UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

March 11, 2009

Mr. Phil Mook
AFRPA Western Region Execution Center
3411 Olson Street
McClellan California 95652

Re: Third Five-Year Review, Former Castle Air Force Base, Atwater, California

Dear Mr. Mook:

The U.S. Environmental Protection Agency (EPA) Region 9 has received the Final Third Five-Year Review Report for the Former Castle Air Force Base (Castle Airport), Atwater, California, dated January 21, 2009. We have reviewed the aforementioned document. Based on this review, EPA agrees with the findings, conclusions and recommendations provided in the Report, and concurs with the Air Force that the remedies in place at Castle Airport remain protective of human health and the environment considering current land uses and controls. As a part of this Five Year Review Process, two outstanding issues were highlighted:

- Lack of Active Pump-and-Treat for residual contamination above the MCL in the shallow zone of the Main Base Plume
- Lack of Effectiveness of the MW003 Wellhead Treatment System for the Castle Vista Plume

The EPA looks forward to working with the Air Force and the state regulatory agencies to resolve these issues within the timeline specified in the Final Report.

We appreciate the opportunity to work with you on this project and look forward to continued success at Castle Airport. If you have any questions regarding this letter, please contact Sarah Kloss, Remedial Project Manager, at (415) 972-3156, or via email at kloss.sarah@epa.gov.

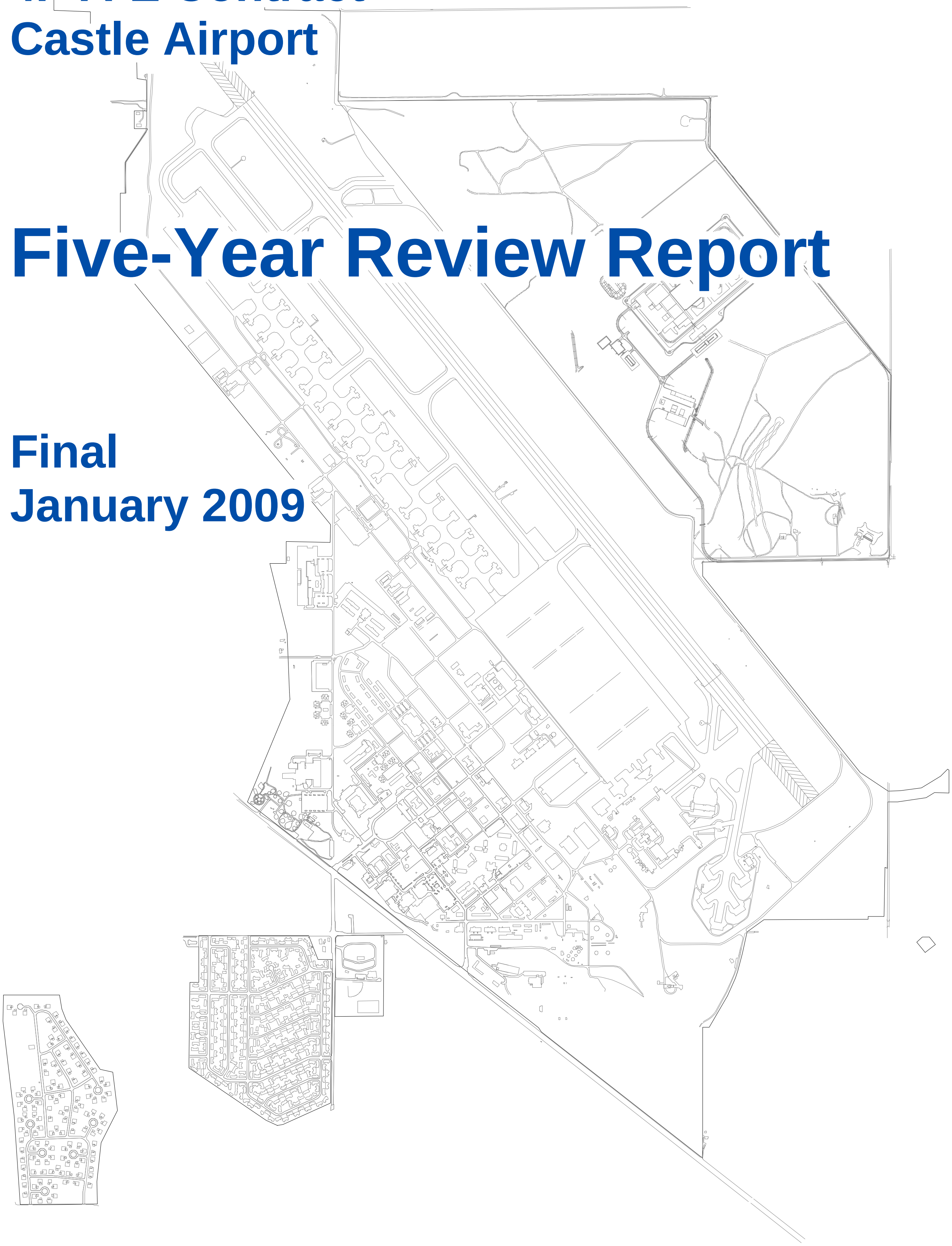
Sincerely,

Michael M. Montgomery
Assistant Director
Superfund Federal Facility and Site Cleanup Branch

cc: Marcus Pierce, CVRWQCB
Theresa McGarry, DTSC

United States Air Force
4P A-E Contract
Castle Airport

Five-Year Review Report



Final
January 2009

DEPARTMENT OF THE AIR FORCE
AIR FORCE REAL PROPERTY AGENCY

21 January 2009

MEMORANDUM FOR SEE DISTRIBUTION

FROM: AFRPA Western Region Execution Center
3411 Olson Street
McClellan CA 95652-1003

SUBJECT: Change Pages, Five-Year Review Report for Castle Airport

1. Please find attached the change pages to our Five-Year Review for Castle Airport, final version. These change pages address three comments received from EPA on 16 January 2009. To update your report:

a. Replace the report title page;
b. Replace the table of contents (list of table, figures, and acronyms remain unchanged);
c. Replace the executive summary section including the five-year review summary form;
d. Replace section 9;
e. Replace section 10.

2. I will forward to you the AF signed title page as a pdf file in the very near future. At that time, the AF will have completed the Castle Five-Year Review, and you copy of the report will be complete. Thank you for your support of the Castle cleanup program. Please feel free to contact me at (916) 643-1250 ext 100, or by e-mail at philip.mook@lackland.af.mil.

Philip H Mook Jr
PHILIP H. MOOK, JR.
Senior Representative

Attachment:
Change pages, Five-Year Review for Castle Airport, January 2009

DISTRIBUTION:
EPA, Region IX (Sarah Kloss), 2 copies
DTSC (Theresa McGarry), 1 copy
RWQCB (Marcus Pierce), 1 copy

cc:
Castle Admin Record Mgr (Gary Yuki), w/o attachment
AFCEE (Stanley Pehl), w/o attachment
Jacobs (Richard Bateman), w/o attachment

JACOBS

Federal Operations
3237 Peacekeeper Way, Suite 202, McClellan, CA 95652
Telephone: 916.568.4700
Fax: 916.568.4747

Transmittal #86-014

CASTLE AIRPORT TRANSMITTAL

To: Mr. Phil Mook
AFRPA Western Execution Center
3411 Olson Street
McClellan, CA 95652

Date: 08 January 2009
Contract No.: F41624-03-D-8605
T.O. No.: 0086
Air Force Project No.: DESR2007-0753
Jacobs Project No.: 12BC8601
Project Name: Five Year Review and Ecological Monitoring, Castle Airport, CA.

From:

Richard Bateman
Project Manager

CDRL #	VERSION	DESCRIPTION OF DELIVERABLE	DATE SUBMITTED
A001C	Final	Five-Year Review Report - Castle Airport	01/23/09

REMARKS: The electronic submittal of the final Five-Year Review document (CD) will be mailed to all document recipients by 06 February 2009.

DISTRIBUTION:

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RWQCB
Marcus Pierce

DTSC
Theresa McGarry

*Transmittal only

Final Five-Year Review Report

Third Five-Year Review Report

for

Castle Airport

Atwater

Merced County, California

January 2009

Prepared for
Air Force Center for Engineering and the Environment
Brooks City-Base, TX 78235

Prepared by
Jacobs
3237 Peacekeeper Way, Suite 202
McClellan, CA 95652

Approved By:

Robert M. Moore — 22 JANUARY 2009

Robert M. Moore
Director, Air Force Real Property Agency
United States Air Force

Date

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LIST OF ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
µg/dl	micrograms per deciliter
AFCEE	Air Force Center for Engineering and the Environment
AFRPA	Air Force Real Property Agency
Air Force	United States Air Force
AM	Atwater Municipal (Well)
ARAR	applicable or relevant and appropriate requirement
AST	aboveground storage tank
B#	Building (number)
bgs	below ground surface
BCT	Base Conversion Team (also BRAC Cleanup Team)
BHHRA	baseline human health risk assessment
BoP	Federal Bureau of Prisons
BTEX	benzene, toluene, ethylbenzene and xylenes
BV	bioventing
CAFB	Castle Air Force Base
Cal/EPA	California Environmental Protection Agency
CB	Comprehensive Basewide
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cis-1,2-DCE	*cis*-1,2-dichloroethene
COC	contaminant of concern
COPC	contaminant of potential concern
1,2-DCA	1,2-dichloroethane
DA-#	Discharge Area-(number)
DBCP	1,2-dibromo-3-chloropropane
DEHP	di(2-ethylhexyl) phthalate
DP-#	Disposal Pit-number
DTSC	Department of Toxic Substances Control

LIST OF ACRONYMS AND ABBREVIATIONS

E&D	excavation and disposal
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ETC-#	Earth Technology Corporation-(number)
EW	extraction well
FFS	Focused Feasibility Study
Freon 12	dichlorodifluoromethane
FTA-#	Fire Training Area-(number)
GAC	granular activated carbon
gpm	gallons per minute
HCDF1234678	1,2,3,4,6,7,8-heptachlorodibenzofuran
HCDD	hexachlorinated dibenzo-p-dioxins, (total)
HCDF	hexachlorinated dibenzofurans, (total)
HSZ	hydrostratigraphic zone
IAG	Interagency Agreement
IC	institutional control
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
ISCO	in-situ chemical oxidation
JP	Jet Propulsion (jet fuel)
LF-#	Landfill-(number)
LSS	Lower Subshallow (HSZ)
LTM	Long-term (cap) maintenance and monitoring
LTEM	long-term ecological monitoring
LTGSP	Long-Term Groundwater Sampling Program

LIST OF ACRONYMS AND ABBREVIATIONS

MCL	maximum contaminant level
mg/kg	milligram per kilogram
MID	Merced Irrigation District
MOU	Memorandum of Understanding
MW	monitoring well
NCP	National Contingency Plan
NFA	no further action
ND	not detected
NPDES	National Pollutant Discharge Elimination System
O&M	operation and maintenance
OU	Operable Unit
OCDD	octachlorodibenzo-p-dioxin
OPS	operating properly and successfully
PAH	polynuclear aromatic hydrocarbon
PCE	tetrachloroethene
PRC	PRC Environmental Management
PW	production well
Q#/##	Quarter/Year
RAB	Restoration Advisory Board
RAO	remedial action objective
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
ROD	Record of Decision
RSL	Regional Screening Level
RWQCB	Regional Water Quality Control Board

LIST OF ACRONYMS AND ABBREVIATIONS

SCOU	Source Control Operable Unit
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TBC	to be considered
TBV	threshold background value
TCE	trichloroethene
TEER	Technical and Economic Evaluation Report
USAF	U. S. Air Force
USS	Upper Subshallow (HSZ)
UST	underground storage tank
VOC	volatile organic compound
WPI	Waste Policy Institute
WQSA	water quality site assessment

EXECUTIVE SUMMARY

This is the third five-year review completed for the Castle Airport Superfund site near the community of Atwater, in Merced County, California. The first five-year review was finalized in September 1999. The second five-year review was finalized in January 2004. Since the second five-year review, all Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) decisions and documentation have been completed, all remedial actions are in place or completed, operating properly and successfully (OPS) determinations were made for the groundwater and Landfill 4 remedial actions, all property was found suitable for transfer and all property has been transferred. All Castle Airport site and basewide milestones achieved, both prior to and since the last five-year review, are listed in Table 2-1.

With most actions at Castle Airport complete, this review addresses only those groundwater and vadose zone sites where contaminants remain above levels that allow for unlimited use and unrestricted exposure. It addresses the remedies selected in the *Comprehensive Basewide Record of Decision – Part 1* (CB ROD – Part 1) and the *Comprehensive Basewide Record of Decision – Part 2* (CB ROD – Part 2) for two groundwater plumes with ongoing remedial actions (Main Base Plume and Castle Vista Plume). It also addresses ongoing remedies selected in the *Source Control Operable Unit Record of Decision Part 3* (SCOU ROD Part 3) for 11 SCOU sites (Earth Technology Corporation 10 [ETC-10]; ETC-12; Fire Training Area 1 [FTA-1]; Landfill 3 [LF-3]; LF-4 including Disposal Pit 5 [DP-5] and DP-6; and LF-5 including DP-8, DP-8A and LF-5 Trenches). One other SCOU site (Discharge Area 4 [DA-4]) was addressed in the previous five-year review but is not addressed herein. The selected remedial action for DA-4 was completed and site closed (no further action) with regulatory agency approval during this five-year review period (see Table 1-1 and Table 2-1). The Building 51/Building 54 (B51/B54), DA-5 and ETC-8 sites, whose remedies were also selected in the SCOU ROD Part 3, were not addressed in the previous five-year review and are also not addressed herein. The selected remedies for these sites (soil vapor extraction [SVE] for B51/B54, SVE and bioventing [BV] for DA-5 and excavation and disposal [E&D] for ETC-8) were completed and the sites closed (no further action) with regulatory agency approval during this five-year review period (see Table 1-1 and Table 2-1).

The selected remedy for the Main Base Plume and the Castle Vista Plume is pump-and-treat remediation for plume capture and cleanup to maximum contaminant levels (MCLs).

The selected remedy for ETC-10 is institutional controls (ICs) and long-term ecological monitoring (LTEM) of the adjacent wetlands. The selected remedy for ETC-12 is LTEM of the adjacent wetlands. The selected remedy for FTA-1 is soil vapor extraction (SVE) with capping, BV, E&D, long-term cap maintenance and monitoring (LTM), ICs and LTEM of the adjacent wetlands. The selected remedy for LF-3 is LTEM of the adjacent wetlands. The selected remedy for LF-4, including DP-5 and DP-6, is LTM and ICs. The selected remedy for LF-5, including DP-8, DP-8A and LF-5 Trenches, is LTM, ICs and LTEM of the adjacent wetlands.

Results of this five-year review for the individual plumes/sites assessed are summarized below.

Main Base Plume: The remedial action implemented for the Main Base Plume is protective of human health and the environment. The remedy is functioning as designed (plume control and reduction), expected progress has been made towards achieving MCL cleanup levels, all components of the remedy are being operated in a safe and proper manner and have been optimized to the extent practical (OU-1 treatment plant and MW883/MW1021, MW941, and MW1009 wellhead treatment systems have been shut down). ICs to restrict use of groundwater exceeding MCLs are in place, are effective, and regular IC monitoring is being conducted. There have been no changes in criteria, standards or methods which affect the protectiveness of the remedy and no other information has been identified that would affect protectiveness. A screening level assessment determined that the cancer risk associated with potential vapor intrusion from the current levels of groundwater contamination in the Shallow HSZ is less than $1x10^{-6}$.

The technical assessment identified the lack of active Shallow HSZ pump-and-treat remediation and plume capture in the former OU-1 area where TCE concentrations have rebounded to above MCL levels as a potential issue. To address this issue, the Air Force will perform an assessment of the feasibility of optimizing the existing remedy (pump-and-treat) or applying alternative technologies (e.g., ISCO) to address the remaining contamination in the Shallow HSZ. The assessment will be presented in the form of a Technical Memorandum appended to the 2009 or 2010 LTGSP Annual Report. If the Technical Memorandum recommends a change in the remedy and the regulatory agencies concur, the Air Force will prepare the necessary documentation (i.e., a ROD Amendment or an Explanation of Significant Difference) to change the remedy for this portion of the Main

Base Plume. The deadline for this remedy change documentation will be the end of fiscal year 2011.

Castle Vista Plume: The remedial action implemented for the Castle Vista Plume is protective of human health and the environment. The remedy is functioning as designed (plume control and reduction), expected progress has been made towards achieving MCL cleanup levels, all components of the remedy are being operated in a safe and proper manner and have been optimized to the extent practical (Castle Vista treatment plant shut down). ICs to restrict use of groundwater exceeding MCLs are in place, are effective, and regular IC monitoring is being conducted. There have been no changes in criteria, standards or methods which affect the protectiveness of the remedy and no other information has been identified that would affect protectiveness.

The lack of effectiveness of the MW003 wellhead treatment system in eliminating the small residual portion of the Castle Vista Plume was identified as an issue. In response to this issue, a pilot study work plan to implement in-situ chemical oxidation (ISCO) at MW003 and vicinity has been prepared and approved by the regulatory agencies. Implementation of the pilot study was scheduled for the fall of 2008 but has been delayed due to the need to conduct additional site characterization. The deadline for completion of the pilot study is now 30 September 2009.

Earth Technology Corporation 10: The remedial actions implemented for ETC-10 are protective of human health and the environment. The remedies are functioning as designed (access restricted and ecological monitoring conducted), there are no issues and no other information has been identified that would affect protectiveness. ICs to restrict site access and alteration are in place and maintained as part of the Air Force/BoP MOU. Ecological surveys of background (not impacted) and potentially impacted vernal pools at and in the vicinity of ETC-10 were conducted in the spring of 2008. Results of the surveys show no evidence that fairy shrimp abundance, plant diversity or plant abundance is statistically less (95% confidence level) in potentially impacted pools than in background pools.

Earth Technology Corporation 12: The remedial action implemented for ETC-12 is protective of human health and the environment. The remedy is functioning as designed (ecological monitoring conducted), there are no issues and no other information has been identified that would affect protectiveness. Ecological surveys of background (not impacted) and potentially impacted vernal pools at and in the vicinity of ETC-12 were conducted in the spring of 2008. Results of the surveys show no evidence that fairy shrimp abundance, plant diversity or plant abundance is statistically less (95% confidence level) in potentially impacted pools than in background pools.

Fire Training Area 1: The remedial actions implemented for FTA-1 are protective of human health and the environment. The ongoing remedies are functioning as designed (access restricted, cap maintenance and monitoring active and ecological monitoring conducted), there are no issues and no other information has been identified that would affect protectiveness. ICs to restrict site access and alteration are in place and maintained as part of the Air Force/BoP MOU. Maintenance and monitoring of the cap, including reporting of any evidence of human access or alteration, is being conducted quarterly. Ecological surveys of background (not impacted) and potentially impacted vernal pools at and in the vicinity of FTA-1 were conducted in the spring of 2008. Results of the surveys show no evidence that fairy shrimp abundance, plant diversity or plant abundance is statistically less (95% confidence level) in potentially impacted pools than in background pools. Although not an issue for the FTA-1 remedies, continued sampling of the two monitoring wells at FTA-1 with recent TCE detections near or above the MCL is recommended.

Landfill 3: The remedial action implemented for LF-3 is protective of human health and the environment. The remedy is functioning as designed (ecological monitoring conducted), there are no issues and no other information has been identified that would affect protectiveness. Ecological surveys of background (not impacted) and potentially impacted vernal pools at and in the vicinity of LF-3 were conducted in the spring of 2008. Results of the surveys show no evidence that fairy shrimp abundance, plant diversity or plant abundance is statistically less (95% confidence level) in potentially impacted pools than in background pools.

Landfill 4: The remedial actions implemented for LF-4/DP-5/DP-6 are protective of human health and the environment. The ongoing remedies are functioning as designed (access restricted, cap maintenance and monitoring active), there are no issues and no other information has been identified that would affect protectiveness. ICs to restrict site access and alteration are in place as part of the deed transferring the parcel containing LF-4 to Merced County and a State Land Use Covenant executed by the Air Force and the State of California. Maintenance and monitoring of the cap and its ancillary facilities, including reporting of any evidence of human access or alteration, is being conducted quarterly.

<u>Landfill 5</u>: The remedial actions implemented for LF-5/DP-8/DP-8A/LF-5 Trenches are protective of human health and the environment. The ongoing remedies are functioning as designed (access restricted, cap maintenance and monitoring active and ecological monitoring conducted), there are no issues and no other information has been identified that would affect protectiveness. ICs to restrict site access and alteration are in place and maintained as part of the Air Force/BoP MOU. Maintenance and monitoring of the cap and its ancillary facilities, including reporting of any evidence of human access or alteration, is being conducted quarterly. Ecological surveys of background (not impacted) and potentially impacted vernal pools at and in the vicinity of LF-5 were conducted in the spring of 2008. Results of the surveys show no evidence that fairy shrimp abundance, plant diversity or plant abundance is statistically less (95% confidence level) in potentially impacted pools than in background pools.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name ***(from WasteLAN)*****: Castle Air Force Base**		
EPA ID ***(from WasteLAN)*****: CA3570024551**		
Region: 9	**State: CA**	**City/County: Atwater / Merced**
SITE STATUS		
NPL status: ☒ Final ☐ Deleted ☐ Other (specify)		
Remediation status (choose all that apply): ☐ Under Construction ☒ Operating ☐ Complete		
Multiple OUs?* ☒ YES ☐ NO	**Construction completion date: 05/05/2000**	
Has site been put into reuse? ☒ YES ☐ NO		
REVIEW STATUS		
Lead agency: ☐ EPA ☐ State ☐ Tribe ☒ Other Federal Agency **U.S. Air Force**		
Author name: Jacobs		
Author title: not applicable	**Author affiliation: Jacobs**	
Review period:** **05/01/2008 to 11/28/2008**		
Date(s) of site inspection: Site inspection an ongoing activity – five-year review prepared by onsite contractor		
Type of review: ☒ Post-SARA ☐ Pre-SARA ☐ NPL-Removal only ☐ Non-NPL Remedial Action Site ☐ NPL State/Tribe-lead ☐ Regional Discretion		
Review number: ☐ 1 (first) ☐ 2 (second) ☒ 3 (third) ☐ Other (specify) ___________		
Triggering action: ☒ Actual RA Onsite Construction at OU # 1 ☐ Actual RA Start at OU#____ ☐ Construction Completion ☐ Previous Five-Year Review Report ☐ Other (specify)		
Triggering action date ***(from WasteLAN)*****: 03/1993**		
Due date ***(five years after triggering action date)*****:** third review – **01/23/09**		

* [“OU” refers to operable unit.]
** [Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.]

Five-Year Review Summary Form

continued

Issues

- The technical assessment identified no issues for the ETC-10 remedial action, the ETC-12 remedial action, the FTA-1 remedial action, the LF-3 remedial action, the LF-4 remedial action or the LF-5 remedial action.
- The technical assessment identified the lack of active Shallow HSZ pump-and-treat remediation and plume capture in the former OU-1 area where TCE concentrations have rebounded to above MCL levels as a potential issue for the Main Base Plume remedial action.
- The technical assessment identified the lack of effectiveness of the MW003 wellhead treatment system in eliminating the small residual portion of the plume at MW003 as an issue for the Castle Vista Plume remedial action. That portion of the Castle Vista Plume has been captured but not cleaned up by wellhead treatment.

Recommendations and Follow-up Actions

- It is recommended that the Air Force perform an assessment of the feasibility of optimizing the existing remedy (pump-and-treat) or applying alternative technologies (e.g., ISCO) to address the remaining contamination in the Shallow HSZ Main Base Plume. The assessment will be presented in the form of a Technical Memorandum appended to the 2009 or 2010 LTGSP Annual Report. If the Technical Memorandum recommends a change in the remedy and the regulatory agencies concur, the Air Force will prepare the necessary documentation (i.e., a ROD Amendment or an Explanation of Significant Difference) to change the remedy for this portion of the Main Base Plume. The deadline for this remedy change documentation will be the end of fiscal year 2011.
- It is recommended that an alternative remedial technology be implemented to clean up the residual Castle Vista Plume. Alternative remedial technologies have been evaluated and a work plan for conducting an in-situ chemical oxidation pilot study at MW003 has been approved. Air Force implementation of the pilot study was scheduled for the fall of 2008 but has been delayed due to the need to conduct additional site characterization. The deadline for completion of the pilot study is now 30 September 2009.
- Independent of an identified issue, it is recommended that one additional round of long-term ecological monitoring be conducted at an appropriate time during the next five years (a year with average or above winter precipitation) to further confirm that there are no ecological impacts to vernal pools associated with ETC-10, ETC-12, FTA-1, LF-3 or LF-5.
- Also independent of an identified issue but based on concerns expressed by the regulatory agencies, it is recommended that a focused round of groundwater sampling for 1,4-dioxane be conducted. This compound, an emerging chemical of concern, has been detected at several sites in the Central Valley of California but the groundwater at Castle Airport has never been tested for this chemical. The Air Force will conduct a round of sampling for 1,4-dioxane as part of the LTGSP Q1/09 sampling event. All treatment plant influents and effluents and selected monitoring wells will be sampled.

Five-Year Review Summary Form

continued

Protectiveness Statement(s)

Main Base Plume Remedial Action (CB ROD – Part 1 - plume capture and cleanup to MCLs; CB ROD – Part 2 - ICs, wellhead treatment or alternative water supply to protect public and private drinking water wells; wellhead treatment to address groundwater contamination in the off-base Confined HSZ plume)

The remedial action implemented for the Main Base Plume is protective of human health and the environment. The remedy is functioning as designed (plume control and reduction), expected progress has been made towards achieving MCL cleanup levels, all components of the remedy are being operated in a safe and proper manner and have been optimized to the extent practical (OU-1 treatment plant and MW883/MW1021, MW941, and MW1009 wellhead treatment systems have been shut down). ICs to restrict use of groundwater exceeding MCLs are in place, are effective, and regular IC monitoring is being conducted. There have been no changes in criteria, standards or methods which affect the protectiveness of the remedy and no other information has been identified that would affect protectiveness. A screening level assessment determined that the cancer risk associated with potential vapor intrusion from the current levels of groundwater contamination in the Shallow HSZ was less than $1x10^{-6}$. The technical assessment identified the lack of active Shallow HSZ pump-and-treat remediation and plume capture in the former OU-1 area where TCE concentrations have rebounded to above MCL levels as a potential issue. To address this issue, the Air Force will perform an assessment of the feasibility of optimizing the existing remedy (pump-and-treat) or applying alternative technologies (e.g., ISCO) to address the remaining contamination in the Shallow HSZ. The assessment will be presented in the form of a Technical Memorandum appended to the 2009 or 2010 LTGSP Annual Report. If the Technical Memorandum recommends a change in the remedy and the regulatory agencies concur, the Air Force will prepare the necessary documentation (i.e., a ROD Amendment or an Explanation of Significant Difference) to change the remedy for this portion of the Main Base Plume. The deadline for this remedy change documentation will be the end of fiscal year 2011.

Castle Vista Plume Remedial Action (CB ROD – Part 1 - plume capture and cleanup to MCLs; CB ROD – Part 2 – ICs and wellhead treatment or alternative water supply to protect public and private drinking water wells)

The remedial action implemented for the Castle Vista Plume is protective of human health and the environment. The remedy is functioning as designed (plume control and reduction), expected progress has been made towards achieving MCL cleanup levels, all components of the remedy are being operated in a safe and proper manner and have been optimized to the extent practical (Castle Vista treatment plant shut down). ICs to restrict use of groundwater exceeding MCLs are in place, are effective, and regular IC monitoring is being conducted. There have been no changes in criteria, standards or methods which affect the protectiveness of the remedy and no other information has been identified that would affect protectiveness. The lack of effectiveness of the MW003 wellhead treatment system in eliminating the small residual portion of the Castle Vista Plume was identified as an issue. In response to this issue, a pilot study work plan to implement in-situ chemical oxidation (ISCO) at MW003 and vicinity has been prepared and approved by the regulatory agencies. Implementation of the pilot study was scheduled for the fall of 2008 but has been delayed due to the need to conduct additional site characterization. The deadline for completion of the pilot study is now 30 September 2009.

Five-Year Review Summary Form

continued

Earth Technology Corporation 10 Remedial Action (ICs and LTEM)

The remedial actions implemented for ETC-10 are protective of human health and the environment. The remedies are functioning as designed (access restricted and ecological monitoring conducted), there are no issues and no other information has been identified that would affect protectiveness. ICs to restrict site access and alteration are in place and maintained as part of the Air Force/BoP MOU. Ecological surveys of background (not impacted) and potentially impacted vernal pools at and in the vicinity of ETC-10 were conducted in the spring of 2008. Results of the surveys show no evidence that fairy shrimp abundance, plant diversity or plant abundance is statistically less (95% confidence level) in potentially impacted pools than in background pools.

Earth Technology Corporation 12 Remedial Action (LTEM)

The remedial action implemented for ETC-12 is protective of human health and the environment. The remedy is functioning as designed (ecological monitoring conducted), there are no issues and no other information has been identified that would affect protectiveness. Ecological surveys of background (not impacted) and potentially impacted vernal pools at and in the vicinity of ETC-12 were conducted in the spring of 2008. Results of the surveys show no evidence that fairy shrimp abundance, plant diversity or plant abundance is statistically less (95% confidence level) in potentially impacted pools than in background pools.

Fire Training Area 1 Remedial Action (SVE, BV, E&D, ICs, LTM and LTEM; SVE/capping and E&D completed; BV not necessary)

The remedial actions implemented for FTA-1 are protective of human health and the environment. The ongoing remedies are functioning as designed (access restricted, cap maintenance and monitoring active and ecological monitoring conducted), there are no issues and no other information has been identified that would affect protectiveness. ICs to restrict site access and alteration are in place and maintained as part of the Air Force/BoP MOU. Maintenance and monitoring of the cap, including reporting of any evidence of human access or alteration, is being conducted quarterly. Ecological surveys of background (not impacted) and potentially impacted vernal pools at and in the vicinity of FTA-1 were conducted in the spring of 2008. Results of the surveys show no evidence that fairy shrimp abundance, plant diversity or plant abundance is statistically less (95% confidence level) in potentially impacted pools than in background pools. Although not an issue for the FTA-1 remedies, continued sampling of the two monitoring wells at FTA-1 with recent TCE detections near or above the MCL is recommended.

Landfill 3 Remedial Action (LTEM)

The remedial action implemented for LF-3 is protective of human health and the environment. The remedy is functioning as designed (ecological monitoring conducted), there are no issues and no other information has been identified that would affect protectiveness. Ecological surveys of background (not impacted) and potentially impacted vernal pools at and in the vicinity of LF-3 were conducted in the spring of 2008. Results of the surveys show no evidence that fairy shrimp abundance, plant diversity or plant abundance is statistically less (95% confidence level) in potentially impacted pools than in background pools.

Five-Year Review Summary Form

continued

Landfill 4 (DP-5, DP-6) Remedial Action (ICs and LTM)

The remedial actions implemented for LF-4/DP-5/DP-6 are protective of human health and the environment. The ongoing remedies are functioning as designed (access restricted, cap maintenance and monitoring active), there are no issues and no other information has been identified that would affect protectiveness. ICs to restrict site access and alteration are in place as part of the deed transferring the parcel containing LF-4 to Merced County and a State Land Use Covenant executed by the Air Force and the State of California. Maintenance and monitoring of the cap and its ancillary facilities, including reporting of any evidence of human access or alteration, is being conducted quarterly.

Landfill 5 (DP-8, DP-8A, Landfill 5 Trenches) Remedial Action (ICs, LTM and LTEM)

The remedial actions implemented for LF-5/DP-8/DP-8A/LF-5 Trenches are protective of human health and the environment. The ongoing remedies are functioning as designed (access restricted, cap maintenance and monitoring active and ecological monitoring conducted), there are no issues and no other information has been identified that would affect protectiveness. ICs to restrict site access and alteration are in place and maintained as part of the Air Force/BoP MOU. Maintenance and monitoring of the cap and its ancillary facilities, including reporting of any evidence of human access or alteration, is being conducted quarterly. Ecological surveys of background (not impacted) and potentially impacted vernal pools at and in the vicinity of LF-5 were conducted in the spring of 2008. Results of the surveys show no evidence that fairy shrimp abundance, plant diversity or plant abundance is statistically less (95% confidence level) in potentially impacted pools than in background pools.

1 INTRODUCTION

The purpose of five-year reviews is to determine whether the remedy at a site is protective of human health and the environment. The methods, findings and conclusions of reviews are documented in five-year review reports. In addition, five-year review reports identify issues found during the review, if any, and present recommendations to address them.

This five-year review has been prepared pursuant to Section 121 (c) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the National Contingency Plan (NCP). CERCLA Section 121 (c) states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The U.S. Environmental Protection Agency (EPA) interpreted this requirement further in the NCP. 40 CFR Section 300.430(f)(4)(ii) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after initiation of the selected remedial action.*

The responsibility for conducting five-year reviews rests with the EPA. However, through contracts and/or other agreements, the EPA may authorize other parties to perform the reviews. Under Executive Order 12580, the United States Air Force (Air Force or USAF) was authorized to perform the initial and all subsequent five-year reviews for the Castle Airport (formerly Castle Air Force Base [CAFB]) Superfund site, Merced County, California. The EPA retains final authority over whether the five-year review adequately addresses the protectiveness of remedies. EPA will either concur with the final Air Force protectiveness determination, or EPA may provide independent findings.

The United States Air Force Real Property Agency (AFRPA), as the lead agency, is responsible for the five-year review of remedies implemented at the Castle Airport site. This five-year review was conducted for AFRPA by Jacobs under United States Air Force Center for Engineering and the Environment (AFCEE) Contract Number F41624-03-D-8605, Task Order No. 0086. The review was conducted from May through July 2008 and focuses on the remedial actions taken pursuant to the RODs for groundwater at Castle Airport and ongoing long-term (greater than five years) removal/remedial actions at selected vadose zone or SCOU sites at Castle Airport. This report, which documents the results of the review, has been prepared in accordance with the most recent EPA and AFRPA guidance for conducting five-year reviews and preparing five-year review reports (*Comprehensive Five-Year Review Guidance*; EPA, 2001 and *Air Force Real Property Agency Guidance for Five-Year Reviews*; AFRPA, 2007).

Two types of five-year reviews are defined in EPA guidance: statutory reviews and policy reviews. A statutory review is to be conducted for any site where the selected remedy, once ROD cleanup levels are attained, will not allow unlimited use and unrestricted exposure. A policy review is to be conducted for any site where no hazardous substances will remain above levels that allow unlimited use and unrestricted exposure after completion of the remedial action, but where the cleanup levels presented in the ROD will require five or more years to be attained. This five-year review of groundwater and vadose zone remedial actions at Castle Airport is a statutory review because the groundwater remedial actions are long-term and the removal actions already completed at FTA-1 (capping) and at LF-4 and LF-5 (consolidation and capping) have left hazardous substances, pollutants or contaminants on site above levels that allow for unlimited use and unrestricted exposure.

This is the third five-year review for the Castle Airport site. The triggering action for the initial review was the start of construction of the Operable Unit 1 (OU-1) groundwater treatment system in March 1993. The initial five-year review for Castle Airport was completed in March 1998 and was submitted as final to the regulatory agencies on 12 November 1998 (Jacobs Engineering [Jacobs], 1998a). The initial five-year review was signed and accepted by the EPA and state regulatory agencies (Department of Toxic Substances Control [DTSC] and Regional Water Quality Control Board [RWQCB]) on 28 September 1999. The second five-year review was completed in September 2002, and, following an extended period of discussion, was signed by EPA and the state regulatory agencies and issued as final on 23 January 2004 (Jacobs, 2004a). This five-year review is scheduled to be finalized by 23 January 2009.

A draft five-year review report was prepared and submitted to the EPA and the state regulatory agencies (DTSC and RWQCB) on 13 August 2008. Comments on the draft five-year review were received from the EPA on 04 November 2008, from the RWQCB on 05 November 2008 and from the DTSC on 13 November 2008. Responses to their comments were prepared and submitted to the regulatory agencies on 21 November 2008. Selected responses were revised based on additional comments received from the EPA on 08 December 2008. This final five-year review report incorporates changes based on the comments received from the EPA, DTSC and the RWQCB and the Air Force responses to those comments. Copies of the formal responses to EPA, RWQCB and DTSC comments on the draft document are provided in Appendix A.

1.1 SCOPE OF CURRENT FIVE-YEAR REVIEW

At present, there are only two OUs defined for Castle Airport: the Groundwater OU, which includes all identified contaminant plumes, and the SCOU, which includes all 233 identified vadose zone contamination sites. It is noted that the two initial groundwater treatment systems installed and operated at Castle Airport were designated OU-1 and OU-2. These systems were (OU-1) and remain (OU-2) part of the groundwater OU.

Five RODs have been completed and define the CERCLA response process for groundwater contamination and vadose zone contamination at Castle Airport:

- *Final Record of Decision, Comprehensive Basewide Program–Part 1 (Groundwater)* (CB ROD – Part 1) (U.S. Air Force [USAF], 1997)
  - ♦ Addresses the six groundwater plumes identified during the CB RI: Main Base Plume; East Base Plume; Landfill 1 Plume; Landfill 4 Plume; North Base Plume; and Castle Vista Plume.
- *Source Control Operable Unit Record of Decision Part 1* (SCOU ROD Part 1) (Waste Policy Institute [WPI], 2002)
  - ♦ Addresses 169 SCOU sites, 137 of which are identified as no further action (NFA) sites based on lack of contamination, risk management decisions or completed removal actions and 32 of which are CERCLA-exempt.
- *Source Control Operable Unit Record of Decision Part 2* (SCOU ROD Part 2) (Earth Tech, 2003a)
  - ♦ Addresses 53 SCOU sites: 21 with SVE as the selected remedy (one of these sites has excavation and disposal [E&D] as an additional component of the remedy); six with E&D as the selected remedy (two of these sites have BV as an additional component of the remedy); 14 identified as NFA sites based on lack of contamination or completed E&D; and 12 CERCLA-exempt sites.
- *Source Control Operable Unit Record of Decision Part 3* (SCOU ROD Part 3) (Jacobs, 2005a)
  - ♦ Addresses selected remedies for eight SCOU landfill sites (LF-4 including DP-5 and DP-6 and LF-5 including DP-8, DP-8A, DP-9 and LF-5 Trenches) - LTM and ICs. An NFA determination is made for DP-9. Also addresses the selected remedies for

ETC-8; (E&D), ETC-10 (ICs) and FTA-1 (SVE, BV, E&D, LTM and ICs). Presents the remedies for ecological concerns at all SCOU sites: NFA at 225 sites and LTEM at eight sites (ETC-10, ETC-12, FTA-1, LF-3 and LF-5 including associated sites DP-8, DP-8A and LF-5 Trenches). The remedy for ecological concerns at FTA-1 includes E&D of approximately 150 cubic yards of soil outside of the existing cap that exceeds ecological RAOs.

