1	10	10	1	0.5	
None				0	1						
2-stroke	56	3.4	0.92	3.1	2	5	0	0	5	0.5	
2-stroke	22	1.3	0.92	1.2	2	10	0	0	10	0.5	
Utility	264	16.1	0.56	9.0	1	5	10	10	1	1	
Utility	264	16.1	0.56	9.0	1	5	10	10	1	1	
Onroad MD				MD	1	3	4	1	0		30
Offroad				44	1	0	2	1	0	1	
Sport				27	1	5	5	5	1	2	
Sport				42	3	10	20	30	15	1	
None				0	1						
Sport				35	1	0	2	2	0	2	
None				0	1						
None				0	1						
Utility	160	9.8	0.56	5.5	1	0	3	3	0	1	
Electric				0	1	3	3	3	2		
Electric				0	1						
Utility	88	5.4	0.56	3.0	1					1	
Utility	88	5.4	0.56	3.0	1	10	15	15	1	1	
Electric				0	1						
None				0	1	0	1	1	0		
Offroad				170	1	1	0	0	1	2	
2-stroke	40	2.4	0.92	2.2	5	10	30	30	15	1	
2-stroke	40	2.4	0.92	2.2	2	10	30	30	15	1	
Utility				132	1					2	
Utility	318	19.4	0.56	11.0	1					2	

None				0	1						
None				0	1						
None				0	1						
None				0	1						
Onroad LD				LD	1	63	63	63	63		60
None				0	1						
None				0	1						

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Sport				500	1	2	10	10	5	1	
Utility	122	7.4	0.56	4.2	1	2	4	4	1	1	
None				0	1						
Utility	118	7.2	0.56	4.0	1	1	1	1	1	1	
Sport	996	60.8	0.86	52.0	1	1	1	1	1	1	
2-stroke	177	10.8	0.92	9.9	1	1	1	1	1	0.5	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Turbine				420	1	1		1	1	2	
Turbine				420	1	2	5	5	2	2	
Turbine				420	1	2	5	5	2	2	
Utility				5	1		2	2	2	0.5	
None				0	1						
None				0	1						
None				0	1						

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
	30		90		330
	30		30		120
	30		60		180
	60		120		420
	30		60		180
2		10		32	
5		100		350	
4		80		280	
2.5		50		82.5	
	90		4500		14850
	30		450		1080
	180		11880		40860
	45		270		945
	30		90		120
	30		60		60
0.5		0		0	
0.5		5		10	
1		0		0	
1		5		10	
	30		210		450
	90		4320		14400
	30		60		150
	75		1125		3375
	540		32400		113400
	540		32400		110700
	270		4050		12150
	180		2700		6660
	270		10800		27000
	45		225		630
0.5		0.5		1	
1		5		16	
10.5		157.5		336	
0.5		5		11	
1		5		10	
1		10		20	
1		10		26	
1		10		26	
	30		120		240
1		2		3	
2		10		32	
3		90		225	
2		4		8	
1		3		6	
1		0		0	
1		15		41	
2		2		4	
5		150		425	
2		60		170	
2		0		0	
2		0		0	

60	3780	15120

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
1		10		27	
1		4		11	
1		1		4	
1		1		4	
0.5		0.5		2	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
2		2		6	
2		10		28	
2		10		28	
0.5		1		3	

VOC lbs/unit	CO lbs/unit	NO_X lbs/unit	SO_X lbs/unit	PM_{10} lbs/unit	$PM_{2.5}$ lbs/unit	CO_2 lbs/unit	CH_4 lbs/unit	N_20 lbs/unit	CO_2 eqv lbs/unit
0.00190	0.01284	0.01425	0.00003	0.00055	0.00046	2.79845	0.00009	0.00014	2.84273
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00202	0.00846	0.02418	0.00004	0.00118	0.00101	4.21279	0.00009	0.00009	4.24176
0.00202	0.00846	0.02418	0.00004	0.00118	0.00101	4.21279	0.00009	0.00009	4.24176
0.00202	0.00846	0.02418	0.00004	0.00118	0.00101	4.21279	0.00009	0.00009	4.24176
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00190	0.01284	0.01425	0.00003	0.00055	0.00046	2.79845	0.00009	0.00014	2.84273
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.17577	5.83110	0.15159	0.00781	0.00930	0.00605	14.62890	0.00083	0.00036	14.75872
0.14742	4.89060	0.12714	0.00655	0.00780	0.00507	12.26940	0.00069	0.00030	12.37828
0.11907	3.95010	0.10269	0.00529	0.00630	0.00410	9.90990	0.00056	0.00025	9.99784
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.08138	1.45578	0.00904	0.00131	0.01722	0.01119	2.24939	0.00013	0.00006	2.26935
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00190	0.01284	0.01425	0.00003	0.00055	0.00046	2.79845	0.00009	0.00014	2.84273
0.00190	0.01284	0.01425	0.00003	0.00055	0.00046	2.79845	0.00009	0.00014	2.84273
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00190	0.01284	0.01425	0.00003	0.00055	0.00046	2.79845	0.00009	0.00014	2.84273
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00202	0.00846	0.02418	0.00004	0.00118	0.00101	4.21279	0.00009	0.00009	4.24176
0.08138	1.45578	0.00904	0.00131	0.01722	0.01119	2.24939	0.00013	0.00006	2.26935
0.06288	1.12492	0.00699	0.00101	0.01330	0.00865	1.73817	0.00010	0.00004	1.75359
0.03699	0.66172	0.00411	0.00060	0.00783	0.00509	1.02245	0.00006	0.00003	1.03152
0.04439	0.79406	0.00493	0.00071	0.00939	0.00610	1.22694	0.00007	0.00003	1.23783
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00190	0.01284	0.01425	0.00003	0.00055	0.00046	2.79845	0.00009	0.00014	2.84273
0.00190	0.01284	0.01425	0.00003	0.00055	0.00046	2.79845	0.00009	0.00014	2.84273
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.10206	3.38580	0.08802	0.00454	0.00540	0.00351	8.49420	0.00048	0.00021	8.56958
0.31185	10.34550	0.26895	0.01386	0.01650	0.01073	25.95450	0.00147	0.00064	26.18482
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.10357	1.85281	0.01151	0.00167	0.02191	0.01424	2.86286	0.00016	0.00007	2.88827
0.19845	6.58350	0.17115	0.00882	0.01050	0.00683	16.51650	0.00093	0.00041	16.66307
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.16513	1.53659	0.01835	0.00185	0.02426	0.01577	2.92578	0.00017	0.00007	2.95174
0.04439	0.79406	0.00493	0.00071	0.00939	0.00610	1.22694	0.00007	0.00003	1.23783
0.04514	4.51284	0.03846	0.00387	0.00437	0.00284	7.78635	0.00044	0.00019	7.85545
0.04514	4.51284	0.03846	0.00387	0.00437	0.00284	7.78635	0.00044	0.00019	7.85545
0.00190	0.01284	0.01425	0.00003	0.00055	0.00046	2.79845	0.00009	0.00014	2.84273
0.03906	0.23871	0.28645	0.00029	0.02604	0.02214	30.12240	0.00172	0.00076	30.39337
0.15309	5.07870	0.13203	0.00680	0.00810	0.00527	12.74130	0.00072	0.00032	12.85437
0.23814	7.90020	0.20538	0.01058	0.01260	0.00819	19.81980	0.00112	0.00049	19.99568
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.19845	6.58350	0.17115	0.00882	0.01050	0.00683	16.51650	0.00093	0.00041	16.66307
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.02759	2.75785	0.02350	0.00236	0.00267	0.00173	4.75833	0.00027	0.00012	4.80055
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.01505	1.50428	0.01282	0.00129	0.00146	0.00095	2.59545	0.00015	0.00006	2.61848
0.01505	1.50428	0.01282	0.00129	0.00146	0.00095	2.59545	0.00015	0.00006	2.61848
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.13281	0.83845	0.97395	0.00111	0.05031	0.04276	116.38200	0.00664	0.00293	117.42894
0.08138	1.45578	0.00904	0.00131	0.01722	0.01119	2.24939	0.00013	0.00006	2.26935
0.08138	1.45578	0.00904	0.00131	0.01722	0.01119	2.24939	0.00013	0.00006	2.26935
1.24740	41.38200	1.07580	0.05544	0.06600	0.04290	103.81800	0.00587	0.00257	104.73929
0.10395	3.44850	0.08965	0.00462	0.00550	0.00358	8.65150	0.00049	0.00021	8.72827

0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
2.83500	94.05000	2.44500	0.12600	0.15000	0.09750	235.95000	0.01335	0.00585	238.04385
0.02107	2.10599	0.01795	0.00181	0.00204	0.00132	3.63363	0.00021	0.00009	3.66588
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.02006	2.00571	0.01709	0.00172	0.00194	0.00126	3.46060	0.00020	0.00009	3.49131
0.29484	9.78120	0.25428	0.01310	0.01560	0.01014	24.53880	0.00139	0.00061	24.75656
0.52734	4.90716	0.05859	0.00589	0.07748	0.05036	9.34362	0.00053	0.00023	9.42654

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131
0.02508	2.50713	0.02136	0.00215	0.00243	0.00158	4.32575	0.00024	0.00011	4.36414
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Surveillance	20%
Physical Control	5%
Vegetation Management	13%
Biological Control	21%
Chemical Control	25%
Other Non-Chemical	15%
CHECKSUM	**100%**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
0.06	0.39	0.43	0.00	0.02	0.01	83.95	0.00	0.00	85.28
0.06	0.25	0.73	0.00	0.04	0.03	126.38	0.00	0.00	127.25
0.06	0.25	0.73	0.00	0.04	0.03	126.38	0.00	0.00	127.25
0.12	0.51	1.45	0.00	0.07	0.06	252.77	0.01	0.01	254.51
0.06	0.39	0.43	0.00	0.02	0.01	83.95	0.00	0.00	85.28
0.35	11.66	0.30	0.02	0.02	0.01	29.26	0.00	0.00	29.52
0.74	24.45	0.64	0.03	0.04	0.03	61.35	0.00	0.00	61.89
0.48	15.80	0.41	0.02	0.03	0.02	39.64	0.00	0.00	39.99
0.20	3.64	0.02	0.00	0.04	0.03	5.62	0.00	0.00	5.67
0.06	0.59	0.06	0.00	0.01	0.01	99.23	0.01	0.00	100.06
0.06	0.39	0.43	0.00	0.02	0.01	83.95	0.00	0.00	85.28
0.34	2.31	2.57	0.00	0.10	0.08	503.72	0.02	0.02	511.69
0.03	0.30	0.03	0.00	0.00	0.00	49.62	0.00	0.00	50.03
0.06	0.39	0.43	0.00	0.02	0.01	83.95	0.00	0.00	85.28
0.06	0.25	0.73	0.00	0.04	0.03	126.38	0.00	0.00	127.25
0.04	0.73	0.00	0.00	0.01	0.01	1.12	0.00	0.00	1.13
0.03	0.56	0.00	0.00	0.01	0.00	0.87	0.00	0.00	0.88
0.04	0.66	0.00	0.00	0.01	0.01	1.02	0.00	0.00	1.03
0.04	0.79	0.00	0.00	0.01	0.01	1.23	0.00	0.00	1.24
0.02	0.20	0.02	0.00	0.00	0.00	33.08	0.00	0.00	33.35
0.06	0.59	0.06	0.00	0.01	0.01	99.23	0.01	0.00	100.06
0.02	0.20	0.02	0.00	0.00	0.00	33.08	0.00	0.00	33.35
0.05	0.50	0.05	0.00	0.01	0.00	82.69	0.00	0.00	83.39
0.38	3.57	0.35	0.01	0.05	0.03	595.39	0.03	0.01	600.38
0.38	3.57	0.35	0.01	0.05	0.03	595.39	0.03	0.01	600.38
0.51	3.47	3.85	0.01	0.15	0.12	755.58	0.02	0.04	767.54
0.34	2.31	2.57	0.00	0.10	0.08	503.72	0.02	0.02	511.69
0.19	1.78	0.18	0.00	0.02	0.02	297.69	0.02	0.01	300.19
0.03	0.30	0.03	0.00	0.00	0.00	49.62	0.00	0.00	50.03
0.05	1.69	0.04	0.00	0.00	0.00	4.25	0.00	0.00	4.28
0.31	10.35	0.27	0.01	0.02	0.01	25.95	0.00	0.00	26.18
1.09	19.45	0.12	0.02	0.23	0.15	30.06	0.00	0.00	30.33
0.10	3.29	0.09	0.00	0.01	0.00	8.26	0.00	0.00	8.33
0.17	1.54	0.02	0.00	0.02	0.02	2.93	0.00	0.00	2.95
0.04	0.79	0.00	0.00	0.01	0.01	1.23	0.00	0.00	1.24
0.05	4.51	0.04	0.00	0.00	0.00	7.79	0.00	0.00	7.86
0.05	4.51	0.04	0.00	0.00	0.00	7.79	0.00	0.00	7.86
0.06	0.39	0.43	0.00	0.02	0.01	83.95	0.00	0.00	85.28
0.04	0.24	0.29	0.00	0.03	0.02	30.12	0.00	0.00	30.39
0.31	10.16	0.26	0.01	0.02	0.01	25.48	0.00	0.00	25.71
0.71	23.70	0.62	0.03	0.04	0.02	59.46	0.00	0.00	59.99
0.40	13.17	0.34	0.02	0.02	0.01	33.03	0.00	0.00	33.33
0.03	2.76	0.02	0.00	0.00	0.00	4.76	0.00	0.00	4.80
0.02	1.50	0.01	0.00	0.00	0.00	2.60	0.00	0.00	2.62
0.02	1.50	0.01	0.00	0.00	0.00	2.60	0.00	0.00	2.62
0.27	1.68	1.95	0.00	0.10	0.09	232.76	0.01	0.01	234.86
0.41	7.28	0.05	0.01	0.09	0.06	11.25	0.00	0.00	11.35
0.16	2.91	0.02	0.00	0.03	0.02	4.50	0.00	0.00	4.54
2.49	82.76	2.15	0.11	0.13	0.09	207.64	0.01	0.01	209.48
0.21	6.90	0.18	0.01	0.01	0.01	17.30	0.00	0.00	17.46

0.04	0.40	0.04	0.00	0.01	0.00	66.15	0.00	0.00	66.71
11.88	**282.27**	**23.84**	**0.37**	**1.70**	**1.24**	**5675.73**	**0.25**	**0.19**	**5739.06**
VOC	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
lbs/day	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**
2.84	94.05	2.45	0.13	0.15	0.10	235.95	0.01	0.01	238.04
0.02	2.11	0.02	0.00	0.00	0.00	3.63	0.00	0.00	3.67
0.02	2.01	0.02	0.00	0.00	0.00	3.46	0.00	0.00	3.49
0.29	9.78	0.25	0.01	0.02	0.01	24.54	0.00	0.00	24.76
0.26	2.45	0.03	0.00	0.04	0.03	4.67	0.00	0.00	4.71
3.43	**110.40**	**2.76**	**0.15**	**0.21**	**0.14**	**272.25**	**0.02**	**0.01**	**274.67**
VOC	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
lbs/day	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**
0.00	0.02	5.84	0.01	0.08	0.05	1083.20	0.03	0.03	1094.58
0.00	0.02	5.84	0.01	0.08	0.05	1083.20	0.03	0.03	1094.58
0.00	0.02	5.84	0.01	0.08	0.05	1083.20	0.03	0.03	1094.58
0.01	1.25	0.01	0.00	0.00	0.00	2.16	0.00	0.00	2.18
0.02	**1.32**	**17.52**	**0.03**	**0.24**	**0.16**	**3251.75**	**0.09**	**0.10**	**3285.93**
15.34	**393.99**	**44.12**	**0.55**	**2.15**	**1.53**	**9199.74**	**0.35**	**0.30**	**9299.66**
3.05	78.47	8.79	0.11	0.43	0.31	1832.28	0.07	0.06	1852.18
0.84	21.51	2.41	0.03	0.12	0.08	502.15	0.02	0.02	507.61
2.06	53.02	5.94	0.07	0.29	0.21	1238.13	0.05	0.04	1251.58
3.26	83.72	9.38	0.12	0.46	0.33	1954.95	0.07	0.06	1976.18
3.85	98.83	11.07	0.14	0.54	0.38	2307.60	0.09	0.07	2332.66
2.27	58.44	6.55	0.08	0.32	0.23	1364.63	0.05	0.04	1379.45
15.34	**393.99**	**44.12**	**0.55**	**2.15**	**1.53**	**9199.74**	**0.35**	**0.30**	**9299.66**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
0.2	1.2	1.3	0.0	0.0	0.0	251.9	0.0	0.0	255.8
0.1	0.3	0.7	0.0	0.0	0.0	126.4	0.0	0.0	127.3
0.1	0.5	1.5	0.0	0.1	0.1	252.8	0.0	0.0	254.5
0.2	1.0	2.9	0.0	0.1	0.1	505.5	0.0	0.0	509.0
0.1	0.8	0.9	0.0	0.0	0.0	167.9	0.0	0.0	170.6
1.8	58.3	1.5	0.1	0.1	0.1	146.3	0.0	0.0	147.6
14.7	489.1	12.7	0.7	0.8	0.5	1226.9	0.1	0.0	1237.8
9.5	316.0	8.2	0.4	0.5	0.3	792.8	0.0	0.0	799.8
4.1	72.8	0.5	0.1	0.9	0.6	112.5	0.0	0.0	113.5
3.2	29.7	2.9	0.0	0.4	0.3	4961.6	0.3	0.1	5003.2
0.9	5.8	6.4	0.0	0.2	0.2	1259.3	0.0	0.1	1279.2
22.5	152.6	169.3	0.3	6.5	5.4	33245.6	1.0	1.6	33771.6
0.2	1.8	0.2	0.0	0.0	0.0	297.7	0.0	0.0	300.2
0.2	1.2	1.3	0.0	0.0	0.0	251.9	0.0	0.0	255.8
0.1	0.5	1.5	0.0	0.1	0.1	252.8	0.0	0.0	254.5
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.3	5.6	0.0	0.0	0.1	0.0	8.7	0.0	0.0	8.8
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.2	4.0	0.0	0.0	0.0	0.0	6.1	0.0	0.0	6.2
0.1	1.4	0.1	0.0	0.0	0.0	231.5	0.0	0.0	233.5
3.0	28.5	2.8	0.0	0.4	0.3	4763.1	0.3	0.1	4803.1
0.0	0.4	0.0	0.0	0.0	0.0	66.2	0.0	0.0	66.7
0.8	7.4	0.7	0.0	0.1	0.1	1240.4	0.1	0.0	1250.8
22.8	214.0	21.2	0.3	3.0	1.9	35723.3	2.0	0.8	36023.0
22.8	214.0	21.2	0.3	3.0	1.9	35723.3	2.0	0.8	36023.0
7.7	52.0	57.7	0.1	2.2	1.8	11333.7	0.4	0.6	11513.0
5.1	34.7	38.5	0.1	1.5	1.2	7555.8	0.2	0.4	7675.4
7.6	71.3	7.1	0.1	1.0	0.6	11907.8	0.7	0.3	12007.7
0.2	1.5	0.1	0.0	0.0	0.0	248.1	0.0	0.0	250.2
0.1	1.7	0.0	0.0	0.0	0.0	4.2	0.0	0.0	4.3
1.6	51.7	1.3	0.1	0.1	0.1	129.8	0.0	0.0	130.9
16.3	291.8	1.8	0.3	3.5	2.2	450.9	0.0	0.0	454.9
1.0	32.9	0.9	0.0	0.1	0.0	82.6	0.0	0.0	83.3
0.8	7.7	0.1	0.0	0.1	0.1	14.6	0.0	0.0	14.8
0.4	7.9	0.0	0.0	0.1	0.1	12.3	0.0	0.0	12.4
0.5	45.1	0.4	0.0	0.0	0.0	77.9	0.0	0.0	78.6
0.5	45.1	0.4	0.0	0.0	0.0	77.9	0.0	0.0	78.6
0.2	1.5	1.7	0.0	0.1	0.1	335.8	0.0	0.0	341.1
0.1	0.5	0.6	0.0	0.1	0.0	60.2	0.0	0.0	60.8
1.5	50.8	1.3	0.1	0.1	0.1	127.4	0.0	0.0	128.5
21.4	711.0	18.5	1.0	1.1	0.7	1783.8	0.1	0.0	1799.6
0.8	26.3	0.7	0.0	0.0	0.0	66.1	0.0	0.0	66.7
0.1	8.3	0.1	0.0	0.0	0.0	14.3	0.0	0.0	14.4
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.2	22.6	0.2	0.0	0.0	0.0	38.9	0.0	0.0	39.3
0.3	1.7	1.9	0.0	0.1	0.1	232.8	0.0	0.0	234.9
12.2	218.4	1.4	0.2	2.6	1.7	337.4	0.0	0.0	340.4
4.9	87.3	0.5	0.1	1.0	0.7	135.0	0.0	0.0	136.2
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

2.7	25.0	2.5	0.0	0.3	0.2	4167.7	0.2	0.1	4202.7
193.90	**3403.51**	**395.67**	**4.57**	**30.57**	**21.85**	**160809.42**	**7.76**	**5.13**	**162563.77**
VOC	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
lbs/qtr	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**
28.4	940.5	24.5	1.3	1.5	1.0	2359.5	0.1	0.1	2380.4
0.1	8.4	0.1	0.0	0.0	0.0	14.5	0.0	0.0	14.7
0.0	2.0	0.0	0.0	0.0	0.0	3.5	0.0	0.0	3.5
0.3	9.8	0.3	0.0	0.0	0.0	24.5	0.0	0.0	24.8
0.3	2.5	0.0	0.0	0.0	0.0	4.7	0.0	0.0	4.7
29.01	**963.16**	**24.82**	**1.28**	**1.56**	**1.02**	**2406.71**	**0.14**	**0.06**	**2428.06**
VOC	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
lbs/qtr	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**
0.0	0.0	5.8	0.0	0.1	0.1	1083.2	0.0	0.0	1094.6
0.0	0.1	29.2	0.1	0.4	0.3	5416.0	0.1	0.2	5472.9
0.0	0.1	29.2	0.1	0.4	0.3	5416.0	0.1	0.2	5472.9
0.0	2.5	0.0	0.0	0.0	0.0	4.3	0.0	0.0	4.4
0.05	**2.75**	**64.22**	**0.12**	**0.88**	**0.57**	**11919.49**	**0.33**	**0.38**	**12044.77**
222.97	**4369.43**	**484.71**	**5.97**	**33.01**	**23.43**	**175135.62**	**8.22**	**5.58**	**177036.60**
44.41	870.24	96.54	1.19	6.58	4.67	34881.18	1.64	1.11	35259.79
12.17	238.50	26.46	0.33	1.80	1.28	9559.49	0.45	0.30	9663.25
30.01	588.05	65.23	0.80	4.44	3.15	23570.34	1.11	0.75	23826.18
47.38	928.50	103.00	1.27	7.02	4.98	37216.32	1.75	1.18	37620.28
55.93	1096.00	121.58	1.50	8.28	5.88	43929.85	2.06	1.40	44406.68
33.07	648.13	71.90	0.89	4.90	3.48	25978.45	1.22	0.83	26260.43
222.97	**4369.43**	**484.71**	**5.97**	**33.01**	**23.43**	**175135.62**	**8.22**	**5.58**	**177036.60**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
0.6	4.2	4.7	0.0	0.2	0.2	923.5	0.0	0.0	938.1
0.2	1.0	2.9	0.0	0.1	0.1	505.5	0.0	0.0	509.0
0.4	1.5	4.4	0.0	0.2	0.2	758.3	0.0	0.0	763.5
0.8	3.6	10.2	0.0	0.5	0.4	1769.4	0.0	0.0	1781.5
0.3	2.3	2.6	0.0	0.1	0.1	503.7	0.0	0.0	511.7
5.6	186.6	4.9	0.2	0.3	0.2	468.1	0.0	0.0	472.3
51.6	1711.7	44.5	2.3	2.7	1.8	4294.3	0.2	0.1	4332.4
33.3	1106.0	28.8	1.5	1.8	1.1	2774.8	0.2	0.1	2799.4
6.7	120.1	0.7	0.1	1.4	0.9	185.6	0.0	0.0	187.2
10.4	98.1	9.7	0.2	1.4	0.9	16373.2	0.9	0.4	16510.5
2.0	13.9	15.4	0.0	0.6	0.5	3022.3	0.1	0.1	3070.1
77.5	524.8	582.3	1.1	22.4	18.6	114344.9	3.6	5.6	116153.8
0.7	6.2	0.6	0.0	0.1	0.1	1041.9	0.1	0.0	1050.7
0.2	1.5	1.7	0.0	0.1	0.1	335.8	0.0	0.0	341.1
0.1	0.5	1.5	0.0	0.1	0.1	252.8	0.0	0.0	254.5
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.6	11.2	0.1	0.0	0.1	0.1	17.4	0.0	0.0	17.5
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.4	7.9	0.0	0.0	0.1	0.1	12.3	0.0	0.0	12.4
0.3	3.0	0.3	0.0	0.0	0.0	496.2	0.0	0.0	500.3
10.1	95.1	9.4	0.2	1.3	0.9	15877.0	0.9	0.4	16010.2
0.1	1.0	0.1	0.0	0.0	0.0	165.4	0.0	0.0	166.8
2.4	22.3	2.2	0.0	0.3	0.2	3721.2	0.2	0.1	3752.4
79.6	748.8	74.3	1.2	10.4	6.7	125031.7	7.2	2.9	126080.4
77.7	731.0	72.5	1.2	10.2	6.6	122054.7	7.0	2.8	123078.5
23.0	156.0	173.2	0.3	6.7	5.5	34001.2	1.1	1.7	34539.1
12.6	85.5	94.9	0.2	3.7	3.0	18637.7	0.6	0.9	18932.6
19.0	178.3	17.7	0.3	2.5	1.6	29769.4	1.7	0.7	30019.1
0.4	4.2	0.4	0.0	0.1	0.0	694.6	0.0	0.0	700.4
0.1	3.4	0.1	0.0	0.0	0.0	8.5	0.0	0.0	8.6
5.0	165.5	4.3	0.2	0.3	0.2	415.3	0.0	0.0	419.0
34.8	622.5	3.9	0.6	7.4	4.8	961.9	0.1	0.0	970.5
2.2	72.4	1.9	0.1	0.1	0.1	181.7	0.0	0.0	183.3
1.7	15.4	0.2	0.0	0.2	0.2	29.3	0.0	0.0	29.5
0.9	15.9	0.1	0.0	0.2	0.1	24.5	0.0	0.0	24.8
1.2	117.3	1.0	0.1	0.1	0.1	202.4	0.0	0.0	204.2
1.2	117.3	1.0	0.1	0.1	0.1	202.4	0.0	0.0	204.2
0.5	3.1	3.4	0.0	0.1	0.1	671.6	0.0	0.0	682.3
0.1	0.7	0.9	0.0	0.1	0.1	90.4	0.0	0.0	91.2
4.9	162.5	4.2	0.2	0.3	0.2	407.7	0.0	0.0	411.3
53.6	1777.5	46.2	2.4	2.8	1.8	4459.5	0.3	0.1	4499.0
1.6	52.7	1.4	0.1	0.1	0.1	132.1	0.0	0.0	133.3
0.2	16.5	0.1	0.0	0.0	0.0	28.5	0.0	0.0	28.8
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.6	61.7	0.5	0.1	0.1	0.0	106.4	0.0	0.0	107.4
0.5	3.4	3.9	0.0	0.2	0.2	465.5	0.0	0.0	469.7
34.6	618.7	3.8	0.6	7.3	4.8	956.0	0.1	0.0	964.5
13.8	247.5	1.5	0.2	2.9	1.9	382.4	0.0	0.0	385.8
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

10.6	99.8	9.9	0.2	1.4	0.9	16670.9	1.0	0.4	16810.7
585.06	**10000.43**	**1248.16**	**13.74**	**91.04**	**65.37**	**524430.01**	**25.44**	**16.61**	**530113.64**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
76.5	2539.4	66.0	3.4	4.1	2.6	6370.7	0.4	0.2	6427.2
0.2	23.2	0.2	0.0	0.0	0.0	40.0	0.0	0.0	40.3
0.1	8.0	0.1	0.0	0.0	0.0	13.8	0.0	0.0	14.0
1.2	39.1	1.0	0.1	0.1	0.0	98.2	0.0	0.0	99.0
1.1	9.8	0.1	0.0	0.2	0.1	18.7	0.0	0.0	18.9
79.09	**2619.48**	**67.42**	**3.49**	**4.30**	**2.79**	**6541.30**	**0.37**	**0.16**	**6599.35**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
0.0	0.1	17.5	0.0	0.2	0.2	3249.6	0.1	0.1	3283.7
0.0	0.3	81.7	0.1	1.1	0.7	15164.8	0.4	0.5	15324.2
0.0	0.3	81.7	0.1	1.1	0.7	15164.8	0.4	0.5	15324.2
0.1	7.5	0.1	0.0	0.0	0.0	13.0	0.0	0.0	13.1
0.16	**8.20**	**180.99**	**0.33**	**2.47**	**1.61**	**33592.08**	**0.93**	**1.08**	**33945.15**
664.31	**12628.11**	**1496.57**	**17.56**	**97.81**	**69.77**	**564563.40**	**26.74**	**17.85**	**570658.15**

132.31	2515.10	298.07	3.50	19.48	13.90	112442.21	5.33	3.55	113656.08
36.26	689.28	81.69	0.96	5.34	3.81	30815.75	1.46	0.97	31148.42
89.41	1699.53	201.41	2.36	13.16	9.39	75980.82	3.60	2.40	76801.08
141.17	2683.47	318.02	3.73	20.79	14.83	119969.72	5.68	3.79	121264.86
166.63	3167.55	375.39	4.40	24.54	17.50	141611.32	6.71	4.48	143140.09
98.54	1873.17	221.99	2.60	14.51	10.35	83743.57	3.97	2.65	84647.63
664.31	**12628.11**	**1496.57**	**17.56**	**97.81**	**69.77**	**564563.40**	**26.74**	**17.85**	**570658.15**

Napa County Mosquito Abatement District Vehicles and Equipments

Land Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
2003 Toyota	3.4L	20%				70%	10%	100%	Gasoline
2005 Toyota	3.4L	20%				70%	10%	100%	Gasoline
2007 Chevy	6.0L	40%			30%		30%	100%	Gasoline
2008 Chevy A	6.0L	20%	5%	20%	15%	35%	5%	100%	Gasoline
2008 Chevy B	6.0L	36%	5%	20%	5%	29%	5%	100%	Gasoline
2008 Jeep Wrangler	5.0L	50%					50%	100%	Gasoline
2009 Chevy A	6.0L	36%	5%	20%	5%	29%	5%	100%	Gasoline
2009 Chevy B	6.0L	25%	4%	18%	21%	27%	5%	100%	Gasoline
2010 Chevy	6.0L	36%	5%	20%	5%	29%	5%	100%	Gasoline
2011 Toyota	4.0L	50%					50%	100%	Gasoline
Daewoo Forklift	2.7L		100%					100%	LPG
Echo Chainsaw CS330T	Echo 32.5cc		100%					100%	50:1 gas/oil mix
FloTech Trash Pump	ProPower 5.5hp		100%					100%	Gasoline
Hand Sprayer – London Fog Colt	Techumseh 49cc					100%		100%	50:1 gas/oil mix
Hand Sprayer – London Fog Colt	Techumseh 49cc					100%		100%	50:1 gas/oil mix
Intellispray 5SDE	Honda GX120 9.2			40%		60%		100%	Gasoline
Intellispray 5SDE	Honda GX120 9.2			40%		60%		100%	Gasoline
Intellispray 5SDE	Honda GX120 9.2			40%		60%		100%	Gasoline
Intellispray 5SDE	Honda GX120 9.2			40%		60%		100%	Gasoline
Intellispray 5SDE	Honda GX120 9.2			40%		60%		100%	Gasoline
Intellispray 9TBE	Honda GX270			40%		60%		100%	Gasoline
JD9 ULV	Honda GX240 242cc					100%		100%	Gasoline
London Fog 18-20 ULV	Honda GX120 7.0					100%		100%	Gasoline
London Fog 18-20 ULV	Honda GX120 7.0					100%		100%	Gasoline
London Fog XKE	Honda GX120 7.0					100%		100%	Gasoline
Maruyama Back Sprayer	Kawasaki 40.2cc					100%		100%	50:1 gas/oil mix
Maruyama Back Sprayer	Kawasaki 40.2cc					100%		100%	50:1 gas/oil mix
Maruyama Back Sprayer	Kawasaki 40.2cc					100%		100%	50:1 gas/oil mix
Northstar Pressure Washer	Honda GX390		100%					100%	Gasoline
Pioneer Backpack Fogger	Electric					100%		100%	Zero
Stihl Blower BR420	Stihl 40.2cc		100%					100%	50:1 gas/oil mix
Stihl Weed Wacker	Stihl 40.2cc		100%					100%	50:1 gas/oil mix
Wisconsin Robin ULV	Wisconsin 252cc					100%		100%	Gasoline

Water Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
Argo ATV 1	725cc	30%				70%		100%	Gasoline
Argo ATV 2	725cc	30%				70%		100%	Gasoline
Argo ATV 3	725cc	30%				70%		100%	Gasoline
Argo Sprayer 1	Honda GX120 7.0					100%		100%	Gasoline
Argo Sprayer 2	Honda GX120 7.0					100%		100%	Gasoline
Argo Sprayer 3	Honda GX120 7.0					100%		100%	Gasoline
Polaris ATV 1	499cc	35%				65%		100%	Gasoline
Polaris ATV 2	499cc	35%				65%		100%	Gasoline
Polaris Spot Sprayer	ShurFlo					100%		100%	Zero
Polaris Sprayer - 50 gal Stainless Steel Tank	Honda GX120 7.0					100%		100%	Gasoline
Tracker Boat	Mercury 4 stroke (15 hp)	40%				60%		100%	Gasoline

Aerial Applications	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
1960 Hiller Soloy helicopter (Alpine) 120 gal material tank	Allison 250-C20J turboshaft, 420 shp					100%		100%	Jet A
1968 Bell 206 Jet Ranger helicopter (Alpine) 120 gal material tank	Allison 250-C20J turboshaft, 420 shp					100%		100%	Jet A
1989 Bell 206 Jet Ranger helicopter (Alpine) 120 gal material tank	Allison 250-C20J turboshaft, 420 shp					100%		100%	Jet A
Isolair 4400 bucket system (helicopter-mounted)	N/A					100%		100%	Zero
Isolair Air spray system model 3900 (helicopter-mounted)	N/A					100%		100%	Zero
	100.00%	11%	13%	7%	2%	64%	4%	4900%	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Onroad LD				LD	1	4	26	18	3		45
Onroad LD				LD	1	4	28	20	11		39
Onroad LD				LD	1	32	22	22	10		27
Onroad LD				LD	1	44	45	47	36		63
Onroad LD				LD	1	53	59	54	48		93
Onroad LD				LD	1	5	5	12	0		60
Onroad LD				LD	1	55	53	56	40		117
Onroad LD				LD	1	50	57	54	46		75
Onroad LD				LD	1	55	54	57	51		135
Onroad LD				LD	1	29	37	50	20		66
Propane	2700	164.8	0.56	92.0	1	0	0	0	1	0.5	
2-stroke	33	2.0	0.92	1.9	1	0	0	0	1	0.5	
Utility	160	9.8	0.56	5.5	1	0	0	0	1	0.5	
2-stroke	49	3.0	0.92	2.8	1	0	6	2	0	0.5	
2-stroke	49	3.0	0.92	2.8	1	0	6	2	0	0.5	
Utility	120	7.3	0.56	4.1	1	9	21	22	26	4.9	
Utility	120	7.3	0.56	4.1	1	6	21	4	27	3.8	
Utility	120	7.3	0.56	4.1	1	4	7	0	25	3.7	
Utility	120	7.3	0.56	4.1	1	0	5	0	22	2.4	
Utility	120	7.3	0.56	4.1	1	0	5	0	22	2.4	
Utility	270	16.5	0.56	9.2	1	4	15	1	28	4.8	
Utility	240	14.6	0.56	8.2	1	0	3	2	0	1.8	
Utility	120	7.3	0.56	4.1	1	0	13	6	0	1.1	
Utility	120	7.3	0.56	4.1	1	0	8	1	0	0.7	
Utility	120	7.3	0.56	4.1	1	0	5	0	0	0.4	
2-stroke	40	2.4	0.92	2.2	1	12	17	9	6	3.9	
2-stroke	40	2.4	0.92	2.2	1	3	6	2	0	2.5	
2-stroke	40	2.4	0.92	2.2	1	3	6	2	0	2.5	
Utility	390	23.8	0.56	13.0	1	0	0	0	1	0.5	
Electric				0	1	0	12	10	0	0.8	
2-stroke	40	2.4	0.92	2.2	1	0	0	0	1	0.5	
2-stroke	40	2.4	0.92	2.2	1	0	0	0	1	0.5	
Utility	252	15.4	0.56	8.6	1	1	3	4	0	1.9	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Sport	725	44.2	0.86	38.0	1	5	6	2	2	5	
Sport	725	44.2	0.86	38.0	1	6	15	2	0	2.9	
Sport	725	44.2	0.86	38.0	1	6	6	1	1	3.9	
Utility	120	7.3	0.56	4.1	1	5	6	2	2	4.8	
Utility	120	7.3	0.56	4.1	1	6	15	2	0	2.8	
Utility	120	7.3	0.56	4.1	1	6	6	1	1	3.8	
Sport	499	30.5	0.86	26.0	1	4	7	6	3	3.4	
Sport	499	30.5	0.86	26.0	1	2	3	4	0	2.2	
Electric				0	1	3	4	3	1	3.4	
Utility	120	7.3	0.56	4.1	1	3	4	3	1	3.4	
Sport	286	17.5	0.86	15.0	1	3	6	6	3	3.5	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Turbine				420	1	4	2	2	0	3	
Turbine				420	1	4	2	2	0	3	
Turbine				420	1	4	2	2	0	3	
None				0	1	2	0	0	0	1	
None				0	1	6	0	0	0	2	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
	45		1170		2295
	39		1092		2457
	27		864		2322
	63		2961		10836
	93		5487		19902
	60		720		1320
	117		6552		23868
	75		4275		15525
	135		7695		29295
	66		3300		8976
0.5		0.5		0.5	
0.5		0.5		0.5	
0.5		0.5		0.5	
0.5		3		4	
0.5		3		4	
4.9		127.4		382.2	
3.8		102.6		220.4	
3.7		92.5		133.2	
2.4		52.8		64.8	
2.4		52.8		64.8	
4.8		134.4		230.4	
1.8		5.4		9	
1.1		14.3		20.9	
0.7		5.6		6.3	
0.4		2		2	
3.9		66.3		171.6	
2.5		15		27.5	
2.5		15		27.5	
0.5		0.5		0.5	
0.8		9.6		17.6	
0.5		0.5		0.5	
0.5		0.5		0.5	
1.9		7.6		15.2	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
5		30		75	
2.9		43.5		66.7	
3.9		23.4		54.6	
4.8		28.8		72	
2.8		42		64.4	
3.8		22.8		53.2	
3.4		23.8		68	
2.2		8.8		19.8	
3.4		13.6		37.4	
3.4		13.6		37.4	
3.5		21		63	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
3		12		24	
3		12		24	
3		12		24	
1		2		2	
2		12		12	

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.73030	0.30746	0.46754	0.00033	0.00552	0.00359	75.73440	0.00006	0.00017	75.78690
0.07028	1.25727	0.00781	0.00113	0.01487	0.00967	1.94266	0.00011	0.00005	1.95989
0.02759	2.75785	0.02350	0.00236	0.00267	0.00173	4.75833	0.00027	0.00012	4.80055
0.10357	1.85281	0.01151	0.00167	0.02191	0.01424	2.86286	0.00016	0.00007	2.88827
0.10357	1.85281	0.01151	0.00167	0.02191	0.01424	2.86286	0.00016	0.00007	2.88827
0.02057	2.05585	0.01752	0.00176	0.00199	0.00129	3.54712	0.00020	0.00009	3.57859
0.02057	2.05585	0.01752	0.00176	0.00199	0.00129	3.54712	0.00020	0.00009	3.57859
0.02057	2.05585	0.01752	0.00176	0.00199	0.00129	3.54712	0.00020	0.00009	3.57859
0.02057	2.05585	0.01752	0.00176	0.00199	0.00129	3.54712	0.00020	0.00009	3.57859
0.02057	2.05585	0.01752	0.00176	0.00199	0.00129	3.54712	0.00020	0.00009	3.57859
0.04615	4.61313	0.03931	0.00396	0.00446	0.00290	7.95938	0.00045	0.00020	8.03001
0.04113	4.11170	0.03504	0.00353	0.00398	0.00259	7.09423	0.00040	0.00018	7.15719
0.02057	2.05585	0.01752	0.00176	0.00199	0.00129	3.54712	0.00020	0.00009	3.57859
0.02057	2.05585	0.01752	0.00176	0.00199	0.00129	3.54712	0.00020	0.00009	3.57859
0.02057	2.05585	0.01752	0.00176	0.00199	0.00129	3.54712	0.00020	0.00009	3.57859
0.08138	1.45578	0.00904	0.00131	0.01722	0.01119	2.24939	0.00013	0.00006	2.26935
0.08138	1.45578	0.00904	0.00131	0.01722	0.01119	2.24939	0.00013	0.00006	2.26935
0.08138	1.45578	0.00904	0.00131	0.01722	0.01119	2.24939	0.00013	0.00006	2.26935
0.12285	4.07550	0.10595	0.00546	0.00650	0.00423	10.22450	0.00058	0.00025	10.31523
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.08138	1.45578	0.00904	0.00131	0.01722	0.01119	2.24939	0.00013	0.00006	2.26935
0.08138	1.45578	0.00904	0.00131	0.01722	0.01119	2.24939	0.00013	0.00006	2.26935
0.04314	4.31227	0.03675	0.00370	0.00417	0.00271	7.44029	0.00042	0.00018	7.50632

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.21546	7.14780	0.18582	0.00958	0.01140	0.00741	17.93220	0.00101	0.00044	18.09133
0.21546	7.14780	0.18582	0.00958	0.01140	0.00741	17.93220	0.00101	0.00044	18.09133
0.21546	7.14780	0.18582	0.00958	0.01140	0.00741	17.93220	0.00101	0.00044	18.09133
0.02057	2.05585	0.01752	0.00176	0.00199	0.00129	3.54712	0.00020	0.00009	3.57859
0.02057	2.05585	0.01752	0.00176	0.00199	0.00129	3.54712	0.00020	0.00009	3.57859
0.02057	2.05585	0.01752	0.00176	0.00199	0.00129	3.54712	0.00020	0.00009	3.57859
0.14742	4.89060	0.12714	0.00655	0.00780	0.00507	12.26940	0.00069	0.00030	12.37828
0.14742	4.89060	0.12714	0.00655	0.00780	0.00507	12.26940	0.00069	0.00030	12.37828
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.02057	2.05585	0.01752	0.00176	0.00199	0.00129	3.54712	0.00020	0.00009	3.57859
0.08505	2.82150	0.07335	0.00378	0.00450	0.00293	7.07850	0.00040	0.00018	7.14132

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Surveillance	11%
Physical Control	13%
Vegetation Management	7%
Biological Control	2%
Chemical Control	64%
Other Non-Chemical	4%
CHECKSUM	**100%**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
0.03	0.30	0.03	0.00	0.00	0.00	49.62	0.00	0.00	50.03
0.03	0.26	0.03	0.00	0.00	0.00	43.00	0.00	0.00	43.36
0.02	0.18	0.02	0.00	0.00	0.00	29.77	0.00	0.00	30.02
0.04	0.42	0.04	0.00	0.01	0.00	69.46	0.00	0.00	70.04
0.07	0.61	0.06	0.00	0.01	0.01	102.54	0.01	0.00	103.40
0.04	0.40	0.04	0.00	0.01	0.00	66.15	0.00	0.00	66.71
0.08	0.77	0.08	0.00	0.01	0.01	129.00	0.01	0.00	130.08
0.05	0.50	0.05	0.00	0.01	0.00	82.69	0.00	0.00	83.39
0.09	0.89	0.09	0.00	0.01	0.01	148.85	0.01	0.00	150.10
0.05	0.44	0.04	0.00	0.01	0.00	72.77	0.00	0.00	73.38
0.37	0.15	0.23	0.00	0.00	0.00	37.87	0.00	0.00	37.89
0.04	0.63	0.00	0.00	0.01	0.00	0.97	0.00	0.00	0.98
0.01	1.38	0.01	0.00	0.00	0.00	2.38	0.00	0.00	2.40
0.05	0.93	0.01	0.00	0.01	0.01	1.43	0.00	0.00	1.44
0.05	0.93	0.01	0.00	0.01	0.01	1.43	0.00	0.00	1.44
0.10	10.07	0.09	0.01	0.01	0.01	17.38	0.00	0.00	17.54
0.08	7.81	0.07	0.01	0.01	0.00	13.48	0.00	0.00	13.60
0.08	7.61	0.06	0.01	0.01	0.00	13.12	0.00	0.00	13.24
0.05	4.93	0.04	0.00	0.00	0.00	8.51	0.00	0.00	8.59
0.05	4.93	0.04	0.00	0.00	0.00	8.51	0.00	0.00	8.59
0.22	22.14	0.19	0.02	0.02	0.01	38.21	0.00	0.00	38.54
0.07	7.40	0.06	0.01	0.01	0.00	12.77	0.00	0.00	12.88
0.02	2.26	0.02	0.00	0.00	0.00	3.90	0.00	0.00	3.94
0.01	1.44	0.01	0.00	0.00	0.00	2.48	0.00	0.00	2.51
0.01	0.82	0.01	0.00	0.00	0.00	1.42	0.00	0.00	1.43
0.32	5.68	0.04	0.01	0.07	0.04	8.77	0.00	0.00	8.85
0.20	3.64	0.02	0.00	0.04	0.03	5.62	0.00	0.00	5.67
0.20	3.64	0.02	0.00	0.04	0.03	5.62	0.00	0.00	5.67
0.06	2.04	0.05	0.00	0.00	0.00	5.11	0.00	0.00	5.16
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.04	0.73	0.00	0.00	0.01	0.01	1.12	0.00	0.00	1.13
0.04	0.73	0.00	0.00	0.01	0.01	1.12	0.00	0.00	1.13
0.08	8.19	0.07	0.01	0.01	0.01	14.14	0.00	0.00	14.26
2.67	**102.84**	**1.54**	**0.09**	**0.35**	**0.23**	**999.24**	**0.05**	**0.02**	**1007.41**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
1.08	35.74	0.93	0.05	0.06	0.04	89.66	0.01	0.00	90.46
0.62	20.73	0.54	0.03	0.03	0.02	52.00	0.00	0.00	52.46
0.84	27.88	0.72	0.04	0.04	0.03	69.94	0.00	0.00	70.56
0.10	9.87	0.08	0.01	0.01	0.01	17.03	0.00	0.00	17.18
0.06	5.76	0.05	0.00	0.01	0.00	9.93	0.00	0.00	10.02
0.08	7.81	0.07	0.01	0.01	0.00	13.48	0.00	0.00	13.60
0.50	16.63	0.43	0.02	0.03	0.02	41.72	0.00	0.00	42.09
0.32	10.76	0.28	0.01	0.02	0.01	26.99	0.00	0.00	27.23
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.07	6.99	0.06	0.01	0.01	0.00	12.06	0.00	0.00	12.17
0.30	9.88	0.26	0.01	0.02	0.01	24.77	0.00	0.00	24.99
3.97	**152.03**	**3.42**	**0.19**	**0.22**	**0.15**	**357.58**	**0.02**	**0.01**	**360.75**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
0.00	0.03	8.75	0.02	0.12	0.08	1624.80	0.04	0.05	1641.87
0.00	0.03	8.75	0.02	0.12	0.08	1624.80	0.04	0.05	1641.87
0.00	0.03	8.75	0.02	0.12	0.08	1624.80	0.04	0.05	1641.87
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.01	**0.10**	**26.26**	**0.05**	**0.36**	**0.23**	**4874.39**	**0.13**	**0.16**	**4925.62**

6.65	**254.97**	**31.22**	**0.33**	**0.93**	**0.60**	**6231.21**	**0.21**	**0.19**	**6293.79**

0.72	27.73	3.40	0.04	0.10	0.07	677.80	0.02	0.02	684.61
0.85	32.47	3.98	0.04	0.12	0.08	793.52	0.03	0.02	801.49
0.46	17.59	2.15	0.02	0.06	0.04	429.83	0.01	0.01	434.14
0.11	4.21	0.52	0.01	0.02	0.01	103.01	0.00	0.00	104.04
4.27	163.86	20.06	0.21	0.60	0.39	4004.50	0.13	0.12	4044.72
0.24	9.11	1.12	0.01	0.03	0.02	222.54	0.01	0.01	224.78
6.65	**254.97**	**31.22**	**0.33**	**0.93**	**0.60**	**6231.21**	**0.21**	**0.19**	**6293.79**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
0.8	7.7	0.8	0.0	0.1	0.1	1290.0	0.1	0.0	1300.8
0.8	7.2	0.7	0.0	0.1	0.1	1204.0	0.1	0.0	1214.1
0.6	5.7	0.6	0.0	0.1	0.1	952.6	0.1	0.0	960.6
2.1	19.6	1.9	0.0	0.3	0.2	3264.7	0.2	0.1	3292.1
3.9	36.2	3.6	0.1	0.5	0.3	6049.8	0.3	0.1	6100.6
0.5	4.8	0.5	0.0	0.1	0.0	793.9	0.0	0.0	800.5
4.6	43.3	4.3	0.1	0.6	0.4	7224.1	0.4	0.2	7284.6
3.0	28.2	2.8	0.0	0.4	0.3	4713.5	0.3	0.1	4753.0
5.4	50.8	5.0	0.1	0.7	0.5	8484.3	0.5	0.2	8555.5
2.3	21.8	2.2	0.0	0.3	0.2	3638.5	0.2	0.1	3669.0
0.4	0.2	0.2	0.0	0.0	0.0	37.9	0.0	0.0	37.9
0.0	0.6	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0
0.0	1.4	0.0	0.0	0.0	0.0	2.4	0.0	0.0	2.4
0.3	5.6	0.0	0.0	0.1	0.0	8.6	0.0	0.0	8.7
0.3	5.6	0.0	0.0	0.1	0.0	8.6	0.0	0.0	8.7
2.6	261.9	2.2	0.2	0.3	0.2	451.9	0.0	0.0	455.9
2.1	210.9	1.8	0.2	0.2	0.1	363.9	0.0	0.0	367.2
1.9	190.2	1.6	0.2	0.2	0.1	328.1	0.0	0.0	331.0
1.1	108.5	0.9	0.1	0.1	0.1	187.3	0.0	0.0	188.9
1.1	108.5	0.9	0.1	0.1	0.1	187.3	0.0	0.0	188.9
6.2	620.0	5.3	0.5	0.6	0.4	1069.7	0.1	0.0	1079.2
0.2	22.2	0.2	0.0	0.0	0.0	38.3	0.0	0.0	38.6
0.3	29.4	0.3	0.0	0.0	0.0	50.7	0.0	0.0	51.2
0.1	11.5	0.1	0.0	0.0	0.0	19.9	0.0	0.0	20.0
0.0	4.1	0.0	0.0	0.0	0.0	7.1	0.0	0.0	7.2
5.4	96.5	0.6	0.1	1.1	0.7	149.1	0.0	0.0	150.5
1.2	21.8	0.1	0.0	0.3	0.2	33.7	0.0	0.0	34.0
1.2	21.8	0.1	0.0	0.3	0.2	33.7	0.0	0.0	34.0
0.1	2.0	0.1	0.0	0.0	0.0	5.1	0.0	0.0	5.2
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.7	0.0	0.0	0.0	0.0	1.1	0.0	0.0	1.1
0.0	0.7	0.0	0.0	0.0	0.0	1.1	0.0	0.0	1.1
0.3	32.8	0.3	0.0	0.0	0.0	56.5	0.0	0.0	57.0
48.98	**1982.36**	**37.23**	**1.88**	**6.50**	**4.22**	**40658.52**	**2.32**	**0.95**	**41000.71**
VOC	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
lbs/qtr	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**
6.5	214.4	5.6	0.3	0.3	0.2	538.0	0.0	0.0	542.7
9.4	310.9	8.1	0.4	0.5	0.3	780.1	0.0	0.0	787.0
5.0	167.3	4.3	0.2	0.3	0.2	419.6	0.0	0.0	423.3
0.6	59.2	0.5	0.1	0.1	0.0	102.2	0.0	0.0	103.1
0.9	86.3	0.7	0.1	0.1	0.1	149.0	0.0	0.0	150.3
0.5	46.9	0.4	0.0	0.0	0.0	80.9	0.0	0.0	81.6
3.5	116.4	3.0	0.2	0.2	0.1	292.0	0.0	0.0	294.6
1.3	43.0	1.1	0.1	0.1	0.0	108.0	0.0	0.0	108.9
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.3	28.0	0.2	0.0	0.0	0.0	48.2	0.0	0.0	48.7
1.8	59.3	1.5	0.1	0.1	0.1	148.6	0.0	0.0	150.0
29.67	**1131.69**	**25.57**	**1.41**	**1.67**	**1.08**	**2666.51**	**0.15**	**0.07**	**2690.17**
VOC	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
lbs/qtr	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**	**lbs/qtr**
0.0	0.1	35.0	0.1	0.5	0.3	6499.2	0.2	0.2	6567.5
0.0	0.1	35.0	0.1	0.5	0.3	6499.2	0.2	0.2	6567.5
0.0	0.1	35.0	0.1	0.5	0.3	6499.2	0.2	0.2	6567.5
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.05	**0.39**	**105.05**	**0.19**	**1.43**	**0.93**	**19497.54**	**0.54**	**0.62**	**19702.49**
78.70	**3114.45**	**167.85**	**3.47**	**9.60**	**6.23**	**62822.57**	**3.01**	**1.64**	**63393.37**
8.56	338.78	18.26	0.38	1.04	0.68	6833.56	0.33	0.18	6895.65
10.02	396.62	21.38	0.44	1.22	0.79	8000.26	0.38	0.21	8072.95
5.43	214.83	11.58	0.24	0.66	0.43	4333.48	0.21	0.11	4372.85
1.30	51.48	2.77	0.06	0.16	0.10	1038.50	0.05	0.03	1047.93
50.58	2001.51	107.87	2.23	6.17	4.00	40373.12	1.94	1.05	40739.94
2.81	111.23	5.99	0.12	0.34	0.22	2243.66	0.11	0.06	2264.05
78.70	**3114.45**	**167.85**	**3.47**	**9.60**	**6.23**	**62822.57**	**3.01**	**1.64**	**63393.37**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
1.6	15.2	1.5	0.0	0.2	0.1	2530.4	0.1	0.1	2551.6
1.7	16.2	1.6	0.0	0.2	0.1	2709.0	0.2	0.1	2731.7
1.6	15.3	1.5	0.0	0.2	0.1	2560.2	0.1	0.1	2581.6
7.6	71.6	7.1	0.1	1.0	0.6	11947.5	0.7	0.3	12047.7
14.0	131.4	13.0	0.2	1.8	1.2	21943.4	1.3	0.5	22127.4
0.9	8.7	0.9	0.0	0.1	0.1	1455.4	0.1	0.0	1467.6
16.8	157.6	15.6	0.3	2.2	1.4	26316.2	1.5	0.6	26536.9
10.9	102.5	10.2	0.2	1.4	0.9	17117.4	1.0	0.4	17261.0
20.6	193.5	19.2	0.3	2.7	1.7	32299.8	1.8	0.7	32570.8
6.3	59.3	5.9	0.1	0.8	0.5	9896.7	0.6	0.2	9979.7
0.4	0.2	0.2	0.0	0.0	0.0	37.9	0.0	0.0	37.9
0.0	0.6	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0
0.0	1.4	0.0	0.0	0.0	0.0	2.4	0.0	0.0	2.4
0.4	7.4	0.0	0.0	0.1	0.1	11.5	0.0	0.0	11.6
0.4	7.4	0.0	0.0	0.1	0.1	11.5	0.0	0.0	11.6
7.9	785.7	6.7	0.7	0.8	0.5	1355.7	0.1	0.0	1367.7
4.5	453.1	3.9	0.4	0.4	0.3	781.8	0.0	0.0	788.7
2.7	273.8	2.3	0.2	0.3	0.2	472.5	0.0	0.0	476.7
1.3	133.2	1.1	0.1	0.1	0.1	229.9	0.0	0.0	231.9
1.3	133.2	1.1	0.1	0.1	0.1	229.9	0.0	0.0	231.9
10.6	1062.9	9.1	0.9	1.0	0.7	1833.8	0.1	0.0	1850.1
0.4	37.0	0.3	0.0	0.0	0.0	63.8	0.0	0.0	64.4
0.4	43.0	0.4	0.0	0.0	0.0	74.1	0.0	0.0	74.8
0.1	13.0	0.1	0.0	0.0	0.0	22.3	0.0	0.0	22.5
0.0	4.1	0.0	0.0	0.0	0.0	7.1	0.0	0.0	7.2
14.0	249.8	1.6	0.2	3.0	1.9	386.0	0.0	0.0	389.4
2.2	40.0	0.2	0.0	0.5	0.3	61.9	0.0	0.0	62.4
2.2	40.0	0.2	0.0	0.5	0.3	61.9	0.0	0.0	62.4
0.1	2.0	0.1	0.0	0.0	0.0	5.1	0.0	0.0	5.2
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.7	0.0	0.0	0.0	0.0	1.1	0.0	0.0	1.1
0.0	0.7	0.0	0.0	0.0	0.0	1.1	0.0	0.0	1.1
0.7	65.5	0.6	0.1	0.1	0.0	113.1	0.0	0.0	114.1
131.90	**4126.20**	**104.54**	**4.14**	**17.74**	**11.50**	**134541.23**	**7.70**	**3.13**	**135672.18**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
16.2	536.1	13.9	0.7	0.9	0.6	1344.9	0.1	0.0	1356.8
14.4	476.8	12.4	0.6	0.8	0.5	1196.1	0.1	0.0	1206.7
11.8	390.3	10.1	0.5	0.6	0.4	979.1	0.1	0.0	987.8
1.5	148.0	1.3	0.1	0.1	0.1	255.4	0.0	0.0	257.7
1.3	132.4	1.1	0.1	0.1	0.1	228.4	0.0	0.0	230.5
1.1	109.4	0.9	0.1	0.1	0.1	188.7	0.0	0.0	190.4
10.0	332.6	8.6	0.4	0.5	0.3	834.3	0.0	0.0	841.7
2.9	96.8	2.5	0.1	0.2	0.1	242.9	0.0	0.0	245.1
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.8	76.9	0.7	0.1	0.1	0.0	132.7	0.0	0.0	133.8
5.4	177.8	4.6	0.2	0.3	0.2	445.9	0.0	0.0	449.9
65.26	**2476.94**	**56.24**	**3.09**	**3.66**	**2.38**	**5848.48**	**0.33**	**0.15**	**5900.38**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
0.0	0.3	70.0	0.1	1.0	0.6	12998.4	0.4	0.4	13135.0
0.0	0.3	70.0	0.1	1.0	0.6	12998.4	0.4	0.4	13135.0
0.0	0.3	70.0	0.1	1.0	0.6	12998.4	0.4	0.4	13135.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.10	**0.79**	**210.11**	**0.37**	**2.87**	**1.86**	**38995.08**	**1.08**	**1.25**	**39404.97**
197.27	**6603.93**	**370.88**	**7.61**	**24.27**	**15.74**	**179384.80**	**9.10**	**4.52**	**180977.54**
21.46	718.35	40.34	0.83	2.64	1.71	19512.67	0.99	0.49	19685.92
25.12	840.99	47.23	0.97	3.09	2.00	22844.11	1.16	0.58	23046.94
13.61	455.54	25.58	0.52	1.67	1.09	12373.89	0.63	0.31	12483.76
3.26	109.17	6.13	0.13	0.40	0.26	2965.34	0.15	0.07	2991.67
126.77	4244.04	238.35	4.89	15.59	10.11	115282.19	5.85	2.91	116305.77
7.05	235.85	13.25	0.27	0.87	0.56	6406.60	0.33	0.16	6463.48
197.27	**6603.93**	**370.88**	**7.61**	**24.27**	**15.74**	**179384.80**	**9.10**	**4.52**	**180977.54**

Northern Salinas Valley Mosquito Abatement District Vehicles and Equipments

Land Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
Bean Pump	Honda Gx 160 5.5 HP			100%				100%	Gasoline
Birchmeier Sprayer (backpacks 4)	N/A			50%		50%		100%	Zero
Blow Mite Granule Spreader (backpack)	20 cc					100%		100%	50:1 gas/oil mix
Cat 320 Excavator	138 HP		50%	50%				100%	Diesel
Cat D3 Dozer	5.2 Liter		50%	50%				100%	Diesel
Chevy Silverado 4X4	6.6 Liter			90%			10%	100%	Diesel
Dodge Ram 50 Right hand drive	2.0 Liter				100%			100%	Gasoline
Ford F-150 4X4 (3)	5.4 Liter	25%			25%	40%	10%	100%	Gasoline
Ford F-150 4X4 Flare Side	5.8 Liter					90%	10%	100%	Gasoline
Ford F-150 Xl	5.4 Liter	25%			25%	40%	10%	100%	Gasoline
Ford F-350 4X4	6.0 Liter		50%	50%				100%	Diesel
Ford Windstar Sport SE	3.8 Liter						100%	100%	Gasoline
GPI Model 1505 Fuel Transfer	½ HP						100%	100%	Zero
Jeep Liberty 4X4	3.7 Liter						100%	100%	Gasoline
Jeep Wrangler 4X4	4.0 Liter	25%					75%	100%	Gasoline
John Deere 6420 with Flail Mulch Mower S900 (PTO)	90 hp		30%	70%				100%	Diesel
Maruyama Backpack Blower (Mister/Duster)	40.2 CC					90%	10%	100%	50:1 gas/oil mix
Mozzie Fogger – Arro-Gun System with electric shur flow pump	Honda GX 160 5.5 HP					100%		100%	Gasoline
Mozzie Granular Applicator – Arro-Gun System	Honda GX 160 5.5 HP					100%		100%	Gasoline
Robin Micro Gen Fogger	20 cc					100%		100%	50:1 gas/oil mix
Spyker Hand Granular Spreader (2)	N/A					100%		100%	Zero
Stihl Chainsaw 011AV	2.5 CI			100%				100%	50:1 gas/oil mix
Stihl Chainsaw 028 AV Super	47 CC			100%				100%	50:1 gas/oil mix
Stihl Leaf Blower BG 65	1.66 CI			100%				100%	50:1 gas/oil mix

Water Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
Argo ATV	570 CC	10%			45%	45%		100%	Gasoline
Argo Sprayer System	ShurFlo Electric					100%		100%	Zero
Valco Flat Bottom Boat (go devil engine/prop)	Briggs & Stratton 9 HP			50%		50%		100%	Gasoline

Aerial Applications	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
Jet Ranger (Helicopter)	Rolls Royce					100%		100%	Jet A
	100.00%	3%	6%	29%	7%	39%	15%	2800%	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Utility	160	9.8	0.56	5.5	1	15	15	15	15	1.60	
None				0	4	15	15	15	15	1.60	
2-stroke	20	1.2	0.92	1.1	1	15	15	15	15	0.13	
Offroad	4039	246.5	0.56	138.0	1	9	21	21	9	2.50	
Offroad	5200	317.3	0.56	178.0	1	9	21	21	9	1.67	
Onroad MD				MD	1	15	15	15	15		96
Onroad LD				LD	1	15	15	15	15		5
Onroad LD				LD	3	15	15	15	15		53
Onroad LD				LD	1	15	15	15	15		8
Onroad LD				LD	1	15	15	15	15		160
Onroad MD				MD	1	15	15	15	15		96
Onroad LD				LD	1	15	15	15	15		48
Electric				0	1	15	15	15	15	0.13	
Onroad LD				LD	1	15	15	15	15		12
Onroad LD				LD	1	15	15	15	15		24
Offroad	2635	160.8	0.56	90.0	1	9	21	21	9	1.67	
2-stroke	40	2.4	0.92	2.2	1	15	15	15	15	0.20	
Utility	160	9.8	0.56	5.5	1	15	15	15	15	0.13	
Utility	160	9.8	0.56	5.5	1	15	15	15	15	0.13	
2-stroke	20	1.2	0.92	1.1	1	15	15	15	15	0.13	
None				0	2	15	15	15	15	0.07	
2-stroke	41	2.5	0.92	2.3	1	0	30	30	0	0.13	
2-stroke	47	2.9	0.92	2.6	1	15	15	15	15	0.13	
2-stroke	27	1.6	0.92	1.5	1	0	30	30	0	0.13	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Sport	570	34.8	0.86	30.0	1	15	15	15	15	1.60	
Electric				0	1	15	15	15	15	1.60	
Utility	264	16.1	0.56	9.0	1	15	15	15	15	1.60	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Turbine				420	1	15	15	15	15	0.67	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
1.60		24		96	
6.40		96		384	
0.13		2		8	
2.50		52.5		150	
1.67		35		100	
	96		1440		5760
	5		75		300
	160		2400		9600
	8		120		480
	160		2400		9600
	96		1440		5760
	48		720		2880
0.13		2		8	
	12		180		720
	24		360		1440
1.67		35		100	
0.20		3		12	
0.13		2		8	
0.13		2		8	
0.13		2		8	
0.13		2		8	
0.13		4		8	
0.13		2		8	
0.13		4		8	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
1.6		24		96	
1.6		24		96	
1.6		24		96	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
0.67		10		40	

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.02759	2.75785	0.02350	0.00236	0.00267	0.00173	4.75833	0.00027	0.00012	4.80055
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.04069	0.72789	0.00452	0.00065	0.00861	0.00560	1.12470	0.00006	0.00003	1.13468
0.10781	0.68063	0.79061	0.00090	0.04084	0.03471	94.47480	0.00539	0.00238	95.32467
0.13906	0.61454	1.01978	0.00116	0.03512	0.02985	121.85880	0.00695	0.00307	122.95501
0.00190	0.01284	0.01425	0.00003	0.00055	0.00046	2.79845	0.00009	0.00014	2.84273
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00190	0.01284	0.01425	0.00003	0.00055	0.00046	2.79845	0.00009	0.00014	2.84273
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.07990	0.44389	0.58593	0.00059	0.03551	0.03018	61.61400	0.00352	0.00155	62.16826
0.08138	1.45578	0.00904	0.00131	0.01722	0.01119	2.24939	0.00013	0.00006	2.26935
0.02759	2.75785	0.02350	0.00236	0.00267	0.00173	4.75833	0.00027	0.00012	4.80055
0.02759	2.75785	0.02350	0.00236	0.00267	0.00173	4.75833	0.00027	0.00012	4.80055
0.04069	0.72789	0.00452	0.00065	0.00861	0.00560	1.12470	0.00006	0.00003	1.13468
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.08508	1.52195	0.00945	0.00137	0.01800	0.01170	2.35164	0.00013	0.00006	2.37250
0.09618	1.72047	0.01069	0.00155	0.02035	0.01323	2.65837	0.00015	0.00007	2.68196
0.05549	0.99258	0.00617	0.00089	0.01174	0.00763	1.53368	0.00009	0.00004	1.54729

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.17010	5.64300	0.14670	0.00756	0.00900	0.00585	14.15700	0.00080	0.00035	14.28263
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.04514	4.51284	0.03846	0.00387	0.00437	0.00284	7.78635	0.00044	0.00019	7.85545

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131

Surveillance	3%
Physical Control	6%
Vegetation Management	29%
Biological Control	7%
Chemical Control	39%
Other Non-Chemical	15%
CHECKSUM	**100%**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
0.04	4.41	0.04	0.00	0.00	0.00	7.61	0.00	0.00	7.68
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.01	0.10	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.15
0.27	1.70	1.98	0.00	0.10	0.09	236.19	0.01	0.01	238.31
0.23	1.02	1.70	0.00	0.06	0.05	203.10	0.01	0.01	204.93
0.18	1.23	1.37	0.00	0.05	0.04	268.65	0.01	0.01	272.90
0.00	0.03	0.00	0.00	0.00	0.00	5.51	0.00	0.00	5.56
0.11	1.06	0.10	0.00	0.01	0.01	176.41	0.01	0.00	177.89
0.01	0.05	0.01	0.00	0.00	0.00	8.82	0.00	0.00	8.89
0.11	1.06	0.10	0.00	0.01	0.01	176.41	0.01	0.00	177.89
0.18	1.23	1.37	0.00	0.05	0.04	268.65	0.01	0.01	272.90
0.03	0.32	0.03	0.00	0.00	0.00	52.92	0.00	0.00	53.37
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.01	0.08	0.01	0.00	0.00	0.00	13.23	0.00	0.00	13.34
0.02	0.16	0.02	0.00	0.00	0.00	26.46	0.00	0.00	26.68
0.13	0.74	0.98	0.00	0.06	0.05	102.69	0.01	0.00	103.61
0.02	0.29	0.00	0.00	0.00	0.00	0.45	0.00	0.00	0.45
0.00	0.37	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0.64
0.00	0.37	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0.64
0.01	0.10	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.15
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.01	0.20	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.32
0.01	0.23	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.36
0.01	0.13	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.21
1.40	**14.88**	**7.71**	**0.02**	**0.38**	**0.31**	**1549.56**	**0.07**	**0.05**	**1566.88**
VOC	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
lbs/day	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**
0.27	9.03	0.23	0.01	0.01	0.01	22.65	0.00	0.00	22.85
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.07	7.22	0.06	0.01	0.01	0.00	12.46	0.00	0.00	12.57
0.34	**16.25**	**0.30**	**0.02**	**0.02**	**0.01**	**35.11**	**0.00**	**0.00**	**35.42**
VOC	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
lbs/day	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**
0.00	0.01	1.95	0.00	0.03	0.02	361.07	0.01	0.01	364.86
0.00	**0.01**	**1.95**	**0.00**	**0.03**	**0.02**	**361.07**	**0.01**	**0.01**	**364.86**
1.75	**31.14**	**9.95**	**0.04**	**0.43**	**0.34**	**1945.73**	**0.09**	**0.06**	**1967.16**
0.05	0.95	0.30	0.00	0.01	0.01	59.07	0.00	0.00	59.72
0.11	2.00	0.64	0.00	0.03	0.02	125.08	0.01	0.00	126.46
0.51	9.01	2.88	0.01	0.12	0.10	562.87	0.03	0.02	569.07
0.12	2.17	0.69	0.00	0.03	0.02	135.51	0.01	0.00	137.00
0.69	12.29	3.93	0.02	0.17	0.13	767.87	0.03	0.02	776.33
0.27	4.73	1.51	0.01	0.07	0.05	295.33	0.01	0.01	298.59
1.75	**31.14**	**9.95**	**0.04**	**0.43**	**0.34**	**1945.73**	**0.09**	**0.06**	**1967.16**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
0.7	66.2	0.6	0.1	0.1	0.0	114.2	0.0	0.0	115.2
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.1	1.5	0.0	0.0	0.0	0.0	2.2	0.0	0.0	2.3
5.7	35.7	41.5	0.0	2.1	1.8	4959.9	0.3	0.1	5004.5
4.9	21.5	35.7	0.0	1.2	1.0	4265.1	0.2	0.1	4303.4
2.7	18.5	20.5	0.0	0.8	0.7	4029.8	0.1	0.2	4093.5
0.1	0.5	0.0	0.0	0.0	0.0	82.7	0.0	0.0	83.4
1.7	15.8	1.6	0.0	0.2	0.1	2646.2	0.2	0.1	2668.4
0.1	0.8	0.1	0.0	0.0	0.0	132.3	0.0	0.0	133.4
1.7	15.8	1.6	0.0	0.2	0.1	2646.2	0.2	0.1	2668.4
2.7	18.5	20.5	0.0	0.8	0.7	4029.8	0.1	0.2	4093.5
0.5	4.8	0.5	0.0	0.1	0.0	793.9	0.0	0.0	800.5
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.1	1.2	0.1	0.0	0.0	0.0	198.5	0.0	0.0	200.1
0.3	2.4	0.2	0.0	0.0	0.0	396.9	0.0	0.0	400.3
2.8	15.5	20.5	0.0	1.2	1.1	2156.5	0.1	0.1	2175.9
0.2	4.4	0.0	0.0	0.1	0.0	6.7	0.0	0.0	6.8
0.1	5.5	0.0	0.0	0.0	0.0	9.5	0.0	0.0	9.6
0.1	5.5	0.0	0.0	0.0	0.0	9.5	0.0	0.0	9.6
0.1	1.5	0.0	0.0	0.0	0.0	2.2	0.0	0.0	2.3
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.3	6.1	0.0	0.0	0.1	0.0	9.4	0.0	0.0	9.5
0.2	3.4	0.0	0.0	0.0	0.0	5.3	0.0	0.0	5.4
0.2	4.0	0.0	0.0	0.0	0.0	6.1	0.0	0.0	6.2
25.11	**249.07**	**143.63**	**0.34**	**7.09**	**5.81**	**26502.95**	**1.31**	**0.84**	**26792.15**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
4.1	135.4	3.5	0.2	0.2	0.1	339.8	0.0	0.0	342.8
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.1	108.3	0.9	0.1	0.1	0.1	186.9	0.0	0.0	188.5
5.17	**243.74**	**4.44**	**0.27**	**0.32**	**0.21**	**526.64**	**0.03**	**0.01**	**531.31**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
0.0	0.1	29.2	0.1	0.4	0.3	5416.0	0.1	0.2	5472.9
0.01	**0.11**	**29.18**	**0.05**	**0.40**	**0.26**	**5415.98**	**0.15**	**0.17**	**5472.91**
30.29	**492.92**	**177.26**	**0.67**	**7.81**	**6.28**	**32445.57**	**1.49**	**1.03**	**32796.38**

0.92	14.96	5.38	0.02	0.24	0.19	984.95	0.05	0.03	995.60
1.95	31.69	11.40	0.04	0.50	0.40	2085.79	0.10	0.07	2108.34
8.76	142.59	51.28	0.19	2.26	1.82	9386.04	0.43	0.30	9487.52
2.11	34.33	12.34	0.05	0.54	0.44	2259.60	0.10	0.07	2284.03
11.95	194.53	69.95	0.26	3.08	2.48	12804.41	0.59	0.41	12942.86
4.60	74.82	26.91	0.10	1.19	0.95	4924.77	0.23	0.16	4978.02
30.29	**492.92**	**177.26**	**0.67**	**7.81**	**6.28**	**32445.57**	**1.49**	**1.03**	**32796.38**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
2.6	264.8	2.3	0.2	0.3	0.2	456.8	0.0	0.0	460.9
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.3	5.8	0.0	0.0	0.1	0.0	9.0	0.0	0.0	9.1
16.2	102.1	118.6	0.1	6.1	5.2	14171.2	0.8	0.4	14298.7
13.9	61.5	102.0	0.1	3.5	3.0	12185.9	0.7	0.3	12295.5
10.9	74.0	82.1	0.2	3.2	2.6	16119.1	0.5	0.8	16374.1
0.2	2.0	0.2	0.0	0.0	0.0	330.8	0.0	0.0	333.5
6.7	63.4	6.3	0.1	0.9	0.6	10584.7	0.6	0.2	10673.5
0.3	3.2	0.3	0.0	0.0	0.0	529.2	0.0	0.0	533.7
6.7	63.4	6.3	0.1	0.9	0.6	10584.7	0.6	0.2	10673.5
10.9	74.0	82.1	0.2	3.2	2.6	16119.1	0.5	0.8	16374.1
2.0	19.0	1.9	0.0	0.3	0.2	3175.4	0.2	0.1	3202.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5	4.8	0.5	0.0	0.1	0.0	793.9	0.0	0.0	800.5
1.0	9.5	0.9	0.0	0.1	0.1	1587.7	0.1	0.0	1601.0
8.0	44.4	58.6	0.1	3.6	3.0	6161.4	0.4	0.2	6216.8
1.0	17.5	0.1	0.0	0.2	0.1	27.0	0.0	0.0	27.2
0.2	22.1	0.2	0.0	0.0	0.0	38.1	0.0	0.0	38.4
0.2	22.1	0.2	0.0	0.0	0.0	38.1	0.0	0.0	38.4
0.3	5.8	0.0	0.0	0.1	0.0	9.0	0.0	0.0	9.1
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.7	12.2	0.1	0.0	0.1	0.1	18.8	0.0	0.0	19.0
0.8	13.8	0.1	0.0	0.2	0.1	21.3	0.0	0.0	21.5
0.4	7.9	0.0	0.0	0.1	0.1	12.3	0.0	0.0	12.4
84.10	**892.98**	**462.75**	**1.22**	**22.86**	**18.62**	**92973.32**	**4.48**	**3.05**	**94012.84**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
16.3	541.7	14.1	0.7	0.9	0.6	1359.1	0.1	0.0	1371.1
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.3	433.2	3.7	0.4	0.4	0.3	747.5	0.0	0.0	754.1
20.66	**974.96**	**17.77**	**1.10**	**1.28**	**0.83**	**2106.56**	**0.12**	**0.05**	**2125.26**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
0.1	0.4	116.7	0.2	1.6	1.0	21663.9	0.6	0.7	21891.7
0.05	**0.44**	**116.73**	**0.21**	**1.59**	**1.03**	**21663.94**	**0.60**	**0.69**	**21891.65**
104.82	**1868.38**	**597.25**	**2.52**	**25.73**	**20.49**	**116743.82**	**5.20**	**3.80**	**118029.74**
3.18	56.72	18.13	0.08	0.78	0.62	3544.01	0.16	0.12	3583.05
6.74	120.11	38.39	0.16	1.65	1.32	7504.96	0.33	0.24	7587.63
30.32	540.50	172.78	0.73	7.44	5.93	33772.32	1.50	1.10	34144.32
7.30	130.12	41.59	0.18	1.79	1.43	8130.37	0.36	0.26	8219.93
41.36	737.34	235.70	0.99	10.16	8.08	46072.11	2.05	1.50	46579.60
15.91	283.59	90.65	0.38	3.91	3.11	17720.04	0.79	0.58	17915.23
104.82	**1868.38**	**597.25**	**2.52**	**25.73**	**20.49**	**116743.82**	**5.20**	**3.80**	**118029.74**

