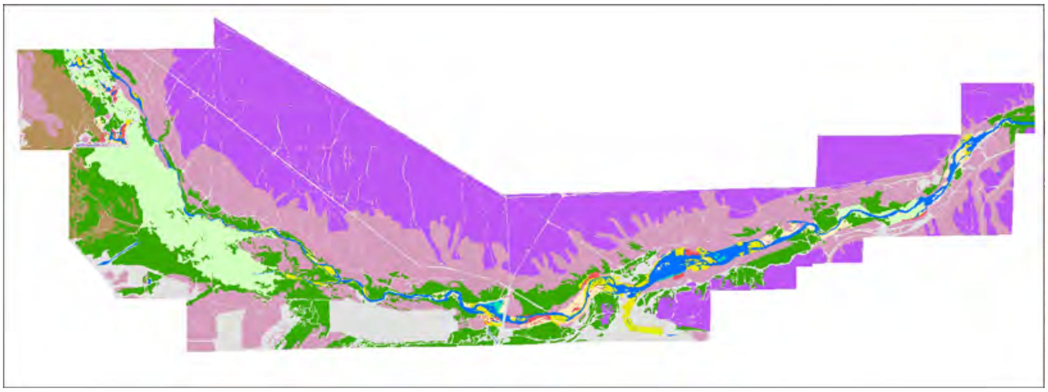
Las Vegas Wash Coordination Committee

Land Cover Types of the Las Vegas Wash, Nevada



March 2008

Las Vegas Wash Coordination Committee

www.lvwash.org

Land Cover Types of the Las Vegas Wash, Nevada

SOUTHERN NEVADA WATER AUTHORITY
Las Vegas Wash Project Coordination Team

Prepared for:

Las Vegas Wash Coordination Committee

Prepared by:

Seth A. Shanahan[1], Dave Silverman[2], and Art Ehrenberg[3]

[1]Southern Nevada Water Authority
Las Vegas Wash Project Coordination Team
100 City Parkway, Suite 700
Las Vegas, Nevada 89106

[2]Xeric Specialties Consulting
437 Calle De Collie
Ridgecrest, California 93555

[3]Southern Nevada Water Authority
Data Resources Division
100 City Parkway, Suite 700
Las Vegas, Nevada 89106

March 2008

ACKNOWLEDGEMENTS

The U.S. Bureau of Reclamation (BOR) provided funding for this project under assistance agreement number 04FG300026. Clark County Parks and Recreation and the BOR provided access to study sites. We wish to acknowledge the contributions of Lee Watson with SpecTIR. Nick Rice provided valuable logistical support by coordinating ground based spectrometer data acquisition and Cindy Hopkins conducted field surveys. We would like to thank the members of the Research and Environmental Monitoring Study Team for reviewing this document and the Las Vegas Wash Coordination Committee for their continued support for this project and the implementation of the Las Vegas Wash Comprehensive Adaptive Management Plan.

Land Cover Types of the Las Vegas Wash, Nevada

Table of Contents

Page No.

Page No.

List of Figures

Page No.

List of Appendices

1.0 INTRODUCTION

Vegetation type, extent, continuity, and structure are some of the most important factors that determine wildlife diversity and distribution. Other contributing factors that shape wildlife communities include disturbance, competition, climate, and water availability. Because vegetation communities in the southwestern U.S. gradate sharply along zones of soil moisture, wildlife are often restricted to specific vegetation types. Along the Las Vegas Wash (Wash), Nevada, more than 250 wildlife species have been documented to occur in distinct wetland, riparian, and upland vegetation types. Recent studies have investigated the diversity and distribution of amphibians, birds, fishes, mammals, and reptiles (Shanahan 2005, 2005a, Van Dooremolen 2005, O'Farrell and Shanahan 2006, Larkin 2006). Moreover, focused surveys for the endangered southwestern willow flycatcher (*Empidonax traillii extimus*) and Yuma clapper rail (*Rallus longirostris yumanensis*) have been conducted since as early as 1998 (SWCA 1998, 1999, 2000, 2001, 2002, 2003, 2005, 2006; McKernan and Braden 2001, 2002). Field surveys have concluded that wildlife habitats are improving. Habitat analyses are integral components of the biological surveys that are conducted in the Wash. Because survey locations are finite, however, vegetation descriptions are often spatially limited. Vegetative communities described from a landscape perspective are helpful to understand the landscape structure and its effects on the distribution and abundance of organisms.

The Las Vegas Wash Coordination Committee, a multi-stakeholder collaborative planning group, has been facilitating biological resource inventories and ecological improvements along the Wash for the past several years. Besides the wildlife studies previously described, on the ground activities have included constructing multiple erosion control structures and stream bank protection facilities. Moreover, extensive revegetation projects have been completed to further protect the channel bed and banks from eroding as well as to improve wildlife habitat values. These activities are directed by a planning document that was completed in 2000, the Las Vegas Wash Comprehensive Adaptive Management Plan (CAMP). Among the action items that were listed in the CAMP was a recommendation to prepare a long-term wildlife management plan for the Wash, which is currently underway (Shanahan et al. 2007). In order for wildlife management planning to be successful, however, the availability and extent of wildlife habitats must be considered. Often, wildlife management is effectively accomplished by focusing management recommendations towards habitats.

The goal for this study is to identify and delineate land cover types along the Wash with specific attention given to vegetated cover types (i.e., vegetation communities). Vegetation communities are described by using standardized vegetation classifications (Association for Biodiversity Information 2001), Geographic Information System (GIS) technologies, and appropriate ecological methodologies (e.g., Barbour et al. 1999, Mueller-Dombois and Ellenberg 1974). This study provides a critical catalog of vegetative communities along the Wash using a repeatable standardized nomenclature. This study was conducted to facilitate wildlife management planning along the Wash (Shanahan et al. 2007), however, ecosystem restoration initiatives (Kloeppel et al. 2006, Bickmore 2003) were intended to benefit from these data as well. Specifically important land cover classifications, such as wetlands, are also presented to help plan for and meet long-term management goals along the Wash.

1.1 Biotic Communities

Plants and animals are distributed in different parts of the world for a variety of reasons. For example, continental scale distributions are typically artifacts of past geologic activity whereas watershed scale distributions are often artifacts of local climate, topography, substrate type, and catchment size. Regardless of the mechanisms that drive where species occur, there are often observable units of similarity across the landscape. Natural units of similarity include areas that are characterized by like physical, climatological, or biological components whereas artificial units of similarity are often described politically or socially. For the purposes of this study, we are interested in units of similarity that are characterized by biological components, specifically vegetation.

Merriam and Steineger (1890) were the first to popularize the biotic community concept in the U.S. with their description of the life zones of San Francisco Peak, Arizona. Merriam and Steineger (1890) described six life zones, which were based almost exclusively on elevation. Each life zone had a characteristic flora and fauna that was readily observed and distinguishable from one another. From lowest to highest, the life zones include the lower sonoran, upper sonoran, transition, canadian, hudsonian, and arctic-alpine. The lower sonoran life zone, which encompasses biological communities between 100 and 3,000 feet above mean sea level, describe the Wash. This life zone is further characterized by the dominance of creosote bush (*Larrea tridentata*) and white bursage (*Ambrosia dumosa*) vegetation.

Since the development of the life zone concept, biotic community classifications have grown in complexity and geographic extent. For example, Bailey (1983) prepared a map of functionally similar ecosystems (i.e., ecoregions) in the U.S. for the purposes of facilitating environmental conservation and estimating ecosystem productivity. From coarse to fine resolution, Bailey (1983) described four classification levels; the domain, division, province, and section. The Wash, for example, is within the dry domain, desert division, American desert (Mojave-Colorado-Sonoran) province, creosote bush section. Brown et al. (1998) prepared a classification similar to Bailey's (1983) but for both the U.S. and the remaining parts of North America. Their classification uses a biogeographic approach that incorporates both zoogeographic and phytogeographic information. Brown et al. (1998) describe seven levels of hierarchal classification in North America which they split between the neartic and neotropical biogeographic realms. Their levels include the hydrologic regime, formation type, climatic zone, biotic community, series, association, and stand. Brown et al. (1998) have classified the Wash as a part of the neartic realm, natural upland vegetation regime, desertlands formation, warm temperate desertlands zone, Mojave desertscrub community with the Mojave desertscrub community being nearly 48 miles^2. Classifications past the community level were not prepared. The most recent ecoregion mapping efforts have been facilitated by the U.S. Environmental Protection Agency's Western Ecology Division. The most detailed ecoregion classification (Level IV) for Nevada was completed by Bryce et al. (2003) and the Wash is listed as being within the creosote bush-dominated basins, arid footslopes, and arid valleys and canyonlands (Figure 1)

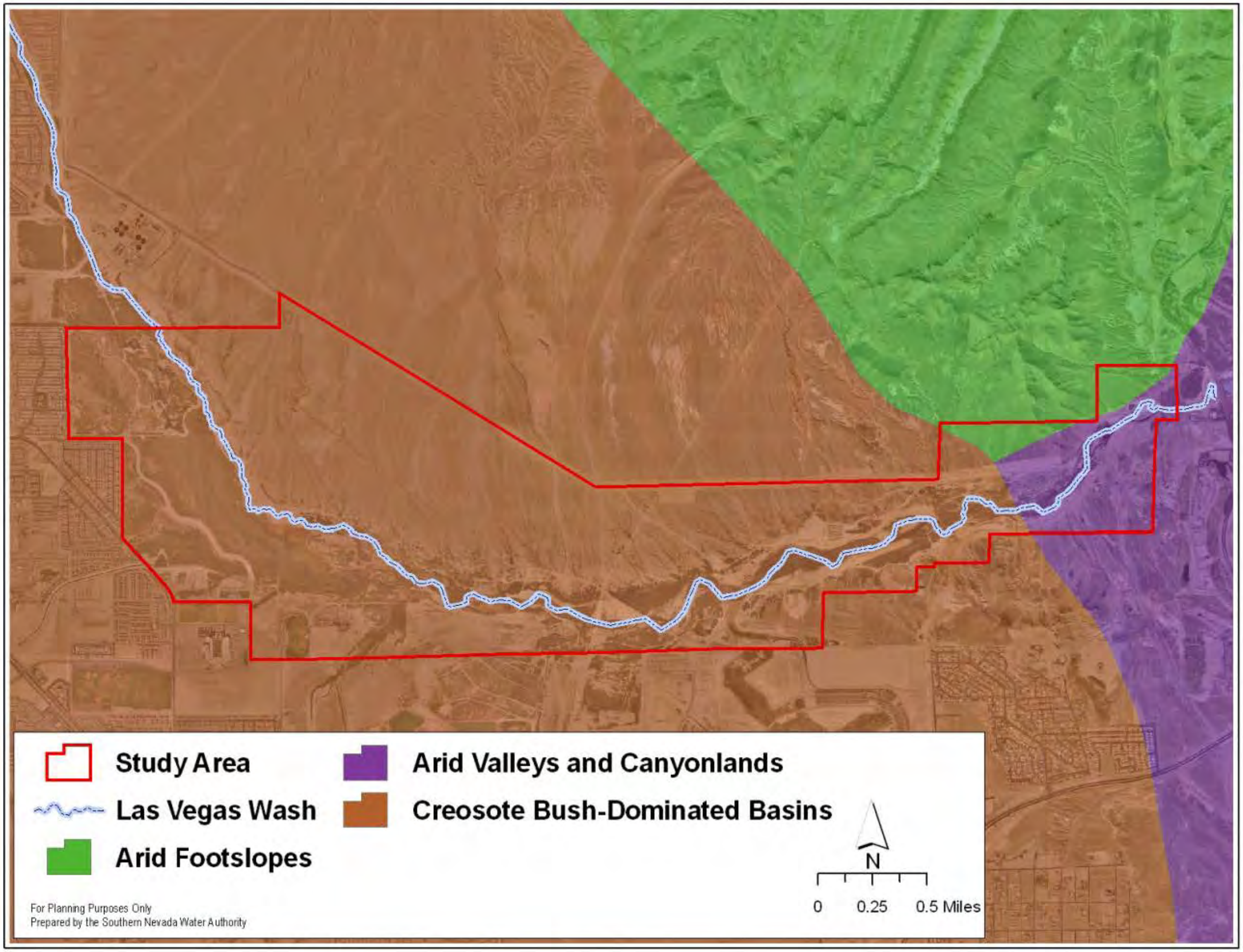


Figure 1: Level IV ecoregions of the Las Vegas Wash from Byrce et al. (2003).

Although biotic community classifications at a regional scale are helpful towards understanding the patterning of broad geographic areas, local landscape characteristics are important for achieving finer scale resolution. Bradley and Deacon (1965) prepared the earliest and most comprehensive description of the biotic communities of Southern Nevada from a fine scale by compiling information from field observations, peer-reviewed literature, and local ecological knowledge. Classifications were based mostly on physiognomic and species information, hydrologic regime, and position in the landscape. Based on their biotic community descriptions, the Wash is defined as part of the stream riparian and stream communities.

1.2 Historical Vegetation Classifications

Plants are a component of the biotic community and they are often the most easily observed and measured unit of the community. Recent advances in the collection and analysis of remotely sensed data make plants even more easily measured. With these new techniques, several vegetation classifications have historically been prepared for the Wash to meet various goals. Unfortunately, these vegetation classifications were not typically prepared using a hierarchal standard and are therefore not easily replicated. Moreover, because the Wash is a spatio-temporally dynamic system, historical classifications are not indicative of present conditions.

1.2.1 Las Vegas Wash Vegetation Study (1975-1986)

The earliest vegetation classification that was prepared for the Wash incorporated color infrared aerial imagery from 1975, 1982, and 1984-1986 (BOR 1987). The objective of this study was to inventory the aerial extent and document temporal changes in the extent of the vegetation communities found along the Wash. This classification listed several vegetation/land cover types described as salt cedar, mixed shrub, desert, barren/disturbed, eroded/scoured, dead, thistle/smotherweed, reed marsh, cattail marsh, mixed marsh, wetland annuals, open water, and facilities.

1.2.2 Clark County Wetlands Park Environmental Impact Statement (1994)

In 1994, a delineation and classification of vegetation communities was prepared to support the preparation of environmental documents for the Clark County Wetlands Park (Wetlands Park; Southwest Wetlands Consortium 1998). This vegetation survey established nine vegetative communities within the Wetlands Park boundary. The communities include emergent wetland/hydroriparian, strand, common reed, tamarisk, alkali, disturbed, upland, xeroriparian, and *Atriplex*.

1.2.3 Southwest Regional Gap Analysis Program (2003)

The Southwest Regional Gap Analysis Program (SWReGAP) began in 1999 as a five state collaborative mapping project for assessing biodiversity (Lowry et al. 2005). SWReGAP provides the most comprehensive description of land cover types near the Wash, however, mapping resolution is poor and classifications are misapplied and not indicative of current conditions. Eight cover types were described for the Wash area, which include: (1) developed open space-low intensity, (2) Sonora-Mojave creosote bush-white bursage desert scrub, (3) Sonora-Mojave mixed salt desert scrub, (4) North American warm desert bedrock cliff and outcrop, (5) North American warm desert wash, (6) North American warm desert pavement, (7) North American warm desert badland, and (8) invasive southwest riparian woodland and shrubland.

1.2.4 Clark County Wetlands Park Improvements Environmental Assessment (2005)

In 2004, SWCA (2005a) prepared an Environmental Assessment for various trails, interpretive, and habitat enhancement projects in the Wetlands Park. A new vegetation classification was not created, rather, the classification schema previously developed by the Southwest Wetlands Consortium (1998) was used. SWCA (2005a) found that the plant communities in the park changed only slightly with most communities decreasing in extent. The most substantial change appears to be an increase of nearly 200 acres of upland vegetation from 1994 to 2004.

2.0 MATERIALS AND METHODS

Land cover types within the study area have been delineated by using digital spatial information products, a standardized classification nomenclature, and field surveys. Although this report primarily identifies and delineates the vegetation types found near the Wash, relevant land cover classifications conducted by others have also been included. Moreover, a specific classification for wetlands and other waters of the U.S. was prepared.

2.1 National Vegetation Classification System

The National Vegetation Classification System (NVCS) was a collaborative product of the Nature Conservancy and natural heritage programs across the country (Grossman et al. 1998). Although originally developed to help meet the goals of the Nature Conservancy, which are to conserve species and natural communities, many federal, state, and local agencies, scientific organizations, and scientists have supported using this system for describing plant communities. This system is widely used in the U.S. and has been adopted as the Federal Geographic Data Committee's vegetation classification and information standard (FGDC 1997). Moreover, the U.S. Geological Survey has used the NVCS to meet goals of the Gap Analysis Program which are to provide "broad geographic information on the status of ordinary species (those not threatened with extinction or naturally rare) and their habitats in order to provide land managers, planners, scientists, and policy makers with the information they need to make better-informed decisions" (Scott and Jennings 1997). Plant communities along the Wash were described within the NVCS framework. Attempts were made to use existing community descriptions if possible. For example, SWReGAP described more than 400 vegetation alliances that were found in Arizona, Colorado, Nevada, New Mexico, and Utah (Association for Biodiversity Information 2001), many of which occur along the Wash. The NVCS program consists of eight hierarchal classification levels (Grossman et al. 1998, Anderson et al. 1998) described below. These categories are based on physiognomy and floristics. Scientific names have been primarily used to construct classification types and are used throughout this document where appropriate. Colloquial names, however, are reported parenthetically in the section headers when scientific names have been used in an attempt to facilitate broader usage of the cover type names and to fall in line with recent classification trends (FGDC 2006).

2.1.1 System

At the top of the hierarchal classification system is the System level. The System level divides vegetation into terrestrial, aquatic, or subterranean types. Terrestrial systems include areas that have rooted plants, including wetland and shallow water areas. Vegetation communities along the Wash are within the terrestrial system.

2.1.2 Formation Class

The next level below the System level is the Formation Class level. The Formation Class level is the first in a series of five levels that are used to describe the physiognomy of a vegetation type, which is characterized by a community's structure and form. The Formation Class uses structural attributes of the community including relative cover and height to separate vegetation into several categories. This level has seven classifications including forest, woodland, shrubland, dwarf-shrubland, herbaceous, non-vascular, and sparse vegetation. Forest and woodland classes include areas that are dominated by arborescent plants with the former class having generally 60 to 100% cover and the latter class having generally 25 to 60% cover. Areas that are dominated by arborescent plants that are more than ten feet high are included in forest and woodland classes. Shrubland communities include areas that are dominated by shrubs more than two feet in height while dwarf-shrubland communities include areas with shrubs that are less than two feet. Cover for these classes is typically greater than 25% but can be substantially less than 25% if shrubs are the most prominent species. Herbaceous classes include areas that are dominated by herbs which generally form greater than 25% cover. These classes, however, may have shrubs, dwarf-shrubs, and trees as components of the community. Non-Vascular classes include areas that are typically dominated by lichens, bryophytes, or algae that contribute to more than 25% of the cover for the area. Sparse vegetation classes are not well defined in the NVCS framework, however, communities of 0 to 25% cover are typically described here.

2.1.3 Formation Subclass

Leaf phenology is the primary structural characteristic that divides the forest, woodland, shrubland, and dwarf-shrubland classes into the following subclasses: evergreen, deciduous, or mixed evergreen-deciduous. Herbaceous classes are separated into subclasses described by persistence (annual or perennial) and growth form (graminoid, forb, or hydromorphic) while the relative dominance of lichens, bryophytes, or algae separate the Non-vascular classes. Sparse vegetation classes are generally described by soil type.

2.1.4 Formation Group

The formation group divides subclasses based upon leaf characteristics and macroclimatic conditions. Forest, woodland, shrubland, and dwarf-shrubland classes are typically attributed to broad-leaf, needle-leaf, xeromorphic, or microphyllous groups. Macroclimatic types for all classes include tropical or sub-tropical, temperate or sub-polar, winter-rain, drought-deciduous, or cold-deciduous. Sparse vegetation classes are typically described by landform or topographic types.

2.1.5 Formation Subgroup

This level of the NVCS divides groups into two major vegetation types including natural/semi-natural or cultural subgroups. Natural/semi-natural subgroups are areas that consist of natural, semi-natural, or modified vegetation. The cultural subgroup was identified in the NVCS to account for areas that are planted/cultivated such as orchards and vinyards. Although revegetation sites along the Wash are planted, these areas are treated in the natural/semi-natural subgroup.

2.1.6 Formation

Plant communities that have similar physiognomic features and are found along specific ranges in environmental conditions, including hydrologic conditions and topographic position are define in the formation category. Cowardin et al. (1979) hydrologic modifiers are used here. Additional physiognomic characteristics not described at the higher levels are described here.

2.1.7 Alliance

The alliance is the first of two levels in the NVCS that describes the floristic components (i.e., species) of a vegetation community. Alliances are physiognomically uniform groups of associations that are typically described by the dominant and co-dominant species of the community. When constructing alliance names, if the dominant and co-dominant species are within the same stratum they are separated by a hyphen (-) and if they are in different strata they are separated by a forward slash (/). The uppermost species in the alliance is typically listed first; however, species that are low in stature may be listed first if they are diagnostic. Once the dominant and co-dominant species have been listed for the name, the class (e.g., Forest, Woodland, Shrubland) that the alliance is within is usually listed next followed by the term "alliance" (except for Sparse Vegetation classes). If an alliance requires a hydrologic modifier, it is typically listed before the class designation. An example of an alliance name that includes a hydrologic modifier is the *Populus fremontii-Salix gooddingii* Temporarily Flooded Forest Alliance while an example of an alliance without a hydrologic modifier is the *Atriplex hymenelytra* Dwarf-Shrubland Alliance.

2.1.8 Association

Associations are the most detailed classifications in the NVCS framework. The definition of an association is "a plant community type of definite floristic composition, uniform habitat conditions, and uniform physiognomy" (Flahault and Schroter 1910). The most distinctive difference between the association and the alliance levels is that the association is often spatially limited and is often driven by unique hydrologic or edaphic conditions within an alliance. Naming conventions for associations follow the same rules as the alliance naming conventions; however, the term "alliance" is not included in the text string.

2.2 Field Surveys

Field reconnaissance surveys were conducted to confirm the presence of vegetation types that occur along the Wash. Surveys began in the fall of 2004 and continued through to the spring of 2006. Surveys were conducted to determine physiognomic and floristic attributes of vegetation communities and to record the spectral signatures of these communities. Data collected from the field helped confirm vegetation types during the aerial photointerpretation process. Moreover, field survey data were used to prepare dichotomous keys of the vegetation types.

2.2.1 Survey Plots

Several ecological sampling methods (see Barbour et al. 1999, Buckland et al. 1993) were used to determine physiognomic and floristic characteristics of vegetation communities. Data collection began in the fall of 2004 and was completed by the spring of 2005. Survey plots typically followed a relevé approach which included circular and irregular plot shapes of varying size. Transects, however, were also used but mostly to distinguish linear communities and between community boundaries. Circular plots were typically used in upland habitats consisting of shrub and dwarf-shrub plants while irregular plots were used mostly in streamside communities. Certain vegetation types (e.g., *Tamarix ramosissima* Shrubland Alliances and *Phragmites australis* Herbaceous Alliances) were not surveyed with the relevé approach; rather, surveys were conducted from the periphery of these communities with a point intercept method. Minimal survey effort was required for these areas because these site conditions could be diagnostically recognize through photointerpretation.

More than 140 plots were sampled along the Wash with most of the effort focusing on areas that were not well characterized from previous survey efforts (Shanahan and Silverman 2006) or were difficult to photointerpret. Global Positioning System (GPS) units (Trimble Navigation Limited, Sunnyvale, CA) were used to document coordinate locations of plots and to record physiognomic and floristic information from the sampled plant communities. A custom data dictionary was prepared in GPS Pathfinder Office (Trimble Navigation Limited, Sunnyvale, CA) to aid in the data collection process. The following information was collected from the sample plots; project, plot ID number, field crew, date, time, offset, plot diameter, landform, slope angle and aspect, surficial geology, soil texture, soil drainage, hydrologic regime (see Cowardin et al. 1979), disturbance level, successional state, trees present, tall shrubs present, shrubs present, low shrubs present, emergent species present, aquatic/riparian species present, perennial species present, grass/forbs present, annual herbs present, NVCS formation class, NVCS formation subclass, NVCS alliance (dominant/co-dominant species), NVCS association, and up to five dominant species for which cover (Braun-Blanquet cover classes), associativity, canopy type, and height were recorded. These attributes were modified depending on the plot type. For example, irregular boundary plots would not require an entry under the plot diameter heading. Survey plot data was loaded into a GIS database and was used during the photointerpretation process. Moreover, surveyed locations were used as training sites for calibrating vegetation classifications that were prepared.

2.2.2 Spectral Radiometer

Spectral signatures for several plant species were collected with a Cropscan MSR-16 multispectral radiometer (Cropscan, Inc., Rochester, MN) and a FieldSpec Pro (Analytical Spectral Devices, Inc., Boulder, CO) hyperspectral radiometer. The Cropscan MSR-16 radiometers can accommodate up to 16 bands of incident or reflected electromagnetic radiation in wavelengths between 450 and 1,750 nanometers (nm) while the FieldSpec Pro collects a wider range of spectral information between 350 and 2,500 nm. Coordinate locations were documented for each location where the radiometers were used. Moreover, data were downloaded and compiled into graphs consisting of percent reflectance on the y-axis and wavelength on the x-axis. These graphs were used to evaluate the uniqueness of the reflectance signatures for the different species. If signatures were determined to be unique, these data were used to facilitate the photointerpretation process.