- *Comprehensive Basewide Record of Decision – Part 2* (CB ROD – Part 2) (AFRPA, 2006a)
  - Addresses groundwater use restrictions (ICs) for areas overlying maximum contaminant level (MCL) plumes until CB ROD – Part 1 cleanup levels are achieved. Updates the groundwater remedy to include wellhead treatment within the plume and at Atwater municipal well 18 (AM18), if necessary, to address the MCL plume southwest of Castle Airport where capture is not practical because of AM18 pumping. Provides an overview of final remedies for all groundwater plumes (six) and SCOU sites (233).

This five-year review focuses on the ongoing groundwater remedial actions at Castle Airport addressed by the CB ROD – Part 1 (pump-and-treat remediation for plume capture and cleanup to MCLs or monitoring) and ongoing long-term (longer than five years) removal/remedial actions or LTEM at 11 SCOU sites addressed by SCOU ROD Part 3. Groundwater plumes addressed are the Main Base Plume (OU-2, Phase 3 and wellhead groundwater treatment systems; plume capture and cleanup) and the Castle Vista Plume (MW003 wellhead treatment system; plume capture and cleanup). These plumes have been addressed in both of the previous five-year reviews. SCOU sites addressed are ETC-10 (ICs and LTEM), ETC-12 (LTEM), FTA-1 (LTM, ICs and LTEM), LF-3 (LTEM), LF-4 (ICs and LTM) and LF-5 (ICs, LTM and LTEM). Associated sites also addressed herein are DP-5 and DP-6 at LF-4 and DP-8, DP-8A and LF-5 Trenches at LF-5. This five-year review is the second to address ETC-10, FTA-1, LF-4 and LF-5 and the first to address ETC-12 and LF-3.

This five-year review does not provide technical assessments for SCOU sites at Castle Airport other than the 11 sites noted above. The remaining 222 SCOU sites are not evaluated for one of two reasons: (1) the site is currently designated as NFA or (2) the site is a non-CERCLA or a CERCLA exclusion site. All SCOU sites, site linkages, selected remedies, ROD affiliation and the rationale for technical assessment or exclusion from technical assessment in this five-year review are listed in Table 1-1. The ROD affiliation of all SCOU sites and the location of the majority of SCOU sites at Castle Airport are shown on Plate 1 (linear sites such as pipelines and sites with uncertain location not shown; plate in plastic sleeve at end of this report).

This five-year review was conducted by evaluating the status and performance of the ongoing groundwater remedial actions and the ongoing long-term SCOU removal/remedial actions, and determining whether those actions meet or demonstrate progress consistent with meeting the specific goals and objectives stated/anticipated in the applicable ROD (i.e., is the remedy protective?). The assessment of protectiveness is based on the following three questions:

1. Is the remedy functioning as intended by the decision documents?
2. Are the exposure assumptions, toxicity data, cleanup levels and RAOs used at the time of remedy selection still valid?
3. Has any other information come to light that could call into question the protectiveness of the remedy?

As stated in the guidance, these questions provide a framework for organizing and evaluating available data on the groundwater and SCOU site remedies and ensure that all relevant issues are considered when assessing protectiveness.

1.2 REPORT ORGANIZATION

The remainder of this five-year review is organized as follows:

- Section 2, Site Chronology, identifies the sequence and dates of major events in the CERCLA response process at Castle Airport.
- Section 3, Background, introduces the Castle Airport site and briefly describes the geologic/hydrogeologic framework and contaminant distribution in groundwater and the vadose zone.
- Section 4, Remedial Actions, provides a brief description of the remedial actions and the decision documents for Castle Airport. The remedy selection process and implementation of the selected remedies for the groundwater plumes and SCOU sites evaluated in this five-year review are emphasized.
- Section 5, Progress Since Last Review, summarizes major actions/accomplishments since the last five-year review.
- Section 6, Five-Year Review Process, briefly outlines those elements of the standard five-year review process conducted at Castle Airport.
- Section 7, Technical Assessment, evaluates the protectiveness of each of the ongoing groundwater and SCOU site remedial actions (individual assessment for each identified contaminant plume and SCOU site).
- Section 8, Issues, summarizes any issues or concerns regarding protectiveness identified during the technical assessment.
- Section 9, Recommendations and Follow-Up Actions, lists and describes any recommended actions or modifications to the existing actions that are necessary or appropriate to achieve and/or maintain protectiveness of the evaluated remedial actions.

- Section 10, Protectiveness Statements, provides a summary statement regarding the protectiveness of each of the evaluated groundwater and SCOU site remedial actions at Castle Airport.
- Section 11, Next Review, identifies the schedule for preparing the next and anticipated subsequent five-year review documents for Castle Airport.
- Section 12, References, lists all documents cited in the text.

2 SITE CHRONOLOGY

This section presents a brief chronology, in table and figure format, of the major events directly related to the groundwater and vadose zone remedial actions at Castle Airport. Table 2-1 lists dates and events (major field activity, primary documents, removal actions, remedial actions, etc.) from the initial discovery of contaminated groundwater in 1978 through the first scheduled ecological monitoring events in February and April 2008. Figure 2-1 shows the primary CERCLA documents that have been and will be prepared for Castle Airport and the integration of the major operable units (vadose zone and groundwater) at Castle Airport. A full citation for all documents referenced in Table 2-1 and/or included on Figure 2-1 is provided in Section 12.

3 BACKGROUND

3.1 PHYSICAL CHARACTERISTICS

Castle Airport, formerly CAFB, is located in central California within the San Joaquin Valley in Merced County, as shown on Figure 3-1. The site is approximately 6 miles northwest of Merced, near the communities of Winton (to the north and west) and Atwater (to the southwest). The former CAFB covered an area of 2,777 acres composed of runway and airfield operations, industrial areas, housing, recreational facilities and several noncontiguous parcels of land located near the base. The largest noncontiguous parcels are two former housing annexes (Castle Gardens and Castle Vista), totaling approximately 206 acres, located to the southwest of the former base (Figure 3-1).

Land use within a 3-mile radius of Castle Airport is mixed urban and agricultural. Several small dairies, a large chicken ranch, row crops and open pasture land are located immediately east of Castle Airport. Open pasture land is predominant to the south. An urbanized area (City of Atwater) bounds the site to the southwest. Orchards (primarily almonds) are predominant to the west, while in the north are mixed orchards and pasture land. There are several environmentally sensitive wetland areas within Castle Airport, mostly in the eastern and northern portions.

The subsurface at Castle Airport consists of a relatively thick vadose zone (approximately 60 to 70 feet) and an underlying sequence of lithologically distinct, but hydraulically connected, water-bearing or hydrostratigraphic zones (HSZs). The vadose zone typically consists of sand underlain by a few inches to several feet of hardpan that is underlain by laterally discontinuous alluvial sands, silts, gravels and clays. Below the water table, five HSZs have been identified and designated, in descending order, as the Shallow, Upper Subshallow (USS), Lower Subshallow (LSS), Confined, and Deep HSZs. A generalized basewide conceptual model based on these HSZs is shown on Figure 3-2.

The Shallow HSZ is the uppermost water-bearing unit underlying Castle Airport and the surrounding area. This zone is unconfined and extends from the water table (currently 70 to 80 feet below ground surface [bgs] and generally declining) to an average depth of about 95 feet bgs. In some areas, the Shallow HSZ extends to a maximum depth of 115 feet bgs. The lithology is mixed sands, silts and gravels with minor amounts of clay. The basal layer of the Shallow HSZ appears to consist of sand- and gravel-filled relict stream channels. The saturated thickness of the Shallow HSZ averages from 20 to 25 feet and ranges from about 5 to 45 feet.

The USS HSZ extends from the bottom of the Shallow HSZ to an average depth of 130 feet bgs and a maximum depth of about 160 feet bgs. The lithology is heterogeneous both laterally and vertically, consisting mostly of fine-grained flood plain deposits grading into medium-grained sands to the south of Castle Airport. The saturated thickness of the USS HSZ averages about 35 feet, with a maximum of about 65 feet.

The LSS HSZ extends from the base of the USS HSZ to an average depth of 220 feet bgs and a maximum depth of about 245 feet bgs. The lithology is predominantly fine-grained sands, silts and clays. A 10- to 25-foot thick, gravel-bearing horizon occurs intermittently near the base of the zone. The saturated thickness of the LSS HSZ averages about 85 feet, with a maximum of about 115 feet.

The Confined HSZ extends from the base of the overlying LSS HSZ to an average depth of 350 feet bgs and a maximum depth of about 370 feet bgs within the Castle Airport boundary. To the southwest, the base of the Confined HSZ dips downward to an average depth of about 400 feet bgs and a maximum depth of perhaps 430 feet bgs. The zone is predominantly fine-grained but also contains more continuous clean sands and gravels than does the overlying LSS HSZ. The North Merced Gravel, which occurs at the base of the zone, does not appear to be laterally continuous. Where present, this gravel comprises the majority of the clean sands and gravels in the Confined HSZ. The saturated thickness of the Confined HSZ ranges from about 125 to 185 feet.

The Deep HSZ underlies the Confined HSZ. The lithology and vertical extent of the Deep HSZ is not well defined.

3.2 LAND AND RESOURCE USE

Prior to establishment of the Merced Army Flying School at the site in 1941, the base area was mixed agricultural and undeveloped land. While an active military base (1941-1995), land uses were those typical of military airfield operations: flight operations (fueling); fuel storage and transfer (tanks and pipelines); aircraft maintenance (solvents, hydraulic fluid, etc.); fire training (fuels, oils and solvents); and general base operations (industrial and domestic wastes). Current and future land use at Castle Airport includes a civilian airport, educational, industrial, medical and housing facilities and a federal prison. The land surrounding Castle Airport will likely remain a mix of urban and agricultural use for the foreseeable future.

The only significant resource use at Castle Airport is the pumping of groundwater for water supply. At present there are three active water supply wells within Castle Airport: production well 10 (PW10; grid Q9; screened from 261 to 734 feet bgs), PW12 (grid R15; screened from 360 to 875 feet bgs) and AM21 (grid L14; screened from 360 to 670 feet bgs) (Figure 3-3). All are completed in water-bearing zones beneath and/or upgradient of areas of known groundwater contamination at Castle Airport (Section 3.3; Figure 3-3). Production well PW10 (primary) and PW12 (backup) supply water to all facilities and for all uses at Castle Airport except the federal prison, which is supplied by AM21. PW10 and PW12 were installed by the Air Force; AM21 was installed by the City of Atwater.

3.3 HISTORY OF CONTAMINATION

Numerous activities/facilities at CAFB generated soil and groundwater contaminants during all or a portion of active base operations (1941-1995). Contamination at CAFB was first identified in 1978 when trichloroethene (TCE) was detected in groundwater samples from several on-base production wells. Potential source areas and related contaminants at Castle Airport are as follows (Jacobs, 1997a):

- **Engine Maintenance Shops.** Buildings used for degreasing and repair of aircraft engines. Expected contaminants included volatile organic compounds (VOCs), primarily TCE and its degradation products; aromatic VOCs such as benzene, toluene, ethylbenzene and xylenes (BTEX); other petroleum compounds and metals.
- **Washracks and Discharge Areas.** Washracks, typically associated with aircraft hangers and maintenance areas, were used for cleaning the outer surfaces of aircraft and other equipment. Discharge areas were locations where liquid wastes were released onto the ground surface. Expected contaminants included TCE and its degradation products and metals.
- **Landfills and Disposal Pits.** Areas used for the disposal of domestic, construction and industrial wastes (solid and liquid). Expected contaminants included VOCs, BTEX, semivolatile organic compounds (SVOCs), chlorofluorohydrocarbons and metals.
- **Storage Tanks and Tank Farms.** Aboveground storage tanks (ASTs) and underground storage tanks (USTs) used for storage of fuels and oils. Expected contaminants were petroleum hydrocarbons included in jet fuel, gasoline, diesel, heating oil, motor oil and hydraulic fluid.
- **Utility Pipelines.** Fuel, domestic and industrial waste (sewer) and storm drain pipelines. Expected contaminants were VOCs and petroleum hydrocarbons.
- **Hazardous Waste Storage Sites and Solid Waste Management Units**. Hazardous waste storage sites included bermed, concrete-lined or open areas used for the temporary storage of drummed (typical) wastes. Solid waste management units

included silver recovery units, washrack tanks, grease traps and oil/water separators. Expected contaminants were VOCs, SVOCs, BTEX and other petroleum hydrocarbons, paints, pesticides and metals.

- **Surface Release and Fire Training Areas.** Accidental spills during base operations and purposeful releases of flammable liquids to the ground surface for fire training exercises. Expected contaminants included fuels, BTEX and VOCs.
- **Miscellaneous.** Small sites, such as stains on concrete flightlines that do not fall into any of the other categories. Expected contaminants for flightline stains were polyaromatic hydrocarbons and metals.

Site characterization investigations were begun during 1981 under the Department of Defense Installation Restoration Program (IRP). These and the extensive site characterization programs that followed have resulted in the installation of several hundred soil and soil vapor borings and in the installation of over 350 monitoring wells within, and in areas adjacent to, Castle Airport. The results of the separate groundwater and vadose zone investigations are presented in two comprehensive RI/FS reports, CB RI/FS–Part 1 for groundwater (Jacobs, 1996) and SCOU RI/FS for the vadose zone (Jacobs, 1997a).

3.4 REMOVAL ACTIONS TO DATE

Several groundwater and vadose zone removal actions have been undertaken at Castle Airport to address groundwater, soil or soil gas contamination. Groundwater removal actions were implemented at Discharge Area 4 (DA-4) and Wallace Road in 1991 and at Building 84 (B84) in 1993. E&D, consolidation and capping and SVE removal actions have been initiated and completed at numerous SCOU sites, all of which are listed in Table 2-1. The only SCOU sites with removal actions with continuing components (now remedial actions) are ETC-10 (E&D), FTA-1 (capping), LF-3 (E&D) and LF-4 and LF-5 and their associated sites (consolidation and capping). All removal actions were designed with input from, and implemented with the concurrence of, the Base Conversion Team (BCT), including EPA, DTSC and RWQCB.

Because they are precursors to the groundwater remedial actions ultimately addressed in this five-year review as defined in the CB ROD – Part 1, brief descriptions of the three groundwater removal actions completed at Castle Airport and the actions defined by two preceding RODs (OU-1 Interim ROD [USAF, 1991] and OU-2 Final ROD [USAF, 1993]) are provided in Sections 3.4.1 through 3.4.4. The groundwater remedial actions and the SCOU sites with ongoing long-term remedial actions that are addressed in this five-year review are described in Section 4.

3.4.1 DA-4 Groundwater Removal Action

The DA-4 groundwater treatment system, located adjacent to the DA-4 site (grids K8 and L8 on Plate 1), consisted of one Shallow HSZ extraction well (DA4-2) and two 20,000-pound liquid-phase granular activated carbon (GAC) vessels operated in series. The DA-4 system was implemented to address a “hot spot” area of groundwater contamination that had a maximum TCE concentration of approximately 2,000 micrograms per liter (µg/L) at the time of system startup. The extraction well was pumped at an average rate of 170 gallons per minute (gpm). Treated groundwater was discharged to the Merced Irrigation District (MID) Casad Lateral Canal under a National Pollutant Discharge Elimination System (NPDES) permit. The system operated from July 1991 until it was decommissioned in May 1995. TCE concentrations in the system influent ranged from about 2,000 µg/L at startup to 58 µg/L at shutdown. The system removed an estimated 414 pounds of TCE and treated approximately 341 million gallons of groundwater. Extraction well DA4-2 was later integrated into the OU-2 system. The two 20,000-pound GAC vessels were moved and incorporated into the OU-2 treatment plant.

3.4.2 Wallace Road Groundwater Removal Action

The Wallace Road groundwater treatment system, located along the western base boundary south of the DA-4 site (grids M/N/P8 on Plate 1), consisted of four extraction wells and two 20,000-pound liquid-phase GAC vessels operated in series. The Wallace Road system was implemented to address a hot spot area of groundwater contamination that had a maximum TCE concentration of about 120 µg/L at the time of system startup. Three of the four extraction wells (WR1, WR2 and WR3) were screened across the Shallow and USS HSZs; the fourth extraction well (WR4) was screened only in the Shallow HSZ. The extraction wells were pumped at a combined average rate of about 450 gpm. Similar to the DA-4 system, treated groundwater was discharged to the MID Casad Lateral Canal under an NPDES permit. The system was in operation from December 1991 until April 1996, when it was taken off line to accommodate construction of the OU-2 groundwater treatment plant. TCE concentrations in the system influent ranged from about 120 µg/L at startup to 42 µg/L at shutdown. The system removed an estimated 438 pounds of TCE and treated approximately 969 million gallons of groundwater. The three extraction wells that were screened across the Shallow and USS HSZs were destroyed when the system was decommissioned; extraction well WR4 (Shallow HSZ) was not destroyed and was later incorporated into the OU-2 system. The two 20,000-pound GAC vessels were incorporated into the OU-2 treatment plant, which was constructed in essentially the same location as the Wallace Road facility.

3.4.3 B84 Groundwater Removal Action

The B84 groundwater treatment system, located near SCOU sites B84, B54 and B51 (grid R11 on Plate 1), consisted of one Shallow HSZ extraction well (EW01) and two 10,000-pound liquid-phase GAC vessels operated in series. The B84 system was implemented to address a hot spot area of groundwater contamination which had a maximum TCE concentration of about 480 µg/L at the time of system startup. EW01 was pumped at an average rate of about 130 gpm. Treated groundwater was discharged to the sanitary sewer system. The system was in operation from January 1993 through May 1994, when it was taken off line to accommodate startup of the OU-1 system (July 1994). TCE concentration in the system influent ranged from a high of about 480 µg/L at startup to about 130 µg/L at shutdown. The system removed an estimated 222 pounds of TCE and treated approximately 116 million gallons of groundwater. EW01 was incorporated into the OU-1 system; components of the treatment plant were later used for the Phase 2 groundwater treatment system.

3.4.4 OU-1 and OU-2 Groundwater Remedial Actions

During the latter portion of initial RI field activities at Castle Airport (1990-1991), the Air Force divided Castle Airport into two groundwater OUs: OU-1 and OU-2. The Air Force defined these OUs in an attempt to segregate major groundwater contaminant plumes and their source areas. The general location and extent of OU-1 and OU-2 correspond to Main Plume Region 1 and Main Plume Region 2, which were the southeast and northwest portions of the single Main Base Plume Region shown on Plate 1.

An Interim OU-1 ROD was finalized in August of 1991 (USAF, 1991). The stated purpose of the OU-1 action was to remove contaminants from hot spots in the Shallow HSZ Main Base Plume.

Standards for groundwater cleanup were not established in the OU-1 Interim ROD, but were ultimately set as MCLs (5 µg/L for TCE) in the CB ROD – Part 1 (USAF, 1997). Standards for treated groundwater were originally set at MCLs in the OU-1 Interim ROD. However, prior to construction and operation of the OU-1 system, discharge standards were changed to values compatible with those subsequently included in the CB ROD – Part 1 (30-day median of 0.5 µg/L for TCE).

OU-1 groundwater treatment system construction began in March 1993 and the system was placed in service on 29 July 1994. The system originally consisted of four extraction wells and nine injection wells, all completed in the Shallow HSZ, with groundwater treatment by dual-stage air stripping (two air-stripping towers operated in series).

The OU-1 basis of design and rationale for well placement is documented in the *Final Basis of Design Report, Operable Unit No. 1, Castle Air Force Base, California* (PRC Environmental Management [PRC], 1992. The system was upgraded during the spring of 1996 to improve performance and treatment plant reliability. Major modifications included relocating control elements above ground and sealing the data highway and electrical conduits against water infiltration. The treatment plant pad was also upgraded to prevent future flooding. A fifth extraction well was installed in April 1996 to increase mass removal. Following these modifications, system capacity was approximately 425 gpm. The OU-1 extraction and injection well, conveyance system and treatment plant locations are shown on Plate 1.

A ROD for OU-2 was finalized in November 1993 (USAF, 1993). The stated OU-2 groundwater treatment system objective was to remediate degraded groundwater in the OU-2 area, or that portion of the Main Base Plume as defined in 1992-1993 not covered by the OU-1 groundwater treatment system. Similar to OU-1, standards for treated groundwater, which were set at MCLs in the OU-2 Final ROD, were changed to values compatible with those subsequently included in the CB ROD – Part 1 (30-day median of 0.5 µg/L for TCE).

Construction of the OU-2 groundwater treatment system began in March 1995 and was completed by mid-November 1996. The system went on line on 22 November 1996 and originally consisted of 15 extraction wells, 11 injection wells (two of these were subsequently incorporated into the Phase 3 system; see Section 4.2) and four pairs of GAC vessels (operated in series). Of the 15 extraction wells, nine are completed in the Shallow HSZ and six are completed in the USS HSZ. Five of the injection wells are completed in the Shallow HSZ, five in the USS HSZ and one in the LSS HSZ (one USS HSZ and the LSS HSZ injection well are now part of Phase 3). The four GAC vessel pairs (all 20,000-pound vessels; one pair each from the DA-4 and Wallace Road systems) are connected in parallel, while each vessel pair is connected in series. System capacity at startup was approximately 2,200 gpm. The OU-2 extraction and injection well, conveyance system and treatment plant locations are shown on Plate 1.

3.5 BASIS FOR TAKING ACTION

Contaminated media at Castle Airport are groundwater and soil. The basis for taking action in each is discussed separately in the following subsections.

3.5.1 Basis for Groundwater Action

Hazardous substances released to groundwater and identified as contaminants of concern (COCs) during the CB RI are in the following list. Groundwater COCs were those contaminants detected in groundwater at concentrations exceeding their respective MCLs or at concentrations that, with exposure, would result in a cancer risk greater than 1E-06 and/or a non-cancer hazard index equal to or greater than 1 (Jacobs, 1996). To identify COCs, monitoring wells were completed in all of the identified HSZs. They were and remain more numerous in the Shallow and USS HSZs than in the LSS and Confined HSZs; only one monitoring well, since destroyed, was completed in the Deep HSZ. Regular quarterly groundwater monitoring under the Long-Term Groundwater Sampling Program (LTGSP) was initiated at Castle Airport in 1993.

Contaminants of Concern in Groundwater

1,1-dichloroethene
1,2-dibromo-3-chloropropane
1,2-dibromoethane (ethylene dibromide)
1,2-dichlorobenzene
1,2-dichloroethane
1,2-dichloropropane
arsenic
benzene
bromodichloromethane
carbon tetrachloride
cis-1,2-dichloroethene
chloroform
di(2-ethylhexyl)phthalate
hexachlorobutadiene
tetrachloroethene
trichloroethene
vinyl chloride

CB RI sampling and early LTGSP monitoring results documented that TCE was the primary groundwater contaminant at Castle Airport. It was detected in the Shallow, USS, LSS and Confined HSZs both beneath and downgradient of the former base. Free-phase TCE was not encountered during exploratory drilling, nor were concentrations high enough to suggest its presence.

Based primarily on TCE distribution, six plume regions were identified (see Plate 1):

- Main Base Plume Region (initially subdivided into Region 1 and Region 2)
- East Base Plume Region

- North Base Plume Region
- Landfill 1 Plume Region
- Landfill 4 Plume Region
- Castle Vista Landfill B Plume Region (*cis*-1,2-dichloroethene [*cis*-1,2-DCE] plume identified by subsequent data gap sampling; hereafter Castle Vista Plume Region)

While TCE was by far the predominant contaminant and was the primary driver for subsequent remedial evaluations and decisions, several other organic compounds, as listed above, were detected in groundwater during the CB RI. Although numerous other organics were detected, most did not occur at concentrations above regulatory standards. In addition, the second quarter 1994 (Q2/94) TCE plumes outlined on Figures 3-4 (Shallow HSZ), 3-5 (USS HSZ), 3-6 (LSS HSZ) and 3-7 (Confined HSZ) generally encompassed these other compounds such that they would be addressed by remediation of TCE.

The only notable exceptions were 1,2-dibromo-3-chloropropane (DBCP); di(2-ethylhexyl)phthalate (DEHP); benzene; and *cis*-1,2-DCE.

DBCP, an agricultural fumigant commonly detected in groundwater throughout the area, formed a distinct plume in the western portion and to the west of the base. Although listed as a contaminant of potential concern (COPC), it is not considered a Castle Airport-derived contaminant.

DEHP formed a small plume in the North Base Plume Region. DEHP was not viewed as a significant issue because the isolated plume was small and reported concentrations were low.

The highest benzene concentrations were detected in the deeper HSZs (LSS and Confined) where CB RI data did not show extensive plumes (subsequent site characterization and monitoring data showed that the TCE plumes in the LSS and Confined HSZs were larger and did encompass the area of high benzene concentration detected during the CB RI). Recent monitoring data show that benzene plumes are no longer present. During 2007, benzene was detected in only one well (trace concentration of 0.32 µg/L at Shallow HSZ monitoring well MW1003 [grid H6]) and benzene was not detected in any well sampled during 2006. The last detection of benzene above the MCL was at Shallow HSZ monitoring well JM11 in 2001 (grid S12; 14 µg/L); all samples from JM11 in 2006 and 2007 were ND for all VOCs. The last detection of benzene above the MCL in the LSS HSZ was a reported 5.4 µg/L at MW863 (grid R12) in 1995. The last detections of benzene above the MCL in the

Confined HSZ were a reported 5.7 µg/L at MW929 (grid S8) in 1994 and a reported 17 µg/L at MW606 (grid S10) in 1995.

A small *cis*-1,2-DCE plume was identified to the west of the small TCE plume at Castle Vista Landfill B. Although not considered a significant issue at the time of the CB RI, a subsequent data gap investigation defined a much larger and higher concentration *cis*-1,2-DCE plume located downgradient of Castle Vista Landfill B that encompassed both the Shallow and USS HSZs (Q1/97 *cis*-1,2-DCE plumes are shown on Figures 3-8 and 3-9, respectively).

As noted above, the CB RI results clearly showed that TCE was the principal COC in groundwater at Castle Airport. Based on CB RI data, it was estimated that there was approximately 6,600 pounds of TCE in the groundwater (estimate based on the sum of dissolved and solid mass and area inside 0.5 µg/L TCE contour) and that approximately 98 percent of this total was contained within the Main Base Plume Region (Regions 1 and 2) (Jacobs, 1996). One of the three small plumes in the East Base Plume Region (downgradient of B1762 and B1709; grids K12, K13, L12 and L13 on Plate 1) was estimated to contain approximately 1.8 percent of the identified TCE mass, but was later incorporated into the Main Base Plume. All of the remaining plume regions (East Base, North Base, Landfill 1, Landfill 4 and Castle Vista Landfill B) were estimated to contain only about 0.2 percent of the total TCE mass in groundwater at Castle Airport.

3.5.2 Basis for Vadose Zone Action

Hazardous substances released to soil and identified as COCs during the SCOU RI are in the following list. Their basis for identification as a COC is also noted. COCs were identified based on their potential to affect human health (baseline human health risk assessment [BHHRA] process—reported concentrations resulted in a cancer risk greater than $1\text{x}10^{-6}$, a non-cancer hazard index equal to or greater than 1.0 or an estimated blood-lead concentration greater than 10 micrograms per deciliter [µg/dL]) or their potential to result in concentrations in groundwater exceeding the federal or state MCL (water quality site assessment [WQSA] process) (Jacobs, 1997a).

Contaminants of Concern in Soil

1,1-*bis*(chlorophenyl)-2,2-dichloroethene (BHHRA)	*cis*-1,2-dichloroethene (WQSA)
1,1-*bis*(chlorophenyl)-2,2,2-trichloroethane (BHHRA)	dibenz(a,h)anthracene (BHHRA)
1,2-dibromo-3-chloropropane (BHHRA)	dichlorodifluoromethane (WQSA)
1,2-dichloroethane (BHHRA)	dieldrin (BHHRA)
1,2,2-trimethylbenzene (WQSA)	diesel (WQSA)
1,2,3-trichloropropane (BHHRA)	dioxins (BHHRA)
1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin (BHHRA)	ethylbenzene (WQSA)
1,4-dichlorobenzene (BHHRA)	gasoline (WQSA)
2,4-dinitrotoluene (BHHRA)	heptachlor epoxide (BHHRA)
antimony (BHHRA; WQSA)	indeno(1,2,3-c,d)pyrene (BHHRA; WQSA)
arsenic (BHHRA)	jet fuel (primarily JP-4) (WQSA)
benzene (WQSA)	lead (BHHRA; WQSA)
benzo(a)anthracene (BHHRA; WQSA)	methylene chloride (BHHRA)
benzo(a)pyrene (BHHRA; WQSA)	naphthalene (WQSA)
benzo(b)fluoranthene (BHHRA; WQSA)	polychlorinated biphenyls (BHHRA)
benzo(k)fluoranthene (BHHRA)	pyrene (WQSA)
cadmium (BHHRA)	tetrachloroethene (WQSA)
chloroform (WQSA)	thallium (BHHRA)
chlordane(a) (BHHRA)	toluene (WQSA)
chlordane(g) (BHHRA)	trichloroethene (WQSA)
chrysene (BHHRA; WQSA)	xylenes (WQSA)

Notes: 1,1-*bis*(chlorophenyl)-2,2-dichloroethene commonly known as DDE
1,1-*bis*(chlorophenyl)-2,2,2-trichloroethane commonly known as DDT

A recent summary of pertinent information for all 233 SCOU sites, including COCs and the basis for taking action or not taking action, is provided in the CB RI/FS – Part 2 (Jacobs, 2002b). Brief site descriptions and summaries of the basis for taking action at the ETC-10, ETC-12, FTA-1, LF-3, LF-4 (including DP-5 and DP-6) and LF-5 (including DP8, DP-8A and LF-5 Trenches) sites follow. BHHRA COCs listed for a site may be different than those identified during the SCOU RI because here they are based on the updated BHHRA (Jacobs, 2001a).

3.5.2.1 Earth Technology Corporation 10

ETC-10, an active skeet-shooting range until 1995, is located in grid L16 (Figure 3-3). Wetlands are present to the north and south and in the western portion of the site (Plate 1). The presence of clay pigeon shards and lead pellets was confirmed during a visual inspection of the site prior to the SCOU RI. Based on site configuration, it was assumed that particulate deposits would be distributed in a fan-shaped arc extending 300-500 feet radially from the shooting stand.

The COPCs for this site were lead and polynuclear aromatic hydrocarbons (PAHs) derived from lead shot and clay pigeon shards. During the SCOU RI, one soil boring and 18 surface locations were sampled. Soil samples (total of 19) were analyzed for general metals with specific analyses for antimony, arsenic and lead. Antimony, arsenic and lead were identified as COCs based on potential human health risk (updated BHHRA COCs), while antimony and lead were also identified as WQSA COCs based on their potential to impact groundwater. A complete presentation of RI activities/results for the ETC-10 site is provided in Section 7.8.4b of the SCOU RI/FS (Jacobs, 1997a). During later sampling conducted to assess ecological risk, the PAH benzo(a)pyrene was identified as a COC based on potential human health risk.

In addition to risks to human health and water quality, the *Scoping and Phase I Ecological Risk Assessment* (ERA) (Jacobs, 1995) identified ETC-10 as one of 25 SCOU sites with the potential to impact ecological habitat. The Phase I ERA also determined that metals (primarily lead) contamination at ETC-10 represented a potential risk to almost all target receptors. ETC-10 was not included in the Phase II ERA because the potential for impact was clear. Following the Phase II ERA, the Air Force, EPA and DTSC determined that additional contaminant characterization (soluble lead in wetlands soil) and biological survey data were needed to support remedy selection. These data sets were collected during March and June 2001, respectively, and the results presented in the *CB RI/FS – Part 2* (Jacobs, 2002b). Analytical results indicated that soluble lead is present at ETC-10 at levels that could have an impact on ecological receptors. However, the biological survey results indicated that lead contamination had not, to that point in time, affected the ecological health of the wetland communities. Although the biological survey results indicated that metals contamination had not affected the ecological health of the wetland communities, analytical data, including toxicity analyses and bioassays, indicated that contaminants within the wetlands associated with ETC-10 represented a potential adverse risk to ecological receptors.

3.5.2.2 Earth Technology Corporation 12

ETC-12, a former dump site, is located in grid H15/16 (Figure 3-3) and is composed of two noncontiguous sections, both of which contain wetlands (Plate 1). The dump site was identified based on analysis of a 1958 aerial photograph (EPA, 1991). During site inspection, surface debris and disturbed ground confirmed the area as a probable dump site (Jacobs, 1997a).

The COPCs at the ETC-12 site were VOCs, SVOCs and metals. During the SCOU RI, three soil samples and 21 shallow soil gas samples were collected. Two surface soil samples were collected from the wetlands most likely to receive runoff from the site and were analyzed for PAHs and metals. The soil gas samples were analyzed for VOCs while the site soil samples were analyzed for SVOCs and metals. No SVOCs or PAHs were detected in the soil samples. VOCs were reported in several of the soil gas samples, but only at very low concentrations. Several metals were detected in surface and shallow soil samples at concentrations exceeding threshold background values (TBVs): aluminum, barium, beryllium, chromium, copper, lead, molybdenum, nickel, vanadium and zinc. A complete presentation of RI activities/results for the ETC-12 site is provided in Section 7.8.11 of the SCOU RI/FS (Jacobs, 1997a).

The selected remedy for human health and water quality risk at ETC-12 established in the *SCOU ROD Part 1* (WPI, 2002) was NFA. However, the Scoping and Phase I ERA (Jacobs, 1995) identified ETC-12 as one of 25 SCOU sites with the potential to impact ecological habitat. The Phase II ERA (Jacobs, 1997b) determined that soil contamination at ETC-12 represented a potential risk to several target receptors. The primary risk drivers were the metals chromium, lead and vanadium. Following the Phase II ERA, the Air Force, EPA and DTSC determined that biological survey data from the associated wetlands were needed to support remedy selection. These data were collected during June 2001 and the results presented in the *CB RI/FS – Part 2* (Jacobs, 2002b). Although the biological survey results indicated that metals contamination had not, to that point in time, affected the ecological health of the wetland communities, analytical data, including toxicity analyses and bioassays, indicated that contaminants within the wetlands associated with ETC-12 represented a potential adverse risk to ecological receptors.

3.5.2.3 Fire Training Area 1

FTA-1, used for fire training exercises from 1955 through 1975, is located in grid L15 (Figure 3-3). Fuel, waste oil, solvents and other chemicals were accumulated weekly in a 2,000-gallon tank at the site. These materials were applied directly to soil pits and ignited. Other chemicals stored in 55-gallon drums were burned in an area adjacent to the pits. Multiple burn areas were identified from aerial photographs. The burn areas were unlined and no surface fluid collection systems were present. The surface at FTA-1 is unpaved, except for the area surrounding B1888. Wetlands occur to the north, east and west of the site (Plate 1).

The COPCs at the FTA-1 site were VOCs, SVOCs and fuels associated with the burn pits and other fire training activities. During the SCOU RI, 44 soil borings, 11 surface locations and 24 soil gas probes were sampled. Soil samples (total of 166) were analyzed for VOCs, SVOCs, petroleum hydrocarbons, dioxins/furans, metals, total organic carbon and pH; soil gas samples (total of 103) were analyzed for VOCs. Arsenic; cadmium; lead; benzene; TCE; 1,2,3,4,6,7,8-heptachlorodibenzofuran (HCDF1234678); hexachlorinated dibenzo-p-dioxins (HCDD); hexachlorinated dibenzofurans (HCDF); octachlorodibenzo-p-dioxin (OCDD); benzo(a)anthracene; benzo(a)fluoranthene; benzo(a)pyrene; and indeno (1,2,3-c,d) pyrene were identified as COCs based on potential human health risk (updated BHHRA COCs). In addition, arsenic; lead; zinc; fuels (gasoline, diesel and jet fuel); TCE; benzene; toluene; xylenes; *cis*-1,2-DCE; isopropylbenzene; 1,2-dichloroethane (1,2-DCA); carbon tetrachloride; and chloroform were identified as WQSA COCs based on their potential to impact groundwater. Considering only the more common COCs, the maximum concentrations of TCE detected at the site were 360 milligrams per kilogram (mg/kg) in soil and 970 µg/L in soil gas, while the maximum concentrations of benzene detected at the site were 9.7 mg/kg in soil and 172 µg/L in soil gas. The maximum reported concentrations of fuels in soil were 5,400 mg/kg gasoline, 19,000 mg/kg diesel and 5,900 mg/kg jet fuel. A complete presentation of RI activities/results for the FTA-1 site is provided in Section 7.5.1 of the SCOU RI/FS (Jacobs, 1997a).

In addition to risks to human health and water quality, the Scoping and Phase I ERA identified FTA-1 as one of 25 SCOU sites with the potential to impact ecological habitat (Jacobs, 1995). Results of the Phase II ERA (Jacobs, 1997b) showed that sediments in both the wetlands northwest and east of FTA-1 represented a risk to several target receptors. Following the Phase II ERA, the Air Force, EPA and DTSC determined that additional contaminant characterization in the wetlands and biological survey data were necessary to support remedy selection. These data were collected during March and June 2001, respectively, and the results presented in the CB RI/FS – Part 2 (Jacobs, 2002b). Similar to other sites, the biological survey results indicated that contamination had not, to that point in time, affected the ecological health of the wetland communities. However, based on the additional contaminant characterization data, it was determined that metals contamination at FTA-1 represented a potential adverse risk to ecological receptors.

3.5.2.4 Landfill 3

LF-3 is a former landfill located in grid K/L16 (Figure 3-3). The approximately 2-acre landfill was operational from 1954 to 1956. During this time, general refuse and some chemical wastes were disposed of in shallow trenches. The landfill was closed after only two years of operation due to the existence of a hardpan layer at about 8-feet bgs and resulting poor drainage (Jacobs, 1997a). A large wetland runs north-south through the western portion of the site (Plate 1).

The COPCs at the site were VOCs, SVOCs, fuels and metals. During the SCOU RI, nine surface soil/shallow soil gas locations, four soil borings and two test pits were sampled. Low concentrations of VOCs and SVOCs were detected in soil samples but no VOCs were detected in the shallow soil gas samples. Several metals were detected at concentrations exceeding TBVs, including a maximum reported concentration of lead of over 28,000 mg/kg. A complete presentation of RI activities/results for the LF-3 site is provided in Section 7.5.3 of the SCOU RI/FS (Jacobs, 1997a).