San Mateo County Mosquito and Vector Control District Vehicles and Equipments

Land Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
Argo Avenger (off road)	Kawasaki 41.1 cubic inches 26 hp	10%			90%			100%	Gasoline
Atlas Tire Balancer	Electric						100%	100%	Zero
Atlas Tire Changer	Electric						100%	100%	Zero
Chevy 2500 pickup truck 4x4	Onroad	25%		25%			50%	100%	Gasoline
Clark Grizzly ULV Truck Mounted Sprayer (2 units)	Briggs & Stratton					100%		100%	Gasoline
Curtis Dyna-Fog Twister XL ULV Backpack Sprayer	40.2 cc					100%		100%	Gasoline
Dewalt 10" Compound Miter Saw DW703	Electric						100%	100%	Zero
Dewalt 14" Multicutter Metal Saw	Electric						100%	100%	Zero
Dodge 2500 4X4 truck 2005	Onroad				100%			100%	Gasoline
Dodge Power Wagon 1948	Onroad						100%	100%	Diesel
ECHO Chainsaw CS 301 (2 units)	30.1 cc			100%				100%	50:1 gas/oil mix
ECHO Weedeater SRM 225	22.5 cc			100%				100%	50:1 gas/oil mix
Ford Escape Hybrid 4x4	Onroad	25%					75%	100%	Gasoline
Ford F-150 pickup truck 4x4 (3 vehicles)	Onroad	60%			25%	15%		100%	Gasoline
Ford Ranger pickup truck 4x4 (8 vehicles)	Onroad	60%	5%	5%	20%	10%		100%	Gasoline
Fork Lift - hydraulic	Offroad (49 hp)						100%	100%	Gasoline
Hotsy High Pressure Washer	Briggs & Stratton						100%	100%	Gasoline
Jeep Wrangler (Right Hand Drive) (8 vehicles)	Onroad				10%	90%		100%	Gasoline
Maruyama Power Mister/Duster Backpack Sprayer	Kawasaki 40.2cc				100%			100%	50:1 gas/oil mix
Nissan Frontier Pro4X pickup truck 4x4 (2 vehicles)	Onroad	60%	5%	5%	20%	10%		100%	Gasoline
Nurse Rig 200 gal tank and sprayer	Briggs & Stratton			80%	20%			100%	Gasoline
Porta-Pak ULV Backpack Sprayer	Kawasaki 40.2cc					100%		100%	50:1 gas/oil mix
Stihl Chainsaw 021	44 cc			100%				100%	50:1 gas/oil mix
Stihl Chainsaw 026	44 cc			100%				100%	50:1 gas/oil mix
Stihl Chainsaw 039	44 cc			100%				100%	50:1 gas/oil mix
Stihl Chainsaw 260	47 cc			100%				100%	50:1 gas/oil mix
Stihl Chainsaw 290	47 cc			100%				100%	50:1 gas/oil mix
Stihl Trimmer HS 85 (6 units)	25.4 cc			100%				100%	50:1 gas/oil mix
Stihl Weedeater FS 250	25.4 cc			100%				100%	50:1 gas/oil mix
Toyota Sienna Van	Onroad	25%					75%	100%	Gasoline
Univar Dynajet ULV Electric Truck Mounted Sprayer (2 units)	Electric					100%		100%	Zero

Water Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
Argo Avenger ATV	Kawasaki 41.1 cubic inches 26 hp	10%			90%			100%	Gasoline
GTO Airboat	502 cubic inches: output 500hp	20%		70%	10%			100%	Gasoline
GTO Airboat 50 gallon spray tank	7.4 cu in			100%				100%	Gasoline
Klamath Boat 14'	Johnson or Mercury 15 hp 4 stroke	80%					20%	100%	Gasoline
Klamath Boat 18'	Johnson or Mercury 15 hp 4 stroke	70%			30%			100%	Gasoline

Aerial Applications	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
1989 Bell 206 Jet Ranger helicopter (Alpine) 120 gal material tank	Allison 250-C20J turboshaft, 420 shp				100%			100%	Jet A
Isolair 4500 broadcaster (helicopter-mounted)	N/A				100%			100%	Zero
Isolair Air spray system model 3900 (helicopter-mounted)	N/A				100%			100%	Zero
	100.00%	11%	0%	30%	21%	13%	24%	3900%	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Sport				49	1	5	5	0	5	4	
Electric				0	1	5	5	5	5	2	
Electric				0	1	5	5	5	5	2	
Onroad LD				LD	1	20	20	20	20		90
Utility	146	8.9	0.56	5.0	2	20	20	20	20	12	
Onroad LD				LD	1	5	10	10	5		30
Electric				0	1	1	1	1	1	1	
Electric				0	1	1	1	1	1	1	
Onroad LD				LD	1	1	1	3	1		150
Onroad MD				MD	1	1	1	1	1		30
2-stroke	30	1.8	0.92	1.7	2	4	10	6	6	2	
2-stroke	23	1.4	0.92	1.3	1		5	5		2	
Onroad LD				LD	1	50	50	50	50		90
Onroad LD				LD	3	180	180	180	180		30
Onroad LD				LD	8	520	520	520	520		90
Utility				49	1	5	5	5	5	1	
Utility	146	8.9	0.56	5.0	1	50	50	50	50	1	
Onroad LD				LD	8	0	240	520	120		120
2-stroke	40	2.4	0.92	2.2	1	5	10	10	5	1	
Onroad LD				LD	2	130	130	130	130		30
Utility	146	8.9	0.56	5.0	1	5	3	30	15	3	
2-stroke	40	2.4	0.92	2.2	1	2	10	10	2	1	
2-stroke	44	2.7	0.92	2.5	1	2	5	3	3	1	
2-stroke	44	2.7	0.92	2.5	1	2	5	3	3	1	
2-stroke	44	2.7	0.92	2.5	1	1	1	1	1	1	
2-stroke	47	2.9	0.92	2.6	1	2	5	3	3	1	
2-stroke	47	2.9	0.92	2.6	1	2	5	3	3	1	
2-stroke	25	1.5	0.92	1.4	6		60	30		6	
2-stroke	25	1.5	0.92	1.4	1		5	5		2	
Onroad LD				LD	1	15	15	15	15		60
Electric				0	2	20	20	20	20	12	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Sport				26	4	40	20	0	12	16	
Sport				500	1	10	10	20	20	3	
Utility	122	7.4	0.56	4.2	1	0	0	15	15	5	
Sport				15	1	2	2	2	2	3	
Sport				15	1	5	5	5	5	2	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Turbine				420	1	2	2	2	0	4	
None				0	1	0	2	2	0	2	
None				0	1	2	0	0	0	8	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
4		20		60	
2		10		40	
2		10		40	
	90		1800		7200
24		480		1920	
	30		300		900
1		1		4	
1		1		4	
	150		450		900
	30		30		120
4		40		104	
2		10		20	
	90		4500		18000
	90		16200		64800
	720		374400		1497600
1		5		20	
1		50		200	
	960		499200		844800
1		10		30	
	60		7800		31200
3		90		159	
1		10		24	
1		5		13	
1		5		13	
1		1		4	
1		5		13	
1		5		13	
36		2160		3240	
2		10		20	
	60		900		3600
24		480		1920	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
64		2560		4608	
3		60		180	
5		75		150	
3		6		24	
2		10		40	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
4		8		24	
2		4		8	
8		16		16	

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.27783	9.21690	0.23961	0.01235	0.01470	0.00956	23.12310	0.00131	0.00057	23.32830
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.02508	2.50713	0.02136	0.00215	0.00243	0.00158	4.32575	0.00024	0.00011	4.36414
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00190	0.01284	0.01425	0.00003	0.00055	0.00046	2.79845	0.00009	0.00014	2.84273
0.06288	1.12492	0.00699	0.00101	0.01330	0.00865	1.73817	0.00010	0.00004	1.75359
0.04809	0.86023	0.00534	0.00077	0.01017	0.00661	1.32919	0.00008	0.00003	1.34098
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.46305	15.36150	0.39935	0.02058	0.02450	0.01593	38.53850	0.00218	0.00096	38.88050
0.02508	2.50713	0.02136	0.00215	0.00243	0.00158	4.32575	0.00024	0.00011	4.36414
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.08138	1.45578	0.00904	0.00131	0.01722	0.01119	2.24939	0.00013	0.00006	2.26935
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.02508	2.50713	0.02136	0.00215	0.00243	0.00158	4.32575	0.00024	0.00011	4.36414
0.08138	1.45578	0.00904	0.00131	0.01722	0.01119	2.24939	0.00013	0.00006	2.26935
0.09248	1.65430	0.01028	0.00149	0.01957	0.01272	2.55613	0.00014	0.00006	2.57881
0.09248	1.65430	0.01028	0.00149	0.01957	0.01272	2.55613	0.00014	0.00006	2.57881
0.09248	1.65430	0.01028	0.00149	0.01957	0.01272	2.55613	0.00014	0.00006	2.57881
0.09618	1.72047	0.01069	0.00155	0.02035	0.01323	2.65837	0.00015	0.00007	2.68196
0.09618	1.72047	0.01069	0.00155	0.02035	0.01323	2.65837	0.00015	0.00007	2.68196
0.05179	0.92641	0.00575	0.00083	0.01096	0.00712	1.43143	0.00008	0.00004	1.44413
0.05179	0.92641	0.00575	0.00083	0.01096	0.00712	1.43143	0.00008	0.00004	1.44413
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.14742	4.89060	0.12714	0.00655	0.00780	0.00507	12.26940	0.00069	0.00030	12.37828
2.83500	94.05000	2.44500	0.12600	0.15000	0.09750	235.95000	0.01335	0.00585	238.04385
0.02107	2.10599	0.01795	0.00181	0.00204	0.00132	3.63363	0.00021	0.00009	3.66588
0.08505	2.82150	0.07335	0.00378	0.00450	0.00293	7.07850	0.00040	0.00018	7.14132
0.08505	2.82150	0.07335	0.00378	0.00450	0.00293	7.07850	0.00040	0.00018	7.14132

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Surveillance	11%
Physical Control	0%
Vegetation Management	30%
Biological Control	21%
Chemical Control	13%
Other Non-Chemical	24%
CHECKSUM	**100%**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
1.11	36.87	0.96	0.05	0.06	0.04	92.49	0.01	0.00	93.31
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.06	0.59	0.06	0.00	0.01	0.01	99.23	0.01	0.00	100.06
0.60	60.17	0.51	0.05	0.06	0.04	103.82	0.01	0.00	104.74
0.02	0.20	0.02	0.00	0.00	0.00	33.08	0.00	0.00	33.35
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.11	0.99	0.10	0.00	0.01	0.01	165.39	0.01	0.00	166.77
0.06	0.39	0.43	0.00	0.02	0.01	83.95	0.00	0.00	85.28
0.25	4.50	0.03	0.00	0.05	0.03	6.95	0.00	0.00	7.01
0.10	1.72	0.01	0.00	0.02	0.01	2.66	0.00	0.00	2.68
0.06	0.59	0.06	0.00	0.01	0.01	99.23	0.01	0.00	100.06
0.06	0.59	0.06	0.00	0.01	0.01	99.23	0.01	0.00	100.06
0.51	4.75	0.47	0.01	0.07	0.04	793.85	0.05	0.02	800.51
0.46	15.36	0.40	0.02	0.02	0.02	38.54	0.00	0.00	38.88
0.03	2.51	0.02	0.00	0.00	0.00	4.33	0.00	0.00	4.36
0.67	6.34	0.63	0.01	0.09	0.06	1058.47	0.06	0.02	1067.35
0.08	1.46	0.01	0.00	0.02	0.01	2.25	0.00	0.00	2.27
0.04	0.40	0.04	0.00	0.01	0.00	66.15	0.00	0.00	66.71
0.08	7.52	0.06	0.01	0.01	0.00	12.98	0.00	0.00	13.09
0.08	1.46	0.01	0.00	0.02	0.01	2.25	0.00	0.00	2.27
0.09	1.65	0.01	0.00	0.02	0.01	2.56	0.00	0.00	2.58
0.09	1.65	0.01	0.00	0.02	0.01	2.56	0.00	0.00	2.58
0.09	1.65	0.01	0.00	0.02	0.01	2.56	0.00	0.00	2.58
0.10	1.72	0.01	0.00	0.02	0.01	2.66	0.00	0.00	2.68
0.10	1.72	0.01	0.00	0.02	0.01	2.66	0.00	0.00	2.68
1.86	33.35	0.21	0.03	0.39	0.26	51.53	0.00	0.00	51.99
0.10	1.85	0.01	0.00	0.02	0.01	2.86	0.00	0.00	2.89
0.04	0.40	0.04	0.00	0.01	0.00	66.15	0.00	0.00	66.71
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.86	**190.41**	**4.18**	**0.20**	**1.00**	**0.65**	**2898.38**	**0.16**	**0.07**	**2923.48**
VOC	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
lbs/day	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**
9.43	313.00	8.14	0.42	0.50	0.32	785.24	0.04	0.02	792.21
8.51	282.15	7.34	0.38	0.45	0.29	707.85	0.04	0.02	714.13
0.11	10.53	0.09	0.01	0.01	0.01	18.17	0.00	0.00	18.33
0.26	8.46	0.22	0.01	0.01	0.01	21.24	0.00	0.00	21.42
0.17	5.64	0.15	0.01	0.01	0.01	14.16	0.00	0.00	14.28
18.47	**619.79**	**15.93**	**0.83**	**0.98**	**0.64**	**1546.65**	**0.09**	**0.04**	**1560.38**
VOC	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
lbs/day	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**	**lbs/day**
0.01	0.04	11.67	0.02	0.16	0.10	2166.39	0.06	0.07	2189.17
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.01	**0.04**	**11.67**	**0.02**	**0.16**	**0.10**	**2166.39**	**0.06**	**0.07**	**2189.17**
25.34	**810.24**	**31.79**	**1.05**	**2.14**	**1.39**	**6611.43**	**0.31**	**0.18**	**6673.02**
2.89	92.45	3.63	0.12	0.24	0.16	754.38	0.04	0.02	761.41
0.06	2.08	0.08	0.00	0.01	0.00	16.95	0.00	0.00	17.11
7.70	246.19	9.66	0.32	0.65	0.42	2008.86	0.09	0.05	2027.57
5.29	169.32	6.64	0.22	0.45	0.29	1381.62	0.06	0.04	1394.49
3.41	109.07	4.28	0.14	0.29	0.19	890.00	0.04	0.02	898.29
5.98	191.13	7.50	0.25	0.50	0.33	1559.62	0.07	0.04	1574.15
25.34	**810.24**	**31.79**	**1.05**	**2.14**	**1.39**	**6611.43**	**0.31**	**0.18**	**6673.02**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
5.6	184.3	4.8	0.2	0.3	0.2	462.5	0.0	0.0	466.6
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.3	11.9	1.2	0.0	0.2	0.1	1984.6	0.1	0.0	2001.3
12.0	1203.4	10.3	1.0	1.2	0.8	2076.4	0.1	0.1	2094.8
0.2	2.0	0.2	0.0	0.0	0.0	330.8	0.0	0.0	333.5
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.3	3.0	0.3	0.0	0.0	0.0	496.2	0.0	0.0	500.3
0.1	0.4	0.4	0.0	0.0	0.0	84.0	0.0	0.0	85.3
2.5	45.0	0.3	0.0	0.5	0.3	69.5	0.0	0.0	70.1
0.5	8.6	0.1	0.0	0.1	0.1	13.3	0.0	0.0	13.4
3.2	29.7	2.9	0.0	0.4	0.3	4961.6	0.3	0.1	5003.2
11.4	107.0	10.6	0.2	1.5	1.0	17861.7	1.0	0.4	18011.5
262.9	2472.4	245.2	4.0	34.4	22.2	412803.0	23.6	9.6	416265.3
2.3	76.8	2.0	0.1	0.1	0.1	192.7	0.0	0.0	194.4
1.3	125.4	1.1	0.1	0.1	0.1	216.3	0.0	0.0	218.2
350.6	3296.5	326.9	5.3	45.9	29.6	550404.0	31.5	12.8	555020.4
0.8	14.6	0.1	0.0	0.2	0.1	22.5	0.0	0.0	22.7
5.5	51.5	5.1	0.1	0.7	0.5	8600.1	0.5	0.2	8672.2
2.3	225.6	1.9	0.2	0.2	0.1	389.3	0.0	0.0	392.8
0.8	14.6	0.1	0.0	0.2	0.1	22.5	0.0	0.0	22.7
0.5	8.3	0.1	0.0	0.1	0.1	12.8	0.0	0.0	12.9
0.5	8.3	0.1	0.0	0.1	0.1	12.8	0.0	0.0	12.9
0.1	1.7	0.0	0.0	0.0	0.0	2.6	0.0	0.0	2.6
0.5	8.6	0.1	0.0	0.1	0.1	13.3	0.0	0.0	13.4
0.5	8.6	0.1	0.0	0.1	0.1	13.3	0.0	0.0	13.4
111.9	2001.0	12.4	1.8	23.7	15.4	3091.9	0.2	0.1	3119.3
0.5	9.3	0.1	0.0	0.1	0.1	14.3	0.0	0.0	14.4
0.6	5.9	0.6	0.0	0.1	0.1	992.3	0.1	0.0	1000.6
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
778.40	**9924.20**	**626.67**	**13.28**	**110.28**	**71.40**	**1005143.90**	**57.53**	**23.31**	**1013578.33**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
377.4	12519.9	325.5	16.8	20.0	13.0	31409.7	1.8	0.8	31688.4
170.1	5643.0	146.7	7.6	9.0	5.9	14157.0	0.8	0.4	14282.6
1.6	157.9	1.3	0.1	0.2	0.1	272.5	0.0	0.0	274.9
0.5	16.9	0.4	0.0	0.0	0.0	42.5	0.0	0.0	42.8
0.9	28.2	0.7	0.0	0.0	0.0	70.8	0.0	0.0	71.4
550.44	**18366.03**	**474.70**	**24.53**	**29.19**	**18.98**	**45952.44**	**2.60**	**1.14**	**46360.23**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
0.0	0.1	23.3	0.0	0.3	0.2	4332.8	0.1	0.1	4378.3
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.01	**0.09**	**23.35**	**0.04**	**0.32**	**0.21**	**4332.79**	**0.12**	**0.14**	**4378.33**

1328.85	**28290.32**	**1124.72**	**37.85**	**139.80**	**90.58**	**1055429.13**	**60.25**	**24.59**	**1064316.89**

151.63	3228.00	128.33	4.32	15.95	10.34	120427.17	6.87	2.81	121441.29
3.41	72.54	2.88	0.10	0.36	0.23	2706.23	0.15	0.06	2729.02
403.77	8595.90	341.74	11.50	42.48	27.52	320688.08	18.31	7.47	323388.59
277.70	5911.95	235.04	7.91	29.21	18.93	220557.63	12.59	5.14	222414.94
178.88	3808.31	151.40	5.10	18.82	12.19	142077.00	8.11	3.31	143273.43
313.47	6673.61	265.32	8.93	32.98	21.37	248973.03	14.21	5.80	251069.63
1328.85	**28290.32**	**1124.72**	**37.85**	**139.80**	**90.58**	**1055429.13**	**60.25**	**24.59**	**1064316.89**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
16.7	553.0	14.4	0.7	0.9	0.6	1387.4	0.1	0.0	1399.7
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.1	47.5	4.7	0.1	0.7	0.4	7938.5	0.5	0.2	8005.1
48.2	4813.7	41.0	4.1	4.7	3.0	8305.4	0.5	0.2	8379.1
0.6	5.9	0.6	0.0	0.1	0.1	992.3	0.1	0.0	1000.6
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.6	5.9	0.6	0.0	0.1	0.1	992.3	0.1	0.0	1000.6
0.2	1.5	1.7	0.0	0.1	0.1	335.8	0.0	0.0	341.1
6.5	117.0	0.7	0.1	1.4	0.9	180.8	0.0	0.0	182.4
1.0	17.2	0.1	0.0	0.2	0.1	26.6	0.0	0.0	26.8
12.6	118.9	11.8	0.2	1.7	1.1	19846.3	1.1	0.5	20012.8
45.5	427.9	42.4	0.7	6.0	3.8	71446.7	4.1	1.7	72045.9
1051.7	9889.5	980.7	16.0	137.6	88.9	1651211.9	94.5	38.3	1665061.3
9.3	307.2	8.0	0.4	0.5	0.3	770.8	0.0	0.0	777.6
5.0	501.4	4.3	0.4	0.5	0.3	865.2	0.0	0.0	872.8
593.3	5578.7	553.2	9.0	77.6	50.2	931452.9	53.3	21.6	939265.4
2.4	43.7	0.3	0.0	0.5	0.3	67.5	0.0	0.0	68.1
21.9	206.0	20.4	0.3	2.9	1.9	34400.2	2.0	0.8	34688.8
4.0	398.6	3.4	0.3	0.4	0.3	687.8	0.0	0.0	693.9
2.0	34.9	0.2	0.0	0.4	0.3	54.0	0.0	0.0	54.5
1.2	21.5	0.1	0.0	0.3	0.2	33.2	0.0	0.0	33.5
1.2	21.5	0.1	0.0	0.3	0.2	33.2	0.0	0.0	33.5
0.4	6.6	0.0	0.0	0.1	0.1	10.2	0.0	0.0	10.3
1.3	22.4	0.1	0.0	0.3	0.2	34.6	0.0	0.0	34.9
1.3	22.4	0.1	0.0	0.3	0.2	34.6	0.0	0.0	34.9
167.8	3001.6	18.6	2.7	35.5	23.1	4637.8	0.3	0.1	4679.0
1.0	18.5	0.1	0.0	0.2	0.1	28.6	0.0	0.0	28.9
2.5	23.8	2.4	0.0	0.3	0.2	3969.3	0.2	0.1	4002.6
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2003.23	**26206.92**	**1710.23**	**35.45**	**273.09**	**176.74**	**2739743.82**	**156.81**	**63.54**	**2762734.10**
VOC	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
lbs/yr	**lbs/yr**	**lbs/yr**	**lbs/yr**	**lbs/yr**	**lbs/yr**	**lbs/yr**	**lbs/yr**	**lbs/yr**	**lbs/yr**
679.3	22535.9	585.9	30.2	35.9	23.4	56537.4	3.2	1.4	57039.1
510.3	16929.0	440.1	22.7	27.0	17.6	42471.0	2.4	1.1	42847.9
3.2	315.9	2.7	0.3	0.3	0.2	545.0	0.0	0.0	549.9
2.0	67.7	1.8	0.1	0.1	0.1	169.9	0.0	0.0	171.4
3.4	112.9	2.9	0.2	0.2	0.1	283.1	0.0	0.0	285.7
1198.21	**39961.36**	**1033.35**	**53.38**	**63.54**	**41.30**	**100006.46**	**5.66**	**2.48**	**100893.93**
VOC	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
lbs/yr	**lbs/yr**	**lbs/yr**	**lbs/yr**	**lbs/yr**	**lbs/yr**	**lbs/yr**	**lbs/yr**	**lbs/yr**	**lbs/yr**
0.0	0.3	70.0	0.1	1.0	0.6	12998.4	0.4	0.4	13135.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.03	**0.26**	**70.04**	**0.12**	**0.96**	**0.62**	**12998.36**	**0.36**	**0.42**	**13134.99**
3201.47	**66168.55**	**2813.62**	**88.96**	**337.58**	**218.66**	**2852748.65**	**162.83**	**66.44**	**2876763.02**
365.30	7550.00	321.04	10.15	38.52	24.95	325505.94	18.58	7.58	328246.04
8.21	169.66	7.21	0.23	0.87	0.56	7314.74	0.42	0.17	7376.32
972.76	20105.06	854.91	27.03	102.57	66.44	866796.70	49.48	20.19	874093.38
669.03	13827.53	587.97	18.59	70.55	45.69	596151.32	34.03	13.88	601169.71
430.97	8907.30	378.76	11.97	45.44	29.44	384023.86	21.92	8.94	387256.56
755.22	15608.99	663.73	20.98	79.64	51.58	672956.09	38.41	15.67	678621.02
3201.47	**66168.55**	**2813.62**	**88.96**	**337.58**	**218.66**	**2852748.65**	**162.83**	**66.44**	**2876763.02**

Santa Clara County Vector Control District Vehicles and Equipments

Land Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
Dodge ¾ ton (1)	5.9 L V8	50%	5%		20%	25%		100%	Gasoline
Dodge Dakota Pickup truck(1)	3.7 L V6	50%	5%		20%	25%		100%	Gasoline
Ford Escape (1)	2.4 L Hybrid	50%	5%		20%	25%		100%	Gasoline
Ford Expedition	4.6 L	50%	5%		20%	25%		100%	Gasoline
Ford F150 (14)	4.6 L V8	50%	5%		20%	25%		100%	Gasoline
Ford F250 (10)	5.4 L V8	50%	5%		20%	25%		100%	Gasoline
Ford Personnel Van(1)	2.4 L 4cyl	50%	5%		20%	25%		100%	Gasoline
Ford Ranger (5)	4.0 L V6	50%	5%		20%	25%		100%	Gasoline
Fork Lift (1)	Battery	50%	5%		20%	25%		100%	Zero
GMC ½ ton (5)	5.3 L V8	50%	5%		20%	25%		100%	Gasoline
International flatbed truck	5.6 L	50%	5%		20%	25%		100%	Diesel

Water Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
Argo Avenger ATV(2)	26 HP Kohler engine	50%				50%		100%	Gasoline
Argo Conquest	20 HP Kawasaki	50%				50%		100%	Gasoline
Boat	Battery	50%				50%		100%	Zero
Kabota	3 cyl 21HP	50%			15%	35%		100%	Diesel
Maruyama Spreader	25 cc 2 stroke	50%				50%		100%	50:1 gas/oil mix
Yamaha Quads (2)	400cc 4 stroke	50%				50%		100%	Gasoline

Aerial Applications	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
Alpine Helicopter Services	Alison C20 Gas Turbine					100%		100%	Jet A
	100.00%	47%	3%	0%	13%	37%	0%	1800%	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Onroad LD				LD	1		60	60	10		120
Onroad LD				LD	1	30	30	30	30		60
Onroad LD				LD	1	20	20	20	20		30
Onroad LD				LD	1	45	45	45	45		30
Onroad LD				LD	14	60	60	60	60		90
Onroad LD				LD	10	60	60	60	60		90
Onroad LD				LD	1	30	30	30	30		30
Onroad LD				LD	5	25	60	60	15		180
Electric				0	1	10	10	10	10	1	
Onroad LD				LD	5	5	30	30	5		60
Onroad MD				MD	1	3	2	2	3		30

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Sport				26	2	13.20	13.20	13.20	13.20	0.12	
Sport	382	23.3	0.86	20.0	1	8.25	8.25	8.25	8.25	0.13	
Electric				0	1	0.51	0.51	0.51	0.51	0.01	
Offroad				21	1	3.64	3.64	3.64	3.64	0.06	
2-stroke	25	1.5	0.92	1.4	1	0.33	0.33	0.33	0.33	0.01	
Sport	400	24.4	0.86	21.0	2	14.80	14.80	14.80	14.80	0.11	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Turbine				420	1	1				0.031	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
	120		7200		15600
	60		1800		7200
	30		600		2400
	30		1350		5400
	1260		75600		302400
	900		54000		216000
	30		900		3600
	900		54000		144000
1		10		40	
	300		9000		21000
	30		90		300

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
0.23		3.04		12.14	
0.13		1.07		4.29	
0.01		0.00		0.02	
0.06		0.22		0.87	
0.01		0.00		0.01	
0.22		3.26		13.02	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
0.031		0.031		0.031	

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00190	0.01284	0.01425	0.00003	0.00055	0.00046	2.79845	0.00009	0.00014	2.84273

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.14742	4.89060	0.12714	0.00655	0.00780	0.00507	12.26940	0.00069	0.00030	12.37828
0.11340	3.76200	0.09780	0.00504	0.00600	0.00390	9.43800	0.00053	0.00023	9.52175
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.01864	0.13672	0.13672	0.00016	0.01657	0.01409	16.43040	0.00094	0.00041	16.57820
0.05179	0.92641	0.00575	0.00083	0.01096	0.00712	1.43143	0.00008	0.00004	1.44413
0.11907	3.95010	0.10269	0.00529	0.00630	0.00410	9.90990	0.00056	0.00025	9.99784

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131

Surveillance	47%
Physical Control	3%
Vegetation Management	0%
Biological Control	13%
Chemical Control	37%
Other Non-Chemical	0%
CHECKSUM	**100%**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
0.08	0.79	0.08	0.00	0.01	0.01	132.31	0.01	0.00	133.42
0.04	0.40	0.04	0.00	0.01	0.00	66.15	0.00	0.00	66.71
0.02	0.20	0.02	0.00	0.00	0.00	33.08	0.00	0.00	33.35
0.02	0.20	0.02	0.00	0.00	0.00	33.08	0.00	0.00	33.35
0.88	8.32	0.83	0.01	0.12	0.07	1389.24	0.08	0.03	1400.89
0.63	5.94	0.59	0.01	0.08	0.05	992.31	0.06	0.02	1000.64
0.02	0.20	0.02	0.00	0.00	0.00	33.08	0.00	0.00	33.35
0.63	5.94	0.59	0.01	0.08	0.05	992.31	0.06	0.02	1000.64
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.21	1.98	0.20	0.00	0.03	0.02	330.77	0.02	0.01	333.55
0.06	0.39	0.43	0.00	0.02	0.01	83.95	0.00	0.00	85.28
2.61	**24.36**	**2.80**	**0.04**	**0.35**	**0.23**	**4086.29**	**0.23**	**0.10**	**4121.19**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
0.03	1.12	0.03	0.00	0.00	0.00	2.82	0.00	0.00	2.85
0.01	0.49	0.01	0.00	0.00	0.00	1.23	0.00	0.00	1.24
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.01	0.01	0.00	0.00	0.00	0.99	0.00	0.00	0.99
0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01
0.03	0.87	0.02	0.00	0.00	0.00	2.18	0.00	0.00	2.20
0.08	**2.50**	**0.07**	**0.00**	**0.01**	**0.00**	**7.22**	**0.00**	**0.00**	**7.29**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
0.00	0.00	0.09	0.00	0.00	0.00	16.79	0.00	0.00	16.97
0.00	**0.00**	**0.09**	**0.00**	**0.00**	**0.00**	**16.79**	**0.00**	**0.00**	**16.97**
2.68	**26.85**	**2.97**	**0.04**	**0.36**	**0.23**	**4110.30**	**0.23**	**0.10**	**4145.44**
1.27	12.68	1.40	0.02	0.17	0.11	1940.98	0.11	0.05	1957.57
0.08	0.82	0.09	0.00	0.01	0.01	125.59	0.01	0.00	126.67
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.35	3.51	0.39	0.01	0.05	0.03	536.62	0.03	0.01	541.21
0.98	9.85	1.09	0.02	0.13	0.09	1507.11	0.09	0.04	1519.99
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.68	**26.85**	**2.97**	**0.04**	**0.36**	**0.23**	**4110.30**	**0.23**	**0.10**	**4145.44**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
5.1	47.5	4.7	0.1	0.7	0.4	7938.5	0.5	0.2	8005.1
1.3	11.9	1.2	0.0	0.2	0.1	1984.6	0.1	0.0	2001.3
0.4	4.0	0.4	0.0	0.1	0.0	661.5	0.0	0.0	667.1
0.9	8.9	0.9	0.0	0.1	0.1	1488.5	0.1	0.0	1501.0
53.1	499.2	49.5	0.8	6.9	4.5	83354.4	4.8	1.9	84053.6
37.9	356.6	35.4	0.6	5.0	3.2	59538.9	3.4	1.4	60038.3
0.6	5.9	0.6	0.0	0.1	0.1	992.3	0.1	0.0	1000.6
37.9	356.6	35.4	0.6	5.0	3.2	59538.9	3.4	1.4	60038.3
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.3	59.4	5.9	0.1	0.8	0.5	9923.1	0.6	0.2	10006.4
0.2	1.2	1.3	0.0	0.0	0.0	251.9	0.0	0.0	255.8
143.75	**1351.25**	**135.17**	**2.19**	**18.83**	**12.18**	**225672.72**	**12.91**	**5.24**	**227567.40**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
0.4	14.8	0.4	0.0	0.0	0.0	37.2	0.0	0.0	37.6
0.1	4.0	0.1	0.0	0.0	0.0	10.1	0.0	0.0	10.2
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	3.6
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.4	12.9	0.3	0.0	0.0	0.0	32.3	0.0	0.0	32.6
0.96	**31.78**	**0.86**	**0.04**	**0.05**	**0.04**	**83.23**	**0.00**	**0.00**	**83.97**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
0.0	0.0	0.1	0.0	0.0	0.0	16.8	0.0	0.0	17.0
0.00	**0.00**	**0.09**	**0.00**	**0.00**	**0.00**	**16.79**	**0.00**	**0.00**	**16.97**
144.71	**1383.02**	**136.11**	**2.23**	**18.88**	**12.22**	**225772.73**	**12.92**	**5.24**	**227668.34**
68.34	653.09	64.27	1.05	8.92	5.77	106614.90	6.10	2.47	107510.05
4.42	42.26	4.16	0.07	0.58	0.37	6898.61	0.39	0.16	6956.53
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18.89	180.56	17.77	0.29	2.47	1.60	29475.88	1.69	0.68	29723.37
53.06	507.11	49.91	0.82	6.92	4.48	82783.34	4.74	1.92	83478.39
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
144.71	**1383.02**	**136.11**	**2.23**	**18.88**	**12.22**	**225772.73**	**12.92**	**5.24**	**227668.34**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
11.0	103.0	10.2	0.2	1.4	0.9	17200.1	1.0	0.4	17344.4
5.1	47.5	4.7	0.1	0.7	0.4	7938.5	0.5	0.2	8005.1
1.7	15.8	1.6	0.0	0.2	0.1	2646.2	0.2	0.1	2668.4
3.8	35.7	3.5	0.1	0.5	0.3	5953.9	0.3	0.1	6003.8
212.4	1996.9	198.0	3.2	27.8	18.0	333417.8	19.1	7.7	336214.3
151.7	1426.4	141.4	2.3	19.8	12.8	238155.6	13.6	5.5	240153.1
2.5	23.8	2.4	0.0	0.3	0.2	3969.3	0.2	0.1	4002.6
101.1	950.9	94.3	1.5	13.2	8.6	158770.4	9.1	3.7	160102.1
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14.7	138.7	13.8	0.2	1.9	1.2	23154.0	1.3	0.5	23348.2
0.6	3.9	4.3	0.0	0.2	0.1	839.5	0.0	0.0	852.8
504.52	**4742.55**	**474.19**	**7.68**	**66.08**	**42.75**	**792045.24**	**45.32**	**18.38**	**798694.71**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
1.8	59.4	1.5	0.1	0.1	0.1	149.0	0.0	0.0	150.3
0.5	16.1	0.4	0.0	0.0	0.0	40.5	0.0	0.0	40.8
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.1	0.1	0.0	0.0	0.0	14.4	0.0	0.0	14.5
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.6	51.4	1.3	0.1	0.1	0.1	129.1	0.0	0.0	130.2
3.84	**127.10**	**3.42**	**0.17**	**0.22**	**0.14**	**332.92**	**0.02**	**0.01**	**335.87**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
0.0	0.0	0.1	0.0	0.0	0.0	16.8	0.0	0.0	17.0
0.00	**0.00**	**0.09**	**0.00**	**0.00**	**0.00**	**16.79**	**0.00**	**0.00**	**16.97**
508.37	**4869.65**	**477.70**	**7.85**	**66.29**	**42.90**	**792394.94**	**45.34**	**18.39**	**799047.55**
240.06	2299.56	225.58	3.71	31.31	20.26	374186.50	21.41	8.68	377328.01
15.53	148.79	14.60	0.24	2.03	1.31	24212.07	1.39	0.56	24415.34
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66.37	635.76	62.37	1.03	8.66	5.60	103451.56	5.92	2.40	104320.10
186.40	1785.54	175.16	2.88	24.31	15.73	290544.81	16.62	6.74	292984.10
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
508.37	**4869.65**	**477.70**	**7.85**	**66.29**	**42.90**	**792394.94**	**45.34**	**18.39**	**799047.55**

Solano County Mosquito Abatement District Vehicles and Equipments

Land Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
Chevrolet Astro Van	4.3L						100%	100%	Gasoline
Clark Forklift	Nissan 4 cylinder						100%	100%	LPG
Colt handheld ULV Fogger x 6	Tecumseh TCII					100%		100%	50:1 gas/oil mix
Craftsman 24" Leaf Vac	Briggs 190cc						100%	100%	Gasoline
Ford Pickup Truck	6.8L					100%		100%	Gasoline
Ford Pickup Truck x6	4.6L & 6.2L	80%			1%	19%		100%	Gasoline
Kubota Tractor	27hp						100%	100%	Diesel
Leco 500 ULV Fogger x2	Briggs 5.5hp					100%		100%	Gasoline
London Fog M.A.G. ULV Fogger x3	Briggs 3hp					100%		100%	Gasoline
Maruyama MD155DX Backpack Sprayer x 5	Kawasaki 40.2cc					100%		100%	50:1 gas/oil mix
Pro-Mist 25HD	Electric					100%		100%	Zero
Snapper Rear Engine Riding Mower	Briggs 12.5hp						100%	100%	Gasoline
Stihl 025 Chainsaw	44cc						100%	100%	50:1 gas/oil mix
Stihl BG55 Leaf Blower	27cc						100%	100%	50:1 gas/oil mix
Stihl FS83 Weedeater	25.4 cc						100%	100%	50:1 gas/oil mix
Stihl HS Hedge trimmer	25.4 cc						100%	100%	50:1 gas/oil mix
Toro Push Mower	Kawasaki 6.5hp						100%	100%	Gasoline

Water Surveillance and Applications/Management	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
Achilles Inflatable boat	Electric	100%						100%	Zero
Argo ATV Avenger	Koehler Aegis 25	90%				10%		100%	Gasoline
Argo ATV Avenger x2	Koehler Aegis 26	90%				10%		100%	Gasoline
Argo ATV Conquest x4	Kawasaki FD620	90%				10%		100%	Gasoline
Argo ATV Mangnum	Koehler 18hp	100%						100%	Gasoline
Honda ATV TRX300FW x2	300cc	100%						100%	Gasoline
Honda ATV TRX350FM	350cc	15%				85%		100%	Gasoline
Honda ATV TRX400FE	400cc	15%				85%		100%	Gasoline
Honda ATV TRX500FM	500cc	15%				85%		100%	Gasoline
Invader boat 19'	Mercury 90hp	100%						100%	Gasoline

Aerial Applications	Engine/Motor	Sur-veil	Phys Cntl	Veg Mgt	Bio Cntl	Chem Cntl	Non Chem	ALL ALTS	Petro Fuel
1960 Hiller Soloy helicopter (Alpine) 120 gal material tank	Allison 250-C20J turboshaft, 420 shp					100%		100%	Jet A
1968 Bell 206 Jet Ranger helicopter (Alpine) 120 gal material tank	Allison 250-C20J turboshaft, 420 shp					100%		100%	Jet A
1989 Bell 206 Jet Ranger helicopter (Alpine) 120 gal material tank	Allison 250-C20J turboshaft, 420 shp					100%		100%	Jet A
1992 Air Tractor AT-502 Turbine (PT6A series turboprop)	507 kW (680shp) Pratt & Whitney Canada					100%		100%	Jet A
Isolair 4400 bucket system (helicopter-mounted)	N/A					100%		100%	Zero
Isolair Air spray system model 3900 (helicopter-mounted)	N/A					100%		100%	Zero
	100.00%	24%	0%	0%	0%	46%	30%	3300%	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Onroad LD				LD	1	60	60	60	50		30
Propane	2700	164.8	0.56	92.0	1	5	5	5	5	0.5	
2-stroke	49	3.0	0.92	2.8	6	0	10	4	0	0.5	
Utility	190	11.6	0.56	6.5	1	1	0	0	1	1	
Onroad LD				LD	1	0	10	2	8		60
Onroad LD				LD	6	50	60	60	50		120
Offroad	790	48.2	0.56	27.0	1	5	5	5	5	1	
Utility	160	9.8	0.56	5.5	2	0	5	2	8	2	
Utility	88	5.4	0.56	3.0	3	0	15	15	5	2	
2-stroke	40	2.4	0.92	2.2	5	5	10	10	0	1	
Electric				0	1	0	10	2	8	1	
Utility	366	22.3	0.56	13.0	1	10	10	10	10	1	
2-stroke	44	2.7	0.92	2.5	1	1	1	0	0	0.1	
2-stroke	27	1.6	0.92	1.5	1	10	15	15	10	1	
2-stroke	25	1.5	0.92	1.4	1	10	15	15	10	0.5	
2-stroke	25	1.5	0.92	1.4	1	0	2	2	0	1	
Utility	190	11.6	0.56	6.5	1	5	5	5	5	1	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Electric				0	1	0	0	2	0	2	
Sport	476	29.0	0.86	25.0	1	15	10	6	10	3	
Sport	495	30.2	0.86	26.0	2	4	8	8	20	4	
Sport	620	37.8	0.86	33.0	4	0	0	5	15	4	
Sport	343	20.9	0.86	18.0	1	0	0	0	2	2	
Sport	300	18.3	0.86	16.0	2	0	2	2	0	1	
Sport	350	21.4	0.86	18.0	1	0	15	15	0	3	
Sport	400	24.4	0.86	21.0	1	0	6	6	0	2	
Sport	500	30.5	0.86	26.0	1	0	8	8	0	3	
Sport	1715	104.7	0.86	90.0	1	0	0	4	0	2	

Engine/Motor Type			Power Output		Quantity	Winter	Spring	Summer	Fall	Activity Schedule	
category	ccd	cid	BHP/cid	BHP		days	days	days	days	hrs/day	mi/day
Turbine				420	1	2	0	0	0	2	
Turbine				420	1	2	0	0	0	2	
Turbine				420	1	2	0	0	0	2	
Turbine				680	1	4	6	10	14	4	
None				0	1	2	0	0	0	1	
None				0	1	6	0	0	0	2	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
	30		1800		6900
0.5		2.5		10	
3		30		42	
1		1		2	
	60		600		1200
	720		43200		158400
1		5		20	
4		32		60	
6		90		210	
5		50		125	
1		10		20	
1		10		40	
0.1		0.1		0.2	
1		15		50	
0.5		7.5		25	
1		2		4	
1		5		20	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
2		4		4	
3		45		123	
8		160		320	
16		240		320	
2		4		4	
2		4		8	
3		45		90	
2		12		24	
3		24		48	
2		8		8	

Peak Daily		Highest Quarter		Annual Total	
hours	miles	hours	miles	hours	miles
2		4		4	
2		4		4	
2		4		4	
4		56		136	
1		2		2	
2		12		12	

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.73030	0.30746	0.46754	0.00033	0.00552	0.00359	75.73440	0.00006	0.00017	75.78690
0.10357	1.85281	0.01151	0.00167	0.02191	0.01424	2.86286	0.00016	0.00007	2.88827
0.03260	3.25927	0.02777	0.00279	0.00315	0.00205	5.62348	0.00032	0.00014	5.67338
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
0.02397	0.14648	0.17578	0.00018	0.01598	0.01358	18.48420	0.00105	0.00046	18.65048
0.02759	2.75785	0.02350	0.00236	0.00267	0.00173	4.75833	0.00027	0.00012	4.80055
0.01505	1.50428	0.01282	0.00129	0.00146	0.00095	2.59545	0.00015	0.00006	2.61848
0.08138	1.45578	0.00904	0.00131	0.01722	0.01119	2.24939	0.00013	0.00006	2.26935
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.12285	4.07550	0.10595	0.00546	0.00650	0.00423	10.22450	0.00058	0.00025	10.31523
0.09248	1.65430	0.01028	0.00149	0.01957	0.01272	2.55613	0.00014	0.00006	2.57881
0.05549	0.99258	0.00617	0.00089	0.01174	0.00763	1.53368	0.00009	0.00004	1.54729
0.05179	0.92641	0.00575	0.00083	0.01096	0.00712	1.43143	0.00008	0.00004	1.44413
0.05179	0.92641	0.00575	0.00083	0.01096	0.00712	1.43143	0.00008	0.00004	1.44413
0.03260	3.25927	0.02777	0.00279	0.00315	0.00205	5.62348	0.00032	0.00014	5.67338

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.14175	4.70250	0.12225	0.00630	0.00750	0.00488	11.79750	0.00067	0.00029	11.90219
0.14742	4.89060	0.12714	0.00655	0.00780	0.00507	12.26940	0.00069	0.00030	12.37828
0.18711	6.20730	0.16137	0.00832	0.00990	0.00644	15.57270	0.00088	0.00039	15.71089
0.10206	3.38580	0.08802	0.00454	0.00540	0.00351	8.49420	0.00048	0.00021	8.56958
0.09072	3.00960	0.07824	0.00403	0.00480	0.00312	7.55040	0.00043	0.00019	7.61740
0.10206	3.38580	0.08802	0.00454	0.00540	0.00351	8.49420	0.00048	0.00021	8.56958
0.11907	3.95010	0.10269	0.00529	0.00630	0.00410	9.90990	0.00056	0.00025	9.99784
0.14742	4.89060	0.12714	0.00655	0.00780	0.00507	12.26940	0.00069	0.00030	12.37828
0.51030	16.92900	0.44010	0.02268	0.02700	0.01755	42.47100	0.00240	0.00105	42.84789

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131
0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131
0.00220	0.01772	4.72464	0.00835	0.06443	0.04188	876.87360	0.02424	0.02809	886.09069
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Surveillance	24%
Physical Control	0%
Vegetation Management	0%
Biological Control	0%
Chemical Control	46%
Other Non-Chemical	30%
CHECKSUM	**100%**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
0.02	0.20	0.02	0.00	0.00	0.00	33.08	0.00	0.00	33.35
0.37	0.15	0.23	0.00	0.00	0.00	37.87	0.00	0.00	37.89
0.31	5.56	0.03	0.01	0.07	0.04	8.59	0.00	0.00	8.66
0.03	3.26	0.03	0.00	0.00	0.00	5.62	0.00	0.00	5.67
0.04	0.40	0.04	0.00	0.01	0.00	66.15	0.00	0.00	66.71
0.51	4.75	0.47	0.01	0.07	0.04	793.85	0.05	0.02	800.51
0.02	0.15	0.18	0.00	0.02	0.01	18.48	0.00	0.00	18.65
0.11	11.03	0.09	0.01	0.01	0.01	19.03	0.00	0.00	19.20
0.09	9.03	0.08	0.01	0.01	0.01	15.57	0.00	0.00	15.71
0.41	7.28	0.05	0.01	0.09	0.06	11.25	0.00	0.00	11.35
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.12	4.08	0.11	0.01	0.01	0.00	10.22	0.00	0.00	10.32
0.01	0.17	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.26
0.06	0.99	0.01	0.00	0.01	0.01	1.53	0.00	0.00	1.55
0.03	0.46	0.00	0.00	0.01	0.00	0.72	0.00	0.00	0.72
0.05	0.93	0.01	0.00	0.01	0.01	1.43	0.00	0.00	1.44
0.03	3.26	0.03	0.00	0.00	0.00	5.62	0.00	0.00	5.67
2.21	**51.69**	**1.37**	**0.05**	**0.31**	**0.20**	**1029.28**	**0.06**	**0.02**	**1037.68**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.43	14.11	0.37	0.02	0.02	0.01	35.39	0.00	0.00	35.71
1.18	39.12	1.02	0.05	0.06	0.04	98.16	0.01	0.00	99.03
2.99	99.32	2.58	0.13	0.16	0.10	249.16	0.01	0.01	251.37
0.20	6.77	0.18	0.01	0.01	0.01	16.99	0.00	0.00	17.14
0.18	6.02	0.16	0.01	0.01	0.01	15.10	0.00	0.00	15.23
0.31	10.16	0.26	0.01	0.02	0.01	25.48	0.00	0.00	25.71
0.24	7.90	0.21	0.01	0.01	0.01	19.82	0.00	0.00	20.00
0.44	14.67	0.38	0.02	0.02	0.02	36.81	0.00	0.00	37.13
1.02	33.86	0.88	0.05	0.05	0.04	84.94	0.00	0.00	85.70
6.99	**231.93**	**6.03**	**0.31**	**0.37**	**0.24**	**581.85**	**0.03**	**0.01**	**587.02**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
0.00	0.02	5.84	0.01	0.08	0.05	1083.20	0.03	0.03	1094.58
0.00	0.02	5.84	0.01	0.08	0.05	1083.20	0.03	0.03	1094.58
0.00	0.02	5.84	0.01	0.08	0.05	1083.20	0.03	0.03	1094.58
0.01	0.07	18.90	0.03	0.26	0.17	3507.49	0.10	0.11	3544.36
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.02	**0.14**	**36.41**	**0.06**	**0.50**	**0.32**	**6757.08**	**0.19**	**0.22**	**6828.11**
9.21	**283.75**	**43.80**	**0.43**	**1.17**	**0.77**	**8368.22**	**0.28**	**0.25**	**8452.80**
2.22	68.36	10.55	0.10	0.28	0.18	2015.98	0.07	0.06	2036.36
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.09	0.01	0.00	0.00	0.00	2.54	0.00	0.00	2.56
4.20	129.32	19.96	0.19	0.53	0.35	3813.88	0.13	0.12	3852.43
2.79	85.98	13.27	0.13	0.36	0.23	2535.82	0.08	0.08	2561.46
9.21	**283.75**	**43.80**	**0.43**	**1.17**	**0.77**	**8368.22**	**0.28**	**0.25**	**8452.80**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
1.3	11.9	1.2	0.0	0.2	0.1	1984.6	0.1	0.0	2001.3
1.8	0.8	1.2	0.0	0.0	0.0	189.3	0.0	0.0	189.5
3.1	55.6	0.3	0.1	0.7	0.4	85.9	0.0	0.0	86.6
0.0	3.3	0.0	0.0	0.0	0.0	5.6	0.0	0.0	5.7
0.4	4.0	0.4	0.0	0.1	0.0	661.5	0.0	0.0	667.1
30.3	285.3	28.3	0.5	4.0	2.6	47631.1	2.7	1.1	48030.6
0.1	0.7	0.9	0.0	0.1	0.1	92.4	0.0	0.0	93.3
0.9	88.3	0.8	0.1	0.1	0.1	152.3	0.0	0.0	153.6
1.4	135.4	1.2	0.1	0.1	0.1	233.6	0.0	0.0	235.7
4.1	72.8	0.5	0.1	0.9	0.6	112.5	0.0	0.0	113.5
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.2	40.8	1.1	0.1	0.1	0.0	102.2	0.0	0.0	103.2
0.0	0.2	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3
0.8	14.9	0.1	0.0	0.2	0.1	23.0	0.0	0.0	23.2
0.4	6.9	0.0	0.0	0.1	0.1	10.7	0.0	0.0	10.8
0.1	1.9	0.0	0.0	0.0	0.0	2.9	0.0	0.0	2.9
0.2	16.3	0.1	0.0	0.0	0.0	28.1	0.0	0.0	28.4
46.14	**738.80**	**35.99**	**0.89**	**6.38**	**4.15**	**51316.10**	**2.93**	**1.19**	**51745.48**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.4	211.6	5.5	0.3	0.3	0.2	530.9	0.0	0.0	535.6
23.6	782.5	20.3	1.0	1.2	0.8	1963.1	0.1	0.0	1980.5
44.9	1489.8	38.7	2.0	2.4	1.5	3737.4	0.2	0.1	3770.6
0.4	13.5	0.4	0.0	0.0	0.0	34.0	0.0	0.0	34.3
0.4	12.0	0.3	0.0	0.0	0.0	30.2	0.0	0.0	30.5
4.6	152.4	4.0	0.2	0.2	0.2	382.2	0.0	0.0	385.6
1.4	47.4	1.2	0.1	0.1	0.0	118.9	0.0	0.0	120.0
3.5	117.4	3.1	0.2	0.2	0.1	294.5	0.0	0.0	297.1
4.1	135.4	3.5	0.2	0.2	0.1	339.8	0.0	0.0	342.8
89.29	**2962.01**	**77.00**	**3.97**	**4.72**	**3.07**	**7431.01**	**0.42**	**0.18**	**7496.95**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr	lbs/qtr
0.0	0.0	11.7	0.0	0.2	0.1	2166.4	0.1	0.1	2189.2
0.0	0.0	11.7	0.0	0.2	0.1	2166.4	0.1	0.1	2189.2
0.0	0.0	11.7	0.0	0.2	0.1	2166.4	0.1	0.1	2189.2
0.1	1.0	264.6	0.5	3.6	2.3	49104.9	1.4	1.6	49621.1
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.14	**1.12**	**299.60**	**0.53**	**4.09**	**2.66**	**55604.10**	**1.54**	**1.78**	**56188.57**
135.57	**3701.93**	**412.59**	**5.39**	**15.19**	**9.88**	**114351.21**	**4.88**	**3.15**	**115431.01**
32.66	891.83	99.40	1.30	3.66	2.38	27548.25	1.18	0.76	27808.38
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.04	1.12	0.13	0.00	0.00	0.00	34.65	0.00	0.00	34.98
61.78	1687.18	188.04	2.46	6.92	4.50	52116.43	2.23	1.44	52608.56
41.08	1121.80	125.03	1.63	4.60	2.99	34651.88	1.48	0.96	34979.09
135.57	**3701.93**	**412.59**	**5.39**	**15.19**	**9.88**	**114351.21**	**4.88**	**3.15**	**115431.01**

VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
4.8	45.6	4.5	0.1	0.6	0.4	7607.7	0.4	0.2	7671.6
7.3	3.1	4.7	0.0	0.1	0.0	757.3	0.0	0.0	757.9
4.4	77.8	0.5	0.1	0.9	0.6	120.2	0.0	0.0	121.3
0.1	6.5	0.1	0.0	0.0	0.0	11.2	0.0	0.0	11.3
0.8	7.9	0.8	0.0	0.1	0.1	1323.1	0.1	0.0	1334.2
111.2	1046.0	103.7	1.7	14.5	9.4	174647.4	10.0	4.0	176112.3
0.5	2.9	3.5	0.0	0.3	0.3	369.7	0.0	0.0	373.0
1.7	165.5	1.4	0.1	0.2	0.1	285.5	0.0	0.0	288.0
3.2	315.9	2.7	0.3	0.3	0.2	545.0	0.0	0.0	549.9
10.2	182.0	1.1	0.2	2.2	1.4	281.2	0.0	0.0	283.7
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.9	163.0	4.2	0.2	0.3	0.2	409.0	0.0	0.0	412.6
0.0	0.3	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.5
2.8	49.6	0.3	0.0	0.6	0.4	76.7	0.0	0.0	77.4
1.3	23.2	0.1	0.0	0.3	0.2	35.8	0.0	0.0	36.1
0.2	3.7	0.0	0.0	0.0	0.0	5.7	0.0	0.0	5.8
0.7	65.2	0.6	0.1	0.1	0.0	112.5	0.0	0.0	113.5
153.97	**2158.20**	**128.26**	**2.78**	**20.44**	**13.30**	**186588.63**	**10.64**	**4.31**	**188148.95**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17.4	578.4	15.0	0.8	0.9	0.6	1451.1	0.1	0.0	1464.0
47.2	1565.0	40.7	2.1	2.5	1.6	3926.2	0.2	0.1	3961.0
59.9	1986.3	51.6	2.7	3.2	2.1	4983.3	0.3	0.1	5027.5
0.4	13.5	0.4	0.0	0.0	0.0	34.0	0.0	0.0	34.3
0.7	24.1	0.6	0.0	0.0	0.0	60.4	0.0	0.0	60.9
9.2	304.7	7.9	0.4	0.5	0.3	764.5	0.0	0.0	771.3
2.9	94.8	2.5	0.1	0.2	0.1	237.8	0.0	0.0	239.9
7.1	234.7	6.1	0.3	0.4	0.2	588.9	0.0	0.0	594.2
4.1	135.4	3.5	0.2	0.2	0.1	339.8	0.0	0.0	342.8
148.82	**4937.06**	**128.35**	**6.61**	**7.87**	**5.12**	**12385.96**	**0.70**	**0.31**	**12495.87**
VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
0.0	0.0	11.7	0.0	0.2	0.1	2166.4	0.1	0.1	2189.2
0.0	0.0	11.7	0.0	0.2	0.1	2166.4	0.1	0.1	2189.2
0.0	0.0	11.7	0.0	0.2	0.1	2166.4	0.1	0.1	2189.2
0.3	2.4	642.6	1.1	8.8	5.7	119254.8	3.3	3.8	120508.3
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.32	**2.54**	**677.57**	**1.20**	**9.24**	**6.01**	**125753.99**	**3.48**	**4.03**	**127075.83**
303.11	**7097.80**	**934.18**	**10.59**	**37.56**	**24.42**	**324728.58**	**14.81**	**8.65**	**327720.65**
73.02	1709.93	225.05	2.55	9.05	5.88	78230.07	3.57	2.08	78950.88
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.09	2.15	0.28	0.00	0.01	0.01	98.40	0.00	0.00	99.31
138.15	3234.88	425.76	4.83	17.12	11.13	147997.51	6.75	3.94	149361.17
91.85	2150.85	283.09	3.21	11.38	7.40	98402.60	4.49	2.62	99309.29
303.11	**7097.80**	**934.18**	**10.59**	**37.56**	**24.42**	**324728.58**	**14.81**	**8.65**	**327720.65**

Emission Factors for Onroad Vehicles, Offroad Equipments, Vessels, Aircrafts

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
50:1 gas/oil mix	2-stroke	0.1	0.00370	0.06617	0.00041	0.00006	0.00078	0.00051	0.11011	0.00001	0.00000	0.11109
50:1 gas/oil mix	2-stroke	0.2	0.00740	0.13234	0.00082	0.00012	0.00157	0.00102	0.22022	0.00001	0.00001	0.22217
50:1 gas/oil mix	2-stroke	0.3	0.01110	0.19852	0.00123	0.00018	0.00235	0.00153	0.33033	0.00002	0.00001	0.33326
50:1 gas/oil mix	2-stroke	0.4	0.01480	0.26469	0.00164	0.00024	0.00313	0.00203	0.44044	0.00002	0.00001	0.44435
50:1 gas/oil mix	2-stroke	0.5	0.01850	0.33086	0.00206	0.00030	0.00391	0.00254	0.55055	0.00003	0.00001	0.55544
50:1 gas/oil mix	2-stroke	0.6	0.02219	0.39703	0.00247	0.00036	0.00470	0.00305	0.66066	0.00004	0.00002	0.66652
50:1 gas/oil mix	2-stroke	0.7	0.02589	0.46320	0.00288	0.00042	0.00548	0.00356	0.77077	0.00004	0.00002	0.77761
50:1 gas/oil mix	2-stroke	0.8	0.02959	0.52938	0.00329	0.00048	0.00626	0.00407	0.88088	0.00005	0.00002	0.88870
50:1 gas/oil mix	2-stroke	0.9	0.03329	0.59555	0.00370	0.00054	0.00704	0.00458	0.99099	0.00006	0.00002	0.99978
50:1 gas/oil mix	2-stroke	1.0	0.03699	0.66172	0.00411	0.00060	0.00783	0.00509	1.02245	0.00006	0.00003	1.03152
50:1 gas/oil mix	2-stroke	1.1	0.04069	0.72789	0.00452	0.00065	0.00861	0.00560	1.12470	0.00006	0.00003	1.13468
50:1 gas/oil mix	2-stroke	1.2	0.04439	0.79406	0.00493	0.00071	0.00939	0.00610	1.22694	0.00007	0.00003	1.23783
50:1 gas/oil mix	2-stroke	1.3	0.04809	0.86023	0.00534	0.00077	0.01017	0.00661	1.32919	0.00008	0.00003	1.34098
50:1 gas/oil mix	2-stroke	1.4	0.05179	0.92641	0.00575	0.00083	0.01096	0.00712	1.43143	0.00008	0.00004	1.44413
50:1 gas/oil mix	2-stroke	1.5	0.05549	0.99258	0.00617	0.00089	0.01174	0.00763	1.53368	0.00009	0.00004	1.54729
50:1 gas/oil mix	2-stroke	1.6	0.05918	1.05875	0.00658	0.00095	0.01252	0.00814	1.63592	0.00009	0.00004	1.65044
50:1 gas/oil mix	2-stroke	1.7	0.06288	1.12492	0.00699	0.00101	0.01330	0.00865	1.73817	0.00010	0.00004	1.75359
50:1 gas/oil mix	2-stroke	1.8	0.06658	1.19109	0.00740	0.00107	0.01409	0.00916	1.84041	0.00010	0.00005	1.85674
50:1 gas/oil mix	2-stroke	1.9	0.07028	1.25727	0.00781	0.00113	0.01487	0.00967	1.94266	0.00011	0.00005	1.95989
50:1 gas/oil mix	2-stroke	2.0	0.07398	1.32344	0.00822	0.00119	0.01565	0.01017	2.04490	0.00012	0.00005	2.06305
50:1 gas/oil mix	2-stroke	2.1	0.07768	1.38961	0.00863	0.00125	0.01644	0.01068	2.14715	0.00012	0.00005	2.16620
50:1 gas/oil mix	2-stroke	2.2	0.08138	1.45578	0.00904	0.00131	0.01722	0.01119	2.24939	0.00013	0.00006	2.26935
50:1 gas/oil mix	2-stroke	2.3	0.08508	1.52195	0.00945	0.00137	0.01800	0.01170	2.35164	0.00013	0.00006	2.37250
50:1 gas/oil mix	2-stroke	2.4	0.08878	1.58813	0.00986	0.00143	0.01878	0.01221	2.45388	0.00014	0.00006	2.47566
50:1 gas/oil mix	2-stroke	2.5	0.09248	1.65430	0.01028	0.00149	0.01957	0.01272	2.55613	0.00014	0.00006	2.57881
50:1 gas/oil mix	2-stroke	2.6	0.09618	1.72047	0.01069	0.00155	0.02035	0.01323	2.65837	0.00015	0.00007	2.68196
50:1 gas/oil mix	2-stroke	2.7	0.09987	1.78664	0.01110	0.00161	0.02113	0.01374	2.76062	0.00016	0.00007	2.78511
50:1 gas/oil mix	2-stroke	2.8	0.10357	1.85281	0.01151	0.00167	0.02191	0.01424	2.86286	0.00016	0.00007	2.88827
50:1 gas/oil mix	2-stroke	2.9	0.10727	1.91899	0.01192	0.00173	0.02270	0.01475	2.96511	0.00017	0.00007	2.99142
50:1 gas/oil mix	2-stroke	3.0	0.15980	1.48702	0.01776	0.00179	0.02348	0.01526	2.83140	0.00016	0.00007	2.85653
50:1 gas/oil mix	2-stroke	3.1	0.16513	1.53659	0.01835	0.00185	0.02426	0.01577	2.92578	0.00017	0.00007	2.95174
50:1 gas/oil mix	2-stroke	3.2	0.17045	1.58615	0.01894	0.00190	0.02504	0.01628	3.02016	0.00017	0.00007	3.04696
50:1 gas/oil mix	2-stroke	3.3	0.17578	1.63572	0.01953	0.00196	0.02583	0.01679	3.11454	0.00018	0.00008	3.14218
50:1 gas/oil mix	2-stroke	3.4	0.18111	1.68529	0.02012	0.00202	0.02661	0.01730	3.20892	0.00018	0.00008	3.23740
50:1 gas/oil mix	2-stroke	3.5	0.18643	1.73485	0.02071	0.00208	0.02739	0.01781	3.30330	0.00019	0.00008	3.33261
50:1 gas/oil mix	2-stroke	3.6	0.19176	1.78442	0.02131	0.00214	0.02818	0.01831	3.39768	0.00019	0.00008	3.42783
50:1 gas/oil mix	2-stroke	3.7	0.19709	1.83399	0.02190	0.00220	0.02896	0.01882	3.49206	0.00020	0.00009	3.52305
50:1 gas/oil mix	2-stroke	3.8	0.20241	1.88356	0.02249	0.00226	0.02974	0.01933	3.58644	0.00020	0.00009	3.61827
50:1 gas/oil mix	2-stroke	3.9	0.20774	1.93312	0.02308	0.00232	0.03052	0.01984	3.68082	0.00021	0.00009	3.71348
50:1 gas/oil mix	2-stroke	4.0	0.21307	1.98269	0.02367	0.00238	0.03131	0.02035	3.77520	0.00021	0.00009	3.80870
50:1 gas/oil mix	2-stroke	4.1	0.21839	2.03226	0.02427	0.00244	0.03209	0.02086	3.86958	0.00022	0.00010	3.90392
50:1 gas/oil mix	2-stroke	4.2	0.22372	2.08183	0.02486	0.00250	0.03287	0.02137	3.96396	0.00022	0.00010	3.99914
50:1 gas/oil mix	2-stroke	4.3	0.22905	2.13139	0.02545	0.00256	0.03365	0.02187	4.05834	0.00023	0.00010	4.09435
50:1 gas/oil mix	2-stroke	4.4	0.23437	2.18096	0.02604	0.00262	0.03444	0.02238	4.15272	0.00023	0.00010	4.18957
50:1 gas/oil mix	2-stroke	4.5	0.23970	2.23053	0.02663	0.00268	0.03522	0.02289	4.24710	0.00024	0.00011	4.28479
50:1 gas/oil mix	2-stroke	4.6	0.24503	2.28009	0.02723	0.00274	0.03600	0.02340	4.34148	0.00025	0.00011	4.38001
50:1 gas/oil mix	2-stroke	4.7	0.25035	2.32966	0.02782	0.00280	0.03678	0.02391	4.43586	0.00025	0.00011	4.47522
50:1 gas/oil mix	2-stroke	4.8	0.25568	2.37923	0.02841	0.00286	0.03757	0.02442	4.53024	0.00026	0.00011	4.57044
50:1 gas/oil mix	2-stroke	4.9	0.26101	2.42880	0.02900	0.00292	0.03835	0.02493	4.62462	0.00026	0.00011	4.66566
50:1 gas/oil mix	2-stroke	5.0	0.26633	2.47836	0.02959	0.00298	0.03913	0.02544	4.71900	0.00027	0.00012	4.76088
50:1 gas/oil mix	2-stroke	5.1	0.27166	2.52793	0.03018	0.00304	0.03991	0.02594	4.81338	0.00027	0.00012	4.85609
50:1 gas/oil mix	2-stroke	5.2	0.27698	2.57750	0.03078	0.00310	0.04070	0.02645	4.90776	0.00028	0.00012	4.95131
50:1 gas/oil mix	2-stroke	5.3	0.28231	2.62707	0.03137	0.00315	0.04148	0.02696	5.00214	0.00028	0.00012	5.04653
50:1 gas/oil mix	2-stroke	5.4	0.28764	2.67663	0.03196	0.00321	0.04226	0.02747	5.09652	0.00029	0.00013	5.14175
50:1 gas/oil mix	2-stroke	5.5	0.29296	2.72620	0.03255	0.00327	0.04305	0.02798	5.19090	0.00029	0.00013	5.23696
50:1 gas/oil mix	2-stroke	5.6	0.29829	2.77577	0.03314	0.00333	0.04383	0.02849	5.28528	0.00030	0.00013	5.33218
50:1 gas/oil mix	2-stroke	5.7	0.30362	2.82533	0.03374	0.00339	0.04461	0.02900	5.37966	0.00030	0.00013	5.42740
50:1 gas/oil mix	2-stroke	5.8	0.30894	2.87490	0.03433	0.00345	0.04539	0.02951	5.47404	0.00031	0.00014	5.52262
50:1 gas/oil mix	2-stroke	5.9	0.31427	2.92447	0.03492	0.00351	0.04618	0.03001	5.56842	0.00032	0.00014	5.61783
50:1 gas/oil mix	2-stroke	6.0	0.31960	2.97404	0.03551	0.00357	0.04696	0.03052	5.66280	0.00032	0.00014	5.71305
50:1 gas/oil mix	2-stroke	6.1	0.32492	3.02360	0.03610	0.00363	0.04774	0.03103	5.75718	0.00033	0.00014	5.80827
50:1 gas/oil mix	2-stroke	6.2	0.33025	3.07317	0.03669	0.00369	0.04852	0.03154	5.85156	0.00033	0.00015	5.90349
50:1 gas/oil mix	2-stroke	6.3	0.33558	3.12274	0.03729	0.00375	0.04931	0.03205	5.94594	0.00034	0.00015	5.99871
50:1 gas/oil mix	2-stroke	6.4	0.34090	3.17231	0.03788	0.00381	0.05009	0.03256	6.04032	0.00034	0.00015	6.09392
50:1 gas/oil mix	2-stroke	6.5	0.34623	3.22187	0.03847	0.00387	0.05087	0.03307	6.13470	0.00035	0.00015	6.18914
50:1 gas/oil mix	2-stroke	6.6	0.35156	3.27144	0.03906	0.00393	0.05165	0.03358	6.22908	0.00035	0.00015	6.28436
50:1 gas/oil mix	2-stroke	6.7	0.35688	3.32101	0.03965	0.00399	0.05244	0.03408	6.32346	0.00036	0.00016	6.37958
50:1 gas/oil mix	2-stroke	6.8	0.36221	3.37057	0.04025	0.00405	0.05322	0.03459	6.41784	0.00036	0.00016	6.47479
50:1 gas/oil mix	2-stroke	6.9	0.36754	3.42014	0.04084	0.00411	0.05400	0.03510	6.51222	0.00037	0.00016	6.57001
50:1 gas/oil mix	2-stroke	7.0	0.37286	3.46971	0.04143	0.00417	0.05479	0.03561	6.60660	0.00037	0.00016	6.66523
50:1 gas/oil mix	2-stroke	7.1	0.37819	3.51928	0.04202	0.00423	0.05557	0.03612	6.70098	0.00038	0.00017	6.76045
50:1 gas/oil mix	2-stroke	7.2	0.38352	3.56884	0.04261	0.00429	0.05635	0.03663	6.79536	0.00038	0.00017	6.85566
50:1 gas/oil mix	2-stroke	7.3	0.38884	3.61841	0.04320	0.00435	0.05713	0.03714	6.88974	0.00039	0.00017	6.95088
50:1 gas/oil mix	2-stroke	7.4	0.39417	3.66798	0.04380	0.00440	0.05792	0.03765	6.98412	0.00040	0.00017	7.04610
50:1 gas/oil mix	2-stroke	7.5	0.39950	3.71755	0.04439	0.00446	0.05870	0.03815	7.07850	0.00040	0.00018	7.14132
50:1 gas/oil mix	2-stroke	7.6	0.40482	3.76711	0.04498	0.00452	0.05948	0.03866	7.17288	0.00041	0.00018	7.23653