2.3 Geographic Information Systems and Remote Sensing

Maps are important tools that are used by scientists, engineers, and planners. For example, a map that depicts wetland marsh habitats along the Colorado River would be helpful for a wildlife biologist who is evaluating the occurrence and status of the federally endangered Yuma clapper rail (*Rallus longirostris yumanensis*) in that area. Although hand-drawn maps were historically common, new tools have been developed to facilitate modern cartography. One of these tools is

GIS, a combination of computer software and hardware, which is used to display, manage, and analyze spatial data. Increasingly, GIS is the standard tool of choice for map making.

To produce high-quality maps, spatial (vector and raster) and non-spatial data (attributes) are typically used. Data that exhibit physical dimension as points, lines, or polygons are considered vector data while raster information consists of data that are in rows or columns (gridded) such as in a digital image. Remote sensing, which is considered to be the detection, recognition, or evaluation of reflected or emitted electromagnetic energy from airborne or space platforms (Hallert 1960), is a common method for acquiring raster data. Although this study has used GIS tools to interpret spatially referenced raster and vector data, non-spatial information has been used to describe the quantitative and qualitative attributes of the land cover types found along the Wash.

2.3.1 Tools

Several computer software tools were used to prepare maps of the vegetation types that occur along the Wash. ArcInfo versions of ArcCatalog 9.2 and ArcMap 9.2 (ESRI, Redlands, CA) were used to display, manage, and analyze most of the mapping data. Combined, these software programs are part of and an integrated collection of tools within the ArcGIS framework. Raster data processing and interpretation was completed with the ERDAS Imagine 9.0 (Leica Geosystems, Norcross, GA) software. The Feature Analyst for ERDAS Imagine add-on was used to extract feature information from raster data. ENVI 4.3 (ITT Visual Information Solutions, Boulder, CO) was also used to analyze raster data and to visualize spatial data. AutoCAD 2005 (Autodesk, San Rafael, CA) was used to evaluate planimetric data.

2.3.2 Spatial Data

Several spatial datasets were used to prepare land cover classifications along the Wash. Both orthorectified raster and georeferenced vector data were helpful in evaluating existing and past conditions. The most important data that were used included a combination of digital images that were collected in the fall of 2005 and spring of 2006. Fixed wing aerial imagery of the Wash was collected on November 5, 2005 and May 23, 2006. The first flight acquired color imagery at a six inch resolution (i.e. pixel size represents six inches on the ground). The second flight acquired hyperspectral imagery with VNIR and SWIR sensors (SpecTIR, Easton, MD). The VNIR sensor collected spectral data from 400 to 990 nm and the SWIR sensor collected data from 970 to 2,450 nm for more than 250 bands. Because of flight altitude restrictions, hyperspectral imagery had a resolution of nine feet per pixel. Using an integrated approach, several vector datasets were used in conjunction with the raster data. Soil survey data prepared by the Natural Resources Conservation Service was used to help make classifications in the NVCS framework. Planimetric surface elevation data which was created in AutoCAD was converted into a spatial database and used to define desert washes, roads, and other features in the study area. Planimetric data was also helpful in estimating flood frequency, which facilitated hydrologic classifications.

2.3.3 Photointerpretation

Photointerpretation was used to delineate vegetation community boundaries in the study area. Because this process was iterative, GIS analysts and biologists worked closely together to resolve classification anomalies. The results of each step informed and directed the methods used in the next step. After obtaining a comprehensive spatial dataset, the first step in the photointerpretation process was to load the sampling plot data into the GIS. Viewing the sampling plot data across the study area helped define the "search image" characteristics of the vegetation communities. Moreover, sampling plots were helpful in setting up training sites that were used in the raster analyses. These data were re-evaluated during each step so that the resulting classification was consistent with the field conditions. Spectral radiometer data was also used to define "search image" characteristics and it too was re-evaluated as classifications were prepared. Towards the beginning of the raster classification process, easily distinguished land cover types such as open water, trails/roads, and facilities were separated out using the planimetric data. Vegetation classification was achieved much more efficiently by incorporating this step. Unsupervised classifications were then prepared for both the color infrared and hyperspectral imagery. These classifications were prepared using between 6 and 12 categories until the classification closely represented the field conditions. For communities that were not well represented in the unsupervised classification, supervised classifications were prepared. Input data for the supervised classifications included observational, sample plot, and spectral radiometer data. Although the color and hyperspectral imagery were both used, these data offered different levels of usefulness. For example, the color imagery was used to evaluate boundaries while the hyperspectral imagery was used to classify species signatures. After the major classifications were prepared, heads-up digitizing was used to refine community boundaries.

2.4 Accuracy Assessment

Statistically significant accuracy assessment procedures (see TNC and ESRI 1994) were not used for the final mapping product because of the relatively small size of the study area, extensive familiarity of the study area by the authors, and minimal cover types. Rather, an observational stepwise validation procedure was used to determine the accuracy of the classification. Once the final map was completed, field reconnaissance was performed in the winter of 2006 and spring of 2007 to validate land cover types. Classified cover types that were not consistent with field conditions were re-interpreted with the methods described.

2.5 Waters of the U.S. Determination

Significant hydrologic alterations have taken place along the Wash since the last known wetland delineations were done on a large scale in this area. These historic data have been compiled and are presented in the results section of this report. Because wetlands are protected by a variety of laws, regulations, and executive orders, it is important to identify where these areas currently exist. Therefore, a wetland determination was conducted according to the U.S. Army Corps of Engineers (Corps) wetland delineation manual (Environmental Laboratory 1987). For these purposes, wetlands are defined as "areas that are inundated or saturated by surface or ground water 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" (Environmental Laboratory 1987). Because of the vast amount of spatial data available and extensive knowledge of the study area by the authors, routine determination procedures were used for delineating wetlands. This information will help with various ecological restoration initiatives implemented along the Wash and the long term conservation of these important areas (see the Nevada Wetlands Priority Conservation Plan 2006). Although wetlands were delineated within the study area, these areas are only one component of the jurisdictional waters of the U.S. (WOUS) that are within the Corps authority to regulate. For example, the Corps regulates the discharge of dredged or fill material into wetlands, deepwater areas, and flood zones that are typically inundated by the two to five year flood event as identified by the presence of an ordinary high water mark. For planning purposes, WOUS, including wetlands, have been delineated. Because field level studies were not completed for these areas, these data should be used as a first step in determining if an area is jurisdictional.

3.0 RESULTS AND DISCUSSION

A variety of datasets were used to facilitate land cover classification along the Wash. For example, soil survey data from the Natural Resources Conservation Service and wetland data from the U.S. Fish and Wildlife Service (FWS) were used. Classifications that were previously prepared by others in the NVCS framework were also helpful. These data are included below for reference purposes and to facilitate ecological restoration planning activities. The results of this study show that there are several land cover types within the approximately 2,878 acre study area. Unvegetated and sparsely vegetated cover types include open water areas and areas that have been disturbed by humans or by natural processes such as flooding. Unvegetated cover types include slightly more than 15% of the study area with the remaining cover types being vegetated. Plant species that were documented by Shanahan and Silverman (2006) were attributed to the land cover types described herein (Appendix A).

3.1 Unvegetated and Sparsely Vegetated Cover Types

Several cover types occur along the Wash that are either unvegetated or sparsely vegetated (see Appendix B for a dichotomous key to the major formation classes and Appendix C for a map of the major land cover types). These areas include 435 acres within the study area and are much less extensive then the vegetated cover types.

3.1.1 Open Water

Open water cover types are found where surface water from the Wash and other tributaries is visible and not obstructed by vascular plant cover (Appendix C). Approximately 77 acres (2.67% of the study area) of open water are found in the study area. These areas consist of shallow riffles and deepwater pools and runs. Several large open water impoundments are found behind rock structures that have been constructed in the Wash to prevent erosion. As additional erosion control structures are built, open water is expected to increase in aerial extent. Combined with peripheral shallow water areas, open water is important for a variety of wildlife including all of the fish found in the Wash (Shanahan 2005).

3.1.2 Disturbed Area – Human

Several areas that are disturbed as a result of human actions are found in the study area (Appendix C). Disturbed areas typically include roads, trails, buildings, or other human made features and these areas contribute 329 acres or 11.44% of the study area. The most destructive of these disturbances results from illegal off road usage on the north side of the Wash. Dirt bikes, quads, and other all terrain vehicles have denuded vegetation in many upland habitats (pers. obs.). Some of the most destroyed habitats include areas of gypsiferous soils which support an extensive colony of the critically endangered Las Vegas bearpoppy (*Arctomecon californica;* Figure 2; Shanahan and Silverman 2006). Dozens of roads crisscross upland areas, further destroying substrate integrity and fragmenting habitats. Other types of human disturbance that are found in the study area include activities associated with the construction of erosion control structures. These projects require rock stockpiling sites and construction lay down yards. Disturbed areas like these are temporary since active revegetation occurs when projects are completed.

Figure 2: Off-highway vehicle disturbance in Las Vegas bearpoppy habitat.

3.1.3 Disturbed Area – Natural

Naturally disturbed areas are found mostly along the active stream channel and only contribute 29 acres or 1.01% of the study area (Appendix C). These areas include point bars, gravel deposits, and other redistributed channel sediments with minimal or no vegetation cover. These areas are disturbed as a result of periodic flooding and therefore are constantly changing. Depending on when flooding has occurred, vegetation may be present in several or more seral stages. A variety of species may be found on these sites including forbs, graminoids, and woody taxa (Figure 3). Examples of species that are found in these areas include cocklebur (*Xanthium strumarium*), common reed (*Phragmites australis*), cattail (*Typha domingensis*), sunflower (*Helianthus annuus*), dock (*Rumex stenophyllus*), Bermuda grass (*Cynodon dactylon*), and nutsedge (*Cyperus esculentus*). Over time these areas may transition towards vegetation communities described elsewhere in the NVCS framework. For example, willow (*Salix* spp.) seedlings may be found on post-flooded sites as a minor vegetation component, however, with time they may become dominant.

Figure 3: Recent germination by cocklebur, Goodding's willow, and salt cedar on a recently created sandbar as a result of flooding.

3.2 Vegetated Cover Types

Vegetated cover types include 2,443 acres or nearly 85% of the study area (see Appendix B for a dichotomous key to the major formation classes and Appendix C for a map of the major land cover types). Only the major vegetated land cover types could be mapped. Several major physiognomic types are found within the study area; they include forest, woodland, shrubland, dwarf shrubland, and herbaceous types. The shrubland formation class is the most extensive vegetation cover type and the forest formation class is the least extensive cover type. Boundaries between the formation classes are often obscured because of the subtle transitions in hydrology, topography, or soils that are in the landscape.

3.2.1 Forest Formation Class

The forest formation class is the least extensive class in the study area with only ten acres (0.36% of the study area) represented. Forest areas are dominated by trees generally greater than ten feet tall and are typically found near the Wash channel. The *Populus fremontii-Salix gooddingii* Temporarily Flooded Forest Alliance is the only forested alliance found in the study area.

3.2.1.1 *Populus fremontii-Salix gooddingii* Temporarily Flooded Forest Alliance (Cottonwood-Willow Riparian Forest)

This alliance is characterized by two co-dominant taxa, the Goodding's willow (*Salix gooddingii*) and the cottonwood (*Populus fremontii*; Figure 4). Although these species are often found together in this community, they may occur singly. These species are generally found close to the water's edge or where depth to groundwater is within 15 feet. Trees are generally 30 to 35 feet tall depending on age and location. Associated species often include shrubs such as the sandbar willow (*Salix exigua*), Emory baccharis (*Baccharis emoryi*), seepwillow (*Baccharis salicifolia*), and arrowweed (*Pluchea sericea*). A variety of herbaceous species are also found in this alliance including yerba mansa (*Anemopsis californica*), horseweed (*Conyza* spp.), salt heliotrope (*Heliotropium curassavicum*), and sunflower. Most of these areas are a result of active restoration activities; however, many areas that have not been actively planted have Goodding's willow seedlings on them. In contrast, very few cottonwood seedlings have been found along the Wash. Areas where this alliance is most extensive include downstream of the Pabco Road Weir and on the Bostick Weir.

Figure 4: *Populus fremontii-Salix gooddingii* Temporarily Flooded Forest Alliance.

3.2.2 Woodland Formation Class

Two associations are classified within the woodland formation class, the *Prosopis* spp. Woodland Association and the *Acacia greggii* Woodland Association. Most often, these associations are included within the *Larrea tridentata* Shrubland Alliance along washes and other drainages, however, with active restoration of the floodplain, these associations can be found in areas bordering the *Atriplex* spp. Shrubland Alliance and the *Populus fremontii-Salix gooddingii* Temporarily Flooded Forest Alliance.

3.2.2.1 *Prosopis* spp. Woodland Association (Mesquite Woodland)

The *Prosopis* spp. Woodland Association is dominated by the presence of honey mesquite (*Prosopis glandulosa* var. *torreyana*) or screwbean mesquite (*P. pubescens*) and is found in two different kinds of areas. Along major washes or other drainages in the *Larrea tridentata* Shrubland Alliance, a well developed woodland of honey mesquites is often present. These woodland communities are linear and honey mesquite is generally no taller than 15 feet. Salt cedar (*Tamarix ramosissima*) is a common sub-dominant to nearly co-dominant species in this association and several wash type species are also found therein. Honey mesquite woodlands are often well defined, however, they are not extensive. In other areas, mesquite woodlands can be found near the Wash channel. As soil hydrology increases, screwbean mesquite tends to be more prevalent than honey mesquite, however, with active restoration obscuring the natural sorting of these species, these communities are defined at the genus level. Isolated patches of this woodland association are also found within the *Atriplex* spp. Shrubland Alliance and the *Distichlis spicata* Intermittently Flooded Herbaceous Alliance. Mesquites that are present in saltgrass (*Distichlis spicata*) dominated communities are relatively rare but are important sources of forage habitat for the phainopepla (*Phainopepla nitens*). Around five acres or 0.18% of the study area could be classified in the *Prosopis* spp. Woodland Association, however, the extent of this association is much greater.

3.2.2.2 *Acacia greggii* Woodland Association (Catclaw Wash Scrub)

The *Acacia greggii* Woodland Association is closely related to the *Prosopis* spp. Woodland Association. It occurs in a variety of drainages from narrow bajada drainages to broad washes, but generally all are steep or very well-drained (Figure 5). This association is characterized by catclaw (*Acacia greggii*) as a prominent tall arborescent shrub, though rarely is it the dominant relative cover species in this association. Often this species is less than 15 feet tall, however, this species has been reported to reach heights greater than 35 feet. In other upland wash drainage systems in the study area, catclaw is an occasional associate and where sections of drainage support them in a regular or clustered distribution, this association is defined. Many of the same wash type species found in the mesquite woodland areas are also found in this association. These species include honey mesquite, galleta grass (*Pleuraphis rigida*), white bursage, wolfberry (*Lycium andersonii*), and at lower zones, fourwing saltbush (*Atriplex canescens*) and desert saltbush (*A. polycarpa*) are often associates. Catclaw woodlands occur strictly within the *Larrea tridentata* Shrubland Alliance.

Figure 5: ***Acacia greggii*** **Woodland Association.**

3.2.3 Shrubland Formation Class

The shrubland formation class is the most extensive vegetation type (2,105 acres or more than 73%) found in the study area (Appendix C). Within this class three major alliances are found including the *Larrea tridentata* Shrubland Alliance, *Atriplex* spp. Shrubland Alliance, and the

Tamarix ramosissima Shrubland Alliance. One other shrubland alliance is found along the Wash but to a lesser extent, the *Salix exigua* Temporarily Flooded Shrubland Alliance. Considerable overlap is observed at the boundaries of these communities with species commingling frequently and often persistently. Hydrologic and edaphic conditions appear to be the primary drivers that sort these communities in the study area. For example, the *Salix exigua* Temporarily Flooded Shrubland Alliance is the most hydric of the communities and along with the *Tamarix ramosissima* Shrubland Alliance they are most often found bordering the Wash while the *Atriplex* spp. Shrubland Alliance is a more mesic transitional community that gradates into the xeric *Larrea tridentata* Shrubland Alliance. Ten major associations are found within the various shrubland alliances.

3.2.3.1 *Salix exigua* Temporarily Flooded Shrubland Alliance (Sandbar Willow Riparian Scrub)

This alliance is dominated by the cold-deciduous shrub sandbar willow and is the most hydric of the shrubland alliances, often only found within several feet of the water's edge (Figure 6). These areas are a part of the wetland mosaic with species from adjacent communities commonly intergrading to become substantial cover components. On the wetland edges, cattails, common reed, tules, or other bulrush are most often found while on the mesic edges, quailbush (*Atriplex lentiformis*) and arrowweed are common. Often large trees (Goodding's willow and cottonwood) are found singly and sporadically as overstory components.

Figure 6: *Salix exigua* Temporarily Flooded Shrubland Alliance.

Understory herbaceous material often consists of various native, naturalized, or weedy species from the Asteraceae, Poaceae, and Chenopodiaceae. Two acres (0.05% of the study area) are mapped as part of the *Salix exigua* Temporarily Flooded Shrubland Alliance (Appendix C). However, the extent of sandbar willow in the study area is substantially greater than represented by the mapped units.

3.2.3.2 *Atriplex* spp. Shrubland Alliance (Saltbush Scrub)

The *Atriplex* spp. Shrubland Alliance (769 acres or 26.72% of the study area) consists of four associations that are typically dominated by quailbush, fourwing saltbush, desert saltbush, or shadscale (*Atriplex confertifolia;* Figure 7). The first three associations are considered true shrublands dominated by plants greater than two feet tall or at least those species are more prominent. These associations are described in this section, however, associations dominated by shadscale are described in the dwarf shrubland section of this report. This alliance is typically found as a transitional zone between hydric and xeric communities. The community is found on both sides of the Wash and along the main channel of the Wash, quailbush is one of the most common saltbush species. Leading away from the channel, fourwing saltbush, desert saltbush, and shadscale are typically found. These species often occur within drainages and low-lying alluvial areas in the *Larrea tridentata* Shrubland Alliance. Several other species are found in these areas including species from the Chenopodiaceae family.

Figure 7: *Atriplex* spp. Shrubland Alliance.

3.2.3.3 *Atriplex lentiformis* Shrubland Association (Quailbush Thicket)

The *Atriplex lentiformis* Shrubland Association is a subcomponent of the *Atriplex* spp. Shrubland Alliance where dense monocultural stands of quailbush dominate. These areas are found close to the Wash often adjoining or commingling with the *Tamarix ramosissima* Shrubland Alliance and the *Bassia hyssopifolia* Herbaceous Association (Figure 8). Plant height often exceeds six feet tall forming large nearly impenetrable thickets. Most of these communities lay on the historical floodplain of the Wash and on adjacent terraces, however, with adequate hydrology this species is opportunistically found in disturbed areas. Although the *Atriplex lentiformis* Shrubland Association is exceptional habitat for a variety of native birds (emberizids and gnat catchers), it quickly colonizes newly disturbed areas that are reserved for restoration efforts. Regardless of management activities to reduce the extent of quailbush in these areas, it often persists. Depending on substrate type, several other plants occur along the edges of this association including, salt heliotrope and horseweed. This association consists of 117 acres or around 15% of the *Atriplex* spp. Shrubland Alliance (Appendix C).

3.2.3.4 *Atriplex canescens* Shrubland Association (Fourwing Saltbush Scrub)

Within the greater *Atriplex* spp. Shrubland Alliance the *Atriplex canescens* Shrubland Association is discontinuous, often grading into washes and other drainages in the *Larrea*

Figure 8: *Atriplex lentiformis* Shrubland Association in the foreground and the *Tamarix ramosissima* Shrubland Alliance in the background. The Disturbed-Natural land cover type is also represented between the two communities.

tridentata Shrubland Alliance. This association is dominated by fourwing saltbush, however, other species may contribute significantly to cover. These species include shadscale, creosote bush, wolfberry, white bursage, and a variety of other Chenopodiaceae shrubs. Along drainages, mesquite, catclaw, and sometimes salt cedar are found in abundance. Typically, this association occurs on the north side of the study area, but it can be found in isolated areas on the southeast corner of the study area

3.2.3.5 *Atriplex polycarpa* Shrubland Association (Desert Saltbush Scrub)

The *Atriplex polycarpa* Shrubland Association is dominated by desert saltbush (allscale), however, creosote bush, bush seepweed (*Suaeda moquinii*), and other Chenopodiaceae shrubs are often important components of cover (Figure 9). Cumulative cover often exceeds 50%. This association is a well defined community that is found southeast of the Duck Creek channel within the study area. Moreover, the association is found near the Burns Street drainage channel that enters the study area to the west of the City of Henderson Water Reclamation Facility. Historically this association appears to be much more extensive, however, various facilities appear to have been built on this community. This community is bordered by the *Tamarix ramosissima* Shrubland Alliance and the *Larrea tridentata* Shrubland Alliance.

3.2.3.6 *Larrea tridentata* Shrubland Alliance (Creosote Bush Scrub)

This alliance occurs within the project area on most of the upland terrain not subject to seasonal or intermittent inundation or prolonged raised water tables. It is the most widespread vegetation type for upland terrain in Southern Nevada and is the most extensive land cover type in the study

Figure 9: *Atriplex polycarpa* Shrubland Association.

area (954 acres or 33.14%; Appendix C). It is characterized by creosote bush, a sparsely-leafed shrub that can vary in height depending on local water availability, soil-root depth and watershed type (Figure 10). It is among the most homogenously distributed plant species in North America and typically occurs as evenly-spaced individuals independent of most terrain and soil types. Nearly every upland plant species in the project area, at least in some localized microhabitat type, can occur within this alliance.

Many species are associated with this alliance including, white bursage, indigo bush (*Psorothamnus fremontii*), saltbush, desert senna (*Senna armata*), Torrey ephedra (*Ephedra torreyana*), and cactus (*Opuntia* spp.) among others. This alliance is found in xeric areas on the north and south side of the Wash. On terraces, banks, or other high points, this alliance can be found substantially intruding into the *Atriplex* spp. Shrubland Alliance. Associated species adapted to the various topographies, soil types, and surficial features found within this alliance help define the associations found therein. For example, with the predominance of subshrubs like desert holly (*Atriplex hymenelytra*) or white bursage, portions of this alliance are classified as dwarf shrublands at the association level. Moreover, specific soil types such as the high gypsiferous soils found in the north central portion of the study area harbor unique species including Las Vegas bearpoppy, sandpaper plant (*Petalonyx nitidus*), Palmer’s phacelia (*Phacelia palmeri*), and naked-stemmed sunray (*Enceliopsis argophylla*). Various drainages that dissect this alliance also harbor unique communities including the *Larrea tridentata* Wash Shrubland Association, *Prosopis* spp. Woodland Association, *Acacia greggii* Woodland

Figure 10: *Larrea tridentata* Shrubland Alliance. An *Ambrosia dumosa/Larrea tridentata* Dwarf Shrubland Association grading into a *Pleuraphis rigida* Herbaceous Association is visible in the foreground.

Association, and the *Pleuraphis rigida* Herbaceous Association. The *Larrea tridentata* Shrubland Alliance has been impacted heavily by OHV usage causing some areas to be described elsewhere in this classification framework. One of the primary reasons for this is likely the perceived sparseness of vegetation often found in this alliance. Contrary to this, however, the *Larrea tridentata* Shrubland Alliance is the most botanically rich of all the alliances in the study area (Shanahan and Silverman 2006). A diverse assemblage of annual forbs and herbs characterize many of the areas within this alliance.

3.2.3.7 *Larrea tridentata* Shrubland Association (Creosote Bush Pure Stand)

The *Larrea tridentata* Shrubland Association is a component of the *Larrea tridentata* Shrubland Alliance and is distinguished from other associations by the lack of co-dominant or other prominent associated species. Often this association is found on rocky slopes or pavement ridges with perennial associate species nearly absent. Topography and surficial substrates appear to limit the occurrence of species that are normally associated with this community. Various forbs and herbs are found in this association including plants from the Hydrophyllaceae, Boraginaceae, and Polygonaceae families.

3.2.3.8 *Larrea tridentata/Ambrosia dumosa* Shrubland Association (Creosote Bush-Bursage Scrub)

The *Larrea tridentata*/*Ambrosia dumosa* Shrubland Association is dominated by creosote bush in the shrub layer and white bursage in the dwarf shrub layer with creosote bush contributing the most amount of cover (Figure 11). Often this community transitions into the *Ambrosia dumosa*/*Larrea tridentata* Dwarf Shrubland Association as white bursage cover increases. In fact, these two associations consist of the same species and generally in the same densities. Therefore, the major distinguishing characteristic between them is the percent composition of cover that is attributed to either species. The *Larrea tridentata*/*Ambrosia dumosa* Shrubland Association is one of the most abundant communities in the Mojave Desert and it appears to be well represented within the *Larrea tridentata* Shrubland Alliance. This association contains many of the xeric species found in adjacent associations. This association occurs mostly on bajada ridges and terraces, above coalescing drainages. It is also common on some rocky slopes and in shallow drainages of low diversity and weak watershed potential. Many other woody species, primarily dwarf shrubs, can be included as lesser relative cover, especially range rhatany (*Krameria erecta*), wolfberry, and occasionally shadscale or desert holly. Perennial herbs are rare in this association and annual plant species are generally sparse, except under shrubs.

Figure 11: *Larrea tridentata/Ambrosia dumosa* Shrubland Association.