The Scoping and Phase 1 ERA (Jacobs, 1995) identified LF-3 as one of 25 SCOU sites with the potential to impact ecological habitat. The Phase II ERA (Jacobs, 1997b) determined that soil contamination at LF-3 represented a potential risk to several target receptors. The primary risk drivers were metals (principally lead) and PAHs. A removal action was completed for the LF-3 site in 1999. The removal action included the excavation of all waste areas, followed by backfilling with clean soil. The removal action eliminated all sample locations that the Phase II ERA had shown to represent ecological risk. However, the Air Force, EPA and DTSC determined that further characterization of the contamination in the wetlands and biological survey data from the wetlands were needed to support remedy selection. These data sets were collected during March and June 2001, respectively, and the results presented in the CB RI/FS – Part 2 (Jacobs, 2002b). Although biological survey results indicated that metals and PAH contamination has not, to that point in time, affected the ecological health of the wetland communities, analytical data, including toxicity analysis and bioassays, indicated that contaminants within the wetlands associated with LF-3 represent a potential adverse risk to ecological receptors.

3.5.2.5 Landfill 4 (DP-5, DP-6)

LF-4, a CAFB landfill used between 1957 and 1970, is located in grid G6 (Figure 3-3). LF-4 occupied approximately 14 acres and contained approximately 26,000 cubic yards of municipal-type waste. Minor amounts of chemical wastes may have been disposed of in

LF-4. LF-4 was a trench-and-fill style landfill operation. The northern one-third of the landfill (previously part of an agricultural field) was incorporated into LF-4 between 1957 and 1961. Twelve trenches in the southern two-thirds of the landfill were excavated to approximately 16 feet bgs prior to receiving waste materials. Disposal pits DP-5 and DP-6 were located at the southern end of LF-4 across one of the trenches. These pits reportedly received industrial wastes from CAFB between 1954 and 1970. Wastes may have included solvents, oils and miscellaneous chemicals.

The COPCs at the site were VOCs, SVOCs, petroleum hydrocarbons and metals potentially associated with any chemical wastes disposed at the site. During the SCOU RI and subsequent data gap investigation, seven soil borings, six surface locations and 63 soil gas borings/probes were sampled. Soil samples (total of 27) were analyzed for VOCs, SVOCs, petroleum hydrocarbons and metals; soil gas samples (total of approximately 100) were analyzed for VOCs. At the completion of the SCOU RI, 1,2-DCA in soil and dichlorodifluoromethane (Freon 12) in soil gas were identified as WQSA COCs based on potential to impact to groundwater. A complete presentation of RI activities/results for LF-4 and associated sites is provided in Section 7.6.3 of the SCOU RI/FS (Jacobs, 1997a). The more significant bases for action at LF-4 were landfill closure requirements and the subsequent designation of LF-4 as the primary consolidation landfill for Castle Airport. Under this designation, wastes from outlying trenches and other Castle Airport SCOU sites, primarily other landfills, were consolidated and capped at LF-4.

The scoping and Phase 1 ERA (Jacobs, 1995) did not identify LF-4 as a SCOU site with the potential to impact ecological habitat. The primary reason for this determination was the lack of any sensitive ecological habitat at and in the vicinity of LF-4.

3.5.2.6 Landfill 5 (DP-8, DP-8A, DP-9, LF-5 Trenches)

LF-5, a CAFB landfill used between 1971 and 1977, is located in grids E10-E12 and F10-F12 (Figure 3-3). Wetlands were located within, south and east of the site (Plate 1). The landfill was unlined and contained approximately 100,000 cubic yards of waste materials, primarily municipal wastes, construction wastes and demolition debris. LF-5 contained 12 trenches (A through L; LF-5 Trenches) and five disposal pits (DP-7, DP-8, DP-8A, DP-9 and DP-10). The trenches extended to a depth of approximately 15 feet bgs. Portions of the trenches and the disposal pits were reportedly used for the disposal of 55-gallon drums and uncontained liquid chemical wastes from CAFB operations.

The COPCs at the site were VOCs, SVOCs, petroleum hydrocarbons, metals and radioactivity potentially associated with any chemical wastes disposed at the site. During the SCOU RI and subsequent data gap investigation, 92 soil borings, 11 surface locations and 179 soil gas probes/borings were sampled. Soil samples (total of 249) were analyzed for VOCs, SVOCs, dioxins/furans, petroleum hydrocarbons, metals and radioactivity; soil gas samples (total of approximately 465) were analyzed for VOCs. At the completion of the SCOU RI and subsequent data gap investigation, diesel; 1,2-DCA; benzene; *cis*-1,2-DCE; Freon 12; p-isopropyltoluene; tetrachloroethene (PCE); TCE; vinyl chloride and xylenes were identified as WQSA COCs based on potential to impact groundwater. No significant contamination was detected beneath DP-7 and DP-10, and they were eliminated from consideration for remedial action (NFA in SCOU ROD 1). A complete presentation of RI activities/results for LF-5 and associated sites is provided in Section 7.3.1 of the SCOU RI/FS (Jacobs, 1997a). The more significant bases for action at the LF-5 site were landfill closure requirements and the subsequent designation of LF-5 as the secondary or overflow consolidation landfill for Castle Airport. Under this designation, wastes from outlying trenches and other Castle Airport SCOU sites, primarily other landfills, were consolidated and capped at LF-5 when wastes to be consolidated exceeded the capacity of the area to be capped at LF-4.

The Scoping and Phase I ERA (Jacobs, 1995) identified LF-5, including DP-7, DP-8, DP-8A, DP-9, DP-10 and the LF-5 Trenches, as one of 25 SCOU sites with the potential to impact ecological habitat. The Phase II ERA determined that metals contamination in wetlands soils at LF-5 represented a potential risk to a limited number of target receptors (Jacobs, 1997b). However, three of the sites associated with LF-5 (DP-7, DP-10 and DP-9) were not used for landfill disposal and their selected remedies relative to human health and groundwater quality were established as NFA in the SCOU ROD Part 1 (DP-7 and DP-10) and the SCOU ROD Part 3 (DP-9). Since there was minimal contamination associated with these DPs, they were excluded from further ecological evaluation. Following the Phase II ERA, the Air Force, EPA and DTSC determined that additional contaminant characterization (metals) and biological survey data were needed to support ecological remedy selection. These data were collected during March and June 2001, respectively, and the results presented in the CB RI/FS – Part 2 (Jacobs, 2002b). Although biological survey results indicated that metals contamination had not, to that point in time, affected the ecological health of the wetland communities, analytical data, including toxicity analysis and bioassays, indicated that contaminants within the wetlands associated with LF-5, including

DP-8, DP-8A and the LF-5 Trenches, represented a potential adverse risk to ecological receptors.

4 REMOVAL/REMEDIAL ACTIONS

This section describes selection of remedies, removal action or remedial action implementation, and remedial system operation and maintenance (O&M) for all groundwater plumes and for ETC-10, ETC-12, FTA-1, LF-3, LF-4 and LF-5. These discussions provide the basis for protectiveness evaluations that follow in Section 7.

4.1 GROUNDWATER REMEDIAL ACTIONS

This section describes the remedy selection processes and presents the final remedies for all identified groundwater plumes at Castle Airport based on the CB ROD – Part 1 (USAF, 1997) and the CB ROD – Part 2 (USAF, 2006). The implementation and operation of the ongoing groundwater remedial actions per the CB ROD – Part 1 and the CB ROD – Part 2 are then described.

As discussed in Section 3.5.1, six plumes were identified during the groundwater RI at Castle Airport (Jacobs, 1996). The identified plumes were designated Main Base Plume, East Base Plume, North Base Plume, Landfill 1 Plume, Landfill 4 Plume, and Castle Vista Plume. The locations and historical contaminant concentrations of these plumes are shown on Figures 3-4 through 3-7 (Q2/94 data for the Shallow, USS, LSS and Confined HSZs, respectively; Main Base, East Base, North Base, Landfill 1 and Landfill 4 TCE plumes) and on Figures 3-8 and 3-9 (Q1/97 data for the Shallow and USS HSZs, respectively; Castle Vista *cis*-1,2-DCE Plume).

4.1.1 Remedy Selection

The initial remedy selection process for identified groundwater plumes at Castle Airport is documented in Volume 3 of 3 (Groundwater Feasibility Study) of the CB RI/FS – Part 1 (Jacobs, 1996). The CB ROD – Part 1 (USAF, 1997) presented the selected remedy for each of the six major plumes. This ROD incorporated, and therefore superseded, both the OU-1 Interim ROD (USAF, 1991) and the OU-2 Final ROD (USAF, 1993). The remedy selection process and selected remedies for all six plumes are summarized on Figure 4-1.

Discharge standards for treated groundwater were also established in the CB ROD – Part 1. These standards, as modified by a Memorandum of Non-Significant Changes to Record of Decision for CB – Part 1 Groundwater—Final, dated 9 December 1997, are listed in Table 4-1. The 30-day median concentration for discharge of the primary contaminant (TCE) and for most other VOCs is 0.5 µg/L (USAF, 1997). It is noted that the discharge limit in Table 4-1 for the constituent designated "VOCs" represents the cumulative limit for all VOCs; all other limits are for the individual VOCs listed.

The CB ROD – Part 2 (USAF, 2006) presented additional remedies for plumes or portions of plumes where groundwater contamination exceeding MCLs resulted in potential adverse groundwater risks not addressed by the CB ROD – Part 1 remedies.

4.1.2 Remedy Implementation

Groundwater remedies identified in the CB ROD – Part 1 were implemented following finalization of the ROD in January 1997. Groundwater remedies identified in the CB ROD – Part 2 had already been implemented or was implemented following finalization of the ROD in 2006. Implementation of the remedies for individual plumes is addressed separately in the following subsections.

4.1.2.1 Main Base Plume Remedy Implementation

The CB ROD – Part 1 remedy for the Main Base Plume is plume capture and cleanup to MCLs (the primary contaminant is TCE). The CB ROD – Part 2 remedies for the Main Base Plume are:

- ICs to restrict groundwater use within plumes exceeding an MCL
- Wellhead treatment or provision of an alternative drinking water supply to protect against adverse impacts to public and private drinking water wells
- Local (wellhead) treatment to address groundwater contamination exceeding MCLs within the off-base Confined HSZ plume

4.1.2.1.1 CB ROD – Part 1 Remedy Implementation

The MCL for TCE at the time of the CB ROD – Part 1 was 5 µg/L, and that value remains in effect as of the date of this five-year review. While other VOCs have been detected at low concentrations in portions of the Main Base Plume (e.g., *cis*-1,2-DCE and PCE), they are consistently at much lower concentrations than TCE and, almost without exception, occur within the TCE plume boundaries. Remedial technologies selected for the Main Base Plume (air stripping and liquid-phase GAC) are appropriate for all other VOCs present as well as for TCE. For these reasons, all Main Base Plume discussion and assessment focuses on the TCE plume as the most conservative and representative element of the plume.

The CB ROD – Part 1 established a three-phased approach for remediation of the Main Base Plume. As described in Section 3.4, three groundwater removal actions (DA-4, Wallace Road and B84) and two groundwater remedial actions (OU-1 and OU-2) had been implemented prior to the ROD. The existing OU-1 and OU-2 systems, operational since July 1994 and November 1996, respectively (see Section 3.4.4), constituted Phase 1 of the Main Base Plume remedial action. Phase 2 and Phase 3 of the Main Base Plume remedial action, brought online in September 1997 and May 2000, respectively, comprise the main elements of the Main Base Plume remedial action The approximate locations of the groundwater removal actions (all decommissioned; see Table 2-1) and the OU-1, OU-2 and Phase 2/Phase 3 systems are shown on Figure 4-2. The locations of major OU-1, OU-2 and Phase 2/Phase 3 treatment system components (treatment plants, extraction wells, injection wells and conveyance pipelines) are shown on Plate 1 and on Figure 3-3. Plate 1 and Figure 3-3 show Q4/07 MCL plume boundaries for all HSZs combined.

The OU-1 groundwater treatment system was brought online in July 1994 to address an area of high TCE concentration (a “hot spot”) within the Shallow HSZ Main Base Plume (see Figure 3-4; monitoring wells JM13 [grid Q10], MW516 [grid Q10], MW556 [grid R10], MW220 [grid S10], TW16 [grid R11], MW873 [grid R12] and MW310 [grid R13] define the hot spot). The system was designed and implemented with five Shallow HSZ extraction wells, two air-stripping towers and nine Shallow HSZ injection wells. System capacity at startup was about 700 gpm. By the spring of 2003, TCE concentrations in the OU-1 area had been reduced to levels such that continued operation of the treatment system was not required to address the hot spot. The OU-1 system was taken offline, with regulatory agency approval, on 27 May 2003.

The OU-2 groundwater treatment system was brought online in November 1996 to address areas of high TCE concentration in the northern portion of the Main Base Plume, both on base and off base and in the Shallow and USS HSZs (see Figure 3-4 and Figure 3-5). The system was designed and implemented with 15 extraction wells (nine Shallow HSZ and 6 USS HSZ), four pairs of GAC vessels, and eleven injection wells (five Shallow HSZ, five USS HSZ and one LSS HSZ). System capacity at startup was over 2,000 gpm.

Phase 2 of the Main Base Plume remedial action was to enhance the OU-1/OU-2 actions by addressing groundwater contamination in the deeper HSZs (USS, LSS and Confined). Specific objectives of the Phase 2 system were to eliminate the addition of TCE mass to the Confined HSZ; remediate TCE hot spots in the USS, LSS and Confined HSZs; and remediate a small residual hot spot in the Shallow HSZ. Another Phase 2 objective was the development of additional hydrogeological data for the USS, LSS and Confined HSZs through a program of long-term pumping tests and tracer tests. These data were used in a *Technical and Economic Evaluation Report* (TEER) (Jacobs, 1999c) to support Phase 3 design.

The Phase 2 groundwater treatment system was placed in operation in September 1997. The system was designed and implemented with seven extraction wells (one in the Shallow HSZ and two each in the USS, LSS and Confined HSZs), two GAC vessel pairs and seven injection wells (all in the LSS HSZ). System capacity at startup was approximately 1,300 gpm.

Phase 3 objectives were to assess results from Phase 1/Phase 2 operation, determine what additional system components would be required to meet ROD objectives and implement any necessary actions. As noted previously, TEER results were used to help design Phase 3. The expanded Phase 3 system was placed in operation in May 2000. Major elements of the expansion consisted of: (1) replacing the Phase 2 surge tank with a combination air stripper/surge tank (eliminated low concentrations of *cis*-1,2-DCE and other minor contaminants in influent which were causing excessive carbon usage); (2) adding eight extraction wells and 10 injection wells (eight new wells and two previously part of OU-2); and (3) adding one pair of GAC vessels. Of the eight extraction wells, five were completed in the USS HSZ, two in the LSS HSZ and one in the Confined HSZ. Six of the injection wells were completed in the Shallow HSZ and four in the USS HSZ (one USS HSZ and one LSS HSZ injection well were incorporated from OU-2). The addition of these components brought the Phase 3 system up to 15 extraction wells, 17 injection wells and three pairs of GAC vessels. System capacity at startup was almost 2,500 gpm.

Since January of 2001, wellhead treatment systems have been installed on several monitoring wells within the Main Base Plume. Although completely independent of the Phase 3 groundwater treatment system, these wellhead systems are defined as components of the Phase 3 system because the Phase 3 system has been identified as the "final" system for Main Base Plume remediation. To date, wellhead treatment systems have been installed and operated at monitoring wells MW883/MW1021, MW824/MW1037, MW941, MW951 and MW1009. These systems were installed to address areas where increasing TCE concentrations have recently been detected and which are outside of the hydraulic influence, or at least the near-term hydraulic influence, of the three main groundwater treatment systems. General system locations are shown as separate elements of the Phase 3 system on Figure 4-2 (small circular areas), while specific well locations are shown on Plate 1 and Figure 3-3.

Monitoring wells MW883 and MW1021 (both Shallow HSZ) are located in grid K12 (Plate 1; Figure 3-3). MW883 and MW1021 represent an area in the extreme northeast portion of the Main Base Plume where TCE concentrations increased after remaining low for several years. Wellhead treatment was initiated at this location to hopefully reduce the remedial timeframe. A mobile, solar-powered GAC treatment system was operated at MW883 from January 2001 to January 2002. This system had a maximum pumping capacity of 10 gpm during daylight hours. To enhance groundwater treatment, MW1021 was drilled and completed and a skid-mounted GAC treatment system of approximately 100 gpm capacity was installed and placed in operation in August 2002. At startup, the two-well system operated at a pumping rate of about 30 gpm and the inlet TCE concentration was about 80 µg/L. The system was shut down, with regulatory agency concurrence, in October 2004 due to declining pumping rates and low TCE concentration (8 gpm and approximately 8 µg/L, respectively).

MW824 (Shallow HSZ) is located in grid L10 (Plate 1; Figure 3-3). The MW824 location represents the downgradient portion of the northeast segment of the Main Base Plume addressed at MW883/MW1021. The basis and design of the wellhead treatment system are the same as for MW883/MW1021. The system was installed and placed in operation in August 2002. At startup, the system operated at a pumping rate of about 20 gpm and the inlet TCE concentration was about 15 µg/L. By May 2005, the pumping rate had decreased to 5 gpm and the inlet TCE concentration to 8 µg/L. MW1037 was added to the system in June 2005 and the pumping rate and inlet TCE concentration increased slightly to 16 gpm and 12 µg/L, respectively. The sustainable pumping rate and the inlet TCE concentration continued a slow decline until the system was shut down in October 2006 when water levels in MW824 and MW1037 had decreased to such an extent that pumping could not be sustained. The inlet TCE concentration just prior to shutdown was about 5 µg/L. Since shutdown, water levels in the Shallow HSZ have remained low or declined further and the system remains offline. Water levels have generally been declining in the Shallow HSZ since about 1999. Declines vary by location but typically have ranged from about 5 to 9 feet during the period 1999-2007. Declines exceeding 10 feet have occurred locally.

MW941, MW951 and MW1009 (all Confined HSZ) are all located in the former Castle Gardens housing area in grids S8, U7 and U8, respectively (Plate 1; Figure 3-3). All of these wells are in an area downgradient of Castle Airport where TCE concentrations in the Confined HSZ increased in the late 1990s. An additional factor driving wellhead treatment at MW941, MW951 and MW1009 was the detection of low levels of TCE in City of Atwater municipal water supply well AM18, beginning in the spring of 2001 and sporadic detections of low levels of TCE in City of Atwater municipal water supply wells AM16 and AM20. All three wells produce water from the Confined and the underlying Deep HSZ. AM18 is located approximately 5,500 feet downgradient of the southwest boundary of Castle Airport in grid W5; AM16 is located about 3,000 feet downgradient of the southwest boundary of Castle Airport and about 3,000 feet north of AM18 in grid T6; AM20 is located approximately 4,800 feet downgradient of the southwest boundary of Castle Airport and about 2,800 feet south-southeast of AM18 in grid AA7. The locations of AM16 and AM18 are shown on Figure 3-3 (see Figure 7-8 for the AM20 location).

To reduce contaminant mass migrating towards AM16 and AM18 and potentially AM20, the mobile, solar-powered GAC treatment system formerly used at MW883 was placed in operation at MW941 and skid-mounted GAC treatment systems of approximately 100 gpm capacities were installed at MW951 and MW1009. The solar-powered system was placed in operation at MW941 in June 2002 and operated until it was shut down and removed, with regulatory agency approval, in May 2004. Inlet TCE concentration at the MW941 system ranged from about 11 µg/L at startup to about 7 µg/L just prior to shutdown. The MW951 system was placed in operation in July 2001 and remains in operation. At startup, the system operated at a pumping rate of about 70 gpm and the inlet TCE concentration was about 20 µg/L. The current (December 2007) inlet TCE concentration is about 6 µg/L. The MW1009 system was placed in operation in January 2002 and operated until February 2008, when it was shut down to assess potential TCE concentration rebound. At startup, the system operated at a pumping rate of about 80 gpm and the inlet TCE concentration was about 18 µg/L. As of January 2008, the pumping rate had decreased to about 12 gpm (limited by injection well capacity) and the inlet TCE concentration had decreased to about 4 µg/L. Rebound monitoring of TCE concentration continues while a formal request for system shutdown is in preparation.

4.1.2.1.2 CB ROD – Part 2 Remedy Implementation

<u>ICs to restrict groundwater use within plumes exceeding an MCL</u>: ICs, in the form of land use restrictions, were incorporated as a grantee covenant in the deed formally transferring

the former CAFB to Merced County. These covenants placed restrictions on the installation of wells, precluded disturbance of any existing groundwater remediation systems and precluded activities that would limit access to any existing groundwater remediation system. Groundwater use on the property transferred to the Federal Bureau of Prisons (BoP) was already restricted by terms of the Air Force/BoP Memorandum of Understanding (MOA). Following publication of the CB ROD – Part 2, The Air Force notified the City of Atwater, Merced County and private landowners in the unincorporated portion of Merced County overlying a plume exceeding an MCL that the groundwater should not be used for human consumption. The location and extent of off-base plumes exceeding an MCL are updated and documented each year in the LTGSP annual report. If monitoring results show that a plume exceeding an MCL has migrated, newly affected parcel owners are notified by the Air Force.

<u>Wellhead treatment or provision of an alternative drinking water supply to protect against adverse impacts to public and private drinking water wells</u>: Regular monitoring of contaminant concentration in public and domestic water supply wells downgradient of Castle Airport has long been and remains a component of the LTGSP. If a contaminant concentration in any drinking water well begins to exceed one-half the MCL, the Air Force has agreed that, in consultation with the EPA, DTSC and RWQCB, it will take immediate action, as necessary, to implement wellhead treatment or provide an alternative drinking water supply. In the past, the Air Force provided an alternative water supply to three residences along Wallace Road, has installed replacement domestic wells at three residences along Wallace Road and has installed and operated wellhead treatment systems on several domestic wells. Currently, the Air Force is maintaining a wellhead treatment system at domestic well D5766 (grid N4; Figure 3-3).

<u>Local (wellhead) treatment to address groundwater contamination exceeding MCLs within the off-base Confined HSZ plume</u>: As described in Section 4.1.2.1.1, the Air Force has installed and operated three wellhead treatment systems in the off-base Confined HSZ plume (MW941, MW951 and MW1009) to address contaminant migration towards AM18. Based on declining TCE concentrations, one of the systems has been shut down (MW941) and one of the systems is off-line pending shutdown (MW1009). The MW951 system remains in operation. Furthermore, the Air Force has agreed that should AM18 become inoperative for an extended period, additional remedial actions to capture and clean up the off base Confined HSZ plume will be evaluated and may be implemented by the Air Force

with regulatory agency review and approval. The operational status of AM18 is monitored through the LTGSP.

4.1.2.2 East Base Plume Remedy Implementation

The CB ROD – Part 1 remedy for the Shallow HSZ East Base Plume was sealing and abandonment of selected wells to prevent further cross-contamination of HSZs, monitoring and annual assessments to determine whether or not monitoring needed to be continued and/or active remediation initiated. Three base water supply wells in the East Base Plume area that were open to multiple HSZs (PW5, PW5A and PW11) were abandoned during 1995-1996. Monitoring, already ongoing under the LTGSP since 1993, was continued and annual assessments were initiated in 1998. The annual assessment in the *Long-Term Groundwater Sampling Program 2003 Annual Report* (Jacobs, 2004c) documented that TCE concentrations had been less than the MCL in all monitoring wells for a minimum of a year. Per the CB ROD – Part 1, the East Base Plume remedy was considered complete and monitoring was terminated as of Q4/03.

Because the CB ROD – Part 1 remedy is complete, CB ROD – Part 2 remedies do not apply to the East Base Plume.

4.1.2.3 North Base, Landfill 1 and Landfill 4 Plume Remedy Implementation

The CB ROD – Part 1 remedy for the North Base, Landfill 1 and Landfill 4 plumes was ICs to prevent installation of water supply wells, monitoring and annual assessments to determine whether or not monitoring needed to be continued and/or active remediation initiated. Since the CB ROD – Part 1 was signed, the Air Force and subsequently Merced County, which currently has oversight of lands within Castle Airport except for the area of the North Base Plume, have provided control to prevent installation of water supply wells. ICs to prevent installation of water supply wells in the area of the North Base Plume are currently addressed through the BoP and the existing MOU between the BoP and the Air Force. Monitoring, already ongoing under the LTGSP since 1993, was continued and annual assessments were initiated for all three plumes in 1998.

The annual assessment in the *Long-Term Groundwater Sampling Program 2000 Annual Report* (Jacobs, 2001b) documented that TCE concentrations had been less than the MCL in all Landfill 1 Plume monitoring wells for a minimum of a year and monitoring was terminated after the Q1/01 sampling event. The annual assessment in the *Long-Term Groundwater Sampling Program 2006 Annual Report* (Jacobs, 2007) documented that TCE concentrations had been less than the MCL in all Landfill 4 Plume monitoring wells for a minimum of a year and monitoring was terminated as of Q4/06. The annual assessment in the *Long-Term Groundwater Sampling Program 2007 Annual Report* (Jacobs, 2008) documented that TCE concentrations had been less than the MCL in all North Base Plume monitoring wells for a minimum of a year and monitoring was terminated as of Q4/07. Because the CB ROD – Part 1 remedy is complete, CB ROD – Part 2 remedies do not apply to the Landfill 1, Landfill 4 or North Base plumes.

4.1.2.4 Castle Vista Plume Remedy Implementation

The CB ROD – Part 1 remedy for the Castle Vista Plume is plume capture and cleanup to MCLs (the primary contaminant is *cis*-1,2-DCE). The State of California MCL for *cis*-1,2-DCE was 6 µg/L at the time of the CB ROD – Part 1 and has not changed as of the date of this five-year review.

The Castle Vista Plume groundwater remediation system consisted of a single groundwater treatment system located in the former Castle Vista housing area (Figure 4-2; Figure 3-3). Construction of the Castle Vista groundwater treatment system was completed in September 1997 and the system was placed in operation in October 1997. The Castle Vista system was designed to remediate the *cis*-1,2-DCE plume that exists in the Shallow and USS HSZs to the west and southwest of Castle Vista Landfill B. City of Atwater municipal water supply well AM06 (Figure 3-9), which is screened in the USS and lower HSZs, was located immediately downgradient of the plume in the USS HSZ. AM06 was sampled monthly as part of the LTGSP beginning in June 1997. Samples from this well contained only low concentrations of *cis*-1,2-DCE, well below the MCL of 6 µg/L.

The original Castle Vista system consisted of seven extraction wells—six in the Shallow HSZ and one in the USS HSZ; eight injection wells—all completed in the Shallow HSZ; and a liquid-phase GAC treatment plant (two 20,000-pound vessels). System capacity was approximately 550 gpm. At startup, flow through the treatment plant was about 450 gpm and the inlet *cis*-1,2-DCE concentration was between 20 and 25 µg/L. Over time, contaminant concentrations were reduced in all extraction wells and all plume monitoring wells except for MW003, located within the plume source area (see Figure 3-3). The Castle Vista groundwater treatment system was shut down, with regulatory agency approval, in August 2003. As of July 2003, flow through the plant had decreased to about 60 gpm and the inlet *cis*-1,2-DCE concentration was about 3.5 µg/L. Concurrent with treatment plant shutdown, MW003 was converted to a low-capacity extraction well (GAC wellhead treatment system). At startup, the system operated at a pumping rate of about 13 gpm and the inlet *cis*-1,2-DCE concentration was about 10 µg/L. During rebound assessments, *cis*-1,2-DCE concentrations at MW003 were as high as 93 µg/L. The current (December 2007) *cis*-1,2-DCE concentration at MW003 is about 18 µg/L. The MW003 system operated continuously, except for several periods of rebound assessment, from August 2003 through July 2008, when it was shut down due to low water levels in the well. Water levels have generally been declining in the Shallow HSZ, in both the Main Base and Castle Vista Plume areas, since about 1999. Declines vary by location but typically have ranged from about 5 to 9 feet during the period 1999-2007. Declines exceeding 10 feet have occurred locally. The water level at MW003 declined about 9 feet during the period 1999-2007.

CB ROD – Part 2 remedies applicable to the Castle Vista Plume have been implemented as described in Section 4.1.2.1.2.

4.1.3 Main Base and Castle Vista Plume System Operation and Maintenance

All groundwater treatment plants and wellhead treatment systems at Castle Airport are operated in accordance with a comprehensive O&M plan (*Castle Groundwater Treatment Systems Operation and Maintenance Plan, Change 3 to Final*; Jacobs, 2006). This plan supercedes previous O&M plans for the individual treatment plants and wellhead systems, but references considerable material from those documents.

O&M activities for each of the individual plants are extensive and are well beyond the scope of this document. An O&M status report is prepared monthly for the Air Force. Each of these reports provides the following:

- A performance summary (total gallons treated, average plant flow in gpm, inlet contaminant concentration [sampled monthly], estimated mass of contaminant removed, which extraction and injection wells were operational and, where applicable, carbon vessel configuration [identifies lead vessels in pairs]).
- Analytical results for plant influent and effluent samples (minimum of monthly).
- A summary of maintenance/upgrade work completed during the month.
- A summary of plant up time (percent of possible hours for month).
- A listing of system shutdowns and corrective actions implemented.
- A listing of equipment problems and upgrades.
- A listing of regular maintenance and/or upgrade work planned for the coming month.

The most critical pieces of information in these monthly summaries are the analytical results for plant effluent (relates to discharge standards established in the CB ROD – Part 1).

During the past five years (2003-2007), there have been no events at the OU-1, OU-2, Phase 3 plants or at any of the wellhead treatment systems where the final effluent exceeded ROD discharge standards for VOCs.

Three spills of untreated water have occurred during the period. On 20 September 2005, there was a power outage at the Phase 3 plant related to a series of thunderstorms. Because of a 15-minute time-lapse between injection pump shutdown and the extraction wells being shut off, approximately 7,000 gallons of partially treated water (inlet TCE concentration was 15 µg/L) was released to the ground in the vicinity of the treatment plant. On 25 January 2006, a pipeline from inactive extraction well EW02 broke during temporary pumping of the well for sampling and approximately 1,200 gallons of water containing about 11 µg/L of TCE was discharged to the local sewer system. On 15 July 2007, a pipe connection broke at the MW951 wellhead treatment system and approximately 1,000 gallons of untreated water (concentration of 8 µg/L TCE) flowed into a storm drain (minimal amount) or into an internal infiltration pond (most of the spill) within Castle Gardens and infiltrated/evaporated. The regulatory agencies were notified of all of these spills and the agencies issued no formal criticism of treatment system operations.

The discharge from the Phase 3 treatment plant has exceeded ROD discharge standards for calcium, chloride and total dissolved solids (not COCs at Castle Airport) since the plant came on line. Plant operation has continued, with regulatory agency concurrence, because of the relatively benign nature of these constituents. In addition, studies have documented the prohibitive cost of treating extracted groundwater to reduce calcium, chloride and total dissolved solids concentrations in plant effluent (Jacobs, 2002c).

Other than these minor spills and exceedences of discharge standards, no other O&M issues are identified for the period 2003 to 2008. The percentage of up-time throughout the period has been consistently high for all of the operating plants and systems, commonly exceeding 95 percent for a given month.

4.2 VADOSE ZONE REMOVAL/REMEDIAL ACTIONS

This section describes the selection of final remedies and the implementation of removal/remedial actions at 11 Castle Airport SCOU sites: ETC-10; ETC-12; FTA-1; LF-3; LF-4 (DP-5 and DP-6); and LF-5 (DP-8, DP-8A and LF-5 Trenches). Site locations are shown on Plate 1 and Figure 3-3.

4.2.1 Remedy Selection

Final remedies for ETC-10; ETC-12; FTA-1; LF-3; and LF-4 and LF-5 and their associated sites are presented in the SCOU ROD Part 1 (WPI, 2002) and the SCOU ROD Part 3 (Jacobs, 2005a).

4.2.1.1 Earth Technology Corporation 10

The SCOU FS preferred alternative for ETC-10 was excavation and off-site disposal. The BCT later changed the preferred alternative (post-FS decision) to excavation and on-site disposal. An action memorandum was submitted in October 1996 and the removal action at ETC-10 was performed during July 1997 and August 1998. At completion of the removal action, lead and benzo(a)pyrene concentrations in soil met occupational but did not meet residential RAOs. As part of the CB RI/FS – Part 2 (Jacobs, 2002b) two focused feasibility studies (FFSs) were performed for ETC-10 to address post removal action concerns. The ETC-10 FFS was performed to provide a CERCLA evaluation of alternatives to address residual lead in soil contamination. The ecological FFS, included in the CB RI/FS –Part 2 (Jacobs, 2002b) was performed to address concerns and evaluate alternatives regarding potential contamination of wetlands located within or near ETC-10 and other SCOU Sites. The ETC-10 FFS preferred alternative was ICs to permanently control human access, with the exception of occasional access for scientific study and monitoring. The ecological FFS preferred alternative for ETC-10 was LTEM. The final remedy for ETC-10, established in the SCOU ROD Part 3 (Jacobs, 2005a), is ICs and LTEM.

4.2.1.2 Earth Technology Corporation 12

The selected remedy for human health and water quality risk at ETC-12 was established in the *SCOU ROD Part 1* (WPI, 2002) as NFA. However, the Scoping, Phase I and Phase II ERAs (Jacobs, 1995; Jacobs, 1997b) and subsequent biological survey data (CB RI/FS – Part 2 [Jacobs, 2002b]) determined that soil contamination at ETC-12 represented a potential risk to several ecological receptors. The ecological FFS preferred alternative for ETC-12 was LTEM (Jacobs, 2002b). The final remedy for ecological risk at ETC-12, established in the SCOU ROD Part 3 (Jacobs, 2005a), is LTEM.

4.2.1.3 Fire Training Area 1

The SCOU FS preferred alternative was SVE for VOC contamination and soil treatment (*ex-situ* solidification and stabilization) for non-VOC contamination. An action memorandum was submitted in September 1995 and a removal action comprising an SVE system and surface cap was implemented in 1996. The SVE system operated intermittently through August 2005.

In order to incorporate new site data and updated RAOs, and to further evaluate alternatives for non-VOC contamination, a FFS was performed for FTA-1 non-VOC contamination (Jacobs, 2002a). The FTA-1 FFS selected capping and ICs to ensure long-term cap integrity as the preferred alternative for non-VOC contamination. The FFS also concluded that the existing engineered cap would fulfill the requirements of the non-VOC capping preferred alternative. Similar to ETC-10, the ecological FFS identified LTEM as the preferred alternative to address concerns regarding the wetlands adjacent to FTA-1 and also noted the need to excavate and dispose of approximately 150 cubic yards of soil not under the existing cap that posed an ecological concern (Jacobs, 2002b). The final remedy for FTA-1, established in the SCOU ROD Part 3 (Jacobs, 2005a), is SVE, BV, LTM, ICs, E&D and LTEM.

4.2.1.4 Landfill 3

The selected remedy for human health and water quality risk at LF-3 was established in the *SCOU ROD Part 1* (WPI, 2002) as NFA. However, the Scoping, Phase I and Phase II ERAs (Jacobs, 1995; Jacobs, 1997b) determined that soil contamination at LF-3 posed a potential risk to several ecological receptors. An E&D removal action was completed in 1999, but subsequent characterization of contamination and biological surveys in adjacent wetlands indicated that contaminants within the wetlands associated with LF-3 represented a potential adverse risk to ecological receptors. The ecological FFS preferred alternative for LF-3 was LTEM (Jacobs, 2002b). The final remedy for ecological risk at LF-3, established in the SCOU ROD Part 3 (Jacobs, 2005a), is LTEM.

4.2.1.5 Landfill 4 (DP-5, DP-6)

The SCOU FS preferred alternative for LF-4 was landfill zoning (consolidation and capping in place), long-term maintenance and monitoring, and ICs. Following BCT post-FS decisions to consolidate waste from other Castle Airport landfills and sites at LF-4, the preferred alternative was revised to consolidation and capping with an engineered alternative to a Class III cap. Long-term maintenance and monitoring and ICs remained a part of the preferred alternative. An action memorandum was submitted in September 1997 and the LF-4 removal action, which included excavation of perimeter trenches and waste consolidation, importing wastes from other sites and capping, was initiated in 1997 and completed in 1999. A post-closure long-term maintenance and monitoring program was initiated following capping. The final remedy for LF-4 and its associated sites, established in the SCOU ROD Part 3 (Jacobs, 2005a), is LTM and ICs.

4.2.1.6 Landfill 5 (DP-8, DP-8A, LF-5 Trenches)

The SCOU FS preferred alternative for LF-5 was landfill zoning (consolidation and capping in place), long-term maintenance and monitoring and ICs. Following BCT post-FS decisions to consolidate waste from other Castle Airport landfills and sites at LF-5, the preferred alternative was revised to consolidation and capping with an engineered alternative to a Class III cap. Long-term maintenance and monitoring and ICs remained a part of the preferred alternative. An action memorandum was submitted in October 1998 and the LF-5 removal action, which included excavation of perimeter trenches and waste consolidation, importing wastes from other sites and capping, was initiated in 1998 and completed in 1999. A post-closure long-term maintenance and monitoring program was initiated following capping. Similar to ETC-10, ETC-12, FTA-1 and LF-3, the ecological FFS identified LTEM as the preferred alternative to address concerns regarding the wetlands adjacent to LF-5 (Jacobs, 2002b). The final remedy for LF-5 and its associated sites, established in the SCOU ROD Part 3 (Jacobs, 2005a), is LTM, ICs and LTEM.

4.2.2 Remedy Implementation

This section describes removal and remedial actions implemented at ETC-10, ETC-12, FTA-1, LF-3 and at LF-4 and LF-5 and their associated sites. All removal and remedial actions were designed with input from, and implemented with the concurrence of, the BCT.

4.2.2.1 Earth Technology Corporation 10

An E&D removal action has been completed and IC and LTEM remedies have been implemented. The E&D removal action took place from 27 July 1997 through 10 August 1998. Approximately 5,050 cubic yards of contaminated soil was transported to and disposed in LF-5. The removal action closure report for ETC-10 was finalized in July 1999 (Jacobs, 1999b).

ETC-10 and its associated wetlands are located within the BoP United States Penitentiary, Atwater Complex, and public access is, and will for the foreseeable future, be prohibited. In addition, implementation of the selected remedy will not threaten sensitive ecological habitats. ICs are currently in place and implemented as follows: (1) the Air Force/BoP MOU precludes site alterations that would interfere with Interagency Agreement (IAG) or IRP activities without notification of EPA, DTSC and the Air Force and approval of the Air Force;

(2) the Air Force/BoP MOU establishes access for the Air Force and the BCT; (3) other than access required pursuant to the IAG/IRP, the BoP's *Preservation Area Mitigation and Management Plan* (Louis Berger and Associates [Berger], 1998) restricts access to activities that are necessary for implementation of the plan and (4) elements of prison security (e.g., patrolled security fencing) restrict the potential for human exposure to site contamination. ICs will be maintained at ETC-10 until soils are at levels that allow for unrestricted use and exposure. Given that there are no plans to remediate the soil, it is assumed that ICs will be maintained indefinitely. Modification or termination of ICs requires Air Force, EPA and State of California approval.