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
50:1 gas/oil mix	2-stroke	7.7	0.41015	3.81668	0.04557	0.00458	0.06026	0.03917	7.26726	0.00041	0.00018	7.33175
50:1 gas/oil mix	2-stroke	7.8	0.41548	3.86625	0.04616	0.00464	0.06105	0.03968	7.36164	0.00042	0.00018	7.42697
50:1 gas/oil mix	2-stroke	7.9	0.42080	3.91581	0.04676	0.00470	0.06183	0.04019	7.45602	0.00042	0.00018	7.52219
50:1 gas/oil mix	2-stroke	8.0	0.42613	3.96538	0.04735	0.00476	0.06261	0.04070	7.55040	0.00043	0.00019	7.61740
50:1 gas/oil mix	2-stroke	8.1	0.43146	4.01495	0.04794	0.00482	0.06339	0.04121	7.64478	0.00043	0.00019	7.71262
50:1 gas/oil mix	2-stroke	8.2	0.43678	4.06452	0.04853	0.00488	0.06418	0.04171	7.73916	0.00044	0.00019	7.80784
50:1 gas/oil mix	2-stroke	8.3	0.44211	4.11408	0.04912	0.00494	0.06496	0.04222	7.83354	0.00044	0.00019	7.90306
50:1 gas/oil mix	2-stroke	8.4	0.44744	4.16365	0.04972	0.00500	0.06574	0.04273	7.92792	0.00045	0.00020	7.99827
50:1 gas/oil mix	2-stroke	8.5	0.45276	4.21322	0.05031	0.00506	0.06652	0.04324	8.02230	0.00045	0.00020	8.09349
50:1 gas/oil mix	2-stroke	8.6	0.45809	4.26279	0.05090	0.00512	0.06731	0.04375	8.11668	0.00046	0.00020	8.18871
50:1 gas/oil mix	2-stroke	8.7	0.46342	4.31235	0.05149	0.00518	0.06809	0.04426	8.21106	0.00046	0.00020	8.28393
50:1 gas/oil mix	2-stroke	8.8	0.46874	4.36192	0.05208	0.00524	0.06887	0.04477	8.30544	0.00047	0.00021	8.37914
50:1 gas/oil mix	2-stroke	8.9	0.47407	4.41149	0.05267	0.00530	0.06966	0.04528	8.39982	0.00048	0.00021	8.47436
50:1 gas/oil mix	2-stroke	9.0	0.47940	4.46105	0.05327	0.00536	0.07044	0.04578	8.49420	0.00048	0.00021	8.56958
50:1 gas/oil mix	2-stroke	9.1	0.48472	4.51062	0.05386	0.00542	0.07122	0.04629	8.58858	0.00049	0.00021	8.66480
50:1 gas/oil mix	2-stroke	9.2	0.49005	4.56019	0.05445	0.00548	0.07200	0.04680	8.68296	0.00049	0.00022	8.76001
50:1 gas/oil mix	2-stroke	9.3	0.49538	4.60976	0.05504	0.00554	0.07279	0.04731	8.77734	0.00050	0.00022	8.85523
50:1 gas/oil mix	2-stroke	9.4	0.50070	4.65932	0.05563	0.00560	0.07357	0.04782	8.87172	0.00050	0.00022	8.95045
50:1 gas/oil mix	2-stroke	9.5	0.50603	4.70889	0.05623	0.00565	0.07435	0.04833	8.96610	0.00051	0.00022	9.04567
50:1 gas/oil mix	2-stroke	9.6	0.51136	4.75846	0.05682	0.00571	0.07513	0.04884	9.06048	0.00051	0.00022	9.14088
50:1 gas/oil mix	2-stroke	9.7	0.51668	4.80803	0.05741	0.00577	0.07592	0.04935	9.15486	0.00052	0.00023	9.23610
50:1 gas/oil mix	2-stroke	9.8	0.52201	4.85759	0.05800	0.00583	0.07670	0.04985	9.24924	0.00052	0.00023	9.33132
50:1 gas/oil mix	2-stroke	9.9	0.52734	4.90716	0.05859	0.00589	0.07748	0.05036	9.34362	0.00053	0.00023	9.42654
50:1 gas/oil mix	**2-stroke**	**10**	**0.53266**	**4.95673**	**0.05918**	**0.00595**	**0.07826**	**0.05087**	**7.86500**	**0.00045**	**0.00020**	**7.93480**
50:1 gas/oil mix	2-stroke	11	0.58593	5.45240	0.06510	0.00655	0.08609	0.05596	8.65150	0.00049	0.00021	8.72827
50:1 gas/oil mix	2-stroke	12	0.63920	5.94807	0.07102	0.00714	0.09392	0.06105	9.43800	0.00053	0.00023	9.52175
50:1 gas/oil mix	2-stroke	13	0.69246	6.44375	0.07694	0.00774	0.10174	0.06613	10.22450	0.00058	0.00025	10.31523
50:1 gas/oil mix	2-stroke	14	0.74573	6.93942	0.08286	0.00833	0.10957	0.07122	11.01100	0.00062	0.00027	11.10871
50:1 gas/oil mix	2-stroke	15	0.79899	7.43509	0.08878	0.00893	0.11740	0.07631	11.79750	0.00067	0.00029	11.90219
50:1 gas/oil mix	2-stroke	16	0.85226	7.93076	0.09470	0.00952	0.12522	0.08140	12.58400	0.00071	0.00031	12.69567
50:1 gas/oil mix	2-stroke	17	0.90553	8.42644	0.10061	0.01012	0.13305	0.08648	13.37050	0.00076	0.00033	13.48915
50:1 gas/oil mix	2-stroke	18	0.95879	8.92211	0.10653	0.01071	0.14088	0.09157	14.15700	0.00080	0.00035	14.28263
50:1 gas/oil mix	2-stroke	19	1.01206	9.41778	0.11245	0.01131	0.14870	0.09666	14.94350	0.00085	0.00037	15.07611
50:1 gas/oil mix	2-stroke	20	1.06533	9.91346	0.11837	0.01191	0.15653	0.10174	15.73000	0.00089	0.00039	15.86959
50:1 gas/oil mix	2-stroke	21	1.11859	10.40913	0.12429	0.01250	0.16436	0.10683	16.51650	0.00093	0.00041	16.66307
50:1 gas/oil mix	2-stroke	22	1.17186	10.90480	0.13021	0.01310	0.17218	0.11192	17.30300	0.00098	0.00043	17.45655
50:1 gas/oil mix	2-stroke	23	1.22513	11.40047	0.13613	0.01369	0.18001	0.11701	18.08950	0.00102	0.00045	18.25003
50:1 gas/oil mix	2-stroke	24	1.27839	11.89615	0.14204	0.01429	0.18783	0.12209	18.87600	0.00107	0.00047	19.04351
50:1 gas/oil mix	2-stroke	25	1.33166	12.39182	0.14796	0.01488	0.19566	0.12718	19.66250	0.00111	0.00049	19.83699
50:1 gas/oil mix	2-stroke	26	1.38492	12.88749	0.15388	0.01548	0.20349	0.13227	20.44900	0.00116	0.00051	20.63047
50:1 gas/oil mix	2-stroke	27	1.43819	13.38316	0.15980	0.01607	0.21131	0.13735	21.23550	0.00120	0.00053	21.42395
50:1 gas/oil mix	2-stroke	28	1.49146	13.87884	0.16572	0.01667	0.21914	0.14244	22.02200	0.00125	0.00055	22.21743
50:1 gas/oil mix	2-stroke	29	1.54472	14.37451	0.17164	0.01726	0.22697	0.14753	22.80850	0.00129	0.00057	23.01091
50:1 gas/oil mix	2-stroke	30	1.59799	14.87018	0.17755	0.01786	0.23479	0.15262	23.59500	0.00134	0.00059	23.80439
50:1 gas/oil mix	2-stroke	31	1.65126	15.36586	0.18347	0.01845	0.24262	0.15770	24.38150	0.00138	0.00060	24.59786
50:1 gas/oil mix	2-stroke	32	1.70452	15.86153	0.18939	0.01905	0.25045	0.16279	25.16800	0.00142	0.00062	25.39134
50:1 gas/oil mix	2-stroke	33	1.75779	16.35720	0.19531	0.01964	0.25827	0.16788	25.95450	0.00147	0.00064	26.18482
50:1 gas/oil mix	2-stroke	34	1.81106	16.85287	0.20123	0.02024	0.26610	0.17296	26.74100	0.00151	0.00066	26.97830
50:1 gas/oil mix	2-stroke	35	1.86432	17.34855	0.20715	0.02083	0.27393	0.17805	27.52750	0.00156	0.00068	27.77178
50:1 gas/oil mix	2-stroke	36	1.91759	17.84422	0.21307	0.02143	0.28175	0.18314	28.31400	0.00160	0.00070	28.56526
50:1 gas/oil mix	2-stroke	37	1.97085	18.33989	0.21898	0.02202	0.28958	0.18823	29.10050	0.00165	0.00072	29.35874
50:1 gas/oil mix	2-stroke	38	2.02412	18.83557	0.22490	0.02262	0.29741	0.19331	29.88700	0.00169	0.00074	30.15222
50:1 gas/oil mix	2-stroke	39	2.07739	19.33124	0.23082	0.02321	0.30523	0.19840	30.67350	0.00174	0.00076	30.94570
50:1 gas/oil mix	2-stroke	40	2.13065	19.82691	0.23674	0.02381	0.31306	0.20349	31.46000	0.00178	0.00078	31.73918
50:1 gas/oil mix	2-stroke	41	2.18392	20.32258	0.24266	0.02441	0.32088	0.20857	32.24650	0.00182	0.00080	32.53266
50:1 gas/oil mix	2-stroke	42	2.23719	20.81826	0.24858	0.02500	0.32871	0.21366	33.03300	0.00187	0.00082	33.32614
50:1 gas/oil mix	2-stroke	43	2.29045	21.31393	0.25449	0.02560	0.33654	0.21875	33.81950	0.00191	0.00084	34.11962
50:1 gas/oil mix	2-stroke	44	2.34372	21.80960	0.26041	0.02619	0.34436	0.22384	34.60600	0.00196	0.00086	34.91310
50:1 gas/oil mix	2-stroke	45	2.39698	22.30527	0.26633	0.02679	0.35219	0.22892	35.39250	0.00200	0.00088	35.70658
50:1 gas/oil mix	2-stroke	46	2.45025	22.80095	0.27225	0.02738	0.36002	0.23401	36.17900	0.00205	0.00090	36.50006
50:1 gas/oil mix	2-stroke	47	2.50352	23.29662	0.27817	0.02798	0.36784	0.23910	36.96550	0.00209	0.00092	37.29354
50:1 gas/oil mix	2-stroke	48	2.55678	23.79229	0.28409	0.02857	0.37567	0.24419	37.75200	0.00214	0.00094	38.08702
50:1 gas/oil mix	2-stroke	49	2.61005	24.28797	0.29001	0.02917	0.38350	0.24927	38.53850	0.00218	0.00096	38.88050
50:1 gas/oil mix	2-stroke	50	2.66332	24.78364	0.29592	0.02976	0.39132	0.25436	39.32500	0.00223	0.00098	39.67398
50:1 gas/oil mix	2-stroke	51	2.71658	25.27931	0.30184	0.03036	0.39915	0.25945	40.11150	0.00227	0.00099	40.46745
50:1 gas/oil mix	2-stroke	52	2.76985	25.77498	0.30776	0.03095	0.40698	0.26453	40.89800	0.00231	0.00101	41.26093
50:1 gas/oil mix	2-stroke	53	2.82312	26.27066	0.31368	0.03155	0.41480	0.26962	41.68450	0.00236	0.00103	42.05441
50:1 gas/oil mix	2-stroke	54	2.87638	26.76633	0.31960	0.03214	0.42263	0.27471	42.47100	0.00240	0.00105	42.84789
50:1 gas/oil mix	2-stroke	55	2.92965	27.26200	0.32552	0.03274	0.43045	0.27980	43.25750	0.00245	0.00107	43.64137
50:1 gas/oil mix	2-stroke	56	2.98291	27.75768	0.33143	0.03333	0.43828	0.28488	44.04400	0.00249	0.00109	44.43485
50:1 gas/oil mix	2-stroke	57	3.03618	28.25335	0.33735	0.03393	0.44611	0.28997	44.83050	0.00254	0.00111	45.22833
50:1 gas/oil mix	2-stroke	58	3.08945	28.74902	0.34327	0.03452	0.45393	0.29506	45.61700	0.00258	0.00113	46.02181
50:1 gas/oil mix	2-stroke	59	3.14271	29.24469	0.34919	0.03512	0.46176	0.30014	46.40350	0.00263	0.00115	46.81529
50:1 gas/oil mix	2-stroke	60	3.19598	29.74037	0.35511	0.03572	0.46959	0.30523	47.19000	0.00267	0.00117	47.60877
50:1 gas/oil mix	2-stroke	61	3.24925	30.23604	0.36103	0.03631	0.47741	0.31032	47.97650	0.00271	0.00119	48.40225
50:1 gas/oil mix	2-stroke	62	3.30251	30.73171	0.36695	0.03691	0.48524	0.31541	48.76300	0.00276	0.00121	49.19573
50:1 gas/oil mix	2-stroke	63	3.35578	31.22738	0.37286	0.03750	0.49307	0.32049	49.54950	0.00280	0.00123	49.98921
50:1 gas/oil mix	2-stroke	64	3.40905	31.72306	0.37878	0.03810	0.50089	0.32558	50.33600	0.00285	0.00125	50.78269

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
50:1 gas/oil mix	2-stroke	65	3.46231	32.21873	0.38470	0.03869	0.50872	0.33067	51.12250	0.00289	0.00127	51.57617
50:1 gas/oil mix	2-stroke	66	3.51558	32.71440	0.39062	0.03929	0.51655	0.33575	51.90900	0.00294	0.00129	52.36965
50:1 gas/oil mix	2-stroke	67	3.56884	33.21008	0.39654	0.03988	0.52437	0.34084	52.69550	0.00298	0.00131	53.16313
50:1 gas/oil mix	2-stroke	68	3.62211	33.70575	0.40246	0.04048	0.53220	0.34593	53.48200	0.00303	0.00133	53.95661
50:1 gas/oil mix	2-stroke	69	3.67538	34.20142	0.40838	0.04107	0.54003	0.35102	54.26850	0.00307	0.00135	54.75009
50:1 gas/oil mix	2-stroke	70	3.72864	34.69709	0.41429	0.04167	0.54785	0.35610	55.05500	0.00312	0.00137	55.54357
50:1 gas/oil mix	2-stroke	71	3.78191	35.19277	0.42021	0.04226	0.55568	0.36119	55.84150	0.00316	0.00138	56.33704
50:1 gas/oil mix	2-stroke	72	3.83518	35.68844	0.42613	0.04286	0.56350	0.36628	56.62800	0.00320	0.00140	57.13052
50:1 gas/oil mix	2-stroke	73	3.88844	36.18411	0.43205	0.04345	0.57133	0.37137	57.41450	0.00325	0.00142	57.92400
50:1 gas/oil mix	2-stroke	74	3.94171	36.67979	0.43797	0.04405	0.57916	0.37645	58.20100	0.00329	0.00144	58.71748
50:1 gas/oil mix	2-stroke	75	3.99497	37.17546	0.44389	0.04464	0.58698	0.38154	58.98750	0.00334	0.00146	59.51096
50:1 gas/oil mix	2-stroke	76	4.04824	37.67113	0.44980	0.04524	0.59481	0.38663	59.77400	0.00338	0.00148	60.30444
50:1 gas/oil mix	2-stroke	77	4.10151	38.16680	0.45572	0.04583	0.60264	0.39171	60.56050	0.00343	0.00150	61.09792
50:1 gas/oil mix	2-stroke	78	4.15477	38.66248	0.46164	0.04643	0.61046	0.39680	61.34700	0.00347	0.00152	61.89140
50:1 gas/oil mix	2-stroke	79	4.20804	39.15815	0.46756	0.04702	0.61829	0.40189	62.13350	0.00352	0.00154	62.68488
50:1 gas/oil mix	2-stroke	80	4.26131	39.65382	0.47348	0.04762	0.62612	0.40698	62.92000	0.00356	0.00156	63.47836
50:1 gas/oil mix	2-stroke	81	4.31457	40.14949	0.47940	0.04822	0.63394	0.41206	63.70650	0.00360	0.00158	64.27184
50:1 gas/oil mix	2-stroke	82	4.36784	40.64517	0.48532	0.04881	0.64177	0.41715	64.49300	0.00365	0.00160	65.06532
50:1 gas/oil mix	2-stroke	83	4.42111	41.14084	0.49123	0.04941	0.64960	0.42224	65.27950	0.00369	0.00162	65.85880
50:1 gas/oil mix	2-stroke	84	4.47437	41.63651	0.49715	0.05000	0.65742	0.42732	66.06600	0.00374	0.00164	66.65228
50:1 gas/oil mix	2-stroke	85	4.52764	42.13219	0.50307	0.05060	0.66525	0.43241	66.85250	0.00378	0.00166	67.44576
50:1 gas/oil mix	2-stroke	86	4.58090	42.62786	0.50899	0.05119	0.67307	0.43750	67.63900	0.00383	0.00168	68.23924
50:1 gas/oil mix	2-stroke	87	4.63417	43.12353	0.51491	0.05179	0.68090	0.44259	68.42550	0.00387	0.00170	69.03272
50:1 gas/oil mix	2-stroke	88	4.68744	43.61920	0.52083	0.05238	0.68873	0.44767	69.21200	0.00392	0.00172	69.82620
50:1 gas/oil mix	2-stroke	89	4.74070	44.11488	0.52674	0.05298	0.69655	0.45276	69.99850	0.00396	0.00174	70.61968
50:1 gas/oil mix	2-stroke	90	4.79397	44.61055	0.53266	0.05357	0.70438	0.45785	70.78500	0.00401	0.00176	71.41316
50:1 gas/oil mix	2-stroke	91	4.84724	45.10622	0.53858	0.05417	0.71221	0.46293	71.57150	0.00405	0.00177	72.20663
50:1 gas/oil mix	2-stroke	92	4.90050	45.60190	0.54450	0.05476	0.72003	0.46802	72.35800	0.00409	0.00179	73.00011
50:1 gas/oil mix	2-stroke	93	4.95377	46.09757	0.55042	0.05536	0.72786	0.47311	73.14450	0.00414	0.00181	73.79359
50:1 gas/oil mix	2-stroke	94	5.00703	46.59324	0.55634	0.05595	0.73569	0.47820	73.93100	0.00418	0.00183	74.58707
50:1 gas/oil mix	2-stroke	95	5.06030	47.08891	0.56226	0.05655	0.74351	0.48328	74.71750	0.00423	0.00185	75.38055
50:1 gas/oil mix	2-stroke	96	5.11357	47.58459	0.56817	0.05714	0.75134	0.48837	75.50400	0.00427	0.00187	76.17403
50:1 gas/oil mix	2-stroke	97	5.16683	48.08026	0.57409	0.05774	0.75917	0.49346	76.29050	0.00432	0.00189	76.96751
50:1 gas/oil mix	2-stroke	98	5.22010	48.57593	0.58001	0.05833	0.76699	0.49854	77.07700	0.00436	0.00191	77.76099
50:1 gas/oil mix	2-stroke	99	5.27337	49.07160	0.58593	0.05893	0.77482	0.50363	77.86350	0.00441	0.00193	78.55447
50:1 gas/oil mix	2-stroke	100	5.32663	49.56728	0.59185	0.05953	0.78265	0.50872	78.65000	0.00445	0.00195	79.34795
50:1 gas/oil mix	2-stroke	101	5.37990	50.06295	0.59777	0.06012	0.79047	0.51381	79.43650	0.00449	0.00197	80.14143
50:1 gas/oil mix	2-stroke	102	5.43317	50.55862	0.60369	0.06072	0.79830	0.51889	80.22300	0.00454	0.00199	80.93491
50:1 gas/oil mix	2-stroke	103	5.48643	51.05430	0.60960	0.06131	0.80612	0.52398	81.00950	0.00458	0.00201	81.72839
50:1 gas/oil mix	2-stroke	104	5.53970	51.54997	0.61552	0.06191	0.81395	0.52907	81.79600	0.00463	0.00203	82.52187
50:1 gas/oil mix	2-stroke	105	5.59296	52.04564	0.62144	0.06250	0.82178	0.53416	82.58250	0.00467	0.00205	83.31535
50:1 gas/oil mix	2-stroke	106	5.64623	52.54131	0.62736	0.06310	0.82960	0.53924	83.36900	0.00472	0.00207	84.10883
50:1 gas/oil mix	2-stroke	107	5.69950	53.03699	0.63328	0.06369	0.83743	0.54433	84.15550	0.00476	0.00209	84.90231
50:1 gas/oil mix	2-stroke	108	5.75276	53.53266	0.63920	0.06429	0.84526	0.54942	84.94200	0.00481	0.00211	85.69579
50:1 gas/oil mix	2-stroke	109	5.80603	54.02833	0.64511	0.06488	0.85308	0.55450	85.72850	0.00485	0.00213	86.48927
50:1 gas/oil mix	2-stroke	110	5.85930	54.52401	0.65103	0.06548	0.86091	0.55959	86.51500	0.00490	0.00215	87.28275
50:1 gas/oil mix	2-stroke	111	5.91256	55.01968	0.65695	0.06607	0.86874	0.56468	87.30150	0.00494	0.00216	88.07622
50:1 gas/oil mix	2-stroke	112	5.96583	55.51535	0.66287	0.06667	0.87656	0.56977	88.08800	0.00498	0.00218	88.86970
50:1 gas/oil mix	2-stroke	113	6.01910	56.01102	0.66879	0.06726	0.88439	0.57485	88.87450	0.00503	0.00220	89.66318
50:1 gas/oil mix	2-stroke	114	6.07236	56.50670	0.67471	0.06786	0.89222	0.57994	89.66100	0.00507	0.00222	90.45666
50:1 gas/oil mix	2-stroke	115	6.12563	57.00237	0.68063	0.06845	0.90004	0.58503	90.44750	0.00512	0.00224	91.25014
50:1 gas/oil mix	2-stroke	116	6.17889	57.49804	0.68654	0.06905	0.90787	0.59011	91.23400	0.00516	0.00226	92.04362
50:1 gas/oil mix	2-stroke	117	6.23216	57.99371	0.69246	0.06964	0.91569	0.59520	92.02050	0.00521	0.00228	92.83710
50:1 gas/oil mix	2-stroke	118	6.28543	58.48939	0.69838	0.07024	0.92352	0.60029	92.80700	0.00525	0.00230	93.63058
50:1 gas/oil mix	2-stroke	119	6.33869	58.98506	0.70430	0.07083	0.93135	0.60538	93.59350	0.00530	0.00232	94.42406
50:1 gas/oil mix	2-stroke	120	6.39196	59.48073	0.71022	0.07143	0.93917	0.61046	94.38000	0.00534	0.00234	95.21754
50:1 gas/oil mix	2-stroke	121	6.44523	59.97641	0.71614	0.07203	0.94700	0.61555	95.16650	0.00538	0.00236	96.01102
50:1 gas/oil mix	2-stroke	122	6.49849	60.47208	0.72205	0.07262	0.95483	0.62064	95.95300	0.00543	0.00238	96.80450
50:1 gas/oil mix	2-stroke	123	6.55176	60.96775	0.72797	0.07322	0.96265	0.62572	96.73950	0.00547	0.00240	97.59798
50:1 gas/oil mix	2-stroke	124	6.60502	61.46342	0.73389	0.07381	0.97048	0.63081	97.52600	0.00552	0.00242	98.39146
50:1 gas/oil mix	2-stroke	125	6.65829	61.95910	0.73981	0.07441	0.97831	0.63590	98.31250	0.00556	0.00244	99.18494
50:1 gas/oil mix	2-stroke	126	6.71156	62.45477	0.74573	0.07500	0.98613	0.64099	99.09900	0.00561	0.00246	99.97842
50:1 gas/oil mix	2-stroke	127	6.76482	62.95044	0.75165	0.07560	0.99396	0.64607	99.88550	0.00565	0.00248	100.77190
50:1 gas/oil mix	2-stroke	128	6.81809	63.44612	0.75757	0.07619	1.00179	0.65116	100.67200	0.00570	0.00250	101.56538
50:1 gas/oil mix	2-stroke	129	6.87136	63.94179	0.76348	0.07679	1.00961	0.65625	101.45850	0.00574	0.00252	102.35886
50:1 gas/oil mix	2-stroke	130	6.92462	64.43746	0.76940	0.07738	1.01744	0.66134	102.24500	0.00579	0.00254	103.15234
50:1 gas/oil mix	2-stroke	131	6.97789	64.93313	0.77532	0.07798	1.02527	0.66642	103.03150	0.00583	0.00255	103.94581
50:1 gas/oil mix	2-stroke	132	7.03116	65.42881	0.78124	0.07857	1.03309	0.67151	103.81800	0.00587	0.00257	104.73929
50:1 gas/oil mix	2-stroke	133	7.08442	65.92448	0.78716	0.07917	1.04092	0.67660	104.60450	0.00592	0.00259	105.53277
50:1 gas/oil mix	2-stroke	134	7.13769	66.42015	0.79308	0.07976	1.04874	0.68168	105.39100	0.00596	0.00261	106.32625
50:1 gas/oil mix	2-stroke	135	7.19095	66.91582	0.79899	0.08036	1.05657	0.68677	106.17750	0.00601	0.00263	107.11973
50:1 gas/oil mix	2-stroke	136	7.24422	67.41150	0.80491	0.08095	1.06440	0.69186	106.96400	0.00605	0.00265	107.91321
50:1 gas/oil mix	2-stroke	137	7.29749	67.90717	0.81083	0.08155	1.07222	0.69695	107.75050	0.00610	0.00267	108.70669
50:1 gas/oil mix	2-stroke	138	7.35075	68.40284	0.81675	0.08214	1.08005	0.70203	108.53700	0.00614	0.00269	109.50017
50:1 gas/oil mix	2-stroke	139	7.40402	68.89852	0.82267	0.08274	1.08788	0.70712	109.32350	0.00619	0.00271	110.29365
50:1 gas/oil mix	2-stroke	140	7.45729	69.39419	0.82859	0.08334	1.09570	0.71221	110.11000	0.00623	0.00273	111.08713
50:1 gas/oil mix	2-stroke	141	7.51055	69.88986	0.83451	0.08393	1.10353	0.71729	110.89650	0.00627	0.00275	111.88061
50:1 gas/oil mix	2-stroke	142	7.56382	70.38553	0.84042	0.08453	1.11136	0.72238	111.68300	0.00632	0.00277	112.67409

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
50:1 gas/oil mix	2-stroke	143	7.61708	70.88121	0.84634	0.08512	1.11918	0.72747	112.46950	0.00636	0.00279	113.46757
50:1 gas/oil mix	2-stroke	144	7.67035	71.37688	0.85226	0.08572	1.12701	0.73256	113.25600	0.00641	0.00281	114.26105
50:1 gas/oil mix	2-stroke	145	7.72362	71.87255	0.85818	0.08631	1.13484	0.73764	114.04250	0.00645	0.00283	115.05453
50:1 gas/oil mix	2-stroke	146	7.77688	72.36823	0.86410	0.08691	1.14266	0.74273	114.82900	0.00650	0.00285	115.84801
50:1 gas/oil mix	2-stroke	147	7.83015	72.86390	0.87002	0.08750	1.15049	0.74782	115.61550	0.00654	0.00287	116.64149
50:1 gas/oil mix	2-stroke	148	7.88342	73.35957	0.87594	0.08810	1.15831	0.75290	116.40200	0.00659	0.00289	117.43497
50:1 gas/oil mix	2-stroke	149	7.93668	73.85524	0.88185	0.08869	1.16614	0.75799	117.18850	0.00663	0.00291	118.22845
50:1 gas/oil mix	2-stroke	150	7.98995	74.35092	0.88777	0.08929	1.17397	0.76308	117.97500	0.00668	0.00293	119.02193
50:1 gas/oil mix	2-stroke	151	8.04322	74.84659	0.89369	0.08988	1.18179	0.76817	118.76150	0.00672	0.00294	119.81540
50:1 gas/oil mix	2-stroke	152	8.09648	75.34226	0.89961	0.09048	1.18962	0.77325	119.54800	0.00676	0.00296	120.60888
50:1 gas/oil mix	2-stroke	153	8.14975	75.83793	0.90553	0.09107	1.19745	0.77834	120.33450	0.00681	0.00298	121.40236
50:1 gas/oil mix	2-stroke	154	8.20301	76.33361	0.91145	0.09167	1.20527	0.78343	121.12100	0.00685	0.00300	122.19584
50:1 gas/oil mix	2-stroke	155	8.25628	76.82928	0.91736	0.09226	1.21310	0.78851	121.90750	0.00690	0.00302	122.98932
50:1 gas/oil mix	2-stroke	156	8.30955	77.32495	0.92328	0.09286	1.22093	0.79360	122.69400	0.00694	0.00304	123.78280
50:1 gas/oil mix	2-stroke	157	8.36281	77.82063	0.92920	0.09345	1.22875	0.79869	123.48050	0.00699	0.00306	124.57628
50:1 gas/oil mix	2-stroke	158	8.41608	78.31630	0.93512	0.09405	1.23658	0.80378	124.26700	0.00703	0.00308	125.36976
50:1 gas/oil mix	2-stroke	159	8.46935	78.81197	0.94104	0.09464	1.24441	0.80886	125.05350	0.00708	0.00310	126.16324
50:1 gas/oil mix	2-stroke	160	8.52261	79.30764	0.94696	0.09524	1.25223	0.81395	125.84000	0.00712	0.00312	126.95672
50:1 gas/oil mix	2-stroke	161	8.57588	79.80332	0.95288	0.09584	1.26006	0.81904	126.62650	0.00716	0.00314	127.75020
50:1 gas/oil mix	2-stroke	162	8.62915	80.29899	0.95879	0.09643	1.26789	0.82413	127.41300	0.00721	0.00316	128.54368
50:1 gas/oil mix	2-stroke	163	8.68241	80.79466	0.96471	0.09703	1.27571	0.82921	128.19950	0.00725	0.00318	129.33716
50:1 gas/oil mix	2-stroke	164	8.73568	81.29034	0.97063	0.09762	1.28354	0.83430	128.98600	0.00730	0.00320	130.13064
50:1 gas/oil mix	2-stroke	165	8.78894	81.78601	0.97655	0.09822	1.29136	0.83939	129.77250	0.00734	0.00322	130.92412
50:1 gas/oil mix	2-stroke	166	8.84221	82.28168	0.98247	0.09881	1.29919	0.84447	130.55900	0.00739	0.00324	131.71760
50:1 gas/oil mix	2-stroke	167	8.89548	82.77735	0.98839	0.09941	1.30702	0.84956	131.34550	0.00743	0.00326	132.51108
50:1 gas/oil mix	2-stroke	168	8.94874	83.27303	0.99430	0.10000	1.31484	0.85465	132.13200	0.00748	0.00328	133.30456
50:1 gas/oil mix	2-stroke	169	9.00201	83.76870	1.00022	0.10060	1.32267	0.85974	132.91850	0.00752	0.00330	134.09804
50:1 gas/oil mix	2-stroke	170	9.05528	84.26437	1.00614	0.10119	1.33050	0.86482	133.70500	0.00757	0.00332	134.89152
50:1 gas/oil mix	2-stroke	171	9.10854	84.76004	1.01206	0.10179	1.33832	0.86991	134.49150	0.00761	0.00333	135.68499
50:1 gas/oil mix	2-stroke	172	9.16181	85.25572	1.01798	0.10238	1.34615	0.87500	135.27800	0.00765	0.00335	136.47847
50:1 gas/oil mix	2-stroke	173	9.21507	85.75139	1.02390	0.10298	1.35398	0.88008	136.06450	0.00770	0.00337	137.27195
50:1 gas/oil mix	2-stroke	174	9.26834	86.24706	1.02982	0.10357	1.36180	0.88517	136.85100	0.00774	0.00339	138.06543
50:1 gas/oil mix	2-stroke	175	9.32161	86.74274	1.03573	0.10417	1.36963	0.89026	137.63750	0.00779	0.00341	138.85891
50:1 gas/oil mix	2-stroke	176	9.37487	87.23841	1.04165	0.10476	1.37746	0.89535	138.42400	0.00783	0.00343	139.65239
50:1 gas/oil mix	2-stroke	177	9.42814	87.73408	1.04757	0.10536	1.38528	0.90043	139.21050	0.00788	0.00345	140.44587
50:1 gas/oil mix	2-stroke	178	9.48141	88.22975	1.05349	0.10595	1.39311	0.90552	139.99700	0.00792	0.00347	141.23935
50:1 gas/oil mix	2-stroke	179	9.53467	88.72543	1.05941	0.10655	1.40093	0.91061	140.78350	0.00797	0.00349	142.03283
50:1 gas/oil mix	2-stroke	180	9.58794	89.22110	1.06533	0.10715	1.40876	0.91569	141.57000	0.00801	0.00351	142.82631
50:1 gas/oil mix	2-stroke	181	9.64121	89.71677	1.07125	0.10774	1.41659	0.92078	142.35650	0.00805	0.00353	143.61979
50:1 gas/oil mix	2-stroke	182	9.69447	90.21245	1.07716	0.10834	1.42441	0.92587	143.14300	0.00810	0.00355	144.41327
50:1 gas/oil mix	2-stroke	183	9.74774	90.70812	1.08308	0.10893	1.43224	0.93096	143.92950	0.00814	0.00357	145.20675
50:1 gas/oil mix	2-stroke	184	9.80100	91.20379	1.08900	0.10953	1.44007	0.93604	144.71600	0.00819	0.00359	146.00023
50:1 gas/oil mix	2-stroke	185	9.85427	91.69946	1.09492	0.11012	1.44789	0.94113	145.50250	0.00823	0.00361	146.79371
50:1 gas/oil mix	2-stroke	186	9.90754	92.19514	1.10084	0.11072	1.45572	0.94622	146.28900	0.00828	0.00363	147.58719
50:1 gas/oil mix	2-stroke	187	9.96080	92.69081	1.10676	0.11131	1.46355	0.95131	147.07550	0.00832	0.00365	148.38067
50:1 gas/oil mix	2-stroke	188	10.01407	93.18648	1.11267	0.11191	1.47137	0.95639	147.86200	0.00837	0.00367	149.17415
50:1 gas/oil mix	2-stroke	189	10.06734	93.68215	1.11859	0.11250	1.47920	0.96148	148.64850	0.00841	0.00369	149.96763
50:1 gas/oil mix	2-stroke	190	10.12060	94.17783	1.12451	0.11310	1.48703	0.96657	149.43500	0.00846	0.00371	150.76111
50:1 gas/oil mix	2-stroke	191	10.17387	94.67350	1.13043	0.11369	1.49485	0.97165	150.22150	0.00850	0.00372	151.55458
50:1 gas/oil mix	2-stroke	192	10.22714	95.16917	1.13635	0.11429	1.50268	0.97674	151.00800	0.00854	0.00374	152.34806
50:1 gas/oil mix	2-stroke	193	10.28040	95.66485	1.14227	0.11488	1.51051	0.98183	151.79450	0.00859	0.00376	153.14154
50:1 gas/oil mix	2-stroke	194	10.33367	96.16052	1.14819	0.11548	1.51833	0.98692	152.58100	0.00863	0.00378	153.93502
50:1 gas/oil mix	2-stroke	195	10.38693	96.65619	1.15410	0.11607	1.52616	0.99200	153.36750	0.00868	0.00380	154.72850
50:1 gas/oil mix	2-stroke	196	10.44020	97.15186	1.16002	0.11667	1.53398	0.99709	154.15400	0.00872	0.00382	155.52198
50:1 gas/oil mix	2-stroke	197	10.49347	97.64754	1.16594	0.11726	1.54181	1.00218	154.94050	0.00877	0.00384	156.31546
50:1 gas/oil mix	2-stroke	198	10.54673	98.14321	1.17186	0.11786	1.54964	1.00726	155.72700	0.00881	0.00386	157.10894
50:1 gas/oil mix	2-stroke	199	10.60000	98.63888	1.17778	0.11845	1.55746	1.01235	156.51350	0.00886	0.00388	157.90242
50:1 gas/oil mix	2-stroke	200	10.65327	99.13456	1.18370	0.11905	1.56529	1.01744	157.30000	0.00890	0.00390	158.69590
Methane	**Methane**	**10**	**0.07938**	**0.03342**	**0.05082**	**0.00004**	**0.00060**	**0.00039**	**6.99600**	**0.00014**	**0.00001**	**7.00262**
CNG	Methane	11	0.08732	0.03676	0.05590	0.00004	0.00066	0.00043	7.69560	0.00015	0.00001	7.70288
CNG	Methane	12	0.09526	0.04010	0.06098	0.00004	0.00072	0.00047	8.39520	0.00017	0.00001	8.40314
CNG	Methane	13	0.10319	0.04345	0.06607	0.00005	0.00078	0.00051	9.09480	0.00018	0.00002	9.10340
CNG	Methane	14	0.11113	0.04679	0.07115	0.00005	0.00084	0.00055	9.79440	0.00019	0.00002	9.80367
CNG	Methane	15	0.11907	0.05013	0.07623	0.00005	0.00090	0.00059	10.49400	0.00021	0.00002	10.50393
CNG	Methane	16	0.12701	0.05347	0.08131	0.00006	0.00096	0.00062	11.19360	0.00022	0.00002	11.20419
CNG	Methane	17	0.13495	0.05681	0.08639	0.00006	0.00102	0.00066	11.89320	0.00023	0.00002	11.90445
CNG	Methane	18	0.14288	0.06016	0.09148	0.00006	0.00108	0.00070	12.59280	0.00025	0.00002	12.60471
CNG	Methane	19	0.15082	0.06350	0.09656	0.00007	0.00114	0.00074	13.29240	0.00026	0.00002	13.30497
CNG	Methane	20	0.15876	0.06684	0.10164	0.00007	0.00120	0.00078	13.99200	0.00028	0.00002	14.00524
CNG	Methane	21	0.16670	0.07018	0.10672	0.00008	0.00126	0.00082	14.69160	0.00029	0.00003	14.70550
CNG	Methane	22	0.17464	0.07352	0.11180	0.00008	0.00132	0.00086	15.39120	0.00030	0.00003	15.40576
CNG	Methane	23	0.18257	0.07687	0.11689	0.00008	0.00138	0.00090	16.09080	0.00032	0.00003	16.10602
CNG	Methane	24	0.19051	0.08021	0.12197	0.00009	0.00144	0.00094	16.79040	0.00033	0.00003	16.80628
CNG	Methane	25	0.19845	0.08355	0.12705	0.00009	0.00150	0.00098	17.49000	0.00035	0.00003	17.50655
CNG	Methane	26	0.20639	0.08689	0.13213	0.00009	0.00156	0.00101	18.18960	0.00036	0.00003	18.20681
CNG	Methane	27	0.21433	0.09023	0.13721	0.00010	0.00162	0.00105	18.88920	0.00037	0.00003	18.90707
CNG	Methane	28	0.22226	0.09358	0.14230	0.00010	0.00168	0.00109	19.58880	0.00039	0.00003	19.60733
CNG	Methane	29	0.23020	0.09692	0.14738	0.00010	0.00174	0.00113	20.28840	0.00040	0.00003	20.30759

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
CNG	Methane	30	0.23814	0.10026	0.15246	0.00011	0.00180	0.00117	20.98800	0.00041	0.00004	21.00785
CNG	Methane	31	0.24608	0.10360	0.15754	0.00011	0.00186	0.00121	21.68760	0.00043	0.00004	21.70812
CNG	Methane	32	0.25402	0.10694	0.16262	0.00012	0.00192	0.00125	22.38720	0.00044	0.00004	22.40838
CNG	Methane	33	0.26195	0.11029	0.16771	0.00012	0.00198	0.00129	23.08680	0.00046	0.00004	23.10864
CNG	Methane	34	0.26989	0.11363	0.17279	0.00012	0.00204	0.00133	23.78640	0.00047	0.00004	23.80890
CNG	Methane	35	0.27783	0.11697	0.17787	0.00013	0.00210	0.00137	24.48600	0.00048	0.00004	24.50916
CNG	Methane	36	0.28577	0.12031	0.18295	0.00013	0.00216	0.00140	25.18560	0.00050	0.00004	25.20942
CNG	Methane	37	0.29371	0.12365	0.18803	0.00013	0.00222	0.00144	25.88520	0.00051	0.00004	25.90969
CNG	Methane	38	0.30164	0.12700	0.19312	0.00014	0.00228	0.00148	26.58480	0.00052	0.00005	26.60995
CNG	Methane	39	0.30958	0.13034	0.19820	0.00014	0.00234	0.00152	27.28440	0.00054	0.00005	27.31021
CNG	Methane	40	0.31752	0.13368	0.20328	0.00014	0.00240	0.00156	27.98400	0.00055	0.00005	28.01047
CNG	Methane	41	0.32546	0.13702	0.20836	0.00015	0.00246	0.00160	28.68360	0.00057	0.00005	28.71073
CNG	Methane	42	0.33340	0.14036	0.21344	0.00015	0.00252	0.00164	29.38320	0.00058	0.00005	29.41100
CNG	Methane	43	0.34133	0.14371	0.21853	0.00015	0.00258	0.00168	30.08280	0.00059	0.00005	30.11126
CNG	Methane	44	0.34927	0.14705	0.22361	0.00016	0.00264	0.00172	30.78240	0.00061	0.00005	30.81152
CNG	Methane	45	0.35721	0.15039	0.22869	0.00016	0.00270	0.00176	31.48200	0.00062	0.00005	31.51178
CNG	Methane	46	0.36515	0.15373	0.23377	0.00017	0.00276	0.00179	32.18160	0.00063	0.00006	32.21204
CNG	Methane	47	0.37309	0.15707	0.23885	0.00017	0.00282	0.00183	32.88120	0.00065	0.00006	32.91230
CNG	Methane	48	0.38102	0.16042	0.24394	0.00017	0.00288	0.00187	33.58080	0.00066	0.00006	33.61257
CNG	Methane	49	0.38896	0.16376	0.24902	0.00018	0.00294	0.00191	34.28040	0.00068	0.00006	34.31283
CNG	Methane	50	0.39690	0.16710	0.25410	0.00018	0.00300	0.00195	34.98000	0.00069	0.00006	35.01309
CNG	Methane	51	0.40484	0.17044	0.25918	0.00018	0.00306	0.00199	35.67960	0.00070	0.00006	35.71335
CNG	Methane	52	0.41278	0.17378	0.26426	0.00019	0.00312	0.00203	36.37920	0.00072	0.00006	36.41361
CNG	Methane	53	0.42071	0.17713	0.26935	0.00019	0.00318	0.00207	37.07880	0.00073	0.00006	37.11388
CNG	Methane	54	0.42865	0.18047	0.27443	0.00019	0.00324	0.00211	37.77840	0.00075	0.00006	37.81414
CNG	Methane	55	0.43659	0.18381	0.27951	0.00020	0.00330	0.00215	38.47800	0.00076	0.00007	38.51440
CNG	Methane	56	0.44453	0.18715	0.28459	0.00020	0.00336	0.00218	39.17760	0.00077	0.00007	39.21466
CNG	Methane	57	0.45247	0.19049	0.28967	0.00021	0.00342	0.00222	39.87720	0.00079	0.00007	39.91492
CNG	Methane	58	0.46040	0.19384	0.29476	0.00021	0.00348	0.00226	40.57680	0.00080	0.00007	40.61518
CNG	Methane	59	0.46834	0.19718	0.29984	0.00021	0.00354	0.00230	41.27640	0.00081	0.00007	41.31545
CNG	Methane	60	0.47628	0.20052	0.30492	0.00022	0.00360	0.00234	41.97600	0.00083	0.00007	42.01571
CNG	Methane	61	0.48422	0.20386	0.31000	0.00022	0.00366	0.00238	42.67560	0.00084	0.00007	42.71597
CNG	Methane	62	0.49216	0.20720	0.31508	0.00022	0.00372	0.00242	43.37520	0.00086	0.00007	43.41623
CNG	Methane	63	0.50009	0.21055	0.32017	0.00023	0.00378	0.00246	44.07480	0.00087	0.00008	44.11649
CNG	Methane	64	0.50803	0.21389	0.32525	0.00023	0.00384	0.00250	44.77440	0.00088	0.00008	44.81676
CNG	Methane	65	0.51597	0.21723	0.33033	0.00023	0.00390	0.00254	45.47400	0.00090	0.00008	45.51702
CNG	Methane	66	0.52391	0.22057	0.33541	0.00024	0.00396	0.00257	46.17360	0.00091	0.00008	46.21728
CNG	Methane	67	0.53185	0.22391	0.34049	0.00024	0.00402	0.00261	46.87320	0.00092	0.00008	46.91754
CNG	Methane	68	0.53978	0.22726	0.34558	0.00024	0.00408	0.00265	47.57280	0.00094	0.00008	47.61780
CNG	Methane	69	0.54772	0.23060	0.35066	0.00025	0.00414	0.00269	48.27240	0.00095	0.00008	48.31806
CNG	Methane	70	0.55566	0.23394	0.35574	0.00025	0.00420	0.00273	48.97200	0.00097	0.00008	49.01833
CNG	Methane	71	0.56360	0.23728	0.36082	0.00026	0.00426	0.00277	49.67160	0.00098	0.00009	49.71859
CNG	Methane	72	0.57154	0.24062	0.36590	0.00026	0.00432	0.00281	50.37120	0.00099	0.00009	50.41885
CNG	Methane	73	0.57947	0.24397	0.37099	0.00026	0.00438	0.00285	51.07080	0.00101	0.00009	51.11911
CNG	Methane	74	0.58741	0.24731	0.37607	0.00027	0.00444	0.00289	51.77040	0.00102	0.00009	51.81937
CNG	Methane	75	0.59535	0.25065	0.38115	0.00027	0.00450	0.00293	52.47000	0.00104	0.00009	52.51964
CNG	Methane	76	0.60329	0.25399	0.38623	0.00027	0.00456	0.00296	53.16960	0.00105	0.00009	53.21990
CNG	Methane	77	0.61123	0.25733	0.39131	0.00028	0.00462	0.00300	53.86920	0.00106	0.00009	53.92016
CNG	Methane	78	0.61916	0.26068	0.39640	0.00028	0.00468	0.00304	54.56880	0.00108	0.00009	54.62042
CNG	Methane	79	0.62710	0.26402	0.40148	0.00028	0.00474	0.00308	55.26840	0.00109	0.00009	55.32068
CNG	Methane	80	0.63504	0.26736	0.40656	0.00029	0.00480	0.00312	55.96800	0.00110	0.00010	56.02094
CNG	Methane	81	0.64298	0.27070	0.41164	0.00029	0.00486	0.00316	56.66760	0.00112	0.00010	56.72121
CNG	Methane	82	0.65092	0.27404	0.41672	0.00030	0.00492	0.00320	57.36720	0.00113	0.00010	57.42147
CNG	Methane	83	0.65885	0.27739	0.42181	0.00030	0.00498	0.00324	58.06680	0.00115	0.00010	58.12173
CNG	Methane	84	0.66679	0.28073	0.42689	0.00030	0.00504	0.00328	58.76640	0.00116	0.00010	58.82199
CNG	Methane	85	0.67473	0.28407	0.43197	0.00031	0.00510	0.00332	59.46600	0.00117	0.00010	59.52225
CNG	Methane	86	0.68267	0.28741	0.43705	0.00031	0.00516	0.00335	60.16560	0.00119	0.00010	60.22251
CNG	Methane	87	0.69061	0.29075	0.44213	0.00031	0.00522	0.00339	60.86520	0.00120	0.00010	60.92278
CNG	Methane	88	0.69854	0.29410	0.44722	0.00032	0.00528	0.00343	61.56480	0.00121	0.00011	61.62304
CNG	Methane	89	0.70648	0.29744	0.45230	0.00032	0.00534	0.00347	62.26440	0.00123	0.00011	62.32330
CNG	Methane	90	0.71442	0.30078	0.45738	0.00032	0.00540	0.00351	62.96400	0.00124	0.00011	63.02356
CNG	Methane	91	0.72236	0.30412	0.46246	0.00033	0.00546	0.00355	63.66360	0.00126	0.00011	63.72382
CNG	Methane	92	0.73030	0.30746	0.46754	0.00033	0.00552	0.00359	64.36320	0.00127	0.00011	64.42409
CNG	Methane	93	0.73823	0.31081	0.47263	0.00033	0.00558	0.00363	65.06280	0.00128	0.00011	65.12435
CNG	Methane	94	0.74617	0.31415	0.47771	0.00034	0.00564	0.00367	65.76240	0.00130	0.00011	65.82461
CNG	Methane	95	0.75411	0.31749	0.48279	0.00034	0.00570	0.00371	66.46200	0.00131	0.00011	66.52487
CNG	Methane	96	0.76205	0.32083	0.48787	0.00035	0.00576	0.00374	67.16160	0.00132	0.00012	67.22513
CNG	Methane	97	0.76999	0.32417	0.49295	0.00035	0.00582	0.00378	67.86120	0.00134	0.00012	67.92539
CNG	Methane	98	0.77792	0.32752	0.49804	0.00035	0.00588	0.00382	68.56080	0.00135	0.00012	68.62566
CNG	Methane	99	0.78586	0.33086	0.50312	0.00036	0.00594	0.00386	69.26040	0.00137	0.00012	69.32592
CNG	Methane	100	0.79380	0.33420	0.50820	0.00036	0.00600	0.00390	69.96000	0.00138	0.00012	70.02618
CNG	Methane	101	0.80174	0.33754	0.51328	0.00036	0.00606	0.00394	70.65960	0.00139	0.00012	70.72644
CNG	Methane	102	0.80968	0.34088	0.51836	0.00037	0.00612	0.00398	71.35920	0.00141	0.00012	71.42670
CNG	Methane	103	0.81761	0.34423	0.52345	0.00037	0.00618	0.00402	72.05880	0.00142	0.00012	72.12697
CNG	Methane	104	0.82555	0.34757	0.52853	0.00037	0.00624	0.00406	72.75840	0.00144	0.00012	72.82723
CNG	Methane	105	0.83349	0.35091	0.53361	0.00038	0.00630	0.00410	73.45800	0.00145	0.00013	73.52749
CNG	Methane	106	0.84143	0.35425	0.53869	0.00038	0.00636	0.00413	74.15760	0.00146	0.00013	74.22775
CNG	Methane	107	0.84937	0.35759	0.54377	0.00039	0.00642	0.00417	74.85720	0.00148	0.00013	74.92801

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
CNG	Methane	108	0.85730	0.36094	0.54886	0.00039	0.00648	0.00421	75.55680	0.00149	0.00013	75.62827
CNG	Methane	109	0.86524	0.36428	0.55394	0.00039	0.00654	0.00425	76.25640	0.00150	0.00013	76.32854
CNG	Methane	110	0.87318	0.36762	0.55902	0.00040	0.00660	0.00429	76.95600	0.00152	0.00013	77.02880
CNG	Methane	111	0.88112	0.37096	0.56410	0.00040	0.00666	0.00433	77.65560	0.00153	0.00013	77.72906
CNG	Methane	112	0.88906	0.37430	0.56918	0.00040	0.00672	0.00437	78.35520	0.00155	0.00013	78.42932
CNG	Methane	113	0.89699	0.37765	0.57427	0.00041	0.00678	0.00441	79.05480	0.00156	0.00014	79.12958
CNG	Methane	114	0.90493	0.38099	0.57935	0.00041	0.00684	0.00445	79.75440	0.00157	0.00014	79.82985
CNG	Methane	115	0.91287	0.38433	0.58443	0.00041	0.00690	0.00449	80.45400	0.00159	0.00014	80.53011
CNG	Methane	116	0.92081	0.38767	0.58951	0.00042	0.00696	0.00452	81.15360	0.00160	0.00014	81.23037
CNG	Methane	117	0.92875	0.39101	0.59459	0.00042	0.00702	0.00456	81.85320	0.00161	0.00014	81.93063
CNG	Methane	118	0.93668	0.39436	0.59968	0.00042	0.00708	0.00460	82.55280	0.00163	0.00014	82.63089
CNG	Methane	119	0.94462	0.39770	0.60476	0.00043	0.00714	0.00464	83.25240	0.00164	0.00014	83.33115
CNG	Methane	120	0.95256	0.40104	0.60984	0.00043	0.00720	0.00468	83.95200	0.00166	0.00014	84.03142
CNG	Methane	121	0.96050	0.40438	0.61492	0.00044	0.00726	0.00472	84.65160	0.00167	0.00015	84.73168
CNG	Methane	122	0.96844	0.40772	0.62000	0.00044	0.00732	0.00476	85.35120	0.00168	0.00015	85.43194
CNG	Methane	123	0.97637	0.41107	0.62509	0.00044	0.00738	0.00480	86.05080	0.00170	0.00015	86.13220
CNG	Methane	124	0.98431	0.41441	0.63017	0.00045	0.00744	0.00484	86.75040	0.00171	0.00015	86.83246
CNG	Methane	125	0.99225	0.41775	0.63525	0.00045	0.00750	0.00488	87.45000	0.00173	0.00015	87.53273
CNG	Methane	126	1.00019	0.42109	0.64033	0.00045	0.00756	0.00491	88.14960	0.00174	0.00015	88.23299
CNG	Methane	127	1.00813	0.42443	0.64541	0.00046	0.00762	0.00495	88.84920	0.00175	0.00015	88.93325
CNG	Methane	128	1.01606	0.42778	0.65050	0.00046	0.00768	0.00499	89.54880	0.00177	0.00015	89.63351
CNG	Methane	129	1.02400	0.43112	0.65558	0.00046	0.00774	0.00503	90.24840	0.00178	0.00015	90.33377
CNG	Methane	130	1.03194	0.43446	0.66066	0.00047	0.00780	0.00507	90.94800	0.00179	0.00016	91.03403
CNG	Methane	131	1.03988	0.43780	0.66574	0.00047	0.00786	0.00511	91.64760	0.00181	0.00016	91.73430
CNG	Methane	132	1.04782	0.44114	0.67082	0.00048	0.00792	0.00515	92.34720	0.00182	0.00016	92.43456
CNG	Methane	133	1.05575	0.44449	0.67591	0.00048	0.00798	0.00519	93.04680	0.00184	0.00016	93.13482
CNG	Methane	134	1.06369	0.44783	0.68099	0.00048	0.00804	0.00523	93.74640	0.00185	0.00016	93.83508
CNG	Methane	135	1.07163	0.45117	0.68607	0.00049	0.00810	0.00527	94.44600	0.00186	0.00016	94.53534
CNG	Methane	136	1.07957	0.45451	0.69115	0.00049	0.00816	0.00530	95.14560	0.00188	0.00016	95.23560
CNG	Methane	137	1.08751	0.45785	0.69623	0.00049	0.00822	0.00534	95.84520	0.00189	0.00016	95.93587
CNG	Methane	138	1.09544	0.46120	0.70132	0.00050	0.00828	0.00538	96.54480	0.00190	0.00017	96.63613
CNG	Methane	139	1.10338	0.46454	0.70640	0.00050	0.00834	0.00542	97.24440	0.00192	0.00017	97.33639
CNG	Methane	140	1.11132	0.46788	0.71148	0.00050	0.00840	0.00546	97.94400	0.00193	0.00017	98.03665
CNG	Methane	141	1.11926	0.47122	0.71656	0.00051	0.00846	0.00550	98.64360	0.00195	0.00017	98.73691
CNG	Methane	142	1.12720	0.47456	0.72164	0.00051	0.00852	0.00554	99.34320	0.00196	0.00017	99.43718
CNG	Methane	143	1.13513	0.47791	0.72673	0.00051	0.00858	0.00558	100.04280	0.00197	0.00017	100.13744
CNG	Methane	144	1.14307	0.48125	0.73181	0.00052	0.00864	0.00562	100.74240	0.00199	0.00017	100.83770
CNG	Methane	145	1.15101	0.48459	0.73689	0.00052	0.00870	0.00566	101.44200	0.00200	0.00017	101.53796
CNG	Methane	146	1.15895	0.48793	0.74197	0.00053	0.00876	0.00569	102.14160	0.00201	0.00018	102.23822
CNG	Methane	147	1.16689	0.49127	0.74705	0.00053	0.00882	0.00573	102.84120	0.00203	0.00018	102.93848
CNG	Methane	148	1.17482	0.49462	0.75214	0.00053	0.00888	0.00577	103.54080	0.00204	0.00018	103.63875
CNG	Methane	149	1.18276	0.49796	0.75722	0.00054	0.00894	0.00581	104.24040	0.00206	0.00018	104.33901
CNG	Methane	150	1.19070	0.50130	0.76230	0.00054	0.00900	0.00585	104.94000	0.00207	0.00018	105.03927
CNG	Methane	151	1.19864	0.50464	0.76738	0.00054	0.00906	0.00589	105.63960	0.00208	0.00018	105.73953
CNG	Methane	152	1.20658	0.50798	0.77246	0.00055	0.00912	0.00593	106.33920	0.00210	0.00018	106.43979
CNG	Methane	153	1.21451	0.51133	0.77755	0.00055	0.00918	0.00597	107.03880	0.00211	0.00018	107.14006
CNG	Methane	154	1.22245	0.51467	0.78263	0.00055	0.00924	0.00601	107.73840	0.00213	0.00018	107.84032
CNG	Methane	155	1.23039	0.51801	0.78771	0.00056	0.00930	0.00605	108.43800	0.00214	0.00019	108.54058
CNG	Methane	156	1.23833	0.52135	0.79279	0.00056	0.00936	0.00608	109.13760	0.00215	0.00019	109.24084
CNG	Methane	157	1.24627	0.52469	0.79787	0.00057	0.00942	0.00612	109.83720	0.00217	0.00019	109.94110
CNG	Methane	158	1.25420	0.52804	0.80296	0.00057	0.00948	0.00616	110.53680	0.00218	0.00019	110.64136
CNG	Methane	159	1.26214	0.53138	0.80804	0.00057	0.00954	0.00620	111.23640	0.00219	0.00019	111.34163
CNG	Methane	160	1.27008	0.53472	0.81312	0.00058	0.00960	0.00624	111.93600	0.00221	0.00019	112.04189
CNG	Methane	161	1.27802	0.53806	0.81820	0.00058	0.00966	0.00628	112.63560	0.00222	0.00019	112.74215
CNG	Methane	162	1.28596	0.54140	0.82328	0.00058	0.00972	0.00632	113.33520	0.00224	0.00019	113.44241
CNG	Methane	163	1.29389	0.54475	0.82837	0.00059	0.00978	0.00636	114.03480	0.00225	0.00020	114.14267
CNG	Methane	164	1.30183	0.54809	0.83345	0.00059	0.00984	0.00640	114.73440	0.00226	0.00020	114.84294
CNG	Methane	165	1.30977	0.55143	0.83853	0.00059	0.00990	0.00644	115.43400	0.00228	0.00020	115.54320
CNG	Methane	166	1.31771	0.55477	0.84361	0.00060	0.00996	0.00647	116.13360	0.00229	0.00020	116.24346
CNG	Methane	167	1.32565	0.55811	0.84869	0.00060	0.01002	0.00651	116.83320	0.00230	0.00020	116.94372
CNG	Methane	168	1.33358	0.56146	0.85378	0.00060	0.01008	0.00655	117.53280	0.00232	0.00020	117.64398
CNG	Methane	169	1.34152	0.56480	0.85886	0.00061	0.01014	0.00659	118.23240	0.00233	0.00020	118.34424
CNG	Methane	170	1.34946	0.56814	0.86394	0.00061	0.01020	0.00663	118.93200	0.00235	0.00020	119.04451
CNG	Methane	171	1.35740	0.57148	0.86902	0.00062	0.01026	0.00667	119.63160	0.00236	0.00021	119.74477
CNG	Methane	172	1.36534	0.57482	0.87410	0.00062	0.01032	0.00671	120.33120	0.00237	0.00021	120.44503
CNG	Methane	173	1.37327	0.57817	0.87919	0.00062	0.01038	0.00675	121.03080	0.00239	0.00021	121.14529
CNG	Methane	174	1.38121	0.58151	0.88427	0.00063	0.01044	0.00679	121.73040	0.00240	0.00021	121.84555
CNG	Methane	175	1.38915	0.58485	0.88935	0.00063	0.01050	0.00683	122.43000	0.00242	0.00021	122.54582
CNG	Methane	176	1.39709	0.58819	0.89443	0.00063	0.01056	0.00686	123.12960	0.00243	0.00021	123.24608
CNG	Methane	177	1.40503	0.59153	0.89951	0.00064	0.01062	0.00690	123.82920	0.00244	0.00021	123.94634
CNG	Methane	178	1.41296	0.59488	0.90460	0.00064	0.01068	0.00694	124.52880	0.00246	0.00021	124.64660
CNG	Methane	179	1.42090	0.59822	0.90968	0.00064	0.01074	0.00698	125.22840	0.00247	0.00021	125.34686
CNG	Methane	180	1.42884	0.60156	0.91476	0.00065	0.01080	0.00702	125.92800	0.00248	0.00022	126.04712
CNG	Methane	181	1.43678	0.60490	0.91984	0.00065	0.01086	0.00706	126.62760	0.00250	0.00022	126.74739
CNG	Methane	182	1.44472	0.60824	0.92492	0.00066	0.01092	0.00710	127.32720	0.00251	0.00022	127.44765
CNG	Methane	183	1.45265	0.61159	0.93001	0.00066	0.01098	0.00714	128.02680	0.00253	0.00022	128.14791
CNG	Methane	184	1.46059	0.61493	0.93509	0.00066	0.01104	0.00718	128.72640	0.00254	0.00022	128.84817
CNG	Methane	185	1.46853	0.61827	0.94017	0.00067	0.01110	0.00722	129.42600	0.00255	0.00022	129.54843

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
CNG	Methane	186	1.47647	0.62161	0.94525	0.00067	0.01116	0.00725	130.12560	0.00257	0.00022	130.24869
CNG	Methane	187	1.48441	0.62495	0.95033	0.00067	0.01122	0.00729	130.82520	0.00258	0.00022	130.94896
CNG	Methane	188	1.49234	0.62830	0.95542	0.00068	0.01128	0.00733	131.52480	0.00259	0.00023	131.64922
CNG	Methane	189	1.50028	0.63164	0.96050	0.00068	0.01134	0.00737	132.22440	0.00261	0.00023	132.34948
CNG	Methane	190	1.50822	0.63498	0.96558	0.00068	0.01140	0.00741	132.92400	0.00262	0.00023	133.04974
CNG	Methane	191	1.51616	0.63832	0.97066	0.00069	0.01146	0.00745	133.62360	0.00264	0.00023	133.75000
CNG	Methane	192	1.52410	0.64166	0.97574	0.00069	0.01152	0.00749	134.32320	0.00265	0.00023	134.45027
CNG	Methane	193	1.53203	0.64501	0.98083	0.00069	0.01158	0.00753	135.02280	0.00266	0.00023	135.15053
CNG	Methane	194	1.53997	0.64835	0.98591	0.00070	0.01164	0.00757	135.72240	0.00268	0.00023	135.85079
CNG	Methane	195	1.54791	0.65169	0.99099	0.00070	0.01170	0.00761	136.42200	0.00269	0.00023	136.55105
CNG	Methane	196	1.55585	0.65503	0.99607	0.00071	0.01176	0.00764	137.12160	0.00270	0.00024	137.25131
CNG	Methane	197	1.56379	0.65837	1.00115	0.00071	0.01182	0.00768	137.82120	0.00272	0.00024	137.95157
CNG	Methane	198	1.57172	0.66172	1.00624	0.00071	0.01188	0.00772	138.52080	0.00273	0.00024	138.65184
CNG	Methane	199	1.57966	0.66506	1.01132	0.00072	0.01194	0.00776	139.22040	0.00275	0.00024	139.35210
CNG	Methane	200	1.58760	0.66840	1.01640	0.00072	0.01200	0.00780	139.92000	0.00276	0.00024	140.05236
LPG	**Propane**	**10**	**0.07938**	**0.03342**	**0.05082**	**0.00004**	**0.00060**	**0.00039**	**8.23200**	**0.00001**	**0.00002**	**8.23771**
LPG	Propane	11	0.08732	0.03676	0.05590	0.00004	0.00066	0.00043	9.05520	0.00001	0.00002	9.06148
LPG	Propane	12	0.09526	0.04010	0.06098	0.00004	0.00072	0.00047	9.87840	0.00001	0.00002	9.88525
LPG	Propane	13	0.10319	0.04345	0.06607	0.00005	0.00078	0.00051	10.70160	0.00001	0.00002	10.70902
LPG	Propane	14	0.11113	0.04679	0.07115	0.00005	0.00084	0.00055	11.52480	0.00001	0.00003	11.53279
LPG	Propane	15	0.11907	0.05013	0.07623	0.00005	0.00090	0.00059	12.34800	0.00001	0.00003	12.35656
LPG	Propane	16	0.12701	0.05347	0.08131	0.00006	0.00096	0.00062	13.17120	0.00001	0.00003	13.18033
LPG	Propane	17	0.13495	0.05681	0.08639	0.00006	0.00102	0.00066	13.99440	0.00001	0.00003	14.00410
LPG	Propane	18	0.14288	0.06016	0.09148	0.00006	0.00108	0.00070	14.81760	0.00001	0.00003	14.82787
LPG	Propane	19	0.15082	0.06350	0.09656	0.00007	0.00114	0.00074	15.64080	0.00001	0.00003	15.65164
LPG	Propane	20	0.15876	0.06684	0.10164	0.00007	0.00120	0.00078	16.46400	0.00001	0.00004	16.47541
LPG	Propane	21	0.16670	0.07018	0.10672	0.00008	0.00126	0.00082	17.28720	0.00001	0.00004	17.29918
LPG	Propane	22	0.17464	0.07352	0.11180	0.00008	0.00132	0.00086	18.11040	0.00001	0.00004	18.12295
LPG	Propane	23	0.18257	0.07687	0.11689	0.00008	0.00138	0.00090	18.93360	0.00001	0.00004	18.94672
LPG	Propane	24	0.19051	0.08021	0.12197	0.00009	0.00144	0.00094	19.75680	0.00001	0.00004	19.77049
LPG	Propane	25	0.19845	0.08355	0.12705	0.00009	0.00150	0.00098	20.58000	0.00002	0.00005	20.59427
LPG	Propane	26	0.20639	0.08689	0.13213	0.00009	0.00156	0.00101	21.40320	0.00002	0.00005	21.41804
LPG	Propane	27	0.21433	0.09023	0.13721	0.00010	0.00162	0.00105	22.22640	0.00002	0.00005	22.24181
LPG	Propane	28	0.22226	0.09358	0.14230	0.00010	0.00168	0.00109	23.04960	0.00002	0.00005	23.06558
LPG	Propane	29	0.23020	0.09692	0.14738	0.00010	0.00174	0.00113	23.87280	0.00002	0.00005	23.88935
LPG	Propane	30	0.23814	0.10026	0.15246	0.00011	0.00180	0.00117	24.69600	0.00002	0.00005	24.71312
LPG	Propane	31	0.24608	0.10360	0.15754	0.00011	0.00186	0.00121	25.51920	0.00002	0.00006	25.53689
LPG	Propane	32	0.25402	0.10694	0.16262	0.00012	0.00192	0.00125	26.34240	0.00002	0.00006	26.36066
LPG	Propane	33	0.26195	0.11029	0.16771	0.00012	0.00198	0.00129	27.16560	0.00002	0.00006	27.18443
LPG	Propane	34	0.26989	0.11363	0.17279	0.00012	0.00204	0.00133	27.98880	0.00002	0.00006	28.00820
LPG	Propane	35	0.27783	0.11697	0.17787	0.00013	0.00210	0.00137	28.81200	0.00002	0.00006	28.83197
LPG	Propane	36	0.28577	0.12031	0.18295	0.00013	0.00216	0.00140	29.63520	0.00002	0.00006	29.65574
LPG	Propane	37	0.29371	0.12365	0.18803	0.00013	0.00222	0.00144	30.45840	0.00002	0.00007	30.47951
LPG	Propane	38	0.30164	0.12700	0.19312	0.00014	0.00228	0.00148	31.28160	0.00002	0.00007	31.30328
LPG	Propane	39	0.30958	0.13034	0.19820	0.00014	0.00234	0.00152	32.10480	0.00002	0.00007	32.12705
LPG	Propane	40	0.31752	0.13368	0.20328	0.00014	0.00240	0.00156	32.92800	0.00002	0.00007	32.95082
LPG	Propane	41	0.32546	0.13702	0.20836	0.00015	0.00246	0.00160	33.75120	0.00002	0.00007	33.77459
LPG	Propane	42	0.33340	0.14036	0.21344	0.00015	0.00252	0.00164	34.57440	0.00003	0.00008	34.59837
LPG	Propane	43	0.34133	0.14371	0.21853	0.00015	0.00258	0.00168	35.39760	0.00003	0.00008	35.42214
LPG	Propane	44	0.34927	0.14705	0.22361	0.00016	0.00264	0.00172	36.22080	0.00003	0.00008	36.24591
LPG	Propane	45	0.35721	0.15039	0.22869	0.00016	0.00270	0.00176	37.04400	0.00003	0.00008	37.06968
LPG	Propane	46	0.36515	0.15373	0.23377	0.00017	0.00276	0.00179	37.86720	0.00003	0.00008	37.89345
LPG	Propane	47	0.37309	0.15707	0.23885	0.00017	0.00282	0.00183	38.69040	0.00003	0.00008	38.71722
LPG	Propane	48	0.38102	0.16042	0.24394	0.00017	0.00288	0.00187	39.51360	0.00003	0.00009	39.54099
LPG	Propane	49	0.38896	0.16376	0.24902	0.00018	0.00294	0.00191	40.33680	0.00003	0.00009	40.36476
LPG	Propane	50	0.39690	0.16710	0.25410	0.00018	0.00300	0.00195	41.16000	0.00003	0.00009	41.18853
LPG	Propane	51	0.40484	0.17044	0.25918	0.00018	0.00306	0.00199	41.98320	0.00003	0.00009	42.01230
LPG	Propane	52	0.41278	0.17378	0.26426	0.00019	0.00312	0.00203	42.80640	0.00003	0.00009	42.83607
LPG	Propane	53	0.42071	0.17713	0.26935	0.00019	0.00318	0.00207	43.62960	0.00003	0.00010	43.65984
LPG	Propane	54	0.42865	0.18047	0.27443	0.00019	0.00324	0.00211	44.45280	0.00003	0.00010	44.48361
LPG	Propane	55	0.43659	0.18381	0.27951	0.00020	0.00330	0.00215	45.27600	0.00003	0.00010	45.30738
LPG	Propane	56	0.44453	0.18715	0.28459	0.00020	0.00336	0.00218	46.09920	0.00003	0.00010	46.13115
LPG	Propane	57	0.45247	0.19049	0.28967	0.00021	0.00342	0.00222	46.92240	0.00003	0.00010	46.95492
LPG	Propane	58	0.46040	0.19384	0.29476	0.00021	0.00348	0.00226	47.74560	0.00003	0.00010	47.77869
LPG	Propane	59	0.46834	0.19718	0.29984	0.00021	0.00354	0.00230	48.56880	0.00004	0.00011	48.60247
LPG	Propane	60	0.47628	0.20052	0.30492	0.00022	0.00360	0.00234	49.39200	0.00004	0.00011	49.42624
LPG	Propane	61	0.48422	0.20386	0.31000	0.00022	0.00366	0.00238	50.21520	0.00004	0.00011	50.25001
LPG	Propane	62	0.49216	0.20720	0.31508	0.00022	0.00372	0.00242	51.03840	0.00004	0.00011	51.07378
LPG	Propane	63	0.50009	0.21055	0.32017	0.00023	0.00378	0.00246	51.86160	0.00004	0.00011	51.89755
LPG	Propane	64	0.50803	0.21389	0.32525	0.00023	0.00384	0.00250	52.68480	0.00004	0.00012	52.72132
LPG	Propane	65	0.51597	0.21723	0.33033	0.00023	0.00390	0.00254	53.50800	0.00004	0.00012	53.54509
LPG	Propane	66	0.52391	0.22057	0.33541	0.00024	0.00396	0.00257	54.33120	0.00004	0.00012	54.36886
LPG	Propane	67	0.53185	0.22391	0.34049	0.00024	0.00402	0.00261	55.15440	0.00004	0.00012	55.19263
LPG	Propane	68	0.53978	0.22726	0.34558	0.00024	0.00408	0.00265	55.97760	0.00004	0.00012	56.01640
LPG	Propane	69	0.54772	0.23060	0.35066	0.00025	0.00414	0.00269	56.80080	0.00004	0.00012	56.84017
LPG	Propane	70	0.55566	0.23394	0.35574	0.00025	0.00420	0.00273	57.62400	0.00004	0.00013	57.66394
LPG	Propane	71	0.56360	0.23728	0.36082	0.00026	0.00426	0.00277	58.44720	0.00004	0.00013	58.48771
LPG	Propane	72	0.57154	0.24062	0.36590	0.00026	0.00432	0.00281	59.27040	0.00004	0.00013	59.31148

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
LPG	Propane	73	0.57947	0.24397	0.37099	0.00026	0.00438	0.00285	60.09360	0.00004	0.00013	60.13525
LPG	Propane	74	0.58741	0.24731	0.37607	0.00027	0.00444	0.00289	60.91680	0.00004	0.00013	60.95902
LPG	Propane	75	0.59535	0.25065	0.38115	0.00027	0.00450	0.00293	61.74000	0.00005	0.00014	61.78280
LPG	Propane	76	0.60329	0.25399	0.38623	0.00027	0.00456	0.00296	62.56320	0.00005	0.00014	62.60657
LPG	Propane	77	0.61123	0.25733	0.39131	0.00028	0.00462	0.00300	63.38640	0.00005	0.00014	63.43034
LPG	Propane	78	0.61916	0.26068	0.39640	0.00028	0.00468	0.00304	64.20960	0.00005	0.00014	64.25411
LPG	Propane	79	0.62710	0.26402	0.40148	0.00028	0.00474	0.00308	65.03280	0.00005	0.00014	65.07788
LPG	Propane	80	0.63504	0.26736	0.40656	0.00029	0.00480	0.00312	65.85600	0.00005	0.00014	65.90165
LPG	Propane	81	0.64298	0.27070	0.41164	0.00029	0.00486	0.00316	66.67920	0.00005	0.00015	66.72542
LPG	Propane	82	0.65092	0.27404	0.41672	0.00030	0.00492	0.00320	67.50240	0.00005	0.00015	67.54919
LPG	Propane	83	0.65885	0.27739	0.42181	0.00030	0.00498	0.00324	68.32560	0.00005	0.00015	68.37296
LPG	Propane	84	0.66679	0.28073	0.42689	0.00030	0.00504	0.00328	69.14880	0.00005	0.00015	69.19673
LPG	Propane	85	0.67473	0.28407	0.43197	0.00031	0.00510	0.00332	69.97200	0.00005	0.00015	70.02050
LPG	Propane	86	0.68267	0.28741	0.43705	0.00031	0.00516	0.00335	70.79520	0.00005	0.00015	70.84427
LPG	Propane	87	0.69061	0.29075	0.44213	0.00031	0.00522	0.00339	71.61840	0.00005	0.00016	71.66804
LPG	Propane	88	0.69854	0.29410	0.44722	0.00032	0.00528	0.00343	72.44160	0.00005	0.00016	72.49181
LPG	Propane	89	0.70648	0.29744	0.45230	0.00032	0.00534	0.00347	73.26480	0.00005	0.00016	73.31558
LPG	Propane	90	0.71442	0.30078	0.45738	0.00032	0.00540	0.00351	74.08800	0.00005	0.00016	74.13935
LPG	Propane	91	0.72236	0.30412	0.46246	0.00033	0.00546	0.00355	74.91120	0.00005	0.00016	74.96312
LPG	Propane	92	0.73030	0.30746	0.46754	0.00033	0.00552	0.00359	75.73440	0.00006	0.00017	75.78690
LPG	Propane	93	0.73823	0.31081	0.47263	0.00033	0.00558	0.00363	76.55760	0.00006	0.00017	76.61067
LPG	Propane	94	0.74617	0.31415	0.47771	0.00034	0.00564	0.00367	77.38080	0.00006	0.00017	77.43444
LPG	Propane	95	0.75411	0.31749	0.48279	0.00034	0.00570	0.00371	78.20400	0.00006	0.00017	78.25821
LPG	Propane	96	0.76205	0.32083	0.48787	0.00035	0.00576	0.00374	79.02720	0.00006	0.00017	79.08198
LPG	Propane	97	0.76999	0.32417	0.49295	0.00035	0.00582	0.00378	79.85040	0.00006	0.00017	79.90575
LPG	Propane	98	0.77792	0.32752	0.49804	0.00035	0.00588	0.00382	80.67360	0.00006	0.00018	80.72952
LPG	Propane	99	0.78586	0.33086	0.50312	0.00036	0.00594	0.00386	81.49680	0.00006	0.00018	81.55329
LPG	Propane	100	0.79380	0.33420	0.50820	0.00036	0.00600	0.00390	82.32000	0.00006	0.00018	82.37706
LPG	Propane	101	0.80174	0.33754	0.51328	0.00036	0.00606	0.00394	83.14320	0.00006	0.00018	83.20083
LPG	Propane	102	0.80968	0.34088	0.51836	0.00037	0.00612	0.00398	83.96640	0.00006	0.00018	84.02460
LPG	Propane	103	0.81761	0.34423	0.52345	0.00037	0.00618	0.00402	84.78960	0.00006	0.00019	84.84837
LPG	Propane	104	0.82555	0.34757	0.52853	0.00037	0.00624	0.00406	85.61280	0.00006	0.00019	85.67214
LPG	Propane	105	0.83349	0.35091	0.53361	0.00038	0.00630	0.00410	86.43600	0.00006	0.00019	86.49591
LPG	Propane	106	0.84143	0.35425	0.53869	0.00038	0.00636	0.00413	87.25920	0.00006	0.00019	87.31968
LPG	Propane	107	0.84937	0.35759	0.54377	0.00039	0.00642	0.00417	88.08240	0.00006	0.00019	88.14345
LPG	Propane	108	0.85730	0.36094	0.54886	0.00039	0.00648	0.00421	88.90560	0.00006	0.00019	88.96722
LPG	Propane	109	0.86524	0.36428	0.55394	0.00039	0.00654	0.00425	89.72880	0.00007	0.00020	89.79100
LPG	Propane	110	0.87318	0.36762	0.55902	0.00040	0.00660	0.00429	90.55200	0.00007	0.00020	90.61477
LPG	Propane	111	0.88112	0.37096	0.56410	0.00040	0.00666	0.00433	91.37520	0.00007	0.00020	91.43854
LPG	Propane	112	0.88906	0.37430	0.56918	0.00040	0.00672	0.00437	92.19840	0.00007	0.00020	92.26231
LPG	Propane	113	0.89699	0.37765	0.57427	0.00041	0.00678	0.00441	93.02160	0.00007	0.00020	93.08608
LPG	Propane	114	0.90493	0.38099	0.57935	0.00041	0.00684	0.00445	93.84480	0.00007	0.00021	93.90985
LPG	Propane	115	0.91287	0.38433	0.58443	0.00041	0.00690	0.00449	94.66800	0.00007	0.00021	94.73362
LPG	Propane	116	0.92081	0.38767	0.58951	0.00042	0.00696	0.00452	95.49120	0.00007	0.00021	95.55739
LPG	Propane	117	0.92875	0.39101	0.59459	0.00042	0.00702	0.00456	96.31440	0.00007	0.00021	96.38116
LPG	Propane	118	0.93668	0.39436	0.59968	0.00042	0.00708	0.00460	97.13760	0.00007	0.00021	97.20493
LPG	Propane	119	0.94462	0.39770	0.60476	0.00043	0.00714	0.00464	97.96080	0.00007	0.00021	98.02870
LPG	Propane	120	0.95256	0.40104	0.60984	0.00043	0.00720	0.00468	98.78400	0.00007	0.00022	98.85247
LPG	Propane	121	0.96050	0.40438	0.61492	0.00044	0.00726	0.00472	99.60720	0.00007	0.00022	99.67624
LPG	Propane	122	0.96844	0.40772	0.62000	0.00044	0.00732	0.00476	100.43040	0.00007	0.00022	100.50001
LPG	Propane	123	0.97637	0.41107	0.62509	0.00044	0.00738	0.00480	101.25360	0.00007	0.00022	101.32378
LPG	Propane	124	0.98431	0.41441	0.63017	0.00045	0.00744	0.00484	102.07680	0.00007	0.00022	102.14755
LPG	Propane	125	0.99225	0.41775	0.63525	0.00045	0.00750	0.00488	102.90000	0.00008	0.00023	102.97133
LPG	Propane	126	1.00019	0.42109	0.64033	0.00045	0.00756	0.00491	103.72320	0.00008	0.00023	103.79510
LPG	Propane	127	1.00813	0.42443	0.64541	0.00046	0.00762	0.00495	104.54640	0.00008	0.00023	104.61887
LPG	Propane	128	1.01606	0.42778	0.65050	0.00046	0.00768	0.00499	105.36960	0.00008	0.00023	105.44264
LPG	Propane	129	1.02400	0.43112	0.65558	0.00046	0.00774	0.00503	106.19280	0.00008	0.00023	106.26641
LPG	Propane	130	1.03194	0.43446	0.66066	0.00047	0.00780	0.00507	107.01600	0.00008	0.00023	107.09018
LPG	Propane	131	1.03988	0.43780	0.66574	0.00047	0.00786	0.00511	107.83920	0.00008	0.00024	107.91395
LPG	Propane	132	1.04782	0.44114	0.67082	0.00048	0.00792	0.00515	108.66240	0.00008	0.00024	108.73772
LPG	Propane	133	1.05575	0.44449	0.67591	0.00048	0.00798	0.00519	109.48560	0.00008	0.00024	109.56149
LPG	Propane	134	1.06369	0.44783	0.68099	0.00048	0.00804	0.00523	110.30880	0.00008	0.00024	110.38526
LPG	Propane	135	1.07163	0.45117	0.68607	0.00049	0.00810	0.00527	111.13200	0.00008	0.00024	111.20903
LPG	Propane	136	1.07957	0.45451	0.69115	0.00049	0.00816	0.00530	111.95520	0.00008	0.00024	112.03280
LPG	Propane	137	1.08751	0.45785	0.69623	0.00049	0.00822	0.00534	112.77840	0.00008	0.00025	112.85657
LPG	Propane	138	1.09544	0.46120	0.70132	0.00050	0.00828	0.00538	113.60160	0.00008	0.00025	113.68034
LPG	Propane	139	1.10338	0.46454	0.70640	0.00050	0.00834	0.00542	114.42480	0.00008	0.00025	114.50411
LPG	Propane	140	1.11132	0.46788	0.71148	0.00050	0.00840	0.00546	115.24800	0.00008	0.00025	115.32788
LPG	Propane	141	1.11926	0.47122	0.71656	0.00051	0.00846	0.00550	116.07120	0.00008	0.00025	116.15165
LPG	Propane	142	1.12720	0.47456	0.72164	0.00051	0.00852	0.00554	116.89440	0.00009	0.00026	116.97543
LPG	Propane	143	1.13513	0.47791	0.72673	0.00051	0.00858	0.00558	117.71760	0.00009	0.00026	117.79920
LPG	Propane	144	1.14307	0.48125	0.73181	0.00052	0.00864	0.00562	118.54080	0.00009	0.00026	118.62297
LPG	Propane	145	1.15101	0.48459	0.73689	0.00052	0.00870	0.00566	119.36400	0.00009	0.00026	119.44674
LPG	Propane	146	1.15895	0.48793	0.74197	0.00053	0.00876	0.00569	120.18720	0.00009	0.00026	120.27051
LPG	Propane	147	1.16689	0.49127	0.74705	0.00053	0.00882	0.00573	121.01040	0.00009	0.00026	121.09428
LPG	Propane	148	1.17482	0.49462	0.75214	0.00053	0.00888	0.00577	121.83360	0.00009	0.00027	121.91805
LPG	Propane	149	1.18276	0.49796	0.75722	0.00054	0.00894	0.00581	122.65680	0.00009	0.00027	122.74182
LPG	Propane	150	1.19070	0.50130	0.76230	0.00054	0.00900	0.00585	123.48000	0.00009	0.00027	123.56559