3.2.3.9 *Larrea tridentata* Wash Shrubland Association (Creosote Bush Wash Scrub)

The *Larrea tridentata* Wash Shrubland Association is distinguished from other co-associations in the *Larrea tridentata* Shrubland Alliance by the presence of washes and other drainages (Figure 12). Because of the unique characteristics of these areas, namely the conveyance and

Figure 12*:* *Larrea tridentata* Wash Shrubland Association.

retention of surface water, various species besides creosote bush are found here. The *Larrea tridentata* Wash Shrubland Association is typically a weekly defined association that gradates along zones of elevation and moisture. For example, this association is often in upper desert wash reaches that are moderately defined. Mesquites and catclaw are absent from this association, however, the *Prosopis* spp. Woodland Association and *Acacia greggii* Woodland Association may be found in lower reaches of the same drainages that define the *Larrea tridentata* Wash Shrubland Association. The most common associated species in this association are cheese bush (*Ambrosia [Hymenoclea] salsola*), white bursage, Torrey ephedra, and wolfberry. Perennial herbs are rare in this association and annual plant species are generally absent, except under shrubs and along banks or alluvial terraces.

3.2.3.10 *Larrea tridentata-Atriplex* spp. Shrubland Association (Creosote Bush-Saltbush Scrub)

The *Larrea tridentata-Atriplex* spp. Shrubland Association is a transitional association between two major alliances, the *Larrea tridentata* Shrubland Alliance and the *Atriplex* spp. Shrubland Alliance. This transitional zone is co-dominated by creosote bush and saltbush which distinguishes it from other associations (Figure 13). Most often, fourwing saltbush, shadscale, or desert saltbush are the dominant saltbush species present. Species that are found in either alliance can be found in this association.

Figure 13: ***Larrea tridentata-Atriplex*** **spp. Shrubland Association.**

3.2.3.11 *Tamarix ramosissima* Shrubland Alliance (Salt Cedar Thicket)

The presence of the cold deciduous arborescent-like salt cedar shrub strongly defines the *Tamarix ramosissima* Shrubland Alliance. This alliance consists of two associations, the *Tamarix ramosissima-Atriplex lentiformis* Shrubland Association and the *Tamarix ramosissima*/ *Phragmites australis* Shrubland Association. This alliance consists of 381 acres or 13.23% of the study area and it is most often bordered by the *Atriplex* spp. Shrubland Alliance and various permanently to semipermanently flooded herbaceous alliances (Appendix C). Salt cedar is a non-native multi-stemmed woody shrub that is common to most riparian waterways in the western U.S. In some parts of the study area, salt cedar is greater than 25 feet tall which resembles woodland and forest class like characteristics, however, most commonly it is found as a shrubby plant less than 15 feet tall. Moreover, this alliance is often a monoculture with minimal species able to coexist in stand interiors (Figure 14). With suitable hydrology, however, horseweed appears to do exceptionally well in these areas. This alliance is found almost exclusively near the Wash. Because salt cedar is a facultative phreatophyte, it is able to tolerate periods of groundwater depletion. Although a water regime modifier (Cowardin et al. 1978) can be used to describe this alliance, salt cedar is often present in multiple water regimes. For example, salt cedar typically establishes in wet to moist conditions that are classified by Cowardin et al. (1978) as temporarily flooded. This is true for salt cedar stands that are nearest the Wash. Unusually, however, there are several terraced areas that contain relict salt cedar stands that first established in the active Wash floodplain before it was incised by 30+ feet in the 1970s through 1990s. These areas no longer receive regular surface water inundation and therefore would be more appropriately classed as intermittently flooded. For the purpose of this land cover analysis, salt cedar dominated areas are not classified with a water regime modifier, however, temporarily or intermittently flooded water regime modifiers are the most appropriate.

Figure 14: *Tamarix ramosissima* Shrubland Association.

3.2.3.12 *Tamarix ramosissima-Atriplex lentiformis* Shrubland Association (Salt Cedar-Quailbush Thicket)

The *Tamarix ramosissima-Atriplex lentiformis* Shrubland Association is distinguished from other salt cedar associations by the co-dominance of quailbush in the shrub layer. Often quailbush is found as an understory component within a mosaic of clumped salt cedar stands. Less common is a homogeneously regular distribution of these two species. At the borders of this association, various *Atriplex* spp. Shrubland Alliance associations can be identified. One of which, the *Atriplex lentiformis* Shrubland Association, is difficultly distinguished since salt cedar is often a component of that association. This association is not species rich, with most of the species present attributed to the Chenopodiaceae family. Alluvial flats and terraces are the most common locations for this association.

3.2.3.13 *Tamarix ramosissima/Phragmites australis* Shrubland Association (Salt Cedar-Common Reed Thicket and Marsh)

Towards the waters edge, or where groundwater elevation is high, the *Tamarix ramosissima/Phragmites australis* Shrubland Association is found. This association is the wettest of the salt cedar associations and is characterized by an understory of common reed. Most often other species are not present in this association, however, if there are other species present, they often include quailbush. This association is generally the youngest of the associations and is often bordered by various permanently to semipermanently flooded herbaceous alliances.

3.2.4 Dwarf Shrubland Formation Class

Four association level communities are classified in the dwarf shrubland formation class. These communities are dominated by plants that are generally less than two feet tall or they are at least most prominent. Two of these associations, the *Atriplex hymenelytra* Dwarf Shrubland Association and the *Ambrosia dumosa/Larrea tridentata* Dwarf Shrubland Association are within the *Larrea tridentata* Shrubland Alliance. The other two associations, the *Atriplex confertifolia* Dwarf Shrubland Association and the *Allenrolfea occidentalis* Intermittently

Flooded Dwarf Shrubland Association are within the *Atriplex* spp. Shrubland Alliance and the *Distichlis spicata* Intermittently Flooded Herbaceous Alliance, respectively.

3.2.4.1 *Atriplex hymenelytra* Dwarf Shrubland Association (Desert Holly Scrub)

This association refers to vegetation stands where desert holly is co-dominant or locally exceeding creosote bush in cover (Figure 15). It is a sparse dwarf shrub formation, typically on terrace or ridge landforms, often on limiting substrate types that are shallow in available root depth, heavily mineralized or expansive-friable. In the northeast corner of the project area, this association includes beavertail cactus (*Opuntia basilaris*) as a common associate. Other common associates include range rhatany and white bursage. Several herbs and forbs including the rare Talus phacelia (*Phacelia petrosa*) are found in this association. This community is within the *Larrea tridentata* Shrubland Alliance.

Figure 15: *Atriplex hymenelytra* Dwarf Shrubland Association.

3.2.4.2 *Ambrosia dumosa/Larrea tridentata* Dwarf Shrubland Association (Bursage-Creosote Bush Scrub)

The *Ambrosia dumosa/Larrea tridentata* Dwarf Shrubland Association typically occurs along shallow drainages in mid-bajada settings, mostly north of the Wash (Figure 16). It is characterized by dense narrow stands of white bursage, with creosote bush associated in a dwarf-like shrub form. Other common associates include range rhatany, wolfberry, Torrey ephedra, desert holly, and opuntioid cacti (*Cylindropuntia echinocarpa* and *Opuntia basilaris*). An isolated catclaw is often present. Galleta grass is a common perennial herb in this association, with others such as larkspur (*Delphinium parishii*), globe mallow (*Sphaeralcea ambigua*), and small-flowered androstephium (*Androstephium breviflorum*) occasional. Annuals tend to be varied, but restricted closely to the shrub bases. Beadpod (*Lesquerella tenella*) seems to prefer this vegetation type. Other phases of dense white bursage stands occur as isolated patches on some rocky slopes and in shallow drainages of low diversity and weak watershed potential, but

Figure 16: *Ambrosia dumosa/Larrea tridentata* Dwarf Shrubland Association.

without a regular composition. Often this community transitions into the *Larrea tridentata*/*Ambrosia dumosa* Shrubland Association as creosote bush cover increases.

3.2.4.3 *Allenrolfea occidentalis* Intermittently Flooded Dwarf Shrubland Association (Iodinebush Alkaline Meadow)

The *Allenrolfea occidentalis* Intermittently Flooded Dwarf Shrubland Association is dominated by iodinebush (*Allenrolfea occidentalis*). This community is characterized by high depth to water and elevated soil salinity. Soil salinity in this association is typically greater than the *Distichlis spicata* Intermittently Flooded Herbaceous Alliance for which this association is a subcomponent. Saltgrass, bush seepweed, sea lavender (*Limonium californicum*), mist grass (*Muhlenbergia asperifolia*), and alkali sacaton (*Sporobolus airoides*) are native associates typical of this association. Other species present within this association but to a lesser amount include salt cedar and common reed. Typically, the presence of elevated soil salinity prohibits the encroachment of other species.

3.2.4.4 *Atriplex confertifolia* Dwarf Shrubland Association (Shadscale Scrub)

The *Atriplex confertifolia* Dwarf Shrubland Association is found within the greater *Atriplex* spp. Shrubland Alliance. This association is found on sloped terraces of lower bajada areas. Generally shadscale and other Chenopodiaceae shrubs form sparse vegetation cover and are found on well-drained calcareous soils. This association is often found along the downstream edges of the *Larrea tridentata* Shrubland Alliance and between wash type associations of the *Atriplex* spp. Shrubland Alliance.

3.2.5 Herbaceous Formation Class

The herbaceous formation class is divided between graminoid and forb formations with hydrology and nativity further defining the formation. Four graminoid formations are found within this class including the perennial graminoid formation, semipermanently flooded perennial graminoid formation, permanently flooded perennial graminoid formation, and the intermittently flooded perennial graminoid formation. Two forb formations are found within this class including the annual forb formation and the non-native annual forb formation. Alliances and associations are further described. This formation class consists of 322 acres or 11.2% of the study area.

3.2.5.1 Graminoid Formations

Four alliances and one association are found in the graminoid formation including the *Pleuraphis rigida* Herbaceous Association, *Schoenoplectus* spp. Permanently to Semipermanently Flooded Herbaceous Alliance, *Typha domingensis* Permanently Flooded Herbaceous Alliance, *Phragmites australis* Semipermanently Flooded Herbaceous Alliance, and the *Distichlis spicata* Intermittently Flooded Herbaceous Alliance.

3.2.5.1.1 *Pleuraphis rigida* Herbaceous Association (Galleta Grass Wash)

This association occurs within the *Larrea tridentata* Shrubland Alliance, mostly north of the Wash. It is a mixed formation of herbaceous and woody species as cover dominants that is characterized by a single robust caespitose grass species (galleta grass) homogeneously distributed among a mix of shrub and subshrub species. These types of grass stands are restricted in the study area to shallow rocky drainages, minor washes or washlet tributaries in upland terrain. A surficial layer of loose sandy soil is usually present in the channel bottom. Within the study area, the *Pleuraphis rigida* Herbaceous Association typically includes several subshrub species such as white bursage, range rhatany, Torrey ephedra and desert senna. Creosote bush is typically associated in the drainages and surrounding slopes as a broader alliance-type vegetation formation.

Within the drainage systems, the *Pleuraphis rigida* Herbaceous Association grades into more open wash systems with larger shrubs, including phases that could be typed as mesquite-catclaw "strand" woodlands. The upstream transition of the *Pleuraphis rigida* Herbaceous Association grades into more rocky drainages with similar subshrub species, often as a weakly defined *Ambrosia dumosa-Krameria erecta* association or into more abrupt and barren drainages as *Larrea tridentata* Shrubland Alliance. This association is among the most botanically diverse terrestrial habitats within the project area and often includes a wide variety of other, more weakly associated woody and herbaceous plant species. Within the project area and in Southern Nevada in general, this habitat is the preferred foraging habitat of the desert tortoise (*Gopherus agassizii*).

3.2.5.1.2 *Schoenoplectus* spp. Permanently to Semipermanently Flooded Herbaceous Alliance (Tule Marsh)

This alliance occurs within the study area in the primary channel and back waters of the Wash (Appendix C). It is a tall herbaceous formation of "tule" type species (*Schoenoplectus acutus* and *S. californicus*) as dense cover dominants in patchy pure stands introduced through revegetation sites (Figure 17). The alliance is mostly characterized by the common tule (*S. acutus*). These stands occur mostly on banks and shallow sand bars in the study area in a variety of soil textures in various wetland development stages, though mostly seral. Within the study area, the *Schoenoplectus* spp. Permanently to Semipermanently Flooded Herbaceous Alliance includes smaller association-type patches of bulrush (*S. pungens* or *S. americanus*), cattail, common reed, salt cedar, and other introduced graminoids such as rushes (*Juncus* spp.) and spike-rush (*Eleocharis* spp.). Within the active primary channels, the *Schoenoplectus* spp. Permanently to Semipermanently Flooded Herbaceous Alliance abruptly transitions into larger stands of *Typha domingensis* Permanently Flooded Herbaceous Alliance, or *Phragmites australis* Semipermanently Flooded Herbaceous Alliance. Peripherally, it abruptly transitions into alliances and associations on bars, terraces and secondary channels that are disturbed, seral-barren, weedy herbaceous, or characterized by dense alliance and association type stands of salt cedar, quailbush, willow, and cottonwood. Only three acres (0.09%) of this alliance are mapped in the study area, however, the species that dominate this community are found more extensively then what is represented.

Figure 17: *Scheonoplectus* spp. Permanently to Semipermanently Flooded Herbaceous Alliance.

3.2.5.1.3 *Typha domingensis* Permanently Flooded Herbaceous Alliance (Cattail Marsh)

This alliance occurs on 38 acres (1.33%) in the study area mostly in the primary channel and back waters of the Wash (Appendix C). It typically occurs as narrow or patchy pure stands characterized by a single species, cattail as a tall herbaceous formation (Figure 18). These stands occur mostly on sandy soils of flooded banks, bars, or terraces in the study area, typically adjacent to open water. The stands usually appear in the seral stages of vegetation establishment and are often the most hydrologically dependent vegetation alliance in the project area, often being replaced by other mesic-aquatic vegetation better adapted to changing water levels, especially common reed. During type conversion, the common reed becomes a temporary associate of this alliance. *Typha domingensis* Permanently Flooded Herbaceous Alliance abruptly transitions into association or alliance-type stands of *Phragmites australis* Semipermanently Flooded Herbaceous Alliance, *Schoenoplectus* spp. Permanently to Semipermanently Flooded Herbaceous Alliance, or Open Water.

Figure 18: *Typha domingensis* Permanently Flooded Herbaceous Alliance.

3.2.5.1.4 *Phragmites australis* Semipermanently Flooded Herbaceous Alliance (Common Reed Marsh)

This alliance mostly occurs within the study area in the primary channel and back waters of the Wash (Appendix C). It is a tall herbaceous formation characterized by common reed and contributes to 188 acres or 6.53% of the study area (Figure 19). These stands occur on banks, terraces, bars, and in shallow flooded channels in the study area in a variety of soil textures in various wetland development stages. Within the study area, the *Phragmites australis*


Figure 19*: Phragmites australis* Semipermanently Flooded Herbaceous Alliance.

Semipermanently Flooded Herbaceous Alliance often includes salt cedar, cattail, or quailbush as associates. Within the active primary channels, the *Phragmites australis* Semipermanently Flooded Herbaceous Alliance abruptly transitions into stands of *Typha domingensis* Permanently Flooded Herbaceous Alliance or *Schoenoplectus* spp. Permanently to Semipermanently Flooded Herbaceous Alliance. On the edges, it abruptly transitions into alliances and associations on bars, terraces, and secondary channels that are disturbed, seral-barren, weedy herbaceous or characterized by dense association type stands of salt cedar, quailbush, willow, and cottonwood. The aggressive nature of common reed makes it an associate, or sometimes co-dominant in most of the adjacent vegetation.

3.2.5.1.5 *Distichlis spicata* Intermittently Flooded Herbaceous Alliance (Saltgrass Alkaline Meadow)

This alliance occurs within the project area in the Duck Creek drainage system, on inundated terraces with silty-clayey alkaline soils (Appendix C). This vegetation is similar to alkaline meadow or alkaline sink scrub type vegetation. It is mostly a low herbaceous formation of post-climax phase saltgrass that remains as a dominant cover in the understory, with other shrubs, trees, and herbs that form a co-dominant canopy cover (Figure 20). Iodinebush, bush seepweed, sea lavender, mist grass, alkali sacaton, and Emory baccharis are native associates typical of this alliance. Within the project area, the *Distichlis spicata* Intermittently Flooded Herbaceous Alliance includes smaller association-type patches or pure stands of common reed, quailbush, salt cedar, and some native trees (i.e., mesquites). Most of the upland transition for this alliance is now developed or planted. Semi-native associations of saltbush (*Atriplex* spp.) and creosote bush shrublands, and mesquite-catclaw woodlands remain as scattered fragments at the upland transition. The downstream transition of the


Figure 20: *Distichlis spicata* Intermittently Flooded Herbaceous Alliance.

Distichlis spicata Intermittently Flooded Herbaceous Alliance is primarily *Phragmites australis* Semipermanently Flooded Herbaceous Alliance, *Typha domingensis* Permanently Flooded Herbaceous Alliance, or *Tamarix ramosissima* Shrubland Alliances of varying hydrology. This alliance was formerly part of a series of alkaline springs in the Las Vegas area that had a high diversity of biota and likely several rare or sensitive species. Changes to hydrology and surrounding upland terrain have greatly reduced the biodiversity potential of this vegetation type. The *Distichlis spicata* Intermittently Flooded Herbaceous Alliance consists of 95 acres or 3.25% of the study area.

3.2.5.2 Forb Formations

Several forb associations are found within the study area. The Scree Herbaceous Association, Rocky Slopes Herbaceous Association, Desert Pavement Herbaceous Association, *Plantago ovata* Herbaceous Association, *Schismus* spp. Herbaceous Association, and *Sisymbrium irio* Herbaceous Association are all found within the *Larrea tridentata* Shrubland Alliance as minor components. All of the forb associations are characterized by the predominance of annual plants and therefore these communities are not necessarily regularly present spatially or temporally. These communities are further described by the dominant substrates that drive species occurrence. The most extensive forb formation is the *Bassia hyssopifolia* Herbaceous Association. This community is the most robust of the forb formations and it is well defined in all years. The last community, the Non-Native Intermittently Flooded Herbaceous Association is a minor component of most of the wet graminoid formations and can often be found on the edges of the main channel in naturally disturbed areas.

3.2.5.2.1 Scree Herbaceous Association (Talus/Scree Slope)

The prevalence of scree (i.e., small unconsolidated rocks or gravel, fist-size or smaller, located mostly below rock ridges and cliffs) is the dominant characteristic of this association. This association is found within the *Larrea tridentata* Shrubland Alliance mostly in the north portion of the study area, however, portions of this association are found in the southeast corner of the study area. This association is further described as occurring on steep scree or badland slopes with coarse loose soils or soft alluvial-metamorphic strata exposed. Vegetation cover is primarily from seasonal forbs such as blazing star (*Mentzelia tricuspis*), desert sunflower (*Geraea canescens*), sun cups (*Camissonia brevipes*), and other annual plants that are adapted to loose slopes.

3.2.5.2.2 Rocky Slopes Herbaceous Association (Outcrop Rocky Slope)

The Rocky Slopes Herbaceous Association is found in the northeast part of the study area within the *Larrea tridentata* Shrubland Alliance. This association is characterized by the presence of steep rocky slopes, with outcrops, boulders rocks and talus. These areas typically occur where hard rock strata are exposed. Vegetation cover is primarily from seasonal forbs characterized by purple phacelia (*Phacelia. crenulata*), cryptantha (*Cryptantha* spp.), and other annual plants that are adapted to rocky slopes.

3.2.5.2.3 Desert Pavement Herbaceous Association (Desert Pavement)

Desert pavements generally occur on the surface of low desert flats, fans, or bajadas. These surfaces consist of small angular gravels and pebbles that interlock to form a pavement like impervious surface. There is typically a patina on the upper surfaces of the desert pavement.

This herbaceous association is characterized by the dominance of desert pavements and it is found within the *Larrea tridentata* Shrubland Alliance. Vegetation cover primarily consists of seasonal forbs including alkali phacelia (*Phacelia neglecta*), bristly langloisia (*Langloisia setosissima*), pebble pincussion (*Chaenactis carphoclinia*), spiny-herb (*Chorizanthe rigida*), and other annual plants that are adapted to desert pavements.

3.2.5.2.4 *Plantago ovata* Herbaceous Association (Wooly Plantain Field)

Wooly plantain (*Plantago ovata*) defines this association that is found in the *Larrea tridentata* Shrubland Alliance. This association is found on low-angle slope benches and terraces, with typical desert soils of sand and small rocks. These areas typically lack patina weathering. A mixture of other desert annuals are also found here.

3.2.5.2.5 *Schismus* spp. Herbaceous Association (Splitgrass Field)

The low-growing, non-native, annual Mediterranean split grass (*Schismus* spp.) is the dominant species in this herbaceous association. This is a loosely defined association that is found in either small dense localized areas or patchy across a large landscape. The *Schismus* spp. Herbaceous Association is often found within the *Larrea tridentata* Shrubland Alliance, however, it can also be found in disturbed areas.

3.2.5.2.6 *Sisymbrium irio* Herbaceous Association (Ruderal Field)

The *Sisymbrium irio* Herbaceous Association is dominated by the weedy London rocket (*Sisymbrium irio*). This species is a low growing forb of the Brassicaceae family that is one of the most characteristic weeds in urban environments of the Las Vegas Valley. This association is found in both the *Atriplex* spp. Shrubland alliance and the *Larrea tridentata* Shrubland Alliance (Figure 21).

Figure 21: *Sisymbrium irio* Herbaceous Association

3.2.5.2.7 *Bassia hyssopifolia* Herbaceous Association (Bassia Field)

The *Bassia hyssopifolia* Herbaceous Association is a well defined association that is within the *Atriplex* spp. Shrubland Alliance. It is found most often near the *Atriplex lentiformis* Shrubland Association and the *Tamarix ramosissima* Shrubland Alliance. This association is dominated by the non-native weedy bassia (*Bassia hyssopifolia*), an annual forb less than three feet tall that is often found on disturbed sites, fields, and roadsides. Bassia cover approximates 100% on most sites with minimal inclusion of associated species. Often, bassia grows in dense monospecific carpets in the interspaces of the *Tamarix ramosissima* Shrubland Alliance. In some areas, the extent of bassia cover is minimized and therefore is treated as a subcomponent of adjacent salt cedar or quailbush communities. Some of the associated species include Russian thistle (*Salsola tragus*) salt cedar, quailbush, common reed, and horseweed.

3.2.5.2.8 Non-Native Intermittently Flooded Herbaceous Association (Weedy Sandbars and Mudflats)

The Non-Native Intermittently Flooded Herbaceous Association is a loosely defined association that is most often found on the fringes of wet communities including several within the graminoid formation. Also, this community is found in wet spots that are exposed from flood disturbance or fluctuating water levels. Most of the species found in this community are non-native, however, several native plants can be found here but often they do not persist. Vegetation cover is primarily of annual or biennial forbs that are found in tall-growing ephemeral stands of various mesic weeds. They include alkali aster (*Aster subulatus*), cocklebur, pigweed (*Amaranthus* spp), goosefoot (*Chenopodium* spp.), Johnson grass (*Sorghum halepense*), horseweed, marsh fleabane (*Pluchea odorata*), sacred datura (*Datura wrightii*), tall whitetop (*Lepidium latifolium*), knotting smart weed (*Polygonum lapathifolium*), and dock.

3.3 Soil Classification

A soil survey of the Las Vegas Valley and surrounding areas was prepared in 1985 (Speck 1985). In 2000, the Natural Resources Conservation Service updated a portion of the 1985 soil survey by conducting a soil survey for the Wetlands Park. Results of the 2000 survey indicated that 14 soil types were found in the park (Figure 22). They include: (1) Arizo very gravelly loamy sand, flooded, (2) Aztec very gravelly sandy loam, (3) Aztec-Bracken complex, 4 to 30 percent slopes, (4) Baseline-Calville-Badlands, (5) Bracken very gravelly fine sandy loam, (6) Caliza fine sand, 4 to 8% slopes, (7) Caliza very gravelly sandy loam, 2 to 8% slopes, (8) Dumps, (9) Glencarb silt loam, flooded, (10) Land very fine sandy loam, drained, (11) Land very fine sandy loam, wet, (12) McCarren fine sandy loam, (13) Oxyaquic Torrifluvents-Gypwash , and (14) Sunrock-Heleburu-Rock outcrop.