LTEM, consisting of wetlands invertebrate (fairy shrimp) and plant surveys at selected vernal pools, was implemented in the spring of 2008 (surveys are to be conducted every five years, in concert with five-year reviews, for up to 30 years unless the Air Force and the regulatory agencies agree during that period that further monitoring is not warranted). The fairy shrimp survey was completed on 18 and 19 February 2008; the plant survey was completed on 16 and 17 March 2008. To confirm that site contaminants have not impacted wetland habitats, both potentially contaminated (within or downgradient of the site) and uncontaminated (upgradient or remote from any site) vernal pools were surveyed. Results of the surveys are presented in Appendix A.

4.2.2.2 Earth Technology Corporation 12

LTEM, consisting of wetlands invertebrate (fairy shrimp) and plant surveys at selected vernal pools, was implemented in the spring of 2008 (surveys are to be conducted every five years, in concert with five-year reviews, for up to 30 years unless the Air Force and the regulatory agencies agree during that period that further monitoring is not warranted). The fairy shrimp survey was completed on 18 and 19 February 2008; the plant survey was completed on 16 and 17 March 2008. To confirm that site contaminants have not impacted wetland habitats, both potentially contaminated (within or downgradient of the site) and uncontaminated (upgradient or remote from any site) vernal pools were surveyed. Results of the surveys are presented in Appendix A.

4.2.2.3 Fire Training Area 1

SVE/capping and E&D remedial actions have been completed and IC, LTM and LTEM remedies have been implemented. At the completion of the SVE remedial action, it was determined that a BV remedial action was not necessary. The SVE/capping remedial action, consisting of installation of a SVE treatment system and a cap to enhance SVE operation, was implemented at the FTA-1 site in 1996 as a removal action. The Class III engineered cap helped the SVE well network perform more effectively by eliminating inflow of surface air within the area of vapor extraction. In addition, the cap reduced the influence of rainfall on contaminant migration towards the groundwater and protected potential receptors from exposure to the metals and dioxin contamination in shallow soil at the site. The SVE system was started in November 1996 and operated on and off until August 2005. Over the nine years of operation, the SVE system removed 69,220 pounds of contaminants (fuels and VOCs) from the vadose zone. The SVE completion report for FTA-1 was finalized in May 2007 (MWH, 2007a).

The E&D remedial action, completed in September and October 2004, consisted of the excavation and off-site disposal of two areas of metals impacted soils outside of the existing cap. A total of 21.4 cubic yards of impacted soil was removed. These soils had been determined to pose a risk to ecological receptors in the vicinity of FTA-1. The E&D removal action completion report was finalized in March 2005 (MWH, 2005a).

FTA-1 and its associated wetlands are located within the BoP United States Penitentiary, Atwater Complex and the BoPs wetlands preservation area, and public access is, and will for the foreseeable future, be prohibited. ICs are currently in place and implemented as follows: (1) the Air Force/BoP MOU precludes site alterations that would interfere with Interagency Agreement (IAG) or IRP activities without notification of EPA, DTSC and the Air Force and approval of the Air Force; (2) the Air Force/BoP MOU establishes access for the Air Force and the BCT; (3) other than access required pursuant to the IAG/IRP, the BoP’s *Preservation Area Mitigation and Management Plan* (Louis Berger and Associates [Berger], 1998) restricts access to activities that are necessary for implementation of the plan and (4) elements of prison security (e.g., patrolled security fencing) restrict the potential for human exposure to site contamination. In addition, implementation of the selected remedy will not threaten sensitive ecological habitats. ICs will be maintained at FTA-1 until soils are at levels that allow for unrestricted use and exposure. Given that FTA-1 is capped and there are no plans to remediate the capped soil, it is assumed that ICs will be maintained indefinitely. Modification or termination of ICs requires Air Force, EPA and State of California approval.

LTM for the engineered cap at FTA-1 was initiated in 1999 concurrent with implementation of the post-closure maintenance and monitoring program for LF-4 and LF-5 and in accordance with the *Closure and Post-Closure Maintenance Plan for Castle Airport Landfills*

(Jacobs, 1997d). Although FTA-1 is not a landfill, a 30-year maintenance and monitoring period, including cap maintenance, drainage maintenance, erosion control and rodent control was assumed to be appropriate for the FTA-1 cap. LTM activities at FTA-1 include quarterly inspections of the cap, monitoring wells, drainage ditch elevations and condition (additional inspection after major rain events), site security and roads and completion of any necessary repairs. Reports documenting inspection results are prepared annually. Relevant to this five-year review, quarterly inspections of the FTA-1 cap were performed in 2003, 2004, 2005, 2006 and 2007.

LTEM, consisting of wetlands invertebrate (fairy shrimp) and plant surveys at selected vernal pools, was implemented in the spring of 2008 (surveys are to be conducted every five years, in concert with five-year reviews, for up to 30 years unless the Air Force and the regulatory agencies agree during that period that further monitoring is not warranted). The fairy shrimp survey was completed on 18 and 19 February 2008; the plant survey was completed on 16 and 17 March 2008. To confirm that site contaminants have not impacted wetland habitats, both potentially contaminated (within or downgradient of the site) and uncontaminated (upgradient or remote from any site) vernal pools were surveyed. Results of the surveys are presented in Appendix A.

4.2.2.4 Landfill 3

An E&D removal action has been completed and the LTEM remedy has been implemented. The E&D removal action, started in late 1998 and completed in September 1999, resulted in the removal of approximately 57,000 cubic yards of soil, waste and construction debris from disposal trenches and surface disposal areas at LF-3. Almost all of the excavated material was transported to LF-5 for disposal; a small amount of hazardous material was profiled, manifested and disposed at an off-site facility (Jacobs, 2000a).

LTEM, consisting of wetlands invertebrate (fairy shrimp) and plant surveys at selected vernal pools, was implemented in the spring of 2008 (surveys are to be conducted every five years, in concert with five-year reviews, for up to 30 years unless the Air Force and the regulatory agencies agree during that period that further monitoring is not warranted). The fairy shrimp survey was completed on 18 and 19 February 2008; the plant survey was completed on 16 and 17 March 2008. To confirm that site contaminants have not impacted wetland habitats, both potentially contaminated (within or downgradient of the site) and uncontaminated (upgradient or remote from any site) vernal pools were surveyed. Results of the surveys are presented in Appendix A.

4.2.2.5 Landfill 4 (DP-5 and DP-6)

A consolidation and capping removal action has been completed and IC and LTM remedies have been implemented. The consolidation and capping removal action took place from October 1997 through September 1999. Removal action elements included site preparation, excavation of waste from perimeter trenches, consolidation of LF-4 wastes and waste materials excavated from other authorized Castle Airport sites, confirmation sampling, backfilling excavated trenches, and cap installation. Approximately 6,500 cubic yards of non-hazardous, non-designated waste was excavated from perimeter trenches at LF-4 and placed in the area to be capped. Approximately 240,000 cubic yards of waste material and contaminated soil meeting landfill acceptance criteria (non-hazardous and non-designated waste) was imported from other Castle Airport SCOU sites and placed in the area to be capped. The consolidated waste and soil was covered with an engineered alternative to a Class III cap. The caps (two separate areas were capped) consist of a gas collection layer, a low-permeability layer, a drainage layer and a vegetative cover. The *Landfill 4 and Landfill 5 Closure Report* was finalized in May 2003 (Jacobs, 2003b).

ICs for LF-4, in the form of land use restrictions, were incorporated in the deed transferring the parcel containing LF-4 to Merced County and a State Land Use Covenant has been executed by the Air Force with the State of California. These controls establish land use for the LF-4 site as non-irrigated open space and limit groundwater withdrawal and any construction or other site activities that would disturb the cap or any of the existing access control, drainage control or monitoring facilities. ICs will be maintained at LF-4 until soils are at levels that allow for unrestricted use and exposure. Given that LF-4 is capped and there are no plans to remediate the capped soil/wastes, it is assumed that ICs will be maintained indefinitely. Modification or termination of ICs requires Air Force, EPA and State of California approval.

LTM for LF-4 was initiated in 1999 and consisted of a post-closure monitoring and maintenance program for the caps and a post-closure monitoring program for landfill gas and groundwater beneath the landfill. Landfill cap and groundwater monitoring features at LF-4 are shown on Figure 4-3 and Figure 4-4, respectively. Cap monitoring and maintenance activities and landfill gas and groundwater monitoring are conducted in compliance with the approved *Closure and Post-Closure Maintenance Plan for Castle Airport Landfills* (Jacobs, 1997c) and the *Landfill 4 and Landfill 5 Closure and Post-Closure Maintenance Plan Update* (Jacobs, 2000b). Cap monitoring and maintenance activities for LF-4 consist of quarterly and semiannual inspections of the cap, landfill gas collection system, monitoring wells, drainage ditch elevations and condition (additional inspection after major rain events), settlement monuments, site security, roads and completion of any necessary repairs. Reports documenting inspection results are prepared annually. Relevant to this five-year review, quarterly and semiannual inspections were performed in 2003, 2004, 2005, 2006 and 2007.

The landfill gas monitoring system consists of perimeter probes or gas wells and passive gas vents. The perimeter gas wells or probes are used to detect subsurface migration of landfill gas. The landfill gas collection system is monitored at the passive gas vents. Landfill gas monitoring is conducted quarterly.

The LF-4 post-closure groundwater monitoring program has been structured in accordance with post-closure monitoring requirements contained in California Code of Regulations, Title 27, Subchapter 3, Article 1 (27 CCR) and Code of Federal Regulations, Title 40, Part 258 (40 CFR 258). As specified in the regulations, the post-closure groundwater monitoring program at LF-4 consists of two components, semiannual corrective action monitoring which addresses contaminants already in groundwater that were derived from historical landfill releases (releases prior to capping) and semiannual detection monitoring which addresses any new releases from the landfill (releases subsequent to capping). If the corrective action or detection monitoring results indicate “measurably significant” evidence of continuing or a new release from LF-4, the Air Force will notify the regulatory agencies and implement retest/verification procedures. If resampling confirms measurably significant evidence of a continuing or new release, follow-up activities would include a detailed inspection/assessment of the cap and preparation of work plans and/or engineering feasibility studies to addressing potential corrective actions. The LF-4 post-closure groundwater monitoring program is conducted as an integrated part of the ongoing Castle LTGSP. Current results of the LF-4 post-closure groundwater monitoring program are presented in each LTGSP annual and semiannual report. At LF-4, corrective action monitoring was terminated in 2007 (all analytes less than MCLs or ND for minimum of a year) and all corrective action analytes were transferred to the detection monitoring program.

4.2.2.6 Landfill 5 (DP-8, DP-8A and LF-5 Trenches)

A consolidation and capping removal action has been completed and IC, LTM and LTEM remedies have been implemented. The removal action at LF-5 took place from November 1998 through September 1999. Removal action elements included site preparation, excavation of waste from perimeter trenches, consolidation of LF-5 wastes and waste materials excavated from other authorized Castle Airport sites, confirmation sampling, backfilling excavated trenches, and cap installation. Approximately 19,000 cubic yards of non-hazardous, non-designated waste was excavated from perimeter trenches at LF-5 and placed in the area to be capped. Approximately 100,000 cubic yards of waste material and contaminated soil meeting landfill acceptance criteria (non-hazardous and non-designated wastes) was imported from other Castle Airport SCOU sites and placed in the area to be capped. The consolidated waste and soil was covered with an engineered alternative to a Class III cap. The cap consists of a gas collection layer, a low-permeability layer, a drainage layer and a vegetative cover. The *Landfill 4 and Landfill 5 Closure Report* was finalized in May 2003 (Jacobs, 2003b).

LF-5 and its associated wetlands are located within the BoP United States Penitentiary, Atwater Complex and public access is, and will for the foreseeable future, be prohibited. ICs are currently in place and implemented as follows: (1) the Air Force/BoP MOU precludes site alterations that would interfere with Interagency Agreement (IAG) or IRP activities without notification of EPA, DTSC and the Air Force and approval of the Air Force; (2) the Air Force/BoP MOU establishes access for the Air Force and the BCT; (3) other than access required pursuant to the IAG/IRP, the BoP's *Preservation Area Mitigation and Management Plan* (Louis Berger and Associates [Berger], 1998) restricts access to activities that are necessary for implementation of the plan and (4) elements of prison security (e.g., patrolled security fencing) restrict the potential for human exposure to site contamination. In addition, implementation of the selected remedy will not threaten sensitive ecological habitats. ICs will be maintained at LF-5 until soils are at levels that allow for unrestricted use and exposure. Given that LF-5 is capped and there are no plans to remediate the capped soil/wastes, it is assumed that ICs will be maintained indefinitely. Modification or termination of ICs requires Air Force, EPA and State of California approval.

LTM for LF-5 was initiated in 1999 and consisted of a post-closure monitoring and maintenance program for the caps and a post-closure monitoring program for landfill gas and groundwater beneath the landfill. Landfill cap and groundwater monitoring features at LF-5 are shown on Figure 4-5 and Figure 4-6, respectively. Cap monitoring and maintenance activities and landfill gas and groundwater monitoring are conducted in compliance with the approved *Closure and Post-Closure Maintenance Plan for Castle Airport Landfills* (Jacobs, 1997c) and the *Landfill 4 and Landfill 5 Closure and Post-Closure Maintenance Plan Update* (Jacobs, 2000b). Cap monitoring and maintenance activities for

LF-5 consist of quarterly and semiannual inspections of the cap, landfill gas collection system, monitoring wells, drainage ditch elevations and condition (additional inspection after major rain events), settlement monuments, site security and roads and completion of any necessary repairs. Reports documenting inspection results are prepared annually. Relevant to this five-year review, quarterly and semiannual inspections were performed in 2003, 2004, 2005, 2006 and 2007.

The landfill gas monitoring system consists of perimeter probes or gas wells and passive gas vents. The perimeter gas wells or probes are used to detect subsurface migration of landfill gas. The landfill gas collection system is monitored at the passive gas vents. Landfill gas monitoring is conducted quarterly.

The LF-5 post-closure groundwater monitoring program has been structured in accordance with post-closure monitoring requirements contained in California Code of Regulations, Title 27, Subchapter 3, Article 1 (27 CCR) and Code of Federal Regulations, Title 40, Part 258 (40 CFR 258). As specified in the regulations, the post-closure groundwater monitoring program at LF-5 consists of two components, semiannual corrective action monitoring which addresses contaminants already in groundwater that were derived from historical landfill releases (releases prior to capping) and semiannual detection monitoring which addresses any new releases from the landfill (releases subsequent to capping). If the corrective action or detection monitoring results indicate “measurably significant” evidence of continuing or a new release from LF-5, the Air Force will notify the regulatory agencies and implement retest/verification procedures. If resampling confirms measurably significant evidence of a continuing or new release, follow-up activities would include a detailed inspection/assessment of the cap and preparation of work plans and/or engineering feasibility studies to addressing potential corrective actions. The LF-5 post-closure groundwater monitoring program is conducted as an integrated part of the ongoing Castle LTGSP. Current results of the LF-5 post-closure groundwater monitoring program are presented in each LTGSP annual and semiannual report.

LTEM, consisting of wetlands invertebrate (fairy shrimp) and plant surveys at selected vernal pools, was implemented in the spring of 2008 (surveys are to be conducted every five years, in concert with five-year reviews, for up to 30 years unless the Air Force and the regulatory agencies agree during that period that further monitoring is not warranted). The fairy shrimp survey was completed on 18 and 19 February 2008; the plant survey was completed on 16 and 17 March 2008. To confirm that site contaminants have not impacted wetland habitats, both potentially contaminated (within or downgradient of the site) and uncontaminated (upgradient or remote from any site) vernal pools were surveyed. Results of the surveys are presented in Appendix A.

4.2.3 System Operation and Maintenance

There are no system O&M activities for ETC-10, ETC-12 or LF-3. LTM activities are ongoing at FTA-1, LF-4 (including DP-5 and DP-6) and LF-5 (including DP-8, DP-8A and LF-5 Trenches) as described in Section 4.2.2.5 and Section 4.2.2.6.

5 PROGRESS SINCE LAST REVIEW

This section describes the status of issues identified/recommendations presented in the previous five-year review.

5.1 GROUNDWATER REMEDIAL ACTIONS

Technical assessments in the second five-year review for groundwater treatment systems at Castle Airport (Jacobs, 2004a) indicated that the groundwater remedial actions at Castle Airport remained protective of human health and the environment. The groundwater remedial actions were either meeting requirements of the CB ROD – Part 1 (capture of the Main Base and Castle Vista plumes) or were demonstrating adequate progress towards meeting long-term ROD objectives (cleanup to MCLs). Since completion of the previous five-year review, plume extent and contaminant concentrations have continued a general decline. The OU-1 and Castle Vista groundwater treatment systems and the MW883/MW1021 and MW941 wellhead treatment systems have been shut down with regulatory agency concurrence. The MW824/MW1037 and MW1009 wellhead treatment systems are currently off line and formal shutdown is pending. The OU-2 and Phase 3 groundwater treatment plant and the MW003 and MW951 wellhead treatment systems continue to operate.

The following issues and recommendations were presented for the identified plumes at Castle Airport in the second five-year review report. The current status of each issue/recommendation is summarized.

Five issues were identified for the Main Base Plume:

- <u>The exceedences of discharge standards for calcium, chloride and total dissolved solids in the effluent from the Phase 3 treatment plant</u>: The recommendation was for the RWQCB to issue Waste Discharge Requirements for the Phase 3 groundwater treatment plant to address the naturally occurring concentrations of calcium, chloride and total dissolved solids. Table 5-1 shows the calcium, chloride and total dissolved solids concentrations in the final (combined) effluent from the operating treatment plants and wellhead treatment systems for the five-year review period (2003-2007). The table includes only those systems that were in operation for all or most of the five-year period (OU-2, Phase 3, MW951, MW1009 and MW824/MW1037) and those systems currently offline that might be brought back online in the future (MW003). The table also shows the discharge standards (95 percent confidence limit threshold background value) for treated water to be injected to the Shallow, USS and LSS HSZs. Treated effluent from the MW951, MW1009 and MW003 wellhead systems is injected into the Shallow HSZ and discharge standards were not exceeded during any of the five years. As of Q4/07, treated effluent from the OU-2 treatment plant was injected into the USS HSZ (approximately 95 %) and the Shallow HSZ (approximately 5 %). Discharge standards for these HSZs were not exceeded by the OU-2 plant during any of the five years. As of Q4/07, treated effluent from the Phase 3 treatment plant was injected into the Shallow HSZ (approximately 56 %) and the LSS HSZ (approximately 44 %). Discharge standards for the USS HSZ were not exceeded by the Phase 3 plant during any of the five years. Discharge standards for the LSS HSZ were only slightly but consistently exceeded for calcium, chloride and total dissolved solids during all of the five years.

Status: To date, the RWQCB has not issued Waste Discharge Requirements for the Phase 3 groundwater treatment plant, but because of the benign nature of the constituents in question and the fact that flow through the Phase 3 plant continues to decrease, this issue does not affect current or future protectiveness and is not considered an issue for future operations.

- The potential extended remedial timeframe for the northeast extension of the Main Base Plume: The recommendation was to continue operation of the wellhead treatment systems already in service at MW883/MW1021 and MW824 in the northeast extension of the Main Base Plume and to ensure that appropriate OU-2 system extraction wells remained operational to capture any contaminated groundwater not removed by the MW824 system.

  Status: The MW883/MW1021 wellhead treatment system operated until October 2004, when it was shut down due to declining well yield and TCE concentration. MW1037 was added to the MW824 wellhead treatment system in June 2005. The two-well system operated until October 2006 when it was shut down because water levels had declined to the point that pumping could not be sustained. TCE concentrations in MW824 and MW1037 were just above the MCL at shutdown. TCE concentrations have not increased in the vicinity of either of the wellhead systems. Long-term capture of the northeast plume segment continues to be assured by the downgradient operation of USS HSZ extraction wells of the OU-2 treatment system.

- The lack of capture of the off-base portion of the Confined HSZ Main Base Plume: The recommendation was to continue operation of wellhead treatment systems already in service at MW941, MW951 and MW1009.

  Status: The wellhead treatment system at MW941 was shut down in May 2004 when TCE concentrations dropped to below the MCL. TCE concentrations at the MW1009 wellhead treatment system dropped to below the MCL in early 2007. The system was shut down in February 2008 to monitor possible rebound in TCE concentration; permanent shutdown is anticipated. The MW951 wellhead treatment system continues to operate although TCE concentrations are near the MCL.

- TCE impacts to municipal water supply wells: The recommendation was to continue monthly sampling of MW1010 and City of Atwater water supply wells in the vicinity (AM16, AM18 and AM20). In addition, the Air Force was to maintain contingency plans for wellhead treatment at AM18 should the TCE concentration in well discharge approach the MCL and to maintain plans to evaluate and implement additional remedial actions to capture and cleanup the off-base Confined HSZ Main Base Plume if AM18 becomes inoperative and is expected to remain inoperative for an extended period of time.

  Status: Quarterly/semiannual sampling of MW1010 and the municipal water supply wells continues under the LTGSP. TCE concentrations at MW1010 and AM18 have decreased noticeably since the last review. The CB ROD – Part 2 formalized wellhead treatment as the remedy to address TCE contamination in the off-base portion of the Confined HSZ Main Base Plume and established procedures to be implemented by the

Air Force if TCE concentrations at any off-base municipal (or domestic) water supply well approached one-half of the MCL.

- The need for groundwater use restrictions in areas underlain by MCL plumes until CB ROD – Part 1 cleanup levels are achieved: The recommendation was to establish groundwater use restrictions (ICs) in areas underlain by MCL plumes in the CB ROD – Part 2.

  Status: ICs restricting the installation of water supply wells within the former Castle AFB were included as deed covenants when the property was transferred to Merced County in December 2006. Following publication of the CB ROD – Part 2, The Air Force notified the City of Atwater, Merced County and private landowners in the unincorporated portion of Merced County overlying a plume exceeding an MCL that the groundwater should not be used for human consumption. The location and extent of off-base plumes exceeding an MCL are updated and documented each year in the LTGSP annual report. If monitoring results show that a plume exceeding an MCL has migrated, newly affected parcel owners are notified by the Air Force.

One issue was identified for the East Base Plume:

- ROD requirements for termination of groundwater monitoring have been met: The recommendation was to reduce monitoring of the East Base Plume because TCE has been less than the MCL in all monitoring wells for over a year.

  Status: Monitoring of the East Base Plume was stopped, with regulatory agency approval, as of Q4/03.

One issue was identified for the Castle Vista Plume:

- The need for groundwater use restrictions in areas underlain by MCL plumes until CB ROD – Part 1 cleanup levels are achieved: The recommendation was to establish groundwater use restrictions (ICs) in areas underlain by MCL plumes in the CB ROD – Part 2.

  Status: See the response for the corresponding issue for the Main Base Plume.

No issues were identified for the Landfill 1, Landfill 4 or North Base Plumes.

5.2 SCOU REMOVAL/REMEDIAL ACTIONS

The only SCOU sites assessed in the previous five year review were DA-4, ETC-10, FTA-1, LF-4 (DP-5 and DP-6) and LF-5 (DP-8, DP-8A and LF-5 Trenches. The removal actions ongoing or completed at the time at these sites were found to be protective of human health and the environment. Since completion of the previous five-year review, final remedies for the ten sites listed above and for ETC-12 and LF-3 were established in the SCOU ROD Part 3 (see Section 4.2.1). Issues identified for the DA-4 and ETC-10 sites in the previous five-year review are discussed below. A summary discussion of the ETC-8 site is also presented although this site was not addressed in the previous five-year review and is not addressed herein.

One issue was identified for the DA-4 site:

<u>The existence of a small area of residual soil contamination (TCE) located under a shallow subsurface structure on the site</u>: This residual contamination was eliminated by an E&D remedial action (SCOU ROD Part 2) in 2005 (Earth Tech, 2005). The DA-4 site is no longer being evaluated as part of the five-year review process because contaminants precluding unlimited use and unrestricted exposure were not left in place.

One issue was identified for the ETC-10 site:

<u>Lead and benzo(a)pyrene concentrations remaining in soil after the E&D removal action exceeded residential RAOs</u>: ICs were identified as the preferred alternative to address the residual contamination and were established as the selected remedy for ETC-10 (with LTEM) in the SCOU ROD Part 3. ICs for the ETC-10 site were already in place as part of the transfer of property to the BoP. The letter of transfer included the stipulation that ETC-10 and vicinity (and all of the buffer area surrounding the prison) must remain as open space, i.e., no development or human occupation or regular use.

No issues were identified for the FTA-1, LF-4 (DP-5 and DP-6) and LF-5 (DP-8, DP-8A and LF-5 Trenches) sites in the previous five-year review. The ETC-12 and LF-3 sites were not addressed as individual sites in the previous five-year review.

A preliminary E&D action was undertaken at the ETC-8 site in the summer of 2000 to remove PAH-contaminated soils. Potentially contaminated soils were left in place under a paved parking area. The SCOU ROD Part 3 selected remedy for the ETC-8 site – additional E&D, was completed between July and October 2005. The ETC-8 site is not evaluated as part of the present five-year review process because contaminants precluding unlimited use and unrestricted exposure were not left in place.

6 FIVE-YEAR REVIEW PROCESS

Executive Order 12580 authorized the Air Force to perform the initial and all subsequent five-year reviews for the Castle Airport site. The Air Force has and will handle all administrative components of the five-year review process, including community notification and involvement. Public notification of the five-year review process for Castle Airport was published in the June 18, 2008 issue of the Merced Sun-Star. A second notice will be published in the same newspaper after finalization of this document. A copy of the initial community notification is provided in Appendix C. The Castle Restoration Advisory Board (RAB) has been adjourned and need not be notified.

The on-site contractor (Jacobs) responsible for many of the completed and ongoing SCOU site removal and remedial actions and also responsible for operating and maintaining the groundwater remediation systems at Castle Airport has conducted this five-year review for the Air Force. Because Jacobs is on site, coordinates frequently with other base contractors and is aware of all ongoing actions and issues at the former base, Jacobs did not conduct formal interviews with other base contractors. All CERCLA site closure reports and monitoring reports completed by other contractors during this five-year review period were reviewed by Jacobs and pertinent information used in the preparation of this five-year review document. Formal interviews with possibly interested parties were not conducted because Jacobs' on-site personnel are in regular contact with representatives of the property owner (Merced County – Department of Commerce, Aviation and Economic Development), the site developer (Castle Commerce Center) and airfield operations personnel. The Castle RAB was adjourned over a year ago because most cleanup actions were completed, site operations were winding down and community interest was minimal. Jacobs' on-site personnel do maintain regular contact with owners of property adjacent to the base because many are interested in the monitoring wells located on their property – mainly when those wells may be able to be abandoned.

7 TECHNICAL ASSESSMENT

Separate technical assessments are provided for the two groundwater plume remedial actions and the 11 SCOU site remedial actions considered in this five-year review.

7.1 MAIN BASE PLUME REMEDIAL ACTION

The CB ROD – Part 1 remedy for the Main Base Plume is:

- Plume capture and cleanup of the most restrictive contaminant (currently TCE) to MCL levels

The CB ROD – Part 2 remedies for the Main Base Plume are:

- ICs to restrict groundwater use within plumes exceeding an MCL
- Wellhead treatment or provision of an alternative drinking water supply to protect against adverse impacts to public and private drinking water wells
- Local (wellhead) treatment to address groundwater contamination exceeding MCLs within the off-base Confined HSZ plume

The MCL for TCE at the time of the CB ROD – Part 1 was 5 µg/L and that value remains in effect as of the date of this five-year review. While other VOCs occur in the Main Base Plume (*cis*-1,2-DCE and PCE are the most common minor COCs), they are almost always at much lower concentrations than TCE (PCE concentration currently exceeds TCE concentration at one well – MW522 [grid Q10]) and almost without exception occur within the TCE plume boundaries (MW522 is within the TCE plume). For these reasons, this technical assessment addresses only TCE. It is also noted that all discussion of the Main Base Plume in this and following Sections refers to the plume as defined by the 5 µg/L or MCL plume boundary or contour and not the 0.5 µg/L plume contour, which is also shown on selected figures.

The Main Base Plume groundwater remediation system consists of three separate groundwater treatment systems (OU-1 [shut down as of May 2003], OU-2 and Phase 3) and several independent wellhead treatment systems that are administratively identified with the Phase 3 system (MW883/MW1021 [shut down as of August 2002], MW824/MW1037 [off-line as of October 2006], MW941 [shut down as of May 2004], MW951 and MW1009 [off-line as of February 2008]).

7.1.1 Question A: Is the Remedy Functioning as Intended by the Decision Document?

7.1.1.1 Remedial Action Performance

Remedial action performance is assessed in terms of TCE plume reduction (plume extent and concentration), hydraulic control and treatment system operation (cumulative amount of groundwater treated and contaminant mass removed). Information on current conditions (data through Q4/07) is derived from plume and treatment system monitoring conducted under the LTGSP. The primary LTGSP document used to support this five-year review is the *Long-Term Groundwater Sampling Program 2007 Annual Report* (Jacobs, 2008). It is noted that the Main Base Plume groundwater remedy was determined to be operating properly and successfully (OPS achieved) in February 2004 (Jacobs, 2004e).

7.1.1.1.1 Plume Reduction

Current (Q4/07) TCE plume configuration is shown on Figure 7-1 (Shallow HSZ), Figure 7-2 (USS HSZ), Figure 7-3 (LSS HSZ) and Figure 7-4 (Confined HSZ). Comparison of the current TCE plume configurations with those from Q2/94 (Figures 3-4 through 3-7) shows that although the shape of the plume as defined by the 5 µg/L TCE contour has remained relatively unchanged, significant decreases in both plume size or extent and TCE concentration have occurred over the 13 year period as a result of the remedial action.

Another obvious difference between the Q2/94 and the Q4/07 plume maps is the fact that the plume region boundaries are no longer shown. Changes to the original plume region boundaries were documented in the *Castle Airport Long-Term Groundwater Sampling Program 1998 Annual Report* (Jacobs, 1999d). The only changes were that Main Base Plume Regions 1 and 2 were combined into a single region and the eastern boundary of the Main Base Plume Region was expanded eastward to encompass the western segment in the East Base Plume Region. This was done because: (1) the OU-1, OU-2 and Phase 3 systems were integrated into the Main Base Plume remedial system and are evaluated as a single system and (2) the plume segment now originating around MW1027 (Figure 7-1; grid K12) was connected to the Main Base Plume based on evaluation of data collected subsequent to Q2/94. Because the plume region boundaries are unchanged and there is clear separation between plumes, plume region boundaries have not been shown on plume delineation and groundwater elevation contour maps in LTGSP reports since 1998. The revised plume region boundaries are shown on Plate 1 for reference.

Comparison of Figure 3-4 (Q2/94) with Figure 7-1 (Q4/07) shows that there has been a significant reduction in areal extent and in TCE concentrations in the Shallow HSZ Main Base Plume. In Q2/94, the plume (area within the 5 µg/L TCE contour) encompassed an area of approximately 1 square mile (mi^2). In Q4/07, the plume encompassed an area of about 0.11 mi^2 (89% reduction in area). Regarding TCE concentration, in Q2/94 the 50 µg/L contour encompassed a large area of the southern portion of the plume and there were several hot spots where TCE concentrations exceeded 100 µg/L. The maximum reported TCE concentration was 650 µg/L at MW805 [grid L8]. In Q4/07, the 50 µg/L contour has been eliminated (2001) and the maximum reported TCE concentration in the Shallow HSZ is 25 µg/L at MW1039 (grid Q10) (41 µg/L detected in JM13 in an April 2007 sample but that well is now dry). In response to these reductions in plume extent and concentration and the resulting reduced need for pumping for hydraulic control, 17 Shallow HSZ extraction wells (EW01, EW02, EW04, JE1 and JE2 in OU-1; EW07, EW09, EW10, EW13, EW15, EW16, EW17, WR4 and DA4-2 in OU-2; and MW883/MW1021 and EW18 in Phase 3) have been shut off, with regulatory agency concurrence, through Q4/07. At present, there are no active Shallow HSZ extraction wells. To further document cleanup progress, 32 Shallow HSZ monitoring/extraction wells exceeded the MCL cleanup level of 5 µg/L in Q2/94 versus 14 in Q4/07. This reduction is even more dramatic when the post-1994 addition/discovery of the northeast segment of the Main Base Plume is considered (four of the 14 wells in Q4/07).

Since the OU-1 treatment plant was shut down in 2003, there has been a measurable rebound in TCE concentration in the Shallow HSZ in the central portion of the former OU-1 area (Figure 7-1; primarily grids P10 and Q10). The recent reported TCE concentrations at MW1039 and JM13, noted above, are representative of that rebound. This area of groundwater contamination exceeding the MCL is not presently subject to pump-and-treat remediation because there are no active Shallow HSZ extraction wells. The Air Force has not reinitiated pump-and-treat remediation in the Shallow HSZ in this area for several reasons. First, sampling results from downgradient monitoring wells in the Shallow HSZ show no evidence that contaminants are migrating westward and towards the base boundary. Even if migration were occurring, downgradient pumping from the underlying USS HSZ would provide capture. Second, declining water levels in the Shallow HSZ, discussed in Section 4.1.2.1 and Section 4.1.2.4, severely limit the ability to reinitiate pump-and-treat. In 2007, installation and operation of a wellhead treatment system was considered at monitoring well JM13. However, the well went dry before a final decision was made or the plan could be implemented. Lastly, reinitiation of pump-and-treat remediation would not be cost or technically effective because of the relatively low TCE concentrations presently seen in this portion of the Shallow HSZ. In lieu of reinitiating pump-and-treat, the Air Force has chosen to continue monitoring, to rely on downgradient capture from the USS HSZ and to continue to evaluate and potentially implement other remedial options to ultimately achieve cleanup to MCL levels (e.g., the in-situ chemical oxidation [ISCO] pilot test planned in the off-base Castle Vista area; see Section 7.2.1.3).

Comparison of Figure 3-5 (Q2/94) with Figure 7-2 (Q4/07) shows that there has also been a significant reduction in areal extent and TCE concentration in the USS HSZ Main Base Plume. In Q2/94, the plume (area within the 5 µg/L TCE contour) encompassed an area of approximately 0.7 mi^2 while in Q4/07 the plume encompassed an area of approximately 0.21 mi^2 (70% reduction in area). Regarding TCE concentration, in Q2/94 the 50 µg/L and 100 µg/L contours encompassed large areas in the central portion of the plume. The maximum reported TCE concentration was 120 µg/L at MW904 (grid R10). In Q4/07, the 100 µg/L contour has been eliminated, the 50 µg/L contour has almost been eliminated and the maximum reported TCE concentration in the USS HSZ is 56 µg/L at MW904. In response to these reductions in plume extent and concentration and the resulting reduced need for pumping for hydraulic control, five USS HSZ extraction wells (EW05 and EW08 in OU-2 and EW21, EW33 and EW35 in Phase 3) have been shut off, with regulatory agency concurrence, through Q4/07. A Q2/94 versus Q4/07 comparison of the number of USS HSZ extraction/monitoring wells exceeding the MCL cleanup level is not useful because a large number of the extraction and monitoring wells currently sampled in the USS HSZ were installed after Q2/94. However, it is noted that 19 USS HSZ monitoring/extraction wells exceeded the MCL cleanup level of 5 µg/L in Q2/02 (time of the previous five-year review) versus 12 in Q4/07.

Comparison of Figure 3-6 (Q2/94) with Figure 7-3 (Q4/07) shows that there has also been a significant reduction in areal extent and TCE concentration in the LSS HSZ Main Base Plume. In Q2/94, the plume (area within the 5 µg/L TCE contour) encompassed an area of approximately 0.3 mi^2 while in Q4/07 the plume encompassed an area of approximately 0.1 mi^2 (67% reduction in area). Regarding TCE concentration, in Q2/94 the 50 µg/L and 100 µg/L contours encompassed large areas in the east-central portion of the plume (although due to only one well). The maximum reported TCE concentration was 190 µg/L at MW863 (grid R12). In Q4/07, the 100 µg/L and 50 µg/L contours have been eliminated and the maximum reported TCE concentration in the LSS HSZ is 15 µg/L at EW36 (grid S9). In response to these reductions in plume extent and concentration and the resulting reduced need for pumping for hydraulic control, one LSS HSZ extraction well (EW37 in Phase 3) has been shut off, with regulatory agency concurrence, through Q4/07. Again, a Q2/94 versus Q4/07 comparison of the number of LSS HSZ extraction/monitoring wells exceeding the MCL cleanup level is not useful because a large number of the extraction and monitoring wells currently sampled in the LSS HSZ were installed after Q2/94. However, it is noted that eight LSS HSZ monitoring/extraction wells exceeded the MCL cleanup level of 5 µg/L in Q2/02 (time of the previous five-year review) versus six in Q4/07.

Comparison of Figure 3-7 (Q2/94) with Figure 7-4 (Q4/07) shows that there has been a significant reduction in areal extent of the MCL plume and TCE concentration in the on-base portion of the Confined HSZ Main Base Plume and that a new area of off-base contamination has been identified. In Q2/94, the plume (area within the 5 µg/L TCE contour) encompassed an area of approximately 0.1 mi^2 while in Q4/07 the plume encompassed an area of approximately 0.02 mi^2 (80% reduction in area). Between Q2/94 and Q4/07, the original areas of on-base and off-base contamination in the Confined HSZ have been virtually eliminated while significant progress has been made in reducing TCE concentration in the area upgradient of AM18. Regarding TCE concentration, in Q2/94 the maximum reported TCE concentration was 28 µg/L at MW927 (grid T10). In Q4/07, the maximum reported TCE concentration in the Confined HSZ is 12 µg/L at MW1008 (grid T8). In response to these reductions in plume extent and concentration and the resulting reduced need for pumping for hydraulic control, three Confined HSZ extraction wells (EW23, EW24 and MW941) have been shut off, with regulatory agency concurrence, through Q4/07 and MW1009 is currently shut down to evaluate TCE concentration rebound and the need for continued operation. Again, a Q2/94 versus Q4/07 comparison of the number of Confined HSZ extraction/monitoring wells exceeding the MCL cleanup level is not useful because a large number of the extraction and monitoring wells currently sampled in the Confined HSZ were installed after Q2/94. However, it is noted that seven Confined HSZ monitoring/extraction wells exceeded the MCL cleanup level of 5 µg/L in Q2/02 (time of the previous five-year review) versus three in Q4/07.

7.1.1.1.2 Plume Capture

Groundwater elevation contours for Q4/07 for the Shallow, USS, LSS and Confined HSZs are shown on Figures 7-5, 7-6, 7-7 and 7-8, respectively. Prior to groundwater remediation at Castle Airport, groundwater flow in all HSZs was basically from east to west. Groundwater elevation contours from Q4/07 clearly show the effects of pumping for groundwater remediation in the Main Base Plume area. The most noticeable effects have been the development of groundwater depressions near or along the base boundary in all four HSZs and the development of groundwater mounds blocking off-base flow in the Shallow and USS HSZs. A strong flow gradient towards City of Atwater municipal water supply well AM18 in the Confined HSZ is not present on Figure 7-8 because at the time water levels were measured in Q4/07, AM18 was down for repairs and AM16 was operating. When AM18 is operating (the typical condition), the flow gradient is strongly towards AM18 with a much less noticeable effect from AM16.