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
LPG	Propane	151	1.19864	0.50464	0.76738	0.00054	0.00906	0.00589	124.30320	0.00009	0.00027	124.38936
LPG	Propane	152	1.20658	0.50798	0.77246	0.00055	0.00912	0.00593	125.12640	0.00009	0.00027	125.21313
LPG	Propane	153	1.21451	0.51133	0.77755	0.00055	0.00918	0.00597	125.94960	0.00009	0.00028	126.03690
LPG	Propane	154	1.22245	0.51467	0.78263	0.00055	0.00924	0.00601	126.77280	0.00009	0.00028	126.86067
LPG	Propane	155	1.23039	0.51801	0.78771	0.00056	0.00930	0.00605	127.59600	0.00009	0.00028	127.68444
LPG	Propane	156	1.23833	0.52135	0.79279	0.00056	0.00936	0.00608	128.41920	0.00009	0.00028	128.50821
LPG	Propane	157	1.24627	0.52469	0.79787	0.00057	0.00942	0.00612	129.24240	0.00009	0.00028	129.33198
LPG	Propane	158	1.25420	0.52804	0.80296	0.00057	0.00948	0.00616	130.06560	0.00009	0.00028	130.15575
LPG	Propane	159	1.26214	0.53138	0.80804	0.00057	0.00954	0.00620	130.88880	0.00010	0.00029	130.97953
LPG	Propane	160	1.27008	0.53472	0.81312	0.00058	0.00960	0.00624	131.71200	0.00010	0.00029	131.80330
LPG	Propane	161	1.27802	0.53806	0.81820	0.00058	0.00966	0.00628	132.53520	0.00010	0.00029	132.62707
LPG	Propane	162	1.28596	0.54140	0.82328	0.00058	0.00972	0.00632	133.35840	0.00010	0.00029	133.45084
LPG	Propane	163	1.29389	0.54475	0.82837	0.00059	0.00978	0.00636	134.18160	0.00010	0.00029	134.27461
LPG	Propane	164	1.30183	0.54809	0.83345	0.00059	0.00984	0.00640	135.00480	0.00010	0.00030	135.09838
LPG	Propane	165	1.30977	0.55143	0.83853	0.00059	0.00990	0.00644	135.82800	0.00010	0.00030	135.92215
LPG	Propane	166	1.31771	0.55477	0.84361	0.00060	0.00996	0.00647	136.65120	0.00010	0.00030	136.74592
LPG	Propane	167	1.32565	0.55811	0.84869	0.00060	0.01002	0.00651	137.47440	0.00010	0.00030	137.56969
LPG	Propane	168	1.33358	0.56146	0.85378	0.00060	0.01008	0.00655	138.29760	0.00010	0.00030	138.39346
LPG	Propane	169	1.34152	0.56480	0.85886	0.00061	0.01014	0.00659	139.12080	0.00010	0.00030	139.21723
LPG	Propane	170	1.34946	0.56814	0.86394	0.00061	0.01020	0.00663	139.94400	0.00010	0.00031	140.04100
LPG	Propane	171	1.35740	0.57148	0.86902	0.00062	0.01026	0.00667	140.76720	0.00010	0.00031	140.86477
LPG	Propane	172	1.36534	0.57482	0.87410	0.00062	0.01032	0.00671	141.59040	0.00010	0.00031	141.68854
LPG	Propane	173	1.37327	0.57817	0.87919	0.00062	0.01038	0.00675	142.41360	0.00010	0.00031	142.51231
LPG	Propane	174	1.38121	0.58151	0.88427	0.00063	0.01044	0.00679	143.23680	0.00010	0.00031	143.33608
LPG	Propane	175	1.38915	0.58485	0.88935	0.00063	0.01050	0.00683	144.06000	0.00011	0.00032	144.15986
LPG	Propane	176	1.39709	0.58819	0.89443	0.00063	0.01056	0.00686	144.88320	0.00011	0.00032	144.98363
LPG	Propane	177	1.40503	0.59153	0.89951	0.00064	0.01062	0.00690	145.70640	0.00011	0.00032	145.80740
LPG	Propane	178	1.41296	0.59488	0.90460	0.00064	0.01068	0.00694	146.52960	0.00011	0.00032	146.63117
LPG	Propane	179	1.42090	0.59822	0.90968	0.00064	0.01074	0.00698	147.35280	0.00011	0.00032	147.45494
LPG	Propane	180	1.42884	0.60156	0.91476	0.00065	0.01080	0.00702	148.17600	0.00011	0.00032	148.27871
LPG	Propane	181	1.43678	0.60490	0.91984	0.00065	0.01086	0.00706	148.99920	0.00011	0.00033	149.10248
LPG	Propane	182	1.44472	0.60824	0.92492	0.00066	0.01092	0.00710	149.82240	0.00011	0.00033	149.92625
LPG	Propane	183	1.45265	0.61159	0.93001	0.00066	0.01098	0.00714	150.64560	0.00011	0.00033	150.75002
LPG	Propane	184	1.46059	0.61493	0.93509	0.00066	0.01104	0.00718	151.46880	0.00011	0.00033	151.57379
LPG	Propane	185	1.46853	0.61827	0.94017	0.00067	0.01110	0.00722	152.29200	0.00011	0.00033	152.39756
LPG	Propane	186	1.47647	0.62161	0.94525	0.00067	0.01116	0.00725	153.11520	0.00011	0.00033	153.22133
LPG	Propane	187	1.48441	0.62495	0.95033	0.00067	0.01122	0.00729	153.93840	0.00011	0.00034	154.04510
LPG	Propane	188	1.49234	0.62830	0.95542	0.00068	0.01128	0.00733	154.76160	0.00011	0.00034	154.86887
LPG	Propane	189	1.50028	0.63164	0.96050	0.00068	0.01134	0.00737	155.58480	0.00011	0.00034	155.69264
LPG	Propane	190	1.50822	0.63498	0.96558	0.00068	0.01140	0.00741	156.40800	0.00011	0.00034	156.51641
LPG	Propane	191	1.51616	0.63832	0.97066	0.00069	0.01146	0.00745	157.23120	0.00011	0.00034	157.34018
LPG	Propane	192	1.52410	0.64166	0.97574	0.00069	0.01152	0.00749	158.05440	0.00012	0.00035	158.16396
LPG	Propane	193	1.53203	0.64501	0.98083	0.00069	0.01158	0.00753	158.87760	0.00012	0.00035	158.98773
LPG	Propane	194	1.53997	0.64835	0.98591	0.00070	0.01164	0.00757	159.70080	0.00012	0.00035	159.81150
LPG	Propane	195	1.54791	0.65169	0.99099	0.00070	0.01170	0.00761	160.52400	0.00012	0.00035	160.63527
LPG	Propane	196	1.55585	0.65503	0.99607	0.00071	0.01176	0.00764	161.34720	0.00012	0.00035	161.45904
LPG	Propane	197	1.56379	0.65837	1.00115	0.00071	0.01182	0.00768	162.17040	0.00012	0.00035	162.28281
LPG	Propane	198	1.57172	0.66172	1.00624	0.00071	0.01188	0.00772	162.99360	0.00012	0.00036	163.10658
LPG	Propane	199	1.57966	0.66506	1.01132	0.00072	0.01194	0.00776	163.81680	0.00012	0.00036	163.93035
LPG	Propane	200	1.58760	0.66840	1.01640	0.00072	0.01200	0.00780	164.64000	0.00012	0.00036	164.75412
Gasoline	**Sport**	**10**	**0.05670**	**1.88100**	**0.04890**	**0.00252**	**0.00300**	**0.00195**	**4.71900**	**0.00027**	**0.00012**	**4.76088**
Gasoline	Sport	11	0.06237	2.06910	0.05379	0.00277	0.00330	0.00215	5.19090	0.00029	0.00013	5.23696
Gasoline	Sport	12	0.06804	2.25720	0.05868	0.00302	0.00360	0.00234	5.66280	0.00032	0.00014	5.71305
Gasoline	Sport	13	0.07371	2.44530	0.06357	0.00328	0.00390	0.00254	6.13470	0.00035	0.00015	6.18914
Gasoline	Sport	14	0.07938	2.63340	0.06846	0.00353	0.00420	0.00273	6.60660	0.00037	0.00016	6.66523
Gasoline	Sport	15	0.08505	2.82150	0.07335	0.00378	0.00450	0.00293	7.07850	0.00040	0.00018	7.14132
Gasoline	Sport	16	0.09072	3.00960	0.07824	0.00403	0.00480	0.00312	7.55040	0.00043	0.00019	7.61740
Gasoline	Sport	17	0.09639	3.19770	0.08313	0.00428	0.00510	0.00332	8.02230	0.00045	0.00020	8.09349
Gasoline	Sport	18	0.10206	3.38580	0.08802	0.00454	0.00540	0.00351	8.49420	0.00048	0.00021	8.56958
Gasoline	Sport	19	0.10773	3.57390	0.09291	0.00479	0.00570	0.00371	8.96610	0.00051	0.00022	9.04567
Gasoline	Sport	20	0.11340	3.76200	0.09780	0.00504	0.00600	0.00390	9.43800	0.00053	0.00023	9.52175
Gasoline	Sport	21	0.11907	3.95010	0.10269	0.00529	0.00630	0.00410	9.90990	0.00056	0.00025	9.99784
Gasoline	Sport	22	0.12474	4.13820	0.10758	0.00554	0.00660	0.00429	10.38180	0.00059	0.00026	10.47393
Gasoline	Sport	23	0.13041	4.32630	0.11247	0.00580	0.00690	0.00449	10.85370	0.00061	0.00027	10.95002
Gasoline	Sport	24	0.13608	4.51440	0.11736	0.00605	0.00720	0.00468	11.32560	0.00064	0.00028	11.42610
Gasoline	Sport	25	0.14175	4.70250	0.12225	0.00630	0.00750	0.00488	11.79750	0.00067	0.00029	11.90219
Gasoline	Sport	26	0.14742	4.89060	0.12714	0.00655	0.00780	0.00507	12.26940	0.00069	0.00030	12.37828
Gasoline	Sport	27	0.15309	5.07870	0.13203	0.00680	0.00810	0.00527	12.74130	0.00072	0.00032	12.85437
Gasoline	Sport	28	0.15876	5.26680	0.13692	0.00706	0.00840	0.00546	13.21320	0.00075	0.00033	13.33046
Gasoline	Sport	29	0.16443	5.45490	0.14181	0.00731	0.00870	0.00566	13.68510	0.00077	0.00034	13.80654
Gasoline	Sport	30	0.17010	5.64300	0.14670	0.00756	0.00900	0.00585	14.15700	0.00080	0.00035	14.28263
Gasoline	Sport	31	0.17577	5.83110	0.15159	0.00781	0.00930	0.00605	14.62890	0.00083	0.00036	14.75872
Gasoline	Sport	32	0.18144	6.01920	0.15648	0.00806	0.00960	0.00624	15.10080	0.00085	0.00037	15.23481
Gasoline	Sport	33	0.18711	6.20730	0.16137	0.00832	0.00990	0.00644	15.57270	0.00088	0.00039	15.71089
Gasoline	Sport	34	0.19278	6.39540	0.16626	0.00857	0.01020	0.00663	16.04460	0.00091	0.00040	16.18698
Gasoline	Sport	35	0.19845	6.58350	0.17115	0.00882	0.01050	0.00683	16.51650	0.00093	0.00041	16.66307
Gasoline	Sport	36	0.20412	6.77160	0.17604	0.00907	0.01080	0.00702	16.98840	0.00096	0.00042	17.13916
Gasoline	Sport	37	0.20979	6.95970	0.18093	0.00932	0.01110	0.00722	17.46030	0.00099	0.00043	17.61524

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
Gasoline	Sport	38	0.21546	7.14780	0.18582	0.00958	0.01140	0.00741	17.93220	0.00101	0.00044	18.09133
Gasoline	Sport	39	0.22113	7.33590	0.19071	0.00983	0.01170	0.00761	18.40410	0.00104	0.00046	18.56742
Gasoline	Sport	40	0.22680	7.52400	0.19560	0.01008	0.01200	0.00780	18.87600	0.00107	0.00047	19.04351
Gasoline	Sport	41	0.23247	7.71210	0.20049	0.01033	0.01230	0.00800	19.34790	0.00109	0.00048	19.51960
Gasoline	Sport	42	0.23814	7.90020	0.20538	0.01058	0.01260	0.00819	19.81980	0.00112	0.00049	19.99568
Gasoline	Sport	43	0.24381	8.08830	0.21027	0.01084	0.01290	0.00839	20.29170	0.00115	0.00050	20.47177
Gasoline	Sport	44	0.24948	8.27640	0.21516	0.01109	0.01320	0.00858	20.76360	0.00117	0.00051	20.94786
Gasoline	Sport	45	0.25515	8.46450	0.22005	0.01134	0.01350	0.00878	21.23550	0.00120	0.00053	21.42395
Gasoline	Sport	46	0.26082	8.65260	0.22494	0.01159	0.01380	0.00897	21.70740	0.00123	0.00054	21.90003
Gasoline	Sport	47	0.26649	8.84070	0.22983	0.01184	0.01410	0.00917	22.17930	0.00125	0.00055	22.37612
Gasoline	Sport	48	0.27216	9.02880	0.23472	0.01210	0.01440	0.00936	22.65120	0.00128	0.00056	22.85221
Gasoline	Sport	49	0.27783	9.21690	0.23961	0.01235	0.01470	0.00956	23.12310	0.00131	0.00057	23.32830
Gasoline	Sport	50	0.28350	9.40500	0.24450	0.01260	0.01500	0.00975	23.59500	0.00134	0.00059	23.80439
Gasoline	Sport	51	0.28917	9.59310	0.24939	0.01285	0.01530	0.00995	24.06690	0.00136	0.00060	24.28047
Gasoline	Sport	52	0.29484	9.78120	0.25428	0.01310	0.01560	0.01014	24.53880	0.00139	0.00061	24.75656
Gasoline	Sport	53	0.30051	9.96930	0.25917	0.01336	0.01590	0.01034	25.01070	0.00142	0.00062	25.23265
Gasoline	Sport	54	0.30618	10.15740	0.26406	0.01361	0.01620	0.01053	25.48260	0.00144	0.00063	25.70874
Gasoline	Sport	55	0.31185	10.34550	0.26895	0.01386	0.01650	0.01073	25.95450	0.00147	0.00064	26.18482
Gasoline	Sport	56	0.31752	10.53360	0.27384	0.01411	0.01680	0.01092	26.42640	0.00150	0.00066	26.66091
Gasoline	Sport	57	0.32319	10.72170	0.27873	0.01436	0.01710	0.01112	26.89830	0.00152	0.00067	27.13700
Gasoline	Sport	58	0.32886	10.90980	0.28362	0.01462	0.01740	0.01131	27.37020	0.00155	0.00068	27.61309
Gasoline	Sport	59	0.33453	11.09790	0.28851	0.01487	0.01770	0.01151	27.84210	0.00158	0.00069	28.08917
Gasoline	Sport	60	0.34020	11.28600	0.29340	0.01512	0.01800	0.01170	28.31400	0.00160	0.00070	28.56526
Gasoline	Sport	61	0.34587	11.47410	0.29829	0.01537	0.01830	0.01190	28.78590	0.00163	0.00071	29.04135
Gasoline	Sport	62	0.35154	11.66220	0.30318	0.01562	0.01860	0.01209	29.25780	0.00166	0.00073	29.51744
Gasoline	Sport	63	0.35721	11.85030	0.30807	0.01588	0.01890	0.01229	29.72970	0.00168	0.00074	29.99353
Gasoline	Sport	64	0.36288	12.03840	0.31296	0.01613	0.01920	0.01248	30.20160	0.00171	0.00075	30.46961
Gasoline	Sport	65	0.36855	12.22650	0.31785	0.01638	0.01950	0.01268	30.67350	0.00174	0.00076	30.94570
Gasoline	Sport	66	0.37422	12.41460	0.32274	0.01663	0.01980	0.01287	31.14540	0.00176	0.00077	31.42179
Gasoline	Sport	67	0.37989	12.60270	0.32763	0.01688	0.02010	0.01307	31.61730	0.00179	0.00078	31.89788
Gasoline	Sport	68	0.38556	12.79080	0.33252	0.01714	0.02040	0.01326	32.08920	0.00182	0.00080	32.37396
Gasoline	Sport	69	0.39123	12.97890	0.33741	0.01739	0.02070	0.01346	32.56110	0.00184	0.00081	32.85005
Gasoline	Sport	70	0.39690	13.16700	0.34230	0.01764	0.02100	0.01365	33.03300	0.00187	0.00082	33.32614
Gasoline	Sport	71	0.40257	13.35510	0.34719	0.01789	0.02130	0.01385	33.50490	0.00190	0.00083	33.80223
Gasoline	Sport	72	0.40824	13.54320	0.35208	0.01814	0.02160	0.01404	33.97680	0.00192	0.00084	34.27831
Gasoline	Sport	73	0.41391	13.73130	0.35697	0.01840	0.02190	0.01424	34.44870	0.00195	0.00085	34.75440
Gasoline	Sport	74	0.41958	13.91940	0.36186	0.01865	0.02220	0.01443	34.92060	0.00198	0.00087	35.23049
Gasoline	Sport	75	0.42525	14.10750	0.36675	0.01890	0.02250	0.01463	35.39250	0.00200	0.00088	35.70658
Gasoline	Sport	76	0.43092	14.29560	0.37164	0.01915	0.02280	0.01482	35.86440	0.00203	0.00089	36.18267
Gasoline	Sport	77	0.43659	14.48370	0.37653	0.01940	0.02310	0.01502	36.33630	0.00206	0.00090	36.65875
Gasoline	Sport	78	0.44226	14.67180	0.38142	0.01966	0.02340	0.01521	36.80820	0.00208	0.00091	37.13484
Gasoline	Sport	79	0.44793	14.85990	0.38631	0.01991	0.02370	0.01541	37.28010	0.00211	0.00092	37.61093
Gasoline	Sport	80	0.45360	15.04800	0.39120	0.02016	0.02400	0.01560	37.75200	0.00214	0.00094	38.08702
Gasoline	Sport	81	0.45927	15.23610	0.39609	0.02041	0.02430	0.01580	38.22390	0.00216	0.00095	38.56310
Gasoline	Sport	82	0.46494	15.42420	0.40098	0.02066	0.02460	0.01599	38.69580	0.00219	0.00096	39.03919
Gasoline	Sport	83	0.47061	15.61230	0.40587	0.02092	0.02490	0.01619	39.16770	0.00222	0.00097	39.51528
Gasoline	Sport	84	0.47628	15.80040	0.41076	0.02117	0.02520	0.01638	39.63960	0.00224	0.00098	39.99137
Gasoline	Sport	85	0.48195	15.98850	0.41565	0.02142	0.02550	0.01658	40.11150	0.00227	0.00099	40.46745
Gasoline	Sport	86	0.48762	16.17660	0.42054	0.02167	0.02580	0.01677	40.58340	0.00230	0.00101	40.94354
Gasoline	Sport	87	0.49329	16.36470	0.42543	0.02192	0.02610	0.01697	41.05530	0.00232	0.00102	41.41963
Gasoline	Sport	88	0.49896	16.55280	0.43032	0.02218	0.02640	0.01716	41.52720	0.00235	0.00103	41.89572
Gasoline	Sport	89	0.50463	16.74090	0.43521	0.02243	0.02670	0.01736	41.99910	0.00238	0.00104	42.37181
Gasoline	Sport	90	0.51030	16.92900	0.44010	0.02268	0.02700	0.01755	42.47100	0.00240	0.00105	42.84789
Gasoline	Sport	91	0.51597	17.11710	0.44499	0.02293	0.02730	0.01775	42.94290	0.00243	0.00106	43.32398
Gasoline	Sport	92	0.52164	17.30520	0.44988	0.02318	0.02760	0.01794	43.41480	0.00246	0.00108	43.80007
Gasoline	Sport	93	0.52731	17.49330	0.45477	0.02344	0.02790	0.01814	43.88670	0.00248	0.00109	44.27616
Gasoline	Sport	94	0.53298	17.68140	0.45966	0.02369	0.02820	0.01833	44.35860	0.00251	0.00110	44.75224
Gasoline	Sport	95	0.53865	17.86950	0.46455	0.02394	0.02850	0.01853	44.83050	0.00254	0.00111	45.22833
Gasoline	Sport	96	0.54432	18.05760	0.46944	0.02419	0.02880	0.01872	45.30240	0.00256	0.00112	45.70442
Gasoline	Sport	97	0.54999	18.24570	0.47433	0.02444	0.02910	0.01892	45.77430	0.00259	0.00113	46.18051
Gasoline	Sport	98	0.55566	18.43380	0.47922	0.02470	0.02940	0.01911	46.24620	0.00262	0.00115	46.65659
Gasoline	Sport	99	0.56133	18.62190	0.48411	0.02495	0.02970	0.01931	46.71810	0.00264	0.00116	47.13268
Gasoline	Sport	100	0.56700	18.81000	0.48900	0.02520	0.03000	0.01950	47.19000	0.00267	0.00117	47.60877
Gasoline	Sport	101	0.57267	18.99810	0.49389	0.02545	0.03030	0.01970	47.66190	0.00270	0.00118	48.08486
Gasoline	Sport	102	0.57834	19.18620	0.49878	0.02570	0.03060	0.01989	48.13380	0.00272	0.00119	48.56095
Gasoline	Sport	103	0.58401	19.37430	0.50367	0.02596	0.03090	0.02009	48.60570	0.00275	0.00121	49.03703
Gasoline	Sport	104	0.58968	19.56240	0.50856	0.02621	0.03120	0.02028	49.07760	0.00278	0.00122	49.51312
Gasoline	Sport	105	0.59535	19.75050	0.51345	0.02646	0.03150	0.02048	49.54950	0.00280	0.00123	49.98921
Gasoline	Sport	106	0.60102	19.93860	0.51834	0.02671	0.03180	0.02067	50.02140	0.00283	0.00124	50.46530
Gasoline	Sport	107	0.60669	20.12670	0.52323	0.02696	0.03210	0.02087	50.49330	0.00286	0.00125	50.94138
Gasoline	Sport	108	0.61236	20.31480	0.52812	0.02722	0.03240	0.02106	50.96520	0.00288	0.00126	51.41747
Gasoline	Sport	109	0.61803	20.50290	0.53301	0.02747	0.03270	0.02126	51.43710	0.00291	0.00128	51.89356
Gasoline	Sport	110	0.62370	20.69100	0.53790	0.02772	0.03300	0.02145	51.90900	0.00294	0.00129	52.36965
Gasoline	Sport	111	0.62937	20.87910	0.54279	0.02797	0.03330	0.02165	52.38090	0.00296	0.00130	52.84573
Gasoline	Sport	112	0.63504	21.06720	0.54768	0.02822	0.03360	0.02184	52.85280	0.00299	0.00131	53.32182
Gasoline	Sport	113	0.64071	21.25530	0.55257	0.02848	0.03390	0.02204	53.32470	0.00302	0.00132	53.79791
Gasoline	Sport	114	0.64638	21.44340	0.55746	0.02873	0.03420	0.02223	53.79660	0.00304	0.00133	54.27400
Gasoline	Sport	115	0.65205	21.63150	0.56235	0.02898	0.03450	0.02243	54.26850	0.00307	0.00135	54.75009

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
Gasoline	Sport	116	0.65772	21.81960	0.56724	0.02923	0.03480	0.02262	54.74040	0.00310	0.00136	55.22617
Gasoline	Sport	117	0.66339	22.00770	0.57213	0.02948	0.03510	0.02282	55.21230	0.00312	0.00137	55.70226
Gasoline	Sport	118	0.66906	22.19580	0.57702	0.02974	0.03540	0.02301	55.68420	0.00315	0.00138	56.17835
Gasoline	Sport	119	0.67473	22.38390	0.58191	0.02999	0.03570	0.02321	56.15610	0.00318	0.00139	56.65444
Gasoline	Sport	120	0.68040	22.57200	0.58680	0.03024	0.03600	0.02340	56.62800	0.00320	0.00140	57.13052
Gasoline	Sport	121	0.68607	22.76010	0.59169	0.03049	0.03630	0.02360	57.09990	0.00323	0.00142	57.60661
Gasoline	Sport	122	0.69174	22.94820	0.59658	0.03074	0.03660	0.02379	57.57180	0.00326	0.00143	58.08270
Gasoline	Sport	123	0.69741	23.13630	0.60147	0.03100	0.03690	0.02399	58.04370	0.00328	0.00144	58.55879
Gasoline	Sport	124	0.70308	23.32440	0.60636	0.03125	0.03720	0.02418	58.51560	0.00331	0.00145	59.03487
Gasoline	Sport	125	0.70875	23.51250	0.61125	0.03150	0.03750	0.02438	58.98750	0.00334	0.00146	59.51096
Gasoline	Sport	126	0.71442	23.70060	0.61614	0.03175	0.03780	0.02457	59.45940	0.00336	0.00147	59.98705
Gasoline	Sport	127	0.72009	23.88870	0.62103	0.03200	0.03810	0.02477	59.93130	0.00339	0.00149	60.46314
Gasoline	Sport	128	0.72576	24.07680	0.62592	0.03226	0.03840	0.02496	60.40320	0.00342	0.00150	60.93923
Gasoline	Sport	129	0.73143	24.26490	0.63081	0.03251	0.03870	0.02516	60.87510	0.00344	0.00151	61.41531
Gasoline	Sport	130	0.73710	24.45300	0.63570	0.03276	0.03900	0.02535	61.34700	0.00347	0.00152	61.89140
Gasoline	Sport	131	0.74277	24.64110	0.64059	0.03301	0.03930	0.02555	61.81890	0.00350	0.00153	62.36749
Gasoline	Sport	132	0.74844	24.82920	0.64548	0.03326	0.03960	0.02574	62.29080	0.00352	0.00154	62.84358
Gasoline	Sport	133	0.75411	25.01730	0.65037	0.03352	0.03990	0.02594	62.76270	0.00355	0.00156	63.31966
Gasoline	Sport	134	0.75978	25.20540	0.65526	0.03377	0.04020	0.02613	63.23460	0.00358	0.00157	63.79575
Gasoline	Sport	135	0.76545	25.39350	0.66015	0.03402	0.04050	0.02633	63.70650	0.00360	0.00158	64.27184
Gasoline	Sport	136	0.77112	25.58160	0.66504	0.03427	0.04080	0.02652	64.17840	0.00363	0.00159	64.74793
Gasoline	Sport	137	0.77679	25.76970	0.66993	0.03452	0.04110	0.02672	64.65030	0.00366	0.00160	65.22401
Gasoline	Sport	138	0.78246	25.95780	0.67482	0.03478	0.04140	0.02691	65.12220	0.00368	0.00161	65.70010
Gasoline	Sport	139	0.78813	26.14590	0.67971	0.03503	0.04170	0.02711	65.59410	0.00371	0.00163	66.17619
Gasoline	Sport	140	0.79380	26.33400	0.68460	0.03528	0.04200	0.02730	66.06600	0.00374	0.00164	66.65228
Gasoline	Sport	141	0.79947	26.52210	0.68949	0.03553	0.04230	0.02750	66.53790	0.00376	0.00165	67.12837
Gasoline	Sport	142	0.80514	26.71020	0.69438	0.03578	0.04260	0.02769	67.00980	0.00379	0.00166	67.60445
Gasoline	Sport	143	0.81081	26.89830	0.69927	0.03604	0.04290	0.02789	67.48170	0.00382	0.00167	68.08054
Gasoline	Sport	144	0.81648	27.08640	0.70416	0.03629	0.04320	0.02808	67.95360	0.00384	0.00168	68.55663
Gasoline	Sport	145	0.82215	27.27450	0.70905	0.03654	0.04350	0.02828	68.42550	0.00387	0.00170	69.03272
Gasoline	Sport	146	0.82782	27.46260	0.71394	0.03679	0.04380	0.02847	68.89740	0.00390	0.00171	69.50880
Gasoline	Sport	147	0.83349	27.65070	0.71883	0.03704	0.04410	0.02867	69.36930	0.00392	0.00172	69.98489
Gasoline	Sport	148	0.83916	27.83880	0.72372	0.03730	0.04440	0.02886	69.84120	0.00395	0.00173	70.46098
Gasoline	Sport	149	0.84483	28.02690	0.72861	0.03755	0.04470	0.02906	70.31310	0.00398	0.00174	70.93707
Gasoline	Sport	150	0.85050	28.21500	0.73350	0.03780	0.04500	0.02925	70.78500	0.00401	0.00176	71.41316
Gasoline	Sport	151	0.85617	28.40310	0.73839	0.03805	0.04530	0.02945	71.25690	0.00403	0.00177	71.88924
Gasoline	Sport	152	0.86184	28.59120	0.74328	0.03830	0.04560	0.02964	71.72880	0.00406	0.00178	72.36533
Gasoline	Sport	153	0.86751	28.77930	0.74817	0.03856	0.04590	0.02984	72.20070	0.00409	0.00179	72.84142
Gasoline	Sport	154	0.87318	28.96740	0.75306	0.03881	0.04620	0.03003	72.67260	0.00411	0.00180	73.31751
Gasoline	Sport	155	0.87885	29.15550	0.75795	0.03906	0.04650	0.03023	73.14450	0.00414	0.00181	73.79359
Gasoline	Sport	156	0.88452	29.34360	0.76284	0.03931	0.04680	0.03042	73.61640	0.00417	0.00183	74.26968
Gasoline	Sport	157	0.89019	29.53170	0.76773	0.03956	0.04710	0.03062	74.08830	0.00419	0.00184	74.74577
Gasoline	Sport	158	0.89586	29.71980	0.77262	0.03982	0.04740	0.03081	74.56020	0.00422	0.00185	75.22186
Gasoline	Sport	159	0.90153	29.90790	0.77751	0.04007	0.04770	0.03101	75.03210	0.00425	0.00186	75.69794
Gasoline	Sport	160	0.90720	30.09600	0.78240	0.04032	0.04800	0.03120	75.50400	0.00427	0.00187	76.17403
Gasoline	Sport	161	0.91287	30.28410	0.78729	0.04057	0.04830	0.03140	75.97590	0.00430	0.00188	76.65012
Gasoline	Sport	162	0.91854	30.47220	0.79218	0.04082	0.04860	0.03159	76.44780	0.00433	0.00190	77.12621
Gasoline	Sport	163	0.92421	30.66030	0.79707	0.04108	0.04890	0.03179	76.91970	0.00435	0.00191	77.60230
Gasoline	Sport	164	0.92988	30.84840	0.80196	0.04133	0.04920	0.03198	77.39160	0.00438	0.00192	78.07838
Gasoline	Sport	165	0.93555	31.03650	0.80685	0.04158	0.04950	0.03218	77.86350	0.00441	0.00193	78.55447
Gasoline	Sport	166	0.94122	31.22460	0.81174	0.04183	0.04980	0.03237	78.33540	0.00443	0.00194	79.03056
Gasoline	Sport	167	0.94689	31.41270	0.81663	0.04208	0.05010	0.03257	78.80730	0.00446	0.00195	79.50665
Gasoline	Sport	168	0.95256	31.60080	0.82152	0.04234	0.05040	0.03276	79.27920	0.00449	0.00197	79.98273
Gasoline	Sport	169	0.95823	31.78890	0.82641	0.04259	0.05070	0.03296	79.75110	0.00451	0.00198	80.45882
Gasoline	Sport	170	0.96390	31.97700	0.83130	0.04284	0.05100	0.03315	80.22300	0.00454	0.00199	80.93491
Gasoline	Sport	171	0.96957	32.16510	0.83619	0.04309	0.05130	0.03335	80.69490	0.00457	0.00200	81.41100
Gasoline	Sport	172	0.97524	32.35320	0.84108	0.04334	0.05160	0.03354	81.16680	0.00459	0.00201	81.88708
Gasoline	Sport	173	0.98091	32.54130	0.84597	0.04360	0.05190	0.03374	81.63870	0.00462	0.00202	82.36317
Gasoline	Sport	174	0.98658	32.72940	0.85086	0.04385	0.05220	0.03393	82.11060	0.00465	0.00204	82.83926
Gasoline	Sport	175	0.99225	32.91750	0.85575	0.04410	0.05250	0.03413	82.58250	0.00467	0.00205	83.31535
Gasoline	Sport	176	0.99792	33.10560	0.86064	0.04435	0.05280	0.03432	83.05440	0.00470	0.00206	83.79144
Gasoline	Sport	177	1.00359	33.29370	0.86553	0.04460	0.05310	0.03452	83.52630	0.00473	0.00207	84.26752
Gasoline	Sport	178	1.00926	33.48180	0.87042	0.04486	0.05340	0.03471	83.99820	0.00475	0.00208	84.74361
Gasoline	Sport	179	1.01493	33.66990	0.87531	0.04511	0.05370	0.03491	84.47010	0.00478	0.00209	85.21970
Gasoline	Sport	180	1.02060	33.85800	0.88020	0.04536	0.05400	0.03510	84.94200	0.00481	0.00211	85.69579
Gasoline	Sport	181	1.02627	34.04610	0.88509	0.04561	0.05430	0.03530	85.41390	0.00483	0.00212	86.17187
Gasoline	Sport	182	1.03194	34.23420	0.88998	0.04586	0.05460	0.03549	85.88580	0.00486	0.00213	86.64796
Gasoline	Sport	183	1.03761	34.42230	0.89487	0.04612	0.05490	0.03569	86.35770	0.00489	0.00214	87.12405
Gasoline	Sport	184	1.04328	34.61040	0.89976	0.04637	0.05520	0.03588	86.82960	0.00491	0.00215	87.60014
Gasoline	Sport	185	1.04895	34.79850	0.90465	0.04662	0.05550	0.03608	87.30150	0.00494	0.00216	88.07622
Gasoline	Sport	186	1.05462	34.98660	0.90954	0.04687	0.05580	0.03627	87.77340	0.00497	0.00218	88.55231
Gasoline	Sport	187	1.06029	35.17470	0.91443	0.04712	0.05610	0.03647	88.24530	0.00499	0.00219	89.02840
Gasoline	Sport	188	1.06596	35.36280	0.91932	0.04738	0.05640	0.03666	88.71720	0.00502	0.00220	89.50449
Gasoline	Sport	189	1.07163	35.55090	0.92421	0.04763	0.05670	0.03686	89.18910	0.00505	0.00221	89.98058
Gasoline	Sport	190	1.07730	35.73900	0.92910	0.04788	0.05700	0.03705	89.66100	0.00507	0.00222	90.45666
Gasoline	Sport	191	1.08297	35.92710	0.93399	0.04813	0.05730	0.03725	90.13290	0.00510	0.00223	90.93275
Gasoline	Sport	192	1.08864	36.11520	0.93888	0.04838	0.05760	0.03744	90.60480	0.00513	0.00225	91.40884
Gasoline	Sport	193	1.09431	36.30330	0.94377	0.04864	0.05790	0.03764	91.07670	0.00515	0.00226	91.88493

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
Gasoline	Sport	194	1.09998	36.49140	0.94866	0.04889	0.05820	0.03783	91.54860	0.00518	0.00227	92.36101
Gasoline	Sport	195	1.10565	36.67950	0.95355	0.04914	0.05850	0.03803	92.02050	0.00521	0.00228	92.83710
Gasoline	Sport	196	1.11132	36.86760	0.95844	0.04939	0.05880	0.03822	92.49240	0.00523	0.00229	93.31319
Gasoline	Sport	197	1.11699	37.05570	0.96333	0.04964	0.05910	0.03842	92.96430	0.00526	0.00230	93.78928
Gasoline	Sport	198	1.12266	37.24380	0.96822	0.04990	0.05940	0.03861	93.43620	0.00529	0.00232	94.26536
Gasoline	Sport	199	1.12833	37.43190	0.97311	0.05015	0.05970	0.03881	93.90810	0.00531	0.00233	94.74145
Gasoline	**Sport**	**200**	**1.13400**	**37.62000**	**0.97800**	**0.05040**	**0.06000**	**0.03900**	**94.38000**	**0.00534**	**0.00234**	**95.21754**
Gasoline	Sport	210	1.19070	39.50100	1.02690	0.05292	0.06300	0.04095	99.09900	0.00561	0.00246	99.97842
Gasoline	Sport	220	1.24740	41.38200	1.07580	0.05544	0.06600	0.04290	103.81800	0.00587	0.00257	104.73929
Gasoline	Sport	230	1.30410	43.26300	1.12470	0.05796	0.06900	0.04485	108.53700	0.00614	0.00269	109.50017
Gasoline	Sport	240	1.36080	45.14400	1.17360	0.06048	0.07200	0.04680	113.25600	0.00641	0.00281	114.26105
Gasoline	Sport	250	1.41750	47.02500	1.22250	0.06300	0.07500	0.04875	117.97500	0.00668	0.00293	119.02193
Gasoline	Sport	260	1.47420	48.90600	1.27140	0.06552	0.07800	0.05070	122.69400	0.00694	0.00304	123.78280
Gasoline	Sport	270	1.53090	50.78700	1.32030	0.06804	0.08100	0.05265	127.41300	0.00721	0.00316	128.54368
Gasoline	Sport	280	1.58760	52.66800	1.36920	0.07056	0.08400	0.05460	132.13200	0.00748	0.00328	133.30456
Gasoline	Sport	290	1.64430	54.54900	1.41810	0.07308	0.08700	0.05655	136.85100	0.00774	0.00339	138.06543
Gasoline	Sport	300	1.70100	56.43000	1.46700	0.07560	0.09000	0.05850	141.57000	0.00801	0.00351	142.82631
Gasoline	Sport	310	1.75770	58.31100	1.51590	0.07812	0.09300	0.06045	146.28900	0.00828	0.00363	147.58719
Gasoline	Sport	320	1.81440	60.19200	1.56480	0.08064	0.09600	0.06240	151.00800	0.00854	0.00374	152.34806
Gasoline	Sport	330	1.87110	62.07300	1.61370	0.08316	0.09900	0.06435	155.72700	0.00881	0.00386	157.10894
Gasoline	Sport	340	1.92780	63.95400	1.66260	0.08568	0.10200	0.06630	160.44600	0.00908	0.00398	161.86982
Gasoline	Sport	350	1.98450	65.83500	1.71150	0.08820	0.10500	0.06825	165.16500	0.00935	0.00410	166.63070
Gasoline	Sport	360	2.04120	67.71600	1.76040	0.09072	0.10800	0.07020	169.88400	0.00961	0.00421	171.39157
Gasoline	Sport	370	2.09790	69.59700	1.80930	0.09324	0.11100	0.07215	174.60300	0.00988	0.00433	176.15245
Gasoline	Sport	380	2.15460	71.47800	1.85820	0.09576	0.11400	0.07410	179.32200	0.01015	0.00445	180.91333
Gasoline	Sport	390	2.21130	73.35900	1.90710	0.09828	0.11700	0.07605	184.04100	0.01041	0.00456	185.67420
Gasoline	Sport	400	2.26800	75.24000	1.95600	0.10080	0.12000	0.07800	188.76000	0.01068	0.00468	190.43508
Gasoline	Sport	410	2.32470	77.12100	2.00490	0.10332	0.12300	0.07995	193.47900	0.01095	0.00480	195.19596
Gasoline	Sport	420	2.38140	79.00200	2.05380	0.10584	0.12600	0.08190	198.19800	0.01121	0.00491	199.95683
Gasoline	Sport	430	2.43810	80.88300	2.10270	0.10836	0.12900	0.08385	202.91700	0.01148	0.00503	204.71771
Gasoline	Sport	440	2.49480	82.76400	2.15160	0.11088	0.13200	0.08580	207.63600	0.01175	0.00515	209.47859
Gasoline	Sport	450	2.55150	84.64500	2.20050	0.11340	0.13500	0.08775	212.35500	0.01202	0.00527	214.23947
Gasoline	Sport	460	2.60820	86.52600	2.24940	0.11592	0.13800	0.08970	217.07400	0.01228	0.00538	219.00034
Gasoline	Sport	470	2.66490	88.40700	2.29830	0.11844	0.14100	0.09165	221.79300	0.01255	0.00550	223.76122
Gasoline	Sport	480	2.72160	90.28800	2.34720	0.12096	0.14400	0.09360	226.51200	0.01282	0.00562	228.52210
Gasoline	Sport	490	2.77830	92.16900	2.39610	0.12348	0.14700	0.09555	231.23100	0.01308	0.00573	233.28297
Gasoline	Sport	500	2.83500	94.05000	2.44500	0.12600	0.15000	0.09750	235.95000	0.01335	0.00585	238.04385
Jet A	**Turbine**	**200**	**0.00065**	**0.00521**	**1.38960**	**0.00245**	**0.01895**	**0.01232**	**257.90400**	**0.00713**	**0.00826**	**260.61491**
Jet A	Turbine	210	0.00068	0.00547	1.45908	0.00258	0.01990	0.01293	270.79920	0.00748	0.00868	273.64565
Jet A	Turbine	220	0.00071	0.00573	1.52856	0.00270	0.02084	0.01355	283.69440	0.00784	0.00909	286.67640
Jet A	Turbine	230	0.00074	0.00599	1.59804	0.00282	0.02179	0.01416	296.58960	0.00820	0.00950	299.70714
Jet A	Turbine	240	0.00078	0.00625	1.66752	0.00295	0.02274	0.01478	309.48480	0.00855	0.00991	312.73789
Jet A	Turbine	250	0.00081	0.00651	1.73700	0.00307	0.02369	0.01540	322.38000	0.00891	0.01033	325.76864
Jet A	Turbine	260	0.00084	0.00677	1.80648	0.00319	0.02463	0.01601	335.27520	0.00927	0.01074	338.79938
Jet A	Turbine	270	0.00087	0.00703	1.87596	0.00331	0.02558	0.01663	348.17040	0.00962	0.01115	351.83013
Jet A	Turbine	280	0.00091	0.00730	1.94544	0.00344	0.02653	0.01724	361.06560	0.00998	0.01157	364.86087
Jet A	Turbine	290	0.00094	0.00756	2.01492	0.00356	0.02748	0.01786	373.96080	0.01034	0.01198	377.89162
Jet A	Turbine	300	0.00097	0.00782	2.08440	0.00368	0.02842	0.01848	386.85600	0.01069	0.01239	390.92236
Jet A	Turbine	310	0.00100	0.00808	2.15388	0.00380	0.02937	0.01909	399.75120	0.01105	0.01281	403.95311
Jet A	Turbine	320	0.00104	0.00834	2.22336	0.00393	0.03032	0.01971	412.64640	0.01140	0.01322	416.98385
Jet A	Turbine	330	0.00107	0.00860	2.29284	0.00405	0.03127	0.02032	425.54160	0.01176	0.01363	430.01460
Jet A	Turbine	340	0.00110	0.00886	2.36232	0.00417	0.03221	0.02094	438.43680	0.01212	0.01405	443.04534
Jet A	Turbine	350	0.00113	0.00912	2.43180	0.00430	0.03316	0.02155	451.33200	0.01247	0.01446	456.07609
Jet A	Turbine	360	0.00117	0.00938	2.50128	0.00442	0.03411	0.02217	464.22720	0.01283	0.01487	469.10683
Jet A	Turbine	370	0.00120	0.00964	2.57076	0.00454	0.03506	0.02279	477.12240	0.01319	0.01528	482.13758
Jet A	Turbine	380	0.00123	0.00990	2.64024	0.00466	0.03600	0.02340	490.01760	0.01354	0.01570	495.16833
Jet A	Turbine	390	0.00126	0.01016	2.70972	0.00479	0.03695	0.02402	502.91280	0.01390	0.01611	508.19907
Jet A	Turbine	400	0.00129	0.01042	2.77920	0.00491	0.03790	0.02463	515.80800	0.01426	0.01652	521.22982
Jet A	Turbine	410	0.00133	0.01068	2.84868	0.00503	0.03885	0.02525	528.70320	0.01461	0.01694	534.26056
Jet A	Turbine	420	0.00136	0.01094	2.91816	0.00515	0.03979	0.02587	541.59840	0.01497	0.01735	547.29131
Jet A	Turbine	430	0.00139	0.01120	2.98764	0.00528	0.04074	0.02648	554.49360	0.01533	0.01776	560.32205
Jet A	Turbine	440	0.00142	0.01146	3.05712	0.00540	0.04169	0.02710	567.38880	0.01568	0.01818	573.35280
Jet A	Turbine	450	0.00146	0.01172	3.12660	0.00552	0.04264	0.02771	580.28400	0.01604	0.01859	586.38354
Jet A	Turbine	460	0.00149	0.01199	3.19608	0.00565	0.04358	0.02833	593.17920	0.01639	0.01900	599.41429
Jet A	Turbine	470	0.00152	0.01225	3.26556	0.00577	0.04453	0.02894	606.07440	0.01675	0.01942	612.44503
Jet A	Turbine	480	0.00155	0.01251	3.33504	0.00589	0.04548	0.02956	618.96960	0.01711	0.01983	625.47578
Jet A	Turbine	490	0.00159	0.01277	3.40452	0.00601	0.04643	0.03018	631.86480	0.01746	0.02024	638.50652
Jet A	Turbine	500	0.00162	0.01303	3.47400	0.00614	0.04737	0.03079	644.76000	0.01782	0.02066	651.53727
Jet A	Turbine	510	0.00165	0.01329	3.54348	0.00626	0.04832	0.03141	657.65520	0.01818	0.02107	664.56802
Jet A	Turbine	520	0.00168	0.01355	3.61296	0.00638	0.04927	0.03202	670.55040	0.01853	0.02148	677.59876
Jet A	Turbine	530	0.00172	0.01381	3.68244	0.00650	0.05022	0.03264	683.44560	0.01889	0.02189	690.62951
Jet A	Turbine	540	0.00175	0.01407	3.75192	0.00663	0.05116	0.03326	696.34080	0.01925	0.02231	703.66025
Jet A	Turbine	550	0.00178	0.01433	3.82140	0.00675	0.05211	0.03387	709.23600	0.01960	0.02272	716.69100
Jet A	Turbine	560	0.00181	0.01459	3.89088	0.00687	0.05306	0.03449	722.13120	0.01996	0.02313	729.72174
Jet A	Turbine	570	0.00185	0.01485	3.96036	0.00700	0.05400	0.03510	735.02640	0.02031	0.02355	742.75249
Jet A	Turbine	580	0.00188	0.01511	4.02984	0.00712	0.05495	0.03572	747.92160	0.02067	0.02396	755.78323
Jet A	Turbine	590	0.00191	0.01537	4.09932	0.00724	0.05590	0.03633	760.81680	0.02103	0.02437	768.81398
Jet A	Turbine	600	0.00194	0.01563	4.16880	0.00736	0.05685	0.03695	773.71200	0.02138	0.02479	781.84472

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
Jet A	Turbine	610	0.00197	0.01589	4.23828	0.00749	0.05779	0.03757	786.60720	0.02174	0.02520	794.87547
Jet A	Turbine	620	0.00201	0.01615	4.30776	0.00761	0.05874	0.03818	799.50240	0.02210	0.02561	807.90621
Jet A	Turbine	630	0.00204	0.01641	4.37724	0.00773	0.05969	0.03880	812.39760	0.02245	0.02603	820.93696
Jet A	Turbine	640	0.00207	0.01668	4.44672	0.00785	0.06064	0.03941	825.29280	0.02281	0.02644	833.96771
Jet A	Turbine	650	0.00210	0.01694	4.51620	0.00798	0.06158	0.04003	838.18800	0.02317	0.02685	846.99845
Jet A	Turbine	660	0.00214	0.01720	4.58568	0.00810	0.06253	0.04065	851.08320	0.02352	0.02726	860.02920
Jet A	Turbine	670	0.00217	0.01746	4.65516	0.00822	0.06348	0.04126	863.97840	0.02388	0.02768	873.05994
Jet A	Turbine	680	0.00220	0.01772	4.72464	0.00835	0.06443	0.04188	876.87360	0.02424	0.02809	886.09069
Jet A	Turbine	690	0.00223	0.01798	4.79412	0.00847	0.06537	0.04249	889.76880	0.02459	0.02850	899.12143
Jet A	Turbine	700	0.00227	0.01824	4.86360	0.00859	0.06632	0.04311	902.66400	0.02495	0.02892	912.15218
Jet A	Turbine	710	0.00230	0.01850	4.93308	0.00871	0.06727	0.04373	915.55920	0.02530	0.02933	925.18292
Jet A	Turbine	720	0.00233	0.01876	5.00256	0.00884	0.06822	0.04434	928.45440	0.02566	0.02974	938.21367
Jet A	Turbine	730	0.00236	0.01902	5.07204	0.00896	0.06916	0.04496	941.34960	0.02602	0.03016	951.24441
Jet A	Turbine	740	0.00240	0.01928	5.14152	0.00908	0.07011	0.04557	954.24480	0.02637	0.03057	964.27516
Jet A	Turbine	750	0.00243	0.01954	5.21100	0.00920	0.07106	0.04619	967.14000	0.02673	0.03098	977.30591
Jet A	Turbine	760	0.00246	0.01980	5.28048	0.00933	0.07201	0.04680	980.03520	0.02709	0.03140	990.33665
Jet A	Turbine	770	0.00249	0.02006	5.34996	0.00945	0.07295	0.04742	992.93040	0.02744	0.03181	1003.36740
Jet A	Turbine	780	0.00252	0.02032	5.41944	0.00957	0.07390	0.04804	1005.82560	0.02780	0.03222	1016.39814
Jet A	Turbine	790	0.00256	0.02058	5.48892	0.00970	0.07485	0.04865	1018.72080	0.02816	0.03263	1029.42889
Jet A	Turbine	800	0.00259	0.02084	5.55840	0.00982	0.07580	0.04927	1031.61600	0.02851	0.03305	1042.45963
Jet A	Turbine	810	0.00262	0.02110	5.62788	0.00994	0.07674	0.04988	1044.51120	0.02887	0.03346	1055.49038
Jet A	Turbine	820	0.00265	0.02137	5.69736	0.01006	0.07769	0.05050	1057.40640	0.02922	0.03387	1068.52112
Jet A	Turbine	830	0.00269	0.02163	5.76684	0.01019	0.07864	0.05112	1070.30160	0.02958	0.03429	1081.55187
Jet A	Turbine	840	0.00272	0.02189	5.83632	0.01031	0.07959	0.05173	1083.19680	0.02994	0.03470	1094.58261
Jet A	Turbine	850	0.00275	0.02215	5.90580	0.01043	0.08053	0.05235	1096.09200	0.03029	0.03511	1107.61336
Jet A	Turbine	860	0.00278	0.02241	5.97528	0.01055	0.08148	0.05296	1108.98720	0.03065	0.03553	1120.64410
Jet A	Turbine	870	0.00282	0.02267	6.04476	0.01068	0.08243	0.05358	1121.88240	0.03101	0.03594	1133.67485
Jet A	Turbine	880	0.00285	0.02293	6.11424	0.01080	0.08338	0.05419	1134.77760	0.03136	0.03635	1146.70560
Jet A	Turbine	890	0.00288	0.02319	6.18372	0.01092	0.08432	0.05481	1147.67280	0.03172	0.03677	1159.73634
Jet A	Turbine	900	0.00291	0.02345	6.25320	0.01105	0.08527	0.05543	1160.56800	0.03208	0.03718	1172.76709
Jet A	Turbine	910	0.00295	0.02371	6.32268	0.01117	0.08622	0.05604	1173.46320	0.03243	0.03759	1185.79783
Jet A	Turbine	920	0.00298	0.02397	6.39216	0.01129	0.08717	0.05666	1186.35840	0.03279	0.03801	1198.82858
Jet A	Turbine	930	0.00301	0.02423	6.46164	0.01141	0.08811	0.05727	1199.25360	0.03315	0.03842	1211.85932
Jet A	Turbine	940	0.00304	0.02449	6.53112	0.01154	0.08906	0.05789	1212.14880	0.03350	0.03883	1224.89007
Jet A	Turbine	950	0.00308	0.02475	6.60060	0.01166	0.09001	0.05851	1225.04400	0.03386	0.03924	1237.92081
Jet A	Turbine	960	0.00311	0.02501	6.67008	0.01178	0.09096	0.05912	1237.93920	0.03421	0.03966	1250.95156
Jet A	Turbine	970	0.00314	0.02527	6.73956	0.01190	0.09190	0.05974	1250.83440	0.03457	0.04007	1263.98230
Jet A	Turbine	980	0.00317	0.02553	6.80904	0.01203	0.09285	0.06035	1263.72960	0.03493	0.04048	1277.01305
Jet A	Turbine	990	0.00320	0.02579	6.87852	0.01215	0.09380	0.06097	1276.62480	0.03528	0.04090	1290.04379
Jet A	Turbine	1000	0.00324	0.02606	6.94800	0.01227	0.09475	0.06158	1289.52000	0.03564	0.04131	1303.07454
Gasoline	**Utility**	**1.0**	**0.00657**	**0.50143**	**0.00560**	**0.00043**	**0.00049**	**0.00032**	**0.94380**	**0.00005**	**0.00002**	**0.95218**
Gasoline	Utility	1.1	0.00723	0.55157	0.00616	0.00047	0.00053	0.00035	1.03818	0.00006	0.00003	1.04739
Gasoline	Utility	1.2	0.00788	0.60171	0.00672	0.00052	0.00058	0.00038	1.13256	0.00006	0.00003	1.14261
Gasoline	Utility	1.3	0.00854	0.65185	0.00728	0.00056	0.00063	0.00041	1.22694	0.00007	0.00003	1.23783
Gasoline	Utility	1.4	0.00920	0.70200	0.00783	0.00060	0.00068	0.00044	1.32132	0.00007	0.00003	1.33305
Gasoline	Utility	1.5	0.00985	0.75214	0.00839	0.00064	0.00073	0.00047	1.41570	0.00008	0.00004	1.42826
Gasoline	Utility	1.6	0.01051	0.80228	0.00895	0.00069	0.00078	0.00050	1.51008	0.00009	0.00004	1.52348
Gasoline	Utility	1.7	0.01117	0.85243	0.00951	0.00073	0.00082	0.00054	1.60446	0.00009	0.00004	1.61870
Gasoline	Utility	1.8	0.01183	0.90257	0.01007	0.00077	0.00087	0.00057	1.69884	0.00010	0.00004	1.71392
Gasoline	Utility	1.9	0.01248	0.95271	0.01063	0.00082	0.00092	0.00060	1.79322	0.00010	0.00004	1.80913
Gasoline	Utility	2.0	0.01314	1.00285	0.01119	0.00086	0.00097	0.00063	1.88760	0.00011	0.00005	1.90435
Gasoline	Utility	2.1	0.01380	1.05300	0.01175	0.00090	0.00102	0.00066	1.98198	0.00011	0.00005	1.99957
Gasoline	Utility	2.2	0.01445	1.10314	0.01231	0.00095	0.00107	0.00069	2.07636	0.00012	0.00005	2.09479
Gasoline	Utility	2.3	0.01511	1.15328	0.01287	0.00099	0.00112	0.00073	2.17074	0.00012	0.00005	2.19000
Gasoline	Utility	2.4	0.01577	1.20342	0.01343	0.00103	0.00116	0.00076	2.26512	0.00013	0.00006	2.28522
Gasoline	Utility	2.5	0.01642	1.25357	0.01399	0.00107	0.00121	0.00079	2.35950	0.00013	0.00006	2.38044
Gasoline	Utility	2.6	0.01708	1.30371	0.01455	0.00112	0.00126	0.00082	2.45388	0.00014	0.00006	2.47566
Gasoline	Utility	2.7	0.01774	1.35385	0.01511	0.00116	0.00131	0.00085	2.54826	0.00014	0.00006	2.57087
Gasoline	Utility	2.8	0.01839	1.40400	0.01567	0.00120	0.00136	0.00088	2.64264	0.00015	0.00007	2.66609
Gasoline	Utility	2.9	0.01905	1.45414	0.01623	0.00125	0.00141	0.00091	2.73702	0.00015	0.00007	2.76131
Gasoline	**Utility**	**3.0**	**0.01505**	**1.50428**	**0.01282**	**0.00129**	**0.00146**	**0.00095**	**2.59545**	**0.00015**	**0.00006**	**2.61848**
Gasoline	Utility	3.1	0.01555	1.55442	0.01325	0.00133	0.00150	0.00098	2.68197	0.00015	0.00007	2.70577
Gasoline	Utility	3.2	0.01605	1.60457	0.01367	0.00138	0.00155	0.00101	2.76848	0.00016	0.00007	2.79305
Gasoline	Utility	3.3	0.01655	1.65471	0.01410	0.00142	0.00160	0.00104	2.85500	0.00016	0.00007	2.88033
Gasoline	Utility	3.4	0.01705	1.70485	0.01453	0.00146	0.00165	0.00107	2.94151	0.00017	0.00007	2.96761
Gasoline	Utility	3.5	0.01756	1.75499	0.01495	0.00150	0.00170	0.00110	3.02803	0.00017	0.00008	3.05490
Gasoline	Utility	3.6	0.01806	1.80514	0.01538	0.00155	0.00175	0.00113	3.11454	0.00018	0.00008	3.14218
Gasoline	Utility	3.7	0.01856	1.85528	0.01581	0.00159	0.00179	0.00117	3.20106	0.00018	0.00008	3.22946
Gasoline	Utility	3.8	0.01906	1.90542	0.01624	0.00163	0.00184	0.00120	3.28757	0.00019	0.00008	3.31674
Gasoline	Utility	3.9	0.01956	1.95556	0.01666	0.00168	0.00189	0.00123	3.37409	0.00019	0.00008	3.40403
Gasoline	Utility	4.0	0.02006	2.00571	0.01709	0.00172	0.00194	0.00126	3.46060	0.00020	0.00009	3.49131
Gasoline	Utility	4.1	0.02057	2.05585	0.01752	0.00176	0.00199	0.00129	3.54712	0.00020	0.00009	3.57859
Gasoline	Utility	4.2	0.02107	2.10599	0.01795	0.00181	0.00204	0.00132	3.63363	0.00021	0.00009	3.66588
Gasoline	Utility	4.3	0.02157	2.15614	0.01837	0.00185	0.00209	0.00136	3.72015	0.00021	0.00009	3.75316
Gasoline	Utility	4.4	0.02207	2.20628	0.01880	0.00189	0.00213	0.00139	3.80666	0.00022	0.00009	3.84044
Gasoline	Utility	4.5	0.02257	2.25642	0.01923	0.00193	0.00218	0.00142	3.89318	0.00022	0.00010	3.92772
Gasoline	Utility	4.6	0.02307	2.30656	0.01965	0.00198	0.00223	0.00145	3.97969	0.00023	0.00010	4.01501
Gasoline	Utility	4.7	0.02357	2.35671	0.02008	0.00202	0.00228	0.00148	4.06621	0.00023	0.00010	4.10229

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
Gasoline	Utility	4.8	0.02408	2.40685	0.02051	0.00206	0.00233	0.00151	4.15272	0.00023	0.00010	4.18957
Gasoline	Utility	4.9	0.02458	2.45699	0.02094	0.00211	0.00238	0.00154	4.23924	0.00024	0.00011	4.27685
Gasoline	Utility	5.0	0.02508	2.50713	0.02136	0.00215	0.00243	0.00158	4.32575	0.00024	0.00011	4.36414
Gasoline	Utility	5.1	0.02558	2.55728	0.02179	0.00219	0.00247	0.00161	4.41227	0.00025	0.00011	4.45142
Gasoline	Utility	5.2	0.02608	2.60742	0.02222	0.00224	0.00252	0.00164	4.49878	0.00025	0.00011	4.53870
Gasoline	Utility	5.3	0.02658	2.65756	0.02265	0.00228	0.00257	0.00167	4.58530	0.00026	0.00011	4.62599
Gasoline	Utility	5.4	0.02709	2.70771	0.02307	0.00232	0.00262	0.00170	4.67181	0.00026	0.00012	4.71327
Gasoline	Utility	5.5	0.02759	2.75785	0.02350	0.00236	0.00267	0.00173	4.75833	0.00027	0.00012	4.80055
Gasoline	Utility	5.6	0.02809	2.80799	0.02393	0.00241	0.00272	0.00177	4.84484	0.00027	0.00012	4.88783
Gasoline	Utility	5.7	0.02859	2.85813	0.02436	0.00245	0.00276	0.00180	4.93136	0.00028	0.00012	4.97512
Gasoline	Utility	5.8	0.02909	2.90828	0.02478	0.00249	0.00281	0.00183	5.01787	0.00028	0.00012	5.06240
Gasoline	Utility	5.9	0.02959	2.95842	0.02521	0.00254	0.00286	0.00186	5.10439	0.00029	0.00013	5.14968
Gasoline	Utility	6.0	0.03010	3.00856	0.02564	0.00258	0.00291	0.00189	5.19090	0.00029	0.00013	5.23696
Gasoline	Utility	6.1	0.03060	3.05870	0.02606	0.00262	0.00296	0.00192	5.27742	0.00030	0.00013	5.32425
Gasoline	Utility	6.2	0.03110	3.10885	0.02649	0.00267	0.00301	0.00195	5.36393	0.00030	0.00013	5.41153
Gasoline	Utility	6.3	0.03160	3.15899	0.02692	0.00271	0.00306	0.00199	5.45045	0.00031	0.00014	5.49881
Gasoline	Utility	6.4	0.03210	3.20913	0.02735	0.00275	0.00310	0.00202	5.53696	0.00031	0.00014	5.58610
Gasoline	Utility	6.5	0.03260	3.25927	0.02777	0.00279	0.00315	0.00205	5.62348	0.00032	0.00014	5.67338
Gasoline	Utility	6.6	0.03311	3.30942	0.02820	0.00284	0.00320	0.00208	5.70999	0.00032	0.00014	5.76066
Gasoline	Utility	6.7	0.03361	3.35956	0.02863	0.00288	0.00325	0.00211	5.79651	0.00033	0.00014	5.84794
Gasoline	Utility	6.8	0.03411	3.40970	0.02906	0.00292	0.00330	0.00214	5.88302	0.00033	0.00015	5.93523
Gasoline	Utility	6.9	0.03461	3.45985	0.02948	0.00297	0.00335	0.00218	5.96954	0.00034	0.00015	6.02251
Gasoline	Utility	7.0	0.03511	3.50999	0.02991	0.00301	0.00340	0.00221	6.05605	0.00034	0.00015	6.10979
Gasoline	Utility	7.1	0.03561	3.56013	0.03034	0.00305	0.00344	0.00224	6.14257	0.00035	0.00015	6.19707
Gasoline	Utility	7.2	0.03611	3.61027	0.03076	0.00310	0.00349	0.00227	6.22908	0.00035	0.00015	6.28436
Gasoline	Utility	7.3	0.03662	3.66042	0.03119	0.00314	0.00354	0.00230	6.31560	0.00036	0.00016	6.37164
Gasoline	Utility	7.4	0.03712	3.71056	0.03162	0.00318	0.00359	0.00233	6.40211	0.00036	0.00016	6.45892
Gasoline	Utility	7.5	0.03762	3.76070	0.03205	0.00322	0.00364	0.00236	6.48863	0.00037	0.00016	6.54621
Gasoline	Utility	7.6	0.03812	3.81084	0.03247	0.00327	0.00369	0.00240	6.57514	0.00037	0.00016	6.63349
Gasoline	Utility	7.7	0.03862	3.86099	0.03290	0.00331	0.00373	0.00243	6.66166	0.00038	0.00017	6.72077
Gasoline	Utility	7.8	0.03912	3.91113	0.03333	0.00335	0.00378	0.00246	6.74817	0.00038	0.00017	6.80805
Gasoline	Utility	7.9	0.03963	3.96127	0.03376	0.00340	0.00383	0.00249	6.83469	0.00039	0.00017	6.89534
Gasoline	Utility	8.0	0.04013	4.01141	0.03418	0.00344	0.00388	0.00252	6.92120	0.00039	0.00017	6.98262
Gasoline	Utility	8.1	0.04063	4.06156	0.03461	0.00348	0.00393	0.00255	7.00772	0.00040	0.00017	7.06990
Gasoline	Utility	8.2	0.04113	4.11170	0.03504	0.00353	0.00398	0.00259	7.09423	0.00040	0.00018	7.15719
Gasoline	Utility	8.3	0.04163	4.16184	0.03546	0.00357	0.00403	0.00262	7.18075	0.00041	0.00018	7.24447
Gasoline	Utility	8.4	0.04213	4.21199	0.03589	0.00361	0.00407	0.00265	7.26726	0.00041	0.00018	7.33175
Gasoline	Utility	8.5	0.04264	4.26213	0.03632	0.00365	0.00412	0.00268	7.35378	0.00042	0.00018	7.41903
Gasoline	Utility	8.6	0.04314	4.31227	0.03675	0.00370	0.00417	0.00271	7.44029	0.00042	0.00018	7.50632
Gasoline	Utility	8.7	0.04364	4.36241	0.03717	0.00374	0.00422	0.00274	7.52681	0.00043	0.00019	7.59360
Gasoline	Utility	8.8	0.04414	4.41256	0.03760	0.00378	0.00427	0.00277	7.61332	0.00043	0.00019	7.68088
Gasoline	Utility	8.9	0.04464	4.46270	0.03803	0.00383	0.00432	0.00281	7.69984	0.00044	0.00019	7.76816
Gasoline	Utility	9.0	0.04514	4.51284	0.03846	0.00387	0.00437	0.00284	7.78635	0.00044	0.00019	7.85545
Gasoline	Utility	9.1	0.04564	4.56298	0.03888	0.00391	0.00441	0.00287	7.87287	0.00045	0.00020	7.94273
Gasoline	Utility	9.2	0.04615	4.61313	0.03931	0.00396	0.00446	0.00290	7.95938	0.00045	0.00020	8.03001
Gasoline	Utility	9.3	0.04665	4.66327	0.03974	0.00400	0.00451	0.00293	8.04590	0.00046	0.00020	8.11730
Gasoline	Utility	9.4	0.04715	4.71341	0.04016	0.00404	0.00456	0.00296	8.13241	0.00046	0.00020	8.20458
Gasoline	Utility	9.5	0.04765	4.76356	0.04059	0.00408	0.00461	0.00299	8.21893	0.00047	0.00020	8.29186
Gasoline	Utility	9.6	0.04815	4.81370	0.04102	0.00413	0.00466	0.00303	8.30544	0.00047	0.00021	8.37914
Gasoline	Utility	9.7	0.04865	4.86384	0.04145	0.00417	0.00470	0.00306	8.39196	0.00047	0.00021	8.46643
Gasoline	Utility	9.8	0.04916	4.91398	0.04187	0.00421	0.00475	0.00309	8.47847	0.00048	0.00021	8.55371
Gasoline	Utility	9.9	0.04966	4.96413	0.04230	0.00426	0.00480	0.00312	8.56499	0.00048	0.00021	8.64099
Gasoline	**Utility**	**10**	**0.09450**	**3.13500**	**0.08150**	**0.00420**	**0.00500**	**0.00325**	**7.86500**	**0.00045**	**0.00020**	**7.93480**
Gasoline	Utility	11	0.10395	3.44850	0.08965	0.00462	0.00550	0.00358	8.65150	0.00049	0.00021	8.72827
Gasoline	Utility	12	0.11340	3.76200	0.09780	0.00504	0.00600	0.00390	9.43800	0.00053	0.00023	9.52175
Gasoline	Utility	13	0.12285	4.07550	0.10595	0.00546	0.00650	0.00423	10.22450	0.00058	0.00025	10.31523
Gasoline	Utility	14	0.13230	4.38900	0.11410	0.00588	0.00700	0.00455	11.01100	0.00062	0.00027	11.10871
Gasoline	Utility	15	0.14175	4.70250	0.12225	0.00630	0.00750	0.00488	11.79750	0.00067	0.00029	11.90219
Gasoline	Utility	16	0.15120	5.01600	0.13040	0.00672	0.00800	0.00520	12.58400	0.00071	0.00031	12.69567
Gasoline	Utility	17	0.16065	5.32950	0.13855	0.00714	0.00850	0.00553	13.37050	0.00076	0.00033	13.48915
Gasoline	Utility	18	0.17010	5.64300	0.14670	0.00756	0.00900	0.00585	14.15700	0.00080	0.00035	14.28263
Gasoline	Utility	19	0.17955	5.95650	0.15485	0.00798	0.00950	0.00618	14.94350	0.00085	0.00037	15.07611
Gasoline	Utility	20	0.18900	6.27000	0.16300	0.00840	0.01000	0.00650	15.73000	0.00089	0.00039	15.86959
Gasoline	Utility	21	0.19845	6.58350	0.17115	0.00882	0.01050	0.00683	16.51650	0.00093	0.00041	16.66307
Gasoline	Utility	22	0.20790	6.89700	0.17930	0.00924	0.01100	0.00715	17.30300	0.00098	0.00043	17.45655
Gasoline	Utility	23	0.21735	7.21050	0.18745	0.00966	0.01150	0.00748	18.08950	0.00102	0.00045	18.25003
Gasoline	Utility	24	0.22680	7.52400	0.19560	0.01008	0.01200	0.00780	18.87600	0.00107	0.00047	19.04351
Gasoline	Utility	25	0.23625	7.83750	0.20375	0.01050	0.01250	0.00813	19.66250	0.00111	0.00049	19.83699
Gasoline	Utility	26	0.24570	8.15100	0.21190	0.01092	0.01300	0.00845	20.44900	0.00116	0.00051	20.63047
Gasoline	Utility	27	0.25515	8.46450	0.22005	0.01134	0.01350	0.00878	21.23550	0.00120	0.00053	21.42395
Gasoline	Utility	28	0.26460	8.77800	0.22820	0.01176	0.01400	0.00910	22.02200	0.00125	0.00055	22.21743
Gasoline	Utility	29	0.27405	9.09150	0.23635	0.01218	0.01450	0.00943	22.80850	0.00129	0.00057	23.01091
Gasoline	Utility	30	0.28350	9.40500	0.24450	0.01260	0.01500	0.00975	23.59500	0.00134	0.00059	23.80439
Gasoline	Utility	31	0.29295	9.71850	0.25265	0.01302	0.01550	0.01008	24.38150	0.00138	0.00060	24.59786
Gasoline	Utility	32	0.30240	10.03200	0.26080	0.01344	0.01600	0.01040	25.16800	0.00142	0.00062	25.39134
Gasoline	Utility	33	0.31185	10.34550	0.26895	0.01386	0.01650	0.01073	25.95450	0.00147	0.00064	26.18482
Gasoline	Utility	34	0.32130	10.65900	0.27710	0.01428	0.01700	0.01105	26.74100	0.00151	0.00066	26.97830
Gasoline	Utility	35	0.33075	10.97250	0.28525	0.01470	0.01750	0.01138	27.52750	0.00156	0.00068	27.77178