3.4 Wetlands and Other Waters of the U.S.

Wetlands are transitional zones between upland and aquatic areas. In Southern Nevada, these areas provide critical habitat for a diversity of wildlife not found elsewhere in the Mojave Desert. Moreover, these areas are highly valued for their ecosystem functions which include floodwater storage, nutrient cycling, stream bank stability, and sediment removal. Cowardin et al. (1979) prepared a classification hierarchy for wetlands and deepwater habitats in the United States which is used as part of the FWS' National Wetland Inventory (NWI) mapping program. Cowardin et al. (1979) define wetlands as "lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow

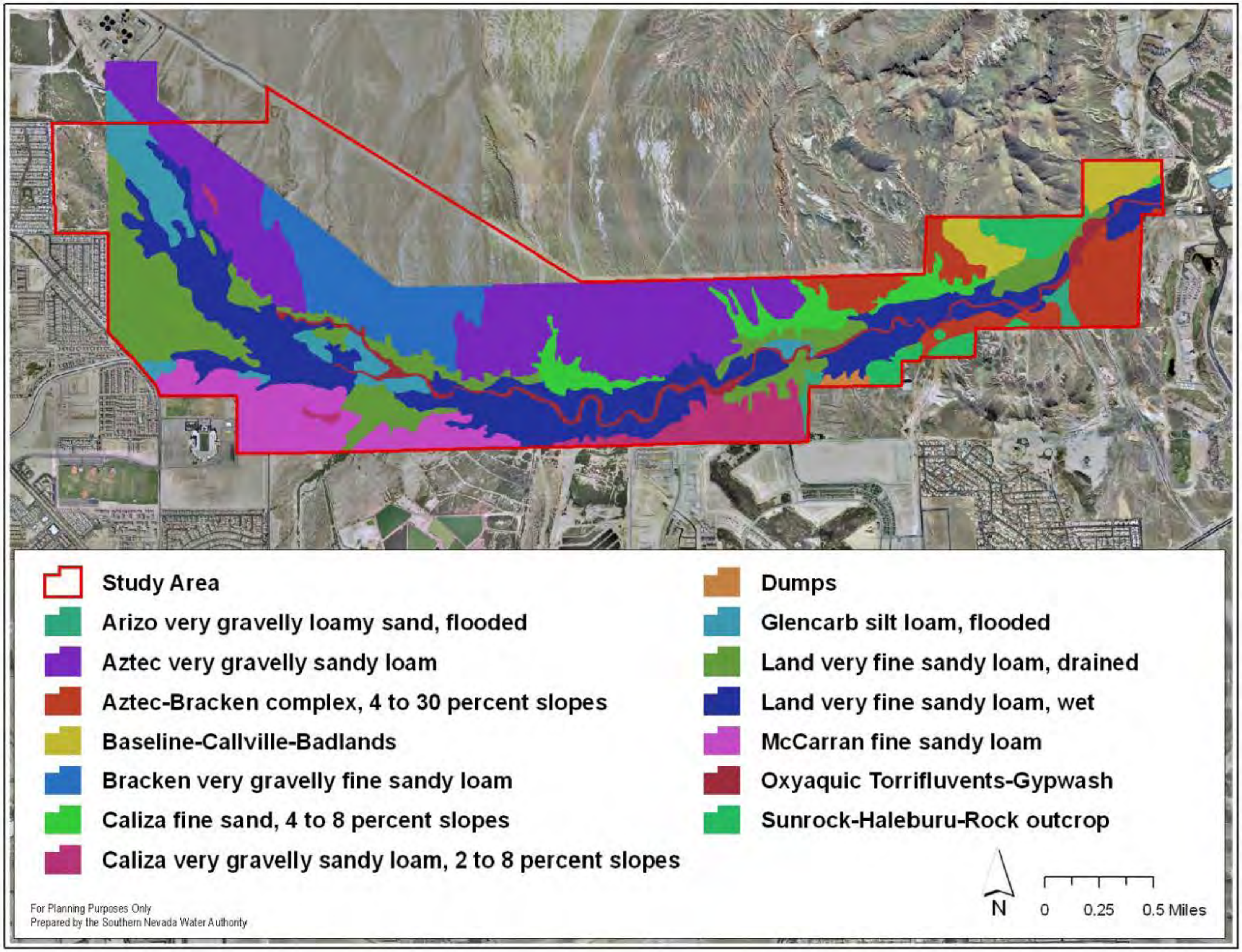


Figure 22: Soil survey for the Clark County Wetlands Park prepared by the Natural Resources Conservation Service in 2000.

water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes, (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of the year" and deepwater habitats as "permanently flooded lands lying below the deepwater boundary of wetlands." These definitions are used by the FWS in their NWI mapping efforts.

For the Wash, two wetland types consisting of 1,043 acres within the study area were historically mapped by the FWS (Figure 23). Each type is within the Palustrine System which includes non-tidal areas that are dominated by trees, shrubs, persistent emergents, and emergent mosses and lichens. The wetland classes described along the Wash include Palustrine scrub-shrub and Palustrine emergent. Palustrine scrub-shrub was the most extensive wetland type found along the Wash with approximately 817 acres in the study area. These areas are dominated by woody plants including shrubs, small trees, young trees, and stunted trees that are less than 20 feet tall. Salt cedar would have been the most common woody plant in Palustrine scrub-shrub Wash wetlands. Palustrine emergent areas were the next most extensive wetland historically found along the Wash with approximately 226 acres. These areas were dominated by rooted perennial hydrophytes with cattail and common reed as the most common species.

Wetlands have been substantially decreased since the NWI maps were prepared. Within the study area wetlands potentially occur within several land cover types. Confirmed wetland land cover types include the *Schoenoplectus* spp. Permanently to Semipermanently Flooded Herbaceous Alliance, *Typha domingensis* Permanently Flooded Alliance, and *Salix exigua* Temporarily Flooded Shrubland Alliance. These areas consist of approximately 42 acres of confirmed wetlands. Other areas that are likely wetlands include the *Phragmites australis* Semipermanently Flooded Herbaceous Alliance and *Populus fremontii-Salix gooddingii* Temporarily Flooded Forest Alliance, however, field reconnaissance would need to be completed for confirmation. There are approximately 198 acres of these likely wetland areas. Other WOUS that are found in the study area include the Open Water land cover type which consists of 77 acres in the study area. Ordinary high water mark evaluations were not conducted along the Open Water land cover type and therefore jurisdictional areas are typically greater than what is reported here. Cumulatively, there are around 317 acres that are considered to be wetlands (Figure 24); however, there may be other areas that could be classified as wetlands. For example, portions of the Disturbed-Natural, *Tamarix ramosissima* Shrubland Alliance, and *Distichlis spicata* Intermittently Flooded Herbaceous Alliance cover types could be classified as wetlands.

Wetlands along the Wash have substantially declined since the FWS prepared the NWI mapping products. Much of the original wetland mapping for the Wash, however, was done at a 1:58,000 and 1:65,000 scale from color infrared aerial photographs taken in 1981 and 1983 and 1:80,000 scale from black and white aerial photographs taken in 1973. Therefore, wetlands documented by the FWS were not as detailed as the wetlands described in this report. Although wetlands were likely overestimated by the FWS, historical erosion of the Wash channel has led to widespread reduction of wetlands in the study area.

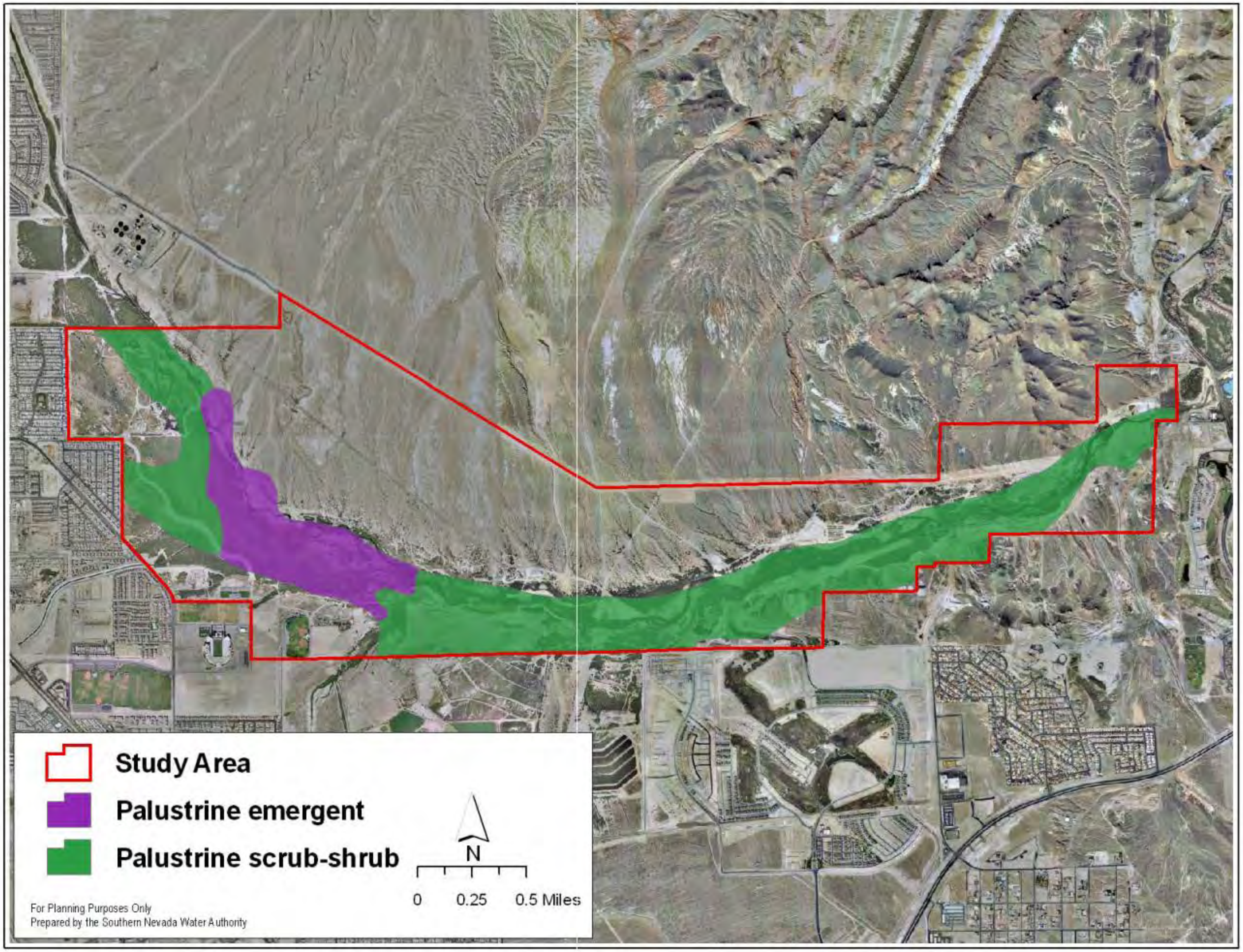


Figure 23: Wetlands (1,043 acres) within the study area that were mapped by the U.S. Fish and Wildlife Service for their National Wetland Inventory Program.

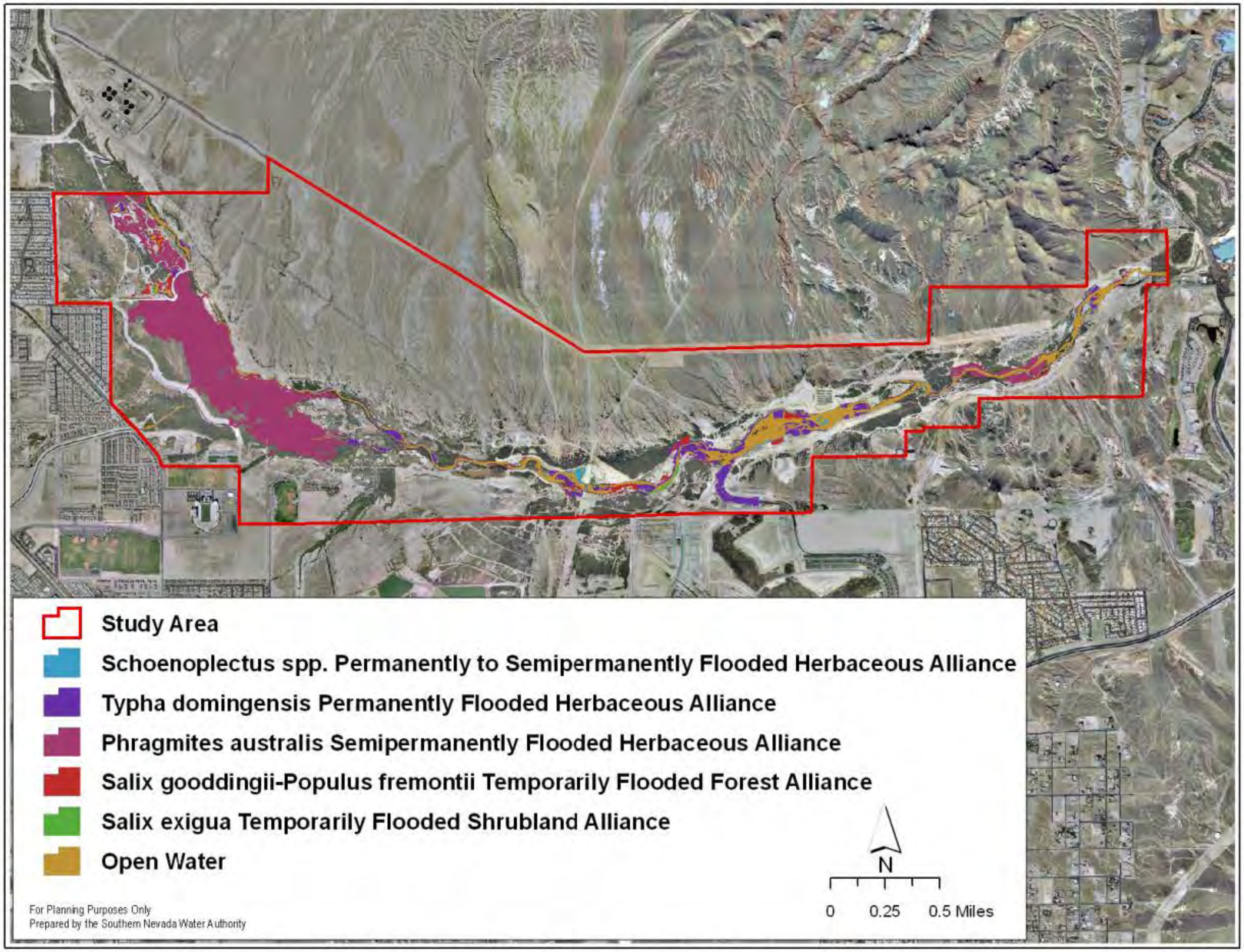


Figure 24: Wetland areas (317 acres) within the study area that may meet the U.S. Army Corps of Engineers definition of a "wetland" or "water of the U.S."

4.0 RECOMMENDATIONS

Several land cover types are found in the study area. Most of these cover types are vegetated, however, there are many areas that have been disturbed by natural and anthropogenic activities. Vegetation within the study area is mixed between forest, woodland, shrubland, dwarf shrubland, and herbaceous formation classes with shrublands being the most dominant type. Moreover, the *Larrea tridentata* Shrubland Alliance is the most dominant alliance in the study area. This report represents a comprehensive assessment of the vegetation types found near the Wash and they are described within the NVCS framework. The purpose of using the NVCS is to identify communities based on a standard classification and then to use this classification to repeat this study every five in subsequent years. We recommend that this study should be repeated in five years so that acreage values of the various vegetation types can be compared over time. This information will be useful for wildlife management planning since the vegetation types described in this report provide the foundation for wildlife habitats.

5.0 LITERATURE CITED

Anderson M., P.S. Bourgeron, M.T. Bryer, R. Crawford, L. Engelking, D. Faber-Langendoen, M. Gallyoun, K. Goodin, D.H. Grossman, S. Landaal, K. Metzler, K.D. Patterson, M. Pyne, M. Reid, L. Sneddon, and A.S. Weakley. 1998. International Classification of Ecological Communities: Terrestrial Vegetation of the United States. Volume II. The National Vegetation Classification System: List of Types. The Nature Conservancy, Arlington, Virginia, USA.

Association for Biodiversity Information. 2001. International classification of ecological communities: Terrestrial vegetation of the United States. SW Regional GAP Subset. Association for Biodiversity Information, Arlington, VA and Association for Biodiversity Information, Boulder, CO.

Bailey, R.G. 1983. Delineation of ecosystem regions. Environmental Management 7:365-373.

Barbour, M.G., Burk, J.H., Pitts, W.D., Gilliam, F.S., and Schwartz, M.W. 1999. Terrestrial Plant Ecology, 3rd edition. Benjamin/Cummings, Menlo Park, California

Bickmore, E. 2003. Integrated weed management plan for the lower Las Vegas Wash. Southern Nevada Water Authority, Las Vegas, Nevada.

BOR (U.S. Bureau of Reclamation). 1987. Las Vegas Wash vegetation study. U.S. Bureau of Reclamation, Denver, Colorado.

Bradley, W.G., and J.E. Deacon. 1965. The biotic communities of Southern Nevada. Desert Research Institute, Reno, Nevada.

Brown, D.E., F. Reichenbacher, and S.E. Franson. 1998. A classification of North American biotic communities. The University of Utah Press, Salt Lake City, Utah.

Bryce, S.A., A.J. Woods, J.D. Morefield, J.M. Omernik, T.R. McJay, G.K. Brackley, R.K. Hall, D.K. Higgins, D.C. McMorran, K.E. Vargas, E.B. Peterson, D.C. Zamudio, and J.A. Comstock. 2003. Ecoregions of Nevada (color poster with map, descriptive text, summary tables, and photographs). U.S. Geological Survey, Reston, Virginia, USA.

Buckland, S. T., D. R. Anderson, K. P. Burnham, and J. L. Laake. 1993. Distance sampling: estimating abundance of biological populations. Chapman and Hall, London, U.K. 446pp.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79-31. U.S. Fish and Wildlife Service, Washington, D.C.

Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station, Vicksburg, Mississippi.

FGDC. 1997. FGDC Vegetation Classification and Information Standards. FGDC Secretariat, U.S. Geological Survey, Reston, Virginia, USA.

FGDC. 2006. National Vegetation Classification Standard, Version 2 – Working Draft. FGDC Secretariat, U.S. Geological Survey, Reston, Virginia, USA.

Flahault, C. and C. Schroter. 1910. Rapport sur la nomenclature phytogeographique. Proceedings of the 3rd International Botanical Congress, Brussels.

Grossman, D.H., D. Faber-Langendoen, A.S. Weakley, M. Anderson, P.S. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International Classification of Ecological Communities: Terrestrial Vegetation of the United States. Volume I. The national vegetation classification system: development, status, and applications. The Nature Conservancy, Arlington, Virginia, USA.

Hallert, B. 1960. Photogrammetry. McGraw-Hill Book Company, Inc. New York, New York.

Kloeppel, H., A. Hadley, F. Phillips, and S.A. Shanahan. 2006. Las Vegas Wash revegetation master plan. Southern Nevada Water Authority, Las Vegas, Nevada.

Larkin, J. 2006. An evaluation of small mammal populations in the Las Vegas Wash. Thesis. University of Nevada, Las Vegas, Nevada.

Lowry, J.H., R.D. Ramsey, K. Boykin, D. Bradford, P. Comer, S. Falzarno, W. Kepner, J. Kirby, L. Langs, J. Prior-Magee, G. Manis, L. O'Brien, K. Pohs, W. Reith, T. Sajwaj, S. Schrader, K. Thomas, D. Schrupp, K. Schulz, B. Thompson, C. Wallace, C. Velasquez, E. Waller, and B. Wolk. 2005. The southwest regional gap analysis project: final report on land cover mapping methods. RS/GIS Laboratory, Utah State University, Logan, Utah.

McKernan, R. L., and G. T. Braden. 2001. The status of Yuma clapper rail and yellow-billed cuckoo along portions of Virgin River, Muddy River, and Las Vegas Wash, Southern Nevada, 2001. Final report to the U.S. Fish and Wildlife Service and Southern Nevada Water Authority, Las Vegas, prepared by San Bernardino County Museum, Redlands, California.

McKernan, R. L., and G. T. Braden. 2002. The status of Yuma clapper rail and yellow-billed cuckoo along portions of Virgin River, Muddy River, and Las Vegas Wash, Southern Nevada, 2001. Final report to the U.S. Fish and Wildlife Service and Southern Nevada Water Authority, Las Vegas, prepared by San Bernardino County Museum, Redlands, California.

Merriam, C.H. and Steineger, L. 1890. Results of a biological survey of the San Francisco mountain region and the desert of the Little Colorado, Arizona. North American Fauna Report 3. U.S. Department of Agriculture, Division of Ornithology and Mammalia, Washington, D.C.

Mueller-Dombois, D., and H. Ellenberg. 1974. Aims and methods of vegetative ecology. John Wiley & Sons, New York, USA.

O'Farrell M.J. and S.A. Shanahan. 2006. Las Vegas Wash bat survey, 2004-2005. Southern Nevada Water Authority, Las Vegas, Nevada.

Scott, J. M. and M. D. Jennings. 1997. "A Description of the National Gap Analysis Program". the official description of the National Gap Analysis Program.

Shanahan, S.A. 2005. Las Vegas Wash fish survey summary report, 2002-2003. Southern Nevada Water Authority, Las Vegas, Nevada.

Shanahan, S.A. 2005a. Las Vegas Wash reptile survey summary report, 2001-2003. Southern Nevada Water Authority, Las Vegas, Nevada.

Shanahan, S.A. and D. Silverman. 2006. Las Vegas Botanical inventory, 2002-2005. Southern Nevada Water Authority, Las Vegas, Nevada.

Shanahan, S.A., D.M. Van Dooremolen, T. Sharp, S. Martin, and B. Brown. 2007. Las Vegas Wash wildlife management plan. Southern Nevada Water Authority, Las Vegas, Nevada.

Southwest Wetlands Consortium. 1998. Final Program Environmental Impact Statement for the Clark County Wetlands Park. Final Report to the Bureau of Reclamation and Clark County Department of Parks and Recreation, prepared by Southwest Wetlands Consortium, Las Vegas Nevada

Speck, R.L. 1982. Soil survey of Las Vegas Valley area Nevada: part of Clark County. U.S. Department of Agriculture, Soil Conservation Service, Las Vegas, Nevada.

SWCA. 1998. Survey for southwestern willow flycatchers along Las Vegas Wash, Clark County Wetlands Park, Nevada. SWCA Environmental Consultants, Salt Lake City, Utah.

SWCA. 1999. Survey for southwestern willow flycatchers along Las Vegas Wash, Clark County Wetlands Park, Nevada. SWCA Environmental Consultants, Salt Lake City, Utah.

SWCA. 2000. Survey for southwestern willow flycatchers along Las Vegas Wash, Clark County Wetlands Park, Nevada. SWCA Environmental Consultants, Salt Lake City, Utah.

SWCA. 2001. Survey for southwestern willow flycatchers along Las Vegas Wash, Clark County Wetlands Park, Nevada. SWCA Environmental Consultants, Salt Lake City, Utah.

SWCA. 2002. A survey for Yuma clapper rails, yellow-billed cuckoos and southwestern willow flycatchers along Las Vegas Wash, Clark County Wetlands Park, Nevada. SWCA Environmental Consultants, Salt Lake City, Utah.

SWCA. 2003. Survey for Yuma Clapper Rails, Yellow-billed Cuckoos, and Southwestern Willow Flycatchers along Las Vegas Wash in Clark County, Nevada. SWCA Environmental Consultants, Salt Lake City, Utah.

SWCA. 2005. Survey for Yuma Clapper Rails, Yellow-billed Cuckoos, and Southwestern Willow Flycatchers along Las Vegas Wash in Clark County, Nevada. SWCA Environmental Consultants, Salt Lake City, Utah.

SWCA. 2005a. Clark County Wetlands Park improvements environmental assessment, Final. SWCA Environmental Consultants, Las Vegas, Nevada.

SWCA. 2006. Survey for Southwestern Willow Flycatchers in 2005 along Las Vegas Wash in Clark County, Nevada. SWCA Environmental Consultants, Salt Lake City, Utah.

TNC (The Nature Conservancy) and ESRI (Environmental Systems Research Institute). 1994. Field methods for vegetation mapping. TNC, Arlington, Virginia.

Van Dooremolen, D.M. 2005. Las Vegas Wash bird census summary report, 2000-2003. Southern Nevada Water Authority, Las Vegas, Nevada.

Appendix A

List of Plant Species Documented by Shanahan and Silverman (2006) that Occur in the Various Land Cover Types found along the Las Vegas Wash

List of species detected by Shanahan and Silverman (2006). Family and species names follow the Integrated Taxonomic Information System (www.itis.usda.gov). Each species is attributed a combined frequency[1]/fidelity[2] value of 0-9 for each of the land cover types documented in this study. Land cover type codes[3] consisting of the first letter of each word in the colloquial name are used. Broad geogpraphic alliances such as the *Atriplex* spp. Shrubland Alliance (Saltbush Scrub) and the *Larrea tridentata* Shrubland Alliance (Creosote Bush Scrub) are not included.