Estimated hydraulic capture zones and the Q4/07 MCL plume contours (5 µg/L plume contour for TCE) for each HSZ in the TCE Main Base Plume are also shown on Figures 7-5 through 7-8. The hydraulic capture zones portrayed on these figures are the result of interpretation of the computer-generated groundwater elevation contours by a professional hydrogeologist. They are generally a conservative interpretation of present-day (Q4/07) plume capture.

The following paragraphs present a brief assessment of capture of the Main Base TCE plume in each HSZ as of Q4/07.

Groundwater flow patterns and plume locations shown on Figure 7-5 demonstrate complete capture of the plume in the Shallow HSZ (area within the 5 µg/L TCE contour) except for the small, intermittent plume at inactive extraction well EW13 (grid M7). There are currently no active extraction wells in the Shallow HSZ. Capture of the southern portion of the plume is the result of extensive downgradient pumping in the underlying USS HSZ (Phase 3 USS HSZ extraction wells; see Figure 7-6). Water level measurements indicate continuing capture of the northeast portion of the Shallow HSZ Main Base Plume even though the MW824/MW1037 wellhead treatment system has not been in operation since October 2006. Even if this condition is a measurement anomaly, capture of this portion of the Shallow HSZ plume is ensured by the continuing downgradient operation of OU-2 USS HSZ extraction wells EW11 (grid M8) and EW12 (grid L8) (Figure 7-6). The small intermittent MCL plume at EW13 falls well within the estimated capture zone for the underlying USS HSZ (Figure 7-6). Because of the small and intermittent nature of this plume segment and the fact that capture by pumping from the underlying USS HSZ is very likely, the residual contamination at EW13 is not an issue. The reported TCE concentration at EW13 last exceeded 10 µg/L in Q1/00. The 5.5 µg/L TCE concentration shown on Figure 7-1 was from a January 2007 sample (well sampled annually). A special sample collected in May 2007 had a reported TCE concentration of 3.2 µg/L. Since 2005, the reported TCE concentration at EW13 has fluctuated from ND to 7.3 µg/L.

As noted in Section 7.1.1.1.1, since the OU-1 treatment plant was shut down in 2003, there has been a measurable rebound in TCE concentration in the Shallow HSZ in the central portion of the former OU-1 area. Because there are no extraction wells active in the Shallow HSZ, this area of contamination exceeding the MCL is not now subject to capture by pumping from the Shallow HSZ. The Air Force has not reinitiated pump-and-treat remediation in the Shallow HSZ in this area because there is no evidence that contaminants are migrating westward; downgradient pumping from the underlying USS HSZ will provide capture if migration does occur; declining water levels in the Shallow HSZ severely limit the ability to reinitiate pump-and-treat; and it would not be cost or technically effective to reinitiate pump-and-treat because of the relatively low TCE concentrations presently seen in this portion of the Shallow HSZ. In lieu of reinitiating pump-and-treat, the Air Force has chosen to continue monitoring, to rely on downgradient capture from the USS HSZ and to continue to evaluate and potentially implement other remedial options, if needed, to achieve cleanup to MCL levels (e.g., the in-situ chemical oxidation [ISCO] pilot test planned in the off-base Castle Vista area; see Section 7.2.1.3).

Groundwater flow patterns and plume and extraction well locations shown on Figure 7-6 demonstrate complete capture of the USS HSZ Main Base Plume (area within the 5 µg/L TCE contour). The isolated plume segment formerly present at MW897 (grid P4) was last present in Q1/03.

Groundwater flow patterns and plume and extraction well locations shown on Figure 7-7 demonstrate complete capture of the LSS HSZ Main Base Plume (area within the 5 µg/L TCE contour).

Groundwater flow patterns and plume and extraction well locations shown on Figure 7-8 demonstrate complete capture of the small, residual on-base portion of the Confined HSZ Main Base Plume and partial capture of the downgradient and off-base portion of the plume (areas within the 5 µg/L TCE contour). The downgradient plume segment encompassing MW1008 (grid T8) and MW951 (grid U8) is only partially captured by the wellhead treatment systems at MW951 and, until recently, MW1009 (grid U7). Although significantly reduced in size and concentration over the last few years by wellhead treatment system operation (MW941, MW951 and MW1009), this portion of the Confined HSZ Main Base Plume remains mostly under the hydraulic control of City of Atwater municipal water supply well

AM18 and to a lesser extent AM16. Sampled since March 2001, the highest TCE concentration reported in the discharge from AM18 was 1.5 µg/L in March 2002. Since Q1/05, all reported TCE concentrations at AM18 have been less than the method reporting limit of 0.5 µg/L (not detected [ND] to an estimated 0.42 µg/L). The highest reported TCE concentration at MW1010 (grid W6), the designated guard well for AM18, was 24 µg/L in June 2002. All reported TCE concentrations at MW1010 have been less than the MCL (2.9 µg/L to 4.7 µg/L) since Q3/05 and have been less than 4 µg/L since Q3/06.

7.1.1.1.3 Treatment System Operation

Treatment system operation for the Main Base Plume is summarized in terms of the number of extraction and injection wells (OU-1, OU-2 and Phase 2/3 only) and the cumulative gallons of groundwater treated and pounds of contaminant removed (all VOCs but primarily TCE) as of system shutdown or the end of Q4/07 (December 2007):

- The OU-1 treatment system went online in July 1994 (five extraction wells and nine injection wells) and was shut down in May 2003 (all extraction and injection wells offline). During its approximate eight years of operation, the system treated over 1.59 billion gallons of groundwater and removed 695 pounds of VOCs.
- The OU-2 system went online in November 1996 (15 extraction wells and 11 injection wells) and remains in operation (four extraction wells and five injection wells). During its approximate 11 years of operation, the system has treated over 4.83 billion gallons of groundwater and removed 834 pounds of VOCs.
- The Phase 2 treatment system went online in September 1997 (seven extraction wells and seven injection wells). The Phase 3 expansion went online in May 2000 (eight additional extraction wells and eight additional injection wells) and remains in operation (eight extraction wells and 15 injection wells). During its approximate 10 years of operation, the system has treated over 6.53 billion gallons of groundwater and removed 1,147 pounds of VOCs.
- The MW883/MW1021 wellhead system went online in January 2001 (solar wagon at MW883; MW883/MW1021 system online in August 2002) and was shut down in October 2004. During its approximate four years of operation, the system treated over 19.8 million gallons of groundwater and removed 4.5 pounds of VOCs.
- The MW941 wellhead system went online in June 2002 (solar wagon) and was shut down in May 2004. During its approximate two years of operation, the system treated over 2.8 million gallons of groundwater and removed 0.2 pounds of VOCs.
- The MW824/MW1037 wellhead system went online in August 2002 (MW824 only; MW1037 added in June 2005) and was shut down in October 2006 because of low water levels. During its approximate four years of operation, the system treated over 27.5 million gallons of groundwater and removed 2.75 pounds of VOCs.
- The MW951 wellhead system went online in July 2001 and remains in operation. During its approximate seven and one-half years of operation, the system has treated over 220 million gallons of groundwater and removed 22 pounds of VOCs.

- The MW1009 wellhead system went online in January 2002 and was shut down in February 2008 to assess TCE rebound. During its approximate six years of operation, the system treated over 138 million gallons of groundwater and removed 10 pounds of VOCs.
- The entire Main Base Plume remedial system (not counting the prior groundwater removal actions; see Sections 3.4.1, 3.4.2 and 3.4.3) has treated approximately 13.4 billion gallons of groundwater and removed 2,715 pounds of TCE, which is over 90 percent of the estimated original (but post-removal action) contaminant mass of the Main Base Plume (Jacobs, 1996a).

7.1.1.1.4 CB ROD – Part 2 Remedies

ICs to restrict groundwater use within plumes exceeding an MCL: As noted in Section 4.1.2.1.2, ICs, in the form of land use restrictions were incorporated as grantee covenants in the deed formally transferring Castle Airport to Merced County. These covenants, which place restrictions on the installation of wells, preclude disturbance of any existing groundwater remediation systems and preclude activities that would limit access to any existing groundwater remediation system, remain in place. Groundwater use on the property transferred to the BoP is restricted by terms of the Air Force/BoP MOA. The location and extent of off-base plumes exceeding an MCL are updated and documented each year in the LTGSP annual report. If monitoring results show that a plume exceeding an MCL has migrated, newly affected parcel owners are notified by the Air Force. ICs related to groundwater use on Merced County and BoP property are monitored annually by Merced County and the BoP. In addition, any attempt at new groundwater use within Castle Airport would be identified and reported by on-base Air Force contractor personnel conducting the LTGSP. As noted, ICs related to groundwater use in off-base plumes are addressed annually by the LTGSP.

Wellhead treatment or provision of an alternative drinking water supply to protect against adverse impacts to public and private drinking water wells: If a contaminant concentration in any drinking water well begins to exceed one-half the MCL, the Air Force, in consultation with the EPA, DTSC and RWQCB, will take immediate action, as necessary, to implement wellhead treatment or provide an alternative drinking water supply. Currently, the Air Force is maintaining a wellhead treatment system at domestic well D5766 (grid N4; Figure 3-3).

Local (wellhead) treatment to address groundwater contamination exceeding MCLs within the off-base Confined HSZ plume: The Air Force has installed and operated three wellhead treatment systems in the off-base Confined HSZ plume (MW941, MW951 and MW1009) to address contaminant (TCE) migration towards AM18. Since these actions have been implemented, TCE concentration at AM18 and upgradient guard well MW1010 have decreased markedly. Based on declining TCE concentrations, one of the systems has been shut down (MW941) and one of the systems is off-line and will be formally shut down if ongoing monitoring confirms lack of TCE concentration rebound for a year (MW1009). The MW951 system remains in operation. The Air Force maintains its commitment to evaluate, and if appropriate, implement additional remedial action should AM18 become inoperative for an extended period. The Air Force originally committed to evaluating and possibly implementing additional remedial action if AM18 became inoperable for an extended period at a time when TCE concentrations immediately upgradient of AM18 (i.e., at MW1010) were on the order of 20 µg/L. If AM18 became inoperable for an extended period under those conditions, downgradient migration of contaminated groundwater beyond AM18 may have occurred. Additional remedial action, such as wellhead treatment at or near AM18 may have been necessary and appropriate to prevent such migration. However, with upgradient TCE concentrations greatly reduced (Q4/07 TCE concentration at MW1010 was 3.3 µg/L), the need for additional remedial action if AM18 is not operable is minimal. It is further noted that the City of Atwater currently has no plans to shut down AM18 and if the well were to become inoperable due to pump failure or other problems, it would quickly be repaired and placed back in service. The operational status of AM18 continues to be monitored through the LTGSP.

7.1.1.2 System Operations/Operation and Maintenance

As outlined in Section 4.1.3, the groundwater treatment systems comprising the Main Base Plume remedial system are operated in accordance with an approved O&M plan. Monthly status reports document a high percentage of uptime for all treatment systems, which will maintain the documented effectiveness of the remedial system. Treatment plant effluents consistently meet discharge requirements. The limited number of recent minor spills of untreated groundwater was the result of short-term plant upsets and equipment problems and does not represent any shortcoming in operating procedures.

7.1.1.3 Opportunities for Optimization

Remedial process optimization is a continuing component of remedial system operation (proactive plume management) and the LTGSP. Numerous actions that increased efficiency or reduced costs have already been and continue to be implemented. Significant examples include:

- Shutting off extraction wells that are no longer needed for plume capture and where TCE concentrations are less than the MCL
- Eliminating sampling of monitoring wells no longer needed for plume definition

- Sizing pumps for most efficient use of electrical power
- Developing and implementing a modified carbon changeout procedure to reduce overall carbon usage
- Installing a pre-treatment air stripper at the Phase 3 treatment plant to remove *cis*-1,2-DCE and other contaminants, thereby reducing the frequency of carbon changeouts
- Using a solar-powered mobile GAC treatment unit to treat remote plume segments rather than incurring the cost of delivering grid power
- Negotiating reduced quality control requirements for monitoring well sampling as the LTGSP has matured

In addition, some of the routine activities conducted as a part of the LTGSP and proactive plume management result in cost savings and continual optimization of the remedial process. These include the use of a decision tree to optimize sample collection frequency at all monitoring wells, the use of groundwater flow/transport modeling to help assess future remedial system performance and the results of potential changes to the remedial system, and the intermittent adjustments to extraction well pumping rates to maintain needed capture but minimize the pumping (and thereby treatment) of clean groundwater.

7.1.1.4 Early Indicators of Potential Issues

The lack of active Shallow HSZ pump-and-treat remediation and plume capture in the former OU-1 area where TCE concentrations have rebounded to above MCL levels is identified as a potential issue that could affect protectiveness of the Main Base Plume remedy in the future. At this time, the Air Force has chosen not to reinitiate Shallow HSZ pump-and-treat remediation because there is no evidence that contaminants are migrating downgradient, downgradient pumping from the underlying USS HSZ will provide capture if migration occurs, declining water levels in the Shallow HSZ severely limit the ability to reinitiate pump-and-treat and it would not be cost or technically effective to reinitiate pump-and-treat because of the relatively low TCE concentrations presently seen in this portion of the Shallow HSZ. In lieu of reinitiating pump-and-treat, the Air Force has chosen to continue monitoring, to rely on downgradient capture from the USS HSZ and to continue to evaluate and potentially implement other remedial options, if needed, to achieve cleanup to MCL levels.

The ongoing decline in water levels in the Shallow HSZ has resulted in one wellhead treatment system being taken offline (MW824/MW1037) but the TCE concentrations in the systems two extraction wells were nearly at the MCL when the system was shut down and subsequent monitoring has shown no rebound in TCE concentrations or downgradient migration of TCE-impacted groundwater as a result of the shutdown. It is possible that TCE contamination is being left in the vadose zone at this and other locations in the Main Base Plume because of the declining water levels. However, because TCE concentrations have been reduced to relatively low levels or near the MCL throughout the Shallow HSZ Main Base Plume, only low concentrations of TCE could be left behind in the vadose zone and this residual is not seen as an issue potentially affecting protectiveness of the remedy.

7.1.1.5 Implementation of Institutional Controls and Other Measures

See discussion of ICs in Section 7.1.1.1.4.

Access control (security fencing) is in place at all aboveground system facilities (treatment plants, extraction wells, injection wells and wellhead treatment systems). Locking caps and protective casings minimize the potential for vandalism and assure adequate protection of the public from exposure to contaminants at individual monitoring wells.

7.1.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Used at the Time of Remedy Selection Still Valid?

7.1.2.1 Changes in Standards and To Be Considered Guidelines

The standard identified for groundwater cleanup of the Main Base Plume in the CB ROD – Part 1 was MCLs. For the Main Base Plume, the primary contaminant is TCE, and *cis*-1,2-DCE and PCE are minor contaminants. California drinking water standards for these three contaminants have not changed since the CB ROD – Part 1 was signed and implemented: they remain at 5 µg/L for TCE, 6 µg/L for *cis*-1,2-DCE and 5 µg/L for PCE. A review of applicable or relevant and appropriate requirements (ARARs) and to be considered guidelines (TBCs) indicates that no new standards have been promulgated since the CB ROD – Part 1 and the CB ROD – Part 2 that would call into question the protectiveness of the current remedy.

7.1.2.2 Changes in Exposure Pathways

There have been no changes to exposure parameters, potential exposure pathways or site/land use conditions since the last five-year review. LTGSP results have not identified any new or additional contaminants within the Main Base Plume since implementation of the remedy. The primary contaminant remains TCE, while *cis*-1,2-DCE and PCE remain the most common minor contaminants and continue to occur only within the boundaries of the TCE plume.

7.1.2.3 Changes in Toxicity and Other Contaminant Characteristics

Cleanup levels for the Main Base Plume are MCLs. Since publication of the CB ROD – Part 1, toxicity parameters for TCE have been withdrawn from the Integrated Risk Information System (IRIS) database. However, to date the MCL for TCE has not been revised.

Since the 1996 *Comprehensive Basewide Remedial Investigation/Feasibility Study – Part 1 Baseline Human Health Risk Assessment* (Jacobs, 1996), EPA initiated a re-assessment of TCE toxicity. This assessment is currently under review. In the interim, EPA is using toxicity values developed by the California Environmental Protection Agency (Cal/EPA), because they meet the criteria outlined in Superfund's policy on provisional peer-reviewed toxicity values. The Cal/EPA toxicity value is reflected in EPA's 2008 Regional Screening Level (RSL) table. The RSL table was developed using the latest toxicity values, default exposure assumptions and physical and chemical properties and is consistent with the Office of Solid Waste and Emergency Response chemical toxicity hierarchy. For TCE, the current MCL is 5 µg/L and the concentrations at either end of EPA's risk range using the Cal/EPA toxicity values are 1.7 µg/L to 170 µg/L.

7.1.2.4 Changes in Risk Assessment Methods

The cleanup level for the Main Base Plume remedial action is not risk-based. However, a groundwater BHHRA was conducted as part of the CB RI/FS – Part 1 and was recently updated as part of the CB RI/FS – Part 2. The same methods were used to calculate cancer risk and non-cancer hazard in both the original and the updated CB RI/FS – Part 1 BHHRA.

Since the last five-year review, the potential for vapor intrusion has emerged as a significant issue at sites with environmental contamination and now should be considered as a possible exposure pathway. To address this emerging issue, the Air Force has conducted a screening level assessment of the vapor intrusion risk from current levels of groundwater contamination in the Main Base Plume at Castle Airport. To conduct this assessment, the Air Force used the DTSC automated screening tool (automated Excel spreadsheet; DTSC, 2005). This screening tool is based on the Johnson and Ettinger model, one of the most commonly used models for evaluating the indoor air exposure pathway. The following paragraphs describe site conditions pertinent to the assessment, outline the screening process and present the results of the assessment.

The vadose zone at Castle Airport is a laterally and vertically discontinuous sequence of alluvial sediments, primarily silty sands and sandy silts. Silt, sand, gravel and clay layers occur but are typically thin and are not laterally continuous or extensive. Hardpan occurs locally, generally within 10 feet of the land surface. The Shallow HSZ is the shallowest water-bearing zone at Castle Airport. As of Q4/07, the typical depth to water in the Shallow HSZ ranged from 70 to 80 feet. The primary contaminant in Shallow HSZ groundwater is TCE. As of Q4/07, reported TCE concentrations in Shallow HSZ monitoring wells ranged from ND at several locations to 25 µg/L at MW1039 (Figure 7-1; grid Q10). A reported TCE concentration of 41 µg/L is shown at monitoring well JM13 (grid 10) but this sample was collected in Q1/07. Monitoring well JM13 went dry in Q2/07 and has remained dry since. The depth to water at MW1039 in Q4/07 was 75.89 feet.

The DTSC guidance recommends a step-wise approach for the evaluation of vapor intrusion from groundwater. Eleven steps are identified but only the first five apply for a screening evaluation. Using the DTSC Excel spreadsheet and site specific information discussed above or elsewhere in this five-year review document, the following summarizes the five-step process:

- Step 1 – Identify the spill(s) or release(s): The sources and extent of groundwater contamination are well documented in this five-year review report.
- Step 2 – Characterize the site: The site is fully characterized. The variability of vadose zone lithology is well documented and it is also well documented that as of Q4/07, TCE is the predominant groundwater contaminant in the Main Base Plume.
- Step 3 – Identify the site as one where vapor intrusion into indoor air may represent a complete exposure pathway (VOCs are detected in groundwater): A complete exposure pathway may exist at the site. There are numerous existing buildings and there is TCE contamination in groundwater.
- Step 4 – For an existing building, identify whether an imminent hazard exists from vapors migrating into indoor air. If none exists, go to Step 5: No imminent hazard is known to exist at the site.
- Step 5 – Perform a screening evaluation using the provided default vapor attenuation factors: The following site specific parameters were used in the DTSC Excel spreadsheet to represent site conditions as accurately as possible:
    - TCE concentration (25 µg/L) and depth to groundwater (75.89 feet or 2,313 centimeters) are based on Q4/07 data for Shallow HSZ monitoring well MW1039.

- o Silty sand and sandy silt are the predominant lithologies in the vadose zone overlying the Shallow HSZ. To address this range, the spreadsheets default settings for both sand and silt were used.

The following summarizes the DTSC spreadsheet model output using the inputs identified for Step 5. Data entry and results sheets for the DTSC spreadsheet model are presented in Appendix D.

Contaminant	Lithology Assumed	Concentration (µg/L)	Depth to Water (centimeters)	Cancer Risk	Hazard Quotient
TCE	Sand	25	2,313	1.1E-06	2.1E-03
TCE	Silt	25	2,313	2.2E-07	4.3E-04

Given the depth to groundwater, contaminant concentration and the predominant lithology in the vadose zone, the DTSC spreadsheet model indicates that there are no vapor intrusion concerns associated with the current levels of groundwater contamination in the Shallow HSZ at Castle Airport. The calculated cancer risk for an assumed very dry sand vadose zone is essentially at $1x10^{-6}$ while the calculated cancer risk for an assumed silt vadose zone is well below $1x10^{-6}$. Given that the predominant vadose zone lithology is a sand/silt mixture and that there is moisture in the sands at Castle Airport, especially at depth where the water table has been declining, the cancer risk estimate for vapor intrusion from groundwater sources at Castle Airport would be less than $1x10^{-6}$ and not an issue. Hazard quotient values derived from the DTSC spreadsheet model are less than 1 for either an assumed sand or silt vadose zone.

7.1.2.5 Expected Progress Towards Meeting Remedial Action Objectives

Information presented in Section 7.1.1.1 documents significant progress towards meeting the remedial action objective for the Main Base Plume of cleanup to MCLs. Information presented also documents that complete plume capture has been achieved in the Shallow, USS and LSS HSZs. Downgradient portions of the Confined HSZ Main Base Plume are not subject to capture by the on-base Confined HSZ extraction wells. The Air Force has installed and operated wellhead treatment systems on three downgradient Confined HSZ monitoring wells to capture and remove mass from that portion of the plume not under the immediate hydraulic control of municipal water supply wells AM16 and AM18. ICs are in place to prevent inadvertent use of contaminated groundwater and procedures are in place to minimize impact to municipal and domestic water supply wells.

7.1.3 Question C: Has Any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

Based on information provided in this report and a review of recent LTGSP annual and semiannual reports, no data or other information are identified that could call into question the protectiveness of the remedy for the Main Base Plume.

7.2 CASTLE VISTA PLUME REMEDIAL ACTION

The CB ROD – Part 1 remedy for the Castle Vista Plume is:

- Plume capture and cleanup to MCLs

The CB ROD – Part 2 remedies for the Castle Vista Plume are:

- ICs to restrict groundwater use within plumes exceeding an MCL
- Wellhead treatment or provision of an alternative drinking water supply to protect against adverse impacts to public and private drinking water wells

The principal contaminant in the Castle Vista Plume is *cis*-1,2-DCE. The MCL for *cis*-1,2-DCE was 6 µg/L at the time of the CB ROD – Part 1 and has not been changed as of the date of this five-year review. While TCE and PCE have also been detected in the Castle Vista Plume, they are always at much lower concentrations than *cis*-1,2-DCE and, without exception, occur inside the *cis*-1,2-DCE plume boundaries. For these reasons, this technical assessment addresses only *cis*-1,2-DCE.

The main component of the Castle Vista Plume groundwater remediation system, the Castle Vista groundwater treatment plant, was shut down, with regulatory agency concurrence, in August 2003. A wellhead treatment system at monitoring well MW003 (grid U4) operated from treatment plant shutdown until July 2008 when it was shut down due to low water level in the well (Figure 4-2).

7.2.1 Question A: Is the Remedy Functioning as Intended by the Decision Document?

7.2.1.1 Remedial Action Performance

Remedial action performance is assessed in terms of *cis*-1,2-DCE plume reduction (plume extent and concentration), hydraulic control and treatment system operation (cumulative amount of groundwater treated and contaminant mass removed). Information on current conditions (data through Q4/07) is derived from plume and treatment system monitoring conducted under the LTGSP. The primary LTGSP document used to support this five-year review is the *Long-Term Groundwater Sampling Program 2007 Annual Report* (Jacobs, 2008). It is noted that the Castle Vista Plume groundwater remedy was determined to be operating properly and successfully (OPS achieved) in February 2004 (Jacobs, 2004e).

During the period that the Castle Vista groundwater treatment system was in operation (October 1997 through August 2003), there were 17 monitoring wells, six extraction wells (including MW003) and eight injection wells completed in the Shallow HSZ. There were nine monitoring wells and one extraction well completed within the USS HSZ both inside and surrounding the Castle Vista Plume. MW003 (grid U4) was added to the groundwater treatment system in June 2000 at an initial pumping rate of about 13 gpm. However, the pumping rate decreased over time as the local water level declined and MW003 was shut down in May 2002. During July 2002, a new Shallow HSZ extraction well (EW39 [grid U4]) was drilled adjacent to MW003. This well came online in early August 2002 and began pumping at about 80 gpm. Because of continuing reductions in plume size and concentration, EW39 was taken offline when the Castle Vista groundwater treatment plant was shut down in August 2003. At the same time, a small-capacity wellhead treatment system was installed at MW003 and pumping was reinitiated at a rate of about 7 gpm. The MW003 wellhead treatment system operated, with some interruptions for rebound testing, until July 2008 when it was shut down due to low water level in the well. The pumping rate for the MW003 wellhead treatment system ranged from about 7 gpm at startup to less than 1 gpm just prior to shutdown.

7.2.1.1.1 Plume Reduction

Current (Q4/07) *cis*-1,2-DCE plume configuration for the Shallow HSZ is shown on Figure 7-5. A figure is not presented for current *cis*-1,2-DCE plume configuration in the USS HSZ because the plume in the USS HSZ was eliminated by Castle Vista groundwater treatment plant operation. Comparison of the current (Q4/07) Shallow HSZ *cis*-1,2-DCE plume configuration (Figure 7-5) with that from Q1/97 (Figure 3-8) shows that the Shallow HSZ plume has nearly been eliminated over the 10+ year period as a result of the remedial action. All that remains at present (December 2007) is a small residual plume in the immediate vicinity of MW003. The current *cis*-1,2-DCE concentration at MW003 is 19 µg/L. Because all downgradient portions of the Shallow HSZ plume had been eliminated by 2002 or earlier (the first Shallow HSZ extraction well was taken offline in October 1999), the

Castle Vista groundwater treatment plant was shut down, with regulatory agency approval, in August 2003.

The *cis*-1,2-DCE plume in the USS HSZ was not well characterized in Q1/97, in that only four monitoring wells had been installed, sampling results were only available for three, and two of these were outside of the area of USS HSZ contamination (Figure 3-9). Five additional monitoring wells were installed in the USS HSZ from 1997 through 1999 to monitor plume extent and remedial progress because of concern regarding detection of low levels of *cis*-1,2-DCE in City of Atwater municipal water supply well AM06 (grid W2). The highest concentration of *cis*-1,2-DCE reported at AM06 was an estimated 0.98 µg/L in June 1997 (four months before the Castle Vista groundwater treatment system was started). The plume in the USS HSZ was eliminated by early 2002 (no monitoring or extraction wells exceeded the MCL) and concentrations continued to decrease during 2002 and 2003. As noted above, the Castle Vista groundwater treatment plant was shut down in August 2003. At the time the treatment plant was shut down, the reported *cis*-1,2-DCE concentration at AM06 was an estimated 0.18 µg/L. *cis*-1,2-DCE was ND in all samples collected in 2005 and early 2006. The City of Atwater has not operated AM06 since late 2006 (the pump has been removed) and no further samples have been collected.

7.2.1.1.2 Plume Capture

Groundwater elevation contours for Q4/07 for the Shallow HSZ in the Castle Vista area are shown on Figure 7-5. At the scale of the figure, the present day plume is very small and it is difficult to accurately define groundwater flow with the limited number of Shallow HSZ wells remaining. Despite these limitations, complete capture of the residual plume at MW003 is assumed and portrayed on Figure 7-5, primarily because elevated concentrations of *cis*-1,2-DCE have not been reported at EW29 while the MW003 wellhead treatment system was in operation (the reported *cis*-1,2-DCE concentration at EW29 has been ND since Q1/05).

The *cis*-1,2-DCE plume in the USS HSZ has been eliminated by the Castle Vista groundwater remedial action and capture is no longer an issue to be considered.

7.2.1.1.3 Treatment System Operation

Treatment system operation for the Castle Vista Plume is summarized in terms of the number of extraction and injection wells and the cumulative gallons of groundwater treated and pounds of contaminant removed (all VOCs but primarily *cis*-1,2-DCE) as of system shutdown or the end of Q4/07 (December 2007):

- The Castle Vista treatment system went online in October 1997 (six extraction wells [MW003 added later] and eight injection wells) and was shut down in August 2003. During its approximate six years of operation, the system treated over 952 million gallons of groundwater and removed 37.7 pounds of VOCs.
- The MW003 wellhead system went online in August 2003 and operated until July 2008, when it was shut down due to low water level in the well. During its approximate five years of operation, the system treated over 8.6 million gallons of groundwater and removed about 1 pound of VOCs.

7.2.1.1.4 CB ROD – Part 2 Remedies

ICs to restrict groundwater use within plumes exceeding an MCL: Following the finalization of the CB ROD – Part 2 in 2006, the Air Force notified the City of Atwater of the location and extent of the residual Castle Vista Plume that exceeded the MCL for *cis*-1,2-DCE. Subsequently, the location and extent of off-base plumes exceeding an MCL are updated and documented each year in the LTGSP annual report. If monitoring results were to show that the residual Castle Vista Plume has migrated, any newly affected parcel owners would be notified by the Air Force.

Wellhead treatment or provision of an alternate drinking water supply to protect against adverse impacts to public and private drinking water wells: The residual Castle Vista Plume is within the City of Atwater where individual domestic water supply wells are prohibited by City regulations. Because the plume in the USS HSZ has been eliminated, it is very unlikely that *cis*-1,2-DCE concentration will increase at AM06 at any time in the future. In addition, AM06 has not been used by the City for water supply in over two years and there are no plans to resume use (the pump has been removed but the well has not been destroyed). However, until regulatory approved closure of the Castle Vista groundwater remedial action (i.e., the remedial action is complete), the Air Force, in consultation with the EPA, DTSC and RWQCB, will take immediate action, as necessary, to implement wellhead treatment or provide an alternative drinking water supply if use of AM06 resumes and the *cis*-1,2-DCE concentration begins to exceed one-half the MCL.

7.2.1.2 System Operations/Operation and Maintenance

As outlined in Section 4.1.3, the MW003 wellhead treatment system was operated in accordance with an approved O&M plan. Monthly status reports documented a high percentage of uptime for the system, which maintained the documented effectiveness of the remedial system. Treatment plant effluent consistently met discharge requirements and there were no spills or releases of untreated groundwater during the past five years.

7.2.1.3 Opportunities for Optimization

The MW003 wellhead treatment system was a small, low capacity single well system and there were no realistic opportunities for optimization while it was in operation. A work plan for a pilot study to assess ISCO in the source area for MW003 has been approved by the regulatory agencies. Air Force implementation of the pilot study was scheduled for the fall of 2008 but has been delayed due to the need to conduct additional site characterization.

7.2.1.4 Early Indicators of Potential Issues

The MW003 wellhead treatment system operated, although not continuously, for almost five years and there was no measurable decrease in *cis*-1,2-DCE concentration in the small residual plume. This suggests that pump-and-treat is not an effective technology to eliminate the small residual area of contamination at MW003 and thereby achieve closure of the Castle Vista Plume remedial action (see discussion of ISCO pilot study above).

7.2.1.5 Implementation of Institutional Controls and Other Measures

See discussion of ICs in Section 7.2.1.1.4.

Access control (security fencing) is in place at all aboveground system facilities (MW003 wellhead treatment system). All remaining extraction, injection and monitoring wells associated with the Castle Vista Plume are located in locked below-ground vaults or have locking caps and protective casings to assure adequate protection of the public from exposure to contaminants.

7.2.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and the Remedial Action Objectives Used at the Time of Remedy Selection Still Valid?

7.2.2.1 Changes in Standards and To Be Considered Guidelines

The standard identified for groundwater cleanup of the Castle Vista Plume in the CB ROD – Part 1 was MCLs. The primary contaminant is *cis*-1,2-DCE while TCE and PCE are minor contaminants. The California drinking water standards or MCLs for *cis*-1,2-DCE (6 µg/L), TCE (5 µg/L) and PCE (5 µg/L) have not changed since the CB ROD – Part 1 was signed and implemented. A review of ARARs and TBCs indicates that no new standards have been promulgated or proposed since the CB ROD – Part 1 or the CB ROD – Part 2 that would call into question the protectiveness of the current remedy.

7.2.2.2 Changes in Exposure Pathways

There have been no changes to exposure parameters, potential exposure pathways or site/land use conditions since the last five-year review. The most likely exposure pathway, City of Atwater water supply well AM06, has not been used by the City in over two years and there are no plans to resume its use as a water supply source. LTGSP results have not identified any new or additional contaminants within the Castle Vista Plume since implementation of the remedy. The primary contaminant remains *cis*-1,2-DCE.

7.2.2.3 Changes in Toxicity and Other Contaminant Characteristics

Cleanup levels for the Castle Vista Plume are MCLs. There have been no changes to toxicity or other characteristics for *cis*-1,2-DCE or PCE and no changes to MCLs since publication of the CB ROD – Part 1. Since publication of the ROD, toxicity parameters for TCE have been withdrawn from the IRIS database; however, to date the MCL for TCE has not been revised.

Since the 1996 *Comprehensive Basewide Remedial Investigation/Feasibility Study – Part 1 Baseline Human Health Risk Assessment* (Jacobs, 1996), EPA initiated a re-assessment of TCE toxicity. This assessment is currently under review. In the interim, EPA is using toxicity values developed by the California Environmental Protection Agency (Cal/EPA), because they meet the criteria outlined in Superfund's policy on provisional peer-reviewed toxicity values. The Cal/EPA toxicity value is reflected in EPA's 2008 Regional Screening Level (RSL) table. The RSL table was developed using the latest toxicity values, default exposure assumptions and physical and chemical properties and is consistent with the Office of Solid Waste and Emergency Response chemical toxicity hierarchy. For TCE, the current MCL is 5 µg/L and the concentrations at either end of EPA's risk range using the Cal/EPA toxicity values are 1.7 µg/L to 170 µg/L.

7.2.2.4 Changes in Risk Assessment Methods

The cleanup level for the Castle Vista Plume remedial action is not risk-based. However, a groundwater BHHRA was conducted as part of the CB RI/FS–Part 1 and was recently updated as part of the CB RI/FS – Part 2. The same methods were used to calculate cancer risk and non-cancer hazard in both the original and the updated CB RI/FS – Part 1 BHHRA.

7.2.2.5 Expected Progress Towards Meeting Remedial Action Objectives

Information presented in Section 7.2.1.1 documents that there has been very significant progress towards meeting the RAO for the Castle Vista Plume of cleanup to MCLs. The *cis*-1,2-DCE plume in the USS HSZ has been eliminated and only a small residual plume in the original source area remains in the Shallow HSZ.

7.2.3 Question C: Has Any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

Based on information provided in this report and a review of recent LTGSP annual and semiannual reports, no data or other information are identified that could call into question the protectiveness of the remedy for the Castle Vista Plume.

7.3 EARTH TECHNOLOGY CORPORATION 10

The SCOU ROD Part 3 remedy for ETC-10 is:

- ICs and LTEM

As described in Section 4.2.2.1, an E&D removal action has been completed and IC and LTEM remedies have been implemented.

7.3.1 Question A: Is the Remedy Functioning as Intended by the Decision Document?

7.3.1.1 Remedial Action Performance

Remedial action performance is assessed in terms of the effectiveness of ICs and the results of LTEM. Information on the effectiveness of ICs is based on the nature of the controls in place and current site conditions as observed during a recent site inspection. The results of LTEM are based on the wetlands invertebrate (fairy shrimp) and plant surveys conducted in the vicinity of ETC-10 in February and March 2008, respectively.

7.3.1.1.1 Institutional Controls

ETC-10 is currently located within the BoP United States Penitentiary, Atwater Complex and public access is, and will for the foreseeable future, be prohibited and controlled by prison security (fencing and guard patrols). In addition, the Air Force/BoP MOU precludes any site altering activities within the prison parcel, including ETC-10, without notification of EPA, DTSC and the Air Force and the approval of such activities by the Air Force. No requests for site altering activities have been received to date by the Air Force for ETC-10 or its vicinity. Further, no evidence of any regular site use, construction or other site altering activities was observed within the ETC-10 site during a site inspection by on-site Air Force contractor personnel (Jacobs) on 10 June 2008.

7.3.1.1.2 Long-Term Ecological Monitoring

Per the SCOU ROD Part 3, LTEM at ETC-10, consisting of wetlands invertebrate (fairy shrimp) and plant (flora) surveys at selected vernal pools, is to be conducted every five years, in concert with five-year reviews, for up to 30 years unless the Air Force and the regulatory agencies agree during that period that further monitoring is not warranted. A survey of vernal pools potentially impacted by residual soil contamination at ETC-10 and not-impacted background pools was conducted on 18 and 19 February 2008 (fairy shrimp) and 16 and 17 March 2008 (vernal pool flora). Survey procedures and results are presented in Appendix A. Results of the surveys indicate that, at a 95% confidence level and based on the Wilcoxon-Mann-Whitney tests, there is no evidence that fairy shrimp abundance, plant diversity or plant abundance (percent plant coverage) in the potentially impacted pools is statistically less than in the reference pools. Student's t tests and Satterthwait tests also suggest no impact at ETC-10 but these tests are probably not valid because the combined reference pool data are not normally distributed. Given these results, it is reasonable to state that there have been no identifiable effects from residual soil contamination at ETC-10 on vernal pool fairy shrimp or plants.

7.3.1.2 System Operations/Operation and Maintenance

There are no operating remedial systems in place at ETC-10.

7.3.1.3 Opportunities for Optimization

There are no opportunities for optimization at ETC-10 given that there are no operating remedial systems.

7.3.1.4 Early Indicators of Potential Issues

There are no potential issues identified for the ETC-10 remedial action.

7.3.1.5 Implementation of Institutional Controls and Other Measures

See discussion of ICs and access control measures in Section 7.3.1.1.1.

7.3.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and the Remedial Action Objectives Used at the Time of Remedy Selection Still Valid?

7.3.2.1 Changes in Standards and To Be Considered Guidelines

The ETC-10 removal action has been completed. ARARs and TBCs related to site soil contamination are not relevant to the IC and LTEM remedies addressed herein.