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
Gasoline	Utility	36	0.34020	11.28600	0.29340	0.01512	0.01800	0.01170	28.31400	0.00160	0.00070	28.56526
Gasoline	Utility	37	0.34965	11.59950	0.30155	0.01554	0.01850	0.01203	29.10050	0.00165	0.00072	29.35874
Gasoline	Utility	38	0.35910	11.91300	0.30970	0.01596	0.01900	0.01235	29.88700	0.00169	0.00074	30.15222
Gasoline	Utility	39	0.36855	12.22650	0.31785	0.01638	0.01950	0.01268	30.67350	0.00174	0.00076	30.94570
Gasoline	Utility	40	0.37800	12.54000	0.32600	0.01680	0.02000	0.01300	31.46000	0.00178	0.00078	31.73918
Gasoline	Utility	41	0.38745	12.85350	0.33415	0.01722	0.02050	0.01333	32.24650	0.00182	0.00080	32.53266
Gasoline	Utility	42	0.39690	13.16700	0.34230	0.01764	0.02100	0.01365	33.03300	0.00187	0.00082	33.32614
Gasoline	Utility	43	0.40635	13.48050	0.35045	0.01806	0.02150	0.01398	33.81950	0.00191	0.00084	34.11962
Gasoline	Utility	44	0.41580	13.79400	0.35860	0.01848	0.02200	0.01430	34.60600	0.00196	0.00086	34.91310
Gasoline	Utility	45	0.42525	14.10750	0.36675	0.01890	0.02250	0.01463	35.39250	0.00200	0.00088	35.70658
Gasoline	Utility	46	0.43470	14.42100	0.37490	0.01932	0.02300	0.01495	36.17900	0.00205	0.00090	36.50006
Gasoline	Utility	47	0.44415	14.73450	0.38305	0.01974	0.02350	0.01528	36.96550	0.00209	0.00092	37.29354
Gasoline	Utility	48	0.45360	15.04800	0.39120	0.02016	0.02400	0.01560	37.75200	0.00214	0.00094	38.08702
Gasoline	Utility	49	0.46305	15.36150	0.39935	0.02058	0.02450	0.01593	38.53850	0.00218	0.00096	38.88050
Gasoline	Utility	50	0.47250	15.67500	0.40750	0.02100	0.02500	0.01625	39.32500	0.00223	0.00098	39.67398
Gasoline	Utility	51	0.48195	15.98850	0.41565	0.02142	0.02550	0.01658	40.11150	0.00227	0.00099	40.46745
Gasoline	Utility	52	0.49140	16.30200	0.42380	0.02184	0.02600	0.01690	40.89800	0.00231	0.00101	41.26093
Gasoline	Utility	53	0.50085	16.61550	0.43195	0.02226	0.02650	0.01723	41.68450	0.00236	0.00103	42.05441
Gasoline	Utility	54	0.51030	16.92900	0.44010	0.02268	0.02700	0.01755	42.47100	0.00240	0.00105	42.84789
Gasoline	Utility	55	0.51975	17.24250	0.44825	0.02310	0.02750	0.01788	43.25750	0.00245	0.00107	43.64137
Gasoline	Utility	56	0.52920	17.55600	0.45640	0.02352	0.02800	0.01820	44.04400	0.00249	0.00109	44.43485
Gasoline	Utility	57	0.53865	17.86950	0.46455	0.02394	0.02850	0.01853	44.83050	0.00254	0.00111	45.22833
Gasoline	Utility	58	0.54810	18.18300	0.47270	0.02436	0.02900	0.01885	45.61700	0.00258	0.00113	46.02181
Gasoline	Utility	59	0.55755	18.49650	0.48085	0.02478	0.02950	0.01918	46.40350	0.00263	0.00115	46.81529
Gasoline	Utility	60	0.56700	18.81000	0.48900	0.02520	0.03000	0.01950	47.19000	0.00267	0.00117	47.60877
Gasoline	Utility	61	0.57645	19.12350	0.49715	0.02562	0.03050	0.01983	47.97650	0.00271	0.00119	48.40225
Gasoline	Utility	62	0.58590	19.43700	0.50530	0.02604	0.03100	0.02015	48.76300	0.00276	0.00121	49.19573
Gasoline	Utility	63	0.59535	19.75050	0.51345	0.02646	0.03150	0.02048	49.54950	0.00280	0.00123	49.98921
Gasoline	Utility	64	0.60480	20.06400	0.52160	0.02688	0.03200	0.02080	50.33600	0.00285	0.00125	50.78269
Gasoline	Utility	65	0.61425	20.37750	0.52975	0.02730	0.03250	0.02113	51.12250	0.00289	0.00127	51.57617
Gasoline	Utility	66	0.62370	20.69100	0.53790	0.02772	0.03300	0.02145	51.90900	0.00294	0.00129	52.36965
Gasoline	Utility	67	0.63315	21.00450	0.54605	0.02814	0.03350	0.02178	52.69550	0.00298	0.00131	53.16313
Gasoline	Utility	68	0.64260	21.31800	0.55420	0.02856	0.03400	0.02210	53.48200	0.00303	0.00133	53.95661
Gasoline	Utility	69	0.65205	21.63150	0.56235	0.02898	0.03450	0.02243	54.26850	0.00307	0.00135	54.75009
Gasoline	Utility	70	0.66150	21.94500	0.57050	0.02940	0.03500	0.02275	55.05500	0.00312	0.00137	55.54357
Gasoline	Utility	71	0.67095	22.25850	0.57865	0.02982	0.03550	0.02308	55.84150	0.00316	0.00138	56.33704
Gasoline	Utility	72	0.68040	22.57200	0.58680	0.03024	0.03600	0.02340	56.62800	0.00320	0.00140	57.13052
Gasoline	Utility	73	0.68985	22.88550	0.59495	0.03066	0.03650	0.02373	57.41450	0.00325	0.00142	57.92400
Gasoline	Utility	74	0.69930	23.19900	0.60310	0.03108	0.03700	0.02405	58.20100	0.00329	0.00144	58.71748
Gasoline	Utility	75	0.70875	23.51250	0.61125	0.03150	0.03750	0.02438	58.98750	0.00334	0.00146	59.51096
Gasoline	Utility	76	0.71820	23.82600	0.61940	0.03192	0.03800	0.02470	59.77400	0.00338	0.00148	60.30444
Gasoline	Utility	77	0.72765	24.13950	0.62755	0.03234	0.03850	0.02503	60.56050	0.00343	0.00150	61.09792
Gasoline	Utility	78	0.73710	24.45300	0.63570	0.03276	0.03900	0.02535	61.34700	0.00347	0.00152	61.89140
Gasoline	Utility	79	0.74655	24.76650	0.64385	0.03318	0.03950	0.02568	62.13350	0.00352	0.00154	62.68488
Gasoline	Utility	80	0.75600	25.08000	0.65200	0.03360	0.04000	0.02600	62.92000	0.00356	0.00156	63.47836
Gasoline	Utility	81	0.76545	25.39350	0.66015	0.03402	0.04050	0.02633	63.70650	0.00360	0.00158	64.27184
Gasoline	Utility	82	0.77490	25.70700	0.66830	0.03444	0.04100	0.02665	64.49300	0.00365	0.00160	65.06532
Gasoline	Utility	83	0.78435	26.02050	0.67645	0.03486	0.04150	0.02698	65.27950	0.00369	0.00162	65.85880
Gasoline	Utility	84	0.79380	26.33400	0.68460	0.03528	0.04200	0.02730	66.06600	0.00374	0.00164	66.65228
Gasoline	Utility	85	0.80325	26.64750	0.69275	0.03570	0.04250	0.02763	66.85250	0.00378	0.00166	67.44576
Gasoline	Utility	86	0.81270	26.96100	0.70090	0.03612	0.04300	0.02795	67.63900	0.00383	0.00168	68.23924
Gasoline	Utility	87	0.82215	27.27450	0.70905	0.03654	0.04350	0.02828	68.42550	0.00387	0.00170	69.03272
Gasoline	Utility	88	0.83160	27.58800	0.71720	0.03696	0.04400	0.02860	69.21200	0.00392	0.00172	69.82620
Gasoline	Utility	89	0.84105	27.90150	0.72535	0.03738	0.04450	0.02893	69.99850	0.00396	0.00174	70.61968
Gasoline	Utility	90	0.85050	28.21500	0.73350	0.03780	0.04500	0.02925	70.78500	0.00401	0.00176	71.41316
Gasoline	Utility	91	0.85995	28.52850	0.74165	0.03822	0.04550	0.02958	71.57150	0.00405	0.00177	72.20663
Gasoline	Utility	92	0.86940	28.84200	0.74980	0.03864	0.04600	0.02990	72.35800	0.00409	0.00179	73.00011
Gasoline	Utility	93	0.87885	29.15550	0.75795	0.03906	0.04650	0.03023	73.14450	0.00414	0.00181	73.79359
Gasoline	Utility	94	0.88830	29.46900	0.76610	0.03948	0.04700	0.03055	73.93100	0.00418	0.00183	74.58707
Gasoline	Utility	95	0.89775	29.78250	0.77425	0.03990	0.04750	0.03088	74.71750	0.00423	0.00185	75.38055
Gasoline	Utility	96	0.90720	30.09600	0.78240	0.04032	0.04800	0.03120	75.50400	0.00427	0.00187	76.17403
Gasoline	Utility	97	0.91665	30.40950	0.79055	0.04074	0.04850	0.03153	76.29050	0.00432	0.00189	76.96751
Gasoline	Utility	98	0.92610	30.72300	0.79870	0.04116	0.04900	0.03185	77.07700	0.00436	0.00191	77.76099
Gasoline	Utility	99	0.93555	31.03650	0.80685	0.04158	0.04950	0.03218	77.86350	0.00441	0.00193	78.55447
Gasoline	Utility	100	0.94500	31.35000	0.81500	0.04200	0.05000	0.03250	78.65000	0.00445	0.00195	79.34795
Gasoline	Utility	101	0.95445	31.66350	0.82315	0.04242	0.05050	0.03283	79.43650	0.00449	0.00197	80.14143
Gasoline	Utility	102	0.96390	31.97700	0.83130	0.04284	0.05100	0.03315	80.22300	0.00454	0.00199	80.93491
Gasoline	Utility	103	0.97335	32.29050	0.83945	0.04326	0.05150	0.03348	81.00950	0.00458	0.00201	81.72839
Gasoline	Utility	104	0.98280	32.60400	0.84760	0.04368	0.05200	0.03380	81.79600	0.00463	0.00203	82.52187
Gasoline	Utility	105	0.99225	32.91750	0.85575	0.04410	0.05250	0.03413	82.58250	0.00467	0.00205	83.31535
Gasoline	Utility	106	1.00170	33.23100	0.86390	0.04452	0.05300	0.03445	83.36900	0.00472	0.00207	84.10883
Gasoline	Utility	107	1.01115	33.54450	0.87205	0.04494	0.05350	0.03478	84.15550	0.00476	0.00209	84.90231
Gasoline	Utility	108	1.02060	33.85800	0.88020	0.04536	0.05400	0.03510	84.94200	0.00481	0.00211	85.69579
Gasoline	Utility	109	1.03005	34.17150	0.88835	0.04578	0.05450	0.03543	85.72850	0.00485	0.00213	86.48927
Gasoline	Utility	110	1.03950	34.48500	0.89650	0.04620	0.05500	0.03575	86.51500	0.00490	0.00215	87.28275
Gasoline	Utility	111	1.04895	34.79850	0.90465	0.04662	0.05550	0.03608	87.30150	0.00494	0.00216	88.07622
Gasoline	Utility	112	1.05840	35.11200	0.91280	0.04704	0.05600	0.03640	88.08800	0.00498	0.00218	88.86970
Gasoline	Utility	113	1.06785	35.42550	0.92095	0.04746	0.05650	0.03673	88.87450	0.00503	0.00220	89.66318

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
Gasoline	Utility	114	1.07730	35.73900	0.92910	0.04788	0.05700	0.03705	89.66100	0.00507	0.00222	90.45666
Gasoline	Utility	115	1.08675	36.05250	0.93725	0.04830	0.05750	0.03738	90.44750	0.00512	0.00224	91.25014
Gasoline	Utility	116	1.09620	36.36600	0.94540	0.04872	0.05800	0.03770	91.23400	0.00516	0.00226	92.04362
Gasoline	Utility	117	1.10565	36.67950	0.95355	0.04914	0.05850	0.03803	92.02050	0.00521	0.00228	92.83710
Gasoline	Utility	118	1.11510	36.99300	0.96170	0.04956	0.05900	0.03835	92.80700	0.00525	0.00230	93.63058
Gasoline	Utility	119	1.12455	37.30650	0.96985	0.04998	0.05950	0.03868	93.59350	0.00530	0.00232	94.42406
Gasoline	Utility	120	1.13400	37.62000	0.97800	0.05040	0.06000	0.03900	94.38000	0.00534	0.00234	95.21754
Gasoline	Utility	121	1.14345	37.93350	0.98615	0.05082	0.06050	0.03933	95.16650	0.00538	0.00236	96.01102
Gasoline	Utility	122	1.15290	38.24700	0.99430	0.05124	0.06100	0.03965	95.95300	0.00543	0.00238	96.80450
Gasoline	Utility	123	1.16235	38.56050	1.00245	0.05166	0.06150	0.03998	96.73950	0.00547	0.00240	97.59798
Gasoline	Utility	124	1.17180	38.87400	1.01060	0.05208	0.06200	0.04030	97.52600	0.00552	0.00242	98.39146
Gasoline	Utility	125	1.18125	39.18750	1.01875	0.05250	0.06250	0.04063	98.31250	0.00556	0.00244	99.18494
Gasoline	Utility	126	1.19070	39.50100	1.02690	0.05292	0.06300	0.04095	99.09900	0.00561	0.00246	99.97842
Gasoline	Utility	127	1.20015	39.81450	1.03505	0.05334	0.06350	0.04128	99.88550	0.00565	0.00248	100.77190
Gasoline	Utility	128	1.20960	40.12800	1.04320	0.05376	0.06400	0.04160	100.67200	0.00570	0.00250	101.56538
Gasoline	Utility	129	1.21905	40.44150	1.05135	0.05418	0.06450	0.04193	101.45850	0.00574	0.00252	102.35886
Gasoline	Utility	130	1.22850	40.75500	1.05950	0.05460	0.06500	0.04225	102.24500	0.00579	0.00254	103.15234
Gasoline	Utility	131	1.23795	41.06850	1.06765	0.05502	0.06550	0.04258	103.03150	0.00583	0.00255	103.94581
Gasoline	Utility	132	1.24740	41.38200	1.07580	0.05544	0.06600	0.04290	103.81800	0.00587	0.00257	104.73929
Gasoline	Utility	133	1.25685	41.69550	1.08395	0.05586	0.06650	0.04323	104.60450	0.00592	0.00259	105.53277
Gasoline	Utility	134	1.26630	42.00900	1.09210	0.05628	0.06700	0.04355	105.39100	0.00596	0.00261	106.32625
Gasoline	Utility	135	1.27575	42.32250	1.10025	0.05670	0.06750	0.04388	106.17750	0.00601	0.00263	107.11973
Gasoline	Utility	136	1.28520	42.63600	1.10840	0.05712	0.06800	0.04420	106.96400	0.00605	0.00265	107.91321
Gasoline	Utility	137	1.29465	42.94950	1.11655	0.05754	0.06850	0.04453	107.75050	0.00610	0.00267	108.70669
Gasoline	Utility	138	1.30410	43.26300	1.12470	0.05796	0.06900	0.04485	108.53700	0.00614	0.00269	109.50017
Gasoline	Utility	139	1.31355	43.57650	1.13285	0.05838	0.06950	0.04518	109.32350	0.00619	0.00271	110.29365
Gasoline	Utility	140	1.32300	43.89000	1.14100	0.05880	0.07000	0.04550	110.11000	0.00623	0.00273	111.08713
Gasoline	Utility	141	1.33245	44.20350	1.14915	0.05922	0.07050	0.04583	110.89650	0.00627	0.00275	111.88061
Gasoline	Utility	142	1.34190	44.51700	1.15730	0.05964	0.07100	0.04615	111.68300	0.00632	0.00277	112.67409
Gasoline	Utility	143	1.35135	44.83050	1.16545	0.06006	0.07150	0.04648	112.46950	0.00636	0.00279	113.46757
Gasoline	Utility	144	1.36080	45.14400	1.17360	0.06048	0.07200	0.04680	113.25600	0.00641	0.00281	114.26105
Gasoline	Utility	145	1.37025	45.45750	1.18175	0.06090	0.07250	0.04713	114.04250	0.00645	0.00283	115.05453
Gasoline	Utility	146	1.37970	45.77100	1.18990	0.06132	0.07300	0.04745	114.82900	0.00650	0.00285	115.84801
Gasoline	Utility	147	1.38915	46.08450	1.19805	0.06174	0.07350	0.04778	115.61550	0.00654	0.00287	116.64149
Gasoline	Utility	148	1.39860	46.39800	1.20620	0.06216	0.07400	0.04810	116.40200	0.00659	0.00289	117.43497
Gasoline	Utility	149	1.40805	46.71150	1.21435	0.06258	0.07450	0.04843	117.18850	0.00663	0.00291	118.22845
Gasoline	Utility	150	1.41750	47.02500	1.22250	0.06300	0.07500	0.04875	117.97500	0.00668	0.00293	119.02193
Gasoline	Utility	151	1.42695	47.33850	1.23065	0.06342	0.07550	0.04908	118.76150	0.00672	0.00294	119.81540
Gasoline	Utility	152	1.43640	47.65200	1.23880	0.06384	0.07600	0.04940	119.54800	0.00676	0.00296	120.60888
Gasoline	Utility	153	1.44585	47.96550	1.24695	0.06426	0.07650	0.04973	120.33450	0.00681	0.00298	121.40236
Gasoline	Utility	154	1.45530	48.27900	1.25510	0.06468	0.07700	0.05005	121.12100	0.00685	0.00300	122.19584
Gasoline	Utility	155	1.46475	48.59250	1.26325	0.06510	0.07750	0.05038	121.90750	0.00690	0.00302	122.98932
Gasoline	Utility	156	1.47420	48.90600	1.27140	0.06552	0.07800	0.05070	122.69400	0.00694	0.00304	123.78280
Gasoline	Utility	157	1.48365	49.21950	1.27955	0.06594	0.07850	0.05103	123.48050	0.00699	0.00306	124.57628
Gasoline	Utility	158	1.49310	49.53300	1.28770	0.06636	0.07900	0.05135	124.26700	0.00703	0.00308	125.36976
Gasoline	Utility	159	1.50255	49.84650	1.29585	0.06678	0.07950	0.05168	125.05350	0.00708	0.00310	126.16324
Gasoline	Utility	160	1.51200	50.16000	1.30400	0.06720	0.08000	0.05200	125.84000	0.00712	0.00312	126.95672
Gasoline	Utility	161	1.52145	50.47350	1.31215	0.06762	0.08050	0.05233	126.62650	0.00716	0.00314	127.75020
Gasoline	Utility	162	1.53090	50.78700	1.32030	0.06804	0.08100	0.05265	127.41300	0.00721	0.00316	128.54368
Gasoline	Utility	163	1.54035	51.10050	1.32845	0.06846	0.08150	0.05298	128.19950	0.00725	0.00318	129.33716
Gasoline	Utility	164	1.54980	51.41400	1.33660	0.06888	0.08200	0.05330	128.98600	0.00730	0.00320	130.13064
Gasoline	Utility	165	1.55925	51.72750	1.34475	0.06930	0.08250	0.05363	129.77250	0.00734	0.00322	130.92412
Gasoline	Utility	166	1.56870	52.04100	1.35290	0.06972	0.08300	0.05395	130.55900	0.00739	0.00324	131.71760
Gasoline	Utility	167	1.57815	52.35450	1.36105	0.07014	0.08350	0.05428	131.34550	0.00743	0.00326	132.51108
Gasoline	Utility	168	1.58760	52.66800	1.36920	0.07056	0.08400	0.05460	132.13200	0.00748	0.00328	133.30456
Gasoline	Utility	169	1.59705	52.98150	1.37735	0.07098	0.08450	0.05493	132.91850	0.00752	0.00330	134.09804
Gasoline	Utility	170	1.60650	53.29500	1.38550	0.07140	0.08500	0.05525	133.70500	0.00757	0.00332	134.89152
Gasoline	Utility	171	1.61595	53.60850	1.39365	0.07182	0.08550	0.05558	134.49150	0.00761	0.00333	135.68499
Gasoline	Utility	172	1.62540	53.92200	1.40180	0.07224	0.08600	0.05590	135.27800	0.00765	0.00335	136.47847
Gasoline	Utility	173	1.63485	54.23550	1.40995	0.07266	0.08650	0.05623	136.06450	0.00770	0.00337	137.27195
Gasoline	Utility	174	1.64430	54.54900	1.41810	0.07308	0.08700	0.05655	136.85100	0.00774	0.00339	138.06543
Gasoline	Utility	175	1.65375	54.86250	1.42625	0.07350	0.08750	0.05688	137.63750	0.00779	0.00341	138.85891
Gasoline	Utility	176	1.66320	55.17600	1.43440	0.07392	0.08800	0.05720	138.42400	0.00783	0.00343	139.65239
Gasoline	Utility	177	1.67265	55.48950	1.44255	0.07434	0.08850	0.05753	139.21050	0.00788	0.00345	140.44587
Gasoline	Utility	178	1.68210	55.80300	1.45070	0.07476	0.08900	0.05785	139.99700	0.00792	0.00347	141.23935
Gasoline	Utility	179	1.69155	56.11650	1.45885	0.07518	0.08950	0.05818	140.78350	0.00797	0.00349	142.03283
Gasoline	Utility	180	1.70100	56.43000	1.46700	0.07560	0.09000	0.05850	141.57000	0.00801	0.00351	142.82631
Gasoline	Utility	181	1.71045	56.74350	1.47515	0.07602	0.09050	0.05883	142.35650	0.00805	0.00353	143.61979
Gasoline	Utility	182	1.71990	57.05700	1.48330	0.07644	0.09100	0.05915	143.14300	0.00810	0.00355	144.41327
Gasoline	Utility	183	1.72935	57.37050	1.49145	0.07686	0.09150	0.05948	143.92950	0.00814	0.00357	145.20675
Gasoline	Utility	184	1.73880	57.68400	1.49960	0.07728	0.09200	0.05980	144.71600	0.00819	0.00359	146.00023
Gasoline	Utility	185	1.74825	57.99750	1.50775	0.07770	0.09250	0.06013	145.50250	0.00823	0.00361	146.79371
Gasoline	Utility	186	1.75770	58.31100	1.51590	0.07812	0.09300	0.06045	146.28900	0.00828	0.00363	147.58719
Gasoline	Utility	187	1.76715	58.62450	1.52405	0.07854	0.09350	0.06078	147.07550	0.00832	0.00365	148.38067
Gasoline	Utility	188	1.77660	58.93800	1.53220	0.07896	0.09400	0.06110	147.86200	0.00837	0.00367	149.17415
Gasoline	Utility	189	1.78605	59.25150	1.54035	0.07938	0.09450	0.06143	148.64850	0.00841	0.00369	149.96763
Gasoline	Utility	190	1.79550	59.56500	1.54850	0.07980	0.09500	0.06175	149.43500	0.00846	0.00371	150.76111
Gasoline	Utility	191	1.80495	59.87850	1.55665	0.08022	0.09550	0.06208	150.22150	0.00850	0.00372	151.55458

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
Gasoline	Utility	192	1.81440	60.19200	1.56480	0.08064	0.09600	0.06240	151.00800	0.00854	0.00374	152.34806
Gasoline	Utility	193	1.82385	60.50550	1.57295	0.08106	0.09650	0.06273	151.79450	0.00859	0.00376	153.14154
Gasoline	Utility	194	1.83330	60.81900	1.58110	0.08148	0.09700	0.06305	152.58100	0.00863	0.00378	153.93502
Gasoline	Utility	195	1.84275	61.13250	1.58925	0.08190	0.09750	0.06338	153.36750	0.00868	0.00380	154.72850
Gasoline	Utility	196	1.85220	61.44600	1.59740	0.08232	0.09800	0.06370	154.15400	0.00872	0.00382	155.52198
Gasoline	Utility	197	1.86165	61.75950	1.60555	0.08274	0.09850	0.06403	154.94050	0.00877	0.00384	156.31546
Gasoline	Utility	198	1.87110	62.07300	1.61370	0.08316	0.09900	0.06435	155.72700	0.00881	0.00386	157.10894
Gasoline	Utility	199	1.88055	62.38650	1.62185	0.08358	0.09950	0.06468	156.51350	0.00886	0.00388	157.90242
Gasoline	Utility	200	1.89000	62.70000	1.63000	0.08400	0.10000	0.06500	157.30000	0.00890	0.00390	158.69590
Diesel	**Offroad**	**5.0**	**0.00444**	**0.03946**	**0.03255**	**0.00004**	**0.00395**	**0.00335**	**3.91200**	**0.00022**	**0.00010**	**3.94719**
Diesel	Offroad	5.1	0.00453	0.04025	0.03320	0.00004	0.00402	0.00342	3.99024	0.00023	0.00010	4.02614
Diesel	Offroad	5.2	0.00462	0.04103	0.03385	0.00004	0.00410	0.00349	4.06848	0.00023	0.00010	4.10508
Diesel	Offroad	5.3	0.00471	0.04182	0.03450	0.00004	0.00418	0.00356	4.14672	0.00024	0.00010	4.18402
Diesel	Offroad	5.4	0.00479	0.04261	0.03516	0.00004	0.00426	0.00362	4.22496	0.00024	0.00011	4.26297
Diesel	Offroad	5.5	0.00488	0.04340	0.03581	0.00004	0.00434	0.00369	4.30320	0.00025	0.00011	4.34191
Diesel	Offroad	5.6	0.00497	0.04419	0.03646	0.00004	0.00442	0.00376	4.38144	0.00025	0.00011	4.42085
Diesel	Offroad	5.7	0.00506	0.04498	0.03711	0.00004	0.00450	0.00382	4.45968	0.00025	0.00011	4.49980
Diesel	Offroad	5.8	0.00515	0.04577	0.03776	0.00004	0.00458	0.00389	4.53792	0.00026	0.00011	4.57874
Diesel	Offroad	5.9	0.00524	0.04656	0.03841	0.00004	0.00466	0.00396	4.61616	0.00026	0.00012	4.65769
Diesel	Offroad	6.0	0.00533	0.04735	0.03906	0.00004	0.00473	0.00402	4.69440	0.00027	0.00012	4.73663
Diesel	Offroad	6.1	0.00542	0.04814	0.03971	0.00005	0.00481	0.00409	4.77264	0.00027	0.00012	4.81557
Diesel	Offroad	6.2	0.00550	0.04893	0.04036	0.00005	0.00489	0.00416	4.85088	0.00028	0.00012	4.89452
Diesel	Offroad	6.3	0.00559	0.04972	0.04102	0.00005	0.00497	0.00423	4.92912	0.00028	0.00012	4.97346
Diesel	Offroad	6.4	0.00568	0.05050	0.04167	0.00005	0.00505	0.00429	5.00736	0.00029	0.00013	5.05240
Diesel	Offroad	6.5	0.00577	0.05129	0.04232	0.00005	0.00513	0.00436	5.08560	0.00029	0.00013	5.13135
Diesel	Offroad	6.6	0.00586	0.05208	0.04297	0.00005	0.00521	0.00443	5.16384	0.00029	0.00013	5.21029
Diesel	Offroad	6.7	0.00595	0.05287	0.04362	0.00005	0.00529	0.00449	5.24208	0.00030	0.00013	5.28924
Diesel	Offroad	6.8	0.00604	0.05366	0.04427	0.00005	0.00537	0.00456	5.32032	0.00030	0.00013	5.36818
Diesel	Offroad	6.9	0.00613	0.05445	0.04492	0.00005	0.00545	0.00463	5.39856	0.00031	0.00014	5.44712
Diesel	Offroad	7.0	0.00621	0.05524	0.04557	0.00005	0.00552	0.00470	5.47680	0.00031	0.00014	5.52607
Diesel	Offroad	7.1	0.00630	0.05603	0.04622	0.00005	0.00560	0.00476	5.55504	0.00032	0.00014	5.60501
Diesel	Offroad	7.2	0.00639	0.05682	0.04687	0.00005	0.00568	0.00483	5.63328	0.00032	0.00014	5.68396
Diesel	Offroad	7.3	0.00648	0.05761	0.04753	0.00005	0.00576	0.00490	5.71152	0.00033	0.00014	5.76290
Diesel	Offroad	7.4	0.00657	0.05840	0.04818	0.00006	0.00584	0.00496	5.78976	0.00033	0.00015	5.84184
Diesel	Offroad	7.5	0.00666	0.05918	0.04883	0.00006	0.00592	0.00503	5.86800	0.00033	0.00015	5.92079
Diesel	Offroad	7.6	0.00675	0.05997	0.04948	0.00006	0.00600	0.00510	5.94624	0.00034	0.00015	5.99973
Diesel	Offroad	7.7	0.00684	0.06076	0.05013	0.00006	0.00608	0.00516	6.02448	0.00034	0.00015	6.07867
Diesel	Offroad	7.8	0.00692	0.06155	0.05078	0.00006	0.00616	0.00523	6.10272	0.00035	0.00015	6.15762
Diesel	Offroad	7.9	0.00701	0.06234	0.05143	0.00006	0.00623	0.00530	6.18096	0.00035	0.00016	6.23656
Diesel	Offroad	8.0	0.00710	0.06313	0.05208	0.00006	0.00631	0.00537	6.25920	0.00036	0.00016	6.31551
Diesel	Offroad	8.1	0.00719	0.06392	0.05273	0.00006	0.00639	0.00543	6.33744	0.00036	0.00016	6.39445
Diesel	Offroad	8.2	0.00728	0.06471	0.05338	0.00006	0.00647	0.00550	6.41568	0.00037	0.00016	6.47339
Diesel	Offroad	8.3	0.00737	0.06550	0.05404	0.00006	0.00655	0.00557	6.49392	0.00037	0.00016	6.55234
Diesel	Offroad	8.4	0.00746	0.06629	0.05469	0.00006	0.00663	0.00563	6.57216	0.00037	0.00017	6.63128
Diesel	Offroad	8.5	0.00755	0.06708	0.05534	0.00006	0.00671	0.00570	6.65040	0.00038	0.00017	6.71023
Diesel	Offroad	8.6	0.00763	0.06787	0.05599	0.00006	0.00679	0.00577	6.72864	0.00038	0.00017	6.78917
Diesel	Offroad	8.7	0.00772	0.06865	0.05664	0.00006	0.00687	0.00584	6.80688	0.00039	0.00017	6.86811
Diesel	Offroad	8.8	0.00781	0.06944	0.05729	0.00007	0.00694	0.00590	6.88512	0.00039	0.00017	6.94706
Diesel	Offroad	8.9	0.00790	0.07023	0.05794	0.00007	0.00702	0.00597	6.96336	0.00040	0.00018	7.02600
Diesel	Offroad	9.0	0.00799	0.07102	0.05859	0.00007	0.00710	0.00604	7.04160	0.00040	0.00018	7.10494
Diesel	Offroad	9.1	0.00808	0.07181	0.05924	0.00007	0.00718	0.00610	7.11984	0.00041	0.00018	7.18389
Diesel	Offroad	9.2	0.00817	0.07260	0.05990	0.00007	0.00726	0.00617	7.19808	0.00041	0.00018	7.26283
Diesel	Offroad	9.3	0.00826	0.07339	0.06055	0.00007	0.00734	0.00624	7.27632	0.00042	0.00018	7.34178
Diesel	Offroad	9.4	0.00835	0.07418	0.06120	0.00007	0.00742	0.00631	7.35456	0.00042	0.00018	7.42072
Diesel	Offroad	9.5	0.00843	0.07497	0.06185	0.00007	0.00750	0.00637	7.43280	0.00042	0.00019	7.49966
Diesel	Offroad	9.6	0.00852	0.07576	0.06250	0.00007	0.00758	0.00644	7.51104	0.00043	0.00019	7.57861
Diesel	Offroad	9.7	0.00861	0.07655	0.06315	0.00007	0.00765	0.00651	7.58928	0.00043	0.00019	7.65755
Diesel	Offroad	9.8	0.00870	0.07733	0.06380	0.00007	0.00773	0.00657	7.66752	0.00044	0.00019	7.73649
Diesel	Offroad	9.9	0.00879	0.07812	0.06445	0.00007	0.00781	0.00664	7.74576	0.00044	0.00019	7.81544
Diesel	**Offroad**	**10**	**0.00888**	**0.06510**	**0.06510**	**0.00007**	**0.00789**	**0.00671**	**7.82400**	**0.00045**	**0.00020**	**7.89438**
Diesel	Offroad	11	0.00977	0.07161	0.07161	0.00008	0.00868	0.00738	8.60640	0.00049	0.00022	8.68382
Diesel	Offroad	12	0.01065	0.07812	0.07812	0.00009	0.00947	0.00805	9.38880	0.00054	0.00024	9.47326
Diesel	Offroad	13	0.01154	0.08463	0.08463	0.00010	0.01026	0.00872	10.17120	0.00058	0.00026	10.26270
Diesel	Offroad	14	0.01243	0.09114	0.09114	0.00010	0.01105	0.00939	10.95360	0.00062	0.00028	11.05214
Diesel	Offroad	15	0.01332	0.09765	0.09765	0.00011	0.01184	0.01006	11.73600	0.00067	0.00030	11.84157
Diesel	Offroad	16	0.01420	0.10417	0.10417	0.00012	0.01263	0.01073	12.51840	0.00071	0.00031	12.63101
Diesel	Offroad	17	0.01509	0.11068	0.11068	0.00013	0.01342	0.01140	13.30080	0.00076	0.00033	13.42045
Diesel	Offroad	18	0.01598	0.11719	0.11719	0.00013	0.01420	0.01207	14.08320	0.00080	0.00035	14.20989
Diesel	Offroad	19	0.01687	0.12370	0.12370	0.00014	0.01499	0.01274	14.86560	0.00085	0.00037	14.99933
Diesel	Offroad	20	0.01776	0.13021	0.13021	0.00015	0.01578	0.01342	15.64800	0.00089	0.00039	15.78876
Diesel	Offroad	21	0.01864	0.13672	0.13672	0.00016	0.01657	0.01409	16.43040	0.00094	0.00041	16.57820
Diesel	Offroad	22	0.01953	0.14323	0.14323	0.00016	0.01736	0.01476	17.21280	0.00098	0.00043	17.36764
Diesel	Offroad	23	0.02042	0.14974	0.14974	0.00017	0.01815	0.01543	17.99520	0.00103	0.00045	18.15708
Diesel	Offroad	24	0.02131	0.15625	0.15625	0.00018	0.01894	0.01610	18.77760	0.00107	0.00047	18.94652
Diesel	**Offroad**	**25**	**0.02219**	**0.13563**	**0.16276**	**0.00016**	**0.01480**	**0.01258**	**17.11500**	**0.00098**	**0.00043**	**17.26896**
Diesel	Offroad	26	0.02308	0.14106	0.16927	0.00017	0.01539	0.01308	17.79960	0.00102	0.00045	17.95972
Diesel	Offroad	27	0.02397	0.14648	0.17578	0.00018	0.01598	0.01358	18.48420	0.00105	0.00046	18.65048
Diesel	Offroad	28	0.02486	0.15191	0.18229	0.00018	0.01657	0.01409	19.16880	0.00109	0.00048	19.34124

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
Diesel	Offroad	29	0.02575	0.15733	0.18880	0.00019	0.01716	0.01459	19.85340	0.00113	0.00050	20.03200
Diesel	Offroad	30	0.02663	0.16276	0.19531	0.00020	0.01776	0.01509	20.53800	0.00117	0.00052	20.72275
Diesel	Offroad	31	0.02752	0.16818	0.20182	0.00020	0.01835	0.01560	21.22260	0.00121	0.00053	21.41351
Diesel	Offroad	32	0.02841	0.17361	0.20833	0.00021	0.01894	0.01610	21.90720	0.00125	0.00055	22.10427
Diesel	Offroad	33	0.02930	0.17903	0.21484	0.00022	0.01953	0.01660	22.59180	0.00129	0.00057	22.79503
Diesel	Offroad	34	0.03018	0.18446	0.22135	0.00022	0.02012	0.01710	23.27640	0.00133	0.00059	23.48579
Diesel	Offroad	35	0.03107	0.18988	0.22786	0.00023	0.02071	0.01761	23.96100	0.00137	0.00060	24.17655
Diesel	Offroad	36	0.03196	0.19531	0.23437	0.00024	0.02131	0.01811	24.64560	0.00141	0.00062	24.86730
Diesel	Offroad	37	0.03285	0.20074	0.24088	0.00024	0.02190	0.01861	25.33020	0.00145	0.00064	25.55806
Diesel	Offroad	38	0.03374	0.20616	0.24739	0.00025	0.02249	0.01912	26.01480	0.00148	0.00065	26.24882
Diesel	Offroad	39	0.03462	0.21159	0.25390	0.00025	0.02308	0.01962	26.69940	0.00152	0.00067	26.93958
Diesel	Offroad	40	0.03551	0.21701	0.26041	0.00026	0.02367	0.02012	27.38400	0.00156	0.00069	27.63034
Diesel	Offroad	41	0.03640	0.22244	0.26692	0.00027	0.02427	0.02063	28.06860	0.00160	0.00071	28.32110
Diesel	Offroad	42	0.03729	0.22786	0.27343	0.00027	0.02486	0.02113	28.75320	0.00164	0.00072	29.01186
Diesel	Offroad	43	0.03817	0.23329	0.27994	0.00028	0.02545	0.02163	29.43780	0.00168	0.00074	29.70261
Diesel	Offroad	44	0.03906	0.23871	0.28645	0.00029	0.02604	0.02214	30.12240	0.00172	0.00076	30.39337
Diesel	Offroad	45	0.03995	0.24414	0.29296	0.00029	0.02663	0.02264	30.80700	0.00176	0.00077	31.08413
Diesel	Offroad	46	0.04084	0.24956	0.29948	0.00030	0.02723	0.02314	31.49160	0.00180	0.00079	31.77489
Diesel	Offroad	47	0.04173	0.25499	0.30599	0.00031	0.02782	0.02364	32.17620	0.00184	0.00081	32.46565
Diesel	Offroad	48	0.04261	0.26041	0.31250	0.00031	0.02841	0.02415	32.86080	0.00187	0.00083	33.15641
Diesel	Offroad	49	0.04350	0.26584	0.31901	0.00032	0.02900	0.02465	33.54540	0.00191	0.00084	33.84716
Diesel	**Offroad**	**50**	**0.04439**	**0.24660**	**0.32552**	**0.00033**	**0.01973**	**0.01677**	**34.23000**	**0.00195**	**0.00086**	**34.53792**
Diesel	Offroad	51	0.04528	0.25154	0.33203	0.00033	0.02012	0.01710	34.91460	0.00199	0.00088	35.22868
Diesel	Offroad	52	0.04616	0.25647	0.33854	0.00034	0.02052	0.01744	35.59920	0.00203	0.00090	35.91944
Diesel	Offroad	53	0.04705	0.26140	0.34505	0.00035	0.02091	0.01778	36.28380	0.00207	0.00091	36.61020
Diesel	Offroad	54	0.04794	0.26633	0.35156	0.00035	0.02131	0.01811	36.96840	0.00211	0.00093	37.30096
Diesel	Offroad	55	0.04883	0.27126	0.35807	0.00036	0.02170	0.01845	37.65300	0.00215	0.00095	37.99172
Diesel	Offroad	56	0.04972	0.27620	0.36458	0.00037	0.02210	0.01878	38.33760	0.00219	0.00096	38.68247
Diesel	Offroad	57	0.05060	0.28113	0.37109	0.00037	0.02249	0.01912	39.02220	0.00223	0.00098	39.37323
Diesel	Offroad	58	0.05149	0.28606	0.37760	0.00038	0.02288	0.01945	39.70680	0.00227	0.00100	40.06399
Diesel	Offroad	59	0.05238	0.29099	0.38411	0.00039	0.02328	0.01979	40.39140	0.00230	0.00102	40.75475
Diesel	Offroad	60	0.05327	0.29592	0.39062	0.00039	0.02367	0.02012	41.07600	0.00234	0.00103	41.44551
Diesel	Offroad	61	0.05415	0.30086	0.39713	0.00040	0.02407	0.02046	41.76060	0.00238	0.00105	42.13627
Diesel	Offroad	62	0.05504	0.30579	0.40364	0.00040	0.02446	0.02079	42.44520	0.00242	0.00107	42.82702
Diesel	Offroad	63	0.05593	0.31072	0.41015	0.00041	0.02486	0.02113	43.12980	0.00246	0.00108	43.51778
Diesel	Offroad	64	0.05682	0.31565	0.41666	0.00042	0.02525	0.02146	43.81440	0.00250	0.00110	44.20854
Diesel	Offroad	65	0.05771	0.32058	0.42317	0.00042	0.02565	0.02180	44.49900	0.00254	0.00112	44.89930
Diesel	Offroad	66	0.05859	0.32552	0.42968	0.00043	0.02604	0.02214	45.18360	0.00258	0.00114	45.59006
Diesel	Offroad	67	0.05948	0.33045	0.43619	0.00044	0.02644	0.02247	45.86820	0.00262	0.00115	46.28082
Diesel	Offroad	68	0.06037	0.33538	0.44270	0.00044	0.02683	0.02281	46.55280	0.00266	0.00117	46.97158
Diesel	Offroad	69	0.06126	0.34031	0.44921	0.00045	0.02723	0.02314	47.23740	0.00270	0.00119	47.66233
Diesel	Offroad	70	0.06214	0.34524	0.45572	0.00046	0.02762	0.02348	47.92200	0.00273	0.00121	48.35309
Diesel	Offroad	71	0.06303	0.35018	0.46223	0.00046	0.02801	0.02381	48.60660	0.00277	0.00122	49.04385
Diesel	Offroad	72	0.06392	0.35511	0.46874	0.00047	0.02841	0.02415	49.29120	0.00281	0.00124	49.73461
Diesel	Offroad	73	0.06481	0.36004	0.47525	0.00048	0.02880	0.02448	49.97580	0.00285	0.00126	50.42537
Diesel	Offroad	74	0.06570	0.36497	0.48176	0.00048	0.02920	0.02482	50.66040	0.00289	0.00127	51.11613
Diesel	**Offroad**	**75**	**0.06658**	**0.36991**	**0.48827**	**0.00049**	**0.02959**	**0.02515**	**51.34500**	**0.00293**	**0.00129**	**51.80688**
Diesel	Offroad	76	0.06747	0.37484	0.49479	0.00050	0.02999	0.02549	52.02960	0.00297	0.00131	52.49764
Diesel	Offroad	77	0.06836	0.37977	0.50130	0.00050	0.03038	0.02582	52.71420	0.00301	0.00133	53.18840
Diesel	Offroad	78	0.06925	0.38470	0.50781	0.00051	0.03078	0.02616	53.39880	0.00305	0.00134	53.87916
Diesel	Offroad	79	0.07013	0.38963	0.51432	0.00052	0.03117	0.02650	54.08340	0.00309	0.00136	54.56992
Diesel	Offroad	80	0.07102	0.39457	0.52083	0.00052	0.03157	0.02683	54.76800	0.00312	0.00138	55.26068
Diesel	Offroad	81	0.07191	0.39950	0.52734	0.00053	0.03196	0.02717	55.45260	0.00316	0.00139	55.95144
Diesel	Offroad	82	0.07280	0.40443	0.53385	0.00054	0.03235	0.02750	56.13720	0.00320	0.00141	56.64219
Diesel	Offroad	83	0.07369	0.40936	0.54036	0.00054	0.03275	0.02784	56.82180	0.00324	0.00143	57.33295
Diesel	Offroad	84	0.07457	0.41429	0.54687	0.00055	0.03314	0.02817	57.50640	0.00328	0.00145	58.02371
Diesel	Offroad	85	0.07546	0.41923	0.55338	0.00055	0.03354	0.02851	58.19100	0.00332	0.00146	58.71447
Diesel	Offroad	86	0.07635	0.42416	0.55989	0.00056	0.03393	0.02884	58.87560	0.00336	0.00148	59.40523
Diesel	Offroad	87	0.07724	0.42909	0.56640	0.00057	0.03433	0.02918	59.56020	0.00340	0.00150	60.09599
Diesel	Offroad	88	0.07812	0.43402	0.57291	0.00057	0.03472	0.02951	60.24480	0.00344	0.00152	60.78674
Diesel	Offroad	89	0.07901	0.43895	0.57942	0.00058	0.03512	0.02985	60.92940	0.00348	0.00153	61.47750
Diesel	Offroad	90	0.07990	0.44389	0.58593	0.00059	0.03551	0.03018	61.61400	0.00352	0.00155	62.16826
Diesel	Offroad	91	0.08079	0.44882	0.59244	0.00059	0.03591	0.03052	62.29860	0.00355	0.00157	62.85902
Diesel	Offroad	92	0.08168	0.45375	0.59895	0.00060	0.03630	0.03086	62.98320	0.00359	0.00158	63.54978
Diesel	Offroad	93	0.08256	0.45868	0.60546	0.00061	0.03669	0.03119	63.66780	0.00363	0.00160	64.24054
Diesel	Offroad	94	0.08345	0.46361	0.61197	0.00061	0.03709	0.03153	64.35240	0.00367	0.00162	64.93130
Diesel	Offroad	95	0.08434	0.46855	0.61848	0.00062	0.03748	0.03186	65.03700	0.00371	0.00164	65.62205
Diesel	Offroad	96	0.08523	0.47348	0.62499	0.00063	0.03788	0.03220	65.72160	0.00375	0.00165	66.31281
Diesel	Offroad	97	0.08611	0.47841	0.63150	0.00063	0.03827	0.03253	66.40620	0.00379	0.00167	67.00357
Diesel	Offroad	98	0.08700	0.48334	0.63801	0.00064	0.03867	0.03287	67.09080	0.00383	0.00169	67.69433
Diesel	Offroad	99	0.08789	0.48827	0.64452	0.00065	0.03906	0.03320	67.77540	0.00387	0.00170	68.38509
Diesel	**Offroad**	**100**	**0.07812**	**0.49321**	**0.57291**	**0.00065**	**0.02959**	**0.02515**	**68.46000**	**0.00391**	**0.00172**	**69.07585**
Diesel	Offroad	101	0.07891	0.49814	0.57864	0.00066	0.02989	0.02541	69.14460	0.00395	0.00174	69.76660
Diesel	Offroad	102	0.07969	0.50307	0.58437	0.00067	0.03018	0.02566	69.82920	0.00398	0.00176	70.45736
Diesel	Offroad	103	0.08047	0.50800	0.59010	0.00067	0.03048	0.02591	70.51380	0.00402	0.00177	71.14812
Diesel	Offroad	104	0.08125	0.51294	0.59583	0.00068	0.03078	0.02616	71.19840	0.00406	0.00179	71.83888
Diesel	Offroad	105	0.08203	0.51787	0.60155	0.00069	0.03107	0.02641	71.88300	0.00410	0.00181	72.52964
Diesel	Offroad	106	0.08281	0.52280	0.60728	0.00069	0.03137	0.02666	72.56760	0.00414	0.00183	73.22040

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
Diesel	Offroad	107	0.08359	0.52773	0.61301	0.00070	0.03166	0.02691	73.25220	0.00418	0.00184	73.91116
Diesel	Offroad	108	0.08437	0.53266	0.61874	0.00071	0.03196	0.02717	73.93680	0.00422	0.00186	74.60191
Diesel	Offroad	109	0.08516	0.53760	0.62447	0.00071	0.03226	0.02742	74.62140	0.00426	0.00188	75.29267
Diesel	Offroad	110	0.08594	0.54253	0.63020	0.00072	0.03255	0.02767	75.30600	0.00430	0.00189	75.98343
Diesel	Offroad	111	0.08672	0.54746	0.63593	0.00072	0.03285	0.02792	75.99060	0.00434	0.00191	76.67419
Diesel	Offroad	112	0.08750	0.55239	0.64166	0.00073	0.03314	0.02817	76.67520	0.00437	0.00193	77.36495
Diesel	Offroad	113	0.08828	0.55732	0.64739	0.00074	0.03344	0.02842	77.35980	0.00441	0.00195	78.05571
Diesel	Offroad	114	0.08906	0.56226	0.65312	0.00074	0.03374	0.02868	78.04440	0.00445	0.00196	78.74646
Diesel	Offroad	115	0.08984	0.56719	0.65885	0.00075	0.03403	0.02893	78.72900	0.00449	0.00198	79.43722
Diesel	Offroad	116	0.09062	0.57212	0.66457	0.00076	0.03433	0.02918	79.41360	0.00453	0.00200	80.12798
Diesel	Offroad	117	0.09141	0.57705	0.67030	0.00076	0.03462	0.02943	80.09820	0.00457	0.00201	80.81874
Diesel	Offroad	118	0.09219	0.58198	0.67603	0.00077	0.03492	0.02968	80.78280	0.00461	0.00203	81.50950
Diesel	Offroad	119	0.09297	0.58692	0.68176	0.00078	0.03521	0.02993	81.46740	0.00465	0.00205	82.20026
Diesel	Offroad	120	0.09375	0.59185	0.68749	0.00078	0.03551	0.03018	82.15200	0.00469	0.00207	82.89102
Diesel	Offroad	121	0.09453	0.59678	0.69322	0.00079	0.03581	0.03044	82.83660	0.00473	0.00208	83.58177
Diesel	Offroad	122	0.09531	0.60171	0.69895	0.00080	0.03610	0.03069	83.52120	0.00477	0.00210	84.27253
Diesel	Offroad	123	0.09609	0.60664	0.70468	0.00080	0.03640	0.03094	84.20580	0.00480	0.00212	84.96329
Diesel	Offroad	124	0.09687	0.61158	0.71041	0.00081	0.03669	0.03119	84.89040	0.00484	0.00214	85.65405
Diesel	Offroad	125	0.09765	0.61651	0.71614	0.00082	0.03699	0.03144	85.57500	0.00488	0.00215	86.34481
Diesel	Offroad	126	0.09844	0.62144	0.72187	0.00082	0.03729	0.03169	86.25960	0.00492	0.00217	87.03557
Diesel	Offroad	127	0.09922	0.62637	0.72759	0.00083	0.03758	0.03195	86.94420	0.00496	0.00219	87.72632
Diesel	Offroad	128	0.10000	0.63130	0.73332	0.00084	0.03788	0.03220	87.62880	0.00500	0.00220	88.41708
Diesel	Offroad	129	0.10078	0.63624	0.73905	0.00084	0.03817	0.03245	88.31340	0.00504	0.00222	89.10784
Diesel	Offroad	130	0.10156	0.64117	0.74478	0.00085	0.03847	0.03270	88.99800	0.00508	0.00224	89.79860
Diesel	Offroad	131	0.10234	0.64610	0.75051	0.00086	0.03877	0.03295	89.68260	0.00512	0.00226	90.48936
Diesel	Offroad	132	0.10312	0.65103	0.75624	0.00086	0.03906	0.03320	90.36720	0.00516	0.00227	91.18012
Diesel	Offroad	133	0.10390	0.65596	0.76197	0.00087	0.03936	0.03345	91.05180	0.00519	0.00229	91.87088
Diesel	Offroad	134	0.10469	0.66090	0.76770	0.00087	0.03965	0.03371	91.73640	0.00523	0.00231	92.56163
Diesel	Offroad	135	0.10547	0.66583	0.77343	0.00088	0.03995	0.03396	92.42100	0.00527	0.00232	93.25239
Diesel	Offroad	136	0.10625	0.67076	0.77916	0.00089	0.04025	0.03421	93.10560	0.00531	0.00234	93.94315
Diesel	Offroad	137	0.10703	0.67569	0.78489	0.00089	0.04054	0.03446	93.79020	0.00535	0.00236	94.63391
Diesel	Offroad	138	0.10781	0.68063	0.79061	0.00090	0.04084	0.03471	94.47480	0.00539	0.00238	95.32467
Diesel	Offroad	139	0.10859	0.68556	0.79634	0.00091	0.04113	0.03496	95.15940	0.00543	0.00239	96.01543
Diesel	Offroad	140	0.10937	0.69049	0.80207	0.00091	0.04143	0.03521	95.84400	0.00547	0.00241	96.70618
Diesel	Offroad	141	0.11015	0.69542	0.80780	0.00092	0.04173	0.03547	96.52860	0.00551	0.00243	97.39694
Diesel	Offroad	142	0.11094	0.70035	0.81353	0.00093	0.04202	0.03572	97.21320	0.00555	0.00245	98.08770
Diesel	Offroad	143	0.11172	0.70529	0.81926	0.00093	0.04232	0.03597	97.89780	0.00559	0.00246	98.77846
Diesel	Offroad	144	0.11250	0.71022	0.82499	0.00094	0.04261	0.03622	98.58240	0.00562	0.00248	99.46922
Diesel	Offroad	145	0.11328	0.71515	0.83072	0.00095	0.04291	0.03647	99.26700	0.00566	0.00250	100.15998
Diesel	Offroad	146	0.11406	0.72008	0.83645	0.00095	0.04320	0.03672	99.95160	0.00570	0.00251	100.85074
Diesel	Offroad	147	0.11484	0.72501	0.84218	0.00096	0.04350	0.03698	100.63620	0.00574	0.00253	101.54149
Diesel	Offroad	148	0.11562	0.72995	0.84791	0.00097	0.04380	0.03723	101.32080	0.00578	0.00255	102.23225
Diesel	Offroad	149	0.11640	0.73488	0.85363	0.00097	0.04409	0.03748	102.00540	0.00582	0.00257	102.92301
Diesel	Offroad	150	0.11719	0.73981	0.85936	0.00098	0.04439	0.03773	102.69000	0.00586	0.00258	103.61377
Diesel	Offroad	151	0.11797	0.74474	0.86509	0.00099	0.04468	0.03798	103.37460	0.00590	0.00260	104.30453
Diesel	Offroad	152	0.11875	0.74967	0.87082	0.00099	0.04498	0.03823	104.05920	0.00594	0.00262	104.99529
Diesel	Offroad	153	0.11953	0.75461	0.87655	0.00100	0.04528	0.03848	104.74380	0.00598	0.00263	105.68604
Diesel	Offroad	154	0.12031	0.75954	0.88228	0.00101	0.04557	0.03874	105.42840	0.00602	0.00265	106.37680
Diesel	Offroad	155	0.12109	0.76447	0.88801	0.00101	0.04587	0.03899	106.11300	0.00605	0.00267	107.06756
Diesel	Offroad	156	0.12187	0.76940	0.89374	0.00102	0.04616	0.03924	106.79760	0.00609	0.00269	107.75832
Diesel	Offroad	157	0.12265	0.77433	0.89947	0.00102	0.04646	0.03949	107.48220	0.00613	0.00270	108.44908
Diesel	Offroad	158	0.12344	0.77927	0.90520	0.00103	0.04676	0.03974	108.16680	0.00617	0.00272	109.13984
Diesel	Offroad	159	0.12422	0.78420	0.91093	0.00104	0.04705	0.03999	108.85140	0.00621	0.00274	109.83060
Diesel	Offroad	160	0.12500	0.78913	0.91665	0.00104	0.04735	0.04025	109.53600	0.00625	0.00276	110.52135
Diesel	Offroad	161	0.12578	0.79406	0.92238	0.00105	0.04764	0.04050	110.22060	0.00629	0.00277	111.21211
Diesel	Offroad	162	0.12656	0.79899	0.92811	0.00106	0.04794	0.04075	110.90520	0.00633	0.00279	111.90287
Diesel	Offroad	163	0.12734	0.80393	0.93384	0.00106	0.04824	0.04100	111.58980	0.00637	0.00281	112.59363
Diesel	Offroad	164	0.12812	0.80886	0.93957	0.00107	0.04853	0.04125	112.27440	0.00641	0.00282	113.28439
Diesel	Offroad	165	0.12890	0.81379	0.94530	0.00108	0.04883	0.04150	112.95900	0.00644	0.00284	113.97515
Diesel	Offroad	166	0.12969	0.81872	0.95103	0.00108	0.04912	0.04175	113.64360	0.00648	0.00286	114.66590
Diesel	Offroad	167	0.13047	0.82366	0.95676	0.00109	0.04942	0.04201	114.32820	0.00652	0.00288	115.35666
Diesel	Offroad	168	0.13125	0.82859	0.96249	0.00110	0.04972	0.04226	115.01280	0.00656	0.00289	116.04742
Diesel	Offroad	169	0.13203	0.83352	0.96822	0.00110	0.05001	0.04251	115.69740	0.00660	0.00291	116.73818
Diesel	Offroad	170	0.13281	0.83845	0.97395	0.00111	0.05031	0.04276	116.38200	0.00664	0.00293	117.42894
Diesel	Offroad	171	0.13359	0.84338	0.97967	0.00112	0.05060	0.04301	117.06660	0.00668	0.00294	118.11970
Diesel	Offroad	172	0.13437	0.84832	0.98540	0.00112	0.05090	0.04326	117.75120	0.00672	0.00296	118.81046
Diesel	Offroad	173	0.13515	0.85325	0.99113	0.00113	0.05119	0.04352	118.43580	0.00676	0.00298	119.50121
Diesel	Offroad	174	0.13594	0.85818	0.99686	0.00114	0.05149	0.04377	119.12040	0.00680	0.00300	120.19197
Diesel	**Offroad**	**175**	**0.13672**	**0.60418**	**1.00259**	**0.00114**	**0.03452**	**0.02935**	**119.80500**	**0.00684**	**0.00301**	**120.88273**
Diesel	Offroad	176	0.13750	0.60763	1.00832	0.00115	0.03472	0.02951	120.48960	0.00687	0.00303	121.57349
Diesel	Offroad	177	0.13828	0.61108	1.01405	0.00116	0.03492	0.02968	121.17420	0.00691	0.00305	122.26425
Diesel	Offroad	178	0.13906	0.61454	1.01978	0.00116	0.03512	0.02985	121.85880	0.00695	0.00307	122.95501
Diesel	Offroad	179	0.13984	0.61799	1.02551	0.00117	0.03531	0.03002	122.54340	0.00699	0.00308	123.64576
Diesel	Offroad	180	0.14062	0.62144	1.03124	0.00118	0.03551	0.03018	123.22800	0.00703	0.00310	124.33652
Diesel	Offroad	181	0.14140	0.62489	1.03697	0.00118	0.03571	0.03035	123.91260	0.00707	0.00312	125.02728
Diesel	Offroad	182	0.14219	0.62835	1.04269	0.00119	0.03591	0.03052	124.59720	0.00711	0.00313	125.71804
Diesel	Offroad	183	0.14297	0.63180	1.04842	0.00119	0.03610	0.03069	125.28180	0.00715	0.00315	126.40880
Diesel	Offroad	184	0.14375	0.63525	1.05415	0.00120	0.03630	0.03086	125.96640	0.00719	0.00317	127.09956

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
Diesel	Offroad	185	0.14453	0.63870	1.05988	0.00121	0.03650	0.03102	126.65100	0.00723	0.00319	127.79032
Diesel	Offroad	186	0.14531	0.64216	1.06561	0.00121	0.03669	0.03119	127.33560	0.00727	0.00320	128.48107
Diesel	Offroad	187	0.14609	0.64561	1.07134	0.00122	0.03689	0.03136	128.02020	0.00730	0.00322	129.17183
Diesel	Offroad	188	0.14687	0.64906	1.07707	0.00123	0.03709	0.03153	128.70480	0.00734	0.00324	129.86259
Diesel	Offroad	189	0.14765	0.65251	1.08280	0.00123	0.03729	0.03169	129.38940	0.00738	0.00325	130.55335
Diesel	Offroad	190	0.14844	0.65596	1.08853	0.00124	0.03748	0.03186	130.07400	0.00742	0.00327	131.24411
Diesel	Offroad	191	0.14922	0.65942	1.09426	0.00125	0.03768	0.03203	130.75860	0.00746	0.00329	131.93487
Diesel	Offroad	192	0.15000	0.66287	1.09999	0.00125	0.03788	0.03220	131.44320	0.00750	0.00331	132.62562
Diesel	Offroad	193	0.15078	0.66632	1.10571	0.00126	0.03808	0.03236	132.12780	0.00754	0.00332	133.31638
Diesel	Offroad	194	0.15156	0.66977	1.11144	0.00127	0.03827	0.03253	132.81240	0.00758	0.00334	134.00714
Diesel	Offroad	195	0.15234	0.67323	1.11717	0.00127	0.03847	0.03270	133.49700	0.00762	0.00336	134.69790
Diesel	Offroad	196	0.15312	0.67668	1.12290	0.00128	0.03867	0.03287	134.18160	0.00766	0.00338	135.38866
Diesel	Offroad	197	0.15390	0.68013	1.12863	0.00129	0.03886	0.03303	134.86620	0.00769	0.00339	136.07942
Diesel	Offroad	198	0.15469	0.68358	1.13436	0.00129	0.03906	0.03320	135.55080	0.00773	0.00341	136.77018
Diesel	Offroad	199	0.15547	0.68704	1.14009	0.00130	0.03926	0.03337	136.23540	0.00777	0.00343	137.46093
Diesel	Offroad	200	0.15625	0.69049	1.14582	0.00131	0.03946	0.03354	136.92000	0.00781	0.00344	138.15169
Diesel	Offroad	201	0.15703	0.69394	1.15155	0.00131	0.03965	0.03371	137.60460	0.00785	0.00346	138.84245
Diesel	Offroad	202	0.15781	0.69739	1.15728	0.00132	0.03985	0.03387	138.28920	0.00789	0.00348	139.53321
Diesel	Offroad	203	0.15859	0.70085	1.16301	0.00133	0.04005	0.03404	138.97380	0.00793	0.00350	140.22397
Diesel	Offroad	204	0.15937	0.70430	1.16873	0.00133	0.04025	0.03421	139.65840	0.00797	0.00351	140.91473
Diesel	Offroad	205	0.16015	0.70775	1.17446	0.00134	0.04044	0.03438	140.34300	0.00801	0.00353	141.60548
Diesel	Offroad	206	0.16094	0.71120	1.18019	0.00134	0.04064	0.03454	141.02760	0.00805	0.00355	142.29624
Diesel	Offroad	207	0.16172	0.71466	1.18592	0.00135	0.04084	0.03471	141.71220	0.00809	0.00356	142.98700
Diesel	Offroad	208	0.16250	0.71811	1.19165	0.00136	0.04103	0.03488	142.39680	0.00812	0.00358	143.67776
Diesel	Offroad	209	0.16328	0.72156	1.19738	0.00136	0.04123	0.03505	143.08140	0.00816	0.00360	144.36852
Diesel	Offroad	210	0.16406	0.72501	1.20311	0.00137	0.04143	0.03521	143.76600	0.00820	0.00362	145.05928
Diesel	Offroad	211	0.16484	0.72847	1.20884	0.00138	0.04163	0.03538	144.45060	0.00824	0.00363	145.75004
Diesel	Offroad	212	0.16562	0.73192	1.21457	0.00138	0.04182	0.03555	145.13520	0.00828	0.00365	146.44079
Diesel	Offroad	213	0.16640	0.73537	1.22030	0.00139	0.04202	0.03572	145.81980	0.00832	0.00367	147.13155
Diesel	Offroad	214	0.16719	0.73882	1.22603	0.00140	0.04222	0.03589	146.50440	0.00836	0.00369	147.82231
Diesel	Offroad	215	0.16797	0.74228	1.23175	0.00140	0.04242	0.03605	147.18900	0.00840	0.00370	148.51307
Diesel	Offroad	216	0.16875	0.74573	1.23748	0.00141	0.04261	0.03622	147.87360	0.00844	0.00372	149.20383
Diesel	Offroad	217	0.16953	0.74918	1.24321	0.00142	0.04281	0.03639	148.55820	0.00848	0.00374	149.89459
Diesel	Offroad	218	0.17031	0.75263	1.24894	0.00142	0.04301	0.03656	149.24280	0.00852	0.00375	150.58534
Diesel	Offroad	219	0.17109	0.75609	1.25467	0.00143	0.04320	0.03672	149.92740	0.00855	0.00377	151.27610
Diesel	Offroad	220	0.17187	0.75954	1.26040	0.00144	0.04340	0.03689	150.61200	0.00859	0.00379	151.96686
Diesel	Offroad	221	0.17265	0.76299	1.26613	0.00144	0.04360	0.03706	151.29660	0.00863	0.00381	152.65762
Diesel	Offroad	222	0.17344	0.76644	1.27186	0.00145	0.04380	0.03723	151.98120	0.00867	0.00382	153.34838
Diesel	Offroad	223	0.17422	0.76990	1.27759	0.00146	0.04399	0.03739	152.66580	0.00871	0.00384	154.03914
Diesel	Offroad	224	0.17500	0.77335	1.28332	0.00146	0.04419	0.03756	153.35040	0.00875	0.00386	154.72990
Diesel	Offroad	225	0.17578	0.77680	1.28905	0.00147	0.04439	0.03773	154.03500	0.00879	0.00387	155.42065
Diesel	Offroad	226	0.17656	0.78025	1.29477	0.00148	0.04459	0.03790	154.71960	0.00883	0.00389	156.11141
Diesel	Offroad	227	0.17734	0.78371	1.30050	0.00148	0.04478	0.03807	155.40420	0.00887	0.00391	156.80217
Diesel	Offroad	228	0.17812	0.78716	1.30623	0.00149	0.04498	0.03823	156.08880	0.00891	0.00393	157.49293
Diesel	Offroad	229	0.17890	0.79061	1.31196	0.00150	0.04518	0.03840	156.77340	0.00894	0.00394	158.18369
Diesel	Offroad	230	0.17969	0.79406	1.31769	0.00150	0.04538	0.03857	157.45800	0.00898	0.00396	158.87445
Diesel	Offroad	231	0.18047	0.79752	1.32342	0.00151	0.04557	0.03874	158.14260	0.00902	0.00398	159.56520
Diesel	Offroad	232	0.18125	0.80097	1.32915	0.00151	0.04577	0.03890	158.82720	0.00906	0.00400	160.25596
Diesel	Offroad	233	0.18203	0.80442	1.33488	0.00152	0.04597	0.03907	159.51180	0.00910	0.00401	160.94672
Diesel	Offroad	234	0.18281	0.80787	1.34061	0.00153	0.04616	0.03924	160.19640	0.00914	0.00403	161.63748
Diesel	Offroad	235	0.18359	0.81133	1.34634	0.00153	0.04636	0.03941	160.88100	0.00918	0.00405	162.32824
Diesel	Offroad	236	0.18437	0.81478	1.35207	0.00154	0.04656	0.03957	161.56560	0.00922	0.00406	163.01900
Diesel	Offroad	237	0.18515	0.81823	1.35779	0.00155	0.04676	0.03974	162.25020	0.00926	0.00408	163.70976
Diesel	Offroad	238	0.18593	0.82168	1.36352	0.00155	0.04695	0.03991	162.93480	0.00930	0.00410	164.40051
Diesel	Offroad	239	0.18672	0.82513	1.36925	0.00156	0.04715	0.04008	163.61940	0.00934	0.00412	165.09127
Diesel	Offroad	240	0.18750	0.82859	1.37498	0.00157	0.04735	0.04025	164.30400	0.00937	0.00413	165.78203
Diesel	Offroad	241	0.18828	0.83204	1.38071	0.00157	0.04755	0.04041	164.98860	0.00941	0.00415	166.47279
Diesel	Offroad	242	0.18906	0.83549	1.38644	0.00158	0.04774	0.04058	165.67320	0.00945	0.00417	167.16355
Diesel	Offroad	243	0.18984	0.83894	1.39217	0.00159	0.04794	0.04075	166.35780	0.00949	0.00418	167.85431
Diesel	Offroad	244	0.19062	0.84240	1.39790	0.00159	0.04814	0.04092	167.04240	0.00953	0.00420	168.54506
Diesel	Offroad	245	0.19140	0.84585	1.40363	0.00160	0.04833	0.04108	167.72700	0.00957	0.00422	169.23582
Diesel	Offroad	246	0.19218	0.84930	1.40936	0.00161	0.04853	0.04125	168.41160	0.00961	0.00424	169.92658
Diesel	Offroad	247	0.19297	0.85275	1.41509	0.00161	0.04873	0.04142	169.09620	0.00965	0.00425	170.61734
Diesel	Offroad	248	0.19375	0.85621	1.42081	0.00162	0.04893	0.04159	169.78080	0.00969	0.00427	171.30810
Diesel	Offroad	249	0.19453	0.85966	1.42654	0.00163	0.04912	0.04175	170.46540	0.00973	0.00429	171.99886
Diesel	Offroad	250	0.19531	0.86311	1.43227	0.00163	0.04932	0.04192	171.15000	0.00977	0.00431	172.68962
Diesel	Offroad	251	0.19609	0.86656	1.43800	0.00164	0.04952	0.04209	171.83460	0.00980	0.00432	173.38037
Diesel	Offroad	252	0.19687	0.87002	1.44373	0.00165	0.04972	0.04226	172.51920	0.00984	0.00434	174.07113
Diesel	Offroad	253	0.19765	0.87347	1.44946	0.00165	0.04991	0.04243	173.20380	0.00988	0.00436	174.76189
Diesel	Offroad	254	0.19843	0.87692	1.45519	0.00166	0.05011	0.04259	173.88840	0.00992	0.00437	175.45265
Diesel	Offroad	255	0.19922	0.88037	1.46092	0.00166	0.05031	0.04276	174.57300	0.00996	0.00439	176.14341
Diesel	Offroad	256	0.20000	0.88383	1.46665	0.00167	0.05050	0.04293	175.25760	0.01000	0.00441	176.83417
Diesel	Offroad	257	0.20078	0.88728	1.47238	0.00168	0.05070	0.04310	175.94220	0.01004	0.00443	177.52492
Diesel	Offroad	258	0.20156	0.89073	1.47811	0.00168	0.05090	0.04326	176.62680	0.01008	0.00444	178.21568
Diesel	Offroad	259	0.20234	0.89418	1.48383	0.00169	0.05110	0.04343	177.31140	0.01012	0.00446	178.90644
Diesel	Offroad	260	0.20312	0.89764	1.48956	0.00170	0.05129	0.04360	177.99600	0.01016	0.00448	179.59720
Diesel	Offroad	261	0.20390	0.90109	1.49529	0.00170	0.05149	0.04377	178.68060	0.01019	0.00449	180.28796
Diesel	Offroad	262	0.20468	0.90454	1.50102	0.00171	0.05169	0.04393	179.36520	0.01023	0.00451	180.97872

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
Diesel	Offroad	263	0.20547	0.90799	1.50675	0.00172	0.05189	0.04410	180.04980	0.01027	0.00453	181.66947
Diesel	Offroad	264	0.20625	0.91145	1.51248	0.00172	0.05208	0.04427	180.73440	0.01031	0.00455	182.36023
Diesel	Offroad	265	0.20703	0.91490	1.51821	0.00173	0.05228	0.04444	181.41900	0.01035	0.00456	183.05099
Diesel	Offroad	266	0.20781	0.91835	1.52394	0.00174	0.05248	0.04461	182.10360	0.01039	0.00458	183.74175
Diesel	Offroad	267	0.20859	0.92180	1.52967	0.00174	0.05267	0.04477	182.78820	0.01043	0.00460	184.43251
Diesel	Offroad	268	0.20937	0.92526	1.53540	0.00175	0.05287	0.04494	183.47280	0.01047	0.00461	185.12327
Diesel	Offroad	269	0.21015	0.92871	1.54113	0.00176	0.05307	0.04511	184.15740	0.01051	0.00463	185.81403
Diesel	Offroad	270	0.21093	0.93216	1.54685	0.00176	0.05327	0.04528	184.84200	0.01055	0.00465	186.50478
Diesel	Offroad	271	0.21172	0.93561	1.55258	0.00177	0.05346	0.04544	185.52660	0.01059	0.00467	187.19554
Diesel	Offroad	272	0.21250	0.93907	1.55831	0.00178	0.05366	0.04561	186.21120	0.01062	0.00468	187.88630
Diesel	Offroad	273	0.21328	0.94252	1.56404	0.00178	0.05386	0.04578	186.89580	0.01066	0.00470	188.57706
Diesel	Offroad	274	0.21406	0.94597	1.56977	0.00179	0.05406	0.04595	187.58040	0.01070	0.00472	189.26782
Diesel	Offroad	275	0.21484	0.94942	1.57550	0.00180	0.05425	0.04611	188.26500	0.01074	0.00474	189.95858
Diesel	Offroad	276	0.21562	0.95288	1.58123	0.00180	0.05445	0.04628	188.94960	0.01078	0.00475	190.64933
Diesel	Offroad	277	0.21640	0.95633	1.58696	0.00181	0.05465	0.04645	189.63420	0.01082	0.00477	191.34009
Diesel	Offroad	278	0.21718	0.95978	1.59269	0.00181	0.05484	0.04662	190.31880	0.01086	0.00479	192.03085
Diesel	Offroad	279	0.21797	0.96323	1.59842	0.00182	0.05504	0.04679	191.00340	0.01090	0.00480	192.72161
Diesel	Offroad	280	0.21875	0.96669	1.60415	0.00183	0.05524	0.04695	191.68800	0.01094	0.00482	193.41237
Diesel	Offroad	281	0.21953	0.97014	1.60987	0.00183	0.05544	0.04712	192.37260	0.01098	0.00484	194.10313
Diesel	Offroad	282	0.22031	0.97359	1.61560	0.00184	0.05563	0.04729	193.05720	0.01101	0.00486	194.79389
Diesel	Offroad	283	0.22109	0.97704	1.62133	0.00185	0.05583	0.04746	193.74180	0.01105	0.00487	195.48464
Diesel	Offroad	284	0.22187	0.98050	1.62706	0.00185	0.05603	0.04762	194.42640	0.01109	0.00489	196.17540
Diesel	Offroad	285	0.22265	0.98395	1.63279	0.00186	0.05623	0.04779	195.11100	0.01113	0.00491	196.86616
Diesel	Offroad	286	0.22343	0.98740	1.63852	0.00187	0.05642	0.04796	195.79560	0.01117	0.00492	197.55692
Diesel	Offroad	287	0.22422	0.99085	1.64425	0.00187	0.05662	0.04813	196.48020	0.01121	0.00494	198.24768
Diesel	Offroad	288	0.22500	0.99430	1.64998	0.00188	0.05682	0.04829	197.16480	0.01125	0.00496	198.93844
Diesel	Offroad	289	0.22578	0.99776	1.65571	0.00189	0.05701	0.04846	197.84940	0.01129	0.00498	199.62919
Diesel	Offroad	290	0.22656	1.00121	1.66144	0.00189	0.05721	0.04863	198.53400	0.01133	0.00499	200.31995
Diesel	Offroad	291	0.22734	1.00466	1.66717	0.00190	0.05741	0.04880	199.21860	0.01137	0.00501	201.01071
Diesel	Offroad	292	0.22812	1.00811	1.67289	0.00191	0.05761	0.04897	199.90320	0.01141	0.00503	201.70147
Diesel	Offroad	293	0.22890	1.01157	1.67862	0.00191	0.05780	0.04913	200.58780	0.01144	0.00505	202.39223
Diesel	Offroad	294	0.22968	1.01502	1.68435	0.00192	0.05800	0.04930	201.27240	0.01148	0.00506	203.08299
Diesel	Offroad	295	0.23047	1.01847	1.69008	0.00193	0.05820	0.04947	201.95700	0.01152	0.00508	203.77375
Diesel	Offroad	296	0.23125	1.02192	1.69581	0.00193	0.05840	0.04964	202.64160	0.01156	0.00510	204.46450
Diesel	Offroad	297	0.23203	1.02538	1.70154	0.00194	0.05859	0.04980	203.32620	0.01160	0.00511	205.15526
Diesel	Offroad	298	0.23281	1.02883	1.70727	0.00195	0.05879	0.04997	204.01080	0.01164	0.00513	205.84602
Diesel	Offroad	299	0.23359	1.03228	1.71300	0.00195	0.05899	0.05014	204.69540	0.01168	0.00515	206.53678
Diesel	**Offroad**	**300**	**0.22727**	**1.03573**	**1.66664**	**0.00196**	**0.05918**	**0.05031**	**205.38000**	**0.01172**	**0.00517**	**207.22754**
Diesel	Offroad	310	0.23485	1.07026	1.72220	0.00202	0.06116	0.05198	212.22600	0.01211	0.00534	214.13512
Diesel	Offroad	320	0.24242	1.10478	1.77775	0.00209	0.06313	0.05366	219.07200	0.01250	0.00551	221.04271
Diesel	Offroad	330	0.25000	1.13931	1.83331	0.00215	0.06510	0.05534	225.91800	0.01289	0.00568	227.95029
Diesel	Offroad	340	0.25757	1.17383	1.88886	0.00222	0.06708	0.05701	232.76400	0.01328	0.00585	234.85788
Diesel	Offroad	350	0.26515	1.20836	1.94442	0.00228	0.06905	0.05869	239.61000	0.01367	0.00603	241.76546
Diesel	Offroad	360	0.27272	1.24288	1.99997	0.00235	0.07102	0.06037	246.45600	0.01406	0.00620	248.67305
Diesel	Offroad	370	0.28030	1.27741	2.05553	0.00242	0.07299	0.06205	253.30200	0.01445	0.00637	255.58063
Diesel	Offroad	380	0.28787	1.31193	2.11108	0.00248	0.07497	0.06372	260.14800	0.01484	0.00654	262.48821
Diesel	Offroad	390	0.29545	1.34645	2.16664	0.00255	0.07694	0.06540	266.99400	0.01523	0.00672	269.39580
Diesel	Offroad	400	0.30303	1.38098	2.22219	0.00261	0.07891	0.06708	273.84000	0.01562	0.00689	276.30338
Diesel	Offroad	410	0.31060	1.41550	2.27775	0.00268	0.08089	0.06875	280.68600	0.01601	0.00706	283.21097
Diesel	Offroad	420	0.31818	1.45003	2.33330	0.00274	0.08286	0.07043	287.53200	0.01641	0.00723	290.11855
Diesel	Offroad	430	0.32575	1.48455	2.38886	0.00281	0.08483	0.07211	294.37800	0.01680	0.00740	297.02614
Diesel	Offroad	440	0.33333	1.51908	2.44441	0.00287	0.08680	0.07378	301.22400	0.01719	0.00758	303.93372
Diesel	Offroad	450	0.34090	1.55360	2.49997	0.00294	0.08878	0.07546	308.07000	0.01758	0.00775	310.84131
Diesel	Offroad	460	0.34848	1.58813	2.55552	0.00300	0.09075	0.07714	314.91600	0.01797	0.00792	317.74889
Diesel	Offroad	470	0.35606	1.62265	2.61108	0.00307	0.09272	0.07881	321.76200	0.01836	0.00809	324.65648
Diesel	Offroad	480	0.36363	1.65717	2.66663	0.00313	0.09470	0.08049	328.60800	0.01875	0.00827	331.56406
Diesel	Offroad	490	0.37121	1.69170	2.72219	0.00320	0.09667	0.08217	335.45400	0.01914	0.00844	338.47165
Diesel	Offroad	500	0.37878	1.72622	2.77774	0.00326	0.09864	0.08385	342.30000	0.01953	0.00861	345.37923
Diesel	Offroad	510	0.38636	1.76075	2.83330	0.00333	0.10061	0.08552	349.14600	0.01992	0.00878	352.28681
Diesel	Offroad	520	0.39393	1.79527	2.88885	0.00339	0.10259	0.08720	355.99200	0.02031	0.00895	359.19440
Diesel	Offroad	530	0.40151	1.82980	2.94440	0.00346	0.10456	0.08888	362.83800	0.02070	0.00913	366.10198
Diesel	Offroad	540	0.40909	1.86432	2.99996	0.00353	0.10653	0.09055	369.68400	0.02109	0.00930	373.00957
Diesel	Offroad	550	0.41666	1.89885	3.05551	0.00359	0.10851	0.09223	376.53000	0.02148	0.00947	379.91715
Diesel	Offroad	560	0.42424	1.93337	3.11107	0.00366	0.11048	0.09391	383.37600	0.02187	0.00964	386.82474
Diesel	Offroad	570	0.43181	1.96789	3.16662	0.00372	0.11245	0.09558	390.22200	0.02226	0.00982	393.73232
Diesel	Offroad	580	0.43939	2.00242	3.22218	0.00379	0.11442	0.09726	397.06800	0.02265	0.00999	400.63991
Diesel	Offroad	590	0.44696	2.03694	3.27773	0.00385	0.11640	0.09894	403.91400	0.02305	0.01016	407.54749
Diesel	**Offroad**	**600**	**0.45454**	**2.07147**	**3.33329**	**0.00392**	**0.11837**	**0.10061**	**410.76000**	**0.02344**	**0.01033**	**414.45508**
Diesel	Offroad	610	0.46211	2.10599	3.38884	0.00398	0.12034	0.10229	417.60600	0.02383	0.01050	421.36266
Diesel	Offroad	620	0.46969	2.14052	3.44440	0.00405	0.12232	0.10397	424.45200	0.02422	0.01068	428.27025
Diesel	Offroad	630	0.47727	2.17504	3.49995	0.00411	0.12429	0.10564	431.29800	0.02461	0.01085	435.17783
Diesel	Offroad	640	0.48484	2.20957	3.55551	0.00418	0.12626	0.10732	438.14400	0.02500	0.01102	442.08541
Diesel	Offroad	650	0.49242	2.24409	3.61106	0.00424	0.12823	0.10900	444.99000	0.02539	0.01119	448.99300
Diesel	Offroad	660	0.49999	2.27862	3.66662	0.00431	0.13021	0.11068	451.83600	0.02578	0.01137	455.90058
Diesel	Offroad	670	0.50757	2.31314	3.72217	0.00437	0.13218	0.11235	458.68200	0.02617	0.01154	462.80817
Diesel	Offroad	680	0.51514	2.34766	3.77773	0.00444	0.13415	0.11403	465.52800	0.02656	0.01171	469.71575
Diesel	Offroad	690	0.52272	2.38219	3.83328	0.00450	0.13613	0.11571	472.37400	0.02695	0.01188	476.62334
Diesel	Offroad	700	0.53030	2.41671	3.88884	0.00457	0.13810	0.11738	479.22000	0.02734	0.01205	483.53092