				Land Cover Type Code																									
Famliy Scientific Name	Family Common Name	Scientific Name	Common Name	CWRF	MW	CWS	SWRS	QT	FSS	DSS	CBPS	CBWS	CBCS	SCT	SCQT	SCCRTM	DHS	IAM	SS	GGW	TM	CM	CRM	SAM	TSS	ORS	DP	WPF	SF	RF	BF	WSM	CBBS and BCBS
Amaranthaceae	Amaranth Family	Amaranthus albus	Tumbleweed	6	4	3	6	5	3	3	0	3	1	4	5	5	0	2	2	1	5	4	5	2	0	0	0	0	3	4	6	8	0
		Amaranthus blitoides	Prostrate amaranth	2	3	2	2	5	3	3	0	2	2	2	3	4	0	2	3	1	2	3	3	1	0	0	0	0	2	2	4	6	0
		Amaranthus powellii	Amaranth	1	1	0	1	1	0	0	0	0	0	1	1	2	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1	3	0
		Tidestromia oblongifolia	Honey sweet	1	4	4	1	3	5	5	2	4	6	2	2	0	3	0	6	3	0	0	0	0	2	3	2	4	4	2	5	0	4
Asteraceae	Aster Family	Acroptilon repens	Russian knapweed	2	1	0	2	5	2	2	0	0	0	4	5	6	0	6	1	0	3	2	5	5	0	0	0	0	1	2	6	6	0
		Ambrosia dumosa	Burro bush	0	5	7	0	1	7	6	5	8	6	1	1	0	7	0	7	8	0	0	0	0	5	5	6	6	4	2	1	0	9
		Amphipappus fremontii	Chaff bush	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0	1	0	0	0	0	0	4	1	1	0	0	0	0	3
		Aster subulatus var. ligulatus	Alkali aster	6	0	0	6	2	0	0	0	0	0	4	3	5	0	3	0	0	6	4	5	3	0	0	0	0	0	0	2	7	0
		Atrichoseris platyphylla	Gravel ghost	0	2	4	0	0	0	0	6	5	1	0	0	0	6	0	0	5	0	0	0	0	7	6	6	6	0	0	0	0	5
		Baccharis emoryi	Emory waterweed	4	1	0	6	3	2	2	0	0	0	2	2	4	0	5	0	0	5	4	6	3	0	0	0	0	0	1	2	4	0
		Baccharis salicifolia	Seep willow																														
		Baccharis sarothroides	Broom baccharis																														
		Baileya multiradiata	Desert marigold	1	0	5	0	1	3	3	3	7	3	0	0	0	2	0	3	7	0	0	0	0	5	3	2	4	3	1	0	0	4
		Brickellia atractyloides(arguta)	Brickellia	0	1	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	6	0	0	0	0	0	0	2
		Calycoseris wrightii	White tackstem	0	2	4	0	0	0	0	7	6	2	0	0	0	7	0	1	6	0	0	0	0	6	6	7	6	0	0	0	0	6
		Chaenactis carphoclinia	Pebble pincushion	0	2	4	0	0	0	2	7	5	2	0	0	0	8	0	1	5	0	0	0	0	4	6	8	8	1	0	0	0	6
		Chaenactis fremontii	Fremont pincushion	0	2	5	0	0	1	1	6	7	2	0	0	0	5	0	2	6	0	0	0	0	4	4	3	5	2	2	0	0	7
		Chaenactis macrantha	Pincushion	0	1	2	0	0	1	1	4	3	3	0	0	0	4	0	3	3	0	0	0	0	3	2	4	6	1	1	1	0	4
		Chrysothamnus paniculatus	Black band rabbitbrush	0	5	7	0	0	1	1	0	6	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	2
		Conyza canadensis	Horseweed	4	0	0	4	2	0	0	0	0	0	3	3	4	0	2	0	0	4	2	5	1	0	0	0	0	0	1	2	6	0
		Conyza coulteri	Horseweed	6	1	0	6	2	1	2	0	0	0	3	4	6	0	4	1	0	6	3	5	3	0	0	0	0	0	0	4	7	0
		Eclipta prostrata	False daisy	4	0	0	4	1	0	0	0	0	0	2	1	3	0	1	0	0	7	6	6	0	0	0	0	0	0	0	1	6	0
		Encelia farinosa	Brittle bush	0	0	2	0	0	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	2	6	0	0	0	0	0	0	3
		Encelia virginensis	Brittle bush	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	3	0	0	0	0	1	2	0	0	0	0	0	0	2
		Enceliopsis argophylla	Silver-leaf daisy	0	0	3	0	0	0	0	2	3	1	0	0	0	3	0	0	2	0	0	0	0	5	2	1	0	0	0	0	0	3
		Erigeron divergens	Fleabane	1	2	2	1	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	1	0	1	0
		Eriophyllum lanatum	Woolly sunflower	0	1	3	0	0	0	0	5	4	0	0	0	0	5	0	0	4	0	0	0	0	2	5	6	5	0	0	0	0	5
		Eriophyllum wallacei	Woolly daisy	0	0	1	0	0	0	0	2	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	2
		Filago arizonica	Filago	0	1	4	0	0	0	0	5	4	0	0	0	0	2	0	0	4	0	0	0	0	0	2	2	3	0	0	0	0	5
		Geraea canescens	Desert sunflower	0	2	6	0	0	1	2	6	5	2	0	0	0	6	0	1	5	0	0	0	0	8	5	4	6	0	0	0	0	7
		Gnaphalium luteo-album	Cudweed	6	0	0	6	0	0	0	0	0	0	0	0	2	0	0	0	0	4	1	3	0	0	0	0	0	0	0	2	7	0
		Helianthus annuus	Sunflower	5	1	0	6	2	0	0	0	0	0	1	1	2	0	1	0	0	3	1	2	1	0	0	0	0	0	1	2	6	0
		Hymenoclea salsola var. fasciculata	Cheesebush	0	0	1	0	0	0	0	2	3	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
		Hymenoclea salsola var. salsola	Cheesebush	0	5	7	0	0	1	2	1	8	3	0	0	0	2	0	2	6	0	0	0	0	1	2	2	3	2	1	0	0	5
		Isocoma acradenia var. eremophila	Goldenbush	0	2	0	0	2	2	2	0	0	1	1	0	0	0	3	3	0	0	0	0	2	0	0	0	0	1	0	3	0	0
		Lactuca cf. biennis	Prickly lettuce	2	1	0	2	2	0	0	0	0	0	1	1	2	0	1	0	0	2	2	3	1	0	0	0	0	1	1	2	3	0
		Lactuca serriola	Prickly lettuce	4	3	2	4	2	1	1	0	1	1	3	3	3	0	2	1	1	5	2	3	2	0	0	0	0	2	3	3	6	0
		Machaeranthera pinnatifida ssp. gooddingii	Goodding aster	0	0	1	0	0	0	0	3	1	0	0	0	0	2	0	0	2	0	0	0	0	2	6	0	0	0	0	0	0	2
		Malacothrix glabrata	Desert dandelion	0	2	5	0	0	1	2	4	6	2	0	0	0	3	0	1	5	0	0	0	0	4	1	1	3	2	1	0	0	5
		Perityle emoryi	Rock daisy	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3	8	0	0	0	0	0	0	1
		Peucephyllum schottii	Pygmy cedar	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	2	3	0	0	0	0	0	0	1
		Pluchea odorata	Salt marsh fleabane	4	0	0	4	1	0	0	0	0	0	1	1	4	0	4	0	0	5	4	6	3	0	0	0	0	0	0	3	6	0
		Pluchea sericea	Arrow weed	3	0	0	3	1	0	0	0	0	0	1	2	3	0	2	0	0	2	1	2	3	0	0	0	0	0	0	1	2	0
		Prenanthella exigua	Bright white	0	0	0	0	0	0	0	6	0	0	0	0	0	6	0	0	0	0	0	0	0	5	6	6	2	0	0	0	0	5
		Psathyrotes ramosissima	Velvet turtleback	0	2	4	0	1	3	3	6	4	4	1	1	0	6	0	3	4	0	0	0	0	2	3	7	6	2	1	1	0	5
		Psilostrophe cooperi	Paper flower	0	1	1	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
		Rafinesquia neomexicana	Desert chicory/New Mexico Plumeseed	0	2	5	0	0	0	0	6	5	0	0	0	0	6	0	0	6	0	0	0	0	4	4	3	2	0	0	0	0	6
		Sonchus asper	Spiny sow thistle	4	0	0	4	2	1	1	0	0	1	2	2	3	0	1	1	0	3	1	2	0	0	0	0	0	1	1	3	7	0
		Sonchus oleraceus	Sow thistle	3	0	0	3	1	0	0	0	0	0	1	1	2	0	0	0	0	2	1	2	0	0	0	0	0	0	1	2	5	0
		Stephanomeria pauciflora var. pauciflora	Wire lettuce	0	4	5	0	2	3	3	3	6	4	1	1	0	4	0	4	6	0	0	0	0	2	5	3	4	4	3	2	0	6
		Stylocline micropoides	Desert nest straw	0	1	3	0	0	0	0	4	3	1	0	0	0	3	0	0	4	0	0	0	0	4	6	5	3	0	0	0	0	4
		Xanthium strumarium	Cocklebur	6	1	0	6	3	0	0	0	0	0	3	3	4	0	2	0	0	5	4	5	1	0	0	0	0	0	1	3	8	0
		Xylorhiza tortifolia	Mojave woodyaster	0	0	2	0	0	0	0	2	1	1	0	0	0	2	0	0	2	0	0	0	0	4	6	4	2	0	0	0	0	4
Azollaceae	Mosquito Fern Family	Azolla sp.	Mosquito fern	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	2	3	2	0	0	0	0	0	0	0	0	0	0
Bignoniaceae	Bignonia Family	Chilopsis linearis ssp. arcuata	Desert willow																														
Boraginaceae	Borage Family	Amsinckia menziesii var. intermedia	Rancher's fireweed	0	4	4	0	1	2	1	2	4	1	1	1	0	1	0	1	4	0	0	0	0	4	5	1	3	2	3	1	1	3
		Amsinckia tessellata var. tessellata	Devil's lettuce	0	6	5	0	2	3	3	3	5	3	1	1	0	4	0	3	5	0	0	0	0	3	4	2	4	5	6	2	0	4
		Cryptantha angustifolia	Narrow-leaved cryptantha	0	4	7	0	1	4	4	7	7	7	0	0	0	6	0	6	6	0	0	0	0	4	6	5	7	4	2	1	0	7
		Cryptantha barbigera	Bearded cryptantha	0	2	2	0	0	0	0	3	4	0	0	0	0	3	0	0	3	0	0	0	0	2	6	1	1	0	0	0	0	3
		Cryptantha dumetorum	Cryptantha	0	3	6	0	0	0	0	4	6	1	0	0	0	3	0	0	5	0	0	0	0	1	2	1	1	1	0	0	0	4
		Cryptantha holoptera	Winged cryptantha	0	3	4	0	0	1	0	7	7	2	0	0	0	5	0	1	6	0	0	0	0	7	8	3	2	2	1	0	1	6
		Cryptantha inaequata	Cryptantha	0	4	5	0	0	0	0	6	7	1	0	0	0	4	0	0	6	0	0	0	0	6	7	2	4	2	0	0	0	5

List of species detected by Shanahan and Silverman (2006). Family and species names follow the Integrated Taxonomic Information System (www.itis.usda.gov). Each species is attributed a combined frequency[1]/fidelity[2] value of 0-9 for each of the land cover types documented in this study. Land cover type codes[3] consisting of the first letter of each word in the colloquial name are used. Broad geogpraphic alliances such as the *Atriplex* spp. Shrubland Alliance (Saltbush Scrub) and the *Larrea tridentata* Shrubland Alliance (Creosote Bush Scrub) are not included.

Land Cover Type Code

Famliy Scientific Name	Family Common Name	Scientific Name	Common Name	CWRF	MW	CWS	SWRS	QT	FSS	DSS	CBPS	CBWS	CBCS	SCT	SCQT	SCCRTM	DHS	IAM	SS	GGW	TM	CM	CRM	SAM	TSS	ORS	DP	WPF	SF	RF	BF	WSM	CBBS and BCBS
Boraginaceae	Borage Family	Cryptantha maritima	Cryptantha	0	2	3	0	0	0	0	5	4	0	0	0	0	5	0	0	4	0	0	0	0	3	8	1	2	0	0	0	0	5
		Cryptantha nevadensis	Cryptantha	0	2	3	0	0	1	1	6	5	2	0	0	0	4	0	2	6	0	0	0	0	3	4	2	3	1	0	0	0	7
		Cryptantha pterocarya var. cycloptera	Wing-nut cryptantha	0	4	4	0	0	0	0	6	7	2	0	0	0	5	0	1	7	0	0	0	0	4	6	2	3	0	0	0	0	7
		Cryptantha pterocarya var. pterocarya	Wing-nut cryptantha	0	3	4	0	0	0	0	4	6	0	0	0	0	3	0	0	6	0	0	0	0	4	3	1	3	0	0	0	0	4
		Cryptantha recurvata	Cryptantha	0	2	5	0	0	1	1	2	4	2	0	0	0	2	0	1	4	0	0	0	0	4	3	2	3	0	0	0	0	3
		Cryptantha utahensis	Scented cryptantha	0	0	2	0	0	0	0	5	3	0	0	0	0	3	0	0	3	0	0	0	0	5	6	0	0	0	0	0	0	5
		Heliotropium curassavicum	Salt heliotrope	3	1	0	3	2	1	1	0	0	0	3	4	5	0	4	1	0	4	2	5	3	0	0	0	0	0	2	6	6	0
		Pectocarya heterocarpa	Comb-bur	0	3	5	0	0	1	1	7	5	2	0	0	0	5	0	1	6	0	0	0	0	3	2	4	6	2	0	0	2	7
		Pectocarya linearis	Comb-bur	0	2	3	0	0	0	0	4	4	1	0	0	0	4	0	0	4	0	0	0	0	2	1	3	3	1	0	0	1	4
		Pectocarya platycarpa	Comb-bur	0	2	4	0	0	0	0	7	5	2	0	0	0	5	0	0	6	0	0	0	0	3	2	4	6	1	0	0	1	7
		Plagiobothrys jonesii	Jones popcornflower	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	1	0	0	0	0	6	6	0	0	0	0	0	0	1
Brassicaceae	Mustard Family	Brassica tournefortii	Sahara mustard	1	6	7	1	1	2	2	2	7	1	0	0	0	1	0	1	6	0	0	0	0	7	3	1	3	6	6	1	0	3
		Descurainia pinnata ssp. glabra	Tansy mustard	0	4	6	0	1	1	3	3	6	2	0	0	0	3	0	2	6	0	0	0	0	1	1	2	2	3	3	0	0	5
		Descurainia sophia	Flixweed	2	4	3	2	4	3	3	0	2	2	2	3	1	0	0	2	1	0	0	0	0	0	0	0	1	5	6	0	1	1
		Draba cuneifolia var. integrifolia	Draba	0	0	1	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	1	6	2	0	0	0	0	0	1
		Guillenia lasiophylla	California mustard	0	3	4	0	0	0	0	4	6	1	0	0	0	2	0	0	5	0	0	0	0	1	2	0	1	0	0	0	0	5
		Lepidium fremontii var. fremontii	Desert alyssum	0	1	4	0	0	3	2	1	3	6	0	0	0	2	1	6	4	0	0	0	0	0	5	2	4	2	1	3	0	3
		Lepidium lasiocarpum	Shaggyfruit pepperweed	0	3	5	0	0	2	1	6	6	2	0	0	0	5	0	1	7	0	0	0	0	3	8	5	5	3	0	0	0	7
		Lepidium latifolium	Broad-leaved pepperweed	6	3	2	6	3	2	1	0	1	0	5	6	6	0	4	2	0	6	5	6	3	0	0	0	0	1	2	6	7	0
		Lepidium virginicum (lasiocarpum-type)	Virginia pepperweed	1	5	4	1	2	3	3	2	4	1	2	2	0	1	0	2	3	1	0	0	0	0	1	2	2	4	6	2	2	3
		Lesquerella tenella	Bladder pod	0	3	5	0	0	0	0	4	7	1	0	0	0	3	0	0	8	0	0	0	0	1	1	2	3	0	0	0	0	6
		Malcolmia africana	African mustard	0	2	3	0	2	3	2	3	3	4	1	2	0	2	0	4	1	0	0	0	0	2	1	3	4	3	3	3	1	3
		Rorippa nasturtium-aquatica	Water Cress	1	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	3	3	2	0	0	0	0	0	0	0	0	2	0
		Sisymbrium irio	London rocket	3	8	7	2	2	5	4	5	7	3	1	2	1	4	1	4	7	1	0	0	1	2	3	2	4	6	9	4	3	6
		Streptanthella longirostris	Streptanthella	0	2	5	0	0	0	0	1	6	1	0	0	0	0	0	0	6	0	0	0	0	3	0	0	1	0	0	0	0	4
Cactaceae	Cactus Family	Cylindropuntia echinocarpa	Golden cholla	0	1	5	0	0	0	0	2	5	1	0	0	0	5	0	0	6	0	0	0	0	1	3	3	3	1	1	0	0	6
		Cylindropuntia ramosissima	Diamond cholla	0	1	2	0	0	0	0	3	3	0	0	0	0	2	0	0	5	0	0	0	0	0	1	2	3	0	0	0	0	4
		Echinocactus polycephalus	Cottontop cactus	0	0	2	0	0	0	0	4	1	1	0	0	0	3	0	1	2	0	0	0	0	1	6	2	1	0	0	0	0	4
		Mammillaria tetrancistra	Fish-hook cactus	0	0	0	0	0	0	0	3	1	0	0	0	0	3	0	0	1	0	0	0	0	3	5	0	0	0	0	0	0	3
		Opuntia basilaris var. basilaris	Beavertail	0	3	4	0	0	0	1	6	5	1	0	0	0	8	0	0	4	0	0	0	0	1	6	4	3	1	0	0	0	5
		Sclerocactus johnsonii (=Echinomastus johnsonii)	Pineapple cactus	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	2
Campanulaceae	Bellflower Family	Nemacladus glanduliferus var. orientalis	Thread plant	0	0	0	0	0	0	0	6	0	2	0	0	0	6	0	0	0	0	0	0	0	5	4	6	4	0	0	0	0	6
Chenopodiaceae	Goosefoot Family	Allenrolfea occidentalis	Iodine bush	1	4	1	1	5	1	1	0	0	0	3	5	6	0	9	0	0	1	3	6	8	0	0	0	0	0	0	5	3	0
		Atriplex canescens ssp. canescens	Fourwing saltbush	2	5	7	3	5	9	5	1	7	6	4	2	0	0	3	5	5	0	0	0	3	1	2	1	3	3	3	4	1	2
		Atriplex confertifolia	Shadscale	0	4	6	0	2	7	6	2	3	7	2	1	0	6	2	9	5	0	0	0	3	2	4	5	4	3	1	1	0	5
		Atriplex elegans var. fasciculata	Wheelscale	2	0	0	2	5	3	4	0	0	2	3	3	1	0	0	3	0	2	0	1	0	0	0	0	0	5	4	6	5	0
		Atriplex hymenelytra	Desert holly	0	3	3	0	0	2	2	3	5	3	0	0	0	8	0	2	6	0	0	0	0	4	5	5	5	1	0	0	0	6
		Atriplex lentiformis var. lentiformis	Quail bush	5	7	4	5	9	7	6	1	4	5	8	9	8	0	7	4	2	6	6	6	7	0	0	0	1	6	7	7	7	1
		Atriplex polycarpa	Allscale	0	4	5	0	5	7	9	2	7	7	4	3	1	3	3	7	4	0	0	0	3	2	4	3	5	5	4	2	1	5
		Bassia hyssopifolia	Bassia	6	5	3	6	7	5	4	1	3	3	8	7	6	0	7	5	2	3	2	4	7	0	0	0	1	4	5	9	8	2
		Chenopodium album	Lamb's quarters	6	1	1	6	2	2	1	0	0	0	2	2	3	0	3	1	0	5	1	3	2	0	0	0	0	1	3	5	8	0
		Chenopodium ambrosioides	Mexican tea	5	0	0	5	1	0	0	0	0	0	2	1	3	0	2	0	0	6	4	5	1	0	0	0	0	0	0	1	7	0
		Chenopodium berlandieri	Lamb's quarters	3	1	0	3	2	2	2	0	0	1	2	1	3	0	3	1	0	5	3	5	2	0	0	0	0	1	2	2	7	0
		Chenopodium glaucum	Lamb's quarters	1	0	0	1	1	0	0	0	0	0	1	1	2	0	2	0	0	3	2	3	1	0	0	0	0	0	0	2	6	0
		Salsola paulsenii	Russian thistle	1	1	2	1	2	4	4	5	2	4	1	1	1	4	2	5	2	1	0	0	2	5	4	2	3	3	2	5	3	5
		Salsola tragus	Russian thistle	4	5	5	4	4	5	6	5	3	6	5	6	4	4	3	6	3	2	0	1	2	3	3	4	5	7	7	7	6	4
		Suaeda moquinii	Bush seepweed	0	3	4	0	5	7	7	0	3	8	2	2	2	0	7	8	2	0	0	1	6	0	0	1	2	4	3	4	0	2
Convolvulaceae	Morning Glory Family	Convolvulus arvensis	Bind weed	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	3	0
Cyperaceae	Sedge Family	Cyperus erythrorhizos	Nut-sedge	5	0	0	5	1	0	0	0	0	0	2	1	4	0	2	0	0	6	4	4	1	0	0	0	0	0	0	2	6	0
		Eleocharis cf. montevidensis	Spike-rush	2	0	0	2	1	0	0	0	0	0	1	0	3	0	1	0	0	6	4	4	1	0	0	0	0	0	0	0	4	0
		Eleocharis sp. (ca.macrostachya)	Spike-rush	2	0	0	2	1	0	0	0	0	0	1	1	2	0	1	0	0	6	4	4	0	0	0	0	0	0	0	0	4	0
		Schoenoplectus acutus var. occidentalis	Tule	4	0	0	4	0	0	0	0	0	0	0	0	2	0	0	0	0	8	4	4	0	0	0	0	0	0	0	1	3	0
		Schoenoplectus americanus	Olney three-square	2	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	4	3	3	0	0	0	0	0	0	0	1	2	0
		Schoenoplectus californicus	California tule	2	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	4	3	3	0	0	0	0	0	0	0	1	2	0
		Schoenoplectus maritimus	Bulrush	5	0	0	6	1	0	0	0	0	0	2	2	3	0	2	0	0	5	4	5	1	0	0	0	0	0	0	4	8	0
		Schoenoplectus pungens	Common three-square	2	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	4	3	3	0	0	0	0	0	0	0	1	3	0
Ephedraceae	Joint-Fir Family	Ephedra torreyana	Torrey joint-fir	0	3	6	0	0	0	0	2	7	1	0	0	0	2	0	0	7	0	0	0	0	2	2	1	4	0	0	0	0	5
Euphorbiaceae	Spurge Family	Euphorbia micromeria	Sonoran sand-mat	1	3	5	1	2	3	4	4	5	3	1	1	0	3	0	2	5	0	0	0	0	1	0	3	4	6	3	2	1	5
		Euphorbia prostrata	Spurge	1	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	4	0
Fabaceae	Legume Family	Acacia greggii	Catclaw	1	8	7	1	4	6	4	3	7	5	4	4	2	4	2	4	7	0	0	1	1	3	4	4	5	3	2	1	1	5
		Dalea mollissima	Dalea	0	3	4	0	0	0	0	3	5	0	0	0	0	4	0	0	6	0	0	0	0	1	4	3	2	0	0	0	0	4
		Medicago sativa	Alfalfa	2	1	0	2	1	0	0	0	0	0	1	1	2	0	0	0	0	1	0	1	0	0	0	0	0	0	2	1	3	0

List of species detected by Shanahan and Silverman (2006). Family and species names follow the Integrated Taxonomic Information System (www.itis.usda.gov). Each species is attributed a combined frequency[1]/fidelity[2] value of 0-9 for each of the land cover types documented in this study. Land cover type codes[3] consisting of the first letter of each word in the colloquial name are used. Broad geogpraphic alliances such as the *Atriplex* spp. Shrubland Alliance (Saltbush Scrub) and the *Larrea tridentata* Shrubland Alliance (Creosote Bush Scrub) are not included.