7.3.2.2 Changes in Exposure Pathways

There have been no changes in the potential exposure pathways at ETC-10. Exposure pathways of concern, and those addressed by the SCOU ROD Part 3 remedies, are human exposure to residual soil contamination and vernal pool fairy shrimp and flora exposure to contaminants from past and present soil contamination at the site.

7.3.2.3 Changes in Toxicity and Other Contaminant Characteristics

The ETC-10 removal action has been completed. Toxicity and other contaminant characteristics are not relevant to the IC and LTEM remedies addressed herein.

7.3.2.4 Changes in Risk Assessment Methods

The ETC-10 removal action has been completed. Risk assessment methods are not relevant to the IC and LTEM remedies addressed herein.

7.3.2.5 Expected Progress Towards Meeting Remedial Action Objectives

Information presented in Section 7.3.1.1 documents that objectives of the IC and LTEM remedies for ETC-10 are being achieved. Site access is controlled and there has been no identifiable human access or use of the site during the period of this five-year review. The first ecological monitoring event was performed in early 2008 as required.

7.3.3 Question C: Has Any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

Based on information provided in this report, including the results of the recent site inspection and the ecological monitoring program, no data or other information are identified that could call into question the protectiveness of the remedy for ETC-10.

7.4 EARTH TECHNOLOGY CORPORATION 12

The SCOU ROD Part 3 remedy for ETC-12 is:

- LTEM

As described in Section 4.2.2.2, the LTEM remedy has been implemented.

7.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Document?

7.4.1.1 Remedial Action Performance

Remedial action performance is assessed in terms of the results of LTEM. The results of LTEM are based on the wetlands invertebrate (fairy shrimp) and plant surveys conducted in the vicinity of ETC-12 in February and March 2008, respectively.

Per the SCOU ROD Part 3, LTEM at ETC-12, consisting of wetlands invertebrate (fairy shrimp) and plant (flora) surveys at selected vernal pools, is to be conducted every five years, in concert with five-year reviews, for up to 30 years unless the Air Force and the regulatory agencies agree during that period that further monitoring is not warranted. A survey of vernal pools potentially impacted by residual soil contamination at ETC-12 and not-impacted background pools was conducted on 18 and 19 February 2008 (fairy shrimp) and 16 and 17 March 2008 (vernal pool flora). Survey procedures and results are presented in Appendix A. Results of the surveys indicate that, at a 95% confidence level and based on the Wilcoxon-Mann-Whitney tests, there is no evidence that fairy shrimp abundance, plant diversity or plant abundance (percent plant coverage) in the potentially impacted pools is statistically less than in the reference pools. Student's t tests and Satterthwait tests also suggest no impact at ETC-12 but these tests are probably not valid because the combined reference pool data are not normally distributed. Given these results, it is reasonable to state that there have been no identifiable effects from residual soil contamination at ETC-12 on vernal pool fairy shrimp or plants.

7.4.1.2 System Operations/Operation and Maintenance

There are no operating remedial systems in place at ETC-12.

7.4.1.3 Opportunities for Optimization

There are no opportunities for optimization at ETC-12 given that there are no operating remedial systems.

7.4.1.4 Early Indicators of Potential Issues

There are no potential issues identified for the ETC-12 remedial action.

7.4.1.5 Implementation of Institutional Controls and Other Measures

ICs are not part of the remedy for ETC-12. No measures other than LTEM are required or have been implemented at ETC-12.

7.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and the Remedial Action Objectives Used at the Time of Remedy Selection Still Valid?

7.4.2.1 Changes in Standards and To Be Considered Guidelines

ARARs and TBCs related to residual soil contamination at ETC-12 are not relevant to the LTEM remedy addressed herein.

7.4.2.2 Changes in Exposure Pathways

There have been no changes in the potential exposure pathways at ETC-12. The exposure pathway of concern, and that addressed by the SCOU ROD Part 3 remedy, are vernal pool fairy shrimp and flora exposure to contaminants from past and present soil contamination at the site.

7.4.2.3 Changes in Toxicity and Other Contaminant Characteristics

Toxicity and other contaminant characteristics are not relevant to the LTEM remedy addressed herein.

7.4.2.4 Changes in Risk Assessment Methods

Risk assessment methods are not relevant to the LTEM remedy addressed herein.

7.4.2.5 Expected Progress Towards Meeting Remedial Action Objectives

Information presented in Section 7.4.1.1 documents that objectives of the LTEM remedy for ETC-12 are being achieved. The first ecological monitoring event was performed in early 2008 as required.

7.4.3 Question C: Has Any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

Based on information provided in this report, primarily the results of the recent ecological monitoring program, no data or other information are identified that could call into question the protectiveness of the remedy for ETC-12.

7.5 FIRE TRAINING AREA 1

The SCOU ROD Part 3 remedy for FTA-1 is:

- SVE, BV, LTM, ICs, E&D and LTEM

As described in Section 4.2.2.3, SVE/capping and E&D remedial actions have been completed, a BV remedial action was not necessary and IC, LTM and LTEM remedies have been implemented.

7.5.1 Question A: Is the Remedy Functioning as Intended by the Decision Document?

7.5.1.1 Removal Action Performance

Remedial action performance is assessed in terms of the effectiveness of ICs and the results of LTM and LTEM. Information on the effectiveness of ICs is based on the nature of the controls in place, site conditions reported for the annual evaluation of site activities and conditions (since 2006) and site conditions observed during a recent site inspection. The results of LTM are based on the cap inspection and monitoring conducted quarterly for FTA-1 and a recent site inspection. The results of LTEM are based on the wetlands invertebrate (fairy shrimp) and plant surveys conducted in the vicinity of FTA-1 in February and March 2008, respectively.

7.5.1.1.1 Institutional Controls

FTA-1 is currently located within the BoP United States Penitentiary, Atwater Complex and public access is, and will for the foreseeable future, be prohibited and controlled by prison security (fencing and guard patrols). In addition, the Air Force/BoP MOU precludes any site altering activities within the prison parcel, including FTA-1, without notification of EPA, DTSC and the Air Force and the approval of such activities by the Air Force. No requests for site altering activities have been received to date by the Air Force for FTA-1 or its vicinity.

In accordance with the *Closure and Post-Closure Maintenance Plan – Update 2* (AFRPA, 2006b), an annual evaluation of site activities and conditions has been conducted since 2006 as part of landfill (and FTA-1) inspection and monitoring activities. There were no issues with the annual IC evaluation during the 2006 or the 2007 monitoring period (MWH, 2007; MWH, 2008). Further, no evidence of any regular site use, construction or other site altering activities was observed within the FTA-1 site during a site inspection by on-site Air Force contractor personnel (Jacobs) on 10 June 2008.

7.5.1.1.2 Long-Term Monitoring

Quarterly inspections of the FTA-1 cap were performed from 2003 through 2007. The results of these inspections are as follows:

<u>2003</u>: Access roads, fencing and gates in good condition; no evidence of vandalism or unauthorized access; small animal burrows baited and large animal burrows grouted; cap mowed in May; monitoring wells in good condition; cap periphery in good condition; no trash or debris in the area (MWH, 2004b).

<u>2004</u>: Access roads, fencing and gates in good condition; no evidence of vandalism or unauthorized access; small animal burrows baited; cap mowed in May; monitoring wells in good condition; cap periphery in good condition; no trash or debris in the area (MWH, 2004c).

<u>2005</u>: Access roads, fencing and gates in good condition; no evidence of vandalism or unauthorized access; small animal burrows baited; cap mowed in June; monitoring wells in good condition; cap periphery in good condition; no trash or debris in the area (MWH, 2005b).

<u>2006</u>: Access roads, fencing and gates in good condition; no evidence of vandalism or unauthorized access; animal burrows and minor water erosion observed; cap mowed in May; monitoring wells in good condition; cap periphery in good condition; no trash or debris in the area (MWH, 2007b).

<u>2007</u>: Access roads, fencing and gates in good condition; no evidence of vandalism or unauthorized access; animal burrows observed (minor filling of animal burrows and repair of water erosion areas planned for 2008); cap mowed in June; monitoring wells in good condition; cap periphery in good condition; no trash or debris in the area (MWH, 2008).

7.5.1.1.3 Long-Term Ecological Monitoring

Per the SCOU ROD Part 3, LTEM at FTA-1, consisting of wetlands invertebrate (fairy shrimp) and plant (flora) surveys at selected vernal pools, is to be conducted every five years, in concert with five-year reviews, for up to 30 years unless the Air Force and the regulatory agencies agree during that period that further monitoring is not warranted. A survey of vernal pools potentially impacted by soil contamination at FTA-1 and not-impacted background pools was conducted on 18 and 19 February 2008 (fairy shrimp) and 16 and 17 March 2008 (vernal pool flora). Survey procedures and results are presented in Appendix A. Results of the surveys indicate that, at a 95% confidence level and based on the Wilcoxon-Mann-Whitney tests, there is no evidence that fairy shrimp abundance, plant diversity or plant abundance (percent plant coverage) in the potentially impacted pools is statistically less than in the reference pools. Satterthwait tests suggest a possible impact on shrimp abundance at FTA-1 but these tests are probably not valid because the combined reference pool data are not normally distributed. Given these results, it is reasonable to state that there have been no identifiable effects from residual soil contamination at FTA-1 on vernal pool fairy shrimp or plants.

7.5.1.2 System Operations/Operation and Maintenance

There are no operating remedial systems in place at FTA-1. Maintenance of the FTA-1 cap is discussed in Section 7.5.1.1.2.

7.5.1.3 Opportunities for Optimization

There are no opportunities for optimization at FTA-1 given that there are no operating remedial systems.

7.5.1.4 Early Indicators of Potential Issues

There are no potential issues identified for the FTA-1 remedial action. Two LTGSP monitoring wells near FTA-1 (MW320 [grid M15] and MW886 [grid M14]) have recently had reported detections of TCE near or just above the MCL. This is not viewed as a significant issue but monitoring of the two wells will continue until TCE concentrations in both wells are below the MCL for two consecutive sampling events.

7.5.1.5 Implementation of Institutional Controls and Other Measures

See discussion of ICs and access control measures in Section 7.5.1.1.1.

7.5.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and the Remedial Action Objectives Used at the Time of Remedy Selection Still Valid?

7.5.2.1 Changes in Standards and To Be Considered Guidelines

The SVE/capping and E&D actions at FTA-1 were completed as removal actions. ARARs and TBCs related to site soil contamination are not relevant to the IC, LTM and LTEM remedies addressed herein.

7.5.2.2 Changes in Exposure Pathways

There have been no changes in the potential exposure pathways at FTA-1. The exposure pathways of concern, and those addressed by the SCOU ROD Part 3 remedies, are human exposure to residual soil contamination under the cap and vernal pool fairy shrimp and flora exposure to contaminants from former soil contamination at the site. The potential exposure pathway of vapor intrusion to future buildings from residual shallow VOCs that may be present at FTA-1 is not an issue because human use of the site is restricted by ICs in the Air Force/BoP MOU and, in addition, human use or building on the site is precluded since the site is within the BoP Vernal Pool Preservation Area.

7.5.2.3 Changes in Toxicity and Other Contaminant Characteristics

The SVE/capping and E&D actions at FTA-1 were completed as removal actions. Toxicity and other contaminant characteristics are not relevant to the IC, LTM and LTEM remedies addressed herein.

7.5.2.4 Changes in Risk Assessment Methods

The SVE/capping and E&D actions at FTA-1 were completed as removal actions. Risk assessment methods are not relevant to the IC, LTM and LTEM remedies addressed herein.

7.5.2.5 Expected Progress Towards Meeting Remedial Action Objectives

Information presented in Section 7.5.1.1 documents that the objectives of the IC, LTM and LTEM remedies for FTA-1 are being achieved. Site access is controlled and there has been no identifiable human access or use of the site during the period of this five-year review. Cap monitoring and maintenance is being performed quarterly and there have been no significant issues with the cap. The first ecological monitoring event was performed in early 2008 as required.

7.5.3 Question C: Has Any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

Based on information provided in this report, including the results of the cap maintenance and monitoring program, the annual IC evaluations, the recent site inspection and the ecological monitoring program, no data or other information are identified that could call into question the protectiveness of the remedy for FTA-1. The recent detections of TCE at MW320 and MW886 at concentrations slightly exceeding the MCL may become a protectiveness issue for the FTA-1 remedy if TCE concentrations increase further. TCE concentrations in all four samples collected from MW886 during 2007 remained just above the MCL (reported concentrations ranged from 5.5 µg/L to 8.9 µg/L). TCE concentrations in all four samples collected from MW320 during 2007 were less than the MCL (reported concentrations ranged from 1.4 µg/l to 4.9 µg/L). As noted previously, monitoring will continue until TCE concentrations in both wells are below the MCL for two consecutive sampling events.

7.6 LANDFILL 3 REMEDIAL ACTION

The SCOU ROD Part 3 remedy for LF-3 is:

- LTEM

As described in Section 4.2.2.4, an E&D removal action has been completed and the LTEM remedy has been implemented.

7.6.1 Question A: Is the Remedy Functioning as Intended by the Decision Document?

7.6.1.1 Remedial Action Performance

Remedial action performance is assessed in terms of the results of LTEM. The results of LTEM are based on the wetlands invertebrate (fairy shrimp) and plant surveys conducted in the vicinity of LF-3 in February and March 2008, respectively.

Per the SCOU ROD Part 3, LTEM at LF-3, consisting of wetlands invertebrate (fairy shrimp) and plant (flora) surveys at selected vernal pools, is to be conducted every five years, in concert with five-year reviews, for up to 30 years unless the Air Force and the regulatory agencies agree during that period that further monitoring is not warranted. A survey of vernal pools potentially impacted by residual soil contamination at LF-3 and not-impacted background pools was conducted on 18 and 19 February 2008 (fairy shrimp) and 16 and 17 March 2008 (vernal pool flora). Survey procedures and results are presented in Appendix A. Results of the surveys indicate that, at a 95% confidence level and based on the Wilcoxon-Mann-Whitney tests, there is no evidence that fairy shrimp abundance, plant diversity or plant abundance (percent plant coverage) in the potentially impacted pools is statistically less than in the reference pools. Student’s t tests and Satterthwait tests suggest a possible impact to shrimp abundance, plant diversity and plant abundance at LF-3 but these tests are probably not valid because the combined reference pool data are not normally distributed. Given these results, it is reasonable to state that there have been no identifiable effects from residual soil contamination at LF-3 on vernal pool fairy shrimp or plants.

7.6.1.2 System Operations/Operation and Maintenance

There are no operating remedial systems in place at LF-3.

7.6.1.3 Opportunities for Optimization

There are no opportunities for optimization at LF-3 given that there are no operating remedial systems.

7.6.1.4 Early Indicators of Potential Issues

There are no potential issues identified for the LF-3 remedial action.

7.6.1.5 Implementation of Institutional Controls and Other Measures

ICs are not part of the remedy for LF-3. No measures other than LTEM are required or have been implemented at LF-3.

7.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and the Remedial Action Objectives Used at the Time of Remedy Selection Still Valid?

7.6.2.1 Changes in Standards and To Be Considered Guidelines

ARARs and TBCs related to residual soil contamination at LF-3 are not relevant to the LTEM remedy addressed herein.

7.6.2.2 Changes in Exposure Pathways

There have been no changes in the potential exposure pathways at LF-3. The exposure pathway of concern, and that addressed by the SCOU ROD Part 3 remedy, are vernal pool fairy shrimp and flora exposure to contaminants from past and present soil contamination at the site.

7.6.2.3 Changes in Toxicity and Other Contaminant Characteristics

Toxicity and other contaminant characteristics are not relevant to the LTEM remedy addressed herein.

7.6.2.4 Changes in Risk Assessment Methods

Risk assessment methods are not relevant to the LTEM remedy addressed herein.

7.6.2.5 Expected Progress Towards Meeting Remedial Action Objectives

Information presented in Section 7.6.1.1 documents that objectives of the LTEM remedy for LF-3 are being achieved. The first ecological monitoring event was performed in early 2008 as required.

7.6.3 Question C: Has Any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

Based on information provided in this report, primarily the results of the recent ecological monitoring program, no data or other information are identified that could call into question the protectiveness of the remedy for LF-3.

7.7 LANDFILL 4 REMEDIAL ACTION (INCLUDING DP-5 AND DP-6)

The SCOU ROD Part 3 remedy for LF-4 is:

- ICs and LTM

As described in Section 4.2.2.5, a consolidation and capping removal action has been completed and IC and LTM remedies have been implemented.

7.7.1 Question A: Is the Remedy Functioning as Intended by the Decision Document?

7.7.1.1 Remedial Action Performance

Remedial action performance is assessed in terms of the effectiveness of ICs and the results of LTM. Information on the effectiveness of ICs is based on the nature of the controls in place, site conditions reported for the annual evaluation of site activities and conditions (since 2006) and site conditions observed during a recent site inspection. The results of LTM are based on the cap inspection and monitoring conducted quarterly for LF-4, the results of post-closure groundwater monitoring conducted as part of the LTGSP and a recent site inspection.

7.7.1.1.1 Institutional Controls

Land use restrictions for LF-4 were incorporated in the deed transferring the parcel containing LF-4 to Merced County and a State Land Use Covenant has been executed by the Air Force with the State of California. These controls limit site use to non-irrigated open space and preclude any groundwater withdrawal or other activity that would disturb the closed landfill, including the cap, access roads and security fencing, drainage features and monitoring probes/wells.

In accordance with the *Closure and Post-Closure Maintenance Plan – Update 2* (AFRPA, 2006b), an annual evaluation of site activities and conditions has been conducted since 2006 as part of landfill inspection and monitoring activities. There were no issues with the annual IC evaluation of LF-4 during the 2006 or the 2007 monitoring period (MWH, 2007; MWH, 2008). Further, no evidence of any regular site use, construction or other site altering activities was observed within LF-4 during a site inspection by on-site Air Force contractor personnel (Jacobs) on 10 June 2008.

7.7.1.1.2 Long-Term Maintenance and Monitoring

Quarterly inspections of the LF-4 caps were performed from 2003 through 2007. The results of these inspections are as follows:

2003: Minor repairs made to access road, fencing and the main gate; no evidence of vandalism or unauthorized access; settlement monuments and gas vents in good condition; small animal burrows in caps filled; caps mowed in June; drainage channels in good working condition; monitoring probes and wells in good condition; periphery of both caps in good condition; minor trash and debris along fencing removed (MWH, 2004b).

2004: Minor repairs made to access road, fencing and the main gate; no evidence of vandalism or unauthorized access; settlement monuments and gas vents in good condition; portion of caps regraded to maintain minimum three percent grade for drainage; caps mowed in April; sediment buildup noted in portions of drainage channels; monitoring probes and wells in good condition; periphery of both caps in good condition; minor trash and debris along fencing removed (MWH, 2004c).

2005: Access road in good condition; minor repairs to fencing and gates; signs were missing and replaced but no evidence of unauthorized access; labels on two settlement monuments replaced; other settlement monuments and gas vents in good condition; caps in good condition; caps mowed in June; repairs to four areas of the drainage channels; monitoring probes and wells in good condition; evidence of grass fire along portion of landfill periphery; no trash or evidence of unauthorized dumping (MWH, 2005b).

2006: Access road in good condition; minor repairs to fencing and gates; signs were missing and replaced but no evidence of unauthorized access; settlement monuments and gas vents in good condition; minor depressions observed in caps but no repairs; caps mowed in May; 675 feet of drainage channel was regraded; monitoring probes and wells in good condition; periphery of both caps in good condition; no trash or evidence of unauthorized dumping (MWH, 2007b).

2007: Access road, fencing and gates in good condition; unauthorized locks replaced on all gas monitoring wells; settlement monuments and gas vents in good condition; minor cracking observed in caps but no repairs; caps mowed in June; 675 feet of drainage channel had cobbles replaced and was regraded; monitoring probes and wells in good condition; periphery of both caps in good condition; no trash or evidence of unauthorized dumping (MWH, 2008).

Semiannual post-closure groundwater monitoring for LF-4 (corrective action and detection monitoring) was performed from 2003 through 2007 (Q1 and Q3 in 2003, 2004 and 2005; Q2 and Q4 in 2006 and 2007). The significant results of these monitoring events are as follows:

2003: No evidence of a release from the caps warranting action (Jacobs, 2003c; Jacobs, 2004c).

2004: No evidence of a release from the caps warranting action (Jacobs, 2004d; Jacobs, 2005b).

2005: No evidence of a release from the caps warranting action (Jacobs, 2005c; Jacobs, 2006a).

2006: No evidence of a release from the caps warranting action (Jacobs, 2006c; Jacobs, 2007a).

2007: No evidence of a release from the caps warranting action (Jacobs, 2007b; Jacobs, 2008). Corrective action monitoring was eliminated.

7.7.1.2 Systems Operations/Operations and Maintenance

There are no operating remedial systems in place at LF-4. Maintenance of the LF-4 caps is discussed in Section 7.7.1.1.2.

7.7.1.3 Opportunities for Optimization

There are no opportunities for optimization at LF-4 given that there are no operating remedial systems.

7.7.1.4 Early Indicators of Potential Issues

There are no potential issues identified for the LF-4 remedial action.

7.7.1.5 Implementation of Institutional Controls and Other Measures

See discussion of ICs and access control measures in Section 7.7.1.1.1.

7.7.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup levels, and the Remedial Action Objectives Used at the Time of Remedy Selection Still Valid?

7.7.2.1 Changes in Standards and To Be Considered Guidelines

The consolidation and capping of LF-4 was completed as a removal action. ARARs and TBCs related to site soil contamination are not relevant to the IC and LTM remedies assessed herein.

7.7.2.2 Changes in Exposure Pathways

There have been no changes in the potential exposure pathways at LF-4. The exposure pathways of concern, and those addressed by the SCOU ROD Part 3 remedies, are human exposure to residual soil contamination under the caps and groundwater contamination by leachate from the capped waste. The potential exposure pathway of vapor intrusion to future buildings from residual shallow VOCs that may be present at LF-4 is not an issue because human use of the site is restricted by ICs that were incorporated in the deed transferring the parcel containing LF-4 to Merced County and in the State Land Use Covenant that has been executed by the Air Force with the State of California.

7.7.2.3 Changes in Toxicity and Other Contaminant Characteristics

The LF-4 consolidation and capping was completed as a removal action. Toxicity and other contaminant characteristics are not relevant to the IC and LTM remedies addressed herein.

7.7.2.4 Changes in Risk Assessment Methods

The LF-4 consolidation and capping was completed as a removal action. Risk assessment methods are not relevant to the IC and LTM remedies addressed herein.

7.7.2.5 Expected Progress Towards Meeting Removal Action Objectives

Information presented in Section 7.7.1.1 documents that objectives of the IC and LTM remedies for LF-4 are being achieved. Site access is controlled and there has been no identifiable human access or use of the site during the period of this five-year review. Cap monitoring and maintenance is being performed quarterly and there have been no significant issues with the caps.

7.7.3 Question C: Has Any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

Based on information provided in this report, including the results of the cap maintenance and monitoring program, the post-closure groundwater monitoring program, the annual IC evaluations and the recent site inspection, no data or other information are identified that could call into question the protectiveness of the remedy for LF-4.

7.8 LANDFILL 5 REMEDIAL ACTION (INCLUDING DP-8, DP-8A AND LF-5 TRENCHES)

The SCOU ROD Part 3 remedy for LF-5 is:

- ICs, LTM and LTEM

As described in Section 4.2.2.6, a consolidation and capping removal action has been completed and IC, LTM and LTEM remedies have been implemented.

7.8.1 Question A: Is the Remedy Functioning as Intended by the Decision Document?

7.8.1.1 Remedial Action Performance

Remedial action performance is assessed in terms of the effectiveness of ICs and the results of LTM and LTEM. Information on the effectiveness of ICs is based on the nature of the controls in place, site conditions reported for the annual evaluation of site activities and conditions (since 2006) and site conditions observed during a recent site inspection. The results of LTM are based on cap inspection and monitoring conducted quarterly for LF-5, the results of post-closure groundwater monitoring conducted as part of the LTGSP and a recent site inspection. The results of LTEM are based on the wetlands invertebrate (fairy shrimp) and plant surveys conducted in the vicinity of LF-5 in February and March 2008, respectively.

7.8.1.1.1 Institutional Controls

LF-5 is located within the BoP United States Penitentiary, Atwater Complex and public access is, and will for the foreseeable future, be prohibited and controlled by prison security (fencing and guard patrols). In addition, the Air Force/BoP MOU precludes any site altering activities within the prison parcel, including LF-5, without notification of EPA, DTSC and the Air Force and the approval of such activities by the Air Force. No requests for site altering activities have been received to date by the Air Force for LF-5 or its vicinity.

In accordance with the *Closure and Post-Closure Maintenance Plan – Update 2* (AFRPA, 2006b), an annual evaluation of site activities and conditions has been conducted since 2006 as part of landfill inspection and monitoring activities. There were no issues with the annual IC evaluation of LF-5 during the 2006 or the 2007 monitoring period (MWH, 2007;

MWH, 2008). Further, no evidence of any regular site use, construction or other site altering activities was observed within LF-5 during a site inspection by on-site Air Force contractor personnel (Jacobs) on 10 June 2008.

7.8.1.1.2 Long-Term Maintenance and Monitoring

Quarterly inspections of the LF-5 cap were performed from 2003 through 2007. The results of these inspections are as follows:

2003: Access road in good condition; gates in good condition; minor repairs to fencing; no evidence of vandalism or unauthorized access; settlement monuments and gas vents in good condition; numerous small animal burrows in cap observed and baited; cap mowed in June; drainage channels in good working condition; monitoring probes and wells in good condition; cap periphery in good condition; no trash or evidence of unauthorized dumping (MWH, 2004b).

2004: Access road in good condition; minor repairs to gate; fencing in good condition; no evidence of vandalism or unauthorized access; settlement monuments and gas vents in good condition; minor settling in portion of cap observed but no repairs; cap mowed in April; drainage channels in good working condition; monitoring probes and wells in good condition; cap periphery in good condition; no trash or evidence of unauthorized dumping (MWH, 2004c).

2005: Access road in good condition; fencing and gates in good condition; signs were missing and replaced but no evidence of unauthorized access; settlement monuments and gas vents in good condition; minor animal burrowing observed but cap in good condition; cap mowed in May; heavy vegetation in drainage channels but no action required; monitoring probes and wells in good condition; cap periphery in good condition; no trash or evidence of unauthorized dumping (MWH, 2005b).

2006: Access road in good condition; fencing and gates in good condition; signs were missing and replaced but no evidence of unauthorized access; settlement monuments and gas vents in good condition; minor creep and depressions observed in cap but no repairs; cap mowed in May; 460 feet of drainage channel had cobble replaced and was regraded; monitoring probes and wells in good condition; cap periphery in good condition; no trash or evidence of unauthorized dumping (MWH, 2007b).

2007: Access road, fencing and gates in good condition; no evidence of vandalism or unauthorized access; settlement monuments and gas vents in good condition; 1,200 square feet of the cap was regraded to maintain proper drainage; cap mowed in June; 460 feet of drainage channel had cobbles replaced and was regraded; monitoring probes and wells in good condition; cap periphery in good condition; no trash or evidence of unauthorized dumping (MWH, 2008).

Semiannual post-closure groundwater monitoring for LF-5 (corrective action and detection monitoring) was performed from 2003 through 2007 (Q1 and Q3 in 2003, 2004 and 2005; Q2 and Q4 in 2006 and 2007). The significant results of these monitoring events are as follows:

2003: No evidence of a release from the caps warranting action (Jacobs, 2003c; Jacobs, 2004c).

2004: No evidence of a release from the caps warranting action (Jacobs, 2004d; Jacobs, 2005b).

2005: No evidence of a release from the caps warranting action (Jacobs, 2005c; Jacobs, 2006a).

2006: No evidence of a release from the caps warranting action (Jacobs, 2006c; Jacobs, 2007a).

2007: No evidence of a release from the caps warranting action (Jacobs, 2007b; Jacobs, 2008).

7.8.1.1.3 Long-Term Ecological Monitoring

Per the SCOU ROD Part 3, LTEM at LF-5, consisting of wetlands invertebrate (fairy shrimp) and plant (flora) surveys at selected vernal pools, is to be conducted every five years, in concert with five-year reviews, for up to 30 years unless the Air Force and the regulatory agencies agree during that period that further monitoring is not warranted. A survey of vernal pools potentially impacted by residual soil contamination at LF-5 and not-impacted background pools was conducted on 18 and 19 February 2008 (fairy shrimp) and 16 and 17 March 2008 (vernal pool flora). Survey procedures and results are presented in Appendix A. Results of the surveys indicate that, at a 95% confidence level and based on the Wilcoxon-Mann-Whitney tests, there is no evidence that fairy shrimp abundance, plant diversity or plant abundance (percent plant coverage) in the potentially impacted pools is statistically less than in the reference pools. Student's t tests and Satterthwait tests suggest a possible impact to shrimp abundance, plant diversity and plant abundance at LF-5 but these tests are probably not valid because the combined reference pool data are not normally distributed. Given these results, it is reasonable to state that there have been no identifiable effects from residual soil contamination at LF-5 on vernal pool fairy shrimp or plants.

7.8.1.2 Systems Operations/Operations and Maintenance

There are no operating remedial systems in place at LF-5. Maintenance of the LF-5 cap is discussed in Section 7.8.1.1.2.

7.8.1.3 Opportunities for Optimization

There are no opportunities for optimization at LF-5 given that there are no operating remedial systems.

7.8.1.4 Early Indicators of Potential Issues

There are no potential issues identified for the LF-5 remedial action.

7.8.1.5 Implementation of Institutional Controls and Other Measures

See discussion of ICs and access control measures in Section 7.8.1.1.1.

7.8.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup levels, and the Remedial Action Objectives Used at the Time of Remedy Selection Still Valid?

7.8.2.1 Changes in Standards and To Be Considered Guidelines

The consolidation and capping of LF-5 was completed as a removal action. ARARs and TBCs related to site soil contamination are not relevant to the IC and LTM remedies assessed herein.

7.8.2.2 Changes in Exposure Pathways

There have been no changes in the potential exposure pathways at LF-5. The exposure pathways of concern, and those addressed by the SCOU ROD Part 3 remedies, are human exposure to residual soil contamination under the cap and groundwater contamination by leachate from the capped waste. The potential exposure pathway of vapor intrusion to future buildings from residual shallow VOCs that may be present at LF-5 is not an issue because human use of the site is restricted by ICs that were incorporated in the Air Force/BoP MOU. The potential exposure pathway of vapor intrusion to future buildings adjacent to LF-5 is also not an issue. The Atwater prison was constructed in the central portion of the BoP parcel. The remainder of the parcel, including LF-5 and vicinity, constitutes a buffer area for the prison and is to remain open space. LF-5 is located along the northern boundary (fenceline) of the BoP parcel, but, given the nature of the facility, no buildings will ever be considered or allowed to be built near the fence defining prison property – either inside or outside of the fence. In addition, the Federal-to-Federal transfer letter requires the BoP to consult with the Air Force and the regulatory agencies if they plan to construct or operate any type of facility at/adjacent to LF-5.

7.8.2.3 Changes in Toxicity and Other Contaminant Characteristics

The LF-5 consolidation and capping was completed as a removal action. Toxicity and other contaminant characteristics are not relevant to the IC, LTM and LTEM remedies addressed herein.

7.8.2.4 Changes in Risk Assessment Methods

The LF-5 consolidation and capping was completed as a removal action. Risk assessment methods are not relevant to the IC, LTM and LTEM remedies addressed herein.

7.8.2.5 Expected Progress Towards Meeting Removal Action Objectives

Information presented in Section 7.8.1.1 documents that objectives for the IC and LTM remedies for LF-5 are being achieved. Site access is controlled and there has been no identifiable human access or use of the site during the period of this five-year review. Cap monitoring and maintenance is being performed quarterly and there have been no significant issues with the cap. The first ecological monitoring event was performed in early 2008 as required.

7.8.3 Question C: Has Any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

Based on information provided in this report, including the results of the cap maintenance and monitoring program, the post-closure groundwater monitoring program, the annual IC evaluations, the recent site inspection and the ecological monitoring program, no data or other information are identified that could call into question the protectiveness of the remedy for LF-5.

8 ISSUES

8.1 MAIN BASE PLUME REMEDIAL ACTION

The technical assessment identified the lack of active Shallow HSZ pump-and-treat remediation and plume capture in the former OU-1 area where TCE concentrations have rebounded to above MCL levels as a potential issue that could affect protectiveness of the Main Base Plume remedy in the future. At this time, the Air Force has chosen not to reinitiate Shallow HSZ pump-and-treat remediation because there is no evidence that contaminants are migrating downgradient, downgradient pumping from the underlying USS HSZ will provide capture if migration occurs, declining water levels in the Shallow HSZ severely limit the ability to reinitiate pump-and-treat and it would not be cost or technically effective to reinitiate pump-and-treat because of the relatively low TCE concentrations presently seen in this portion of the Shallow HSZ. In lieu of reinitiating pump-and-treat, the Air Force has chosen to continue monitoring, to rely on downgradient capture from the USS HSZ and to continue to evaluate and potentially implement other remedial options, if needed, to achieve cleanup to MCL levels.

Other than this issue, plume capture is almost complete and significant progress has been made in cleanup to the MCL for TCE. ICs to restrict groundwater use within plumes exceeding an MCL are in place and functioning and wellhead treatment has been successfully applied to protect against adverse impacts to drinking water wells and to address groundwater contamination exceeding MCLs within the off-base Confined HSZ plume. A screening level assessment determined that the cancer risk associated with potential vapor intrusion from the current levels of groundwater contamination in the Shallow HSZ is less than 1×10^{-6}.

8.2 CASTLE VISTA PLUME REMEDIAL ACTION

The technical assessment identified the lack of effectiveness of the MW003 wellhead treatment system in eliminating the small residual portion of the plume at MW003 as an issue for the Castle Vista Plume remedial action. That portion of the Castle Vista Plume has been captured but not cleaned up by wellhead treatment. In response to this issue, a pilot study work plan to implement ISCO at MW003 and vicinity has been prepared and approved by the regulatory agencies. Implementation of the pilot study will occur in the fall of 2008. Other than the MW003 area, the Castle Vista Plume has been cleaned up to the MCL for *cis*-1,2-DCE, ICs to restrict groundwater use within plumes exceeding an MCL are in place and functioning and procedures are in place to implement wellhead treatment or provide an alternative water supply, if needed, to protect against adverse impacts to public or private drinking water wells.

8.3 EARTH TECHNOLOGY CORPORATION 10 REMEDIAL ACTION

The technical assessment identified no issues for the ETC-10 remedial action. ICs are in place and functioning and LTEM was conducted in early 2008 as scheduled.

8.4 EARTH TECHNOLOGY CORPORATION 12 REMEDIAL ACTION

The technical assessment identified no issues for the ETC-12 remedial action. LTEM was conducted in early 2008 as scheduled.

8.5 FIRE TRAINING AREA 1 REMEDIAL ACTION

The technical assessment identified no issues for the FTA-1 remedial action. SVE/capping and E&D remedial actions have been completed while a BV remedial action was not necessary. ICs are in place and functioning, LTM is ongoing and LTEM was conducted in early 2008 as scheduled. Two LTGSP monitoring wells near FTA-1 (MW320 [grid M15] and MW886 [grid M14]) have recently had reported detections of TCE near or just above the MCL. This is not viewed as a significant issue but monitoring of the two wells will continue until TCE concentrations in both wells are below the MCL for two consecutive sampling events. If TCE concentrations increase, additional wells (downgradient) may be monitored and other appropriate actions will be assessed with the regulatory agencies.

8.6 LANDFILL 3 REMEDIAL ACTION

The technical assessment identified no issues for the LF-3 remedial action. LTEM was conducted in early 2008 as scheduled.

8.7 LANDFILL 4 (DP-5, DP-6) REMEDIAL ACTION

The technical assessment identified no issues for the LF-4 remedial action. ICs are in place and functioning and LTM is ongoing.

8.8 LANDFILL 5 (DP-8, DP-8A, LF-5 TRENCHES) REMEDIAL ACTION

The technical assessment identified no issues for the LF-5 remedial action. ICs are in place and functioning, LTM is ongoing and LTEM was conducted in early 2008 as scheduled.

9 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

9.1 MAIN BASE PLUME REMEDIAL ACTION

The lack of active Shallow HSZ pump-and-treat remediation and plume capture in the former OU-1 area where TCE concentrations have rebounded to above MCL levels is identified as a potential issue that could affect protectiveness of the Main Base Plume remedy in the future. To address this issue, the Air Force will perform an assessment of the feasibility of optimizing the existing remedy (pump-and-treat) or applying alternative technologies (e.g., ISCO) to address the remaining contamination in the Shallow HSZ. The assessment will be presented in the form of a Technical Memorandum appended to the 2009 or 2010 LTGSP Annual Report. If the Technical Memorandum recommends a change in the remedy and the regulatory agencies concur, the Air Force will prepare the necessary documentation (i.e., a ROD Amendment or an Explanation of Significant Difference) to change the remedy for this portion of the Main Base Plume. The deadline for this remedy change documentation will be the end of fiscal year 2011.

In response to concerns expressed by the regulatory agencies, it is recommended that a focused round of groundwater sampling for 1,4-dioxane be conducted. This compound, an emerging chemical of concern, has been detected at several sites in the Central Valley of California but the groundwater at Castle Airport has never been tested for this chemical. The Air Force will conduct a round of sampling for 1,4-dioxane as part of the LTGSP Q1/09 sampling event. All treatment plant influents and effluents and selected monitoring wells will be sampled.

9.2 CASTLE VISTA PLUME REMEDIAL ACTION

One issue was identified during the technical assessment of the Castle Vista Plume remedial action (plume capture and cleanup to MCLs; ICs; wellhead treatment or alternative water supply to protect public and private drinking water wells). Pump-and-treat remediation (i.e., the MW003 wellhead treatment system) has proven to be an ineffective technology for elimination of the small residual plume centered on MW003. This is delaying the ultimate closure of the Castle Vista Plume remedial action (see Section 7.2.1.4). The Air Force's recommended action is an alternative remedial technology. Alternative remedial approaches have been evaluated and a work plan for conducting an ISCO pilot study at MW003 has been reviewed and approved by the regulatory agencies. Air Force implementation of the pilot study was scheduled for the fall of 2008 but has been delayed due to the need to conduct additional site characterization. The deadline for completion of the pilot study is now 30 September 2009.

9.3 EARTH TECHNOLOGY CORPORATION 10 REMEDIAL ACTION

No issues were identified during the technical assessment of the ETC-10 remedial action (ICs and LTEM) and, therefore, there are no recommended changes to the remedy. Based on the results of the statistical evaluation of the ecological monitoring data for ETC-10 and the other LTEM sites there is no evidence that soil contamination has impacted shrimp abundance, plant diversity or plant abundance. However, it is recommended that one additional round of LTEM be conducted by the Air Force at an appropriate time during the next five years (a year with average or above winter precipitation) to further confirm that there are no ecological impacts.