Factors

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
Diesel	Offroad	710	0.53787	2.45124	3.94439	0.00464	0.14007	0.11906	486.06600	0.02773	0.01223	490.43851
Diesel	Offroad	720	0.54545	2.48576	3.99995	0.00470	0.14204	0.12074	492.91200	0.02812	0.01240	497.34609
Diesel	Offroad	730	0.55302	2.52029	4.05550	0.00477	0.14402	0.12241	499.75800	0.02851	0.01257	504.25368
Diesel	Offroad	740	0.56060	2.55481	4.11106	0.00483	0.14599	0.12409	506.60400	0.02890	0.01274	511.16126
Diesel	**Offroad**	**750**	**0.56817**	**2.58934**	**4.16661**	**0.00490**	**0.14796**	**0.12577**	**513.45000**	**0.02930**	**0.01292**	**518.06885**
Diesel	Offroad	760	0.57575	2.62386	4.22217	0.00496	0.14993	0.12744	520.29600	0.02969	0.01309	524.97643
Diesel	Offroad	770	0.58333	2.65838	4.27772	0.00503	0.15191	0.12912	527.14200	0.03008	0.01326	531.88401
Diesel	Offroad	780	0.59090	2.69291	4.33327	0.00509	0.15388	0.13080	533.98800	0.03047	0.01343	538.79160
Diesel	Offroad	790	0.59848	2.72743	4.38883	0.00516	0.15585	0.13248	540.83400	0.03086	0.01360	545.69918
Diesel	Offroad	800	0.60605	2.76196	4.44438	0.00522	0.15783	0.13415	547.68000	0.03125	0.01378	552.60677
Diesel	Offroad	810	0.61363	2.79648	4.49994	0.00529	0.15980	0.13583	554.52600	0.03164	0.01395	559.51435
Diesel	Offroad	820	0.62120	2.83101	4.55549	0.00535	0.16177	0.13751	561.37200	0.03203	0.01412	566.42194
Diesel	Offroad	830	0.62878	2.86553	4.61105	0.00542	0.16374	0.13918	568.21800	0.03242	0.01429	573.32952
Diesel	Offroad	840	0.63636	2.90006	4.66660	0.00548	0.16572	0.14086	575.06400	0.03281	0.01446	580.23711
Diesel	Offroad	850	0.64393	2.93458	4.72216	0.00555	0.16769	0.14254	581.91000	0.03320	0.01464	587.14469
Diesel	Offroad	860	0.65151	2.96910	4.77771	0.00561	0.16966	0.14421	588.75600	0.03359	0.01481	594.05228
Diesel	Offroad	870	0.65908	3.00363	4.83327	0.00568	0.17164	0.14589	595.60200	0.03398	0.01498	600.95986
Diesel	Offroad	880	0.66666	3.03815	4.88882	0.00575	0.17361	0.14757	602.44800	0.03437	0.01515	607.86744
Diesel	Offroad	890	0.67423	3.07268	4.94438	0.00581	0.17558	0.14924	609.29400	0.03476	0.01533	614.77503
Diesel	Offroad	900	0.68181	3.10720	4.99993	0.00588	0.17755	0.15092	616.14000	0.03515	0.01550	621.68261
Diesel	Offroad	910	0.68938	3.14173	5.05549	0.00594	0.17953	0.15260	622.98600	0.03554	0.01567	628.59020
Diesel	Offroad	920	0.69696	3.17625	5.11104	0.00601	0.18150	0.15428	629.83200	0.03594	0.01584	635.49778
Diesel	Offroad	930	0.70454	3.21078	5.16660	0.00607	0.18347	0.15595	636.67800	0.03633	0.01601	642.40537
Diesel	Offroad	940	0.71211	3.24530	5.22215	0.00614	0.18545	0.15763	643.52400	0.03672	0.01619	649.31295
Diesel	Offroad	950	0.71969	3.27982	5.27771	0.00620	0.18742	0.15931	650.37000	0.03711	0.01636	656.22054
Diesel	Offroad	960	0.72726	3.31435	5.33326	0.00627	0.18939	0.16098	657.21600	0.03750	0.01653	663.12812
Diesel	Offroad	970	0.73484	3.34887	5.38882	0.00633	0.19136	0.16266	664.06200	0.03789	0.01670	670.03571
Diesel	Offroad	980	0.74241	3.38340	5.44437	0.00640	0.19334	0.16434	670.90800	0.03828	0.01688	676.94329
Diesel	Offroad	990	0.74999	3.41792	5.49993	0.00646	0.19531	0.16601	677.75400	0.03867	0.01705	683.85088
Diesel	Offroad	1000	0.75757	3.45245	5.55548	0.00653	0.19728	0.16769	684.60000	0.03906	0.01722	690.75846
Diesel	Offroad	1010	0.76514	3.48697	5.61104	0.00659	0.19926	0.16937	691.44600	0.03945	0.01739	697.66604
Diesel	Offroad	1020	0.77272	3.52150	5.66659	0.00666	0.20123	0.17104	698.29200	0.03984	0.01756	704.57363
Diesel	Offroad	1030	0.78029	3.55602	5.72215	0.00672	0.20320	0.17272	705.13800	0.04023	0.01774	711.48121
Diesel	Offroad	1040	0.78787	3.59055	5.77770	0.00679	0.20517	0.17440	711.98400	0.04062	0.01791	718.38880
Diesel	Offroad	1050	0.79544	3.62507	5.83325	0.00685	0.20715	0.17607	718.83000	0.04101	0.01808	725.29638
Diesel	Offroad	1060	0.80302	3.65959	5.88881	0.00692	0.20912	0.17775	725.67600	0.04140	0.01825	732.20397
Diesel	Offroad	1070	0.81060	3.69412	5.94436	0.00699	0.21109	0.17943	732.52200	0.04179	0.01843	739.11155
Diesel	Offroad	1080	0.81817	3.72864	5.99992	0.00705	0.21307	0.18111	739.36800	0.04218	0.01860	746.01914
Diesel	Offroad	1090	0.82575	3.76317	6.05547	0.00712	0.21504	0.18278	746.21400	0.04258	0.01877	752.92672
Diesel	Offroad	1100	0.83332	3.79769	6.11103	0.00718	0.21701	0.18446	753.06000	0.04297	0.01894	759.83431
Diesel	Offroad	1110	0.84090	3.83222	6.16658	0.00725	0.21898	0.18614	759.90600	0.04336	0.01911	766.74189
Diesel	Offroad	1120	0.84847	3.86674	6.22214	0.00731	0.22096	0.18781	766.75200	0.04375	0.01929	773.64948
Diesel	Offroad	1130	0.85605	3.90127	6.27769	0.00738	0.22293	0.18949	773.59800	0.04414	0.01946	780.55706
Diesel	Offroad	1140	0.86362	3.93579	6.33325	0.00744	0.22490	0.19117	780.44400	0.04453	0.01963	787.46464
Diesel	Offroad	1150	0.87120	3.97031	6.38880	0.00751	0.22688	0.19284	787.29000	0.04492	0.01980	794.37223
Diesel	Offroad	1160	0.87878	4.00484	6.44436	0.00757	0.22885	0.19452	794.13600	0.04531	0.01998	801.27981
Diesel	Offroad	1170	0.88635	4.03936	6.49991	0.00764	0.23082	0.19620	800.98200	0.04570	0.02015	808.18740
Diesel	Offroad	1180	0.89393	4.07389	6.55547	0.00770	0.23279	0.19787	807.82800	0.04609	0.02032	815.09498
Diesel	Offroad	1190	0.90150	4.10841	6.61102	0.00777	0.23477	0.19955	814.67400	0.04648	0.02049	822.00257
Diesel	Offroad	1200	0.90908	4.14294	6.66658	0.00783	0.23674	0.20123	821.52000	0.04687	0.02066	828.91015
Gasoline	**Onroad LD**	**LD**	**0.00070**	**0.00660**	**0.00065**	**0.00001**	**0.00009**	**0.00006**	**1.10257**	**0.00006**	**0.00003**	**1.11182**
Diesel	Onroad MD	MD	0.00190	0.01284	0.01425	0.00003	0.00055	0.00046	2.79845	0.00009	0.00014	2.84273
Diesel	Onroad HD	HD	0.00202	0.00846	0.02418	0.00004	0.00118	0.00101	4.21279	0.00009	0.00009	4.24176
Zero	None	0.0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Zero	Electric	0.0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

VLOOKUP Sort	Fuel List	Load Factor
2-stroke	50:1 gas/oil mix	50%
Electric	Zero	
Methane	CNG	60%
None	Zero	
Offroad	Diesel	60%
Onroad HD	Diesel	
Onroad LD	Gasoline	
Onroad MD	Diesel	
Propane	LPG	60%
Sport	Gasoline	30%
Turbine	Jet A	90%
Utility	Gasoline	50%

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
40 CFR 89.112	**Range**	**Range**	**VOC**	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
Table 1	**KW**	**BHP**	**g/kw-hr**	**g/kw-hr**	**g/kw-hr**		**g/kw-hr**					
Tier 2 (2005-07)	<8	<11	0.90	8.0	6.60	—	0.80	—	—	—	—	—
Tier 2 (2005-07)	8-19	11-25	0.90	6.6	6.60	—	0.80	—	—	—	—	—
Tier 2 (2004-07)	19-37	25-50	0.90	5.5	6.60	—	0.60	—	—	—	—	—
Tier 2 (2004-07)	37-56	50-75	0.90	5.0	6.60	—	0.40	—	—	—	—	—
Tier 2 (2004-07)	56-75	75-101	0.90	5.0	6.60	—	0.40	—	—	—	—	—
Tier 2 (2003-06)	75-130	101-174	0.79	5.0	5.81	—	0.30	—	—	—	—	—
Tier 2 (2003-05)	130-225	174-302	0.79	3.5	5.81	—	0.20	—	—	—	—	—
Tier 2 (2001-05)	225-450	302-603	0.77	3.5	5.63	—	0.20	—	—	—	—	—
Tier 2 (2002-05)	450-560	603-751	0.77	3.5	5.63	—	0.20	—	—	—	—	—
Tier 2 (2006-10)	560-900	751-1207	0.77	3.5	5.63	—	0.20	—	—	—	—	—

Engine	**Heat Rate**	**Range**	**VOC**	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
Category	**BTU/BHP-hr**	**BHP**	**lb/bhp-hr**	**lb/bhp-hr**	**lb/bhp-hr**	**lb/bhp-hr**	**lb/bhp-hr**	**lb/bhp-hr**	**lb/bhp-hr**	**lb/bhp-hr**	**lb/bhp-hr**	**lb/bhp-hr**
Offroad	8,000	5-9.9 (0.1)	8.88E-04	7.89E-03	6.51E-03	7.46E-06	7.89E-04	6.71E-04	7.82E-01	4.46E-05	1.97E-05	7.89E-01
Offroad	8,000	10-24 (1)	8.88E-04	6.51E-03	6.51E-03	7.46E-06	7.89E-04	6.71E-04	7.82E-01	4.46E-05	1.97E-05	7.89E-01
Offroad	7,000	25-49 (1)	8.88E-04	5.43E-03	6.51E-03	6.53E-06	5.92E-04	5.03E-04	6.85E-01	3.91E-05	1.72E-05	6.91E-01
Offroad	7,000	50-74 (1)	8.88E-04	4.93E-03	6.51E-03	6.53E-06	3.95E-04	3.35E-04	6.85E-01	3.91E-05	1.72E-05	6.91E-01
Offroad	7,000	75-99 (1)	8.88E-04	4.93E-03	6.51E-03	6.53E-06	3.95E-04	3.35E-04	6.85E-01	3.91E-05	1.72E-05	6.91E-01
Offroad	7,000	100-174 (1)	7.81E-04	4.93E-03	5.73E-03	6.53E-06	2.96E-04	2.52E-04	6.85E-01	3.91E-05	1.72E-05	6.91E-01
Offroad	7,000	175-299 (1)	7.81E-04	3.45E-03	5.73E-03	6.53E-06	1.97E-04	1.68E-04	6.85E-01	3.91E-05	1.72E-05	6.91E-01
Offroad	7,000	300-590 (10)	7.58E-04	3.45E-03	5.56E-03	6.53E-06	1.97E-04	1.68E-04	6.85E-01	3.91E-05	1.72E-05	6.91E-01
Offroad	7,000	600-740 (10)	7.58E-04	3.45E-03	5.56E-03	6.53E-06	1.97E-04	1.68E-04	6.85E-01	3.91E-05	1.72E-05	6.91E-01
Offroad	7,000	750-1200 (1(	7.58E-04	3.45E-03	5.56E-03	6.53E-06	1.97E-04	1.68E-04	6.85E-01	3.91E-05	1.72E-05	6.91E-01

Engine	**Heat Rate**	**Range**	**VOC**	**CO**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_20**	**CO_2 eqv**
Category	**BTU/BHP-hr**	**BHP**	**lb/bhp-hr**	**lb/bhp-hr**	**lb/bhp-hr**	**lb/bhp-hr**	**lb/bhp-hr**	**lb/bhp-hr**	**lb/bhp-hr**	**lb/bhp-hr**	**lb/bhp-hr**	**lb/bhp-hr**
2-stroke A (2005)	14,000	0.1-0.9 (0.1)	3.70E-02	6.62E-01	4.11E-03	5.95E-04	7.83E-03	5.09E-03	1.10E+00	6.23E-05	2.73E-05	1.11E+00
2-stroke B (2005)	13,000	1.0-2.9 (0.1)	3.70E-02	6.62E-01	4.11E-03	5.95E-04	7.83E-03	5.09E-03	1.02E+00	5.79E-05	2.54E-05	1.03E+00
2-stroke C (2007)	12,000	3.0-9.9 (0.1)	5.33E-02	4.96E-01	5.92E-03	5.95E-04	7.83E-03	5.09E-03	9.44E-01	5.34E-05	2.34E-05	9.52E-01
2-stroke D (2007)	10,000	10-200 (1)	5.33E-02	4.96E-01	5.92E-03	5.95E-04	7.83E-03	5.09E-03	7.87E-01	4.45E-05	1.95E-05	7.93E-01
Methane	10,000	10-200 (1)	7.94E-03	3.34E-03	5.08E-03	3.60E-06	6.00E-05	3.90E-05	7.00E-01	1.38E-05	1.20E-06	7.00E-01
Propane	10,000	10-200 (1)	7.94E-03	3.34E-03	5.08E-03	3.60E-06	6.00E-05	3.90E-05	8.23E-01	6.00E-07	1.80E-06	8.24E-01
Sport	10,000	10-500 (1,10	5.67E-03	1.88E-01	4.89E-03	2.52E-04	3.00E-04	1.95E-04	4.72E-01	2.67E-05	1.17E-05	4.76E-01
Turbine	9,000	200-1000 (1(	3.24E-06	2.61E-05	6.95E-03	1.23E-05	9.47E-05	6.16E-05	1.29E+00	3.56E-05	4.13E-05	1.30E+00
Utility A (2003)	12,000	1.0-2.9 (0.1)	6.57E-03	5.01E-01	5.60E-03	4.30E-04	4.85E-04	3.15E-04	9.44E-01	5.34E-05	2.34E-05	9.52E-01
Utility B (2005)	11,000	3.0-9.9 (0.1)	5.02E-03	5.01E-01	4.27E-03	4.30E-04	4.85E-04	3.15E-04	8.65E-01	4.90E-05	2.15E-05	8.73E-01
Utility C	10,000	10-200 (1)	9.45E-03	3.14E-01	8.15E-03	4.20E-04	5.00E-04	3.25E-04	7.87E-01	4.45E-05	1.95E-05	7.93E-01

Factors

Engine/Motor Type		Output	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Fuel	Category	BHP	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit	lbs/unit
Engine	Model	Range	VOC	CO	NO_X	SO_X	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_20	CO_2 eqv
Category	Year	BHP	lb/mile	lb/mile	lb/mile	lb/mile	lb/mile	lb/mile	lb/mile	lb/mile	lb/mile	lb/mile
Onroad	2014	LD	0.00070	0.00660	0.00065	0.00001	0.00009	0.00006	1.10257	0.00006	0.00003	1.11182
Onroad	2014	MD	0.00190	0.01284	0.01425	0.00003	0.00055	0.00046	2.79845	0.00009	0.00014	2.84273
Onroad	2014	HD	0.00202	0.00846	0.02418	0.00004	0.00118	0.00101	4.21279	0.00009	0.00009	4.24176

GHG Reference	Annex 2	Annex 3	Annex 3	AP-42/Ax2	Annex 2	Annex 3	Annex 3	Composite
Property	Carbon	CH_4	N_2O	HHV	CO_2	CH_4	N_2O	CO_2e
Units	kg/mmBTU	g/kg fuel	g/kg fuel	BTU/lb	lb/mmBTU	lb/mmBTU	lb/mmBTU	lb/mmBTU
Diesel #2	20.17	0.18	0.08	19300	163.0	0.0093	0.0041	164.47
Gasoline	19.46	0.18	0.08	20300	157.3	0.0089	0.0039	158.70
Jet A	19.70	0.087	0.10	19800	159.2	0.0044	0.0051	160.87
CNG/LNG	14.42	0.052	0.004	22400	116.6	0.0023	0.0002	116.71
LPG	16.97	0.003	0.006	21600	137.2	0.0001	0.0003	137.30

<u>Onroad Notes:</u>
Onroad CARB/SCAQMD emission factors for 2014
Onroad N_2O per Annex 3, Table A-101
Onroad HD includes tire & brake wear
Units are lb/mile

<u>Offroad Notes:</u>
Offroad diesel is Tier 2 per 40 CFR 89.112; AP-42 Table 3.3-1
Offroad gasoline (2-stroke, sport, utility) per 40 CFR 90.103; AP-42 Table 3.3-1; Hare & Springer; Nonroad Sudy Report
Offroad gaseous fuels (methane, propane) per AP-42 Table 3.2-2
Offroad CO_2 per Annex 2, Table A-43
Offroad CH_4 & N_2O per Annex 3, Table A-103
Offroad diesel exhaust $PM_{2.5}$ = 85% of PM_{10} per EMFAC 2007 version 2.3
Offroad gasoline exhaust $PM_{2.5}$ = 65% of PM_{10} per EMFAC 2007 version 2.3
Units are lb/hr

<u>Aviation Notes:</u>
Aviation per AP-42 Tables 3.1-1, -2a adjusted for Jet A fuel HHV
Aviation CO_2 per Annex 2, Table A-43
Aviation CH_4 & N_2O per Annex 3, Table A-103
Aviation exhaust $PM_{2.5}$ = 65% of PM_{10} (assumed for Jet A)
Units are lb/hr

<u>General Notes:</u>
CNG = compressed/cryrogenic natural gas
LPG = liquified petroleum/propane gas
EPA GWPs for CO_2 eqv (1, 21, 310)

Other Counties

Attainment Status - North Central Coast Air Basin (2006-08 data)		
Criteria Pollutants	Federal Standards	State Standards
	Status	Status
Ozone (O_3)	Unclassified/Attainment	Moderate Nonattainment
Carbon Monoxide (CO)	Unclassified/Attainment	Unclassified/Attainment
Nitrogen Dioxide (NO_2)	Unclassified/Attainment	Attainment
Sulfur Dioxide (SO_2)	Unclassified	Attainment
Respirable Particulates (PM_{10})	Unclassified	Nonattainment
Fine Particulates ($PM_{2.5}$)	Unclassified/Attainment	Attainment
Lead (Pb)	Unclassified/Attainment	Attainment

Source: MBUAPCD 2009, CARB 2012b

Notes:

North Central Coast Air Basin (NCCAB) - Santa Cruz, San Benito, and Monterey Counties

Santa Cruz and Monterey Counties are "moderate" nonattainment for state 1-hour ozone standard

Santa Cruz and San Benito Counties are unclassified for CO; Monterey County is attainment for CO

Effective July 26, 2007, the ARB designated the NCCAB a nonattainment area for the State ozone standard, which was revised in 2006 to include an 8-hour standard of 0.070 ppm.

On March 12, 2008, EPA adopted a new 8-hour ozone standard of 0.075 ppm, while temporarily retaining the existing 8-hour standard of 0.08 ppm. EPA is expected to issue new designations by March 2010.

In 2006, the Federal 24-hour standard for $PM_{2.5}$ was revised from 65 to 35 ug/m^3. Although final designations have yet to be made, it is expected that the NCCAB will remain designated unclassified/attainment.

On October 15, 2008 EPA substantially strengthened the national ambient air quality standard for lead by lowering the level of the primary standard from 1.5 ug/m^3 to 0.15 ug/m^3. Initial recommendations for designations are to be made by October 2009 with final designations by January 2012.

Emissions Significance Thresholds - North Central Coast Air Basin		
Criteria Emissions	Significance Thresholds	
	Pounds per Day	Tons per Year
Volatile Organic Compounds (VOC as CH_4)	137	25
Carbon Monoxide (CO)	550	100
Oxides of Nitrogen (NO_X as NO_2)	137	25
Sulfur Dioxide (SO_X as SO_2)	150	27
Respirable Particulates (PM_{10})	82	15
Fine Particulates ($PM_{2.5}$)	--	--
Lead (Pb)	--	0.6

Sources: MBUAPCD 2008, 40 CFR 51.166(b)(23)(i)

Notes:

MBUAPCD thresholds expressed in pounds per day only; applies to construction

-- No applicable threshold

Federal Prevention of Significant Deterioration (PSD) thresholds apply for CO and lead

For comparison, VOC, NO_X, SO_X, and PM_{10}, equivalent tons per year is calculated from pounds per day

For ozone nonattainment areas, thresholds apply to precursors VOC and NO_X

Other Counties

Attainment Status - Northern Sonoma County		
Criteria Emissions	Federal Standards	State Standards
	Status	Status
Ozone (O_3)	Unclassified/Attainment	Uncharacterized/Transitional
Carbon Monoxide (CO)	Unclassified/Attainment	Unclassified
Oxides of Nitrogen (NO_X as NO_2)	Unclassified/Attainment	Attainment
Sulfur Dioxide (SO_X as SO_2)	Unclassified	Attainment
Respirable Particulates (PM_{10})	Unclassified	Attainment
Fine Particulates ($PM_{2.5}$)	Unclassified/Attainment	Unclassified
Lead (Pb)	Attainment	Attainment
Source: CARB 2012b		
Notes:		
Northern Sonoma County is transitional (uncharacterized) attainment for ozone		

Emissions Significance Thresholds - Northern Sonoma County	
Criteria Emissions	Significance Threshold
	Tons per Year
Volatile Organic Compounds (VOC as CH_4)	40
Carbon Monoxide (CO)	100
Oxides of Nitrogen (NO_X as NO_2)	40
Sulfur Dioxide (SO_X as SO_2)	40
Respirable Particulates (PM_{10})	15
Fine Particulates ($PM_{2.5}$)	10
Lead (Pb)	0.6
Source: 40 CFR 51.166(b)(23)(i)	

Integrated Mosquito and Vector Management Programs

APPENDIX D

NOISE TECHNICAL REPORT

Noise Technical Report

Project Name	Integrated Mosquito and Vector Management Programs for Nine Districts
Date	June 2013

Prepared for:

Alameda County Mosquito Abatement District
Alameda County Vector Control Services District
Contra Costa Mosquito and Vector Control District
Marin/Sonoma Mosquito and Vector Control District
Napa County Mosquito Abatement District
Northern Salinas Valley Mosquito Abatement District
San Mateo County Mosquito and Vector Control District
Santa Clara County Vector Control District
Solano County Mosquito Abatement District

Prepared by:

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Table of Contents

Tables

Figures

Acronyms

°C	degrees Celsius
°F	degrees Fahrenheit
AB	Assembly Bill
ACMAD	Alameda County Mosquito Abatement District
ACVCSD	Alameda County Vector Control Services District
ADT	average daily trips
ANSI	American National Standards Institute
Caltrans	California Department of Transportation
CCMVCD	Contra Costa Mosquito and Vector Control District
CCR	California Code of Regulations
CDFG	California Department of Fish and Game
CDPH	California Department of Public Health
CDPR	California Department of Pesticide Regulation
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CNEL	Community Noise Equivalent Level
dB	decibel
dBA	decibels, A-weighted scale
District	California Department of Food and Agriculture
DNL	day-night noise level (also Ldn)
DoD	U.S. Department of Defense
DOT	U.S. Department of Transportation
FHWA	Federal Highway Administration
HT	heavy trucks
Hz	Hertz
kHz	kiloHertz
L10-90	percentile sound levels (L1.7, L8.3, L10, L50, and L90)
Ldn	day-night equivalent noise level (also DNL)
Leq	time-averaged integrated equivalent noise level
Lmax	maximum sound level
Lmin	minimum sound level
LOR	local ordinances and regulations
Lp	sound pressure level (also SPL)
LT	light trucks or long-term

Lw	sound power level
MSMVCD	Marin/Sonoma Mosquito Vector Control District
MVC	mosquito and vector control
NCMAD	Napa County Mosquito Abatement District
NSVMAD	Northern Salinas Valley Mosquito Abatement District
PK15	Peak Noise Level
SCCVCD	Santa Clara County Vector Control District
SCMAD	Solano County Mosquito and Vector Control District
SEL	single event level
SMCMVCD	San Mateo County Mosquito and Vector Control District
SP7	SoundPLAN™ Version 7
SPL	sound pressure level (also Lp)
TNM	Traffic Noise Model
USEPA	U.S. Environmental Protection Agency

1 Introduction

This report provides technical information regarding the physical properties of noise; federal, state, and local noise regulations; noise generated by equipment and vehicles that would be used in each of the alternatives being considered in the Integrated Mosquito and Vector Management Programs Programmatic Environmental Impact Report, as well as Best Management Practices that would be implemented. The Integrated Mosquito and Vector Management Programs (Programs) would be implemented by nine mosquito abatement and/or vector control districts in northern California. The nine districts are: Alameda County Mosquito Abatement District (ACMAD), Alameda County Vector Control Services District (ACVCSD), Contra Costa Mosquito and Vector Control District (CCMVCD), Marin/Sonoma Mosquito and Vector Control District (MSMVCD), Napa County Mosquito Abatement District (NCMAD), Northern Salinas Valley Mosquito Abatement District (NSVMAD), San Mateo County Mosquito and Vector Control District (SMCMVCD), Santa Clara County Vector Control District (SCCVCD), and the Solano County Mosquito Abatement District (SCMAD).The Programs provide for mosquito and/or vector control activities within each District’s Program Area. The nine District Program Areas include both the areas within the Districts and the surrounding counties where the Districts may provide mosquito and/or other vector management services when requested.

The immediate nine District Service Areas are located in the following nine counties of the state: Alameda, Contra Costa, Marin, Monterey, Napa, San Mateo, Santa Clara, Solano, and Sonoma. Control activities may also be provided in areas adjacent to the District Service Areas upon request of the adjacent jurisdictions to protect the health and safety of residents in adjacent jurisdictions. Actions that would be taken outside of the nine Districts’ Service Areas are the same types of actions undertaken within the Districts’ Service Areas and in similar types of habitats or sites. Therefore, the nine District Program Areas addressed in this report also include the ten surrounding counties: Mendocino, Merced, Lake, Sacramento, San Benito, San Francisco, San Joaquin, Santa Cruz, Solano, Stanislaus, Yolo, and the portion of Monterey County south of the NSVMAD.

1.1 Report Organization

This report discusses potential noise sources and regulatory requirements that may be applicable to Program implementation by the individual Districts. Following this Introduction (Section 1), are the following:

- Fundamentals of sound including equipment noise sources (Section 2)
- Noise criteria including regulatory standards and local noise ordinances (Section 3)
- Noise generated by District equipment (Section 4)
- Best management practices to reduce unwanted noise (Section 5)

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2 Fundamentals of Sound

Perceptible acoustical sensations can be generally classified into two broad categories: sound and vibration.

2.1 Sound and Noise

Sound is a disturbance in an elastic medium resulting in an audible sensation. Sound is also defined as mechanical energy transmitted from a vibrating or flowing source by longitudinal (or compression) waves through a compressible medium such as air. The term “noise” is both qualitative and quantitative, and is typically referred to as "unwanted” sound.

2.1.1 Vibration

Vibration is a disturbance in a solid elastic medium, which may produce a detectable motion. This differentiation between sound and vibration is most relevant for environmental noise studies when industrial or construction noise sources produce high energy waves at low frequencies that are below human audible thresholds but match the frequency response of nearby structures. These frequencies are typically less than 31 Hertz (Hz). This energy causes vibrations similar to earthquakes. Sources with audible components in addition to the vibration-producing low-frequency energy are typically heard after initial vibrations start and sometimes end depending on distance from the source.

2.2 Physiological and Physical Parameters

Sound can be further characterized by both physiological and physical parameters. These parameters include the following:

- Loudness, as a subjective or perceived noise level that is a qualitative physiological sensation
- Loudness as a numerical scale, using “A-weighted” decibels and by sones (units of perceived loudness)
- Annoyance from high-energy low-frequency single events. This events have well-documented annoyance factors on nearby human receptors. The percentage of annoyed listeners is dependent on the following conditions (U.S. Army 2005):
  - Intensity
  - Duration
  - Repetition
  - Abruptness of onset or cessation
  - Background or ambient noise levels
  - Interference with activity
  - Previous experiences within the community
  - Time of day
  - Fear of personal danger from the noise sources
  - Socioeconomic status and education level of the community
  - The extent people believe that the noise could be controlled

> Sound intensity, the average flow of sound energy through a unit area in a sound field. Sound intensity is a vector quantity with both magnitude and direction.

> Frequency spectrum - the rate of oscillation in cycles per second.

> Wavelength, the distance between successive wave compressions and expansions.

> Energy content as sound pressure level, L_p (also written as SPL). The ear responds to sound pressure as sound waves represent oscillations of pressure just below atmospheric pressure (expansion of longitudinal wave) and just above atmospheric pressure (compression). These pressure oscillations cause the inner ear to vibrate. Sound level meters are also sensitive to these oscillations.

In particular, the SPL has become the most common descriptor used to characterize the loudness of an ambient or environmental sound level. Noise ordinances typically express SPL as “noise level” in dBA at a particular distance. Sound pressure is affected by geophysical properties such as air temperature, pressure, humidity, rain or snow, and wind, as well as physical barriers such as terrain, and the walls of structures. Sound energy dissipates with increasing distance from the source due to absorptive surfaces such as grass, trees, and water. Due to these factors, the noise level perceived by a receptor at a certain location depends on the following parameters:

> Distance between the noise source and the receptor

> Presence or absence of absorptive surfaces

> The amount of mitigative noise features between the receptor and noise source, including intervening terrain, structures, foliage, and ground cover

> Cumulative noise impacts from reflective surfaces, such as building facades, concrete, asphalt, water bodies, etc.

> Current weather conditions (snow, wind, rain) and weather-related ground cover (snow, mud, wet or dry ground)

2.3 Physical Properties of Sound

Sound levels are affected by distance from the source to receiver (propagation) and by localized atmospheric conditions. These are further described below.

2.3.1 Sound Propagation

In an ideal atmosphere without wind, temperature gradients, humidity or ground effects sound levels decay as 6 dB per doubling of distance from a stationary source due to geometrical spreading. If a source generates a level of 90 dBA at 50 feet, then geometrical spreading implies a level of 70 dBA at a distance of 500 feet from the source. If the source is moving, then the maximum level will obey the same relationship, but the exposure time is also a function of sideline distance. For a moving source, the time averaged integrated level (Leq) will decay as 3 dB per doubling of sideline distance (cylindrical spreading), providing the integration time is the constant and extends until the sound level has decayed to 10 dB below its peak level. In this case, if a source generates a Leq of 70 dBA during a drive by in which the source passes 50 feet from the observer at its closest point, then the Leq at 500 feet will be 60 dBA. These simple scaling laws are modified in reality by local atmospheric propagation effects. At low wind speeds and at distances of less than 100 feet, atmospheric propagation effects are small and can be ignored. At larger distances, atmospheric propagation will modify the decay of the sound level with distance. In addition, ground effects can be important at small distances from the source and will depend on the ground cover and the height of the source and receiver above the ground.

Figure 2-1 provides a range of noise levels in the ideal atmosphere at increasing sound power levels. Sound Power is the sound level generated at the noise source. Additionally, color shading delineates the threshold of pain (purple), noise levels that would typically exceed regulatory thresholds (red), and noise levels that may exceed regulatory thresholds depending on time of day and time-weighting (yellow). Noise levels within the white and green bands are typically within or below regulatory thresholds.

Sound Power Level (L_w) of Noise Source (dB*)	Distance from Noise Source to Outdoor Receiver (Feet)											
	1	2	4	8	16	32	64	125	250	500	1000	2000
	Sound Pressure Level (Lp)											
150	144	138	132	126	120	114	108	102	96	90	84	78
140	134	128	122	116	110	104	98	92	86	80	74	68
130	124	118	112	106	100	94	88	82	76	70	64	58
120	114	108	102	96	90	84	78	72	66	60	54	48
110	104	98	92	86	80	74	68	62	56	50	44	38
108	102	96	90	84	78	72	66	60	54	48	42	36
106	100	94	88	82	76	70	64	58	52	46	40	34
104	98	92	86	80	74	68	62	56	50	44	38	32
102	96	90	84	78	72	66	60	54	48	42	36	30
100	94	88	82	76	70	64	58	52	46	40	34	28
98	92	86	80	74	68	62	56	50	44	38	32	26
96	90	84	78	72	66	60	54	48	42	36	30	24
94	88	82	76	70	64	58	52	46	40	34	28	22
93	87	81	75	69	63	57	51	45	39	33	27	21
92	86	80	74	68	62	56	50	44	38	32	26	20
91	85	79	73	67	61	55	49	43	37	31	25	19
90	84	78	72	66	60	54	48	42	36	30	24	18
89	83	77	71	65	59	53	47	41	35	29	23	17
88	82	76	70	64	58	52	46	40	34	28	22	16
87	81	75	69	63	57	51	45	39	33	27	21	15
86	80	74	68	62	56	50	44	38	32	26	20	14
85	79	73	67	61	55	49	43	37	31	25	19	13
84	78	72	66	60	54	48	42	36	30	24	18	12
83	77	71	65	59	53	47	41	35	29	23	17	11
82	76	70	64	58	52	46	40	34	28	22	16	10
81	75	69	63	57	51	45	39	33	27	21	15	9
80	74	68	62	56	50	44	38	32	26	20	14	8
79	73	67	61	55	49	43	37	31	25	19	13	7
78	72	66	60	54	48	42	36	30	24	18	12	6
77	71	65	59	53	47	41	35	29	23	17	11	5
76	70	64	58	52	46	40	34	28	22	16	10	4
75	69	63	57	51	45	39	33	27	21	15	9	3
74	68	62	56	50	44	38	32	26	20	14	8	2
73	67	61	55	49	43	37	31	25	19	13	7	1
72	66	60	54	48	42	36	30	24	18	12	6	0
71	65	59	53	47	41	35	29	23	17	11	5	
70	64	58	52	46	40	34	28	22	16	10	4	
69	63	57	51	45	39	33	27	21	15	9	3	
68	62	56	50	44	38	32	26	20	14	8	2	
67	61	55	49	43	37	31	25	19	13	7	1	
66	60	54	48	42	36	30	24	18	12	6	0	
65	59	53	47	41	35	29	23	17	11	5		
64	58	52	46	40	34	28	22	16	10	4		
63	57	51	45	39	33	27	21	15	9	3		
62	56	50	44	38	32	26	20	14	8	2		
61	55	49	43	37	31	25	19	13	7	1		
60	54	48	42	36	30	24	18	12	6	0		

Figure 2-1 Noise Level Attenuation Due to Geometric Spreading in an Ideal Atmosphere

2.3.2 Effects of Local Atmospheric Conditions

During periods of strong sunshine, the ground surface temperature is increased, and this causes heating of the lower atmosphere. These conditions cause the air temperature to decrease with height, which is referred to as a temperature lapse. When a temperature lapse exists, sound rays are refracted upwards, and a shadow zone is formed a few hundred feet from the source (Glegg 2005). In contrast, during the nighttime hours there is significant cooling of the ground, and the atmospheric temperature increases with height, causing a temperature inversion. This causes sound to be trapped in the lower atmosphere, and sound levels can exceed those expected from spherical spreading. Furthermore, focusing effects can occur from temperature inversions and higher sound levels may be observed in a local area at relatively large distances from the source (Hubbard 1995).

Wind gradients close to the ground can cause the same effects as temperature gradients. Sound propagating upwind is refracted upwards and forms a shadow zone. Sound propagating downwind is refracted downwards and is louder than expected (Hubbard 1995). Sound is also attenuated by molecular absorption as it propagates. This is a strong function of humidity, and frequency and standard curves are available to make corrections for atmospheric absorption of this type. Typically excess attenuations of 5 dB per 1,000 feet of propagation can be expected at 2 kiloHertz (kHz) for a relative humidity of 50-90 percent and temperatures over 60 degrees Fahrenheit (˚F) (Beranek 1971).

An example of excess attenuation over a lake in Europe shows an additional 2-5 dB of attenuation per kilometer over and above atmospheric absorption. Sound level measurements from this study also show that a shadow zone can be formed by a temperature lapse. At a distance of 650 feet in the downwind direction sound levels exceed expected values at 250 Hz by 1 dB, but in the upwind direction the levels are 10 dB lower than expected (Beranek 1971).

2.3.3 Ground Effects

When a source and/or receiver are placed aboveground an interference effect takes place that modifies the measured sound level. At very low frequencies, the spectral levels are increased by 6 dB (at all distances) and at higher frequencies a series of interference dips occur where the spectral level is reduced to zero. When the source and receiver are 4 feet above ground and separated by 50 feet over a hard surface, the first interference dip occurs at 439 Hz. At a source and receiver separation of 300 feet the first separation dip occurs at 2,636 Hz. The ground effect increases the dBA level by 3 dB over a free field level (i.e., the level that would occur if the ground were not present) for a broadband source when the interference dip is at a frequency of approximately 1,000 Hz or less. When the frequency of the first ground interference dip exceeds 20 kHz, then the dBA level is increased by 6 dB relative to the free field level. For propagation over hard surfaces the ground effect, therefore, reduces the geometrical spreading loss of the dBA level when the source and receiver are less than 2,400 feet apart. This effect is relatively small unless propagation takes place over soft ground cover, in which case the effect of ground absorption can be significant. Figure 2-2 illustrates the shadow zone created by a downwind noise source (upper portion), and also illustrates the focusing phenomena created by temperature inversion, upwind noise source, and ground/water surfaces (lower portion).

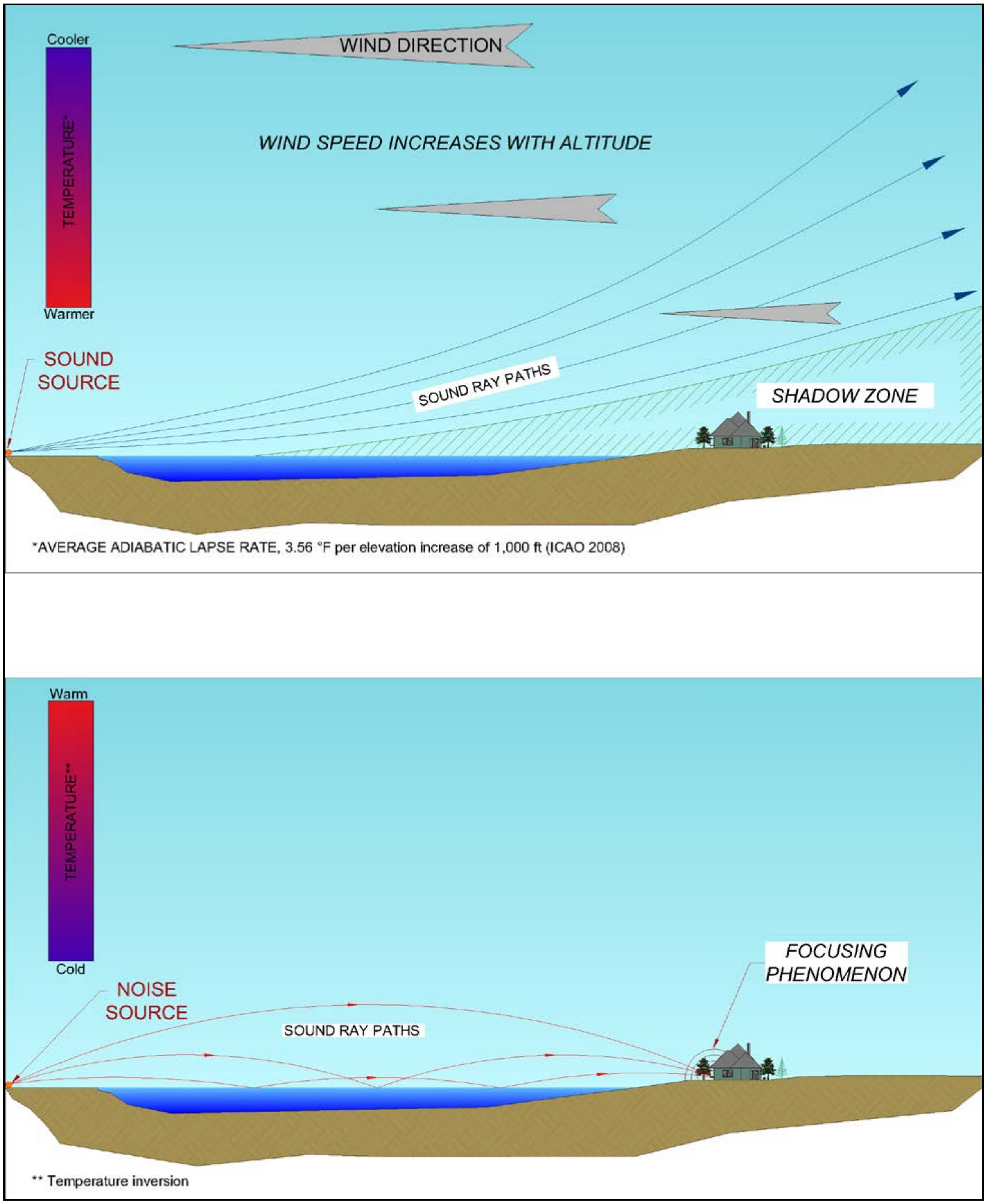

Figure 2-2 Ground Effect and Wind and Temperature Inversion

2.3.4 Reflection, Refraction, Absorption, and Transmission Losses

The sound level measured at a specific location at a discrete time is the sum of all noise source SPLs that converge at that point. Sound will refract around hard edges, be absorbed by foliage, structural materials, and the various atmospheric conditions previously described. Reflection will occur at hard surfaces where sound is not completely absorbed and/or scattered. Sound that reflects back to a source is called an echo. Transmission loss through structural materials such as walls and windows reduce sound pressure the most. Figure 2-3 illustrates these concepts.

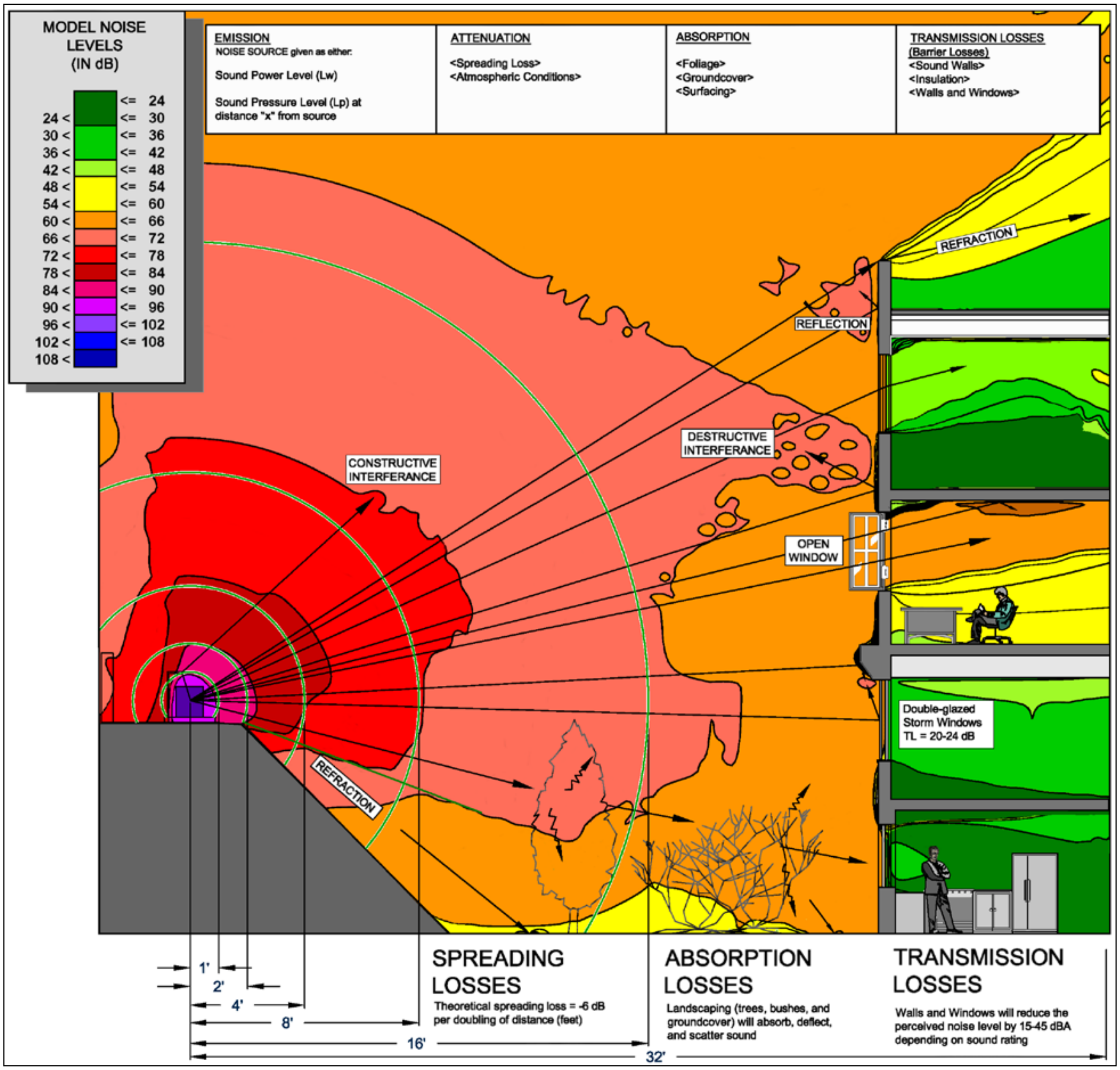

Figure 2-3 Emission, Attenuation, Absorption, and Transmission Loss

2.3.5 Sound Level Measurement

The dB scale is used to quantify sound intensity. Because SPLs can vary by over 1 million times within the range of human hearing, a logarithmic loudness scale (similar to the Richter Scale used for earthquake intensity) is used to keep sound intensity numbers within a manageable range. Since the human ear is not equally sensitive to all sound frequencies within the entire spectrum, noise measurements are weighted more heavily within those frequencies of maximum human sensitivity (middle A and its higher harmonics) in a process called "A-weighting," written as dBA.

Noise measurement metrics used for this analysis are as follows:

> Equivalent sound level (L_{eq}), the average sound level calculated from instantaneous measurements recorded over a specific period of time.

> Maximum sound level (L_{max}) reached during a sampling period. The L_{max} value is the peak noise level that occurred during the measurement period.

> Minimum sound level (L_{min}) reached during a sampling period. The L_{min} value obtained for a particular monitoring location typically reflects ambient conditions.

> Percentile sound levels (L_{90}, L_{50}, and L_{10}) are sound levels that exceed the percentile value during the measurement period.

> Community Noise Equivalent (CNEL): the average of the daytime measurement, evening measurement +5 dBA, and the night measurement +10 dBA.

> Day Night Level (L_{dn}): The day-night sound levelevaluator is recommended by the Environmental Protection Agency and used by most federal agencies as a land-use planning tool. It describes the average daily acoustic energy over the period of 1 year—meaning that moments of quiet are averaged together with moments where loud noises can be heard.

2.3.6 Community Noise Levels

Community noise levels depend on the intensity of nearby human activity. Noise levels are generally considered low when ambient levels are below 45 dBA, moderate in the 45 to 60 dBA range, and high above 60 dBA. In rural and undeveloped areas, L_{dn} can be below 35 dBA. Levels above 75 to 80 dBA are more common near major freeways and airports. Although people often accept the higher levels associated with very noisy urban areas, they nevertheless are considered to be adverse to public health. California uses a stricter equivalent sound level definition (CNEL), which uses the L_{dn} and adds a 5-dB penalty to sound measurements between 10:00 PM and 7:00 AM.

2.3.7 Noise Level Acceptance Criteria

The surrounding land uses dictate what noise levels would be considered acceptable or unacceptable. In rural and undeveloped areas away from roads and other human activity, the day-to-night difference is normally small. Because of diurnal activity, nighttime ambient levels in urban environments are about 7 dB lower than the corresponding daytime levels. Nighttime noise is a concern because of the likelihood of disrupting sleep. Noise levels above 45 dBA at night can result in the onset of sleep interference. At 70 dBA, sleep interference effects become considerable (USEPA 1974).

2.4 Noise Sources

Environmental noise sources are segregated into four categories: single event, mobile, stationary-temporary, and stationary-permanent. Examples of typical stationary and mobile noise sources in are presented in Table 2-1; noise sources that are most applicable to the equipment that would be used by the nine Districts in the Program alternatives are shown in bold. Construction noise sources are always temporary and are typically mobile, but they may be stationary or single event. Construction noise sources are provided in more detail in Table 2-2.

Table 2-1 Typical Stationary and Mobile Noise Source Sound Levels in dBA

Noise Source	Sound Level in dBA at 50 feet(1)	Category
Sprayer, hand-held	**10-20**	**MOBILE**
Noise at ear level from rustling leaves	20	STATIONARY-TEMPORARY
Room in a quiet dwelling at midnight	32	STATIONARY
Soft whisper at 5 feet	34	STATIONARY-TEMPORARY
Large Department Store	50 to 65	STATIONARY-TEMPORARY
Room with window air conditioner	55	STATIONARY-PERMANENT
Leaf Blower/Vac	**55-105**	**MOBILE**
Conversational Speech	60 to 75	STATIONARY
Pump Station Equip. with Noise Abatement	62	STATIONARY-PERMANENT
Sprayer, powered, truck- or trailer-mounted	**65-105**	**MOBILE**
Passenger Car	69	MOBILE
Vacuum cleaner in private home at 10 feet	69	STATIONARY
Tractor, Agricultural at operator's seat	**76-110**	**MOBILE**
Ringing alarm at 2 feet	80	STATIONARY
Brush/Weed Cutter at operator	**90-97**	**MOBILE**
Roof-top Air Conditioner	85	STATIONARY-PERMANENT
Small Bulldozer (Cat D3) or Excavator (Cat 320)	**74-80**	**MOBILE**
Heavy Bulldozer	87	MOBILE
ATV at 5 to 15 feet	**87-109**	**MOBILE**
Heavy city traffic	90	MOBILE
Lawn mower at operator	**91-98**	**MOBILE**
Chain saw at operator	**100-120**	**MOBILE**
Jet aircraft at 500 feet overhead	115	MOBILE
Human pain threshold	120	--
Construction Blast	120 to 145	SINGLE EVENT

Sources: Noise Control Reference Handbook, Industrial Acoustics Company, 1979.

Notes:

Bold indicates Program equipment

[1] Noise level in dBA at approximately 50 feet unless otherwise noted in description

2.4.1 Traffic, Heavy Equipment, and Construction Noise

Although the nine Districts' ongoing mosquito and vector control activities do not involve heavy construction equipment besides bulldozers (for occasional use only), the information is provided for reference purposes.

Heavy equipment and construction noise sources and corresponding noise levels in the adjacent or nearby area will greatly fluctuate depending on the purpose of construction and the particular type, number, and duration of use of various types of construction equipment involved. Program equipment inventories include heavy equipment. The effect of construction noise on nearby receptors depends upon how much noise is generated by each individual piece of equipment; the distance between construction activities and the nearest noise-sensitive receptors; the frequency, type, and duration of noise produced; and the ambient noise levels at the receptors. At a distance of 50 feet, noise levels would be between 68 to 96 Leq. Noise levels in this range would be substantially higher than the ambient noise levels experienced by sensitive receptors in typical rural commercial, recreational, and residential environments.

For traffic noise, a change in noise levels of less than 3 dBA is not discernible to the general population. An increase in average noise levels of 3 dBA is considered barely perceptible, while an increase of 5 dBA is considered readily perceptible to most people (Caltrans 1998).

2.4.2 Characteristics of Groundborne Vibration

Vibrating objects in contact with the ground radiate vibration waves through various soil and rock strata to the foundations of nearby buildings. As the vibration propagates from the foundation throughout the remainder of the building, the vibration of floors and walls may cause perceptible vibration from the rattling of windows or a rumbling noise. The rumbling sound caused by the vibration of room surfaces is called groundborne noise. When assessing annoyance from groundborne noise, vibration is typically expressed as root mean square (rms) velocity in units of decibels of 1 micro-inch per second. To distinguish vibration levels from noise levels, the unit is written as "VdB." Human perception to vibration starts at levels as low as 67 VdB and sometimes lower. Annoyance due to vibration in residential settings starts at approximately 70 VdB. Groundborne vibration is almost never annoying to people who are outdoors. Although the motion of the ground may be perceived, without the effects associated with shaking of building components, the motion does not provoke the same adverse human reaction. In extreme cases, excessive groundborne vibration has the potential to cause structural damage to buildings. Common sources of groundborne vibration include trains and construction activities such as blasting, pile driving, and operating heavy earthmoving equipment.

Program equipment capable of producing ground-borne vibration is limited to bulldozer use. Excessive ground-borne vibration typically occurs when earthwork equipment encounters hard rock during construction, but such actions are not part of the Program alternatives. Occasional use of a small bulldozer may be required for activities such as vegetation clearance and unimproved road maintenance, but this would not result in human annoyance or structural damage from vibration. Similarly, light trucks, which would be used for each of the Program alternatives, would not be capable of producing substantial amounts of vibration.

2.4.3 Critical and Sensitive Receptors

Some land uses are generally regarded as being more sensitive to noise than others due to the types of population groups or activities involved. The definition of critical and sensitive receptors varies by jurisdiction, but in general, critical receptors are those that cannot be interrupted or disturbed by project noise. These include, but are not limited to, police and fire stations, high security operations, noise-sensitive industry, hospitals, nursing homes, and other long-term medical care facilities. Sensitive population groups include children and the elderly and sensitive land uses. These sensitive land uses include residential (single- and multi-family, mobile homes, dormitories, and similar uses), guest lodging, parks and outdoor recreation areas, schools, libraries, churches, and places of public assembly.

Biological receptors with the potential to be adversely affected by noise are primarily terrestrial wildlife species but may include water birds. The concern is whether the use of equipment could increase ambient noise levels. An additional concern is whether short-term or temporary increases in noise levels could affect sensitive wildlife receptors such as nesting eagles or other special-status raptors disrupting nesting, interrupting feeding of nestlings, or causing nest abandonment.

3 Regulatory Criteria

The noise nuisance criteria are derived from local noise ordinances, state laws, and/or federal regulations/standards. These criteria are programmatically evaluated in the PEIR to determine potential noise impacts from Program operations on receptors within the Program area.

3.1 Regulatory Setting

Federal regulations, standards, and guidelines; California state law; and local ordinances and regulations (LOR) pertaining to environmental noise are cited in this section. The LOR citations include all county ordinances and select city ordinances within the District Service Areas. Counties that do not have specific noise ordinances are either referenced as deferring to state or federal regulations, or if a noise element exists in a specific general plan, that element is cited.

3.2 Federal Standards

The federal noise standards or guidelines discussed in this section are applicable and relevant or to-be-considered during implementation of Program alternatives on federal lands including national wildlife refuges. Noise regulations and standards are provided for the following agencies:

> U.S. Department of Transportation (DOT) – Federal Aviation Administration (FAA)

> U.S. Department of Transportation (DOT) – Federal Highway Administration (FHWA)

> U.S. Environmental Protection Agency (USEPA)

3.2.1 U.S. Environmental Protection Agency (USEPA)

The USEPA has developed guidelines on recommended maximum noise levels to protect public health and welfare (EPA 1974). The USEPA does not enforce these regulations, but rather offers them as a planning tool for state and local agencies. The table below provides examples of protective noise levels recommended by the USEPA.

Table 3-1 USEPA Designated Noise Safety Levels

Effect	Noise Level	Area
Hearing Loss	Leq (24)<70 dB	All areas
Outdoor Activity Interference and Annoyance	Ldn <55 dB	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	Leq (24)<55 dB	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor Activity Interference and Annoyance	Ldn <45 dB	Indoor residential areas
	Leq (24)<45 dB	Other indoor areas with human activities such as schools, etc.

Source: USEPA, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, March 1974.

L_{eq} (24) = Represents the sound energy averaged over a 24-hour period.

L_{dn} = Represents the Leq with a 10 dB nighttime weighting.

3.2.2 Federal Aviation Administration

The major parts of CFR Title 14: Aeronautics and Space, Chapter I: Federal Aviation Administration, Department of Transportation, Subchapter C, for fixed-wing aircraft noise and Subchapter H for helicopter noise, were reviewed for applicability to existing and potential Program flight operations, specifically:

Part 36: Noise Standards: Aircraft Type And Airworthiness Certification

Noise data from aircraft power plants, propellers, and combinations of each by aircraft type are well documented as each aircraft type must be certified by the FAA under Part 36 prior to use by general and commercial aviation.

The fixed-wing aircraft proposed for aerial spraying is an Air Tractor 502 . This aircraft make, model, engines, and propellers, as a system, are exempt from noise standards because the aircraft was manufactured for agricultural-type operations, including aerial spraying, exclusively. The helicopters proposed for aerial spraying have FAA noise certifications. Sound level data for the helicopters are presented in Section 4.

Part 91: Flight Operations

Elements of Part 91 are provided as a reference. Altitude limitations governing agricultural operations are given in Part 137, Agricultural Operations.

Fixed-wing aircraft not operating under an Instrument Flight Rules, emergencies, during takeoff or landing, or Part 137 are required to maintain the altitudes listed in Section 91.119 - Minimum Safe Altitudes: General (a)-(d). Section 91.119 (a), (b), and (c) are provided below.

Except when necessary for takeoff or landing, no person may operate an aircraft below the following altitudes:

(a) Anywhere. An altitude allowing, if a power unit fails, an emergency landing without undue hazard to persons or property on the surface.

(b) Over congested areas. Over any congested area of a city, town, or settlement, or over any open air assembly of persons, an altitude of 1,000 feet above the highest obstacle within a horizontal radius of 2,000 feet of the aircraft.

(c) Over other than congested areas. An altitude of 500 feet above the surface, except over open water or sparsely populated areas. In those cases, the aircraft may not be operated closer than 500 feet to any person, vessel, vehicle, or structure.

Section 137.49 – Operations over other than Congested Areas

Notwithstanding Part 91 of this chapter, during the actual dispensing operation, including approaches, departures, and turnarounds reasonably necessary for the operation, an aircraft may be operated over other than congested areas below 500 feet above the surface and closer than 500 feet to persons, vessels, vehicles, and structures, if the operations are conducted without creating a hazard to persons or property on the surface.

Section 137.51 – Operation over Congested Areas: General

(a) Notwithstanding Part 91 of this chapter, an aircraft may be operated over a congested area at altitudes required for the proper accomplishment of the agricultural aircraft operation if the operation is conducted:

    (1) With the maximum safety to persons and property on the surface, consistent with the operation, and

    (2) In accordance with the requirements of paragraph (i) of this section

(i) No person may operate an aircraft over a congested area except in accordance with the requirements of this paragraph.

(3) Prior written approval must be obtained from the appropriate official or governing body of the political subdivision over which the operations are conducted.

(4) Notice of the intended operation must be given to the public by some effective means, such as daily newspapers, radio, television, or door-to-door notice.

(5) A plan for each complete operation must be submitted to, and approved by appropriate personnel of the FAA Flight Standards District Office having jurisdiction over the area where the operation is to be conducted. The plan must include consideration of obstructions to flight, the emergency landing capabilities of the aircraft to be used, and any necessary coordination with air traffic control.

(6) Single engine aircraft must be operated as follows:

(i) Except for helicopters, no person may take off a loaded aircraft, or make a turnaround over a congested area.

(ii) No person may operate an aircraft over a congested area below the altitudes prescribed in Part 91 of this chapter except during the actual dispensing operation, including the approaches and departures necessary for that operation.

(iii) No person may operate an aircraft over a congested area during the actual dispensing operation, including the approaches and departures for that operation, unless it is operated in a pattern and at such an altitude that the aircraft can land, in an emergency, without endangering persons or property on the surface.

(7) Multiengine aircraft must be operated as follows:

(i) No person may take off a multiengine airplane over a congested area except under conditions that will allow the airplane to be brought to a safe stop within the effective length of the runway from any point on takeoff up to the time of attaining, with all engines operating at normal takeoff power, 105 percent of the minimum control speed with the critical engine inoperative in the takeoff configuration or 115 percent of the power-off stall speed in the takeoff configuration, whichever is greater, as shown by the accelerate stop distance data. In applying this requirement, takeoff data is based upon still-air conditions, and no correction is made for any uphill gradient of 1 percent or less when the percentage is measured as the difference between elevations at the end points of the runway divided by the total length. For uphill gradients greater than 1 percent, the effective takeoff length of the runway is reduced 20 percent for each 1 percent grade.

(ii) No person may operate a multiengine airplane at a weight greater than the weight that, with the critical engine inoperative, would permit a rate of climb of at least 50 feet per minute at an altitude of at least 1,000 feet above the elevation of the highest ground or obstruction within the area to be worked or at an altitude of 5,000 feet, whichever is higher. For the purposes of this subdivision, it is assumed that the propeller of the inoperative engine is in the minimum drag position, that the wing flaps and landing gear are in the most favorable positions, and that the remaining engine or engines are operating at the maximum continuous power available.

(iii) No person may operate any multiengine aircraft over a congested area below the altitudes prescribed in Part 91 of this chapter except during the actual dispensing operation, including the approaches, departures, and turnarounds necessary for that operation.

Section 137.53 – Operation over Congested Areas: Pilots And Aircraft

(a) General. No person may operate an aircraft over a congested area except in accordance with the pilot and aircraft rules of this section.

(b) Pilots. Each pilot in command must have at least:

(1) 25 hours of pilot-in-command flight time in the make and basic model of the aircraft, at least 10 hours of which must have been acquired within the preceding 12 calendar months.

(2) 100 hours of flight experience as pilot in command in dispensing agricultural materials or chemicals.

(c) Aircraft.

(1) Each aircraft must –

(i) If it is an aircraft not specified in paragraph (c)(1)(ii) of this section, have had within the preceding 100 hours of time in service a 100-hour or annual inspection by a person authorized by Part 65 or 145 of this chapter, or have been inspected under a progressive inspection system.

(ii) If it is a large or turbine-powered multiengine civil airplane of U.S. registry, have been inspected in accordance with the applicable inspection program requirements of Section 91.409 of this chapter.

(2) If other than a helicopter, it must be equipped with a device capable of jettisoning at least one-half of the aircraft's maximum authorized load of agricultural material within 45 seconds. If the aircraft is equipped with a device for releasing the tank or hopper as a unit, there must be a means to prevent inadvertent release by the pilot or other crewmember.

3.2.3 Federal Highway Administration

Title 23, Part 772 requires comprehensive noise studies using modeling for new construction or reconstruction of highways. The principle tool for evaluating noise impacts due to increased vehicular traffic is the Traffic Noise Model (TNM) latest version.

3.3 State Noise Standards and Guidelines

State noise standards and guidelines include CEQA, the California Department of Parks and Recreation General Plan, land use compatibility regulations and the California Vehicle Code. Elements of these are summarized below.

3.3.1 Department of Parks and Recreation General Plan

Statewide guidelines for General Plans published in 1998 indicate that levels under 70 Ldn should be acceptable to receptors in parks (OPR 1998).

The California Department of Parks and Recreation, Off-Highway Motor Vehicle Recreation Division published a comprehensive OHV noise study in September 2005 as required by Public Resources Code Section 5090.32(0). This division is responsible for enforcing OHV noise emissions violations on land regulated by the State (OPR 2005b).

3.3.2 Land Use Compatibility

The California Government Code § 65302(f) encourages each local government entity to conduct noise studies and implement a noise element as part of their General Plan. In addition, the California Office of Planning and Research published guidelines for evaluating the compatibility of various land uses as a function of community noise exposure, and these are listed in Table 3-2 below. In general, noise levels less than 60 dBA Ldn are acceptable for all land uses, including residences, schools, and other noise-sensitive receptors. The State considers noise levels less than 70 dBA Ldn to be normally acceptable for playgrounds and neighborhood parks (OPR 1998).

It is important to note that the noise levels referred to above only consider permanent, stationary new noise sources. None of the operations involved in the Program are permanent, stationary noise sources so the table is provided for reference only.

Table 3-2 Land Use Compatibility for Community Noise Environment – Permanent Stationary Noise Sources

Land use category	Community Noise Exposure – L_{dn} or CNEL in dBA						
	50	55	60	65	70	75	80
Residential – Low Density Single Family, Duplex, Mobile Home							
Residential – Multifamily							
Transient Lodging – Motel, Hotel							
Schools, Libraries, Churches, Hospitals, Nursing Homes							
Auditorium, Concert Hall, Amphitheaters							
Sports Arena, Outdoor Spectator Sports							
Playgrounds, Neighborhood Parks							
Golf Courses, Riding Stables, Water Recreation, Cemeteries							
Office Buildings, Business Commercial and Professional							
Industrial, Manufacturing, Utilities, Agriculture							

LEGEND
Normally Acceptable: Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.
Conditionally Acceptable: New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features are included in the design.
Normally Unacceptable: New construction or development should be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirement must be made and needed noise insulation features included in the design.
Clearly Unacceptable: New construction or development generally should not be undertaken.

Source: State of California General Plan Guidelines, Office of Planning and Research, June 1998.'

CNEL = Community Noise Equivalent Level

dBA = A-weighted decibel(s)

Ldn = Day-Night Noise Level

3.3.3 California Vehicle Code

Noise from highway vehicles and off-highway equipment is regulated by the Department of Motor Vehicles with cooperation from the California Highway Patrol. Off-highway motor vehicles manufactured between 1975 and 1986 must not exceed 86 dBA, and those manufactured after 1986 must not exceed 82 dBA when measured at 50 feet from the centerline of travel (Vehicle Code Section 38370). Heavy highway vehicles manufactured after 1987 must emit less than 80 dBA (Vehicle Code Sections 27204 and 27206).

3.4 Selected Noise Ordinances within the Districts

Local ordinances and regulations (LOR) were obtained for selected localities within each of the nine Districts. Alameda County MAD and VCSD are combined. Selections were determined by geographical position, and, where identified during research, municipalities that have had historical noise issues related to similar Program-type operations.

Table 3-3 Summary of County and City Noise Ordinances or General Plan Elements Cited

Municipality	Ordinance Title/Description
Alameda County(1)	Alameda County General Ordinance Code, Title 6 Health and Safety, Chapter 6.60 Noise
Albany	Chapter VIII Law Enforcement, 8-1 Noise
Berkeley	Berkeley Municipal Code, Title 13, Chapter 13.40 Community Noise
Piedmont	Piedmont City Code, Chapter 12: Offenses – Misc. Sec. 12.8 Noise Declared Nuisance
Oakland	City of Oakland General Plan, Noise Element
San Leandro	Ordinance No. 2003-005
Contra Costa County(2)	County of Contra Costa, Noise Element, Contra Costa County General Plan, Chapter 11
Brentwood	Title 9 Public Peace, Morals, and Welfare, Chapter 32, Noise Regulations
El Cerrito	Title 10 Public Peace, Morals and Welfare, Chapter 10.30 Noise
Richmond	City of Richmond, Ordinance 14-11, Chapter 9.52, Community Noise Ordinance
San Ramon	Draft San Ramon General Plan 2030, Noise Element
Marin County(1)	Marin County Code of Ordinances, Title 6, Chapter 6.7-Loud and Unnecessary Noises
Fairfax	Municipal Code of Ordinances, Title 8, Chapter 8.20: Noise Control 8.20.050
Novato	The Novato General Plan, Chapter 5 Safety and Noise
San Rafael	San Rafael Code of Ordinances, Title 8, Morals and Conduct, Section 8.13, Noise.
Monterey County(3)	County of Monterey, Title 10 Health and Safety, Chapter 10.60 Noise Control
Monterey	City of Monterey City Code, Chapter 38 - Zoning Ordinance, Part I -- General Provisions
Salinas	Salinas Code of Ordinances, Chapter 21A. – Noise Regulation
Napa County(1)	County of Napa Municipal Code, Title 8 Chapter 8.16 Noise Control Regulations
Calistoga	City of Calistoga 2003 General Plan, Noise Element
Napa	City of Napa Municipal Code, Title 8, Chapter 8.08 Noise Control Regulations
Saint Helena	City of St Helena Code of Ordinances, Chapter 8.24, Noise
San Mateo County(1)	San Mateo County General Plan, Noise Element
Brisbane	Brisbane Municipal Code, Title 9 Public Peace, Morals, and Welfare
Redwood City	Redwood City New General Plan, Section 4.10 Noise and Vibration

Municipality	Ordinance Title/Description
San Mateo City	City Code Title VII – Health, Sanitation & Public Nuisances, 7.30 Noise Regulations
Woodside	Town of Woodside General Plan 2012, Noise Element
Santa Clara County(1)(4)	Code of Ordinances, Title B, Division B11, Chapter VIII Control of Noise and Vibration
Gilroy	City of Gilroy Zoning Ordinance, Section 41
San Jose	Title 10 Public Peace, Morals, and Welfare, Chapter 10-16.
Solano County(2)	Solano County General Plan, Health and Safety Element, Noise
Benicia	City of Benicia Code of Ordinances, Chapter 8.20, Noise
Los Gatos	Los Gatos General Plan 2020, Chapter 10
Sonoma County(2)	Sonoma County General Plan GP2020, Noise Element
Petaluma	City of Petaluma General Plan, Noise Element 10-P-3
Sebastopol	City of Sebastopol Noise Ordinance
Santa Rosa	Santa Rosa City Code, Title 17 Environmental Protection, Chapter 17-16 Noise

Notes:
(1) Noise LOR exempts Federal or State Preempted Activities.
(2) No county noise ordinance.
(3) Exemption based on distance but not specifically for public agency operations.
(4) Specific exemption for government helicopter noise.

3.4.1 Summary of LORs

The typical LOR requires non-residential operations such as construction or other noise-emitting activities related to commercial, industrial, and governmental operations to begin not before 7 am and end between 6 and 8 pm. Many limit work to non-weekend days, and some to Monday through Saturday. If operations are to occur outside of these periods, activities would either be required to comply with exterior and interior noise limits at residential and other sensitive receptors, or acquire a permit with the appropriate regulating agency. **Most noise ordinances exempt emergency operations and government operations where actions protect human health from exposure to potentially dangerous environmental and anthropogenic pathways.**

Seven of the nine counties within the Program area have specific noise ordinances. For example, Marin County allows for exceptions to their noise ordinance for emergency work [Section 6.70.030 (5) c]; and “emergency” is defined as “*a sudden, unexpected occurrence demanding immediate action to prevent or mitigate loss of, or damage to life, health, property, or essential public services (Section 22.130.030)*” (Marin County 2013). Of these seven counties with noise ordinances, six counties exempt actions performed by government entities are regulated by state or federal laws directly. The remaining county exempts all noise based on distance to the nearest occupied dwelling.

The typical noise ordinance generically states “it is unlawful for any person to operate any installed mechanical equipment if the maximum noise level exceeds 50 to 60 dBA at any point at least 1 foot inside the property line of the affected residential property and 3 to 5 feet above ground level.” When measured from a distance of 50 feet, municipal vehicles and vehicles supporting government operations cannot exceed 70 to 85 dBA. Noise levels cannot exceed the ambient level by 10 dBA or more at schools, churches or hospitals. Municipal ordinances provide a single value for maximum noise levels permitted; the ranges given are from review of selected ordinances in the table above.

Many ordinances allow for very loud noise emissions on a short-term basis. The loudest noise may exceed the ordinance limit by, for example, 20 to 25 dB, but would be permitted for only 5 to 15 minutes. Noise that exceeds the ordinance limit by 10 to 15 dB may be permitted for up to an hour. Many Program noise sources fall within these parameters based on total time of use proposed and would not likely exceed ordinance limits at a single location.

4 Program Equipment and Vehicles Noise

The nine Districts provided tables of equipment and vehicles that would be used under each Program alternative with total time and days of use for each of five potential land use types that could be affected: residential, commercial, industrial, agricultural, and open space. Tables 4-1 through 4-9 below show the types of equipment and vehicles that would be used by each District, but they also include noise levels generated by each type of equipment or vehicles at distances of 50 feet and 400 feet from the source.

The noise levels are based on manufacturer data sheets, referenced studies, and noise databases. Where generic equipment names were given, either a range of sound levels or the maximum referenced level are provided. The maximum usage for multiples of the same equipment type for hours per day and days of per quarter is given. Equipment that is not loud enough to affect sensitive receptors for any operational use (i.e. is less than 45 dBA) are listed as “not of concern,” abbreviated as NOC.

Table 4-1 Alameda County Mosquito Abatement District Vehicles and Equipment

Type of Vehicle/Equipment	Hours\day[1]	Days/Quarters				Noise Data in dBA at Indicated Distance		Notes
		Q1	Q2	Q3	Q4	50 feet	400 feet	
Pickup Truck 5.4L V8	4	50	57	55	45	83	65	At 35 mph. See also Note (2)
Pickup Truck 5.0L V8 (2)	3	53	60	55	50	83	65	
Pickup Truck 4.6L V8 (2)	2.5	58	60	58	55	83	65	
Pickup Truck 4.3L V6	4	0	0	1	0	83	65	
Pickup Truck 4.0L V6 (4)	3	55	60	55	40	83	65	
Pickup Truck 3.0L V6	6	0	43	62	22	83	65	
Cargo Van	2	8	15	6	5	83	65	
Jeep (2)	6	0	33	62	22	83	65	
SUV	2	20	15	20	15	83	65	
2001 6x6 Polaris ATV	2	1	2	0	0	87	69	(3)
Maruyama Mist Duster MD155DX	0.75	8	5	7	0	NOC		
Gas Spray Rig in Truck (2)	0.25	30	15	0	0	66	48	(4)
Electric Spray Rig (6)	0.15	0	10	20	1	63	45	
Leaf Blower	0.25	1	0	0	0	76	58	
Brush Cutter	0.5	0	0	0	1	63	45	
Chainsaw	0.5	0	0	0	1	70	50	
2008 ARGO 8/Wheel Avenger	4	30	15	0	0	87	69	(3)
2010/2012 ARGO 8/Wheel 750 HDI EFI (2)	4	30	15	0	0	87	69	(3)
Gas Spray Rig in Argo (3)	4	30	15	0	0	66	48	(4)
1968 Bell 206 Jet Ranger helicopter	4	0	1	0	0		84-87	(5)

Type of Vehicle/Equipment	Hours\day[1]	Days/Quarters				Noise Data in dBA at Indicated Distance		Notes
		Q1	Q2	Q3	Q4	50 feet	400 feet	
1989 Bell 206 Jet Ranger helicopter	4	0	1	0	0		84-87	(5)
1960 Hiller Soloy helicopter	4	0	1	0	0		83-89	Assumed (5)
Isolair Air spray system model 3900 (helicopter-mounted)	*						NOC	(6)
Isolair 4400 bucket system (helicopter-mounted)	*						NOC	
Isolair 4500 broadcaster (helicopter-mounted)	*						NOC	

NOC = Not of Concern

Notes:

(1) Locations will vary throughout listed period of use.

(2) Single hour time-weighted noise levels at 50 and 400 feet are 45 dBA and 34 dBA, respectively per TNM 2.5 Lookup Tables. Sound levels for vehicles varies greatly depending on speed, acceleration, braking, road type, and condition of vehicle. The values provided are very conservative.

(3) ATV range from reference California, 2005b.

(4) Based on sound power levels for typical 2.5-horsepower gasoline engine

(5) The noise values for aircraft (both fixed-wing and rotocraft) noise are approximately 500 feet from point of measure per FAA type certification. Aerial applications are done in response to elevated levels of larval mosquito production in large often difficult to access areas and are not necessarily used every year.

(6) Delivery vehicle noise is greater than 3 dB above equipment noise therefore the equipment noise is NOC

Table 4-2 Alameda County Vector Control Services District Vehicles and Equipment

Type of Vehicle/Equipment	Hours\day[1]	Days/Quarter				Noise Data in dBA at indicated distance		Notes
		Q1	Q2	Q3	Q4	50 feet	400 feet	
GMC Pickup Truck	8	90	91	92	92	83	65	At 35 mph. See also Note (2)
Ford Pickup Truck	8	90	91	92	92	83	65	
Dodge Pickup Truck	8	90	91	92	92	83	65	

Notes:

(1) Locations will vary throughout listed period of use.

(2) Single hour time-weighted noise levels at 50 and 400 feet are 45 dBA and 34 dBA, respectively per TNM 2.5 Lookup Tables.