Famliy Scientific Name	Family Common Name	Scientific Name	Common Name	Land Cover Type Code: CWRF	MW	CWS	SWRS	QT	FSS	DSS	CBPS	CBWS	CBCS	SCT	SCQT	SCCRTM	DHS	IAM	SS	GGW	TM	CM	CRM	SAM	TSS	ORS	DP	WPF	SF	RF	BF	WSM	CBBS and BCBS
Fabaceae	Legume Family	Melilotus alba	White sweet-clover	2	0	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1	2	0
		Melilotus indica	Yellow sweet-clover	5	0	0	5	0	0	0	0	0	0	1	1	3	0	1	0	0	4	2	2	0	0	0	0	0	0	1	3	6	0
		Prosopis alba	White mesquite	1	1	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	1	0
		Prosopis glandulosa var. glandulosa	Honey mesquite	3	7	6	4	4	5	4	2	5	4	4	5	3	1	3	4	4	0	1	4	3	2	2	0	1	0	0	0	0	2
		Prosopis glandulosa var. torreyana	Honey mesquite	5	8	7	5	6	6	2	3	6	5	5	6	5	2	2	5	4	1	0	3	2	1	2	1	1	3	3	3	1	3
		Prosopis pubescens	Screw-bean mesquite																														
		Psorothamnus fremontii var. fremontii	Indigo bush	0	2	6	0	0	2	2	2	6	3	0	0	0	3	0	2	5	0	0	0	0	0	1	2	3	0	0	0	0	6
		Senna armata	Desert senna	0	3	6	0	0	0	0	2	6	2	0	0	0	1	0	1	7	0	0	0	0	1	0	0	1	0	0	0	0	5
Geraniaceae	Geranium Family	Erodium cicutarium	Red-leaf filaree	0	1	3	0	1	2	3	3	4	2	0	0	0	2	0	2	4	0	0	0	0	1	4	3	4	5	4	1	1	4
		Erodium texanum	Texas filaree	0	0	1	0	0	0	0	6	2	2	0	0	0	6	0	1	3	0	0	0	0	0	2	7	6	0	0	0	0	5
Hydrophyllaceae	Waterleaf Family	Eucrypta micrantha	Eucrypta	0	1	3	0	0	0	0	3	5	0	0	0	0	3	0	0	5	0	0	0	0	2	7	2	0	0	0	0	0	4
		Nama pusillum	Nama	0	0	0	0	0	0	0	3	0	0	0	0	0	4	0	0	0	0	0	0	0	0	2	7	3	0	0	0	0	2
		Phacelia ambigua	Purple phacelia	0	2	7	0	0	1	2	8	7	2	0	0	0	6	0	1	7	0	0	0	0	9	8	5	5	0	0	0	0	7
		Phacelia ivesiana	Phacelia	0	1	2	0	0	0	0	4	2	0	0	0	0	3	0	0	3	0	0	0	0	4	4	2	1	0	0	0	0	3
		Phacelia neglecta	Phacelia	0	0	0	0	0	0	0	2	0	0	0	0	0	5	0	0	0	0	0	0	0	0	1	9	2	0	0	0	0	1
		Phacelia palmeri	Palmers phacelia	0	0	2	0	0	0	0	2	2	1	0	0	0	2	0	0	2	0	0	0	0	4	1	0	1	0	0	0	0	2
		Phacelia petrosa	Talus phacelia	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	5	4	0	0	0	0	0	0	0
		Phacelia pulchella var. gooddingii	Goodding phacelia	0	1	3	0	0	0	0	4	3	1	0	0	0	4	0	0	3	0	0	0	0	6	4	4	2	0	0	0	0	3
		Phacelia rotundifolia	Round-leaf phacelia	0	0	0	0	0	0	0	3	0	0	0	0	0	2	0	0	0	0	0	0	0	3	5	0	0	0	0	0	0	2
Juncaceae	Rush Family	Juncus balticus	Wire rush	1	0	0	1	0	0	0	0	0	0	1	1	2	0	2	0	0	4	2	2	2	0	0	0	0	0	0	2	4	0
		Juncus cooperi	Cooper rush	1	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	2	2	2	1	0	0	0	0	0	0	1	2	0
Krameriaceae	Krameria Family	Krameria erecta	Range rhatany	0	3	5	0	0	1	1	2	6	4	0	0	0	6	0	2	6	0	0	0	0	1	4	4	4	1	1	0	0	6
Lemnaceae	Duckweed Family	Lemna sp. (ca. minor)	Duckweed	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	2	2	0	0	0	0	0	0	0	0	0	0
Liliaceae	Lily Family	Androstephium breviflorum	Lily	0	0	3	0	0	0	0	1	2	1	0	0	0	1	0	1	4	0	0	0	0	0	0	3	2	0	0	0	0	3
Loasaceae	Loasa Family	Mentzelia albicaulis	Stick-leaf	0	2	4	0	0	2	1	6	6	2	0	0	0	5	0	1	6	0	0	0	0	5	4	2	5	1	0	0	0	6
		Mentzelia involucrata var. involucrata	Stick-leaf	0	0	1	0	0	0	0	1	2	0	0	0	0	1	0	0	2	0	0	0	0	5	3	0	0	0	0	0	0	2
		Mentzelia obscura	Stick-leaf	0	0	2	0	0	0	0	4	2	1	0	0	0	3	0	0	2	0	0	0	0	4	1	2	2	0	0	0	0	4
		Mentzelia pterosperma	Stick-leaf	0	1	3	0	0	0	0	3	3	1	0	0	0	3	0	1	3	0	0	0	0	6	3	1	3	0	0	0	0	4
		Mentzelia tricuspis	Stick-leaf	0	2	3	0	0	1	0	4	4	1	0	0	0	3	0	0	4	0	0	0	0	8	5	3	3	0	0	0	0	5
		Petalonyx nitidus	Shining sandpaper plant	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
Malvaceae	Mallow Family	Eremalche rotundifolia	Desert five-spot	0	1	4	0	0	0	0	4	4	0	0	0	0	3	0	0	3	0	0	0	0	7	6	6	3	0	0	0	0	4
		Malva parviflora	Cheeseweed	3	1	0	3	2	0	0	0	0	0	1	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	1	5	0
		Sphaeralcea ambigua var. rugosa	Desert mallow	0	3	4	0	0	0	0	2	6	1	0	0	0	1	0	0	6	0	0	0	0	3	6	2	2	0	0	0	0	5
		Sphaeralcea emoryi	Emory mallow	1	3	2	1	2	3	1	0	2	0	1	2	0	0	0	1	2	1	0	0	0	0	0	0	0	1	1	2	3	1
Moraceae	Mulberry Family	Morus alba	White mulberry	1	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0
Nyctaginaceae	Four O'Clock Family	Allionia incarnata	Pink windmills	0	2	4	0	0	1	1	4	4	2	0	0	0	3	0	1	4	0	0	0	0	1	4	4	4	2	0	1	0	5
		Mirabilis bigelovii var. bigelovii	Four o'clock	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	1
Oleaceae	Olive Family	Fraxinus latifolia	Oregon ash																														
		Fraxinus velutina	Velvet ash																														
Onagraceae	Evening Primrose Family	Camissonia boothii ssp. condensata	Woody bottle washer	0	4	5	0	0	1	2	6	6	3	0	0	0	6	0	2	6	0	0	0	0	1	2	6	7	2	1	0	0	6
		Camissonia brevipes ssp. brevipes	Sun cup	0	0	3	0	0	2	1	6	6	3	0	0	0	5	0	2	6	0	0	0	0	9	5	4	4	2	1	0	0	6
		Camissonia brevipes ssp. pallidula	Sun cup	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1
		Camissonia chamaenerioides	Brown-eyed primrose	0	2	3	0	0	0	0	4	5	1	0	0	0	3	0	0	5	0	0	0	0	2	6	3	1	0	0	0	0	5
		Camissonia claviformis var. aurantiaca	Brown-eyed primrose	0	4	6	0	0	0	0	3	7	0	0	0	0	3	0	0	6	0	0	0	0	6	3	2	2	1	0	0	0	5
		Camissonia refracta	Evening primrose	0	3	6	0	0	0	0	4	7	1	0	0	0	2	0	0	7	0	0	0	0	5	4	2	3	0	0	0	0	5
		Camissonia walkeri ssp. tortilis	Evening primrose	0	0	2	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	3	6	1	0	0	0	0	0	1
		Oenothera caespitosa var. crinita	Evening primrose	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	2	2	0	0	0	0	0	0	1
Papaveraceae	Poppy Family	Arctomecon californica	Las Vegas bearpoppy	0	1	2	0	0	0	0	2	3	1	0	0	0	3	0	1	3	0	0	0	0	4	1	1	1	1	0	0	0	5
		Eschscholzia californica	California poppy																														
		Eschscholzia glyptosperma	Desert poppy	0	1	3	0	0	0	0	2	3	0	0	0	0	3	0	0	3	0	0	0	0	6	1	3	2	0	0	0	0	3
		Eschscholzia minutiflora ssp.	Miniature poppy																														
Plantaginaceae	Plantain Family	Plantago major	Common plantain	1	0	0	1	0	0	0	0	0	0	0	0	2	0	1	0	0	3	3	3	1	0	0	0	0	0	0	1	3	0
		Plantago ovata	Desert plantain	0	5	7	0	0	2	3	7	7	4	0	0	0	6	0	2	7	0	0	0	0	5	6	7	9	5	3	1	0	7
Plumbaginaceae	Plumbago Family	Limonium californicum	Sea lavender	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0
Poaceae	Grass Family	Aristida adscensionis	Six-weeks three-awn	0	3	3	0	0	0	0	4	3	1	0	0	0	2	0	0	3	0	0	0	0	1	7	3	1	2	0	0	0	4
		Aristida purpurea	Purple three-awn	0	3	3	0	0	0	0	1	3	0	0	0	0	2	0	0	3	0	0	0	0	1	6	1	0	0	0	0	0	3
		Arundo donax	Giant reed	2	0	0	2	3	0	0	0	0	0	3	2	3	0	1	0	0	2	3	3	0	0	0	0	0	0	0	2	3	0
		Bromus madritensis ssp. rubens	Foxtail chess	2	8	7	2	1	3	4	7	7	5	1	2	0	6	0	4	7	0	0	0	0	3	7	4	6	7	7	2	0	7
		Chloris virgata	Finger grass	2	0	0	2	1	0	0	0	0	0	1	1	2	0	1	0	0	3	0	2	1	0	0	0	0	0	0	2	6	0
		Cynodon dactylon	Bermuda grass	5	3	1	6	2	0	0	0	1	0	2	2	4	0	4	0	1	3	1	3	5	0	0	0	0	0	1	5	8	0
		Dasyochloa pulchella (=Erioneuron pulchellum)	Fluff grass	0	0	1	0	0	0	0	3	3	1	0	0	0	3	0	1	2	0	0	0	0	2	7	3	2	0	0	0	0	3
		Distichlis spicata	Saltgrass	0	1	0	0	3	0	0	0	0	0	3	3	4	0	8	0	0	1	2	3	9	0	0	0	0	0	0	2	1	0

List of species detected by Shanahan and Silverman (2006). Family and species names follow the Integrated Taxonomic Information System (www.itis.usda.gov). Each species is attributed a combined frequency[1]/fidelity[2] value of 0-9 for each of the land cover types documented in this study. Land cover type codes[3] consisting of the first letter of each word in the colloquial name are used. Broad geogpraphic alliances such as the *Atriplex* spp. Shrubland Alliance (Saltbush Scrub) and the *Larrea tridentata* Shrubland Alliance (Creosote Bush Scrub) are not included.

				Land Cover Type Code																													
Famliy Scientific Name	Family Common Name	Scientific Name	Common Name	CWRF	MW	CWS	SWRS	QT	FSS	DSS	CBPS	CBWS	CBCS	SCT	SCQT	SCCRTM	DHS	IAM	SS	GGW	TM	CM	CRM	SAM	TSS	ORS	DP	WPF	SF	RF	BF	WSM	CBBS and BCBS
Poaceae	Grass Family	Echinochloa crus-gallii	Barnyard grass	5	1	0	6	2	0	0	0	0	0	2	2	3	0	2	0	0	4	2	3	2	0	0	0	0	1	2	5	8	0
		Leptochloa uninerva	Mexican sprangletop	4	0	0	4	0	0	0	0	0	0	2	2	3	0	2	0	0	6	6	6	2	0	0	0	0	0	0	2	7	0
		Muhlenbergia asperifolia	Mist grass	0	0	0	0	0	0	0	0	0	0	0	1	1	0	5	0	0	0	1	2	7	0	0	0	0	0	0	1	0	0
		Panicum capillare	Witchgrass	3	0	0	3	0	0	0	0	0	0	0	0	2	0	0	0	0	2	2	3	0	0	0	0	0	0	0	1	6	0
		Panicum cf. hirticaule	Panic grass	0	2	2	0	0	1	1	2	2	1	0	0	0	2	0	0	2	0	0	0	0	1	3	2	1	1	0	0	1	2
		Paspalum distichum	Ditchgrass	1	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	6	5	5	1	0	0	0	0	0	0	0	2	0
		Phragmites australis	Common reed	7	4	1	7	5	2	2	0	0	0	5	6	8	0	7	0	0	6	8	9	7	0	0	0	0	2	4	6	6	0
		Pleuraphis rigida	Galleta grass	0	6	8	0	0	0	0	1	7	1	0	0	0	2	0	0	9	0	0	0	0	1	5	3	1	0	0	0	0	6
		Polypogon monspeliensis	Rabbit's foot grass	3	0	0	3	0	0	0	0	0	0	1	1	4	0	1	0	0	6	4	5	1	0	0	0	0	0	0	2	7	0
		Polypogon viridis	Bent grass	2	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	3	2	2	0	0	0	0	0	0	0	0	4	0
		Schismus barbatus	Splitgrass	2	8	8	2	3	7	7	8	8	6	1	2	0	7	0	6	8	0	0	0	0	6	7	6	8	9	7	2	2	8
		Setaria pumila	Bristlegrass	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	2	0
		Sorghum halapense	Johnsongrass	4	1	0	4	1	0	0	0	0	0	2	2	3	0	1	0	0	4	3	5	0	0	0	0	0	0	0	2	7	0
		Sporobolus airoides	Alkali sacaton	2	2	0	3	3	2	1	0	0	0	2	2	2	0	6	1	0	3	0	2	7	0	0	0	0	1	0	5	5	0
		Vulpia octoflora var. hirtella	Six weeks fescue	1	7	7	1	1	5	5	7	7	3	1	1	0	5	0	3	7	0	0	0	0	5	6	3	5	3	2	0	1	7
Polemoniaceae	Phlox Family	Gilia cana	Gilia	0	0	1	0	0	0	0	2	2	0	0	0	0	1	0	0	2	0	0	0	0	2	3	2	1	0	0	0	0	2
		Gilia clokeyii	Clokey's gilia	0	0	1	0	0	0	0	2	2	0	0	0	0	1	0	0	3	0	0	0	0	1	2	1	2	0	0	0	0	2
		Gilia latifolia	Broad-leaf gilia	0	1	4	0	0	0	0	6	5	0	0	0	0	7	0	0	3	0	0	0	0	3	7	6	3	0	0	0	0	6
		Gilia scopulorum	Rock gilia	0	0	2	0	0	0	0	4	2	0	0	0	0	2	0	0	1	0	0	0	0	3	7	1	1	0	0	0	0	4
		Ipomopsis polycladon	Spreading gilia	0	0	1	0	0	0	0	5	1	1	0	0	0	5	0	0	2	0	0	0	0	0	2	5	3	0	0	0	0	5
		Langloisia setosissima var. setosissima	Bristly langloisia	0	1	5	0	0	0	1	7	5	2	0	0	0	7	0	1	5	0	0	0	0	6	7	7	6	1	0	0	0	6
		Linanthus bigelovii-jonesii	Linanthus	0	1	3	0	0	0	0	6	3	0	0	0	0	7	0	0	3	0	0	0	0	2	6	7	3	0	0	0	0	5
		Linanthus demissus	Desert linanthus	0	2	5	0	0	0	0	4	6	0	0	0	0	3	0	0	6	0	0	0	0	1	3	3	4	0	0	0	0	5
Polygonaceae	Buckwheat Family	Chorizanthe brevicornu	Brittle spineplant	0	1	3	0	0	1	1	6	4	2	0	0	0	6	0	1	4	0	0	0	0	5	7	5	5	1	0	0	0	6
		Chorizanthe corrugata	Corrugated spineplant	0	0	0	0	0	0	0	3	0	0	0	0	0	7	0	0	0	0	0	0	0	1	2	8	4	0	0	0	0	2
		Chorizanthe rigida	Rigid spineplant	0	1	2	0	0	1	2	7	3	3	0	0	0	8	0	2	3	0	0	0	0	2	3	8	7	3	1	0	0	6
		Eriogonum deflexum var. deflexum	Buckwheat	2	2	5	2	1	3	3	3	6	4	2	3	1	2	0	4	5	0	0	0	0	6	3	1	3	5	3	5	2	5
		Eriogonum inflatum var. inflatum	Desert trumpet	0	1	4	0	0	0	1	4	5	1	0	0	0	4	0	1	5	0	0	0	0	4	7	2	2	1	0	0	0	6
		Eriogonum insigne	Buckwheat	0	1	2	0	0	0	0	2	3	1	0	0	0	2	0	0	3	0	0	0	0	5	2	2	2	0	0	0	0	3
		Eriogonum thomasii	Thomas buckwheat	0	0	3	0	0	0	0	4	3	0	0	0	0	5	0	0	3	0	0	0	0	7	7	1	4	0	0	0	0	5
		Eriogonum trichopes var. trichopes	Little trumpet	0	3	5	0	0	0	2	6	6	2	0	0	0	6	0	1	6	0	0	0	0	7	5	6	7	2	0	0	0	7
		Polygonum arenastrum	Common knotweed	3	1	1	3	1	1	0	0	1	0	2	2	4	0	1	0	0	3	2	3	1	0	0	0	0	1	1	3	6	0
		Polygonum lapathifolium	Willow weed	5	0	0	5	1	0	0	0	0	0	1	2	5	0	2	0	0	6	3	4	1	0	0	0	0	0	0	3	8	0
		Rumex stenophyllus	Dock	3	0	0	3	1	0	0	0	0	0	2	2	3	0	1	0	0	5	6	5	1	0	0	0	0	0	0	1	5	0
Portulacaceae	Purslane Family	Portulaca oleracea	Common purslane	3	0	0	3	2	1	1	0	0	0	2	2	2	0	0	0	0	2	2	2	0	0	0	0	0	0	1	3	6	0
Ranunculaceae	Ranunculus Family	Delphinium parishii	Parish larkspur	0	0	2	0	0	0	0	1	2	0	0	0	0	1	0	0	3	0	0	0	0	1	2	1	2	0	0	0	0	2
Resedaceae	Reseda Family	Oligomeris linifolia	Mignonette	0	0	2	0	2	2	2	5	2	3	1	1	0	5	0	3	1	0	0	0	0	2	1	6	6	3	1	2	1	4
Salicaceae	Willow Family	Populus fremontii	Fremont cottonwood	9	0	0	6	2	0	0	0	0	0	4	3	4	0	2	0	0	4	5	5	2	0	0	0	0	0	0	2	5	0
		Salix exigua	Sandbar willow	6	0	0	8	1	0	0	0	0	0	2	1	3	0	0	0	0	4	4	4	0	0	0	0	0	0	0	0	3	0
		Salix gooddingii	Goodding willow	8	0	0	6	2	0	0	0	0	0	3	2	4	0	1	0	0	5	5	5	1	0	0	0	0	0	0	0	3	0
		Salix laevigata	Red willow	2	0	0	1	0	0	0	0	0	0	1	1	2	0	1	0	0	1	1	1	1	0	0	0	0	0	0	0	1	0
Saururaceae	Lizard's-tail Family	Anemopsis californica	Yerba Mansa																														
Scrophulariaceae	Figwort Family	Antirrhinum filipes	Twining snapdragon	0	4	5	0	0	0	0	4	7	2	0	0	0	2	0	1	7	0	0	0	0	0	5	2	1	0	0	0	0	5
		Mohavea breviflora	Golden desert snapdragon	0	0	1	0	0	0	0	2	2	0	0	0	0	1	0	0	1	0	0	0	0	5	4	0	0	0	0	0	0	2
		Veronica anagallis-aquatica	Water speedwell	3	0	0	3	1	0	0	0	0	0	1	1	4	0	0	0	0	5	5	5	0	0	0	0	0	0	0	2	5	0
Solanaceae	Nightshade Family	Datura wrightii	Sacred datura	6	5	4	6	4	2	0	0	3	0	3	4	4	0	1	0	2	1	0	2	0	1	0	0	0	2	3	5	7	0
		Lycium andersonii var. andersonii	Anderson thornbush	0	7	8	0	1	2	3	2	8	4	0	1	0	3	0	3	8	0	0	0	0	1	4	3	3	2	0	0	0	6
		Lycium fremontii	Fremont's desert thorn																														
		Lycium sp.	Thornbush																														
		Nicotiana glauca	Tree tobacco	2	0	0	2	1	0	0	0	0	0	1	1	2	0	0	0	0	3	1	3	0	0	0	0	0	0	1	2	5	0
		Nicotiana obtusifolia	Desert tobacco	0	2	2	0	0	0	0	2	1	0	0	0	0	1	0	0	2	0	0	0	0	5	5	0	0	0	0	0	0	2
		Physalis crassifolia	Ground cherry	0	2	3	0	0	0	0	0	2	0	0	0	0	0	0	0	3	0	0	0	0	4	6	0	0	0	0	0	0	0
		Solanum americanum	Nightshade	2	0	0	3	1	0	0	0	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	6	0
		Solanum elaeagnifolium	Silver-leaf nightshade	3	0	0	4	1	1	1	0	0	0	2	1	2	0	1	0	0	0	0	1	0	0	0	0	0	0	1	4	6	0
Tamaricaceae	Tamarisk Family	Tamarix ramosissima	Salt cedar	7	7	6	7	7	6	6	0	5	3	9	9	9	0	7	4	3	6	7	7	7	0	0	0	0	6	6	7	7	1
Typhaceae	Cattail Family	Typha domingensis	Southern cattail	5	1	0	5	2	0	0	0	0	0	3	3	6	0	5	0	0	7	9	7	5	0	0	0	0	0	0	3	5	0
Ulmaceae	Elm Family	Ulmus pumila	Siberian elm	1	0	0	1	1	0	0	0	0	0	1	1	2	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	2	0
		Ulmus sp.	Elm																														
Viscaceae	Mistletoe Family	Phorodendron californicum	Desert mistletoe	0	8	7	0	2	3	2	0	6	4	1	1	0	0	0	4	5	0	0	0	0	0	0	0	0	0	0	0	0	4
Vitaceae	Grape Family	Vitis arizonica	Desert grape																														
Zannichelliaceae	Horned Pond Weed Family	Zannichellia palustris	Horned pond weed	1	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	2	2	2	1	0	0	0	0	0	0	0	1	0
Zygophyllaceae	Caltrop Family	Larrea tridentata	Creosote bush	1	5	8	1	2	5	6	9	9	8	1	1	1	8	0	6	7	0	0	0	0	3	5	5	6	3	3	0	0	9

[1]Fidelity = Potential to occur in that land cover type, how associated and typical it is for that type and that plant's preference for that land cover type. Fidelity and frequency information is combined and measured by a 0-10 value listed below.

[2]Frequency = How often or how numerous that plant species would occur in that land cover type. Frequency and fidelity information is combined and measured by a 0-10 value listed below.

Notes: Values at the lower levels are estimated partly from observations and collections in Las Vegas Wash project area and general regional estimations. Values at the higher levels are estimated mostly from observations and collections in Las Vegas Wash project area. Occurrence and frequency are estimated from the assumed maximum potentials in the season of maximum detectability.

Value	Fidelity	Frequency	Comments
0	Highly Unlikely	Absent	Plant should not occur in that type, even for a variety of sporadic reasons and the land cover would not support survival of individuals of that species, but germination and juvenile plants are always possible. No observations at Wash to confirm presence, and plant can be generally ruled out of occurring in that indicated land cover type.
1	Unlikely	Unexpected	Plant could occur for a variety of sporadic reasons and indicated land cover type could support limited survival for that species, but likely not to reproduce and become more numerous. No observations at Wash to confirm presence, but plant could not be ruled out of that indicated land cover type, even if no observations in the season of maximum detectability.
2	Unassociated	Rare	Plant might occur and habitat could support it's limited survival, but likely not to be numerous. Usually a single observation or collection at Wash to confirm presence, but plant may not occur at this type currently since time of last observation. Weakly suitable land cover type is a strong limiting factor to how extensive the plant can be for the indicated land cover type. The species should not be ruled out of that land cover type, even if no current observations in the season of maximum detectability.
3	Incidental	Uncommon	Plant may occur on a limited basis and habitat is within reasonable range for plant to thrive in a microhabitat niche. Several observations at Wash to confirm presence. Sub-optimal land cover type expected to be a strong limiting factor to how potentially numerous the plant can be for that type. Nearly always present however, within indicated land cover type as living plants or seed bank, but unlikely that it will be observed without extensive survey in the season of maximum detectability.
4	Peripheral	Infrequent	Plant occurs on a limited basis and habitat is within reasonable range for plant to thrive locally. Preferred habitat for plant is usually adjacent to indicated type, but not intergrading. Sub-optimal land cover type expected to be a strong limiting factor to how potentially numerous the plant can be for that type. Nearly always present within indicated land cover type as living plants or seed bank, but unlikely that it will be observed without some extended survey in the season of maximum detectability.
5	Intergrading	Occasional	Plant occurs on a limited to frequent basis, depending on local factors and seasonal conditions. Preferred habitat for the plant is usually intergrading from an overlapping type of equal or better suitability, that is a subset or inclusive of indicated land cover type. Indicated land cover type suitability not as influential as microhabitat conditions or seasonal effects. Always present within indicated land cover type as living plants or seed bank, but usually not well distributed, should be easy to observe with limited survey in the season of maximum detectability.
6	Inclusive	Expected	Plant occurs on a mostly regular-predictable to frequent basis, depending on seasonal conditions. Land cover type is within preferred range for the plant species and can influence adjacent types with extended occurrences of species. Always present within indicated land cover type as living plants or seed bank, easy to observe, though not numerous, with brief-extended observation in the season of maximum detectability.
7	Associated	Frequent	Plant occurs on a predictable and often frequent basis, depending on seasonal conditions. Land cover type is well-within preferred range for the plant species and can influence adjacent types with extended occurrences of species. Always present within indicated land cover type as living plants or seed bank, easy to observe, often numerous, with brief observation in the season of maximum detectability.
8	Characteristic	Common	Plant occurs on a frequent basis, often a co-dominant cover within the species stratum, depending on seasonal conditions. Land cover type is near-optimal for the plant species and usually influences adjacent types with extended occurrences of species. Always present within indicated land cover type as living plants or seed bank, easy to observe, often numerous, unlikely to be missed in any one place with a brief observation in the season of maximum detectability.
9	Defining	Dominant	Plant is ubiquitous as the dominant cover within the species stratum, depending on seasonal conditions. Land cover type is optimal for the plant species and influences adjacent types, including unlikely habitats, with extended occurrences of species. Always numerous and present within indicated land cover type as living plants or seed bank, always observed in any one place in indicated type with a brief observation in the season of maximum detectability.
10	Exclusive	Regular	Plant is a an obligate to the indicated land cover type and is unlikely to occur in any other types in the project area. Frequency and cover in the land cover type, are relative to the species' typical distribution pattern, local degree of microhabitat suitability and seasonal conditions. Land cover type is optimal for the plant species, but has little or no influence on adjacent types, including similar habitats, with extended occurrences. Always present within indicated land cover type as living plants or seed bank, usually observed with brief observation or limited survey in the season of maximum detectability.