9.4 EARTH TECHNOLOGY CORPORATION 12 REMEDIAL ACTION

No issues were identified during the technical assessment of the ETC-12 remedial action (LTEM) and, therefore, there are no recommended changes to the remedy. Based on the results of the statistical evaluation of the ecological monitoring data for ETC-12 and the other LTEM sites there is no evidence that soil contamination has impacted shrimp abundance, plant diversity or plant abundance. However, it is recommended that one additional round of LTEM be conducted at an appropriate time during the next five years (a year with average or above winter precipitation) to further confirm that there are no ecological impacts.

9.5 FIRE TRAINING AREA 1 REMEDIAL ACTION

No issues were identified during the technical assessment of the FTA-1 remedial action (SVE, BV, E&D, ICs, LTM and LTEM) and, therefore, there are no recommended changes to the remedy. Continued sampling of the two monitoring wells with recent TCE detections near or above the MCL is recommended. Based on the results of the statistical evaluation of the ecological monitoring data for FTA-1 and the other LTEM sites there is no evidence that soil contamination has impacted shrimp abundance, plant diversity or plant abundance. However, it is recommended that one additional round of LTEM be conducted by the Air Force at an appropriate time during the next five years (a year with average or above winter precipitation) to further confirm that there are no ecological impacts.

9.6 LANDFILL 3 REMEDIAL ACTION

No issues were identified during the technical assessment of the LF-3 remedial action (LTEM) and, therefore, there are no recommended changes to the remedy. Based on the results of the statistical evaluation of the ecological monitoring data for LF-3 and the other LTEM sites there is no evidence that soil contamination has impacted shrimp abundance, plant diversity or plant abundance. However, it is recommended that one additional round of LTEM be conducted by the Air Force at an appropriate time during the next five years (a year with average or above winter precipitation) to further confirm that there are no ecological impacts.

9.7 LANDFILL 4 (DP-5, DP-6) REMEDIAL ACTION

No issues were identified during the technical assessment of the LF-4 remedial action (ICs and LTM) and, therefore, there are no recommended changes to the remedy.

9.8 LANDFILL 5 (DP-8, DP-8A, LF-5 TRENCHES) REMEDIAL ACTION

No issues were identified during the technical assessment of the LF-5 remedial action (ICs, LTM and LTEM) and, therefore, there are no recommended changes to the remedy. Based on the results of the statistical evaluation of the ecological monitoring data for LF-5 and the other LTEM sites there is no evidence that soil contamination has impacted shrimp abundance, plant diversity or plant abundance. However, it is recommended that one additional round of LTEM be conducted by the Air Force at an appropriate time during the next five years (a year with average or above winter precipitation) to further confirm that there are no ecological impacts.

10 PROTECTIVENESS STATEMENTS

10.1 MAIN BASE PLUME REMEDIAL ACTION

The remedial action implemented for the Main Base Plume is protective of human health and the environment. The remedy is functioning as designed (plume control and reduction), expected progress has been made towards achieving MCL cleanup levels, all components of the remedy are being operated in a safe and proper manner and have been optimized to the extent practical (OU-1 treatment plant and MW883/MW1021, MW941, and MW1009 wellhead treatment systems have been shut down). ICs to restrict use of groundwater exceeding MCLs are in place, are effective, and regular IC monitoring is being conducted. There have been no changes in criteria, standards or methods which affect the protectiveness of the remedy and no other information has been identified that would affect protectiveness. A screening level assessment determined that the cancer risk associated with potential vapor intrusion from the current levels of groundwater contamination in the Shallow HSZ is less than $1x10^{-6}$.

The technical assessment identified the lack of active Shallow HSZ pump-and-treat remediation and plume capture in the former OU-1 area where TCE concentrations have rebounded to above MCL levels as a potential issue. To address this issue, the Air Force will perform an assessment of the feasibility of optimizing the existing remedy (pump-and-treat) or applying alternative technologies (e.g., ISCO) to address the remaining contamination in the Shallow HSZ. The assessment will be presented in the form of a Technical Memorandum appended to the 2009 or 2010 LTGSP Annual Report. If the Technical Memorandum recommends a change in the remedy and the regulatory agencies concur, the Air Force will prepare the necessary documentation (i.e., a ROD Amendment or an Explanation of Significant Difference) to change the remedy for this portion of the Main Base Plume. The deadline for this remedy change documentation will be the end of fiscal year 2011.

10.2 CASTLE VISTA PLUME REMEDIAL ACTION

The remedial action implemented for the Castle Vista Plume is protective of human health and the environment. The remedy is functioning as designed (plume control and reduction), expected progress has been made towards achieving MCL cleanup levels, all components of the remedy are being operated in a safe and proper manner and have been optimized to the extent practical (Castle Vista treatment plant shut down). ICs to restrict use of groundwater exceeding MCLs are in place, are effective, and regular IC monitoring is being conducted. There have been no changes in criteria, standards or methods which affect the protectiveness of the remedy and no other information has been identified that would affect protectiveness.

The lack of effectiveness of the MW003 wellhead treatment system in eliminating the small residual portion of the Castle Vista Plume was identified as an issue. In response to this issue, a pilot study work plan to implement in-situ chemical oxidation (ISCO) at MW003 and vicinity has been prepared and approved by the regulatory agencies. Implementation of the pilot study was scheduled for the fall of 2008 but has been delayed due to the need to conduct additional site characterization. The deadline for completion of the pilot study is now 30 September 2009.

10.3 EARTH TECHNOLOGY CORPORATION 10 REMEDIAL ACTION

The remedial actions implemented for ETC-10 are protective of human health and the environment. The remedies are functioning as designed (access restricted and ecological monitoring conducted), there are no issues and no other information has been identified that would affect protectiveness. ICs to restrict site access and alteration are in place and maintained as part of the Air Force/BoP MOU. Ecological surveys of background (not impacted) and potentially impacted vernal pools at and in the vicinity of ETC-10 were conducted in the spring of 2008. Results of the surveys show no evidence that fairy shrimp abundance, plant diversity or plant abundance is statistically less (95% confidence level) in potentially impacted pools than in background pools.

10.4 EARTH TECHNOLOGY CORPORATION 12 REMEDIAL ACTION

The remedial action implemented for ETC-12 is protective of human health and the environment. The remedy is functioning as designed (ecological monitoring conducted), there are no issues and no other information has been identified that would affect protectiveness. Ecological surveys of background (not impacted) and potentially impacted vernal pools at and in the vicinity of ETC-12 were conducted in the spring of 2008. Results of the surveys show no evidence that fairy shrimp abundance, plant diversity or plant abundance is statistically less (95% confidence level) in potentially impacted pools than in background pools.

10.5 FIRE TRAINING AREA 1 REMEDIAL ACTION

The remedial actions implemented for FTA-1 are protective of human health and the environment. The ongoing remedies are functioning as designed (access restricted, cap maintenance and monitoring active and ecological monitoring conducted), there are no issues and no other information has been identified that would affect protectiveness. ICs to restrict site access and alteration are in place and maintained as part of the Air Force/BoP MOU. Maintenance and monitoring of the cap, including reporting of any evidence of human access or alteration, is being conducted quarterly. Ecological surveys of background (not impacted) and potentially impacted vernal pools at and in the vicinity of FTA-1 were conducted in the spring of 2008. Results of the surveys show no evidence that fairy shrimp abundance, plant diversity or plant abundance is statistically less (95% confidence level) in potentially impacted pools than in background pools. Although not an issue for the FTA-1 remedies, continued sampling of the two monitoring wells at FTA-1 with recent TCE detections near or above the MCL is recommended.

10.6 LANDFILL 3 REMEDIAL ACTION

The remedial action implemented for LF-3 is protective of human health and the environment. The remedy is functioning as designed (ecological monitoring conducted), there are no issues and no other information has been identified that would affect protectiveness. Ecological surveys of background (not impacted) and potentially impacted vernal pools at and in the vicinity of LF-3 were conducted in the spring of 2008. Results of the surveys show no evidence that fairy shrimp abundance, plant diversity or plant abundance is statistically less (95% confidence level) in potentially impacted pools than in background pools.

10.7 LANDFILL 4 (DP-5, DP-6) REMEDIAL ACTION

The remedial actions implemented for LF-4/DP-5/DP-6 are protective of human health and the environment. The ongoing remedies are functioning as designed (access restricted, cap maintenance and monitoring active), there are no issues and no other information has been identified that would affect protectiveness. ICs to restrict site access and alteration are in place as part of the deed transferring the parcel containing LF-4 to Merced County and a State Land Use Covenant executed by the Air Force and the State of California. Maintenance and monitoring of the cap and its ancillary facilities, including reporting of any evidence of human access or alteration, is being conducted quarterly.

10.8 LANDFILL 5 (DP-8, DP-8A, LF-5 TRENCHES) REMEDIAL ACTION

The remedial actions implemented for LF-5/DP-8/DP-8A/LF-5 Trenches are protective of human health and the environment. The ongoing remedies are functioning as designed (access restricted, cap maintenance and monitoring active and ecological monitoring conducted), there are no issues and no other information has been identified that would affect protectiveness. ICs to restrict site access and alteration are in place and maintained as part of the Air Force/BoP MOU. Maintenance and monitoring of the cap and its ancillary facilities, including reporting of any evidence of human access or alteration, is being conducted quarterly. Ecological surveys of background (not impacted) and potentially impacted vernal pools at and in the vicinity of LF-5 were conducted in the spring of 2008. Results of the surveys show no evidence that fairy shrimp abundance, plant diversity or plant abundance is statistically less (95% confidence level) in potentially impacted pools than in background pools.

11 NEXT REVIEW

The first five-year review for Castle Airport was finalized in September 1999. The second five-year review was finalized in January 2004. This five-year review is to be completed by January 2009. The next five-year review will be scheduled for completion by January 2014.

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TABLES

Table 1-1
SCOU Sites and Rationale for Exclusion from Technical Evaluation
(Bold Sites Included in Technical Evaluation)

	Site	IRP Number	Grid Location	Linked Sites or Group	Selected Remedy or Preferred Alternative	ROD	Rationale for Exclusion
1	B23	SS049	P10		NFA	SCOU-1	Site is NFA (no action was required)
2	B47	SS050	R11		NFA	SCOU-1	Site is NFA (no action was required)
3	B51	SS051	R11	B51 Group	SVE	SCOU-2	Site is NFA (SVE remedial action completed)
4	B52	SS052	R11	B51 Group	SVE	SCOU-2	Site is NFA (SVE remedial action completed)
5	B53	SS053	R12	B51 Group	SVE	SCOU-2	Site is NFA (SVE remedial action completed)
6	B54	SS054	R12	B54 Group	SVE	SCOU-2	Site is NFA (SVE remedial action completed)
7	B59	SS056	S12	PFFA Group	PHO	SCOU-1	Non-CERCLA Site
8	B79	SS060	S12	PFFA Group	PHO	SCOU-1	Non-CERCLA Site
9	B84	SS061	R11	ST-T85, SWMU 4.25	NFA	SCOU-1	Site is NFA (no action was required)
10	B175	SS063	P10	SWMU 4.7; 4.8	PHO	SCOU-1	Non-CERCLA Site
11	B325	SS064	R11	SWMU 4.9, 4.10, 4.11, 4.35	PHO	SCOU-1	Non-CERCLA Site
12	B508	SS065	S12	PFFA Group	PHO	SCOU-1	Non-CERCLA Site
13	B541	SS066	S10		NFA	SCOU-1	Site is NFA (no action was required)
14	B545	SS067	S10	B547	NFA	SCOU-1	Site is NFA (no action was required)
15	B547	SS068	S10	B545	NFA	SCOU-1	Site is NFA (no action was required)
16	B551	SS069	S11	SWMU 4.14	PHO	SCOU-1	Non-CERCLA Site
17	B871	SS070	T11		NFA	SCOU-1	Site is NFA (E&D removal action completed)
18	B909	SS071	S12	PFFA Group	PHO	SCOU-1	Non-CERCLA Site
19	B917	SS072	S12	PFFA Group	PHO	SCOU-1	Non-CERCLA Site
20	B950	SS102	T13	DA-1/TCC-1; B951	PHO	SCOU-1	Non-CERCLA Site
21	B951	SS103	T13	DA-1/TCC-1; B950	PHO	SCOU-1	Non-CERCLA Site
22	B1182	SS073	Q8	SWMU 4.24	NFA	SCOU-1	Site is NFA (no action was required)
23	B1204	SS109	M8	B1205	NFA	SCOU-1	Site is NFA (no action was required)
24	B1205	SS075	M8	B1204, ST-1206	NFA	SCOU-1	Site is NFA (no action was required)
25	B1207	SS077	M8		NFA	SCOU-1	Site is NFA (no action was required)
26	B1253	SS078	R12	B51 Group	SVE	SCOU-2	Site is NFA (SVE remedial action completed)
27	B1260	SS079	R12	B54 Group	SVE	SCOU-2	Site is NFA (SVE remedial action completed)
28	B1266	SS080	S12	B54 Group	SVE	SCOU-2	Site is NFA (SVE remedial action completed)
29	B1314	SS110	K8	DA-4	SVE/E&D	SCOU-2	Site is NFA (SVE/E&D remedial action completed)
30	B1319	SS111	L9	SWMU 4.34	NFA	SCOU-1	Site is NFA (no action was required)
31	B1324	SS081	N10	SWMU 4.19, 4.36	PHO	SCOU-1	Non-CERCLA Site
32	B1325/HWS-3	SS082	N10	STA-36; STA-37	PHO	SCOU-1	Non-CERCLA Site

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SCOU Sites and Rationale for Exclusion from Technical Evaluation
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	Site	IRP Number	Grid Location	Linked Sites or Group	Selected Remedy or Preferred Alternative	ROD	Rationale for Exclusion
33	B1335	SS083	P11		NFA	SCOU-1	Site is NFA (no action was required)
34	B1344	SS085	P11		NFA	SCOU-1	Site is NFA (E&D removal action completed)
35	B1350	SS086	Q12	SWMU 4.31	SVE	SCOU-2	Site is NFA (SVE remedial action completed)
36	B1404	SS113	L10	STA-19	NFA	SCOU-1	Site is NFA (no action was required)
37	B1405	SS114	L10		NFA	SCOU-1	Site is NFA (no action was required)
38	B1529	SS087	Q12	DA-5 Group	NFA	SCOU-1	Site is NFA (no action was required)
39	B1532	SS088	R12	SWMU 4.32	NFA	SCOU-2	Site is NFA (no action was required)
40	B1541	SS089	Q13	SWMU 4.23	NFA	SCOU-2	Site is NFA (E&D removal action completed)
41	B1550	SS090	R13	DA-8; SS-6; SS-7	NFA	SCOU-1	Site is NFA (SVE removal action completed)
42	B1560	SS091	Q14		PHO	SCOU-1	Non-CERCLA Site
43	B1562	SS092	R13		NFA	SCOU-1	Site is NFA (no action was required)
44	B1709	SS116	L13		SVE	SCOU-2	Site is NFA (SVE remedial action completed)
45	B1762	SS117	K13		SVE	SCOU-2	Site is NFA (SVE remedial action completed)
46	B1865/1868	SS105	K14		PHO	SCOU-1	Non-CERCLA Site
47	CVLF-A	LF034	W5		NFA	SCOU-1	Site is NFA (E&D removal action completed)
48	CVLF-B	LF034	U4		NFA	SCOU-1	Site is NFA (E&D/SVE removal action completed)
49	DA-1/TCC-1	SD009	T13	B950; B951	PHO	SCOU-1	Non-CERCLA Site
50	DA-2	SD010	M10		NFA	SCOU-1	Site is NFA (E&D removal action completed)
51	DA-3	SD011	T11	SA-B1	NFA	SCOU-1	Site is NFA (E&D removal action completed)
52	DA-4	SD012	K8	B1314	SVE/E&D	SCOU-2	Site is NFA (SVE/E&D remedial action completed)
53	DA-5	SD013	Q13	B1529, and SWMUs 4.1, 4.20, 4.21, 4.3 and 4.38	SVE/E&D/BV	SCOU-2	Site is NFA (SVE remedial action completed; no E&D and BV); ICs placed on the site due to non-CERCLA residual contaminants
54	DA-6	SD014	T12		PHO	SCOU-1	Non-CERCLA Site
55	DA-7	SD015	S12	PFFA Group	PHO	SCOU-1	Non-CERCLA Site
56	DA-8	SD016	R13	B1550, SS-6, SS-7 and SWMU 4.33	NFA	SCOU-1	Site is NFA (SVE removal action completed)
57	DBF	SS115	H14	SWMU 4.28	NFA	SCOU-1	Site is NFA (no action was required)
58	DP-1	DP099	V13	LF-1	NFA	SCOU-1	Site is NFA (E&D removal action completed)
59	DP-2	DP100	U13	LF-1	NFA	SCOU-1	Site is NFA (no action was required)
60	DP-3	DP101	U13	LF-1	NFA	SCOU-1	Site is NFA (E&D removal action completed)
61	DP-4A/4B	DP028	T13/1		NFA	SCOU-1	Site is NFA (no action was required)
62	**DP-5**	**DP106**	**H6**	**LF-4**	**LTM/IC**	**SCOU-3**	**Site included in technical evaluation (LTM and ICs)**
63	**DP-6**	**DP107**	**H6**	**LF-4**	**LTM/IC**	**SCOU-3**	**Site included in technical evaluation (LTM and ICs)**

Table 1-1
SCOU Sites and Rationale for Exclusion from Technical Evaluation
(Bold Sites Included in Technical Evaluation)

	Site	IRP Number	Grid Location	Linked Sites or Group	Selected Remedy or Preferred Alternative	ROD	Rationale for Exclusion
64	DP-7	DP094	F10	LF-5	NFA	SCOU-1	Site is NFA (no action was required)
65	**DP-8**	**DP095**	**E11**	**LF-5**	**LTM/IC/LTEM**	**SCOU-3**	**Site included in technical evaluation (LTM, ICs and LTEM)**
66	**DP-8A**	**DP096**	**E11**	**LF-5**	**LTM/IC/LTEM**	**SCOU-3**	**Site included in technical evaluation (LTM, ICs and LTEM)**
67	DP-9	DP097	E12	LF-5	NFA	SCOU-3	Site is NFA (no action was required)
68	DP-10	DP098	G12	LF-5	NFA	SCOU-1	Site is NFA (no action was required)
69	ETC-2	SS182	T13		NFA	SCOU-1	Site is NFA (E&D removal action completed)
70	ETC-3	SS183	S13		NFA	SCOU-1	Site is NFA (no action was required)
71	ETC-4	SS184	S12	ST-T61/HWS-1	PHO	SCOU-1	Non-CERCLA Site
72	ETC-5	SS185	S12	B54 Group	SVE	SCOU-2	Site is NFA (SVE remedial action completed)
73	ETC-6	SS186	R10		NFA	SCOU-1	Site is NFA (no action was required)
74	ETC-7	SS187	P9		NFA	SCOU-1	Site is NFA (no action was required)
75	ETC-8	SS188	N9		E&D	SCOU-3	Site is NFA (E&D remedial action completed)
76	**ETC-10**	**SS189**	**L16**		**IC/LTEM**	**SCOU-3**	**Site included in technical evaluation (ICs and LTEM)**
77	ETC-11	WP190	J16		NFA	SCOU-1	Site is NFA (no action was required)
78	**ETC-12**	**WP191**	**H15**	**ETC-13**	**NFA/LTEM**	**SCOU-1/SCOU-3**	**Site included in technical evaluation (LTEM)**
79	ETC-13	WP192	G12	ETC-12	NFA	SCOU-1	Site is NFA (no action was required)
80	F-1	SS166	L10	F1/2/3	NFA	SCOU-1	Site is NFA (no action was required)
81	F-2	SS167	M10	F1/2/3	NFA	SCOU-1	Site is NFA (no action was required)
82	F-3	SS168	M10	F1/2/3	NFA	SCOU-1	Site is NFA (no action was required)
83	F-4	SS169	Q11	F-5, F-6	SVE	SCOU-2	Site is NFA (SVE pilot test sufficient for closure)
84	F-5	SS170	Q11	F4/5/6	NFA	SCOU-1	Site is NFA (no action was required)
85	F-6	SS171	P12	F4/5/6	NFA	SCOU-1	Site is NFA (no action was required)
86	FR	SS104	L16		NFA	SCOU-1	Site is NFA (E&D removal action completed)
87	FS-1	SS017	L11	STA-24	PHO	SCOU-1	Non-CERCLA Site
88	FS-2	SS018	K9		PHO	SCOU-1	Non-CERCLA Site
89	FS-3	SS112	H8		PHO	SCOU-1	Non-CERCLA Site
90	FS-4	SS019	L10		PHO	SCOU-1	Non-CERCLA Site
91	**FTA-1**	**FT001**	**L15**		**SVE/BV/LTM/ IC/E&D/LTEM**	**SCOU-3**	**SVE and E&D remedial actions complete; BV not necessary; site included in technical evaluation for LTM, ICs and LTEM**
92	FTA-2	FT002	J7		NFA	SCOU-1	Site is NFA (no action was required)
93	FTA-3	FT003	K8		PHO	SCOU-1	Non-CERCLA Site

Table 1-1
SCOU Sites and Rationale for Exclusion from Technical Evaluation
(Bold Sites Included in Technical Evaluation)

	Site	IRP Number	Grid Location	Linked Sites or Group	Selected Remedy or Preferred Alternative	ROD	Rationale for Exclusion
94	H-1				NFA	SCOU-1	Site is NFA (no action was required)
95	H-2				NFA	SCOU-1	Site is NFA (no action was required)
96	H-3				NFA	SCOU-1	Site is NFA (no action was required)
97	H-4		R10	UFL-1	PHO	SCOU-1	Non-CERCLA Site
98	HWS-4	SS108	K8	SWMU 4.2	NFA	SCOU-1	Site is NFA (no action was required)
99	IWL	ST044	BWS	SWMU 4.37	NFA	SCOU-1	Site is NFA (no action was required)
100	JP4 Fuel Line	ST035	H7, M		PHO	SCOU-1	Non-CERCLA Site
101	JP7				PHO	SCOU-1	Non-CERCLA Site
102	LF-1	LF004	U13	DP-1, DP-2 and DP-3	NFA	SCOU-1	Site is NFA (E&D removal action completed)
103	LF-2	LF005	S14/T		NFA	SCOU-1	Site is NFA (E&D removal action completed)
104	**LF-3**	**LF006**	**K16**		**NFA/LTEM**	**SCOU-1/SCOU-3**	**Site included in technical evaluation (LTEM)**
105	**LF-4**	**LF007**	**G6**	**DP-5 and DP-6**	**LTM/IC**	**SCOU-3**	**Site included in technical evaluation (LTM and ICs)**
106	**LF-5**	**LF008**	**E&F 1**	**DP-7, DP-8, DP-8A, DP-9 and DP-10**	**LTM/IC/LTEM**	**SCOU-3**	**Site included in technical evaluation (LTM, ICs and LTEM)**
107	**LF-5 Trenches**		**F11/1**	**LF-5**	**LTM/IC/LTEM**	**SCOU-3**	**Site included in technical evaluation (LTM, ICs and LTEM)**
108	LG-1	WP172			NFA	SCOU-1	Site is NFA (no action was required)
109-117	N-2 through N-10	SD137-SD181			NFA	SCOU-1	Site is NFA (no action was required)
118	PCB-1,2,3	SS022	M8	HWS-6	NFA	SCOU-1	Site is NFA (no action was required)
119	PCB-4	SS023	S11		NFA	SCOU-2	Site is NFA (E&D removal action completed)
120	PCB-5	SS024	R10		NFA	SCOU-2	Site is NFA (E&D removal action completed)
121	PCB-6	SS025	T11		NFA	SCOU-2	Site is NFA (no action was required)
122	PCB-7	SS026	L16		NFA	SCOU-1	Site is NFA (no action was required)
123	PCB-8	SS027	R11		NFA	SCOU-1	Site is NFA (no action was required)
124	PCB-9	SS048	N9		NFA	SCOU-1	Site is NFA (E&D removal action completed)
125	PFFA	SS033	S12	PFFA Group	PHO	SCOU-1	Non-CERCLA Site
126	SA-B1	SS162	T11	DA-3	NFA	SCOU-1	Site is NFA (no action was required)
127	SA-B2	SS163	T13	SA B Group	NFA	SCOU-1	Site is NFA (no action was required)
128	SA-B3	SS164	R12	B54 Group	SVE	SCOU-2	Site is NFA (SVE remedial action completed)
129	SA-B4	SS165	P12	SA B Group	NFA	SCOU-1	Site is NFA (no action was required)
130	SDS	SD045	BWS		NFA	SCOU-1	Site is NFA (no action was required)
131	SS-1	WP036	Q10		NFA	SCOU-1	Site is NFA (no action was required)
132	SS-2	WP037	Q10		SVE	SCOU-2	Site is NFA (SVE remedial action completed)

Table 1-1
SCOU Sites and Rationale for Exclusion from Technical Evaluation
(Bold Sites Included in Technical Evaluation)

	Site	IRP Number	Grid Location	Linked Sites or Group	Selected Remedy or Preferred Alternative	ROD	Rationale for Exclusion
133	SS-3	WP038	Q12		NFA	SCOU-1	Site is NFA (no action was required)
134	SS-4	WP039	R12		SVE	SCOU-2	Site is NFA (SVE remedial action completed; B51/B54 Group)
135	SS-5	WP040	R13		NFA	SCOU-1	Site is NFA (no action was required)
136	SS-6	WP041	R13	DA-8; SS-7; B1550	NFA	SCOU-1	Site is NFA (SVE removal action completed)
137	SS-7	WP042	R13	B1550; DA-8; SS-6	NFA	SCOU-1	Site is NFA (SVE removal action completed)
138	SS-8	WP043	S12	PFFA	PHO	SCOU-1	Non-CERCLA Site
139	SS-9		Q11		NFA	SCOU-1	Site is NFA (no action was required)
140	ST-1201		M8		NFA	SCOU-1	Site is NFA (no action was required)
141	ST-1206		M8	B1205	NFA	SCOU-1	Site is NFA (no action was required)
142	ST-1571	SS093	R14	SWMU 4.22	NFA	SCOU-1	Site is NFA (no action was required)
143	ST-55	SS055	R12	B54 Group	SVE	SCOU-2	Site is NFA (SVE remedial action completed)
144	STA-1	SS118	H8	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
145	STA-2	SS119	H7	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
146	STA-3	SS120	H8	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
147	STA-4	SS121	J7	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
148	STA-5	SS122	J8	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
149	STA-6	SS123	J8	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
150	STA-7	SS124	J8	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
151	STA-8	SS125	J8	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
152	STA-9	SS126	J9	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
153	STA-10	SS127	J8	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
154	STA-11	SS128	J9	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
155	STA-12	SS129	K8	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
156	STA-13	SS130	K9	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
157	STA-14	SS131	K9	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
158	STA-15	SS132	K9	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
159	STA-16	SS133	K9	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
160	STA-17	SS134	K9	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
161	STA-18	SS135	K9	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
162	STA-19	SS136	K10	B1404	NFA	SCOU-1	Site is NFA (no action was required)
163	STA-20	SS137	L9	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
164	STA-21	SS138	L9	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)

Table 1-1
SCOU Sites and Rationale for Exclusion from Technical Evaluation
(Bold Sites Included in Technical Evaluation)

	Site	IRP Number	Grid Location	Linked Sites or Group	Selected Remedy or Preferred Alternative	ROD	Rationale for Exclusion
165	STA-22	SS139	L10	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
166	STA-23	SS140	L10	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
167	STA-24	SS141	L10	FS-1	NFA	SCOU-1	Site is NFA (no action was required)
168	STA-25	SS142	L10	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
169	STA-26	SS143	L10	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
170	STA-27	SS144	M10	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
171	STA-28	SS145	M11	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
172	STA-29	SS146	M10	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
173	STA-30	SS147	M11	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
174	STA-31	SS148	M10	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
175	STA-32	SS149	M11	STA-11/41	NFA	SCOU-1	Site is NFA (no action was required)
176	STA-33	SS150	N11	STA-11/41	Exclusion	SCOU-2	CERCLA Exclusion Site
177	STA-34	SS151	MB	STA-11/41	Exclusion	SCOU-2	CERCLA Exclusion Site
178	STA-35	SS152	MB	STA-11/41	Exclusion	SCOU-2	CERCLA Exclusion Site
179	STA-36	SS153	N10	B1325	Exclusion	SCOU-2	CERCLA Exclusion Site
180	STA-37	SS154	N10	B1325	Exclusion	SCOU-2	CERCLA Exclusion Site
181	STA-38	SS155	N10	STA-11/41	Exclusion	SCOU-2	CERCLA Exclusion Site
182	STA-39	SS156	N12	STA-11/41	Exclusion	SCOU-2	CERCLA Exclusion Site
183	STA-40	SS157	N12	STA-11/41	Exclusion	SCOU-2	CERCLA Exclusion Site
184	STA-41	SS158	P12	STA-11/41	Exclusion	SCOU-2	CERCLA Exclusion Site
185	STA-42	SS159	P12	STA-11/41	Exclusion	SCOU-2	CERCLA Exclusion Site
186	STA-43	SS160	P13	STA-11/41	Exclusion	SCOU-2	CERCLA Exclusion Site
187	STA-44	SS161	F8	STA-11/41	Exclusion	SCOU-2	CERCLA Exclusion Site
188	ST-T66	ST058	R12	B54 Group	SVE	SCOU-2	Site is NFA (SVE remedial action completed)
189	ST-T67	SS059	R12	B54 Group	SVE	SCOU-2	Site is NFA (SVE remedial action completed)
190	ST-T85	SS062	R11	B84	NFA	SCOU-1	Site is NFA (no action was required)
191	ST-T61/HWS-1	SS057	S12	ETC-4	PHO	SCOU-1	Non-CERCLA Site
192	SWMU 4.1	SD193	Q13	DA-5	NFA	SCOU-1	Site is NFA (no action was required)
193	SWMU 4.2	SD194	K8	HWS-4	NFA	SCOU-1	Site is NFA (no action was required)
194	SWMU 4.3	SD195	Q13	DA-5	E&D/BV	SCOU-2	Site is NFA (E&D remedial action completed; BV not necessary)
195	SWMU 4.4	SD196	S12	PFFA Group	E&D	SCOU-2	Site is NFA (E&D remedial action completed)
196	SWMU 4.5	SD197	S12	PFFA Group	NFA	SCOU-2	Site is NFA (E&D removal action completed)

Table 1-1
SCOU Sites and Rationale for Exclusion from Technical Evaluation
(Bold Sites Included in Technical Evaluation)

	Site	IRP Number	Grid Location	Linked Sites or Group	Selected Remedy or Preferred Alternative	ROD	Rationale for Exclusion
197	SWMU 4.6	SD198	S12	ETC-5	E&D	SCOU-2	Site is NFA (E&D remedial action completed)
198	SWMU 4.7	SD199	P10	B175	NFA	SCOU-2	Site is NFA (E&D removal action completed)
199	SWMU 4.8	SD200	P10	B175	NFA	SCOU-2	Site is NFA (E&D removal action completed)
200	SWMU 4.9	SD201	R11	B325	NFA	SCOU-1	Site is NFA (no action was required)
201	SWMU 4.10	SD202	R11	B325	NFA	SCOU-1	Site is NFA (no action was required)
202	SWMU 4.11	SD203	R11	B325	NFA	SCOU-1	Site is NFA (no action was required)
203	SWMU 4.12	SD204	S12		NFA	SCOU-1	Site is NFA (no action was required)
204	SWMU 4.13	SD205	S12	PFFA Group	NFA	SCOU-1	Site is NFA (no action was required)
205	SWMU 4.14	SD206	S11	B551	NFA	SCOU-2	Site is NFA (E&D removal action completed)
206	SWMU 4.15	SD207	S12	PFFA Group	NFA	SCOU-2	Site is NFA (no action was required)
207	SWMU 4.16	SD208	S13		E&D	SCOU-2	Site is NFA (E&D remedial action completed)
208	SWMU 4.17	SD209	R12	B54 Group	NFA	SCOU-2	Site is NFA (no action was required)
209	SWMU 4.18	SD210	R12	B54 Group	NFA	SCOU-2	Site is NFA (no action was required)
210	SWMU 4.19	SD211	N10	B1324	NFA	SCOU-1	Site is NFA (no action was required)
211	SWMU 4.20	SD212	Q13	DA-5	NFA	SCOU-1	Site is NFA (no action was required)
212	SWMU 4.21	SD213	Q12	DA-5	E&D/BV	SCOU-2	Site is NFA (E&D remedial action completed; SVE/BV not necessary)
213	SWMU 4.22	SD214	R14	ST-1571	E&D	SCOU-2	Site is NFA (E&D remedial action completed)
214	SWMU 4.23	SD215	Q13	B1541	NFA	SCOU-2	Site is NFA (E&D removal action completed)
215	SWMU 4.24	SD216	Q8	B1182	NFA	SCOU-1	Site is NFA (no action was required)
216	SWMU 4.25	SD217	Q8	B84	NFA	SCOU-1	Site is NFA (no action was required)
217	SWMU 4.26	SD218	R12	B51 Group	NFA	SCOU-1	Site is NFA (no action was required)
218	SWMU 4.27	SD219	R12	B51 Group	NFA	SCOU-1	Site is NFA (no action was required)
219	SWMU 4.28	SD220	H14	DBF	NFA	SCOU-1	Site is NFA (no action was required)
220	SWMU 4.29	SD221	R12	B54 Group	NFA	SCOU-2	Site is NFA (no action was required)
221	SWMU 4.30	SD222	R12	B51 Group	NFA	SCOU-1	Site is NFA (no action was required)
222	SWMU 4.31	SD223	Q12	B1350	NFA	SCOU-1	Site is NFA (no action was required)
223	SWMU 4.32	SD224	R12	B1532	NFA	SCOU-1	Site is NFA (no action was required)
224	SWMU 4.33	SD225	R13	DA-8	NFA	SCOU-1	Site is NFA (no action was required)
225	SWMU 4.34	SD226	L9	B1319	NFA	SCOU-1	Site is NFA (no action was required)
226	SWMU 4.35	SD227	R11	B325	NFA	SCOU-1	Site is NFA (no action was required)
227	SWMU 4.36	SD228	N10	B1324	NFA	SCOU-1	Site is NFA (no action was required)

Table 1-1
SCOU Sites and Rationale for Exclusion from Technical Evaluation
(Bold Sites Included in Technical Evaluation)

	Site	IRP Number	Grid Location	Linked Sites or Group	Selected Remedy or Preferred Alternative	ROD	Rationale for Exclusion
228	SWMU 4.37	SD229	BWS	IWL	NFA	SCOU-1	Site is NFA (no action was required)
229	SWMU 4.38	SD230	Q13	DA-5	NFA	SCOU-1	Site is NFA (no action was required)
230	UFL-1	SS020	R10	H-4	PHO	SCOU-1	Non-CERCLA Site
231	UFL-2	SS021	R12		PHO	SCOU-1	Non-CERCLA Site
232	UFL-3	SS046	P11		PHO	SCOU-1	Non-CERCLA Site
233	UFL-4	SS047	N11		NFA	SCOU-1	Site is NFA (no action was required)

Notes

The terminology "Non-CERCLA Site" is applied to petroleum hydrocarbon-contaminated sites which are not covered under CERCLA, but are addressed under state regulations. The terminology "CERCLA Exclusion Site" is applied to certain runway stain sites (those not previously designated NFA), as contamination from aircraft engine exhaust is specifically excluded from consideration under CERCLA.