Table 4-3 Contra Costa Mosquito and Vector Control District Vehicles and Equipment

Type of Vehicle/Equipment	Hours\day[1]	Days/Quarter				Noise Data in dBA at indicated distance		Notes
		Q1	Q2	Q3	Q4	50 feet	400 feet	
Chevy Pickup Truck(15)	2	30	65	65	30	83	65	At 35 mph. See also Note (2)
Chevy Pickup Truck(7)	2.75	0	65	65	0	83	65	
Chevy Pickup Truck(3)	1.5	15	30	30	15	83	65	
Chevy Pickup Truck(6)	0.5	0	5	5	0	83	65	
Toyota SUV(2)	1.0	8	8	8	8	83	65	
Chevy Sedan(1)	0.5	12	12	12	12	83	65	
Chevy Van(1)	1.0	2	0	0	2	83	65	
Hand Sprayer – Mozzie ULV Model 250(2)	2		1	7		87	69	Based on range of other hand sprayers
A-1 Mist Blower(1)	1.2		1	8		NOC		
Clarke-Cougar ULV(1)	2.5			9		63	45	Varies by nozzle and RPM
Maruyama Mist Duster MD155DX(3)	1.75	4	22	15		NOC		
Stihl SR420(1)	0.5		1			74	56	
Colt-T ULV(1)	0.75		6	8		87	69	Based on range of other ULV sprayers
LECO P-1 ULV(2)	1.0		1			87	69	Based on Range of other ULV sprayers
Gregor Boat(1)	0.5		1			90	72	
Argo ATV(7)	2.0	2	7.5	3.5		87	69	(3)
Polaris ATV(2)	1.0		8	10		87	69	(3)
1968 Bell 206 Jet Ranger helicopter	1		1				84-87	(4)
1989 Bell 206 Jet Ranger helicopter	1		1				84-87	(4)
1960 Hiller Soloy helicopter	1		1				83-89	Assumed (4)

NOC = Not of Concern

Notes:

(1) Locations will vary throughout listed period of use.

(2) Single hour time-weighted noise levels at 50 and 400 feet are 45 dBA and 34 dBA, respectively per TNM 2.5 Lookup Tables. Sound levels for vehicles varies greatly depending on speed, acceleration, braking, road type, and condition of vehicle. The values provided are very conservative.

(3) ATV range from reference California, 2005b.

(4) The noise values for aircraft (both fixed-wing and rotocraft) noise are approximately 500 feet from point of measure. Aerial applications are done in response to elevated levels of larval mosquito production in large often difficult to access areas and are not necessarily used every year.

Table 4-4 Marin-Sonoma Mosquito and Vector Control District Vehicles and Equipment

Type of Vehicle/Equipment (#)	Hours\day[1]	Days/Quarter				Noise Data in dBA at indicated distance		Notes
		Q1	Q2	Q3	Q4	50 feet	400 feet	
Chevy 3500 truck	1.0	4	15	15	2	85	67	At 35 mph. See also Note (2)
Ford F-250 truck (12)	2.0	50	60	60	40	83	65	
Ford F-250 truck 4x4 (9)	3.0	45	60	60	40	83	65	
Ford F-150 truck 4x4 (5)	1.5	10	15	15	5	83	65	
Ford F-350 truck (3)	3.0	10	15	15	5	85	67	
Ford Ranger truck 2x4 (3)	1.5	15	40	40	5	83	65	
Ford Ranger truck 4x4	0.5	3	5	5	1	83	65	
Ford F-550 4x4 (2)	3.0	5	15	15	2	85	67	
Intelli Truck 3500	1.0	3	4	1	0	85	67	
Chevy HD 2500 truck (3)	2.0	50	66	66	45	85	67	
Chevy W4500	1.0	0	1	3	0	85	67	
Ford Explorer (3)	1.0	32	48	48	32	83	65	
Ford Explorer 4x4	0.5	0	2	2	1	83	65	
Ford E-150 Van	1	0	7	7	1	83	65	
Dump Truck 5-ton	0.5	0	0	0	2	87	69	
Chevy Traverse	1.5	6	6	6	3	83	65	
Chevy 1500 Truck (2)	1.5	35	50	50	30	83	65	
Toyota Prius HB Three	2	63	63	63	63	83	65	
John Deere Tractor	2.0	0	2	1	0	76	58	
Argo Avenger (off-road) (5)	1	20	20	20	10	87	69	(3)
Argo Conquest (off-road) (4)	1	20	20	20	10	87	69	(3)
Arctic Cat 500 TBX (off- road) (2)	1	5	5	5	1		69	(3)
Kawasaki 400 (off- road)	1	5	5	5	1	87	69	(3)
Kawasaki 650 (off-road) (3)	2.5	10	20	30	15	87	69	(3)
Dondi Rotary Ditcher DMR35-B	1	1	0	0	1	NOC		
GO-4 Catch Basin Rig	2	1	5	5	5	NOC		
Komatsu (off-road)	2	0	2	2	0	87	69	(3)
Gator (off-road)	1	0	1	1	0	87	69	(3)
Pistenbully PB100 Mower	2.0	1	0	0	1	80	58	Estimated
Pistenbully 72F-H Mower	1.5	0	1	1	0	80	58	Estimated
Nifty-Fifty with Intelli reel	1	10	15	15	1	NOC		
Backpack fogger (Curtis Dynaflow) (5)	0.5	2	20	10	1	NOC		
Becomist Fogger (3)	1	2	15	10	2	50	NOC	

Type of Vehicle/Equipment (#)	Hours\day[1]	Days/Quarter				Noise Data in dBA at indicated distance		Notes
		Q1	Q2	Q3	Q4	50 feet	400 feet	
Electramist fogger	1	1	3	3	2	50	NOC	Assumed
Mozzie Fog Fogger	1	0	3	3	0	75	57	Based on ULV Fogger Range
Mozzie granular applicator	1	3	3	3	2	NOC		
Solo MD 150 DX (5)	1	10	30	30	15	NOC		Appears to be Maruyama Model #
Solo MD 155DX (2)	1	10	30	30	15	NOC		Appears to be Maruyama Model #
High Pressure sprayer	0.5	1	10	10	1	65	47	Generic. Approx. value listed
Echo Chainsaw	1.0	10	0	0	10	90	72	Varies by model, max. value listed
Echo hedge trimmer	1.0	5	0	0	5	51	NOC	Varies by model; value approx
Husqvarna Weedeater (2)	1.0	10	0	0	10	67	49	Varies by model; max value listed
Husqavarna Chainsaw (2)	0.5	5	0	0	5	72	54	Varies by model; max. value listed
Intelli sprayer 150	1.0	5	10	10	1	NOC		
Intelli sprayer 50	1.0	5	10	10	1	NOC		
‘01 International 8000; 2,500-Gal Water Truck	2.0	2	2	2	1	75-88	57-70	Depends on gear and speed
‘99 International 4700; 2,000-gal water truck	1.0	1	2	2	1	75-88	57-70	
‘97 Ford Louisville 2,000-Gal water truck	1.0	1	1	1	1	75-88	57-70	
‘99 Ford F550 Flat Bed 4X4 ruck	1.0	1	2	2	1	85	67	(2)
‘05 Dodge 2,500 4X4 truck	1.0	3	3	3	2	85	67	
Airboat	1.0	2	10	10	5	85-95	67-77	At minimum speed to maintain planning conditions (4)
Grizzly 17 ft. Boat	1.0	1	1	1	1	75-85	57-67	Depends on engine
Klamath Boat	0.5	1	1	1	1	75-85	57-67	Depends on engine
Bell 206 Jet Ranger helicopter	2.0	2	5	5	2		84-87	(5)
1960 Hiller Soloy helicopter	2.0	1	1	1	1		84-89	Assumed (5)

NOC = Not of Concern

(1) Locations will vary throughout listed period of use.

(2) Single hour time-weighted noise levels at 50 and 400 feet are 45 dBA and 34 dBA, respectively per TNM 2.5 Lookup Tables. Sound levels for vehicles varies greatly depending on speed, acceleration, braking, road type, and condition of vehicle. The values provided are very conservative.

(3) ATV range from reference California, 2005b.

(4) Reference: Glegg, et.al., 2005

(5) The noise values for aircraft (both fixed-wing and rotocraft) noise are approximately 500 feet from point of measure. Aerial applications are done in response to elevated levels of larval mosquito production in large often difficult to access areas and are not necessarily used every year.

Table 4-5 Napa County Mosquito and Vector Control District Vehicles and Equipment

		Days/Quarter				Noise Data in dBA at indicated distance		
Type of Vehicle/Equipment (#)	**Hours\day[1]**	**Q1**	**Q2**	**Q3**	**Q4**	**50 feet**	**400 feet**	**Notes**
Chevy Pickup Trucks (6)	4.5	55	54	57	51	83	65	At 35 mph. See also Note (2)
Toyota Pickup Trucks (3)	3	4	28	20	11	83	65	
Jeep Wrangler	5.4	5	5	12	0	83	65	
Daewoo Forklift	0.5	12	8	6	10	64	46	Model-specific; max. value listed
Echo Chainsaw CS330T	2	5	0	0	10	90	72	Model-specific; max. value listed
FloTech Trash Pump	0.5	0	4	6	10	70	52	Model-specific; max. value listed
Stihl Blower BR420	1	0	3	3	1	53	NOC	Approx.
Stihl Weed Wackers (3)	6	10	0	5	10	66	48	Model-specific; max value listed
Northstar Pressure Washer	0.5	10	16	15	10	48	NOC	
Intellispray 9TBE	6	4	15	1	28	NOC		
JD9 ULV	4	0	3	2	0	75	57	Max. value listed
Intellispray 5SDE (4)	5.9	9	21	22	28	NOC		
Wisconsin Robin ULV	3	0	3	2	0	75	57	Max. value listed
Pioneer Backpack Fogger	2	0	12	10	0	NOC		
50-gal Polaris Spot Sprayer	4	3	4	3	1	87	69	
Maruyama Back Sprayers (2)	5	12	17	9	6	NOC		
London Fog 18-20 ULV (2)	2.5	0	13	6	0	61	NOC	Varies by model, nozzle, & rpm
London Fog XKE	1.5	0	5	0	0	61	NOC	Varies by model, nozzle, & rpm
Hand Sprayer, London Fog Colt	1	0	6	2	0	61	NOC	Varies by model, nozzle, & rpm
Tracker Boat	4	3	6	6	3	75-85	57-67	Depends on engine
Argo Sprayers (3)	5.7	5	6	2	2	66	48	
Polaris ATV (2)	5.1	6	15	2	1	87	69	(3)
Argo ATV (3)	4	4	7	6	3	87	69	(3)
Bell 206 Jet Ranger Helicopter	3	4	2	2	0		84-87	(5)
Hiller Soloy Helicopter	3	4	2	2	0		83-89	Assumed (5)

NOC = Not of Concern

(1) Locations will vary throughout listed period of use.

(2) Single hour time-weighted noise levels at 50 and 400 feet are 45 dBA and 34 dBA, respectively per TNM 2.5 Lookup Tables. Sound levels for vehicles varies greatly depending on speed, acceleration, braking, road type, and condition of vehicle. The values provided are very conservative.

(3) ATV range from reference California, 2005b.

(4) Reference: Glegg, et.al., 2005

(5) The noise values for aircraft (both fixed-wing and rotocraft) noise are approximately 500 feet from point of measure. Aerial applications are done in response to elevated levels of larval mosquito production in large often difficult to access areas and are not necessarily used every year.

Table 4-6 Northern Salinas Valley Mosquito Abatement District Vehicles and Equipment

Type of Vehicle/Equipment (#)	Hours\day[1]	Days/Quarter				Noise Data in dBA at indicated distance		Notes
		Q1	Q2	Q3	Q4	50 feet	400 feet	
Chevy Silverado 4X4	16 hrs/mo	23	23	23	23	83	65	At 35 mph. See also Note (2)
Dodge Ram 50 Right hand drive	10 hrs/yr	23	23	23	23	83	65	
Jeep Liberty 4X4	2 hrs/mo	23	23	23	23	83	65	
Jeep Wrangler 4X4	4 hrs/mo	23	23	23	23	83	65	
Ford F-150 4X4 Flare Side	16 hrs/yr	23	23	23	23	83	65	
Ford F-150 4X4 (3)	4 hrs/day	23	23	23	23	83	65	
Ford F-150 Xl	4 hrs/day	23	23	23	23	83	65	
Ford F-350 4X4	16 hrs/mo	23	23	23	23	85	63	(2)
Ford Windstar Sport SE	8 hrs/mo	23	23	23	23	83	65	(2)
Stihl Chainsaw 028 AV Super	8 hrs/yr	23	23	23	23	90	72	Generic Range
Stihl Chainsaw 011AV	8 hrs/yr	45	45	45	0	90	72	Generic Range
Stihl Leaf Blower BG 65	0	00	45	45	0	69	51	
Bean Pump	8 hrs/mo	23	23	23	23	NOC		
Maruyama Backpack Blower	12 hrs/yr	23	23	23	23	NOC		
Cat 320 Excavator	150 hrs/yr	15	32	32	15	56	NOC	Assumes light duty
Cat D3 Dozer	100 hrs/yr	15	32	32	15	62	NOC	Assumes light duty
John Deere 6420 with Flail Mulch Mower S900 (PTO)	100 hrs/yr	15	32	15	15	80		Generic Tractor Range
Blow Mite Granule Spreader (backpack)	8 hrs/yr	23	23	23	23	NOC		
Robin Micro Gen Fogger	8 hr/yr	23	23	23	23	NOC		
Mozzie Fogger – Arro-Gun System	8 hrs/yr	23	23	23	23	NOC		
Mozzie Granular Applicator, Arro-Gun System	8 hrs/yr	23	23	23	23	NOC		
GPI Model 1505 Fuel Transfer	8 hrs/year	23	23	23	23	54	NOC	
Argo ATV	8 hrs/mo	23	23	23	23	87		(3)
Argo Sprayer System	8 hrs/mo	23	23	23	23	66	48	
Valco Flat Bottom Boat (go devil engine/prop)	8 hrs/mo	23	23	23	23	85-95		Assumed
Bell Jet Ranger	40/yr	23	23	23	23		84-87	

NOC = Not of Concern

(1) Locations will vary throughout listed period of use.

(2) Single hour time-weighted noise levels at 50 and 400 feet are 45 dBA and 34 dBA, respectively per TNM 2.5 Lookup Tables. Sound levels for vehicles varies greatly depending on speed, acceleration, braking, road type, and condition of vehicle. The values provided are very conservative.

(3) ATV range from reference California, 2005b.

(4) Reference: Glegg, et.al., 2005

(5) The noise values for aircraft (both fixed-wing and rotocraft) noise are approximately 500 feet from point of measure. Aerial applications are done in response to elevated levels of larval mosquito production in large often difficult to access areas and are not necessarily used every year.

Table 4-7 San Mateo County Mosquito and Vector Control District Vehicles and Equipment

Type of Vehicle/Equipment (#)	Hours\day[1]	Days/Quarter				Noise Data in dBA at indicated distance		Notes
		Q1	Q2	Q3	Q4	50 feet	400 feet	
Chevy 2500 pickup truck 4x4						83	65	At 35 mph. See also Note (2)
Ford F-150 pickup truck 4x4						83	65	
Hyundai Sonata Hybrid						83	65	
Ford Escape Hybrid 4x4						83	65	
Jeep Wrangler (Right Hand Drive)						83	65	
Ford Ranger pickup truck 4x4						83	65	
Nissan Frontier Pro4X pickup truck 4x4						83	65	
Toyota Sienna Van	2	15	15	15	15	83	65	
Nurse Rig 200 gal tank and sprayer	3	5	3	30	15	NOC		
Argo Avenger (off road)	4	5	5	0	5	87	59	(3)
Fork Lift - hydraulic	>1	5	5	5	5	59-63	NOC	Generic range
Porta-Pak ULV Backpack Sprayer	>1	2	10	10	2	75	57	
Maruyama Power Mister/Duster Backpack Sprayer	>1	5	10	10	5	NOC		
Curtis Dyna-Fog Twister XL ULV Backpack Sprayer	>1					NOC		
Clark Grizzly ULV Truck Mounted Sprayer	12	20	20	20	20	87	59	Based on USDA Report; Varies by nozzle, RPM
Univar Dynajet ULV Electric Truck Mounted Sprayer	12*	20	20	20	20	50	NOC	70 dB at nozzle
Hotsy High Pressure Washer	1	50	50	50	50	65	47	Estimated
Dewalt 10" Compound Miter Saw DW703	>1	>1	>1	>1	>1	66	48	Estimated
Dewalt 14" Multicutter Metal Saw	>1	>1	>1	>1	>1	83	61	Approx.
Chicken coops for sentinel chickens						44-90		Varies by Chicken/Rooster type, and activity level
Stihl Chainsaw 026	1	2	5	3	3	90	72	Generic Range Given
Stihl Chainsaw 021	1	2	5	3	3	90	72	Generic Range Given
Stihl Chainsaw 039	>1	>1	>1	>1	>1	90	72	Generic Range Given
Stihl Chainsaw 290	1	2	5	3	3	73	55	

Type of Vehicle/Equipment (#)	Hours\day[1]	Days/Quarter				Noise Data in dBA at indicated distance		Notes
		Q1	Q2	Q3	Q4	50 feet	400 feet	
Stihl Chainsaw 260	1	2	5	3	3	81	63	
ECHO Chainsaw CS 301	2	4	10	6	6	90	72	Generic Range Given
Stihl Trimmer HS 85	6		60	30		51	NOC	Approx. Generic Value Given
ECHO Weedeater SRM 225	2		5	5		69	51	Generic Range given
Stihl Weedeater FS 250	2		5	5		76	58	
05 Dodge 2500 4X4 truck	5	1	1	3	1	83	65	(2)
GTO Airboat	3	10	10	20	20	85-95		(4)
GTO Airboat 50 gallon spray tank	5	0	0	15	15	NOC		(6)
Klamath Boat 14’	3	2	2	2	2	75-85	57-67	Depends on engine
Klamath Boat 18’	2	5	5	5	5	75-85	57-67	Depends on engine
Argo Avenger (off road)	16	40	20	0	12	87		(3)
1989 Bell 206 Jet Ranger helicopter	4	2	2	2	2		84-87	(5)
Isolair Air spray system model 3900 (helicopter-mounted)	8	2	0	0	0	NOC		(6)
Isolair 4500 broadcaster (helicopter-mounted)	2	0	2	2	0	NOC		(6)

NOC = Not of Concern

(1) Locations will vary throughout listed period of use.

(2) Single hour time-weighted noise levels at 50 and 400 feet are 45 dBA and 34 dBA, respectively per TNM 2.5 Lookup Tables. Sound levels for vehicles varies greatly depending on speed, acceleration, braking, road type, and condition of vehicle. The values provided are very conservative.

(3) ATV range from reference California, 2005b.

(4) Reference: Glegg, et.al., 2005

(5) The noise values for aircraft (both fixed-wing and rotocraft) noise are approximately 500 feet from point of measure. Aerial applications are done in response to elevated levels of larval mosquito production in large often difficult to access areas and are not necessarily used every year.

(6) Delivery vehicle noise is greater than 3 dB above equipment noise therefore the equipment noise is NOC.

Table 4-8 Santa Clara County Vector Control District Vehicles and Equipment

Type of Vehicle/Equipment (#)	Hours\day[1]	Days/Quarter				Noise Data in dBA at indicated distance		Notes
		Q1	Q2	Q3	Q4	50 feet	400 feet	
Ford Personnel Van(1)	1	30	30	30	30	83	65	At 35 mph. See also Note (2)
Dodge Pickup truck(1)	2	30	30	30	30	83	65	
Ford F150 (14)	3	60	60	60	60	83	65	
Dodge ¾ ton(1)	4	0	60	60	10	85	67	
GMC ½ ton(5)	2	5	30	30	5	85	67	
Ford Escape(1)	1	20	20	20	20	83	65	
Ford F250(10)	3	60	60	60	60	83	65	
Ford Ranger(5)	6	25	60	60	15	83	65	
Ford Expedition	1	45	45	45	45	83	65	
International flatbed truck	1	3	2	2	3	85	67	
Fork Lift(1)	1	10	10	10	10	59	NOC	
Argo Avenger ATV(2)	2 .75 hrs	13	13	13	13	87	59	(3)
Kabota	1.44 hrs	3	3	3	3	76	58	Generic Tractor Range Given
Boat	12 min	0.5	0.5	0.5	0.5	NOC		Based on limited time of use
Yamaha Quads(2)	2.6 hrs	14	14	14	14	87	59	(3)
Argo Conquest	3 hrs	8	8	8	8	87	59	(3)
Alpine Helicopter Services	45 min	1	0	0	0	NOC		Based on limited time of use

NOC = Not of Concern

(1) Locations will vary throughout listed period of use.

(2) Single hour time-weighted noise levels at 50 and 400 feet are 45 dBA and 34 dBA, respectively per TNM 2.5 Lookup Tables. Sound levels for vehicles varies greatly depending on speed, acceleration, braking, road type, and condition of vehicle. The values provided are very conservative.

(3) ATV range from reference California, 2005b.

Table 4-9 Solano County MAD Vehicles and Equipment

		Days/Quarter				Noise Data in dBA at indicated distance		
Type of Vehicle/Equipment (#)	**Hours\day[1]**	**Q1**	**Q2**	**Q3**	**Q4**	**50 feet**	**400 feet**	**Notes**
Chevrolet Astro Van	1	60	60	60	50	83	65	At 35 mph. See also Note (2)
Ford Pickup Trucks[(7)]	4	50	60	60	50	83	65	
Clark Forklift	0.5	5	5	5	5	68	50	
Kubota Tractor	1	5	5	5	5	76	58	Generic Tractor Range Given
Pro-Mist 25HD	1	0	10	2	8	50	NOC	
Leco 500 ULV Fogger x2	2	0	5	2	8	87	69	Varies by model, nozzle, & RPM
London Fog M.A.G. ULV Fogger x3	2	0	15	15	5	61	NOC	
Colt handheld ULV Fogger x 6	0.5	0	10	4	0	66	48	(4)
Snapper Rear Engine Riding Mower	1	10	10	10	10	65	47	
Toro Push Mower	1	5	5	5	5	61	NOC	
Stihl 025 Chainsaw	.1	1	1	0	0	90	72	
Stihl FS83 Weedeater	0.5	10	15	15	10	59	NOC	
Stihl HS Hedge trimmer	1	0	2	2	0	63	NOC	
Stihl BG55 Leaf Blower	1	10	15	15	10	69	51	
Craftsman 24" Leaf Vac	1	1	0	0	1	55-75	57	Varies by model and type (gas/electric)
Maruyama MD155DX Backpack Sprayer	1	5	10	10	0	NOC		
Argo ATV Magnum	2	0	0	0	2	87	69	(3)
Argo ATV Conquest	4	0	0	5	15	87	69	(3)
Argo ATV Avenger	4	4	8	8	20	87	69	(3)
Argo ATV Avenger	3	15	10	6	10	87	69	(3)
Honda ATV TRX500FM	3	0	8	8	0	87	69	(3)
Honda ATV TRX400FE	2	0	6	6	0	87	69	(3)
Honda ATV TRX350FM	3	0	15	15	0	87	69	(3)
Honda ATV TRX300FW[(2)]	1	0	2	2	0	87	69	(3)
Invader boat 19	2	0	0	4	0	75-85	57-67	Varies by power setting
Achilles Inflatable boat	2	0	0	2	0	75-85	57-67	Varies by power setting

Type of Vehicle/Equipment (#)	Hours\day[1]	Days/Quarter				Noise Data in dBA at indicated distance		Notes
		Q1	Q2	Q3	Q4	50 feet	400 feet	
1968 Bell 206 Jet Ranger helicopter	2	2	0	0	0		84-87	(5)
1989 Bell 206 Jet Ranger helicopter	2	2	0	0	0		84-87	(5)
1960 Hiller Soloy helicopter	2	2	0	0	0		84-87	Estimated (5)
Isolair Air spray system model 3900 (helicopter-mounted)	2	6	0	0	0	NOC		(6)
Isolair 4400 bucket system (helicopter-mounted)	1	2	0	0	0	NOC		(6)
Isolair 4500 broadcaster (helicopter-mounted)	4	4	6	10	14	NOC		(6)
Fixed Wing Aircraft Air Tractor 502	4	4	6	10	14	NA		Not Applicable – Agricultural aircraft are exempt under FAR 36.1(a)(2) and 36.1583.

NA = Not Applicable

NOC = Not of Concern

(1) Locations will vary throughout listed period of use.

(2) Single hour time-weighted noise levels at 50 and 400 feet are 45 dBA and 34 dBA, respectively per TNM 2.5 Lookup Tables. Sound levels for vehicles varies greatly depending on speed, acceleration, braking, road type, and condition of vehicle. The values provided are very conservative.

(3) ATV range from reference California, 2005b.

(4) Based on sound power levels for typical 2.5-horsepower gasoline engine.

(5) The noise values for aircraft (both fixed-wing and rotocraft) noise are approximately 500 feet from point of measure. Aerial applications are done in response to elevated levels of larval mosquito production in large often difficult to access areas and are not necessarily used every year.

(6) Delivery vehicle noise is greater than 3 dB above equipment noise therefore the equipment noise is NOC.

5 Best Management Practices

The following Best Management Practices could be implemented by any of the Districts for any operations that use equipment that may generate noise levels approaching or above significance thresholds at sensitive receptors for even short periods of time.

> Measure 1: Provide Advance Notices. Provide nearby residents and businesses 48-72 hours of advanced notice of project activities, schedule, anticipated traffic, and potential noise issues. The advance notice will describe the potential noise disruption and the steps the District or its contractor plans to take to minimize the noise (for example, by enclosing and muffling equipment, limiting idling and engine brake use). If the activities are delayed due to operational issues or weather delays of more than 1 week, an additional notice will be provided.

> Measure 2: Provide Liaison and Hotline for Nuisance Complaints. The District will provide a liaison to respond to concerns of noise from Program operations. Procedures for reaching the liaison via telephone or in person will be included in notices distributed and posted in accordance with Measure 1. Nuisance complaints filed with the liaison, and the approach used to resolve the complaint, will be reported to the District.

> Measure 3: Properly Maintain Equipment. The application contractor will properly maintain and tune engines of all applicable equipment and maintain properly functioning mufflers on all internal combustion engines to minimize noise levels. Perform noise reduction maintenance during routine maintenance for each vehicle serviced.

> Measure 4: Follow Established Procedures for Aircraft Operations. The District will implement feasible and appropriate measures to ensure aircrew stay within the flight plan published. Measures include daily preflight and post-op briefings, written flight envelope procedures, and review of recorded Global Positioning System (GPS) flight data (including altitude). Complaints filed with the District contractor and the approach used by the aerial application contractor(s) to resolve the complaint will be reported to the District.

> Measure 5: Follow Established Procedures for Airboat Operations. The District will implement feasible and appropriate measures to ensure operators stay within the treatment area published. Measures include daily tailgate meetings and post-operational briefings, mapped operational areas that are permitted with recorded GPS route data. Complaints filed with the District contractor and the approach used by the aerial application contractor(s) to resolve the complaint will be reported to the District.

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Integrated Mosquito
Management Program

APPENDIX E

ALTERNATIVES ANALYSIS REPORT

SOLANO MOSQUITO ABATEMENT DISTRICT

Document Information

Prepared by	Solano County Mosquito Abatement District
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Table of Contents

Attachments

Tables

Introduction

This report documents the analysis of alternatives for the control of mosquitoes within the District's immediate Service Area, and upon request by agencies in adjacent counties to assist in those areas as well. The Service Area and the adjacent counties are called the Program Area for purposes of environmental impact analysis under the California Environmental Quality Act (CEQA). This report is provided as Appendix E, Alternatives Analysis Report, for the Solano County Mosquito Abatement District's Programmatic Environmental Impact Report (PEIR). It presents a list of potential alternatives or "tools" and screening criteria to produce recommended components of the Proposed Program. These components represent a reasonable range of alternatives to be discussed in the environmental consequences/impacts sections of the PEIR on the entirety of the District's Program.

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1 Program Background

The Solano County Mosquito Abatement District (District) has evaluated a range of control methods for mosquito species of human disease and discomfort. The District will continue to develop the most effective strategy and evaluate methods or "tools" to achieve Program objectives in order to protect human and animal health.

1.1 Program Location

The District's Service Area is located in the following county of the state of California: Solano. The areas proposed for control activities cover 582,016.00 acres (909.4 square miles). These activities would be focused in the areas with the greatest problems based on monitoring of mosquitoes and testing for presence of disease pathogens. The District may also provide mosquito control activities upon request from districts in the adjacent counties of Sonoma, Napa, Yolo, Sacramento, and Contra Costa, which (along with Solano County) comprise the District's Program Area.

1.2 Program History

The District was established in 1930 to provide mosquito control services to the residents and businesses of Solano County.

The District's Program is an ongoing series of related actions for control of mosquitoes that transmit human disease and cause discomfort. The District's activities involve the identification of mosquito problems; responsive actions to control existing populations of mosquitoes, prevent new sources of mosquitoes from developing, and manage habitat to minimize mosquito production; education of landowners and others on measures to minimize mosquito production or interaction with mosquitoes; and provision and administration of funding and institutional support necessary to accomplish District objectives.

For over the past two decades, the District has taken an integrated systems approach to mosquito control, utilizing a suite of tools that consist of surveillance, vegetation management, and physical, biological, and chemical controls along with public education. These Program "tools" or components are described in the subsequent subsection as "Program alternatives" for the California Environmental Quality Act (CEQA) process (except for public education, which is exempt from CEQA). Program implementation is weighted heavily towards vegetation management and physical and biological control, in part, to reduce the potential for environmental impacts. To realize effective and environmentally sound mosquito management, mosquito control must be based on several factors:

1. Carefully monitoring or surveying mosquito abundance and/or potential contact with people
2. Establishing treatment criteria (thresholds)
3. Selecting appropriate tools from a wide range of control methods

This ongoing Program consists of a dynamic combination of surveillance, treatment criteria, and use of multiple control activities in a coordinated program with public education that is generally known as Integrated Pest Management (IPM) or Integrated Mosquito Management (IMM).

While these Program components or tools together encompass the District's IMM Program, it is important to acknowledge that the specific tools utilized by District staff vary from day to day and from site to site in response to the mosquito species that are active, their population size or density, their age structure, location, time of year, local climate and weather, potential for mosquito -borne disease, proximity to human populations, including (a) proximity to sensitive receptors, (b) access by District staff to mosquito habitat, (c) abundance of natural predators, (d) availability and cost of control methods, (e) effectiveness of previous control efforts at the site, (f) potential for development of resistance in mosquito populations, (g) landowner policies or concerns, (h) proximity to special-status species, and (i) applicability of Endangered Species Recovery Plans, Habitat Conservation Plans, Natural Community Conservation Plans, and local community concerns, among other variables. Therefore, the specific actions taken in response to current or potential mosquito activity at a specific place and time depend on factors of mosquito and pathogen biology, physical and biotic environment, human settlement patterns, local standards, available control methods, and institutional and legal constraints. While some consistent mosquito sources are exposed to repeated control activity, many areas with minor mosquito activity are not routinely treated, and most of the land within the District's Service Area has never been directly treated for mosquitoes.

2 Potential Tools

Potential tools for use in Program are described below and include measures used for other similar control programs in California. This chapter presents a brief description of each tool. The evaluation of each as to whether it is applicable to or an effective component of a mosquito control program is initially presented here but explained further in Section 3.

2.1 Integrated Pest Management

Description: This method is the use of one or more tools to prevent pest numbers from reaching economically damaging levels. The keys to a successful Integrated Pest Management (IPM) program are monitoring pest numbers, establishing a treatment threshold level to trigger actions that will prevent economic damage, selecting the appropriate tool to prevent pest numbers from reaching economically damaging levels and recognizing that often some crop damage or human and/or animal discomfort is acceptable.

Examples of Tool Use: Integrated Pest Management is used in nearly all crop systems and by all mosquito and control agencies in California.

Applicability to District IMMP: The District's current IMMP uses the key concepts of IPM. Where IPM controls pest numbers and believes that some damage is acceptable, the District has instances in which the threat to public health requires additional measures beyond traditional IPM.

2.2 Mosquito Surveillance

Description: Mosquito surveillance, which is an integral part of the District's responsibility to protect public health and welfare, involves monitoring mosquito populations and habitat, their disease pathogens, and human/mosquito interactions. Mosquito surveillance provides the District with valuable information on what mosquito species are present or likely to occur, when they occur, where they occur, how many they are, and if they are carrying disease or otherwise affecting humans. Mosquito surveillance is critical to an IMM program because the information it provides is evaluated against treatment criteria to decide when and where to institute mosquito control measures. Information gained is used to help form action plans that can also assist in reducing the risk of contracting disease. Equally important is the use of mosquito surveillance in evaluating the efficacy, cost effectiveness, and environmental impacts of specific mosquito control actions.

Examples of Tool Use: Examples include field sampling/counting and trapping, arbovirus surveillance, field inspection of known or suspected habitats, and public service requests.

Applicability to District IMMP: Already used under current Program.

2.3 Physical Control

Description: Physical control is managing mosquito habitat to reduce mosquito production or migration through "source control' measures that are non-chemical or non-biological techniques. In many cases, physical control activities involve restoration and enhancement of natural ecological functioning. The use of this tool historically during the early days of the District began with hand-dug ditches connecting isolated potholes with natural channels in marsh areas before the advent of specialized machinery. Current activities may include, but are not limited to, water control and maintenance of channels, tide gates, levees, and other water control facilities to improve water circulation to modify habitats used by mosquitoes.

Examples of Tool Use: The District's involvement in physical control activities is primarily through public education. The District provides as guidelines mosquito prevention criteria that were endorsed by the California Department of Public Health and the San Francisco Bay Conservation and Development Commission in 1978 as part of the Suisun Marsh Protection Plan under California Assembly Bill 1717. These criteria cover various types of sources and are sent to various governmental agencies and private parties to assist them in avoiding the creation of mosquito- production problems when developing plans for the use of their properties.

Annual meetings are held with the Managers from the California Department of Fish and Wildlife and the Suisun Resource Conservation District. to discuss their plans for habitat improvements to seasonal wetlands managed as waterfowl habitat. District staff has an opportunity to provide input for suggested improvements to prevent or substantially reduce mosquito production that may include items such as construction of new ditches, maintenance of existing ditches and installation or repair of water control structures which are all crucial in the ability to rapidly flood, drain and re-flood areas to prevent or greatly reduce the successful completion of the life cycle of floodwater *Aedes* species (*Aedes melanimon* or *Aedes dorsalis*)

Maintenance is periodically conducted on some of the existing channels that were constructed years ago in the Vallejo marsh area by a private contractor (under the direction of a California Department of Public Health civil engineer) that are still useful in reducing mosquito production in tidal areas. It involves the removal of accumulated sediments and vegetative overgrowth to restore water circulation.

Applicability to District IMMP: Already used under current Program.

2.4 Vegetation Management

Description: The species composition and density of vegetation are basic elements of the habitat value of any area for mosquitoes, for predators of these mosquitoes, and for protected flora and fauna. District staff may occasionally undertake vegetation management activities as a tool to reduce the habitat value of sites for mosquitoes or to aid the production or dispersal of mosquito predators, as well as to allow access by District staff to mosquito habitat for surveillance and other control activities. For minor vegetation management, the District may use hand tools. Other mechanical means (i.e., heavy equipment) would be contracted from an outside source) for vegetation removal or thinning from existing channels or drains. Herbicides (chemical pesticides with specific toxicity to plants) are not currently used but are another tool that can be used to improve surveillance or reduce mosquito habitat.

Examples of Tool Use: Direct vegetation management using tools ranging from shovels and pruners to chain saws, weed whackers, and heavy equipment.

Applicability to District IMMP: Already used on a limited basis under current Program except for herbicide usage, which is a tool for potential future use.

2.5 Biological Control Pathogens (Viruses)

Description: Mosquito viral pathogens are highly host-specific and usually infect mosquito larvae when they are ingested. Upon entering the host, these pathogens multiply rapidly, destroying internal organs and consuming nutrients. The pathogen can be spread to other mosquito larvae in some cases when larval tissue disintegrates and the pathogens are released into the water to be ingested by uninfected larvae.

Examples of Tool Use: Examples of viruses that can infect mosquitoes are mosquito iridoviruses, densonucleosis viruses, nuclear polyhedrosis viruses, cytoplasmic polyhedrosis viruses, and entomopoxviruses.

Applicability to District IMMP: These viruses are not generally available commercially for mosquito control at present. Becnel and White (2007) provide a thorough summary of the current understanding and last 20 years of research concerning mosquito pathogenic viruses. Their review indicates there are still numerous issues to be addressed before mosquito viral pathogens can be used as an effective mosquito control strategy.

2.6 Biological Control Pathogens (Bacteria)

Description: Bacterial mosquito pathogens are highly host-specific and usually infect mosquito larvae when they are ingested. Upon entering the host, these pathogens multiply rapidly, destroying internal organs and consuming nutrients. The pathogen can be spread to other mosquito larvae in some cases when larval tissue disintegrates and the pathogens are released into the water to be ingested by uninfected larvae. Environmental factors such as salinity, low temperatures, high larval densities, life stage (age) of the mosquito, and dense vegetative cover that interferes with application at the mosquito breeding site can limit the effectiveness and presence of certain bacterial pathogens of mosquitoes. For example, *Bacillus sphaericus* (*Bs*) works best in highly polluted waters but not very well in brackish or saline environments. The species of mosquito may also play a role in effectiveness (e.g. several species of *Aedes* mosquitoes, including salt marsh *Aedes,* are not very susceptible to the larvicide *Bs* (Baumann et al., 1991; Davidson, 1989; Mittal, 2003).

Examples of Tool Use: Examples of bacteria pathogenic to mosquitoes are *Bacillus sphaericus* (*Bs*). The several strains of *Bacillus thuringiensis israelensis* (*Bti*), and *Saacharopolyspora spinosa*. Two bacteria, *Bs* and *Bti*, produce proteins that are toxic to most mosquito larvae, while *Saacharopolyspora spinosa* produces compounds known as spinosysns, which effectively control all larval mosquitoes. Of these, the only commercially available live bacteria is *Bs* which can reproduce in natural settings for some time following release. *Bs* is currently available as a granular formulation (VectoLex-CG), water dispersible granule (VectoLex-WDG), and water soluble packet (VectoLex-WSP) for the treatment of immature mosquitoes. *Bti* materials applied by the District do not contain live organisms, but only spores made up of specific protein molecules.

Applicability to District IMMP: Several formulations containing *Bs* and *Bti* are already used under the current Program. Products containing *Saacharopolyspora spinosa* are not currently used, but may be utilized in the future. More information on all three are provided in the sections below.

2.6.1 <u>Bacillus sphaericus</u>

Bacillus sphaericus is a commonly occurring spore-forming bacterium found throughout the world in soil and aquatic environments. Some strains produce a protein endotoxin at the time of sporulation. It is grown in fermentation vats and formulated for end use with processes similar to that of *Bti*. A standard bioassay similar to that used for *Bti* has been developed to determine preparation potencies. The bioassay utilizes *Culex quinquefasciatus* 3^{rd} and 4^{th} instar larvae. The endotoxin destroys the insect's gut in a way similar to *Bti* and has been shown to have activity against larvae of many mosquito genera such as *Culex*, *Culiseta*, *Anopheles* and some *Aedes* species. In California, *Culex* spp. and *Anopheles* spp. may be effectively controlled. Several species of *Aedes* have shown little or no susceptibility, and salt marsh *Aedes* species are not susceptible. The toxin is only active against the feeding larval stages and must be partially digested before it becomes activated. *Bacillus sphaericus*, in contrast to *Bti,* is virtually non-toxic to Black Flies (*Simuliidae*).

Bacillus sphaericus has demonstrated the unique property of being able to control mosquito larvae in highly organic aquatic environments, including sewage waste lagoons, animal waste ponds, and septic ditches. After a single application at labeled rates, field evaluations have shown VectoLex-CG to persist for 2-4 weeks. Field evaluations with VectoLex-CG have shown that *Bacillus sphaericus* may undergo limited recycling in certain organically rich environments.

VectoLex-CG has been extensively tested. Oral, dermal, and inhalation toxicity studies have not found any mammalian toxicity (Siegel and Shadduck 1990). When *B. sphaericus* is applied within label rates, no harmful effects have been found against non-target organisms including dragonfly nymphs, backswimmers, diving beetles, water scavenger beetles, marine amphipods, fairy shrimp, chironomids, water boatmen nymphs, backswimmers, copepods, crawfish, mollusks, and amphibians (Mulla, Darwazeh et al. 1984). This type of pesticide can be used in both environmentally sensitive and non-sensitive sites. Based on the technical data and scientific research, *B. sphaericus* is generally considered to have minimal immediate or cumulative impact is on the environment and the District may use it in any suitable site.

B. sphaericus technical material was not ineffective or pathogenic when administered as a single oral, intravenous or intratracheal installation in rats. No mortalities or treatment-related evidence of toxicological effects were observed. The acute oral and dermal LD_{50} values are greater than 5,000 mg/kg and greater than 2,000 mg/kg, respectively. The technical material is moderately irritating to the skin and eye. Oral exposure of *B. sphaericus* is practically nontoxic to mallard ducks. No mortalities or signs of toxicity occurred following a 9,000 mg/kg oral treatment. Birds fed diets containing 20 percent w/w of the technical material experienced no apparent pathogenic or toxic effects during a 30-day treatment period. Mallards given an intraperitoneal injection of *B. sphaericus* demonstrated toxicological effects including hypoactivity, tremors, ataxia and emaciation. The LD_{50} value was greater than 1.5 mg/kg.

Acute aquatic fresh water fish toxicity tests were done on bluegill sunfish and rainbow trout and daphnids. The 96-hour LC_{50} value for both sheep head minnows and shrimp was 71 mg/liter, while the NOEC (no observable effect concentration) value was 22 mg/liter for sheep head minnows and 50 mg/liter for shrimp. The 96-hour LC_{50} value for oysters was 42 mg/L. with a NOEC of 15 mg/L.

Invertebrate toxicity tests were done on mayfly larvae and honeybees. The LC_{50} and NOEC value for mayfly was 15.5 mg/L. Honeybees exposed to 10^{-4} and 10^{-8} spores/ml for up to 28 days demonstrated no significant decrease in survival when compared to controls.

2.6.2 <u>Bacillus thuringiensis israelensis</u>

Bacillus thuringiensis israelensis (Bti) controls all larval instars provided they have not quit feeding. Each *Bti* organism (under ideal environmental conditions) may produce, five different microscopic protein pro-toxins packaged inside one larger container or crystal. The crystal is commonly referred to as delta (d-) endotoxin. If the d-endotoxin is ingested, these five proteins are released in the alkaline environment of a mosquito larva's gut. The five proteins are converted into five different toxins if specific enzymes are present in the gut. Once converted, these toxins work alone or in combination to destroy the gut wall. This leads to paralysis and death of the larvae. *Bti* is fast acting and its efficacy can be evaluated almost immediately. It usually kills larvae within 1 hour after ingestion, and since each instar must eat in order for the larvae to grow, that means *Bti* usually kills mosquito larvae within 24 hours of application. It leaves no residues, and it is quickly biodegraded. Resistance is unlikely to develop simultaneously to the five different toxins derived from the *Bti* delta-endotoxin since they have five different modes of action. This suggests that this mosquito larvicide will continue to be effective for many years.

Bti is grown commercially in large fermentation vats using sophisticated techniques to control environmental variables such as temperature, moisture, oxygen, pH and nutrients. The process is similar to the production of beer, except that *Bti* bacteria are grown on high protein substrates such as fishmeal or soy flour and the spore and delta endotoxin are the end products. At the end of the fermentation process, *Bti* bacteria exhaust the nutrients in the fermentation machine, producing spores before they lyse and break apart. Coincidental with sporulation, the delta endotoxin is produced. The spores and delta endotoxins are then concentrated via centrifugation and microfiltration of the slurry. It can then be dried for processing and packaging as a solid formulation (s) or further processed as a liquid formulation (s). Since some fermentation medium (e.g. fishmeal) is always present in liquid formulations, they generally smell somewhat like the medium.

Biological larvicides like *Bti* can be applied to almost any mosquito source with the exception of treated, finished drinking water reservoirs and drinking water receptacles. It may be applied to irrigation water.

Although the details are poorly understood, evidence suggests that larvae also undergo a period of reduced feeding or inactivity prior to molting from 1st to 2nd, 2nd to 3rd and 3rd to 4th instars. If *Bti* is applied at these points in their development, the toxic crystals may settle out before the larvae resume feeding, and with synchronous broods of mosquitoes, complete control failures may result. With asynchronous broods, efficacy may be reduced. Kills are usually observed within 24 hours of toxin ingestion.

The amount of toxins contained within the *Bti* products are reported indirectly as the result of at least two different bioassays and are difficult to equate to one another. Prepared volumes of toxins are applied to living mosquito larvae and the resulting mortality produces through formulae numerical measures known as International Toxic Units (ITUs) and *Aedes aegypti* International Toxic Units (AA-ITUs). These measures are only roughly related to observed efficacy in the field, and are therefore inappropriate to consolidate and report on like other toxicants.

The 4-hr Inhalation LC_{50} in rats is calculated to be greater than 2.1 mg/liter (actual) of air, the maximum attainable concentration. The acute Dermal LD_{50} in rabbits is greater than 2,000 mg/kg body weight and is considered to be non-irritating to the eye or skin. That is equivalent to a 220 lb. individual spilling more than a half-gallon of *Bti* liquid onto himself or into his eyes. Toxicology profiles also suggest that the inert ingredients (not the *Bti*) in liquid formulations, may cause minor eye irritations in humans. The acute Oral LD_{50} in rats is greater than 5,000 mg/kg body weight (similar to an individual drinking over 5 quarts) suggesting the material is practically non-toxic in single doses. Common table salt has a LD_{50} of 4,000 mg/kg of body weight. Oral, dermal, and inhalation toxicity studies have not found any mammalian toxicity. Numerous studies have been conducted regarding the effect of *Bacillus thuringiensis* on non-target organisms and the environment. When products that contain *Bti* are applied within label rates, no harmful effects have been found against non-target organisms including tree frog tadpoles, toad tadpoles, California newts, water fleas, mayfly nymphs, damselfly nymphs, water boatmen nymphs, backswimmers, pygmy backswimmers, scavenger water beetle larvae, predaceous water beetles, flatworms, earthworms, fresh water snails, and mussels (Garcia, Des Rochers and Tozer 1981). Long-term studies in wetland habitat have revealed no significant effects on the food chain or inhabitants of wetlands (Lacey and Mulla 1990).

The "Program Evaluation Report" of the Metropolitan Mosquito Control District noted that …"our conclusion from reviewing the scientific literature is generally consistent with the EPA's position that *Bti* and methoprene...pose little risk to people and most non-targets species." (State of Minnesota, Office of Legislative Auditor, January 1999)

There have been reported impacts in larvae in the Order Diptera, Suborder Nematocera, Families Chironomidae (midges), Ceratopogonidae (biting midges) and Dixidae (dixid midges), These non-target species, taxonomically closely related to mosquitoes and black flies, apparently contain the necessary gut pH and enzymes to activate delta-endotoxins (Ali, Baggs and Stewart 1981; Garcia, Tozer and DesRochers 1981; Miura, Takahashi and Mulligan 1980; Miura, Takahashi and Mulligan 1981; Molloy 1992). However, the concentration of *Bti* required to cause these effects is 10 to 1,000 times higher than normal use rates. Further studies report these impacts are short-lived, with the population of these species rebounding quickly. *Bti* is generally considered to have minimal immediate or cumulative impact on the environment.

Biological larvicides like *Bti* can be applied to almost any mosquito source with the exception of treated, finished drinking water reservoirs and drinking water receptacles. It may be applied to irrigation water.

Concerning the operational use of *Bti*, timing of application is extremely important. Optimal benefits are obtained when treating 2nd or 3rd instar larvae. Treatments at other development stages may provide less than desired results. Therefore, a disadvantage of using *Bti* is the limited treatment window available.

2.6.3 Spinosad

Spinosad is a biologically derived insecticide produced via fermentation culture of the actinomycete *Saccharopolyspora spinosa*, a bacterial organism isolated from soil. The natural metabolites produced during the fermentation process were termed "spinosysns." Spinosad is the collective term for the two most prominent and most active compounds in the fermentation broth (spinosyn A and spinosyn D. The public health use products containing Spinosad that are currently available have the trade name "Natular". Spinosad works by altering the function of insect nicotinic acetylcholine receptors in a unique action that causes continuous nervous impulses after ingestion or contact with the active ingredient. This constant involuntary nervous stimulus causes paralysis and death.

All domestic formulations of Natular are listed by the Organic materials Review Institute (OMRI) for use in and around organic agriculture. Spinosad is the only active ingredient with a Group 5 designation by IRAC (Insect Resistance Action Committee). This is a global industry organization that promotes the development of insect resistance management strategies to maintain efficacy and support sustainable agriculture and improved public health. Each group has a distinctly different mode of action. The fact that Spinosad is the only active ingredient in Group 5 used for mosquito control means that it has no cross-resistance with existing products which makes it an excellent option for resistance management. All inert components in domestic Natular formulations are included in EPA's list of Minimal Risk Inert Ingredients. Inerts are non-synthetic (natural) or are synthetic components which do not contribute to mammalian or aquatic toxicity. Spinosad is of low acute and chronic toxicity to a wide range of non-target species. Under laboratory conditions, spinosad is toxic to some aquatic invertebrates, primarily upon chronic exposure. Fortunately, the rapid degradation of spinosad in natural aquatic environments prevents the long-term exposure that would be needed for these effects to occur in real world situations. Excellent results have been observed when Natular formulations have been in habitats with high concentrations of organic debris, e.g. polluted water, sewage lagoons, and waters with high concentrations of leaf litter or other organic debris. Field studies indicate that effect on non-target species is not mitigated by virtue of low application rates and rapid dissipation of spinosad. Liquid spinosad spray residues that have been allowed to dry for up to 3 hours are not harmful to foraging honeybees and bumblebees. Granular and tablet formulations do not pose a bee hazard.

Spinosad is soluble in water, and soluble in common organic solvents such as acetone, acetonitrile, methanol, and toluene. Spinosad is relatively short-lived in the field and photodegrades rapidly. Its half-life is less than one day.

U.S. EPA determined that spinosad does not leach, bioaccumulate, volatize, or persist in the environment. No acute or chronic levels of concern were exceeded for terrestrial animals, aquatic animals or plants.

Saacharopolyspora spinosa are not currently used, but may be utilized in the future. The use of products containing this active ingredient will be done in carefully selected areas to avoid potential effects to non-target invertebrate species.

2.7 Biological Control Parasites

Description: The life cycles of mosquito parasites are biologically more complex than those of mosquito pathogens and involve intermediate hosts, organisms other than mosquitoes. Mosquito parasites are ingested by the feeding larva or actively penetrate the larval cuticle to gain access to the host interior. Once inside the host, parasites consume the internal organs and food reserves until the parasite's developmental process is complete. The host is killed when the parasite reaches maturity and leaves the host (*Romanomermis culicivorax*) or reproduces (*Lagenidium giganteum*). Once free of the host, the parasite can remain dormant in the environment until it can begin its developmental cycle in another host.

Examples of Tool Use: Examples of mosquito parasites are the fungi *Coelomomyces spp*., *Lagenidium giganteum, Culicinomyces clavosporus*, and *Metarhizium anisopliae*; the protozoa *Nosema algerae,* *Hazardia milleh, Vavraia culicis, Helicosporidium* spp.*, Amblyospora californica, Lambornella clarki*, and *Tetrahymena* spp.; and the nematodes *Reesimermis nielseni* and *Romanomermis culicivorax*.

Applicability to District IMMP: These parasites are not generally available commercially for mosquito control at present. However, additional information is provided below.

2.7.1 ***Lagenidium giganteum***

Lagenidium giganteum is an oomycete fungus which parasitizes mosquito larvae. Motile zoospores enter mosquito larva when either ingested or by penetrating the cuticle. The fungus grows rapidly throughout the host body cavity and once the host dies, zoospores are released that can infect other larvae.

Lagenidium giganteum is a highly specific parasite of mosquito larvae. Other organisms are not susceptible and there is no mammalian toxicity. *L. giganteum* was briefly available under the trade name Laginex. Production, storage (short shelf life), registration, and costs were some of the issues limiting the use of this parasite for mosquito control. Other factors included the environmental limitations of temperature (less than 16 or more than 32°C), moderate salinity levels (less than 10 ppt) and moderate organic content of the water (Kerwin 2007; Merriam and Axtel 1982). Scholte et al. (2004) reviews the different entomopathogenic fungi that have been studied for mosquito control purposes and states that there are nine key features of an ideal fungus for mosquito control. These are:

1. kills adult and larval stages,
2. requires no more than a few applications per season
3. is easily dispersed by adult female mosquitoes to uninfected breeding sites,
4. shows residual activity and persistence in mosquito populations after introduction,
5. kills only mosquitoes,
6. is effective over a wide range of salinity, temperature, humidity, and water quality conditions,
7. is easily and cost-effectively mass produced,
8. has a long shelf-life and can be easily stored, and
9. is not harmful to humans or other nontarget organisms.

Scholte concludes by stating that “none of the mosquito-pathogenic fungi presently known exhibit all of these characteristics, by they all exhibit at least some.”

2.7.2 Other Fungi

Other fungi, including the recently reclassified microsporidia, continue to be found and studied for their potential as biological control agents. Andreadis (2007) and Scholte et al. (2004) provide through updated reviews of the entomopathogenic fungi of mosquitoes. Elucidation of their complex life histories and effectiveness as biological control agents of mosquitoes (e.g. *Coelomomyces* spp., *Culicinomyces* spp. and certain microsporidia) are discussed. As mentioned above there are still some technical issues to be solved before these biological control agents could be commercially produced and available for use.

2.7.3 ***Lambornella clarkia***

Lambornella clarkia, has been studied as a biological control agent of container breeding mosquitoes, especially the Western Treehole Mosquito, a natural host of this endoparasitic ciliate (Washburn and Anderson, 1990a,b, 1986; Washburn et al. 1988). This parasite has cysts which are resistant to desiccation and therefore allow this ciliate to persist to the next year. Production and storage methods investigations, and early field trials have been conducted to determine the efficacy of this ciliate for biological control (Anderson, et al., 1986a,b, 1989; Anderson and Washburn 1989a,b, 1990a). Although the data demonstrates that *L. clarkia* appears to be a promising biological control agent, it is at this time not commercially available for use.

2.7.4 Nematodes

Mermithid nematodes, especially *Romanomermis* spp. and *Reesmermis* spp., have received a fair amount of study for use as biological control agents of mosquitoes, with Romanomermis culicivorax having been commercially produced as Skeeter Doom for a short time many years ago. Although this nematode showed much promise there were still the following limitations restricting its widespread use: low salinity levels, organically rich waters with low oxygen levels, predation by other aquatic organisms, the potential for the development of host resistance, and the costs associated with mass in-vivo production (Legner 1995; Peterson, 1978; Peterson and Willis, 1970; Platzer, 2007; Platzer, 1981).

2.8 Biological Control Predators

Description: Mosquito predators are represented by highly complex organisms, such as insects, fish, birds, and bats that consume larval or adult mosquitoes as prey. Predators are opportunistic in their feeding habits and typically forage on a variety of prey types, which allows them to build and maintain populations at levels sufficient to control mosquitoes, even when mosquitoes are scarce.

The effectiveness of a mosquito biological control agent lies in its ability to reduce mosquito numbers as quickly as possible. An ideal biological control agent 1) feeds preferentially on mosquitoes, 2) exhibits an extremely efficient hunting or paralyzing strategy, and 3) reproduces quickly. These traits determine suitability for practical application.

New mosquito sources initially have few predators and other competing aquatic organisms. Mosquito control personnel use this knowledge to develop a control strategy that involves integrated mosquito management techniques.

Since mosquitoes are capable of colonizing sources within days of flooding, initial control efforts attempt to suppress the first generations of mosquitoes until natural predators or competitors can control them.

Initial treatment includes the selective use of pesticides and appropriate environmental manipulation, such as vegetation and water quality management. Once biological control is established in a “managed” source, periodic inspections at timely intervals are adequate to monitor changes in larval abundance. Periodically, the source may require treatments with pesticides when 1) predators are not effective, 2) aquatic and shoreline vegetation provides too much shelter, 3) the water level changes, or 4) water quality does not support predators.

The ability of predators to control mosquitoes is related to four factors: 1) whether mosquitoes are preferred prey, 2) whether the hunting strategy of the predator maximizes contact with mosquitoes, 3) whether the predator consumes large numbers of mosquitoes, and 4) whether the predator is present in sufficient numbers to control mosquitoes. Predator effectiveness is enhanced when proper conditions are present.

Within a typical aquatic environment that produces mosquitoes, predators are distributed among different substrates. For example, the surface of the pond supports water striders, planaria and spiders. Below the water surface, backswimmers, predaceous diving beetles and water scavenger beetles live and feed. If the pond contains vegetation, then the plant surfaces (periphyton) will support *Hydra*, damselfly and dragonfly nymphs, and giant water bug nymphs and adults. The benthos supports dragonfly and damselfly nymphs that feed on organisms associated with silts and organic detritus. Together, the different predators form a special network that accounts for predation throughout the pond. Ideally, an adequate variety of vegetation should be present to maintain sufficient levels of predator diversity. Greater potential for an acceptable level of mosquito control exists when more predators are present. Care should be taken so that mosquitoes do not have an advantage when too much or too little vegetation is removed.

Most of the currently registered mosquito larvicides minimally impact predators. Making applications at the lower end of the label rate when possible can further minimize any undesirable impacts from these larvicides. The overall objective of using predators is to reduce the frequency of pesticide applications. This minimizes environmental impact and delays the development of mosquito resistance to pesticides.

Predation on mosquitoes is a natural process that will occur without human intervention. However, the level of mosquito control by natural predators can be increased by the conservation of predators in the environment and by augmentation of the predator population through stocking and habitat enhancement.

Relatively few biological control agents are currently being used in California, although a wide range of organisms has been studied and tested extensively in the laboratory and field. Many have shown potential, but have not been used for a variety of reasons, including 1) difficulties in mass production, 2) failure to produce a consistent level of control, 3) expense, and 4) restricted application because of environmental concerns. Most agents, particularly predators and parasites, are only effective in association with mosquitofish and larvicides. Currently, the only practical biological control agents in use or consideration by the District are *Bacillus thuringiensis israelensis, Bacillus sphaericus* and the mosquitofish *Gambusia affinis*. Under consideration for use in the future is the bacterium *Saccharopolyspora spinosa.*

Research indicates that mosquitofish do have the potential to impact the environments within which they are placed. Yet, it is also important to remember that care should be taken when working with and evaluating the data from the myriad of studies that have been conducted with mosquitofish. While these studies suggest that mosquitofish can reduce populations of amphibians, fish and invertebrates, there are some significant factors to be considered when working with the data. First, the results of many of these studies are laboratory based and utilize artificial environments that are limited in their ability to emulate natural fully functioning wetland habitats and/or they offer the fish limited prey selection. Second, some studies created outdoor simulated wetland mesocosms; yet even these sites were limited as they did not in many cases have the diversity of microhabitats, vegetation and full range of complex biotic interactions that one might find in well-established natural wetland systems. Third, many studies lacked populations of potential predators of mosquitofish that can be found in natural habitats thus allowing the populations of mosquitofish to exceed levels that would otherwise be found. Fourth, some studies use stocking rates well above those utilized by mosquito control agencies or had stocked ponds with numbers of fish that were much higher than what would occur in the wild for that time of year. Walton (2007) cogently points out that "predation on mosquitofish, environmental complexity and environmental factors may ameliorate the strong effects observed in simple laboratory and mesocosm systems."

Although there is little doubt that mosquitofish are a useful biological control agent of immature mosquitoes, their use and application does have limitations both in terms of effectiveness and in limiting the risk of potential unwanted impacts. The District supports and encourages the presence of the other biological control predators of mosquitoes when practical. Yet, the only readily available biological control agents for use, other than the bacteria *Bacillus sphaericus or Bacillus thuringiensis*, is the mosquitofish. The rearing and stocking of mosquitofish in mosquito breeding habitats is also the most commonly used biological control agent for mosquitoes in the world.

Examples of Tool Use: Examples of mosquito predators include representatives from a wide variety of taxa: coelenterates, *Hydra* spp.; platyhelminths, *Dugesia dorotocephala, Mesostoma lingua, and Planaria* spp.; insects, *Anisoptera, Zygoptera, Belostomidae, Geridae, Notonectidae, Veliidae, Dytiscidae, and Hydrophilidae*; arachnids, *Pardosa* spp.; mosquitofish, *Gambusia affinis*, *Gasterosteus aculeatus*; bats; and birds, *anseriformes, apodiformes, charadriiformes, and passeriformes*.

Applicability to District IMMP: Only mosquitofish are commercially available to use at present, while the District supports the presence of the other species as practical. The District’s rearing (augmented by early season purchases from a commercial source) and stocking of mosquitofish in mosquito habitat is the most commonly used biological control agent for mosquitoes in the world. Nonetheless, the District's use of mosquitofish is limited and carefully monitored and includes rechecking planted sites to verify presence and abundance. Mosquitofish are typically used as a long-term control measure and, therefore, are not planted in habitats prone to drying. Fish are placed in closed man-made water features such as ornamental ponds, water gardens, horse troughs, rain water barrels, and large fountains; and care is taken to verify that this biological control agent cannot gain access to unintended habitats, especially creeks and sensitive wetlands. Citizens are also advised of State regulations prohibiting the introduction of non-native species (e.g., mosquitofish) into waters of the State and the U.S. Operationally, the use of mosquitofish is also limited by factors such as highly polluted water (e.g., dairy lagoons, winery waste ponds, septic ponds), presence or proximity of sensitive species and habitats, and whether or not the mosquito breeding site is a seasonal water source or a permanent impoundment.

2.8.1 Mosquitofish Distribution to the Public

District policy is to take a number of precautions in regard to the distribution of mosquitofish. Residents requesting mosquitofish are required to provide the District with a certain amount of information before receiving fish. The request is then discussed with a district employee prior to fish being provided.

During the discussion, the legal restrictions on planting fish by the public as described in the written statement that is handed to each resident are discussed. Mosquitofish are appropriate in ornamental ponds, horse troughs, non-maintained swimming pools or any other water source that does not connect to a waterway.

Limiting the introduction of the mosquitofish by homeowners to these sources should prevent their migration into habitats used by threatened, endangered, or rare species.

2.8.2 Planting Mosquitofish in Natural Waterways

To minimize the potential impacts of planting mosquitofish in natural waterways, the District will implement a policy incorporating the following elements:

1. Limiting such plantings to areas where the District's historic and ongoing Surveillance Program indicates that mosquito breeding is likely to occur.
2. Consulting appropriate federal and state fish and wildlife department websites, including the USFWS website, CDFW website, and CalFish.org to determine if the area under consideration for treatment, including a 1-mile radius around the site, is a known habitat for threatened and/or endangered species.
3. Not planting in streams until flows have become discontinuous, and stream habitat consists of isolated pools to minimize the potential for the movement of mosquitofish to areas where treatment was not intended.
4. Not planting mosquitofish if there have been reported sightings of threatened and/or endangered species within this area without further surveys by a biologist qualified to perform such surveys, or consultation with agency biologists.
5. District staff conducting a site survey and preparing a written report relating to the occurrence of sensitive species and not planting mosquitofish if the survey identifies the potential presence of sensitive species.

Unless prohibited by the guidelines above, the site will be planted with mosquitofish. The District will keep records of all plantings made by watershed and location, as well as records of any plantings that were planned and discontinued for any of the reasons provided above.

2.9 Synthetic Insecticides

Description: Insecticides used for killing adult mosquitoes that have synthetically-produced active ingredients that are chemically similar to pyrethrin.

Synthetic pyrethroids are photostable compounds and formulated as the active ingredient Permethrin found in products such as Biomist 4/12 percent and Kontrol 4-4. Resmethrin is the active ingredient found in Scourge 18/54 percent.

Synthetic pyrethroids are not cholinesterase inhibitors, are non-cholinesterase inhibitors, are non-corrosive and will not damage painted surfaces. They are less irritating than other mosquito adulticides and have a less offensive odor. In comparison to other adulticides, pyrethroids may be effectively applied at much lower rates of active ingredient per acre. The synthetic pyrethroids are mimics of natural pyrethrum, a botanical insecticide. The acute toxicity of these materials is low to mammals (permethrin oral LD_{50} is greater than 4,000 mg/kg; Resmethrin oral LD_{50}=2,000 mg/kg), 5,000 parts per million of the active ingredients in Scourge® (Pederson, 1990). Neither of these products is listed as carcinogens. Research conducted recently in a series of controlled plot studies in the Central Valley indicated no reductions in either the total abundance or biomass of aquatic macroinvertebrates or fish, and a return to pre-application abundance within 24 hours for flying insects, after label-rate treatments using permethrin, pyrethrin, and resmethrin containing products (Lawler, 1997).

During ultra-low volume (ULV) applications of any adulticides containing the aforementioned active ingredients, it is possible that some non-target beneficial insects may also be killed including honey bees. District staff performs ULV applications during periods when foraging is not occurring. Scientific research has shown that when Scourge® is applied according to the label, foraging bees are not affected by residual pesticide.

Examples of Tool Use: Permethrin (Masterline Kontrol®), Biomist, and Resmethrin (Scourge®)

Applicability to District IMMP: Adulticide materials are used only when necessary to control adult mosquito populations.

The Legislative Audit of Metropolitan MCD concluded that “Studies by EPA and the World Health Organization found that resmethrin and permethrin are broad-spectrum insecticides with the potential to harm other types of insects and aquatic organisms, but they should not be harmful to humans or the environment if applied according to label instructions” (p. xi). Although generally safe to humans and the environment, these products are generally used when larval control has not been successful or possible and there is either the threat of disease transmission or adult mosquito populations are so high that they interfere with the enjoyment of the environment. Consistent with the Legislature’s policy for environmental quality, control of adult mosquitoes may be necessary for the health and safety of the people and to provide a satisfying living environment.

2.10 Botanical Insecticides

Description: Botanical or “natural” insecticides are derived from natural plants in contrast to the synthetic versions described above, Pyrethrin (pyrethrum) is one of the most commonly produced and utilized natural insecticides and is sometimes used by the District as a part of its IMMP. Pyrethrin is a natural insecticide extracted from certain varieties of the flower *Chrysanthemum cinerariaelfolium* and consists of six active ingredients collectively known as pyrethrins (EPA, 2006; Gunasekara, 2005; Worthing & Hance 1991). This insecticide provides effective control of adult mosquitoes and other insect pests at very low dosage and has little residual activity (persistence) due to its sensitivity to sunlight. The chrysanthemum flowers used to produce pyrethrins are grown commercially in parts of Africa, Asia and Australia.

Pyrethrins and pyrethroids exhibit rapid knockdown and kill of adult mosquitoes, characteristics that are considered a major benefit of their use. The mode of action of these compounds relates to their ability to affect sodium channel function in the insects' neural membranes. Their toxicity in insects is markedly increased by the addition of synergists (primarily piperonyl butoxide) which inhibit detoxification of the pyrethrins in insects. There is no evidence that these synergists increase toxicity in mammals.

Pyrethrins are not cholinesterase inhibitors, are non-corrosive, and will not damage painted surfaces. They are less irritating than other mosquito adulticides and have a less offensive odor. In comparison to other adulticides, pyrethrins may be effectively applied at much lower rates of active ingredient per acre.

Examples of Tool Use: Pyrethrins (MGK Pyrocide®) and (Pyrenone Public Health Insecticide).

Applicability to District IMMP: Adulticide materials are used only when necessary to control adult mosquito populations.

2.11 Insect Growth Regulators

Description: Insect Growth Regulators (IGRs) target immature insect populations. IGRs can be target specific, depending on the formulation used and the concentration that is applied to the target population of insects being managed. Therefore, adhering to label requirements and used in the manner for which they are designed, IGRs affect the juvenile stages of the target organisms while causing little or no effects to the non-targets present (e.g., methoprene and mosquitoes). Unlike many traditional insecticides, IGRs do not affect an insect's nervous system, nor do they kill adult mosquitoes. Rather, IGRs prevent the ability of the immature stages to complete their final molt from the pupal stage to adult (prevent adult emergence).

The IGR currently used by the District is s-methoprene. s-Methoprene is a juvenile hormone that is designed to disrupt the transformation of a juvenile mosquito into an adult. It is applied either in response to observed populations of mosquito larvae at a site, or as a sustained–release product that can persist for about 4 months.

s-Methoprene is a true analogue and synthetic mimic of a naturally occurring insect hormone called Juvenile Hormone (JH). JH is found during aquatic life stages of the mosquito and in other insects, but is most prevalent during the early instars. As mosquito larvae mature, the level of JH steadily declines until the 4th instar molt, when levels are very low. This is considered to be a sensitive period when all the physical features of the adult begin to develop. s-Methoprene in the aquatic habitat can be absorbed on contact and the insect's hormone system becomes unbalanced. When this happens during the sensitive period, the imbalance interferes with 4th instar larval development. One effect is to prevent adults from emerging. Since pupae do not eat, they eventually deplete body stores of essential nutrients and then starve to death. For these and perhaps other reasons, s-Methoprene is considered an insect growth regulator (IGR).

Since the biology of midges and mosquitoes are similar, methoprene is effective on both insects in some circumstances. Oral, dermal and inhalation studies have not found any mammalian toxicity. When methoprene products are applied within label rates, no harmful effects have been found against non-target organisms including 35 species of protozoa, earthworms, leeches, water fleas, shrimp, damselflies, mayflies, water beetles, snails, tadpoles, mosquitofish and algae (Miura and Takahashi, 1973) and there is no impact on the food chain of ducks, geese, frogs, toads, salamanders, crabs, shrimp, oysters, and clams (Miura and Takahashi, 1974).

The "Program Evaluation Report" of the Metropolitan Mosquito Control District notes that …"*our conclusion from reviewing the scientific literature is generally consistent with EPA's position that Bti and methoprene … pose little risk to people and most non-target species*" (Office of the Legislative Auditor, State of Minnesota, January 1999, p. x).

According to EPA's *June 2001 Update of the March 1991 Methoprene RED Fact Sheet* (2001 RED) (EPA, 2001), the studies available to EPA indicate that the biochemical insect growth regulator methoprene is of low toxicity and poses very little hazard to people and other non-target species. Exposure to methoprene residues is not expected from drinking water. In aqueous solutions, methoprene degrades rapidly under sunlight into at least 50 minor photolysis products. Methoprene is rapidly metabolized in soil both under aerobic and anaerobic conditions (half-life 10-14 days) with CO_2 as the major product. Degradation in surface water is due to both microbial metabolism and photolysis. It also indicated that methoprene will not result in unreasonable adverse effects on the environment since methoprene degrades rapidly in sunlight, both in water and on inert surfaces. Methoprene is also metabolized rapidly in soil and does not leach. Thus, methoprene is not expected to persist in soil or contaminate ground water. The 2001 RED also concluded that ecological concerns contained in the 1991 RED related to toxicity to estuarine invertebrates have been alleviated as a result of submission of the estuarine invertebrate life cycle toxicity study in 1996, which indicated minimal chronic risk to Mysid Shrimp.

There is no credible or substantial evidence to support the suggestion that methoprene may be associated with deformities in frogs that have been observed in a number of states. Recent exhaustive reviews of this literature by independent analysts in Minnesota and New Zealand also find no evidence to support this claim (Glare & O'Callaghan, 1999; (Office of the Legislative Auditor, State of Minnesota, January 1999, p. x). The observations discussed to support the assertion have not been duplicated by any other researchers (Ankley et al. 1998, Glare & O'Callaghan 1999).

Examples of Tool Use: Liquid and solid formulations of Methoprene (Altosid®).

Applicability to District IMMP: Widely used in all types of sites, year round.

2.12 Surface Films

Description: Surfactant-larvicides and Pupacides form a thin film on water and kill larvae and pupae through suffocation/or direct toxicity. Surface film larvicides are effective against both the larval and pupal stages of mosquitoes, unlike other larvicides currently registered for use in California, which do not act as pupacides. They include highly refined oils and ethoxylated isostearyl alcohols.

GB-1111 (Golden Bear 1111) is a highly refined petroleum based "naphthenic oil" with very low phytotoxicity and no detectible residual products within days after application. Volatility is very low ("non-volatile" according to the MSDS), and environmental breakdown presumably results primarily from natural microbial degradation into simple organic compounds. The label for GB-1111 contains the signal word "CAUTION." GB-1111 contains 99 percent (wt./wt.) oil and 1 percent (wt./wt.) inert ingredients including an emulsifier. The nominal dosage rate is 3 gallons per acre or less. Under special circumstances, such as when treating areas with high organic content, up to 5 gallons per acre may be used.

GB-1111 provides effective control on a wide range of mosquito species. Applied to breeding areas, GB-1111 is an effective material against any mosquito larvae and pupae obtaining atmospheric oxygen at the water surface. It can even be effective in controlling newly emerged adults that are resting on the water surface when drying their wings. Where pupal density is high or where warm water indicates that this will occur soon, GB-1111 is used unless other materials are required by site-specific protocols or other application criteria. Low dosages (1 gallon per acre) of oil work slowly, especially in cold water, and can take 4 to 7 days to give a complete kill. Higher dosage rates are sometimes used (up to 5 gallons per acre) to lower the control time. It is typically applied by hand or ATV. Larviciding oils are non-selective and can impact some other classes of air-breathing aquatic insects that include predators of mosquitoes. The use of larvicidal oils is restricted to areas with heavily polluted waters, other areas where beneficial organisms are low or nonexistent, in areas with late (non-feeding) instar larvae or pupae, or in areas where other larvicides have failed.

The larviciding oils are probably the least studied of the mosquito larvicides, despite their long period of use for mosquito control. Little information has been published on the potential environmental impacts of this pesticide. However, they exhibit low persistence in the environment (i.e., do not persist beyond a few days).

Examples of Tool Use: GB-1111, Agnique, BVA-2, CoCoBear Oil.

Applicability to District IMMP: Agnique and BVA2 are currently used. CoCoBear Oil will be phased in with time. Additional information is provided below.

2.12.1 GB-1111

Little information has been published on the potential environmental impacts of this pesticide. GB-1111 was re-registered as a mosquito larvicide by the California Department of Pesticide Registration on April 20, 1999 (DPR 1999). The USEPA released its Reregistration Eligibility Decision for Aliphatic Solvents on July 12, 2006.

Four studies by Tietze et al. (1991, 1992, 1993, 1994) tested three species of fish (Inland Silversides, Mosquitofish, and Sheepshead Minnows) and a range of microorganisms and concluded that this larvicide is not toxic to the tested organisms at label application rates. Mulla and Darwazeh (1981) experimented with GB-1111 in small experimental ponds and found that benthic invertebrates were unaffected while populations of surface breathing insects were temporarily reduced following application of this larvicide. Miles et al. (2002) conducted a significant independent study of non-target effects of GB-1111 on the tidal marshes of Newark, California, and observed the following effects: 1) surface breathing insect populations were reduced at the time of treatment; 2) this effect did not persist beyond a few days (=no residual pesticide effects); 3) those potentially affected animals with high mobility left the site, while some of those that could not leave died (especially water boatmen (Corixidae); 4) overall populations of invertebrate species were not affected, apparently because of recolonization from neighboring untreated sites. Field application of GB-1111 should be avoided in early spring and during peak hatching of waterfowl in wetland situations, particularly if daily low temperatures are below about 15°C, based on metabolic studies by Koskimies and Lahti (1964). Strict adherence to recommended use and rates for field applications of GB-1111 is important to ensure the survival of avian wetland species. Mallard ducklings and potential prey populations of aquatic invertebrates (genera *Aedes* and *Trichocorixa*) or similar species are typical of brackish or saltwater marshes in the northern and southern hemispheres. When used properly, GB-1111 appeared to have a minimal or short-term impact on these species.

Information was sent to the EPA from the US Centers for Disease Control and Prevention (CDC) regarding surface film agents. It stated "*…that these products have important public health benefits, compared with the various other mosquito larvicides, because these products are among the only pupacides, and surface films provide a valuable option to an integrated mosquito control program*." In addition, information was presented by CDC that "surface film larvicides generally have a shorter environmental persistence (approx. 2 to 3 days) than most chemical larvicide alternatives."

The District has exhausted its supply of GB-1111, which is no longer produced and is now using BVA-2 in its place. Both BVA-2 (currently used) and Masterline Mosquito Larvicide (not currently used) are highly refined petroleum distillates (mineral oil 97 percent and 98 percent respectively) that can be used for the control of mosquito larvae and pupae. Both these larvicides exhibit a low level of toxicity to plant growth (phytotoxicity), have a clear appearance and do not form a visible sheen on the surface of water. They are also free of offensive odors.

When applied evenly over the water surface these products rapidly interrupt the air water interface and suffocate all immature mosquito stages present. This quick action makes them effective larvicides and pupacides. According to the labels for both BVA-2 and Masterline Mosquito Larvicide, these products are toxic to aquatic organisms. They must not be applied directly to water, except when applied for mosquito larval and pupal control; and then only in shallow areas around the border. The responsible State Fish and Wildlife Agency must be consulted before application of this product. According to Vincent (2010) BVA 2 is sufficiently similar to GB-1111, so that EPA, for registration, referred to available data on GB-1111 (see previous paragraphs) and did not require additional environmental impact studies.