[3]Land Cover Type Codes

Code	Colloquial Name	Scientific Name
CWRF	Cottonwood-Willow Riparian Forest	Populus fremontii-Salix gooddingii Temporarily Flooded Forest Alliance
MW	Mesquite Woodland	Prosopis spp. Woodland Association
CWS	Catclaw Wash Scrub	Acacia greggii Woodland Association
SWRS	Sandbar Willow Riparian Scrub	Salix exigua Temporarily Flooded Shrubland Alliance
QT	Quailbush Thicket	Atriplex lentiformis Shrubland Association
FSS	Fourwing Saltbush Scrub	Atriplex canescens Shrubland Association
DSS	Desert Saltbush Scrub	Atriplex polycarpa Shrubland Association
CBPS	Creosote Bush Pure Stand	Larrea tridentata Shrubland Association
CBWS	Creosote Bush Wash Scrub	Larrea tridentata Wash Shrubland Association
CBCS	Creosote Bush Chenopod Scrub	Larrea tridentata-Atriplex spp. Shrubland Association
SCT	Salt Cedar Thicket	Tamarix ramosissima Shrubland Alliance
SCQT	Salt Cedar-Quailbush Thicket	Tamarix ramosissima-Atriplex lentiformis Shrubland Association
SCCRTM	Salt Cedar-Common Reed Thicket and Marsh	Tamarix ramosissima/Phragmites australis Shrubland Association
DHS	Desert Holly Scrub	Atriplex hymenelytra Dwarf Shrubland Association
IAM	Iodinebush Alkaline Meadow	Allenrolfea occidentalis Intermittently Flooded Dwarf Shrubland Association
SS	Shadscale Scrub	Atriplex confertifolia Dwarf Shrubland Association
GGW	Galleta Grass Wash	Pleuraphis rigida Herbaceous Association
TM	Tule Marsh	Schoenoplectus spp. Permanently to Semipermanently Flooded Herbaceous Alliance
CM	Cattail Marsh	Typha domingensis Permanently Flooded Herbaceous Alliance
CRM	Common Reed Marsh	Phragmites australis Semipermanently Flooded Herbaceous Alliance
SAM	Saltgrass Alkaline Meadow	Distichlis spicata Intermittently Flooded Herbaceous Alliance
TSS	Talus/Scree Slope	Scree Herbaceous Association
ORS	Outcrop Rocky Slope	Rocky Slopes Herbaceous Association
DP	Desert Pavement	Desert Pavement Herbaceous Association
WPF	Wooly Plantain Field	Plantago ovata Herbaceous Association
SF	Splitgrass Field	Schismus spp. Herbaceous Association
RF	Ruderal Field	Sisymbrium irio Herbaceous Association
BF	Bassia Field	Bassia hyssopifolia Herbaceous Association
WSM	Weedy Sandbars and Mudflats	Non-Native Intermittently Flooded Herbaceous Association
CBBS and BCBS	Creosote Bush-Bursage Scrub and Bursage-Creosote Bush Scrub	Larrea tridentata/Ambrosia dumosa Shrubland Association and Ambrosia dumosa/Larrea tridentata Dwarf Shrubland Association

Appendix B

Dichotomous Key to the Land Cover Types found along the Las Vegas Wash

Key to the Formation Classes of the Las Vegas Wash, Nevada

1. Vegetation present 2

1a. Vegetation absent or almost entirely so 2a

2. Vegetated Formations.

3. Woody plant species absent .... A. Herbaceous Formation Class

3a. Woody plant species present.

4. Woody plant cover part of a surrounding vegetation pattern characterized by subshrubs, shrubs or trees.

5. Woody vegetation cover primarily formed by single stemmed arborescent plants greater than ten feet tall, or these plants more prominent than shrubs.

6. Arborescent plants with mature canopies of different levels, canopy cover of taller tree species overlapping smaller trees species canopies .... B. Forest Formation Class

6a. Arborescent plants with mature canopies at the same level, canopy cover of tree species intermixed or in close contact .... C. Woodland Formation Class

5a. Woody vegetation cover primarily formed by shrubby plants or multi-stemmed arborescent like plant generally less than ten feet tall, or these plants very prominent.

7. Woody plant cover primarily formed by shrubby plants greater than two feet tall, or these plants most prominent .... D. Shrubland Formation Class

7a. Woody plant cover primarily formed by shrubby plants generally less than two feet tall .... E. Dwarf Shrubland Formation Class

4a. Woody plant cover scattered as isolated plants, or very sparsely distributed in a localized area, generally not part of a surrounding pattern of similar woody plant species .... A. Herbaceous Formation Class

2a. Unvegetated and Sparsely Vegetated Formations.

8. Vegetation present but mostly in the form of annual plants .... A. Herbaceous Formation Class

8a. Rooted vegetation absent or site appears disturbed by natural or anthropogenic occurrences.

9. Site inundated with water .... F. Open Water

9a. Site not inundated with water.

10. Site appears disturbed by the actions of humans .... G. Disturbed Area-Human

10a. Site appears disturbed by natural phenomena such as flooding .... H. Disturbed Area-Natural

Key to the Herbaceous Formations of the Las Vegas Wash, Nevada

A. Herbaceous Formation Class

1. Herbaceous plant cover characterized by mostly perennial graminoid species.

   2. Perennial herbaceous plant cover characterized by grass species that grow in well-drained areas, generally arid upland sites .... I. Perennial Graminoid Formation

   2a. Perennial herbaceous plant cover characterized by monocots that grow in areas inundated, saturated or seasonally saturated with water

      3. Perennial herbaceous plant cover characterized by tall monocot species that grow in areas saturated or inundated with water .... J. Permanently or Semipermanently Flooded Perennial Graminoid Formation

      3a. Perennial herbaceous plant cover characterized by shorter grass species with other perennial herbs that grow in areas seasonally saturated with water .... K. Intermittently Flooded Perennial Graminoid Formation

1a. Herbaceous plant cover characterized by mostly annual forb species.

   4. Annual herbaceous plant cover characterized by low-growing native species that occur on desert pavements, bedrock slopes and friable soil strata .... L. Annual Forb Formation

   4a. Annual herbaceous plant cover characterized by taller invasive annual species with some perennials and early woody plants, of disturbed and seral mesic or riparian sites ....M. Non-Native Annual Forb Formation

Key to the Alliances and Major Associations of the Las Vegas Wash, Nevada

I. Perennial Graminoid Formation

Localized areas of dense galleta grass (*Pleuraphis rigida*) in shallow drainages or washes, or co-dominant with subshrubs such as white bursage (*Ambrosia dumosa),* range rhatany (*Krameria erecta*), ephedra (*Ephedra* spp.), or desert senna (*Senna armata*). Often grading into white bursage or catclaw (*Acacia greggii*) wash scrub.. *Pleuraphis rigida* Herbaceous Association (Galleta Grass Wash)

J. Permanently or Semipermanently Flooded Perennial Graminoid Formation

1. Emergent vegetation, characterized by a mixture of planted species such as bulrush (*Schoenoplectus* spp.) and rush (*Juncus* spp.), with naturalized associates of cattail (*Typha domingensis*) and common reed (*Phragmites australis*)..*Schoenoplectus* spp. Permanently to Semipermanently Flooded Herbaceous Alliance (Tule Marsh)

1a. Emergent vegetation, characterized by naturalized stands of cattail and common reed, planted emergents are absent or a minor part of the cover.

2. Cattail (*Typha domingensis*), as primary or co-dominant emergent vegetation cover, usually restricted to narrow stands, inundated sites near open water, often with common reed as an associate ....*Typha domingensis* Permanently Flooded Herbaceous Alliance (Cattail Marsh)

2a. Common reed (*Phragmites australis*), as primary emergent vegetation cover, often as pure extensive stands, or with salt cedar (*Tamarix ramosissima*), cattail (*Typha domingensis*), or quailbush (*Atriplex lentiformis*), invasive, inundated to seasonally mesic sites ....*Phragmites australis* Semipermanently Flooded Herbaceous Alliance (Common Reed Marsh)

K. Intermittently Flooded Perennial Graminoid Formation

Saltgrass (*Distichlis spicata*) as pure stand of perennial herb cover or as a co-dominant patchy cover with other shrubs and perennials including iodine bush (Allenrolfea occidentalis), seepweed (Suaeda moquinii), sea lavender (*Limonium californicum*), mist grass (*Muhlenbergia asperifolia*), and alkali sacaton (*Sporobolus airoides*). Honey mesquite (*Prosopis glandulosa* var. *torreyana*) and salt cedar (*Tamarix ramosissima*) are often found as components of this formation...............................*Distichlis spicata* Intermittently Flooded Herbaceous Alliance (Saltgrass Alkaline Meadow)

L. Annual Forb Formations

1. Localized, mostly undisturbed, shrubless zones with primary vegetation cover seasonally from annual plants, areas of bajada and foothills, on moderate to steep slopes, with rock outcrops, talus and scree .... 2 or 2a

2. Steep scree or badland slopes, coarse loose soils, typically where soft alluvial-metamorphic strata are exposed, vegetation cover primarily as seasonal forb formations, characterized by blazing star (*Mentzelia tricuspis*), desert sunflower (*Geraea canescens*), sun cups (*Camissonia brevipes*) , and other annual plants that are adapted to loose slopes...Scree Herbaceous Association (Talus/Scree Slope)

2a. Steep rocky slopes, with outcrops, boulders rocks and talus, sandy soils, typically where hard rock strata are exposed, vegetation cover primarily as seasonal forb formations, characterized by purple phacelia (*P. crenulata*), *Cryptantha* spp., and other annual plants that are adapted to rocky slopes .... Rocky Slopes Herbaceous Association (Outcrop Rocky Slope)

1a. Localized mostly undisturbed shrubless zones with primary vegetation cover seasonally from annual plants, areas on bajada ridges, with terraces, rocky flats and pavements .... 3 or 3a

3. Flat-planed terraced ridgetops, with tightly knit pavements of weathered rocks, typically with patina on upper surface, vegetation cover primarily as seasonal forb formations, characterized by *Phacelia neglecta*, *Langloisia setosissima*, *Chaenactis carphoclinia*, rigid spineplant pincushion (*Chorizanthe rigida*) and other annual plants that are adapted to desert pavements ....Desert Pavement Herbaceous Association (Desert Pavement)

3a. Low-angle slope benches and terraces, with typical desert soil of sand and small rocks, without patina weathering, characterized by wooly plantain (*Plantago ovata*) with other mixed desert annuals .... *Plantago ovata* Herbaceous Association (Wooly Plantain Field)

M. Non-Native Annual Forb Formations

1. Weedy annual plant formations of disturbed or invasive sites, vegetation cover primarily from low-growing seasonal stands of splitgrass (*Schismus* spp.) or taller dense seasonal stands of London rocket (*Sisymbrium irio*), plants that mature in late spring or early summer, typically sandy, open disturbed areas on edges of creosote bush scrub .... 2 or 2 a

2. Vegetation cover primarily from low-growing seasonal stands of splitgrass (*Schismus* spp.) .... *Schismus* spp. Herbaceous Association (Splitgrass Field)

2a. Vegetation cover primarily from moderate to tall-growing seasonal stands of London rocket (*Sisymbrium irio*) .... *Sisymbrium irio* Herbaceous Association (Ruderal Field)

1a. Weedy annual plant formations of disturbed or invasive sites, vegetation cover primarily from tall-growing seasonal stands of annuals, little or no splitgrass (*Schismus* spp.) present, stands that mature in late summer or fall, typically finer, mesic soil conditions, in openings among reed, salt cedar and quailbush 3

3. Vegetation cover primarily of annual herbs, moderate to tall-growing seasonal stands of *Bassia hyssopifolia* and Russian thistle (*Salsola* spp.) stands somewhat open, plants all mature by end of fall... *Bassia hyssopifolia* Herbaceous Association (Bassia Field)

3a. Vegetation cover primarily of annual or biennial forbs, tall-growing ephemeral stands of various mesic weeds including *Aster subulatus, Xanthium, Amaranthus, Chenopodium, Sorghum, Conyza, Pluchea odorata, Datura, Lepidium latifolium, Polygonum lapathifolium,* and *Rumex stenophyllus*, stands usually dense, plants mature variably, from the end of fall through the next growing season.. Non-Native Intermittently Flooded Herbaceous Association (Weedy Sandbars and Mudflats)

B. Forest Formation Classes

Areas of older cottonwood (*Populus fremontii*) and willow (*Salix gooddingii*) plantings with understory of salt cedar, mesquite, quailbush and other shrubs or emergents, of disturbed-cultivated, seral-mesic or riparian sites, strand-shaped stands along wash terraces..*Salix gooddingii-Populus fremontii* Temporarily Flooded Forest Alliance (Cottonwood-Willow Riparian Forest)

C. Woodland Formations

1.Open, often linear, low tree/tall shrub stands of mesquite (*Prosopis* spp.) and limited salt cedar, in drainages, washes, and revegetated areas with saltbush or wash scrub species as a significant cover portion or as a dense understory..*Prosopis* spp. Woodland Association (Mesquite Woodland)

1a. Open, linear, low tree/tall shrub stands of catclaw (*Acacia gregii*) and limited salt cedar, in drainages and washes with saltbush or wash scrub species as a significant cover portion or as a dense understory..*Acacia greggii* Woodland Association (Catclaw Wash Scrub)

D. Shrubland Formation Classes

1. Shrub formations with dominant vegetation cover from species other than salt cedar .... 2 or 2a

2. Shrub formations with sandbar willow (*Salix exigua*) as the primary vegetation cover, usually in pure stands or with emergents and other plantings as associates, in revegetation sites, alluvial terraces, riparian wash banks and bars, within the main Las Vegas Wash .... *Salix exigua* Temporarily Flooded Shrubland Alliance (Sandbar Willow Riparian Scrub)

2a. Shrub formations with species other than sandbar willow as primary vegetation cover, outside of main Las Vegas Wash channel.

3. Shrub formations with taller species of saltbush (*Atriplex* spp. greater than 2.5 feet tall) as primary vegetation covers..*Atriplex* spp. Shrubland Alliance (Saltbush Scrub; for Association go to 4 or 4a)

4. Dense pure stands of quailbush (*Atriplex lentiformis*), typically on terraces in zones between salt cedar shrubland and upland scrub types ....*Atriplex lentiformis* Shrubland Association (Quailbush Thicket)

4a. Moderately dense to open stands of other saltbush species, usually in zones upslope of quailbush and salt cedar.

5. Shrub stands with vegetation cover dominated by fourwing saltbush (*A. canescens*), typically in zones between quailbush and other chenopod shrubs, or grading into wash scrubs under catclaw, mesquite and creosote bush ....*Atriplex canescens* Shrubland Association (Fourwing Saltbush Scrub)

5a. Shrub stands with vegetation cover dominated by desert saltbush (*A. polycarpa*), typically in zones upslope of fourwing saltbush or quailbush, often with other chenopod shrubs, or grading into creosote bush scrub...*Atriplex polycarpa* Shrubland Association (Desert Saltbush Scrub)

3a. Shrub formations with species other than saltbush and sandbar willow as primary vegetation covers.

6. Shrub formations with salt cedar as co-dominant vegetation cover ....*Tamarix ramosissima* Shrubland Alliance (Salt Cedar Thicket; for Association go to 10 or 10a)

6a. Shrub types dominated by open stands of creosote bush (*Larrea tridentata*), often with low shrubs as associates..*Larrea tridentata* Shrubland Alliance (Creosote Bush Shrubland Alliance; for Association go to 7 or 7a)

7. Creosote bush in pure stands, without low shrubs, generally rocky slopes or pavement ridges...............................*Larrea tridentata* Shrubland Association (Creosote Bush Pure Stand)

7a. Creosote bush with other shrubs in variable densities.

8. Creosote bush with white bursage (*Ambrosia dumosa*) as secondary cover, and other low shrubs in variable, mostly sparse densities, generally alluvial fan slopes, alternating with other shrub associations of drainages or with barren areas of seasonal annual herbs/forbs ....*Larrea tridentata*/*Ambrosia dumosa* Shrubland Association (Creosote Bush-Bursage Scrub)

8a. Creosote bush co-dominant with other shrubs, generally lower alluvial fan slopes or drainages and washes, often grading into saltbush-dominated vegetation.

9. Creosote bush co-dominant with other mixed shrubs characteristic of drainages and washes, such as *Hymenoclea, Ambrosia, Ephedra, Lycium*. Catclaw (*Acacia gregii*) is absent or very sparse ....*Larrea tridentata* Wash Shrubland Association (Creosote Bush Wash Scrub)

9a. Creosote bush co-dominant with other chenopod shrubs .... *Larrea tridentata-Atriplex* spp. Shrubland Association (Creosote Bush Chenopod Scrub)

1a. Shrub formations with salt cedar as primary vegetation cover...*Tamarix ramosissima* Shrubland Alliance (Salt Cedar Thicket; for Association go to 10 or 10a)

10. Clustered stands of salt cedar, with quailbush (*Atriplex lentiformis*) as a common understory or co-dominant cover, combined as a multi-canopy dense thicket formation, of terraces and alluvial flats mostly .... *Tamarix ramosissima-Atriplex lentiformis* Shrubland Association (Salt Cedar-Quailbush Thicket)

10a. Dense or clustered stands of salt cedar with common reed as a common understory or co-dominant cover, combined as an open woodland along wash banks and inundation zones, with occasional quailbush..*Tamarix ramosissima*/*Phragmites australis* Shrubland Association (Salt Cedar-Common Reed Thicket and Marsh)

E. Dwarf Shrubland Formation Classes

1. Low shrub formations with white bursage (*Ambrosia dumosa*) as primary cover species, often with other low shrubs such as *Krameria*, *Senna*, galleta grass (*Pleuraphis*), and cactus (*Opuntia* spp.), sites typically in upland drainages within greater area of *Larrea tridentata* Shrubland Alliance .... *Ambrosia dumosa/Larrea tridentata* Dwarf Shrubland Association (Bursage-Creosote Bush Scrub)

1. Low shrub formations without white bursage as primary cover, vegetation characterized by other low-growing Chenopod shrubs as dominant cover species, forming at transitional edges of *Larrea tridentata* Shrubland Alliance.

    2. Low shrub formations with desert holly (*Atriplex hymenelytra*) as primary or co-dominant woody plant cover, with low forms of *Larrea* and beavertail cactus (*Opuntia basilaris*), as associates .... *Atriplex hymenelytra* Dwarf Shrubland Association (Desert Holly Scrub)

    2. Low shrub formations without desert holly or white bursage as primary woody cover plants, vegetation cover composed of other species of *Atriplex* or iodine bush (*Allenrolfea*), with bush seepweed (*Suaeda*) as an associate

        3. Areas of alluvial flats where soils are seasonally saturated, with iodine bush (*Allenrolfea occidentalis*) as primary shrub cover, mostly as low shrubs, often in pure stands, or with saltgrass, bush seepweed, and other mesic-soil chenopod shrubs .... *Allenrolfea occidentalis* Intermittently Flooded Dwarf Shrubland Association (Iodinebush Alkaline Meadow)

        3. Localized areas, typically on sloped terraces of lower bajada areas, with generally sparse vegetation on well-drained calcareous soils, with shadscale (*Atriplex confertifolia*), as a prominent low shrub cover, typically between wash types or other saltbush forms of vegetation forms, and the lower end of Creosote Bush Scrub .... *Atriplex confertifolia* Dwarf Shrubland Association (Shadscale Srcub)

Appendix C

Land Cover Types of the Las Vegas Wash

Land Cover Types of the Las Vegas Wash, Nevada

INTRODUCTION

Vegetation type, extent, continuity, and structure are some of the most important factors that determine wildlife diversity and distribution. Other contributing factors that shape wildlife communities include disturbance, competition, climate, and water availability. Because vegetation communities in the southwestern U.S. gradate sharply along zones of soil moisture, wildlife are often restricted to specific vegetation types. Along the Las Vegas Wash (Wash), Nevada, more than 250 wildlife species have been documented to occur in distinct wetland, riparian, and upland vegetation types. Recent studies have investigated the diversity and distribution of amphibians, birds, fishes, mammals, and reptiles. Moreover, focused surveys for the endangered southwestern willow flycatcher (*Empidonax traillii extimus*) and Yuma clapper rail (*Rallus longirostris yumanensis*) have been conducted since as early as 1998. Field surveys have concluded that wildlife habitats are improving. Habitat analyses are integral components of the biological surveys that are conducted in the Wash. Because survey locations are finite, however, vegetation descriptions are often spatially limited. Vegetative communities described from a landscape perspective are helpful to understand the landscape structure and its effects on the distribution and abundance of organisms.

The Las Vegas Wash Coordination Committee, a multi-stakeholder collaborative planning group, has been facilitating biological resource inventories and ecological improvements along the Wash for the past several years. Besides the wildlife studies previously described, on the ground activities have included constructing multiple erosion control structures and stream bank protection facilities. Moreover, extensive revegetation projects have been completed to further protect the channel bed and banks from eroding as well as to improve wildlife habitat values. These activities are directed by a planning document that was completed in 2000, the Las Vegas Wash Comprehensive Adaptive Management Plan (CAMP). Among the action items that were listed in the CAMP was a recommendation to prepare a long-term wildlife management plan for the Wash. In order for wildlife management planning to be successful, however, the availability and extent of wildlife habitats must be considered. Often, wildlife management is effectively accomplished by focusing management recommendations towards habitats.

The goal for this study is to identify and delineate land cover types along the Wash with specific attention given to vegetated cover types (i.e., vegetation communities). Vegetation communities are described by using standardized vegetation classifications and delineated by geographic information system technologies and appropriate ecological methodologies. This study provides a critical catalog of vegetative communities along the Wash using a repeatable standardized nomenclature. This study was conducted to facilitate wildlife management planning along the Wash, however, ecosystem restoration initiatives were intended to benefit from these data as well. Specifically important land cover types, such as wetlands, were also described to help plan for and meet long-term management goals along the Wash.

MATERIALS AND METHODS

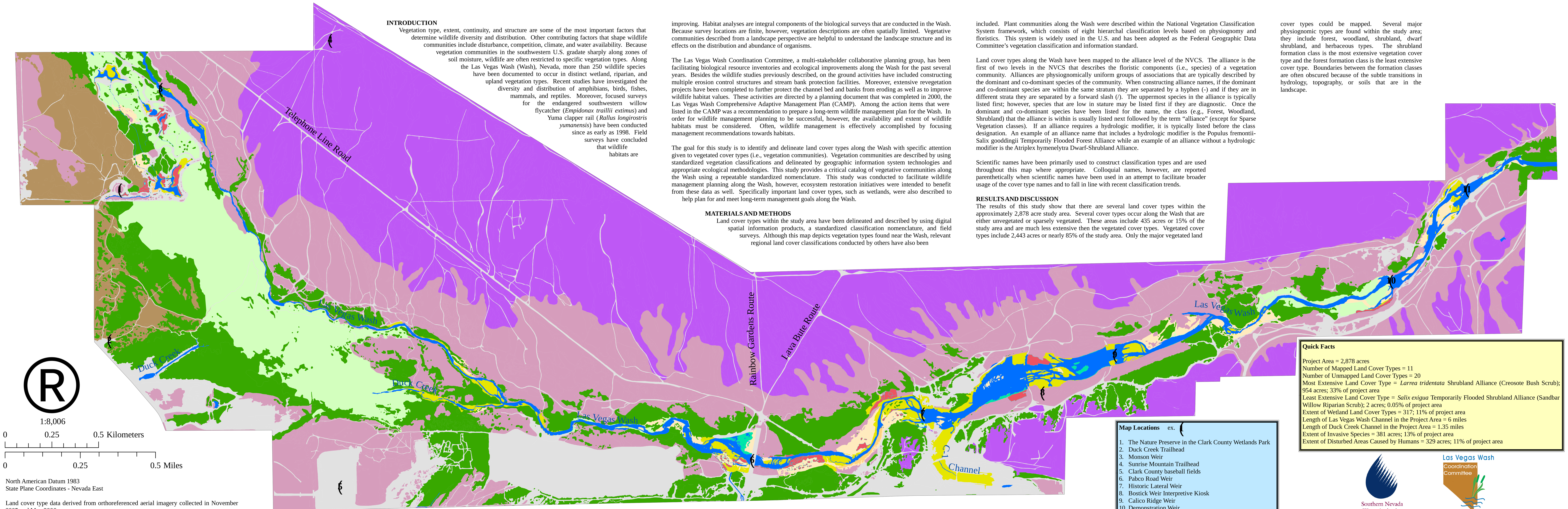
Land cover types within the study area have been delineated and described by using digital spatial information products, a standardized classification nomenclature, and field surveys. Although this map depicts vegetation types found near the Wash, relevant regional land cover classifications conducted by others have also been included. Plant communities along the Wash were described within the National Vegetation Classification System framework, which consists of eight hierarchal classification levels based on physiognomy and floristics. This system is widely used in the U.S. and has been adopted as the Federal Geographic Data Committee's vegetation classification and information standard.

Land cover types along the Wash have been mapped to the alliance level of the NVCS. The alliance is the first of two levels in the NVCS that describes the floristic components (i.e., species) of a vegetation community. Alliances are physiognomically uniform groups of associations that are typically described by the dominant and co-dominant species of the community. When constructing alliance names, if the dominant and co-dominant species are within the same stratum they are separated by a hyphen (-) and if they are in different strata they are separated by a forward slash (/). The uppermost species in the alliance is typically listed first; however, species that are low in stature may be listed first if they are diagnostic. Once the dominant and co-dominant species have been listed for the name, the class (e.g., Forest, Woodland, Shrubland) that the alliance is within is usually listed next followed by the term "alliance" (except for Sparse Vegetation classes). If an alliance requires a hydrologic modifier, it is typically listed before the class designation. An example of an alliance name that includes a hydrologic modifier is the Populus fremontii-Salix gooddingii Temporarily Flooded Forest Alliance while an example of an alliance without a hydrologic modifier is the Atriplex hymenelytra Dwarf-Shrubland Alliance.

Scientific names have been primarily used to construct classification types and are used throughout this map where appropriate. Colloquial names, however, are reported parenthetically when scientific names have been used in an attempt to facilitate broader usage of the cover type names and to fall in line with recent classification trends.

RESULTS AND DISCUSSION

The results of this study show that there are several land cover types within the approximately 2,878 acre study area. Several cover types occur along the Wash that are either unvegetated or sparsely vegetated. These areas include 435 acres or 15% of the study area and are much less extensive then the vegetated cover types. Vegetated cover types include 2,443 acres or nearly 85% of the study area. Only the major vegetated land cover types could be mapped. Several major physiognomic types are found within the study area; they include forest, woodland, shrubland, dwarf shrubland, and herbaceous types. The shrubland formation class is the most extensive vegetation cover type and the forest formation class is the least extensive cover type. Boundaries between the formation classes are often obscured because of the subtle transitions in hydrology, topography, or soils that are in the landscape.



North American Datum 1983
State Plane Coordinates - Nevada East

Land cover type data derived from orthoreferenced aerial imagery collected in November 2005 and May 2006.

Map Locations ex.

1. The Nature Preserve in the Clark County Wetlands Park
2. Duck Creek Trailhead
3. Monson Weir
4. Sunrise Mountain Trailhead
5. Clark County baseball fields
6. Pabco Road Weir
7. Historic Lateral Weir
8. Bostick Weir Interpretive Kiosk
9. Calico Ridge Weir
10. Demonstration Weir
11. Rainbow Gardens Weir

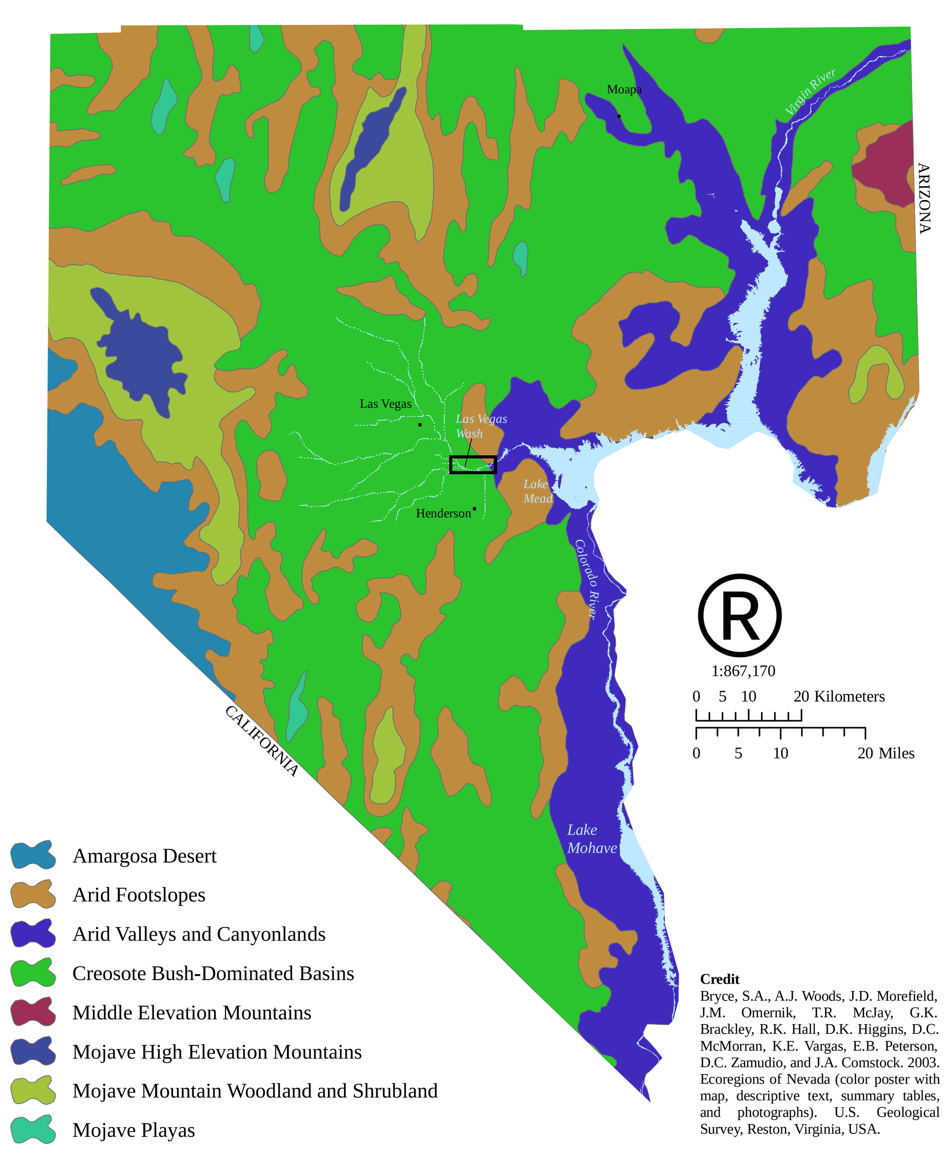
Quick Facts

Project Area = 2,878 acres
Number of Mapped Land Cover Types = 11
Number of Unmapped Land Cover Types = 20
Most Extensive Land Cover Type = *Larrea tridentata* Shrubland Alliance (Creosote Bush Scrub); 954 acres; 33% of project area
Least Extensive Land Cover Type = *Salix exigua* Temporarily Flooded Shrubland Alliance (Sandbar Willow Riparian Scrub); 2 acres; 0.05% of project area
Extent of Wetland Land Cover Types = 317; 11% of project area
Length of Las Vegas Wash Channel in the Project Area = 6 miles
Length of Duck Creek Channel in the Project Area = 1.35 miles
Extent of Invasive Species = 381 acres; 13% of project area
Extent of Disturbed Areas Caused by Humans = 329 acres; 11% of project area

Southern Nevada Water Authority

Las Vegas Wash Coordination Committee

Level IV Ecoregions of Clark County, Nevada



Credit
Bryce, S.A., A.J. Woods, J.D. Morefield, J.M. Omernik, T.R. McJay, G.K. Brackley, R.K. Hall, D.K. Higgins, D.C. McMorran, K.E. Vargas, E.B. Peterson, D.C. Zamudio, and J.A. Comstock. 2003. Ecoregions of Nevada (color poster with map, descriptive text, summary tables, and photographs). U.S. Geological Survey, Reston, Virginia, USA.

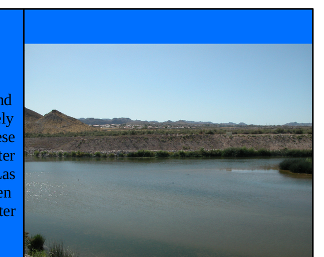
Acknowledgements
The U.S. Bureau of Reclamation (BOR) provided funding for this project under assistance agreement number 04FG300026. Clark County Parks and Recreation and the BOR provided access to study sites. We wish to acknowledge the contributions of Lee Watson with SpecTIR. Nick Rice provided valuable logistical support by coordinating ground based spectrometer data acquisition and Cindy Hopkins conducted field surveys. We would like to thank the members of the Research and Environmental Monitoring Study Team for reviewing this document and the Las Vegas Wash Coordination Committee for their continued support for this project and the implementation of the Las Vegas Wash Comprehensive Adaptive Management Plan.

Recommended Citation
Shanahan, S.A., D. Silverman, and A. Ehrenberg. 2007. Land cover types of the Las Vegas Wash, Nevada (map). Southern Nevada Water Authority, Las Vegas, Nevada, USA.

Land Cover Type
Open Water

Description
Open water cover types are found where surface water from the Las Vegas Wash and other tributaries is visible and not obstructed by vascular plant cover. Approximately 77 acres (2.67% of the study area) of open water are found in the study area. These areas consist of shallow riffles and deepwater pools and runs. Several large open water impoundments are found behind rock structures that have been constructed in the Las Vegas Wash to prevent erosion. As additional erosion control structures are built, open water is expected to increase in aerial extent. Combined with peripheral shallow water areas, open water is important for a variety of wildlife.

Unmapped Subclasses
None



Land Cover Type
Disturbed - Human

Description
Several areas that are disturbed as a result of human actions are found in the study area. Disturbed areas typically include roads, trails, buildings, or other human made features and these areas contribute 329 acres or 11.44% of the study area. The most destructive of these disturbances results from illegal off road usage on the north side of the Las Vegas Wash. Dirt bikes, quads, and other all terrain vehicles have denuded vegetation in many upland habitats. Some of the most destroyed habitats include areas of gypsiferous soils which support an extensive colony of the critically endangered *Arctomecon californica*. Dozens of roads crisscross upland areas, further destroying substrate integrity and fragmenting habitats. Other types of human disturbance that are found in the study area include activities associated with the construction of erosion control structures. These projects require rock stockpiling sites and construction lay down yards. Disturbed areas like these are temporary since active revegetation occurs when projects are completed.

Unmapped Subclasses
None

Land Cover Type
Disturbed - Natural

Description
Naturally disturbed areas are found mostly along the active stream channel and only contribute 29 acres or 1.01% of the study area. These areas include point bars, gravel deposits, and other redistributed channel sediments with minimal or no vegetation cover. These areas are disturbed as a result of periodic flooding and therefore are constantly changing. Depending on when flooding has occurred, vegetation may be present in several or more seral stages. A variety of species may be found on these sites including forbs, graminoids, and woody taxa. Examples of species that are found in these areas include *Xanthium strumarium*, *Phragmites australis*, *Typha domingensis*, *Helianthus annuus*, *Rumex stenophyllus*, *Cynodon dactylon*, and *Cyperus esculentus*. Over time these areas may transition towards vegetation communities described elsewhere in the National Vegetation Classification System framework. For example, *Salix* spp. seedlings may be found on post-flooded sites as a minor vegetation component, however, with time they may become dominant.

Unmapped Subclasses
None

Land Cover Type
Populus fremontii-Salix gooddingii Temporarily Flooded Forest Alliance (Cottonwood-Willow Riparian Forest)

Description
This alliance is characterized by two co-dominant taxa, *Salix gooddingii* and *Populus fremontii*. Although these species are often found together in this community, they may occur singly. These species are generally found close to the water's edge or where depth to groundwater is within 15 feet. Trees are generally 30 to 35 feet tall depending on age and location. Associated species often include shrubs such as *Salix exigua*, *Baccharis emoryi*, *Baccharis salicifolia*, and *Pluchea sericea*. A variety of herbaceous species are also found in this alliance including *Anemopsis californica*, *Conyza* spp., *Heliotropium curassavicum*, and *Xanthium strumarium*. Most of these areas are a result of active restoration activities; however, many areas that have not been actively planted have *Salix gooddingii* seedlings on them. In contrast, very few *Populus fremontii* seedlings have been found along the Wash. Areas where this alliance is most extensive include downstream of the Pabco Road Weir and on the Bostick Weir. This alliance covers approximately 0.3% or 10.25 acres of the study area.

Unmapped Subclasses
None

Land Cover Type
Salix exigua Temporarily Flooded Shrubland Alliance (Sandbar Willow Riparian Scrub)

Description
This alliance is dominated by the cold-deciduous shrub *Salix exigua* and is the most hydric of the shrubland alliances, often only found within several feet of the water's edge. These areas are a part of the wetland mosaic with species from adjacent communities commonly intergrading to become substantial cover components. On the wetland edges, *Typha domingensis*, *Phragmites australis*, and *Schoenoplectus (*spp. are most often found while on the mesic edges, *Atriplex lentiformis* and *Pluchea sericea* are common. Often large trees (*Salix gooddingii* and *Populus fremontii*) are found singly and sporadically as overstory components. Understory herbaceous material often consists of various native, naturalized, or weedy species from the Asteraceae, Poaceae, and Chenopodiaceae. Two acres (0.05% of the study area) are mapped as part of the *Salix exigua* Temporarily Flooded Shrubland Alliance. However, the extent of *Salix exigua* in the study area is substantially greater than represented by the mapped units.

Unmapped Subclasses
None

Land Cover Type
Atriplex spp. Shrubland Alliance (Saltbush Scrub)

Description
The *Atriplex* spp. Shrubland Alliance (769 acres or 26.72% of the study area) consists of four major associations that are typically dominated by *Atriplex lentiformis*, *A. canescens*, *A. polycarpa*, or *A. confertifolia* and one minor association dominated by *Bassia hyssopifolia*. Of the four major associations, three are considered true shrublands dominated by plants greater than two feet tall or at least those species are more prominent whereas the fourth association is a dwarf shrubland type. This alliance is typically found as a transitional zone between hydric and xeric communities. The community is found on both sides of the Las Vegas Wash and along the main channel of the Las Vegas Wash. In these transitional areas, *A. lentiformis* is one of the most common *Atriplex* species. Leading away from the channel, *A. canescens*, *A. polycarpa* , and *A. confertifolia* are typically found. These species can occur within drainages and low-lying alluvial areas in the *Larrea tridentata* Shrubland Alliance. Several other species are found in these areas including several species from the Chenopodiaceae family.

Unmapped Subclasses
Atriplex lentiformis Shrubland Association (Quailbush Thicket)
Atriplex canescens Shrubland Association (Fourwing Saltbush Scrub)
Atriplex polycarpa Shrubland Association (Desert Saltbush Scrub)
Atriplex hymenelytra Dwarf Shrubland Association (Desert Holly Scrub)
Bassia hyssopifolia Herbaceous Association (Bassia Field)

Land Cover Type
Tamarix ramosissima Shrubland Alliance (Salt Cedar Thicket)

Description
The presence of the cold deciduous arborescent-like *Tamarix ramosissima* shrub strongly defines the *Tamarix ramosissima* Shrubland Alliance. This alliance consists of two associations, the *Tamarix ramosissima-Atriplex lentiformis* Shrubland Association and the *Tamarix ramosissima*/*Phragmites australis* Shrubland Association. This alliance consists of 381 acres or 13.23% of the study area and it is most often bordered by the *Atriplex* spp. Shrubland Alliance and various permanently to semipermanently flooded herbaceous alliances. *T. ramosissima* is a non-native multi-stemmed woody shrub that is common to most riparian waterways in the western U.S. In some parts of the study area, *T. ramosissima* is greater than 25 feet tall which resembles woodland and forest class like characteristics, however, most commonly it is found as a shrubby plant less than 15 feet tall. Moreover, this alliance is often a monoculture with minimal species able to coexist in stand interiors. With suitable hydrology, however, *Conyza coulteri* appears to do exceptionally well in these areas. This alliance is found almost exclusively near the Las Vegas Wash. Because *T. ramossima* is a facultative phreatophyte, it is able to tolerate periods of groundwater depletion. Although a water regime modifier can be used to describe this alliance, *T. ramosissima* stands are often present in multiple water regimes. For example, *T. ramosissima* typically establishes in wet to moist conditions that are classified as temporarily flooded. This is true for salt cedar stands that are nearest the Las Vegas Wash. Unusually, however, there are several terraced areas that contain relict *T. ramosissima* stands that first established in the active Las Vegas Wash floodplain before it was incised by 30+ feet in the 1970s through 1990s. These areas no longer receive regular surface water inundation and therefore would be more appropriately classed as intermittently flooded. For the purpose of this land cover analysis, *T. ramosissima* dominated areas are not classified with a water regime modifier, however, temporarily or intermittently flooded water regime modifiers are the most appropriate.

Unmapped Subclasses
Tamarix ramosissima-Atriplex lentiformis Shrubland Association (Salt Cedar-Quailbush Thicket)
Tamarix ramosissima/*Phragmites australis* Shrubland Association (Salt Cedar-Common Reed Thicket and Marsh)

Land Cover Type
Larrea tridentata Shrubland Alliance (Creosote Bush Scrub)

Description
This alliance occurs within the project area on most of the upland terrain not subject to seasonal or intermittent inundation or prolonged raised water tables. It is the most widespread vegetation type for upland terrain in Southern Nevada and is the most extensive land cover type in the study area (954 acres or 33.14%). It is characterized by *Larrea tridentata*, a sparsely-leafed shrub that can vary in height depending on local water availability, soil-root depth and watershed type. It is among the most homogenously distributed plant species in North America and typically occurs as evenly-spaced individuals independent of most terrain and soil types. Nearly every upland plant species in the study area, at least in some localized microhabitat type, can occur within this alliance.

Many species are associated with this alliance including, *Ambrosia dumosa*, *Psorothamnus fremontii*, *Atriplex* spp., *Senna armata*, *Ephedra torreyana*, and *Opuntia* spp. among others. This alliance is found in xeric areas on the north and south side of the Las Vegas Wash. On terraces, banks, or other high points, this alliance can be found substantially intruding into the *Atriplex* spp. Shrubland Alliance. Associated species adapted to the various topographies, soil types, and surficial features found within this alliance help define the associations found therein. For example, with the predominance of subshrubs like *Atriplex hymenelytra* or *Ambrosia dumosa*, portions of this alliance are classified as dwarf shrublands at the association level. Moreover, specific soil types such as the high gypsiferous soils found in the north central portion of the study area harbor unique species including *Arctomecon californica*, *Petalonyx nitidus*, *Phacelia palmeri*, and *Enceliopsis argophylla*. Various drainages that dissect this alliance also harbor unique communities including the *Larrea tridentata* Wash ShrublandAssociation, *Prosopis* spp. Woodland Association, *Acacia greggii* Woodland Association, and the *Pleuraphis rigida* Herbaceous Association. The *Larrea tridentata* Shrubland Alliance has been impacted heavily by off-highway vehicle usage causing some areas to be described elsewhere in this classification framework. One of the primary reasons for this is likely the perceived sparseness of vegetation often found in this alliance. Contrary to this, however, the *Larrea tridentata* Shrubland Alliance is the most botanically rich of all the alliances in the study area. A diverse assemblage of annual forbs and herbs characterize many of the areas within this alliance.

Unmapped Subclasses
Larrea tridentata Shrubland Association (Creosote Bush Pure Stand)
Larrea tridentata/Ambrosia dumosa Shrubland Association (Creosote Bush-Bursage Scrub)
Larrea tridentata Wash Shrubland Association (Creosote Bush Wash Scrub)
Larrea tridentata-Atriplex spp. Shrubland Association (Creosote Bush Chenopod Scrub)
Ambrosia dumosa/Larrea tridentata Dwarf Shrubland Association (Bursage-Creosote Bush Scrub)
Pleuraphis rigida Herbaceous Association (Galleta Grass Wash)
Scree Herbaceous Association (Talus/Scree Slope)
Rocky Slopes Herbaceous Association (Outcrop Rocky Slope)
Desert Pavement Herbaceous Association (Desert Pavement)
Plantago ovata Herbaceous Association (Wooly Plantain Field)
Schismus spp. Herbaceous Association (Splitgrass Field)
Sisymbrium irio Herbaceous Association (Ruderal Field)

Land Cover Type
Schoenoplectus spp. Permanently to Semipermanently Flooded Herbaceous Alliance (Bulrush Marsh)

Description
This alliance occurs within the study area in the primary channel and back waters of the Las Vegas Wash. It is a tall herbaceous formation of "tule" type species (*Schoenoplectus acutus* and *S. californicus*) as dense cover dominants in patchy pure stands introduced through revegetation sites. The alliance is mostly characterized by *S. acutus*. These stands occur mostly on banks and shallow sand bars in the study area in a variety of soil textures in various wetland development stages, though mostly seral. Within the study area, the *Schoenoplectus* spp. Permanently to Semipermanently Flooded Herbaceous Alliance includes smaller association-type patches of *S. pungens* or *S. americanus*, *Typha domingensis*, *Phragmites australis*, *Tamarix ramosissima* , and other introduced graminoids such as *Juncus* spp. and *Eleocharis* spp. Within the active primary channels, the *Schoenoplectus* spp. Permanently to Semipermanently Flooded Herbaceous Alliance abruptly transitions into larger stands of *Typha domingensis* Permanently Flooded Herbaceous Alliance, or *Phragmites australis* Semipermanently Flooded Herbaceous Alliance. Peripherally, it abruptly transitions into alliances and associations on bars, terraces and secondary channels that are disturbed, seral-barren, weedy herbaceous, or characterized by dense alliance and association type stands of *Tamarix ramosissima*, *Atriplex lentiformis*, *Salix* spp., and *Populus fremontii*. Only three acres (0.09%) of this alliance are mapped in the study area, however, the species that dominate this community are found more extensively then what is represented.

Unmapped Subclasses
None

Land Cover Type
Typha domingensis Permanently Flooded Herbaceous Alliance (Cattail Marsh)

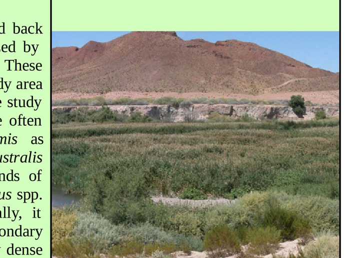
Description
This alliance occurs on 38 acres (1.33%) in the study area mostly in the primary channel and back waters of the Las Vegas Wash. It typically occurs as narrow or patchy pure stands characterized by a single species, *Typha domingensis* as a tall herbaceous formation. These stands occur mostly on sandy soils of flooded banks, bars, or terraces in the study area, typically adjacent to open water. The stands usually appear in the seral stages of vegetation establishment and are often the most hydrologically dependent vegetation alliance in the project area, often being replaced by other mesic-aquatic vegetation better adapted to changing water levels, especially *Phragmites australis*. During type conversion, the *P. australis* becomes a temporary associate of this alliance. *Typha domingensis* Permanently Flooded Herbaceous Alliance abruptly transitions into association or alliance-type stands of *Phragmites australis* Semipermanently Flooded Herbaceous Alliance, *Schoenoplectus* spp. Permanently to Semipermanently Flooded Herbaceous Alliance, or open water.

Unmapped Subclasses
None

Land Cover Type
Phragmites australis Semipermanently Flooded Herbaceous Alliance (Common Reed Marsh)

Description
This alliance mostly occurs within the study area in the primary channel and back waters of the Las Vegas Wash. It is a tall herbaceous formation characterized by *Phragmites australis* and contributes to 188 acres or 6.53% of the study area. These stands occur on banks, terraces, bars, and in shallow flooded channels in the study area in a variety of soil textures in various wetland development stages. Within the study area, the *Phragmites australis* Semipermanently Flooded Herbaceous Alliance often includes *Tamarix ramosissima*, *Typha domingensis*, or *Atriplex lentiformis* as associates. Within the active primary channels, the *Phragmites australis* Semipermanently Flooded Herbaceous Alliance abruptly transitions into stands of *Typha domingensis* Permanently Flooded Herbaceous Alliance or *Schoenoplectus* spp. Permanently to Semipermanently Flooded Herbaceous Alliance. Peripherally, it abruptly transitions into alliances and associations on bars, terraces, and secondary channels that are disturbed, seral-barren, weedy herbaceous or characterized by dense association type stands of *T. ramosissima*, *A. lentiformis*, *Salix* spp., and *Populus fremontii*. The aggressive nature of *P. australis* makes it an associate, or sometimes co-dominant in most of the adjacent vegetation.

Unmapped Subclasses
None



Land Cover Type
Distichlis spicata Intermittently Flooded Herbaceous Alliance (Saltgrass Alkaline Meadow)

Description
This alliance occurs within the project area in the Duck Creek drainage system, on inundated terraces with silty-clayey alkaline soils. This vegetation is similar to alkaline meadow or alkaline sink scrub type vegetation. It is mostly a low herbaceous formation of post-climax phase *Distichlis spicata* that remains as a dominant cover in the understory, with other shrubs, trees, and herbs that form a co-dominant canopy cover. *Allenrolfea occidentalis*, *Suaeda moquinii*, *Limonium californicum*, *Muhlenbergia asperifolia*, *Sporobolus airoides*, and *Baccharis emoryi* are native associates typical of this alliance. Within the project area, the *Distichlis spicata* Intermittently Flooded Herbaceous Alliance includes smaller association-type patches or pure stands of *Phragmites australis*, *Atriplex lentiformis*, *Tamarix ramosissima*, and some native trees (i.e., *Prosopis* spp.). Most of the upland transition for this alliance is now developed or planted. Semi-native associations of *Atriplex* spp. and *Larrea tridentata* shrublands, and *Prosopis-Acacia* woodlands remain as scattered fragments at the upland transition. The downstream transition of the *Distichlis spicata* Intermittently Flooded Herbaceous Alliance is primarily *Phragmites australis* Semipermanently Flooded Herbaceous Alliance, *Typha domingensis* Permanently Flooded Herbaceous Alliance, or *Tamarix ramosissima* Shrubland Alliances of varying hydrology. This alliance was formerly part of a series of alkaline springs in the Las Vegas area that had a high diversity of biota and likely several rare or sensitive species. Changes to hydrology and surrounding upland terrain have greatly reduced the biodiversity potential of this vegetation type. The *Distichlis spicata* Intermittently Flooded Herbaceous Alliance consists of 95 acres or 3.25% of the study area.

Unmapped Subclasses
Allenrolfea occidentalis Intermittently Flooded Dwarf Shrubland Association