2.12.2 Agnique™ MMF

Agnique is the trade name for a surface film larvicide, comprised of ethoxylated fatty alcohol. According to the label, this type of pesticide works by reducing the surface tension of water, which makes breathing difficult for larvae and pupae because they cannot attach to the water's surface. This eventually results in drowning. Agnique has a very low vertebrate toxicity; an average persistence in the environment of 5 to 14 days at label application rates; and no toxic breakdown products, skin irritation, carcinogenicity, mutagenicity, or teratogenicity has been reported. Because of its similar mode of action and effectiveness against pupae, Agnique can be used as an alternative to BVA 2. Because the application rate of Agnique is much lower than that of Golden Bear, this potential shift would not include an increase in volume of materials applied.

A number of efficacy and non-target studies had been conducted on this material when it was registered under the name Aerosurf (prior to being re-named Agnique). The pesticide was reregistered in California in July 1999. Minor proprietary changes in preparation did not apparently change any of the material's potential environmental impacts, and therefore the earlier literature is referenced. This product is now discontinued, but existing stock can still be used.

Most published studies conducted with this larvicide tested application rates of 3 to 100 times the maximum label rate. At these rates, no observable effect on mortality or development was noted in tests on green tree frogs, seven species of fresh and saltwater fish, two species of shrimp, five species of water beetle, or one species of fairy shrimp, crayfish, snail, polychaete worm, mayfly naiad, copepod, ostracod, or midge. In addition, no effect was seen on five species of plants. As with GB-1111, air (surface) breathing insects were temporarily impacted. Water boatmen, backswimmers, and one species of water beetle exhibited increased mortality at application rates above label limits. In addition, a clam, a shrimp, a crab, an amphipod, and one species of isopod exhibited minor to significant increases in mortality at levels several times the highest application rate allowed by the label. It should be noted that the greater persistence of this material (up to two weeks) relative to GB-1111 can reduce the need for repeated applications, but might also increase the duration of suppression of other air-breathing insects. Protocols require application of larvicides only in areas with mosquito la (or with a recent history of production). CoCoBear Oil[1] is a food grade, highly refined petroleum distillate but mostly plant-derived oil (mineral oil) that the company is now producing to replace the discontinued Golden Bear 1111. This new larvicide has similar characteristics and properties to Golden Bear Oil 1111 in that it also demonstrates low-level toxicity to plant growth (phytotoxicity) and rapid environmental breakdown. It forms a thin film on water and kills larvae through suffocation and/or direct toxicity. It is typically applied at application rates of 3 to 5 gallons per acre and can be applied by hand, from an ATV, from watercraft, or from a truck. This product is not currently being used by the District at this time, but may become a replacement for BVA-2 in the future.

2.13 Mass Trapping

Description: There are many types of traps and trapping strategies available for use. Mass trapping uses large numbers of traps, baited with a strong lure (e.g., carbon dioxide, octenol, lactic acid, heat, certain wavelengths of light and sound, and food items such as sugars and proteins) which are placed in an effort to catch sufficient target pests to reduce the population to healthful levels. Depending on the species and density of the vector population being managed, traps may be distributed over a large area. Lures for mosquitoes include but are not limited to carbon dioxide, light, heat, and octenol. Yellow jacket traps utilize heptyl butyrate, sugars (e.g., fruits) and/or proteins (meats). An insecticide, rodenticide, food, or a sticky insert may also be used in the trap. Traps utilizing a toxicant or electric grids are covered below in Section 2.14 Attract and Kill.

[1] Denotes material not currently used but included in the District's Program as an option for future use.

The use of depletion or mass trapping for mosquitoes as a possible alternative and/or supplement to the use of pesticides has received considerable attention by researchers. This technique utilizes specialized traps, which may also contain attractants to enhance their effectiveness, for collecting large numbers of vector or pest organisms. Recent advances in trap design and advances in understanding the biochemical cues and other factors which attract different vectors to their potential hosts has begun to illustrate the possibilities as well as the limitations of mass trapping as a potential management tool.

Smith, et al. (2010) utilized 12 Mosquito Magnet-X traps at a coastal Florida State park and found that the traps did not significantly reduce mosquito numbers compared to the control sites. They further noted that during the latter part of the study mosquito numbers had reached such severe levels that park management requested spraying because of the number of complaints received from users of the park's facilities. They concluded that either more traps, a smaller treatment area, lower mosquito population levels or some combination of all three would be necessary in order to achieve non-pesticide control using mass trapping.

Kline (2007, 2006) also provides an overview of the recent advancements in mass trapping technology and its potential as a mosquito management tool. He notes a number of important concerns significant to the effectiveness of mass trapping as a mosquito management strategy. These are: 1) a thorough understanding of the target mosquitoes' behavior, biology and ecology; 2) which attractants work best, since an attractant for one species of mosquito can be ineffective for another; 3) reproductive or biotic capacity; 4) spatial distribution, as this affects placement of the traps; 5) dispersal capacity, as a high dispersal rate, especially with species that travel long distances, poses challenges with managing localized populations and increases the risk of reinvasion from other sites; 6) density of the mosquito population since this can influence the number of traps required; 7) design of the trap and attractant delivery system since no one trap works best for the collection of all species of mosquitoes; and 8) the willingness of the local citizenry to tolerate a lower level of mosquito control in some circumstances and situations. Other factors such as wind, temperature, humidity, density of vegetative cover, species of mosquitoes present, and time of year, also play a part in the effectiveness of these types of traps.

Ovitraps help assess egg laying female activity and are widely used as a part of mosquito surveillance and monitoring. These types of traps are specifically designed to attract and sample gravid female mosquitoes, either directly or by means of the eggs that are deposited within the trap. The design varies depending on the species of mosquito being sampled Irrespective of the type of ovitrap used, this tool is not effective at capturing large numbers of mosquitoes and also has other limitations. Therefore, although useful for assessing female mosquito egg laying activity, these traps do not appear to be a viable means for significantly reducing mosquito populations.

Examples of Tool Use: Mosquito Magnet X, ovitraps.

Applicability to District IMMP: There are operational difficulties in placing and retrieving large numbers of traps in urban areas. Extensive labor is involved in trap placement and retrieval; therefore, not appropriate for District use beyond surveillance.

2.14 Attract and Kill

Description: A lure is used to draw the target insect to it where the insect dies after either feeding on the insecticide-lure mixture or crawling over the insecticide-lure mixture. The lures used other than dry ice (for live trapping) are pheromones that are attractants which draw the mosquitoes into the traps where they are killed. A bug zapper is a device that attracts and kills flying insects with an electric current. These devices typically consist of a protective cage of plastic or grounded metal bars that has inside an electrified metal grid with an internal fluorescent light source for emitting violet and ultraviolet light. The protective outer cage prevents people and animals (excluding insects) from touching the high voltage grid. The light attracts insects to the metal grid and when they land on the grid they are electrocuted. Unfortunately these traps are not effective at killing biting mosquitoes and instead kill large numbers of harmless and beneficial insects. Another issue generally overlooked by the general user of these traps is the potential for release of airborne insect particles and microbial contaminants.

Examples of Tool Use: The following tools are available: bug zapper/electrocuter, autocidal gravid ovitraps, and mosquito magnets (see Section 2.13 above).

Applicability to District IMMP: Attract and kill technology may be a useful tool in the District's IMMP in the future; however there are operational questions at present about how to apply the material and how best to integrate the tool with other tools. Similar to mass trapping, this tool tends to be labor-intensive for district use in urban areas or on a large scale.

2.15 Inundative Releases

Description: Inundative releases are large scale, periodic releases of parasites or predators to quickly control pest populations. This technique also includes the release of large numbers of genetically modified vectors that have been irradiated, chemosterilized, or have had a gene altered. Inundative releases of predators and parasites can be used in situations where the existing levels of natural enemies are unable to sufficiently reduce vector populations to healthful levels. The use of genetically modified vectors can be for population suppression or to reduce the ability of a vector to harbor and transmit disease. The release of irradiated or chemosterilzed males is similar to the release of predators and parasites in that the goal is vector population reduction. Releases of vector natural enemies or sterile males is not self sustaining and must be periodically repeated to provide effective long-term control. The use of gene altered vectors does not have to be regularly repeated as the goal is to introduce a gene into the vector population that is self sustaining. This introduced gene changes the vector population to a less harmful form and/or reduces or eliminates the vector population entirely.

The use of sterilized or genetically altered mosquitoes for the management of mosquitoes and/or mosquito-borne disease has received and continues to receive considerable attention. Success with the use of this approach has been inconsistent. Benedict and Robinson (2003) summarize the results of sterile and incompatible male releases (also known as sterile insect technique or SIT) and note that regardless of mosquito species three significant factors have contributed to the observed field failures. The significant factors are: production below desired levels, loss of male fitness, and immigration of mosquitoes into the release areas. Mosquito population levels and geographic distribution of the population to be treated may also contribute to the success of sterile male releases for the suppression of mosquito populations.

Whether or not SIT can work and be sustainable over a very large geographic area, as well as in circumstances where there are multiple species of mosquitoes, is not clear at this time. The release of sterile mosquitoes is a complex process involving initial colonization of the relevant species, mass rearing of competitive males for release, packing, transport, and release at the optimum place and time (Dame, 1985). Having a good understanding of target population size, which helps determine the release period, number of releases and ratio of sterile males to indigenous males released, is also important for successful use of this technique. Reduction of male competitiveness by radiation, immigration of fertilized females from outside release zones, and the inability of laboratory-bred males to perform in the wild are some of the factors observed to affect efficacy of SIT in some field tests (Dame, 2009). Even with significant advances in technology and understanding of mosquito population ecology, there is still much to be learned about the application and effectiveness of SIT as a potential tool for integrated mosquito management.

2.15.1 Parasites

Description: Large numbers of parasites are released to temporarily reduce pest numbers. This tool is typically used in situations where existing natural enemies are unable to reduce pest numbers to tolerable levels. Inundative releases must be periodically repeated to provide long-term control.

Examples of Tool Use: *Trichogramma* wasps are used against LBAM in Australian crops.

Applicability to District IMMP: This is not a viable tool; there are no parasites of mosquitoes that are commercially available for this type of mosquito control at present.

2.15.2 Predators

Description of tool: Large numbers of generalist predators are released in an effort to temporarily reduce pest numbers. Typically used in situations where existing natural enemies are unable to reduce pest numbers to tolerable levels. Inundative releases must be periodically repeated to provide long-term control.

Examples of Tool Use: Predatory mites, green lacewings and lady bird beetles are commonly used in inundative release programs.

Applicability to District IMMP: It is unlikely that generalist predators would be an effective tool in mosquito control. These predators eat the most common food sources first, and will not focus on the target species.

2.16 Regulatory Control

Description: Governments use regulatory control measures such as quarantines and hold notices to prevent the human-aided movement of pests and/or items likely to harbor the pest into their jurisdiction or the movement of pests from infested areas into uninfested areas within their jurisdiction. They do not focus on the control of existing populations. Operationally, this can also involve State and local regulations for the creation and management of water impoundments, storm water runoff, water quality, the restoration and/or management of wetland habitats, weed control, and refuse management.

Examples of Tool Use: Temporary cessation of the importation of Lucky Bamboo which carried invasive Asian Tiger Mosquito eggs is an example of a regulatory control action undertaken by the Monterey County Agricultural Commissioner (and California Department of Food and Agriculture).

Applicability to District IMMP: Regulatory actions only prevent the human-aided movement of unwanted pests. They do not reduce existing pest numbers or the ability of the pest to spread on its own. Additionally, regulatory actions have the potential to create as well as eliminate additional vector habitats. Any habitats created will require future surveillance and possible maintenance to minimize potential vector activity (e.g., above and below ground storm water detention basins, flood management projects, seasonal wetland habitats, etc.). Therefore, the District does make every effort to coordinate with those regulatory entities concerning potential introductions of mosquitoes or regulatory actions including but not limited to weed and refuse management, storm water runoff requirements, water quality, and the restoration or enhancement of wetland habitats.

2.17 Repellents

Description: There are materials that can be applied to humans and animals that will repel pest insects from landing on them and then laying eggs or feeding. The District classifies repellents into the broad categories of non-chemical and chemical. Non-chemical repellents are further subdivided into mechanical (e.g. fans and sound producing devices) and non-mechanical (e.g. mosquito plants, eucalyptus trees, castor oil plants, etc.), while chemical repellents are further subdivided into natural and synthetic. Repellents are used to protect individuals from potential interactions with vectors (e.g. being bitten by mosquitoes). . They do not kill the pest, nor do they reduce pest numbers. They force the pests into adjacent areas away from the treated areas or individuals.

Examples of Tool Use: DEET, eucalyptus oil, and IR3553.

Applicability to District IMMP: Repellents are not an effective control measure to reduce the overall number of mosquitoes in an area or the size of the infested area.

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3 Screening of Tools

Reasonable alternatives are developed through a review of the feasibility of all identified potential tools. To be feasible, the alternative should be capable of accomplishing project purposes in a successful manner in California within a reasonable period of time. This section explains the process for determining the components of the 2014 Program.

3.1 Program Objectives

The District undertakes mosquito control activities through its Program to control the following of disease and/ or discomfort in the Program Area: mosquitoes.

The Proposed Program's specific objectives are as follows:

> Reduce the potential for human and animal disease caused by mosquitoes

> Reduce the potential for human and animal discomfort or injury from mosquitoes vectors

> Accomplish effective and environmentally sound mosquito management by means of:

- Surveying for mosquito abundance/human contact
- Establishing treatment criteria
- Appropriately selecting from a wide range of Program tools or components

Most of the relevant mosquito species are quite mobile and cause the greatest hazard or discomfort at a distance from where they breed. Each species has a unique life cycle, and most of them occupy several types of habitats. To effectively control them, an integrated mosquito management program (IMMP) must be employed. District policy is to identify those species that are currently vectors, to recommend techniques for their prevention and control, and to anticipate and minimize any new interactions between mosquitoes and humans. Furthermore, the District is committed to using the least environmentally disruptive tools in its IMMP.

3.2 Criteria

The District has a well-defined process for selecting tools to be used in mosquito. The criteria used for determining the viability and ranking of reasonable tools are listed below:

> **Criterion 1.** The District uses known effective tools to manage pest species that have developed breeding populations in the state.

> **Criterion 2.** The District does not use experimental or hypothetically effective tools.

> **Criterion 3.** Given equal efficacy and operational constraints, the District will use the least environmentally disruptive tools in its control Program.

3.3 Tool Selection Guidelines

The following guidelines (i.e., additional considerations) are used also when applying criteria above to the potential mosquito and/or management tools:

> Are there effective control measures for the target mosquito species or closely related species?

> Are these tools available for use in California?

> Are these tools likely to be effective if used in the District's Service Area?

> Are there environmental circumstances that will likely limit the effectiveness or operational aspects of the tools in natural, rural, or urban settings?

> Are there operational constraints[2] that will limit the effectiveness of the tools?

3.4 Evaluation Results

Table 3-1, Screening with Criteria, shows the results of the scoring for each of the 18 tools described in Section 2 for the key criteria that reflect Program objectives.[3] Table 3-2, applies the tool selection guidelines to those tools meeting all or most of the program criteria. Some alternatives were eliminated from the analysis because they were infeasible or did not meet the overall objectives of the Program, or would not meet the criteria and guidelines for selection. This section concludes with a discussion of how tools remaining (following screening with the criteria and the guidelines) were refined further.

Table 3-1 Screening with Criteria

	Criteria		
	1	2	3
Alternative Tools	Method Known to be Effective?	Not Experimental or Hypothetical?	Least Environmentally Disruptive?
Integrated Pest Management	Y	Y	Y
Mosquito Surveillance	Y	Y	Y
Physical Control	Y	Y	Y
Vegetation Management	Y	Y	Y
Biological Control Pathogens (Viruses)	N	N	NA
Biological Control Pathogens (Bacteria)	Y	Y	Y
Biological Control Parasites	N	N	NA
Biological Control Predators (Mosquitofish)	Y	Y	Y
Synthetic Insecticides	Y	Y	N
Botanical Insecticides	Y	Y	N
Insect Growth Regulators	Y	Y	Y
Mineral Oils/Surface Film	Y	Y	Y
Mass Trapping	N	N	NA
Attract and Kill	N	N	NA
Inundative Releases (Parasites)	N	N	NA
Inundative Releases (Predators)	N	N	NA
Regulatory Control	Y	N	Y
Repellents	N	N	N/A

Shaded cell indicates that criterion eliminates option.

Y = Yes
N = No
N/A = Not Applicable

[2] Operational constraints include conditions for use imposed by the product label requirements or additional best management practices prescribed by the District to limit how, when, and where the tools are used.

[3] There are 17 categories of tools with Inundative Releases counting as 2 separate tools, parasites and predators, for a total of 18 tools.

Based on the screening criteria ("N" values), the following tools are not recommended for inclusion in the Proposed Program: Biological Control Pathogens (Viruses), Biological Control Parasites, Mass Trapping, Attract and Kill, Inundative Releases (Parasites), Inundative Releases (Predators), Regulatory Control, and Repellents. Table 3-2 addresses the remaining tools based on effectiveness and operational guidelines.

Table 3-2 Tool Selection Guidelines

	Guidelines				
Alternative Tools	**Effective Control Measures?**	**Tools Available in California?**	**Tools Effective in District Service Area?**	**Environmental Circumstances Limiting Effectiveness or Operational Aspects of Tools?**	**Operational Constraints Limiting Effectiveness of Tools?**
1. Integrated Mosquito Management	Y	Y	Y	Y	Y
2. Vector Surveillance	Y	Y	Y	Y	N
3. Physical Control	Y	Y	Y	Y	Y
4. Vegetation Management	Y	Y	Y	Y	Y
5. Biological Control (Bacteria)	Y	Y	Y	Y	Y
6. Biological Control (Predators)	Y	Y	Y	Y	N
7. Synthetic Insecticides	Y	Y	Y	Y	N
8. Botanical Insecticides	Y	Y	Y	Y	N
9. Insect Growth Regulators	Y	Y	Y	Y	N
10. Mineral Oils/Surface Film	Y	Y	Y	Y	N

Y = Yes
N = No

All of the remaining ten tools could be applied in areas where environmental circumstances could limit the effectiveness or operational aspects of the tool. For example, physical control and vegetation management activities would be limited in areas covered by HCPs/NCCPs. Operational constraints could limit the effectiveness of physical control, vegetation management, and biological control (bacteria) potentially requiring additional treatments or use of other tools. For example, product labels may contain such measures as restrictions for applications in certain land uses and weather (i.e., wind speed) parameters. Although some of the tools in Table 3-2 may have environmental and/or operational constraints that limit their effectiveness in some circumstances, they remain viable option and, therefore, a part of the District's IMMP. Even with constraints there are situations where their use meets the District's goal of effectively performing its work of minimizing human-mosquito contact with the least or no environmental risk.

3.4.1 Alternatives Considered and Withdrawn from Evaluation

The District determined that of the 18 potential tools, the following eight were not immediately available for use in its IMMP: Biological Control Pathogens (Viruses), Biological Control (Parasites), Mass Trapping, Attract and Kill, Inundative Releases (Parasites), Inundative Releases (Predators), Regulatory Control, and Repellents.

> **Biological Control (Viruses).** None of the mosquito viruses listed (in Section 2.5) are generally commercially available for mosquito control at present.

> **Biological Control (Parasites).** None of the mosquito parasites listed (in Section 2.7) are generally available commercially for mosquito control at present.

> **Mass Trapping.** This tool is not an economically feasible tool due to extensive labor involved in trap placement and retrieval.

> **Attract and Kill.** This has not been proven to be an effective control tool to date. This tool is too labor intensive for District use.

> **Inundative Releases (Parasites).** No parasites for mosquitoes are available for commercial use at present.

> **Inundative Releases (Predators).** With the exception of mosquitofish, there are no other proven, commercially available predators for mosquito control at present.

> **Regulatory Control.** These actions only prevent the human-aided movement of unwanted pests. They do not reduce existing pest numbers or the ability of the pest to spread on its own.

> **Repellents.** Have no value as a control tool; they are strictly a personal protective measure.

3.5 Selected Program Alternatives

In addition to IMM, which is an overall strategy, the following tools were determined to be effective for mosquito and/or control activity: surveillance, physical control, vegetation management-physical, vegetation management-herbicides, biological control pathogens (bacteria), biological control predators, synthetic insecticides, botanical insecticides, insect growth regulators, and mineral oils/surface film. These tools are combined to represent five alternatives or components/elements of the District’s current and Proposed Program.

The District has selected a systems approach over several years using multiple tools and depending upon conditions at specific locations. The District utilizes an overall IPM approach in order to use procedures that will minimize potential environmental impacts. The District’s Program employs IPM principles by first determining the species and abundance of mosquitoes/through evaluation of public service requests and field surveys of immature and adult mosquito/populations and, then, if the populations exceed predetermined criteria, using the most efficient, effective, and environmentally sensitive means of control. For all mosquito species, public education is an important control strategy. In some situations, water management or other physical control activities can be instituted to reduce mosquito-breeding sites. The District also uses biological control such as the planting of mosquitofish in some settings: ornamental fish ponds, water troughs, water gardens, fountains, and unused swimming pools. When these approaches are not effective, or are otherwise deemed inappropriate, then pesticides are used to treat specific pest-producing or pest-harboring areas.

Three core tenets are essential to the success of a sound IMM program.

> First, a proactive approach is necessary to minimize impacts and maximize successful mosquito management. Elements such as thorough surveillance and a strong public education program make all the difference in reducing potential human mosquito interactions.

> Second, long-term environmentally based solutions (e.g., water management, reduction of harborage, and enhancement of predators and parasites) are optimal as they reduce the potential pesticide load in the environment as well as other potential long- and short-term impacts.

> Lastly, utilizing the full array of options and tools (public education, surveillance, physical control, biological control, and when necessary chemical control) in an informed and coordinated approach supports the overall goal of an environmentally sensitive mosquito management program.

The District's Program consists of the following alternatives, which are general types of coordinated and component activities, as described below [District to remove or modify activities below as appropriate to their control program]. The Proposed Program is a combination of these alternatives with the potential for all of these alternatives to be used in their entirety along with public education as described below.

3.5.1 Surveillance

Mosquito surveillance, which is an integral part of the District's responsibility to protect public health and welfare, involves monitoring mosquito populations and habitat, their disease pathogens, and human/mosquito interactions. Mosquito surveillance provides the District with valuable information on what mosquito species are present or likely to occur, when they occur, where they occur, how many they are, and if they are carrying disease or otherwise affecting humans. Mosquito surveillance is critical to an IMM program because the information it provides is evaluated against treatment criteria to decide when and where to institute mosquito control measures. Information gained is used to help form action plans that can also assist in reducing the risk of contracting disease. Equally important is the use of mosquito surveillance in evaluating the efficacy, cost effectiveness, and environmental impacts of specific mosquito control actions.

3.5.1.1 Mosquito Surveillance Methodologies

Mosquitoes in nature are distributed within their environment in a pattern that maximizes their survival to guarantee reproductive success. Immature stages develop in water and later mature to a winged adult that is may be capable of both short and long-range dispersal (depending upon the species). This duality of their life history presents mosquito control agencies with unique circumstances that require separate surveillance strategies for the aquatic versus terrestrial life stages.

Surveillance involves monitoring the abundance of mosquito populations, their habitat, mosquito-borne disease pathogens, and the interactions between mosquitoes and people over time and space. The District routinely uses a variety of traps for surveillance of adult mosquitoes, regular field investigation of known mosquito sources for direct sampling for immature stages, public service requests for adult mosquitoes, and low ground pressure all-terrain vehicles (ATVs) to access these sites. The District conducts surveillance by way of a variety of activities that include:

> **Surveillance of the Immature (Aquatic) Stages.** Mosquito immatures include eggs, four larval stages, and a transitional pupal stage. Mosquito control agencies routinely target the larval and pupal stages to preclude an emergence of adults. Operation evaluation of the presence and abundance of immature mosquitoes is limited to the larval and pupal stages. Sampling and collection of the immature stages (egg, four larval stages, and a transitional pupal stage) involves the use of a 1-pint dipper (a standardized small plastic pot or cup-like container on the end of a 36-inch handle), which scoops up a small amount of water from the mosquito-breeding site. Operationally, the abundance of the immatures in any identifiable "breeding" source is measured through direct sampling, which provides relative local abundance as the number of immatures per unit volume or area of the source. This method requires access by field personnel to within about 3 feet of larval sites at least every 2 weeks in warm weather. The spatial patchiness of larvae requires access to multiple locations within each source, rather than to single "bell-weather" stations.

> **Field Inspection of Known or Suspected Habitats Where Mosquitoes Live and Breed.** Sites where water can collect, be stored, or remain standing for more than a few days are potential habitats for mosquito breeding that require continuous inspection and surveillance. Water runoff into catch basins and stormwater detention systems from land uses including, but not limited to, residential communities, parks and recreation areas, and industrial sites, as well as ornamental ponds, unmaintained swimming pools, seeps/seepages, seasonal wetlands, tidal and diked marshes, freshwater marshes, wastewater ponds, agricultural ponds, managed waterfowl ponds, canals, creeks, streams, tree holes, tires, man-made containers, flooded basements/crawl spaces, and other standing waters are likely sources.

> **Surveillance of the Adult Stage.** Sampling for the presence and abundance of mosquito populations tends to occur the most in areas where the citizenry would have a likelihood of exposure to them. Various methodologies have been developed to both capture and quantify the relative abundance of mosquito species that can affect the welfare of humans and domestic animals. Three kinds of traps, host-seeking traps, light traps, and gravid/oviposition traps, are used as described below:

- **Light traps** (commonly called New Jersey Light traps) use a source of photo-attraction such as an incandescent lamp (25 watt) or fluorescent lamp (5 watt) where they are pulled in by the suction provided by an electric (110 v AC) appliance motor/fan combination. Mosquitoes picked up by the suction are directed downward (via screened cone) inside the trap body to a glass or plastic collection jar containing a 1-inch strip of Vapona, Hot Shot®, or No-Pest® strip (Dichlorvos). The collection jar is enclosed within an expanded metal cage with a hinged trap door at the bottom that is padlocked.
- **Host-seeking traps** use dry ice (carbon dioxide) to attract female mosquitoes behaviorally cued to seek a host to blood feed. The trap's components include a battery power source, a low ampere motor/fan combination, and a collection bag for holding captured live adults.
- **Oviposition traps**, although infrequently worked with, are used to collect gravid Culex spp. mosquitoes and/or to measure their egg-laying activity. This trap uses 5-day-old hay-infused water contained in a small plastic dishpan that has a 6-volt battery-operated fan directly above to draw the gravid female mosquitoes into the small collection net.

> "**Arbovirus**"[4] **surveillance** to determine the likelihood and occurrence of mosquito-borne illness is accomplished through the use of two different methods. The first involves the placement of caged chickens as "sentinel birds." Since the viruses of major concern, West Nile virus, western equine encephalomyelitis, and St. Louis encephalitis, are diseases actively transmitted by mosquitoes to both birds and to humans through bites, caged chickens routine blood samples will reveal whether one or more of the virus specific antibodies are present. The chickens are placed generally 12 to a caged area (4 feet by 8 feet by 6 feet), are humanely treated, and are provided ample shelter with nest boxes, water, and feed. Chickens are used as the early detection system for virus transmission, as they are unaffected by the presence of these viruses in their systems. At the end of the mosquito season, the chickens are adopted out. In addition, dead birds belonging to the family Corvidae (which includes the American Crow, Common Raven, Yellow-billed Magpie and Western Scrub-Jay) are tested in-house for the West Nile virus and at times sent to UC Davis for confirmation.

[4] Arthropod-borne viruses. The primary reservoir for the pathogens that cause these diseases is wild birds, and humans only become exposed as a consequence of an accidental exposure to the bite of infective mosquito vectors.

> **Maintenance of paths and clearings** to facilitate sampling and to provide access to mosquito habitat. It is District policy that staff use preexisting roads, trails, walkways, and open areas to conduct routine and essential surveillance activities with the least impact on the environment. Surveillance is conducted using ATVs, but offroad access is minimized and used only when roads and trails are not available.

> **Analysis of public service requests and surveys** and other methods of data collection.

The District's mosquito surveillance activities are conducted in compliance with accepted federal and state guidelines, in particular the *California Mosquito-borne Virus Surveillance and Response Plan* (CDPH 2013a) and *Best Management Practices for Mosquito Control in California* (CDPH 2012b).These guidelines recognize that local conditions will necessarily vary and, thus, call for flexibility in selection and specific application of control methods.

3.5.2 Physical Control

Managing mosquito habitat to reduce mosquito production or migration, either directly or through public education, is often the most cost-effective and environmentally benign element of a IMM program. This approach to the control of mosquitoes and other pests is often called "physical control" to distinguish it from those mosquito management activities that directly rely on application of chemical pesticides (chemical control) or the introduction or relocation of living agents (biological control). Other terms that have been used for mosquito habitat management include "source reduction," which emphasizes the significance of reducing the habitat value of an area for mosquitoes, or "permanent control," to contrast with the temporary effectiveness of pesticide applications.[5] Mosquito habitat management is important because its use can virtually eliminate the need for pesticide use in and adjacent to the affected habitat and, in some situations, can virtually eliminate mosquito production from specific areas for long periods of time, reducing the potential disturbances associated with frequent biological or chemical control activities. The intent is to reduce the abundance of mosquitoes produced or sheltered by an area while protecting or enhancing the habitat values of the area for desirable species. In many cases, physical control activities involve restoration and enhancement of natural ecological functioning, including production and dispersal of special-status species and/or predators of mosquitoes.

3.5.2.1 Mosquitoes

Physical control for mosquitoes consists of the management of mosquito-producing habitat (including freshwater marshes and lakes, saltwater marshes, temporary standing water for 1 week or more, and wastewater treatment facilities) especially through water control and maintenance or improvement of channels, tide gates, levees, and other water control facilities. Physical control is usually the most effective mosquito control technique because it provides a long-term solution by reducing or eliminating mosquito developmental sites and ultimately reduces the need for chemical applications. The physical control practices may be categorized into three groups: maintenance, new construction, and cultural practices.

Maintenance activities are conducted within tidal, managed tidal, and nontidal marshes, seasonal wetlands, diked, historic baylands, and in some creeks adjacent to these wetlands. The following activities are classified as maintenance:

1. Removal of sediments from existing water circulation ditches
2. Repair of existing water control structures
3. Removal of debris, weeds, and emergent vegetation in natural channels

[5] This terminology can be misleading if periodic maintenance is needed for physical control devices or structure.

4. Clearance of brush for access to streams tributary to wetland areas
5. Filling of existing, nonfunctional water circulation ditches to achieve required water circulation dynamics and restore ditched wetlands

New construction typically involves the creation of new ditches to enhance tidal flow preventing stagnant water.

Cultural practices include vegetation and water management, placing culverts or other engineering works, and making other physical changes to the land. They reduce mosquito production directly by improving water circulation and indirectly by improving habitat values for predators of larval mosquitoes (fish and invertebrates), or by otherwise reducing a site's habitat value to mosquito larvae.

The District performs these physical control activities in accordance with all appropriate environmental regulations (e.g., wetland fill and dredge permits, endangered species review, water quality review, streambed alteration permits, see Section 2.7), and in a manner that generally maintains or improves habitat values for desirable species. Major physical control activities or projects (beyond the scope of the District's 5-year regional wetlands permits with the United States Army Corps of Engineers (USACE) and the San Francisco Bay Conservation and Development Commission) are addressed under this PEIR where known and identified. Minor physical control activities (covered by the regional wetlands permits) are also addressed in this PEIR. They vary substantially from year to year, but typically consist of up to 10,000/21,000 linear feet of ditch maintenance. Under the regional permits, the District's work plans are reviewed annually by trustee and other responsible agencies prior to initiation of the planned work. Completed work is inspected by USACE, United States Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW, formerly Fish and Game), and other responsible agencies.

The District may request/require landowners and stewards to maintain and clear debris from drainage channels and waterways; excavate built-up spoil material; remove water from tires and other urban containers; cut, trim, mow, and harvest aquatic and riparian plants (but not including any mature trees, threatened or endangered plant species, or sensitive habitat areas); and install minor trenching and ditching.

The District does not currently perform these physical control activities buy may choose to use this tool in the future. The average amount of ditch maintenance for the past 5-year period was 1,204 feet with 6,020 feet being done in 2008. No other maintenance work has been performed since that time, but may become necessary in the future.

3.5.3 Vegetation Management

Physical Control

The species composition and density of vegetation are basic elements of the habitat value of any area for mosquitoes, for predators of mosquitoes, and for protected flora and fauna. District staff may advise property owners/managers to undertake vegetation management activities on their property, as a tool to reduce the habitat value of sites for mosquitoes or to aid production or dispersal of mosquito predators, as well as to allow access by District staff to mosquito habitat for surveillance and other control activities. Direct vegetation management by District staff generally consists of activities to reduce the mosquito habitat value of sites by improving water circulation or access by fish and other predators, or to allow access by District staff to standing water for inspections and treatment.

For vegetation management, the District may use hand tools or other mechanical means (i.e., heavy equipment) for vegetation removal or thinning and sometimes applies herbicides (chemical pesticides with specific toxicity to plants) to improve surveillance or reduce mosquito habitats. Vegetation removal or thinning would primarily occur in aquatic habitats to assist with the control of mosquitoes. To reduce the potential for mosquito breeding associated with water retention and infiltration structures, District staff may request property owners/managers to systematically clear weeds and other obstructing vegetation in wetlands and retention basins. In particular, thinning and removal of cattail overgrowth would be done to provide a maximum surface coverage of 30 percent or less. In some sensitive habitats and/or where sensitive species concerns exist, vegetation removal and maintenance actions would be restricted to those months or times of the year that minimize disturbance/impacts. Vegetation management is also performed (under special circumstances) to assist other agencies and landowners with the management of invasive/nonnative weeds. These actions are typically performed under the direction of the concerned agency, which also maintains any required permits.

Tools ranging from shovels and pruners to chain saws and “weed-whackers” up to heavy equipment can all be used at times to clear plant matter that either prevent access to mosquito breeding sites or that prevent good water management practices that would minimize mosquito populations. The District does not currently perform any brushing activities, however should it decide to, it will do so in the following manner: brushing” activities would rely almost entirely on hand tools. Trimmed vegetation would either be removed and disposed of properly from the site or broadcast in such a way as to minimize visual degradation of the habitat. Trimming would is also be kept to a minimum to reduce the possibility of the invasion of exotic species of plants and animals. Surveys for special-status plants, coordination with the landowner, and acquisition of necessary permits would be completed before any work is undertaken. Follow-up surveys are also conducted to verify that the work undertaken was effective and that the physical manipulation of the vegetation did not result in any unintended overall habitat degradation.

In addition, the use of water management to control vegetation is in some ways an extension of physical control, in that water control structures created as part of a physical control project may be used to directly manipulate hydroperiod (flood frequency, duration, and depth) as a tool for vegetation management. Where potential evapotranspiration rates are high, water management can also become a mechanism for salinity management and, indirectly, vegetation management through another path.

Herbicides

Herbicide active ingredients and adjuvants that may be used by the District in the future to manage vegetation for control of mosquito habitat are listed below:

> Alkylphenol

> Butyl alcohol

> Ethoxylate

> Glyphosate

> Imazapyr

> Isopropanol

> Isopropyl amine

> Polydimethylsiloxane

> Polymeric Colorant

Both Aquamaster (labeled for aquatic applications) and Roundup (labeled for terrestrial applications) are used for spot control of actively growing vegetation. All herbicides are applied in strict conformance with label requirements.

3.5.4 Biological Control

Biological control of mosquitoes involves the intentional use of mosquito pathogens (diseases), parasites, and/or predators to reduce the population size of target vectors. It is one of the principal components of a rational and integrated control management program. Biological control is used as a method of protecting the public from mosquitoes and the diseases they transmit without the use of pesticides and potential problem of pesticide resistance; however, the use of pathogens involves chemical treatment with USEPA-registered materials. The different types of biological controls are described in the following paragraphs.

Mosquito Pathogens (Viruses and Bacteria)

Mosquito pathogens include an assortment of viruses and bacteria. Pathogens are highly host-specific and usually infect mosquito larvae when they are ingested. Upon entering the host, these pathogens multiply rapidly, destroying internal organs and consuming nutrients. The pathogen can be spread to other mosquito larvae in some cases when larval tissue disintegrates and the pathogens are released into the water to be ingested by uninfected larvae. Examples of viruses that can infect mosquitoes are mosquito iridoviruses, densonucleosis viruses, nuclear polyhedrosis viruses, cytoplasmic polyhedrosis viruses, and entomopoxviruses. Examples of bacteria pathogenic to mosquitoes are *Bacillus sphaericus* (Bs), the several strains of *Bacillus thuringiensis israelensis* (Bti), and *Saacharopolyspora spinosa*. Two bacteria, *Bs* and *Bti*, produce proteins that are toxic to most mosquito larvae, while *Saacharopolyspora spinosa* produces compounds known as spinosysns, which effectively control all larval mosquitoes. *Bs* can reproduce in natural settings for some time following release. *Bti* materials applied by the District do not contain live organisms, but only spores made up of specific protein molecules. All three bacteria are naturally occurring soil organisms that are commercially produced as mosquito larvicides.

Mosquito Predators

Mosquito predators are represented by highly complex organisms, such as insects, fish, birds, and bats that consume larval or adult mosquitoes as prey. Predators are opportunistic in their feeding habits and typically forage on a variety of prey types, which allows them to build and maintain populations at levels sufficient to control mosquitoes, even when mosquitoes are scarce. Examples of mosquito predators include representatives from a wide variety of taxa: coelenterates, *Hydra* spp.; platyhelminths, *Dugesia dorotocephala, Mesostoma lingua, and Planaria* spp.; insects, *Anisoptera, Zygoptera, Belostomidae, Geridae, Notonectidae, Veliidae, Dytiscidae, and Hydrophilidae*; arachnids, *Pardosa* spp.; mosquitofish, *Gambusia affinis*, *Gasterosteus aculeatus*; bats; and birds, *anseriformes, apodiformes, charadriiformes, and passeriformes*. Only mosquitofish are commercially available to use at present, while the District supports the presence of the other species as practical.

The District’s rearing and stocking of mosquitofish in mosquito habitat is the most commonly used biological control agent for mosquitoes in the world. These fish are ideal control agents for several reasons. They feed primarily at the water’s surface, where larvae can be found. They can tolerate a significant range in water temperature and water quality. They are also easy to handle, transport, stock, and monitor. Correct use of this fish can provide safe, effective, and persistent suppression of a variety of mosquito species in many types of mosquito sources. As with all safe and effective control agents, the use of mosquitofish requires a good knowledge of operational techniques and ecological implications, careful evaluation of stocking sites, use of appropriate stocking methods, and regular monitoring of stocked fish. Mosquitofish reproduce in natural settings, for at least some time after release. Due to allegations that mosquitofish may potentially impact red-legged frog and tiger salamander populations, District policy is to limit the use of mosquitofish given to the public to sources such as ornamental fish ponds, water troughs, water gardens, fountains, and unused swimming pools. Limiting the introduction of the mosquitofish to these sources should prevent their migration into habitats used by threatened, endangered, or rare species.

3.5.4.1 Mosquitofish Distribution to the Public

District policy is to take a number of precautions in regard to the distribution of mosquitofish. Residents requesting mosquitofish are required to provide the District with a certain amount of information before receiving fish. The request is then discussed with a district employee prior to Fish being provided.

During the discussion, the legal restrictions on planting Fish by the public as described in the written statement that is handed to each resident are discussed. Mosquitofish are appropriate in ornamental ponds, horse troughs, non-maintained swimming pools or any other water source that does not connect to a waterway.

Limiting the introduction of the mosquitofish by homeowners to these sources should prevent their migration into habitats used by threatened, endangered, or rare species.

3.5.4.2 Planting Mosquitofish in Natural Waterways

To minimize the potential impacts of planting mosquitofish in natural waterways, the District will implement a policy incorporating the following elements:

1. Limiting such plantings to areas where the District's historic and ongoing Surveillance Program indicates that mosquito breeding is likely to occur.
2. Consulting appropriate federal and state fish and wildlife department websites, including the USFWS website, CDFW website, and CalFish.org to determine if the area under consideration for treatment, including a 1-mile radius around the site, is a known habitat for threatened and/or endangered species.
3. Not planting in streams until flows have become discontinuous, and stream habitat consists of isolated pools to minimize the potential for the movement of mosquitofish to areas where treatment was not intended.
4. Not planting mosquitofish if there have been reported sightings of threatened and/or endangered species within this area without further surveys by a biologist qualified to perform such surveys, or consultation with agency biologists.
5. District staff conducting a site survey and preparing a written report relating to the occurrence of sensitive species and not planting mosquitofish if the survey identifies the potential presence of sensitive species.

Unless prohibited by the guidelines above, the site will be planted with mosquitofish. The District will keep records of all plantings made by watershed and location, as well as records of any plantings that were planned and discontinued for any of the reasons provided above.

On average, the District releases about 120 pounds of mosquitofish annually.

3.5.5 Chemical Control

Chemical control is a Program tool that consists of the application of nonpersistent selective insecticides (and herbicides noted in Section 2.3.3 above) to directly reduce populations of larval or adult mosquitoes. threats to public health. If and when inspections reveal that mosquitoes populations are present at levels that trigger the District's criteria for chemical control – based on the mosquitoes' abundance, density, species composition, proximity to human settlements, water temperature, presence of predators and other factors – District staff will apply pesticides to the site in strict accordance with the pesticide label instructions. Pesticide active ingredients that may be used by the District in the future to control mosquito populations and other are listed below:

> *Bacillus sphaericus* (*Bs*)

> *Bacillus thuringiensis israelensis* (*Bti*)

> Methoprene

> Petroleum Distillate Mineral Oil

> Poly (oxy-1,2-ethanediyl), α (C16-20 branched and linear alkyl)-ω-hydroxy (100%)

> Spinosid

> Temephos (O,O,O'-(thiodi-4, 1-phenylene) O,O,O',O'-tetramethyl phosphorothiolate)

4 No Project Alternative

No Project is defined as what would reasonably be expected to occur in the foreseeable future, based on current plans and consistent with available infrastructure and community services, if the project was not approved and implemented. For the District, the Proposed Program is to continue current activities and introduce similar pesticides to those currently in use if needed. The No Project/No Program condition assumes that the current activities would cease and result in a “do nothing” alternative. It must be evaluated in comparison to the existing condition for California Environmental Quality Act compliance. Key assumptions for the No Project alternative are:

> Current regulatory controls would continue and expand as needed; however, the District would not engage in implementing any of these regulations concerning public health and management of carrying potential diseases. For all practical purposes, the District’s office would close. Public education and other outreach activities would ceases along with the control activities.

> Private landowners would manage mosquito and/or problems on private land without any state or federal oversight with pesticides approved for use. Households would use pesticides commonly available from retail outlets where organophosphates, pyrethrin, and pyrethroids are common ingredients.

> Private landowners would also manage vector habitats (clearing, brushing and draining) with potentially little or no oversight.

“Doing nothing” as the No Project Alternative has potentially serious implications for public health, economic, and environmental conditions in the District’s Program Area.

4.1 Public Health

A wide range of public health issues would occur with the No Project Alternative, First, there would be an increased risk of human cases of vector-borne disease and vector interaction issues for humans, pets and wildlife. The San Francisco Bay Area has a well-documented history concerning human-vector interaction, especially with mosquitoes. The earliest written record dates back to the 1772 diaries of Father Juan Crespi who described the "swarms of mosquitoes" in the Warm Springs Area of the City of Fremont and below the hills of Berkeley. Additional records include the 1810 journal entry of mosquitoes attacking a detachment of soldiers near the Albany Hills as well as references indicating that the indigenous peoples of the Bay Area would take action to avoid the large numbers of mosquitoes present during certain times of the year. It should be noted that these interactions took place at a time when the wetlands and sensitive habitats of the Bay were essentially pristine, having limited human habitation and little or no draining, filling or modification, or loss of wildlife including predators of mosquitoes.

Second, the lack of any form of coordinated surveillance reduces the ability of any agency to perform disease risk assessments and, therefore, predict potential outbreaks. Although vector-borne disease is not as prevalent as in other areas of the world, vector-borne pathogens are still present. West Nile Virus, although introduced in 2005, is present throughout the Bay Area, with positive birds, human cases and some infected horses still being detected and reported every year. Malaria continues to be a concern as there are introduced cases detected in travelers returning from malaria infected regions and some recent immigrants every year. The vector for this pathogen can be found in many areas of the San Francisco Bay region, and reintroduction of the malaria organism into local mosquito populations is monitored closely. The last known endemic transmission of malaria occurred in the Putah Creek area of Napa and Solano counties in 1939.

Third, lack of coordinated surveillance increases the risk of emerging infectious diseases or vectors going undetected until they have become established. The appearance of West Nile Virus in New York City in 1999 is an excellent example of this. For budgetary and other reasons, New York had significantly reduced their vector surveillance and management program many years prior to 1999. By the time the virus had been identified, there had already been a number of human cases and the virus had become well established. Now the virus is endemic throughout the United States and results in numerous cases nationwide. Similarly, the reintroduction of vector-borne diseases such as malaria and dengue that had not been present for many years or even decades could also go undetected until their re-establishment or an outbreak of human cases.

Fourth, lack of public outreach results in less current information being available about vectors and vector-borne disease risk reduction. This can lead to increased production of vectors on private property as well as increased cases of vector-borne disease in humans, their pets and livestock. Additionally, the increase in vector-human interactions would result in an increased risk of severe reactions to the bites and stings of vector organisms (e.g. mosquitoes, ticks, and wasps) in sensitive and immuno-compromised individuals   Research over the last 75 years has documented cases of hypersensitivity and/or severe reactions to mosquito bites in children, immuno-compromised individuals and those persons infected with the Epstein-Barr virus or being treated with zidovudine for the AIDS virus. (Brown et al., 1938; Diven et al., 1988; Galindo et al., 1998; McCormack et al., 1995; Peng et al., 2004; Seon et al., 2013; Simmons and Peng, 1999; Smith et al., 1993; Weed, 1965). Crisp and Johnson (2013) provide a review of mosquito allergy including immunology, diagnosis, and treatment and conclude; 1) treatment should focus on avoidance including limiting breeding sites for mosquitoes as well as the use of repellents and protective clothing, 2) local immediate reactions can be managed with the use of prophylactic antihistamines, 3) individuals with severe or anaphylactic reactions to mosquito bites should carry with them Epi-Pens (autoinjectable epinephrine), and 4) more research is needed in a number of areas concerning management and treatment of patients with hypersensitivity to mosquito bites.

The reaction of persons to vector stings and bites, especially mosquito bites, clearly brings into question the use of the terms "nuisance" and "pest" that have commonly been used in the past to define the difference between those vector organisms which transmit vector-borne diseases (e.g. malaria, West Nile Virus, Tularemia, Lyme Disease, Plague) and those which do not. The use of these terms is a misnomer and should not be used to characterize the importance of one vector over another. Human-vector interactions result in a wide range of mental, emotional and physical responses all of which have health implications even in the absence of pathogenic organisms. The California Health and Safety Code, Division 104, Part 11, Chapter 1, Section 116108 defines a vector as " any animal capable of transmitting the causative agent of human disease or capable of producing human discomfort or injury, including, but not limited to, mosquitoes, flies, other insects, ticks, mites, and rats." This definition inherently recognizes that human discomfort and injury as a result of human-vector interactions, is by its own nature, an issue of health just as important as any vector-borne agent of human disease.

4.2 Economic Conditions

There are a number of economic issues associated with the No Project Alternative.

First, with increased human-vector interactions comes an increase in the number of cases of vector-borne disease. The short-term medical and lost workplace, school and home time associated with illness can cost governments, businesses, families and individuals upwards of many thousands of dollars. For long-term severe cases that result in paralysis, persistent fatigue, muscle weakness and/or decreases or loss of cognitive function, this can mean millions of dollars to families and federal and state governments. Although not as common, there of course is no monetary value that can be adequately calculated for the loss of life due to vector-borne disease. Additionally, the loss of valuable livestock (e.g., horses) and decreased farm productivity can also be significant.

Second, increased vector populations can lead to reduced outdoor recreation activities by the public, resulting in increased usage of electricity for air conditioning and indoor entertainment such as television, video games, computers, lighting, etc. This could also lead to a reduction in revenues for recreational areas such as parks, campgrounds, marinas and other areas that depend on usage fees to help with their maintenance and staffing. Outdoor activities are also significant to tourism, which for many areas is an important part of their economy. Large vector populations and/or reported cases of vector-borne disease can impact tourism and potential revenues.

Third, increased vector populations not only lead to increased levels of vector-borne disease but can also result in decreased property values (Herms and Gray, 1944; Howard, 1909). Within San Francisco Bay, historical mosquito populations were at times so severe as to impact real estate sales (Gray, 1951). The impact of mosquito control work on property values is also illustrated by Headlee (1945) who summarized the economic effect of mosquito control work in New Jersey. Here property valuations from 1915 to 1930 had increased by $555,345,000 over what was expected for those communities which had received mosquito control work. Property values form an essential part of the revenue stream for government services such as schools, police, fire, libraries, parks, and health and welfare programs.

Fourth, the cost of hiring private contractors to provide vector control services on a site-specific basis can end up being more costly than the costs associated with the current program (where there are economies of scale). More significant is the costs associated with having to re-establish a program that has been eliminated. These costs include equipment, staffing, training of staffing and the initial environmental costs associated with a new program working to restore vector levels to a healthful level that existed with the old program prior to its elimination. There is a loss of institutional memory and understanding of local vector populations, their habitats and the local citizenry that cannot be replaced when a program is eliminated. When a program is re-established there will be a period of time when less environmentally friendly measures will be employed to bring vector populations down to a level where maintenance and control measures that have little or no environmental impact can be effectively employed (e.g., New York and West Nile Virus).

4.3 Environmental Conditions

The environmental issues associated with the No Project Alternative cannot be understated.

First, in the absence of organized mosquito and vector control programs, unlicensed individuals could begin applying over the counter pesticides on their own. Most of these individuals have little or no training on the proper and effective use of these materials. This means there is a reasonable possibility of over or under application as well as the potential for creation of unrecognized resistance issues. This is especially true for the indiscriminate use of aerosol foggers as well as concentrated pesticides that require mixing with water prior to application. Additionally, there are sensitive individuals (e.g. asthmatics and chemically sensitive people) and their pets (especially birds and fish) whose health and wellbeing could be affected by the unexpected drift of these pesticides into their yards, open windows, and neighborhood parks.

Second, there is the potential for increased use of inappropriate or unregistered materials such as bleach, oil, gasoline, diesel fuel, etc., in an effort to deal with vectors, especially mosquitoes and yellow jackets. This can cause significant environmental harm compared to those materials that are applied in accordance with label requirements by trained, licensed professionals.

Third, there is a general lack of understanding that exists concerning IPM practices and procedures by many members of the public. Therefore, increased vector-human interactions could lead to the increased use of non-IPM practices to provide rapid relief from vector bites and stings as well as address any fears concerning reports in the media of increased vector-borne disease.

Fourth, as mentioned earlier, some mosquito-borne diseases such as West Nile Virus pose a risk to native bird species, including some species of concern such as Yellow Billed Magpies, hawks, and owls.

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Attachment A
CRITERIA

A.1 CRITERIA FOR MOSQUITO PREVENTION IN DRAINAGEWAY CONSTRUCTION AND MAINTENANCE PRACTICES

Background Statement

Mosquitoes breed in creeks and ditches where ponding occurs due to obstructions, overflow of banks, excessive siltation and back-eddies created from low water flow during the dry months. Consequently, modification of drainageways (digging, and filling, etc.) is often necessary to allow free flow of water. Construction of new ditches must be undertaken to maintain adequate circulation of water.

Although obstructions and ponding in creeks and ditches most often occur naturally, alterations to water flows also arise from new construction, refuse deposits and agricultural activities. The correction and costs of such alterations become the responsibility of the person(s) or agency(s) involved when mosquito production results, and abatement expenditures incurred by SCMAD may be billed to the responsible party, pursuant to the procedures set forth in the California Health and Safety Code, Sections 2000 et. seq.

One type of drainageway used to adequately drain low lands in the marsh is called a spreader ditch. This is a small ditch (18 X 18 inches) which drains into a main ditch or tidal water slough. Main ditches direct flow to a water control structure and thence into a tidal water slough.

Policies for Management of Drainageway Construction and Maintenance

1. Water control structures (flap gates, slide gate, weir box, etc.) should be in working condition to facilitate the flooding and complete draining of managed wetlands.
2. Clear and retrench spreader ditches approximately every three years.
3. Excavate or dredge existing main ditches when necessary.
4. Repair levees and remove debris and vegetation, which are obstructing natural stream channels if such materials create a situation, which may endanger public health and safety.
5. Fill isolated potholes (depressions found in marsh areas) which may create mosquito problems and cannot feasibly be connected to circulating water.
6. Connect pools (depressions found in streambeds) to the main flow of water by minor hand ditching when it appears that they are problem mosquito breeding sites.
7. Maintain all access roads and levees in good repair to allow continuous mosquito surveillance, and provide access for control equipment.
8. Install and maintain water control structures whenever possible to expedite flood water removal.

The preceding mosquito prevention criteria are intended only to offer guidance when considering the development of design options during the planning process for projects. Be advised that these practices have been found to be effective, however once the project has been completed it is essential that conscientious maintenance and management practices be followed to help ensure the successful prevention of mosquito production.

Be further advised that under the California Health and Safety Code (Sections 2000 et. seq.) the responsibility for the cost of mosquito control may fall on the property owner.

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A.2 Criteria for Mosquito Prevention In Dredge Material Disposal Sites

Background Statement

In many instances, land disposal of dredge material creates mosquito-breeding sources. Due to the initial high water content and characteristics of the dredged material, shrinkage cracks occur in the drying process. These shrinkage cracks provide ideal habitat for the production of mosquitoes. Experience by mosquito abatement agencies has shown the use of chemicals to kill mosquito larvae in the cracks is very inefficient and generally not practical. Solutions lie in the water management and periodic manipulation of the surface of the deposited material. Disking the spoil material fills and closes the cracks. Drainage of storm water and keeping the elevation of the ground water below the shrinkage cracks also prevents mosquito problems.

Disposal Site Management

1. Provide ditches/ or water control structures for drainage of surface water. An engineering survey may be necessary.
2. Disking of the areas may be required to close shrinkage cracks.
3. Provide access roads that are capable of supporting maintenance, inspection and mosquito abatement control equipment.
4. Areas designated for permanent water should be constructed and managed for mosquito prevention as necessary for the specific site. Generally, dense aquatic vegetation, algal mats and shallow water bring on mosquito problems.
5. Areas designated for wetland development (saltwater marshes) need ditches to remove and enhance tidal water circulation and/or water control structures (tide gates) to provide water management capabilities. The outboard levee system should be retained until sufficient drying has occurred and all necessary grading and ditching has been finished.
6. Retention of outboard levees and tide gates may be necessary or desirable for water management to prevent excessive production of mosquitoes.
7. Plan and fund a maintenance program for the area to provide for:
    a. Maintenance of ditches and water control structures
    b. Disking as necessary
    c. Maintenance of levees and access roads
    d. Occasional mosquito control with pesticides and /or biological agent such as mosquitofish

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A.3 Criteria for Mosquito Prevention In Duck Clubs Based on Studies Conducted on Grizzly Island Wildlife Refuge*

Background Statement

The District has been faced with an ever-increasing number of housing developments surrounding the Suisun Marsh that are within the flight range of at least four species of mosquitoes that are important either as disease vectors or pests. *Aedes melanimon* and *Aedes dorsalis* and *Culiseta inornata* are strong fliers that feed on mammals including man quite aggressively. *Aedes dorsalis* is capable of flights over 20 miles while *Aedes melanimon* and *Culiseta inornata* can move at least 10 miles from their site of emergence. *Culex tarsalis* is historically the primary vector of Western equine (WEE) and St. Louis (SLE) viruses in California. Since 2005, it has been the primary vector of West Nile virus (WNV) in Solano County. This species is primarily a bird feeder but does feed on mammals including man at times. This mosquito is capable of flights of at least 5-7 miles and has been documented as traveling as far as 16 miles. *Aedes melanimon* has been shown to be involved in a secondary maintenance cycle of WEE transmission in the Central Valley and has been documented as carrying WNV.

The brief descriptions of mosquito management techniques mentioned here are based on studies conducted at the California Department of Fish and Wildlife's Grizzly Island Wildlife Area (GIWA) in the Suisun Marsh. These studies were conducted from 1987–1997 by graduate students Darold P. Batzer, Ferenc A. de Szalay and Eric Schlossberg under Vincent H. Resh professor of aquatic entomology with the Department of Environmental Science, Policy, and Management, University of California, Berkeley. The references listed contain extensive descriptions of each of the methods mentioned.

Methods for Control

I. Water Manipulation/Management

Method Result

Rapid flooding: Mosquito eggs hatch synchronously and therefore fewer treatments are necessary to kill mosquito larvae (Aedes species).

Stable water levels: Because fluctuating water levels cause multiple hatches of (Aedes sp.) when areas are reflooded, stable water levels will also reduce the number of treatments necessary to control mosquito larvae.

Late Flooding (late Oct.-Nov.) Delay flooding until the weather is cooler because fewer adult female mosquitoes are active; therefore, oviposition will be lower. However, note that numbers of other beneficial insects (e.g. midges, beetles) may also be lower late in the season and invertebrates important in duck diets may be lower as well. (e.g. de Szalay, Resh 1997, Envir. Ent.).

II. Vegetation Management

Reduce the amount of emergent vegetation such as pickleweed, and saltgrass by mowing or disking, because open water is not habitat for mosquito larvae. (e.g. de Szalay, Batzer, Schlossberg, Resh Proc. CMVCA 1995). Additional benefits of these treatments are colonization by plants that produce seeds eaten by waterfowl (e.g. brassbuttons, goosefoot, purselane), and also by invertebrates eaten by ducks (midges, beetles, water boatmen). (de Szalay & Resh 1997 Wetlands and Schlossberg & Resh 1997 Proc. MVCAC).

Treat edges of plant stands at water/land interface to remove emergent plant cover in areas where mosquito larvae are carried by wind and wave action. (Batzer & Resh 1995 Wetlands).

* Vincent H. Resh, Darold P. Batzer, Ferenc A. de Szalay and Eric Schlossberg

Permanently flooded marshes have little emergent plant stands in deeper sections. Therefore, mosquito production is lower than in seasonal marshes.

III. Mosquito Predators

Fish-Native stickleback and also the introduced mosquitofish are predators of mosquito larvae; the latter is more effective. These fish can control mosquito populations in areas with low emergent plant cover. Fish populations are usually higher in permanent wetlands and are not very effective to control mosquitoes in seasonally flooded habitats.

Invertebrate predators are extremely important in controlling mosquito populations. Dragonfly larvae, beetles, and water boatmen all feed on mosquito larvae. These species naturally colonized wetlands and usually reduce mosquito populations 2-4 weeks after the wetlands are first flooded. No specific management methods are necessary. Controlling mosquitoes with bacterial toxins (Bti), (Bti/Bs) or with juvenile hormone mimics (Methoprene) is recommended because these chemicals do not affect predatory invertebrates or wildlife.

IV. Mosquito Abatement Implementation of Recommendations

Each year the District meets with biologists/staff from the California Department of Fish and Wildlife's (Grizzly Island Wildlife Area) to discuss upcoming flooding plans for the year. Suggestions are made regarding water control structure or drainage improvements and vegetation management techniques that would help minimize mosquito production on a pond-by-pond basis. The types of vegetation and amounts of each specific type can vary greatly. District personnel can advise CDFW staff as to the location, species and density of mosquito larvae found. Beyond that, any actual physical improvements or vegetation management (by disking, mowing or burning) is done by CDFW staff. During the summer and autumn months communication is frequent due to the number of ponds that are flooded earlier in the year for a variety of waterfowl feed. This gives CDFW the option of rapidly draining the pond(s) with mosquito larvae and then quickly reflooding. The water empties from the pond into a larger drain or slough where mosquito predators can consume them. This may not always be feasible due to the large size of a pond and/or the inability to drain it rapidly. This practice does reduce the need for pesticide applications to control Aedes melanimon or Aedes dorsalis mosquitoes.

A New Jersey light trap is operated on Grizzly Island near CDFW Headquarters to monitor local populations from April through mid-November on a weekly basis.

The District also meets with representatives/staff of the Suisun Resource Conservation District (SRCD) to review the flooding and draining capabilities of individual duck clubs before any early flooding commences. A system of notifying the District by phone and/or fax promptly once flooding has started is in place. Often personal communication in the field occurs between District staff and the duck club owners or staff. As with CDFW property, this greatly reduces the need for pesticide applications to control Aedes mosquitoes by giving the club owner the opportunity to quickly drain the pond(s) with mosquito larvae and then rapidly reflood.

The preceding mosquito prevention criteria are intended only to offer guidance when considering the development of design options during the planning process for projects. Be advised that these practices have been found to be effective; however, once the project has been completed it is essential that conscientious maintenance and management practices be followed to help ensure the successful prevention of mosquito production.

Be further advised that under the California Health and Safety Code (Sections 2000 et. seq.) the responsibility for the cost of mosquito control may fall on the property owner.

A.4 Criteria for Mosquito Prevention In Irrigated Pastures

Background Statement

Those irrigation practices which are advantageous to mosquito control are also beneficial to the production of crops. At least 3 days in water are required for mosquitoes to reach the adult stage in irrigated pastures. With the exception of rice, water which is left standing for more than 24 hours after irrigation is of no benefit to the field in which it remains and usually becomes detrimental to the crop. In most cases, less than ½ inch of standing water in a field is removed by means evaporation, this does not remove the water rapidly enough to promote mosquito control. The extent to which water infiltrates soil varies according to its texture and condition. Soils that are either fine textured, compacted, or excessively tilled, particularly when they are wet, may become almost impervious to water infiltration in a few hours. In this type of situation, the field must be graded with a slope to promote surface drainage for the excess water.

Design Criteria for Irrigated Pastures

1. All fields subject to irrigation should be leveled according to a designed grade with a minimum of soil movement (cutting and filling) and with a minimum down slope fall of 0.2 percent. Use NRCS guidelines for irrigated pastures. Initial laser leveling and periodic maintenance to repair damaged areas are needed to maintain efficient water flow (Lawler and Lanzaro, 2005).
2. Irrigate only as frequently as is needed to maintain proper soil moisture. Check soil moisture regularly until you know how your pasture behaves (Lawler and Lanzaro, 2005).
3. Do not over fertilize. Excessive fertilizers can leach into irrigation tail water, making mosquito production more likely in ditches or further downstream (Lawler and Lanzaro, 2005).
4. Apply only enough water to wet the soil to the depth of rooting (Lawler and Lanzaro, 2005).
5. Drain excess water from the pasture within 24 hours following each irrigation. This prevents scalding and reduces the number of weeds in the pasture. Good check slopes are needed to achieve drainage. A drainage ditch may be used to remove water from the lower end of the field (Lawler and Lanzaro, 2005).
6. Inspect fields for drainage and broken checks to see whether re-leveling or reconstruction of levees is needed. Small low areas that hold water can be filled and replanted by hand. Broken checks create cross-leakage that provide habitat for mosquitoes (Lawler and Lanzaro, 2005).
7. Keep animals off the pasture while the soil is soft. An ideal mosquito habitat is created in irrigated pastures when water collects in hoof prints of livestock that were run on wet fields or left in the field during irrigation. Keeping animals off wet fields until soils stiffen also protects the roots of the forage crop and prevents soil compaction that interferes with plant growth (Lawler and Lanzaro, 2005).
8. Divide up pastures into a number of smaller fields so that the animals can be rooted from one field to another. This allows fields to dry between irrigations and provides a sufficient growth period between grazing. It also prevents hoof damage (pugging), increases production from irrigated pastures, and helps improve water penetration into the soil by promoting a better root system (Lawler and Lanzaro, 2005).

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A.5 Criteria for Mosquito Prevention In Permanent Ponds Used As Waterfowl Habitat

Background Statement

The diversity of waterfowl habitat in the Suisun Marsh is increased by the occurrence of permanent ponds. Permanent ponds, however, should remain a minor part of the marsh habitat because (1) they require specific conditions to provide optimum habitat and (2) other more intensive types of management can generally be carried out that provide for higher yields of waterfowl food.

Seeding of permanent ponds is not necessary since plants such as sago pondweed and widgeon grass should become established in the ponds naturally.

Policies for Management of Permanent Ponds

Establishment:

1. Permanent ponds are recommended only in areas where at least 70% of the total permanent water area will be maintained year round at a minimum depth of 3.5 to 4.0 feet. This depth limits the occurrence of cattails and tules and stimulates the production of desirable pondweeds.
2. Levees surrounding permanent ponds must have a shelf on which cattails and tules can become established to serve as a buffer against wave action.
3. Permanent ponds should be established only in areas where the gates and ditches can provide maximum circulation of water without fluctuation in water level.

Maintenance:

1. Set gates to allow maximum circulation without change in water level. Maintain circulation year round, but especially during the warmer months (April-Sept.). Poor circulation during these months could increase salinity, mosquito reproduction, and the probability of botulism.
2. Once every 5 years, completely drain the pond in February and keep it dry through September. This will control carp populations, allow oxidation of the sediment in pond bottoms resulting in the release of nutrients, and allow for mowing or burning of undesirable vegetation. At this time, an inspection of gates and levees will be undertaken and needed repairs will be made.

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A.6 Criteria for Mosquito Prevention in Permanent Water Impoundments

1. Ponds may be any shape but should not have small coves or irregularities around their perimeters.
2. Ponds should be designed to be emptied by gravity or pumping for cleaning or drying and have graded bottoms so all water can be removed.
3. Side slopes of excavations and levees should be as steep as possible, consistent with soil characteristics and risk factors of slope failure.
4. Where steep side slopes cannot be economically achieved, the slopes should be lined with suitable material such as concrete to 3 feet below the water line or sterilized to achieve weed control.
5. The top width of embankments should be a minimum of 12 feet and should be adequately constructed to support maintenance vehicular traffic.
6. An access ramp should be provided on an inside slope for launching a small boat for mosquito control.
7. Ponds designed for long term storage should have a minimum storage depth of 4 feet.
8. A maintenance program for weed and erosion control along inner slopes is essential.
9. All accumulation of dead algae, vegetation and debris should be routinely removed from the impounded water surface and properly disposed.

Water Conveyance Facilities

1. Ditches must be maintained free of emergent, marginal and floating vegetation.
2. Ditches should be sized and graded for adequate flow and must not be used for water storage.
3. Unpressurized and low pressure pipelines, commonly used in irrigation distribution systems, should be designed to be emptied when not in use and should not be used for water storage because of the mosquito breeding potential in the partially filled pipes.

The preceding mosquito prevention criteria are intended only to offer guidance when considering the development of design options during the planning process for projects. Be advised that these practices have been found to be effective, however once the project has been completed it is essential that conscientious maintenance and management practices be followed to help ensure the successful prevention of mosquito production.

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A.7 Criteria for Mosquito Prevention in Reclaimed Wastewater

Background Statement

Changes in California water pollution regulations and current emphasis for reuse of wastewater have serious prospects for mosquito production. Proposals for reusing effluent and surface runoff or preventing these waters from flowing directly into estuaries or watercourses can create new mosquito sources.

Manipulation of physical features to prevent a mosquito source from developing is the most desirable long-term solution. This can be accomplished through project design and management.

These types of proposals under consideration for the diversion and use of wastewater are;
(1) impoundments for reclamation; (2) agricultural irrigation; (3) recharge of groundwater; (4) development of marshland and wetland habitat and (5) industrial recycling.

Policies for Management of All Lands Which Utilize Wastewater

1. All sites designated for wastewater reclamation should either be graded or ditched as necessary for proper drainage.
2. Sites for temporary impoundments used for waterfowl feeding areas or for production of food should be flooded according to the water management schedules developed by the Suisun Resource Conservation District (SRCD).
3. The use of wastewater for crop irrigation requires careful land preparation and judicious water management to prevent standing water. Crop irrigation by overhead sprinkler is preferred to other methods.
4. Establishment of wetland habitat using wastewater requires land grading or ditching to allow removal of all water from the shallow areas, water control structures, pumps, etc., for complete water management. Access provisions for marsh management equipment such as boats and aquatic or all-terrain vehicles are also required.
5. Excess wastewater at the low ends of sites used for marsh flooding or crop irrigation must be recycled, utilizing a return system or be disposed of in a drainage facility.
6. Water control devices such as pumps, weir boxes and flap gates should be of sufficient capacity to draw down the temporary wastewater impoundments within a time designated by the Solano County Mosquito Abatement District (SCMAD).

Wastewater Storage Ponds

1. Ponds filled with wastewater may be any shape but should not have small coves or irregularities around their perimeters.
2. Ponds should be designed to be emptied by gravity or pumping for cleaning or drying and have graded bottoms so all water can be removed.
3. Side slopes of excavations and levees should be as steep as possible, consistent with soil characteristics and risk factors of slope failure.
4. Where steep side slopes cannot be economically achieved, the slopes should be lined with suitable material such as concrete to 3 feet below the water line or sterilized to achieve weed control.
5. The top width of embankments should be a minimum of 12 feet and should be adequately constructed to support maintenance vehicular traffic.
6. An access ramp should be provided on an inside slope for launching a small boat for mosquito control.

7. Ponds designed for long-term wastewater storage should have a minimum storage depth of 4 feet. Ponds and ditches, which are relatively deep and vegetation free, reduce immature mosquito habitat. Mosquito suppression is increased through wave action and exposure to natural enemies. More efficient surveillance is possible and chemical applications are more effective.
8. A maintenance program for weed and erosion control along inner slopes is essential.
9. All accumulations of dead algae, vegetation and debris should be routinely removed from the impounded wastewater surface and properly disposed.

Wastewater Conveyance Facilities

1. Ditches for wastewater must be maintained free of emergent, marginal and floating vegetation.
2. Ditches should be sized and graded for adequate flow and must not be used for water storage.
3. Unpressurized and low-pressure pipelines, commonly used in irrigation distribution systems, should be designed to be emptied when not in use and should not be used for wastewater storage because of the mosquito breeding potential in the partially filled pipes.

Septic Tanks

1. Septic tanks should be adequately sealed to prevent mosquito entry and production.
2. Tanks should be designed and installed as per Solano County Resource Management standards to prevent ground cracks which could serve as access to mosquitoes.

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A.8 Criteria for Mosquito Prevention in Salt Marsh Restoration of Exterior Levee Lands

Background Statement

These lands were originally tidal marshes, vegetated areas subject to daily tidal action. They were reclaimed for agricultural and other uses by the construction of levees and the installation of one or more water control structures to control the inflow and outflow of water. The Suisun Marsh Protection Plan recommends the restoration of former tidal marshes to tidal action where and when possible.

Salt marsh restoration projects on former exterior areas generally have a great potential for producing large numbers of mosquitoes. At least one mosquito species (*Aedes dorsalis*) produced in these types of areas is an aggressive pest of man and is capable of flying in excess of 20 miles. Mosquito control in California has its origin in the San Francisco Bay Area where efforts where undertaken to control this species by ditching to enhance drainage and water circulation.

Removing or breaching the levee will subject the sites to tidal flow. The extent of tidal flow depends, of course, on the relative elevation of the site to tide. Tidal flushing itself does not create mosquito problems. Mosquito problems arise from the residual tidal and flood waters remaining in depressions and cracked ground.

The following District Practices should be considered prior to removal or breaching of any levee or water control structure.

Policies for Management of Salt Marsh Restoration of Exterior Levee Lands

1. Develop a management program for the control of mosquitoes. Such a plan should be developed in coordination with the Solano County Mosquito Abatement District (SCMAD).
2. If necessary, obtain an engineering survey to locate depressions that would retain tidal water, and to determine the location of ditches for water circulation and drainage.
3. Establish a water recirculation system by interconnecting depressions with ditches that will enhance water movement and provide access for predator fish.
4. Disk or harrow all cracked ground caused by shrinkage and subsidence.
5. Plan and fund a long-term maintenance program on the marsh. The maintenance should include:
   a. Dredging and cleaning of sloughs, spreader ditches and main ditches to enhance water movement and provide access for predator fish.
   b. Disking of cracked ground as needed. All sites designated for wastewater reclamation should either be graded or ditched as necessary for proper drainage.
   c. Maintenance and repair of water control structures.

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A.9 Criteria for Mosquito Prevention in Sedimentation Ponds and Retention Basins

Background Statement

Sediment basins, sediment traps, diversions or similar required measures shall be installed well in advance of any clearing or grading and maintained by the permit-issuing authority. The design of such structures should account for abating potential mosquito problems.*

1. Sedimentation ponds and retention basins may be any shape but should not have small coves or irregularities around their perimeters.
2. Ponds/basins should be designed to be emptied by gravity or pumping for cleaning or drying and have graded bottoms so all water can be removed.
3. Side slopes of excavations and levees should be as steep as possible, consistent with soil characteristics and risk factors of slope failure.
4. Ponds/basins should be kept dry during the period between April 1 and November 1. This serves to prevent mosquito production and substantially reduce the efforts required to keep the vegetation under control.
5. Where steep side slopes cannot be economically achieved, the slopes should be adequately constructed to support maintenance vehicular traffic.
6. The top width of embankments should be a minimum of 12 feet and should be adequately constructed to support vehicular traffic.
7. An access ramp should be provided on an inside slope for launching a small boat for mosquito control.
8. Ponds designed for long-term storage should have a minimum storage depth of 4 feet.
9. A maintenance program for weed and erosion control along inner slopes is essential.
10. All accumulation of dead algae, vegetation and debris should be routinely removed from the impounded water surface and properly disposed.

Water Conveyance Facilities

1. Ditches must be maintained free of emergent, marginal and floating vegetation.
2. Ditches should be sized and graded for adequate flow and must not be used for water storage.
3. Unpressurized and low-pressure pipelines, commonly used in irrigation systems, should be designed to be emptied when not in use and should not be used for water storage because of the mosquito breeding potential in partially filled pipes.

The preceding mosquito prevention criteria are intended only to offer guidance when considering the development of design options during the planning process for projects. Be advised that these practices have been found to be effective, however, once the project has been completed it is essential that conscientious maintenance and management practices be followed to help ensure the successful prevention of mosquito production.

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* This ordinance became effective on January 25, 1980 and is binding on all grading and vegetative removal activities in the county. It is Erosion Control Ordinance 1087 and is contained in Chapter 31 of the Solano County Code, Article III, Section 31-300.

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A.10 Criteria for Mosquito Prevention in Tidal Marshes

Background Statement

Historically, tidal marshes in Solano County were prolific sources of mosquitoes, an aggressive, migrating, day-biting species. In addition to direct abatement, water management practices have been developed by the Solano County Mosquito Abatement District (SCMAD) to prevent the production of mosquitoes in tidal marshes. The principal prevention method consists of the construction of ditches to circulate tidal water into sloughs and bays to avoid ponding. The following recommendations should be considered to reduce the mosquito production in tidal marshes.

Policies for Tidal Marsh Management

1. All marshlands should be periodically surveyed to determine if ditches and drainage water control structures are properly placed to ensure effective drainage.
2. Ensure that all spreader ditches are constructed and maintained free and clear of debris and vegetation. Clear and retrench approximately every three years.
3. Spreader ditches should be properly connected to a slough via a main ditch or by having a flap gate, weir box or other adequate water control mechanism.
4. The capacity of the drainage systems (spreader and main ditches) should take no more than 5 days to ensure full removal of water from the surface to the marsh prior to potential mosquito production.
5. To ensure the effectiveness of the drainage system and water control structures for the prevention of mosquitoes, the SCMAD will conduct surveillance after each bi-monthly high tide.

The preceding mosquito prevention criteria are intended only to offer guidance when considering the development of design options during the planning process for projects. Be advised that these practices have been found to be effective, however once the project has been completed it is essential that conscientious maintenance and management practices be followed to help ensure the successful prevention of mosquito production.

Be further advised that under the California Health and Safety Code (Sections 2000 et. seq.) the responsibility for the cost of mosquito control may fall on the property owner.

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A.11 Criteria For Mosquito Prevention In Utility Construction Practices

Background Statement

Installation of natural gas lines and wells, electrical lines, telephone lines, petroleum pipelines and the like can alter both topography and habitat. Activities which disrupt drainage patterns, obstruct water flow or water control structures, prevent access, or leave mounded debris can cause mosquito production.

Policies For Management of Utility Construction in Marsh Areas

1. SCMAD should be notified of proposed utility construction activities in marsh areas through lead agencies or responsible parties. Such activities should be reviewed by SCMAD at both the project development phase and after the work has been completed to ensure the project is carried out in conformance with SCMAD policies.
2. Installation of utilities should not obstruct water flow or alter drainage patterns without prior notification of SCMAD.
3. Following installation of utilities the topography should be returned to original conditions. Circulation ditches or natural drainageways should drain effectively and levees and/or access roads should be put back in good repair.
4. If mosquitoes are produced as a result of negligent utility construction practices, all costs necessary to abate mosquitoes by SCMAD will be borne by the responsible agencies or property owners, pursuant to the procedures set forth in the California Health and Safety Code, Sections 2061 et. seq. The preceding mosquito prevention criteria are intended only to offer guidance when considering the development of design options during the planning process for projects. Be advised that these practices have been found to be effective, however, once the project has been completed it is essential that conscientious maintenance and management practices be followed to help ensure the successful prevention of mosquito production. Be further advised that under the California Health and Safety Code Sections 2061 et. seq.) the responsibility for the cost of mosquito control may fall on the property owner.

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