BV	bioventing
C&C	consolidation and capping
CB	comprehensive basewide
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
E&D	excavation and disposal
IC	institutional controls
LTM	long-term maintenance and monitoring
LTEM	long-term ecological monitoring
NFA	no further action
PHO	petroleum hydrocarbon only
ROD	record of decision
SCOU	source control operable unit
SVE	soil vapor extraction

Sites

B	Building	HWS	Hazardous Waste Storage Area
HWS	Hazardous Waste Storage Area	IWL	Industrial Waste Line
CVLFA	Castle Vista Landfill A	JP	Jet Propulsion
CVLFB	Castle Vista Landfill B	LF	Landfill
DA	Disposal Area	PCB	Polychlorinated Biphenyls
DBF	Detonation and Burn Facility	PFFA	Petroleum Fuel Farm Area
DP	Disposal Pit	SA	Storage Area
ETC	Earth Technology Corporation Site	SDS	Storm Drain System
F	Aircraft Maintenance Hangar	SS	Sanitary Sewer
FR	Firing Range	ST	Structure
FS	Fuel Spill	STA	Stain
FTA	Fire Training Area	SWMU	Solid Waste Management Unit
H	Gasoline Station	UFL	Underground Fuel Leak

Site Groups

B54	B54, B1260, B1266, ETC-5, SA-B3, ST-55, ST-T66, ST-T67, SWMU 4.17, SWMU 4.18, SWMU 4.29
B51	B51, B52, B53, B1253, SWMU 4.26, SWMU 4.27, SWMU 4.30
PFFA	B59, B79, B508, B909, B917, DA-7, PFFA, SWMU 4.4, SWMU 4.5, SWMU 4.13, SWMU 4.15

Table 2-1
Chronology of Site Events

Date	Action/Event/Document	Comments/Reference
1978	First evidence of TCE contamination in groundwater	
1981-1986	IRP field investigations	
March 1984	RWQCB issues Cleanup and Abatement Order Number 84-027	
August 1984	New base water-supply well installed (PW10)	
August 1987	Base listed on EPA NPL	
May 1988	Second new base water-supply well installed (PW12)	
1988-1994	Series of groundwater field investigations, culminating in the CB RI–Part 1	
1989	Base water-supply line extended along Wallace Road to provide potable water to three residences near the base boundary	
July 1989	Castle Air Force Base Federal Facility Agreement signed by the Air Force, EPA and the California Environmental Protection Agency	
1991-1995	DA-4 groundwater removal action system operation	
August 1991	OU-1 Interim ROD	USAF, 1991
1991-1996	Wallace Road groundwater removal action system operation	
1993-1994	B84 groundwater removal action system operation	
January 1993	Start of quarterly groundwater sampling under the LTGSP	
March 1993	OU-1 groundwater treatment plant–start construction (basis for five-year review schedule)	
May 1993	SCOU Work Plan/Sampling and Analysis Plan	Jacobs, 1993a
1993-1996	SCOU RI field investigations	
August 1993	CB Work Plan/Sampling and Analysis Plan	Jacobs, 1993b
1993-1994	CB RI field investigations	
December 1993	OU-2 ROD	USAF, 1993
July 1994	OU-1 groundwater treatment plant - start operation	
1995-date	Wellhead treatment at selected domestic wells downgradient of base (install at ½ MCL; remove after three events <PQL)	
Sept. 1995 - Oct. 1996	B871 Removal Action	
Sept. 1995	Start of DA-4 Removal Action (SVE and E&D)	
Sept. 1995	Start of FTA-1 Removal Action (capping and SVE)	
June 1996	CB RI/FS–Part 1	Jacobs, 1996
June 1996	CB Proposed Plan –Part 1	USAF, 1996
Oct. 1996 - July 1999	ETC-10 Removal Action (E&D)	Jacobs, 1999b
November 1996	OU-2 groundwater treatment plant - start operation	
January 1997	CB ROD–Part 1	USAF, 1997
Jan. 1997 - Aug. 1998	DA-8 Removal Action	
May 1997	SCOU RI/FS	Jacobs, 1997a
August 1997	SCOU Proposed Plan	WPI, 1997
September 1997	Phase 2 groundwater treatment plant - start operation	

Table 2-1
Chronology of Site Events

Date	Action/Event/Document	Comments/Reference
Sept. 1997 - May 1999	CVLF-A Removal Action	
Sept. 1997 - May 1999	LF-2 Removal Action	
Sept. 1997 - Sept. 2000	CVLF-B Removal Action	
Sept. 1997 - May 2003	LF-4 Removal Action (removal action completed in September 1999; final closure report in May 2003; additional remedy of LTM and ICs recommended for SCOU ROD Part 3)	Jacobs, 2003b
October 1997	Castle Vista groundwater treatment plant - start operation	
Feb. 1998 - Sept. 1998	PCB-9 Removal Action	
Oct. 1998 - Aug. 2000	LF-1 Removal Action	
Oct. 1998 - Aug. 2000	LF-3 Removal Action	Jacobs, 2000a
Oct. 1998 - May 2003	LF-5 Removal Action (removal action completed in September 1999; final closure report in May 2003; additional remedy of LTM and ICs recommended for SCOU ROD Part 3)	Jacobs, 2003b
November 1998	Initial Five-Year Review for Castle Airport	Jacobs, 1998a
July 1999	SCOU Data Gap Investigation Report	Jacobs, 1999a
Aug. 1999 - Aug 2000	FR Removal Action	
May 2000	Phase 3 groundwater treatment plant (expansion of the Phase 2 plant) - start operation	
May 2000 - Dec. 2000	B1344 Removal Action	
May 2000 - Dec. 2000	DA-3 Removal Action	
May 2000 - Dec. 2000	ETC-2 Removal Action	
May 2000 - Dec. 2000	ETC-8 Removal Action (initial)	
Nov. 2000	B1709 SVE Decision Study (START process)	
Nov. 2000	F-4 SVE Decision Study (START process)	
Nov. 2000	SS-2 SVE Decision Study (START process)	
January 2001	MW883 wellhead treatment system (solar wagon) - start operation	
February 2001	SCOU Revised Proposed Plan	Earth Tech, 2001
March 2001	Landfill 1 Plume monitoring terminated	
May 2001	B51/B54 Group Removal Action (start SVE operation)	
June 2001	B1350 Removal Action (start SVE operation)	
June 2001	B1762 Removal Action (start SVE operation)	
June 2001	DA-5 Removal Action (start SVE operation)	
July 2001	MW951 wellhead treatment system - start operation	
January 2002	MW1009 wellhead treatment system - start operation	
January 2002	MW883 wellhead treatment system (solar wagon) - shut down	
April 2002	FTA-1 Focused Feasibility Study (non-VOC remedy of capping, LTM and ICs recommended for SCOU ROD Part 3)	Jacobs, 2002a
June 2002	MW941 wellhead treatment system (solar wagon) - start operation	
August 2002	MW883/MW1021 wellhead treatment system - start operation	
August 2002	MW824 wellhead treatment system - start operation	

Table 2-1
Chronology of Site Events

Date	Action/Event/Document	Comments/Reference
September 2002	SCOU ROD Part 1	WPI, 2002
December 2002	PCB-4 Removal Action (excavation and disposal)	
December 2002	PCB-5 Removal Action (excavation and disposal)	
December 2002	CB RI/FS–Part 2	Jacobs, 2002b
May 2003	SCOU ROD Part 2	Earth Tech, 2003a
May 2003	OU-1 groundwater treatment plant - shut down	
August 2003	Castle Vista groundwater treatment plant - shut down	
August 2003	MW003 wellhead treatment system - start operation	
September 2003 (1)	Hangar F-4 SVE pilot test complete; final closure report issued and approved	Earth Tech, 2003b
October 2003 (1)	B1709 SVE Removal/Remedial Action complete; final closure report issued and approved	Earth Tech, 2003c
October 2003 (1)	B1762 SVE Removal/Remedial Action complete; final closure report issued and approved	Earth Tech, 2003d
December 2003 (1)	CB Proposed Plan –Part 2	Jacobs, 2003a
December 2003 (1)	East Base Plume monitoring terminated	
January 2004	Second Five-Year Review for Castle Airport	Jacobs, 2004a
	Site Events Since Second Five-Year Review	
March 2004	OPS determination for the Main Base Plume, Castle Vista Plume, Landfill 1 Plume, Landfill 4 Plume, B51/B54 Group, B1350, DA-5 and LF-4 (EPA milestone)	Jacobs, 2004e
May 2004	MW941 wellhead treatment system (solar wagon) - shut down	
May 2004	SWMUs 4.16, 4.22, 4.4 and 4.6 Remedial Actions complete (all risk-based closures; no additional E&D); final closure report issued and approved	Jacobs, 2004b
October 2004	MW883/MW1021 wellhead treatment system - shut down	
October 2004	SS-2 SVE Remedial Action complete; final closure report issued and approved	Earth Tech, 2004
October 2004	B1350 SVE Removal/Remedial Action complete; final closure report issued and approved	MWH, 2004a
March 2005	FTA-1 ecological soil E&D completed and approved	MWH, 2005a
June 2005	MW1037 added to the MW824 wellhead treatment system	
June 2005	SCOU ROD Part 3 (presented remedies for LF-4/DP-5/DP-6 [ICs and LTM]; LF-5/DP-8/DP-8A; Landfill 5 Trenches [ICs, LTM, and LTEM]; DP-9 [NFA]; ETC-8 [E&D]; ETC-10 [ICs and LTEM]; FTA-1 [SVE, BV, E&D, ICs, LTM, and LTEM); ETC-12 [LTEM]; and LF-3 [LTEM] Selected remedy for ecological risk at all SCOU sites other than those listed above (total of 225 sites) was NFA	Jacobs, 2005a
November 2005	DA-4/B1314 SVE and E&D Removal/Remedial Action complete; final closure report issued and approved	Earth Tech, 2005
June 2006	B51/B54 Group SVE Removal/Remedial Action complete; final closure report issued and approved (includes sites B51; B52; B53; B54; B1253; B1260; B1266; ETC-5; SA-B3; ST-55; ST-T66; ST-T67; SS-4)	MWH, 2006a

Table 2-1
Chronology of Site Events

Date	Action/Event/Document	Comments/Reference
June 2006	CB ROD–Part 2 (summarized previous RODs, updated groundwater remedy to incorporate wellhead treatment where plume capture impractical and established groundwater use restrictions (ICs) for parcels overlying MCL plumes	AFRPA, 2006a
April 2006	ETC-8 E&D Remedial Action complete; final closure report issued and approved	Jacobs, 2006a
September 2006	DA-5 SVE Removal/Remedial Action complete (E&D and BV not required); final closure report issued and approved (includes sites B1529 and SWMUs 4.1, 4.20, 4.21, 4.3 and 4.38)	MWH, 2006b
September 2006	SWMUs 4.3 and 4.21 E&D Remedial Action complete (BV not required); final closure report issued and approved (SWMUs associated with DA-5 – see above listing)	MWH, 2006c
September 2006	Basewide Construction Complete (EPA milestone)	
October 2006	MW824/MW1037 wellhead treatment system taken offline due to declining water levels	
December 2006	Landfill 4 Plume monitoring terminated	Jacobs, 2007a
December 2006	Castle Airport property transfer to Merced County complete on 19 December	
May 2007	FTA-1 SVE and E&D Removal/Remedial Action complete (BV not required); final closure report issued and approved	MWH, 2007a
November 2007	Sitewide Ready for Anticipated Use (EPA milestone)	
December 2007	North Base Plume monitoring terminated	Jacobs, 2008
February 2008	MW1009 wellhead treatment system taken offline for rebound evaluation	
February 2008	First five-year ecological monitoring for vernal pool invertebrates (fairy shrimp) completed	
April 2008	First five-year ecological monitoring for vernal pool flora completed	

Notes

(1) Although these actions/reports/documents were finalized before the second five-year review was complete (final report issued), they were not available or noted as final in the second five-year review report because of the document preparation process.

Dates for removal actions are from publication of the final action memorandum to publication of the final closure report.

AFRPA	Air Force Real Property Agency	MCL	maximum contaminant level
B#	Building #	NPL	National Priority List
BV	bioventing	OPS	operating properly and successfully
CB	Comprehensive Basewide	OU	operable unit
CVLF- #	Castle Vista Landfill - #	PCB- #	Polychlorinated Biphenyl - #
DA- #	Discharge Area - #	PQL	practical quantitation limit
DP- #	Disposal Pit - #	PW	production well
E&D	excavation and disposal	RI	remedial investigation
EPA	U.S. Environmental Protection Agency	RI/FS	remedial investigation/feasibility study
ETC- #	Earth Technology Corporation - #	ROD	Record of Decision
FR	Firing Range	RWQCB	California Regional Water Quality Control Board
F- #	Aircraft Hanger F- #	SA- #	Storage Area - #

Table 2-1
Chronology of Site Events

Date	Action/Event/Document	Comments/Reference

FTA- #	Fire Training Area - #	SCOU	Source Control Operable Unit
IC	institutional controls	SS- #	Sanitary Sewer - #
IRP	Installation Restoration Program	ST- #	Structure - #
LF- #	Landfill- #	START	SVE Turn On and Remediation Test
LTEM	long-term ecological monitoring	SVE	soil vapor extraction
LTGSP	Long-Term Groundwater Sampling Program	SWMU	Solid Waste Management Unit
LTM	long-term (cap) maintenance and monitoring	TCE	trichloroethene

Table 4-1
Treated Groundwater Discharge Standards

	Standards for Discharge[1]	
Constituent	**30-Day Median (µg/L)**	**Daily Maximum (µg/L)**
Acetone	1	-
Benzene	0.5	1
Bromoform	0.5	1
Carbon tetrachloride	0.5	0.5
Chloroethane	0.5	1
Chloroform	0.5	1
Chloromethane	0.5	1
Chlorobenzene	0.5	1
Dibromochloropropane (DBCP)	0.35	5
Di(2-ethylhexyl)phthalate (DEHP)	0.5	1
Dichlorobenzene (ortho)	0.5	1
Dichlorobenzene (para)	0.5	1
Dichlorodifluoromethane	0.5	1
1,1-DCE	0.5	1
1,2-DCE (*cis*)	0.5	1
1,2-DCE (*trans*)	0.5	1
1,1-DCA	0.5	1
1,2-DCA	0.5	0.5
1,2-dichloropropane	0.5	1
Ethylbenzene	0.5	29
Ethylene dibromide	0.14	0.5
Methylene chloride	0.5	1
Tetrachloroethene (PCE)	0.5	1
Toluene	0.5	42
Trichlorofluoromethane	0.54	1
Trichloroethene (TCE)	0.5	1
VOCs[3]	1	5
Xylenes	0.5	17
TPH (gas)	50	50
TPH (diesel)	50	100
Iron	-	300[2]
Manganese	-	50[2]
Nitrates	-	10 mg/L as Nitrogen[2]
Other constituents	All other constituents must be within background concentrations in the receiving water at the point of discharge. If this is not technically feasible, discharge standards may be established.	

Notes

1 For discharge into the contaminated regions of an aquifer, in lieu of the standards in this table, treated water cannot be discharged at concentrations that exceed the specified aquifer clean-up level or the actual concentrations in the aquifer at the point of discharge, whichever is lower. For constituents where no aquifer clean-up level has been specified, treated water cannot be discharged at constituent concentrations that exceed those of the receiving water.

2 or 95% UTL background at point of discharge, if higher.

3 Cumulative limit for all VOCs.

General Note: All COCs will be included in routine long-term groundwater monitoring; other constituents will be sampled according to the approved Long-Term Groundwater Sampling Program (LTGSP) sampling plan.

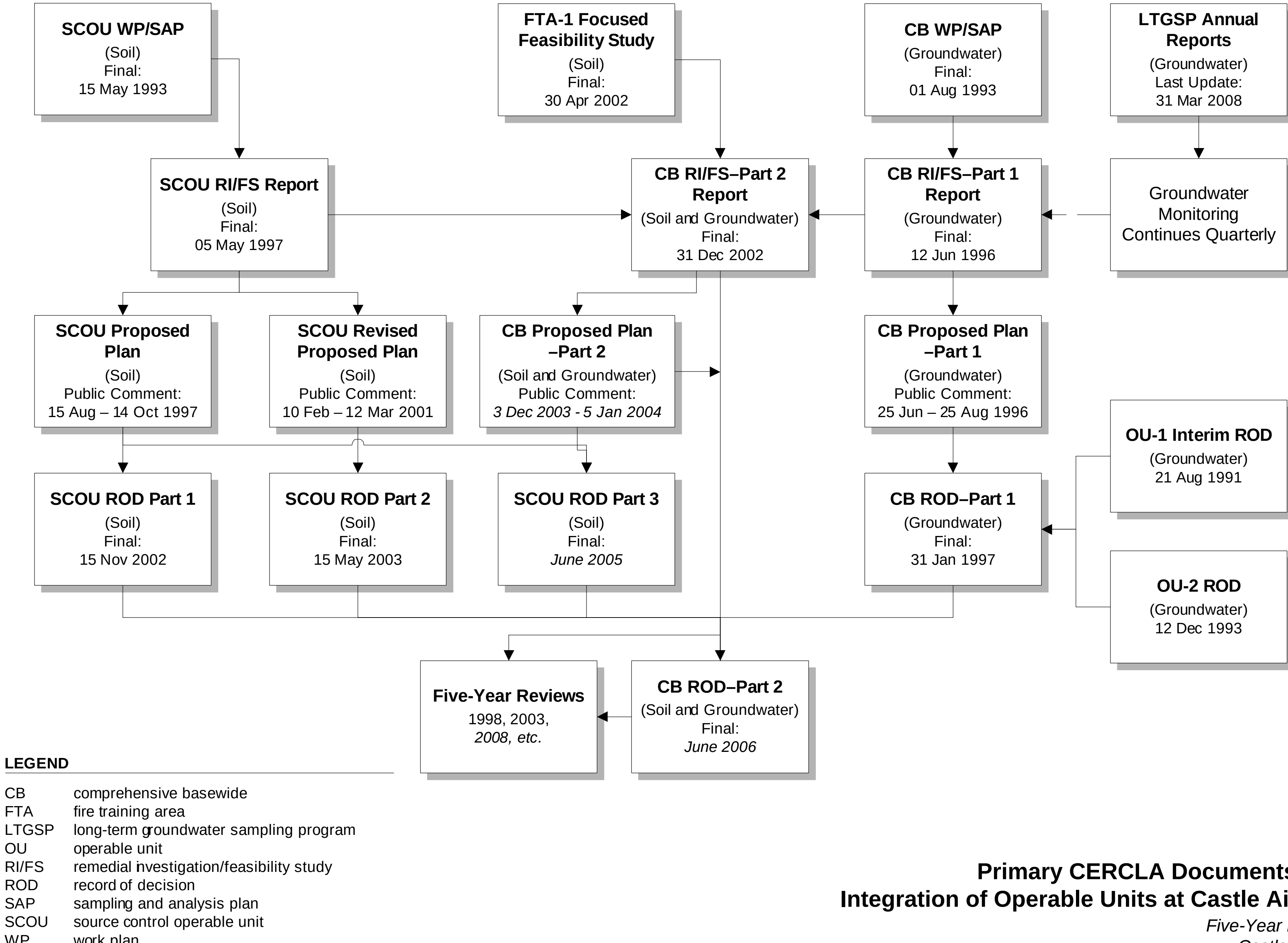
Source: USAF, 1997. Final Record of Decision for Comprehensive Basewide–Part 1, Castle Air Force Base, Merced County, California, as modified by memorandum of non-significant changes to record of decision, 9 December 1997.

µg/L	micrograms per liter	TPH	total petroleum hydrocarbons
COC	contaminant of concern	UTL	upper threshold limit
mg/L	milligrams per liter	VOC	volatile organic compound

Table 5-1
Selected Inorganics in Treatment Plant Combined Effluent Samples
(all values in milligrams per liter [mg/L])

Treatment Plant									95% Threshold Backgroud Values (TBV^{95})		
		OU-2	**Phase 3**	**MW951**	**MW1009**	**MW824/MW1037**	**MW003**		**Shallow HSZ**	**USS HSZ**	**LSS HSZ**
2007											
CA		33	38	25	35	offline	na		85	43	28
CL		15	19	18	26	offline	na		45	22	14
TDS		280	290	260	290	offline	na		620	322	258
2006											
CA		33	38	25	32	36	na		85	43	28
CL		15	19	16	22	27	na		45	22	14
TDS		260	280	240	270	280	na		620	322	258
2005											
CA		31	38	23	28	36	na		85	43	28
CL		16	22	16	20	30	na		45	22	14
TDS		260	270	240	250	290	na		620	322	258
2004											
CA		31.5	37.6	23.3	26.4	32.8	54		85	43	28
CL		13.5	17.5	13	15.1	25	15.3		45	22	14
TDS		190	230	170	170	100	340		620	322	258
2003						(MW824 ONLY)					
CA		33	38.5	23.6	29.7	37.5	na		85	43	28
CL		15	19.2	12.7	18	27.3	na		45	22	14
TDS		270	300	270	240	300	na		620	322	258
Notes:	Samples from each treatment system collected in February of each year except 2003 when samples were collected in January.										
CA	calcium										
Cl	chloride										
HSZ	hydrostratigraphic zone										
LSS	Lower Subshallow										
na	no data										
TDS	total dissolved solids										
USS	Upper Subshallow										

FIGURES



Primary CERCLA Documents and Integration of Operable Units at Castle Airport

Five-Year Review
Castle Airport

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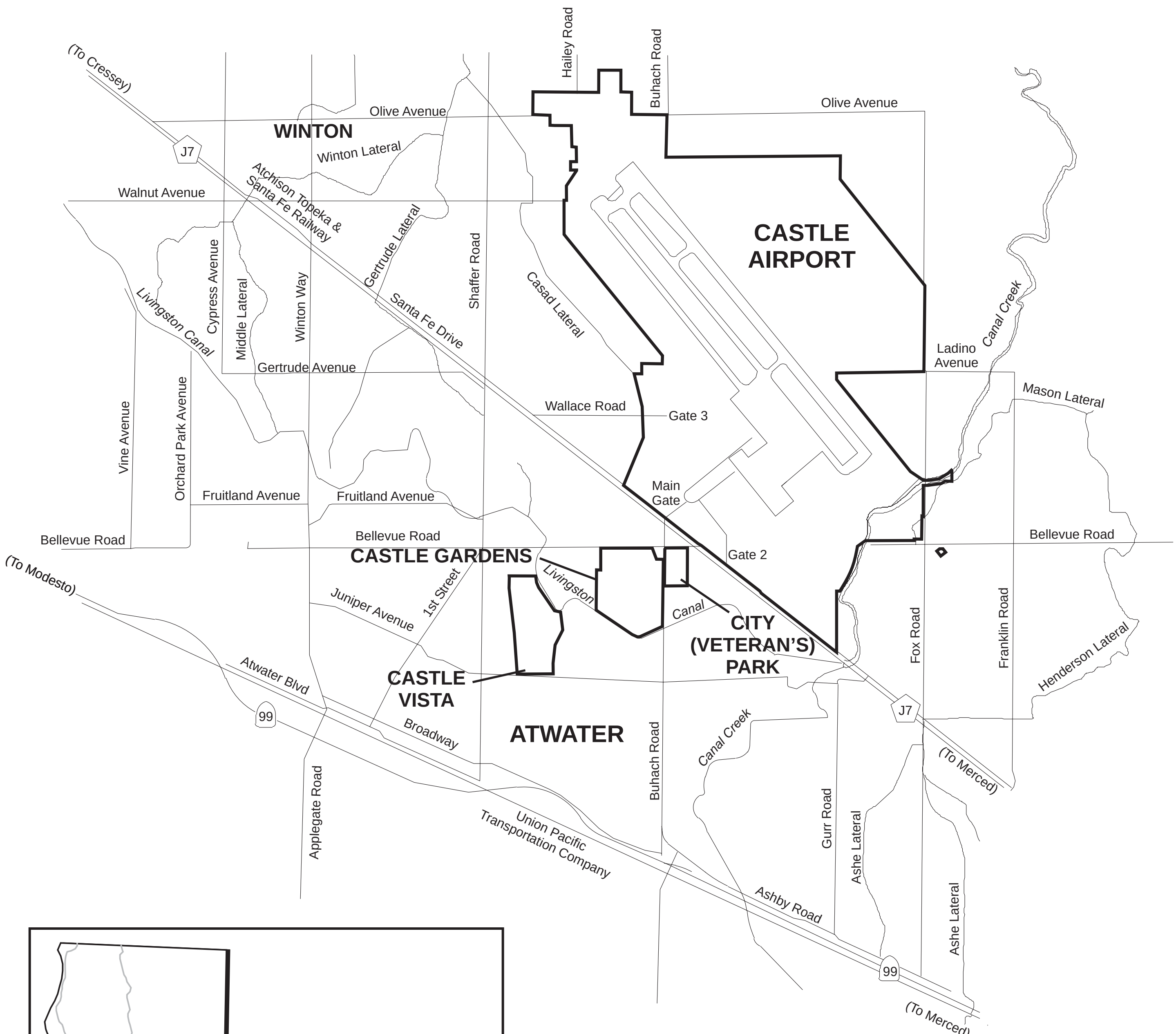
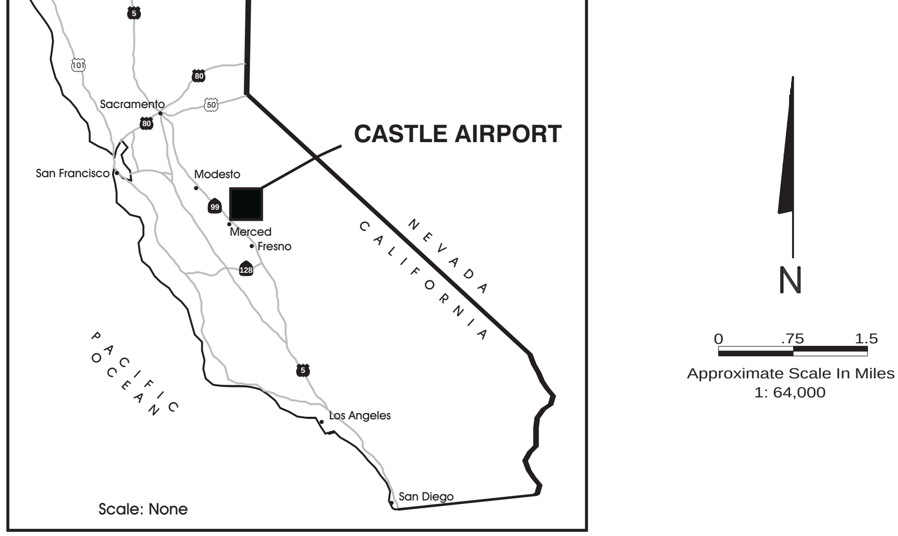
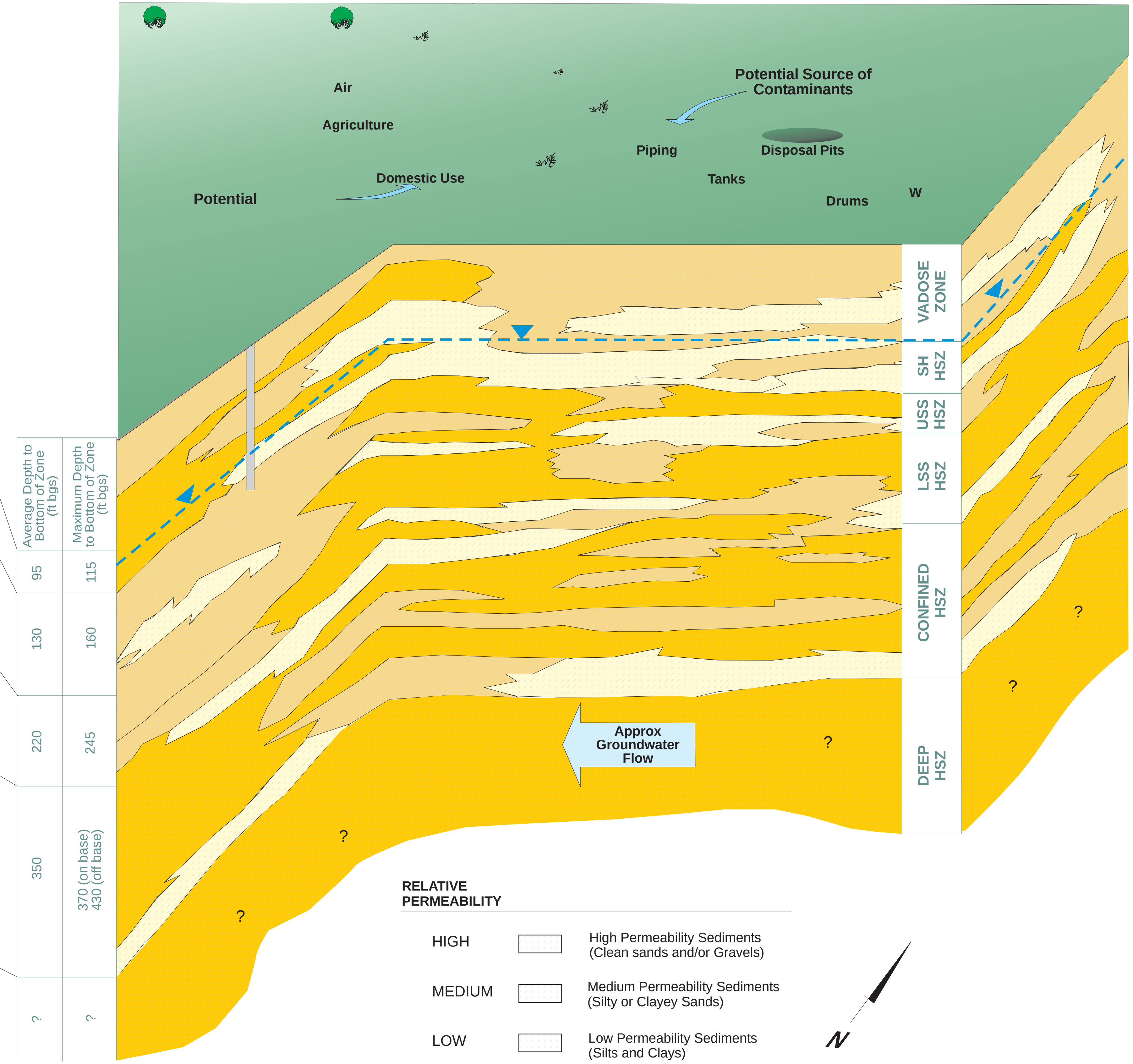
FIGURE 2-1





Castle Airport Vicinity Map
Five-Year Review
Castle Airport

Geologic Age: Period	Geologic Age: Epoch	Stratigraphic Name	Typical Geologic Characteristics of Predominant Water Bearing Sections	Possible Depositional Models	HSZ
Quaternary	Pleistocene	Modesto and Riverbank Formation	Gravel bearing sediments mostly beneath the Main Base Plume, based on isolith plots. The gravel bearing sediments trend in a northwest-southeast direction. These gravels pinch-out to the north and east beneath the runway, and to the southwest of Castle Air Force Base. The gravel bearing zone is mostly bordered by flood plain deposits at the pinch-out boundaries. Maximum thickness of the gravel bearing zone is in excess of 40 feet.	Braided channel deposits surrounded by flood plain deposits. Braided system exhibits shallow channelization with fairly uniform thickness. Top and bottom of gravel bearing zones are gradational with overlying and underlying sands. This information is suggestive of a transgressive-regressive aggradational fluvial-alluvial sequence likely caused by abrupt climatic change (i.e. glacial melting and precipatation with rapid increase in transport energy).	Shallow (SH)
Quaternary	Pleistocene	Turlock Lake Formation	Consisting of mostly fine sands, grading to medium-grained sands to the southwest. Beneath Castle Air Force Base, the water bearing zones are mostly in discontinuous sand lenses ranging in thickness from 5 to 10 feet. To the southwest, the interval between 120 and 155 feet bgs consists mostly of medium-grained sands. Based on a lithofacies plot of sand percentage, the sands appear to trend in a northwest-southeast direction.	Sinuous to meandering channel system surrounded by flood plain deposits. Flood plain sediments exhibit sequences of interbedded thin laminae of fine-grained sand and silt alternating with whitish mottled fine-grained sediments containing root casts and organic carbon residues. This suggests overbank deposits formed during flood stages with concurrent ephemeral shallow lake deposition in flood plain areas. The wet season is followed by a dry season with soil horizon formation and growth of short grasses.	Upper Subshallow (USS)
			Consists mostly of sands, gravelly sands, and sandy gravels. In the central portion of the Main Base Plume, there is a large nongravel bearing area bordered by gravel bearing sediments to the north, south, and west. The extent of this nongravel bearing zone to the east and southeast is not known. The trend of the LSS HSZ appears to be generally northwest-southeast.	Braided channel system bordered by flood plain deposits. May have been formed in similar scenario as the gravel bearing sediments in the Shallow HSZ.	Lower Subshallow (LSS)
			North Merced Gravel Appears to consist of a thin (maximum thickness of about 40 feet), widespread gravel bearing zone. This zone has been encountered at numerous locations throughout Castle Airport. The zone appears to pinch out to the east and west as indicated by the Confined HSZ isolith map.	Braided channel system bordered by flood plain deposits. May have been formed in similar scenario as the gravel bearing sediments in the Shallow HSZ.	Confined
Tertiary	Pliocene	Laguna Formation	Continental deposits	Insufficient data.	Deep

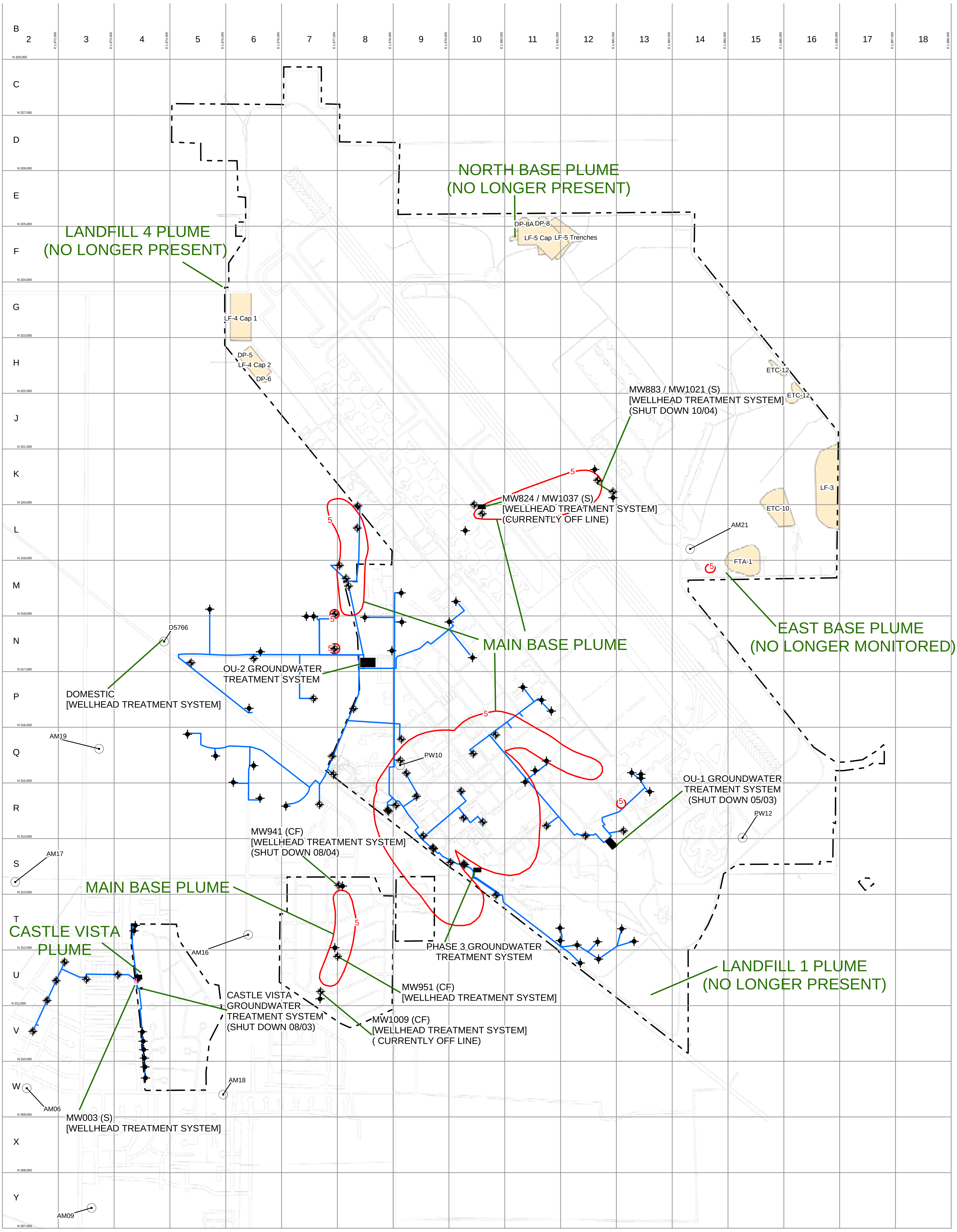


Generalized Basewide Conceptual Model

Five-Year Review

Castle Airport

FIGURE 3-2



LEGEND

- MCL Contour for TCE (Q4 2007; all HSZs)
- MCL Contour for cis-1,2-DCE (Q4 2007; Shallow HSZ only)
- Groundwater Conveyance System
- Groundwater Treatment System
- SCOU Site Included in Five-Year Review
- Extraction Well
- Injection Well
- Atwater Municipal Well (AM)/Production Well (PW)/Domestic Well

B	Building
CF	Confined Hydrostratigraphic Zone
DA	Discharge Area
DP	Disposal Pit
LF	Landfill
MCL	Maximum Contaminant Level
OU	Operable Unit
S	Shallow Hydrostratigraphic Zone
SCOU	Source Control Operable Unit
ST	Structure

Long-Term Soil and Groundwater Remedial Actions

Five-Year Review
Castle Airport

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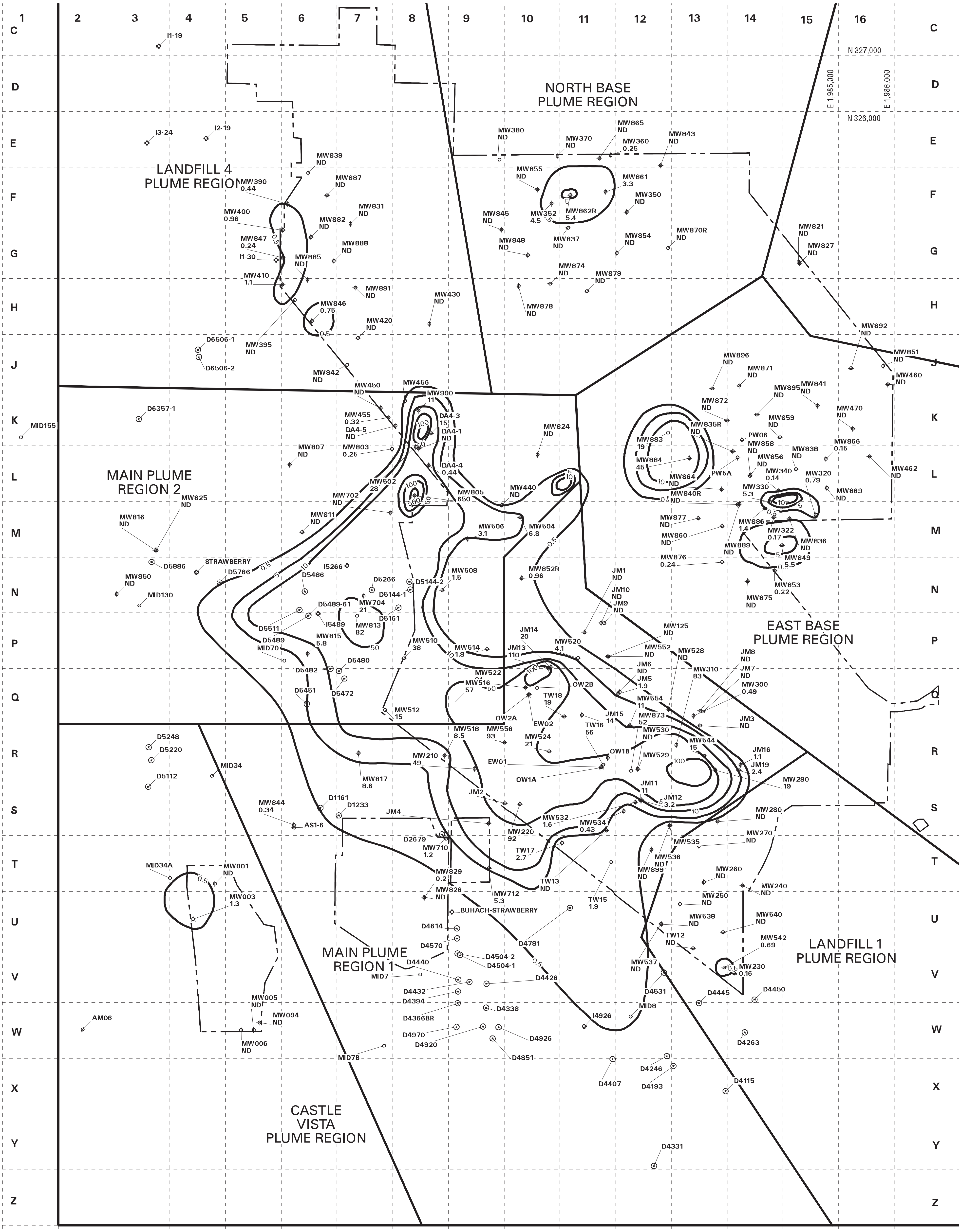
Figure 3-3



LEGEND

MW001	Monitoring well
D4740	Domestic well
PW15	Production well
I1-01	Irrigation well-private
MID1	Irrigation well-public
EW01	Extraction well
JI6	Injection well
AM11	Municipal well
PZ03	Piezometer

Property boundary

Isoconcentration contour of TCE in μg/L

MW875
6.4
Well location with TCE concentration in μg/L

Notes:
Dry wells and wells with insufficient water for sampling not shown on map.

Hydropunch data used for contouring not shown on map.

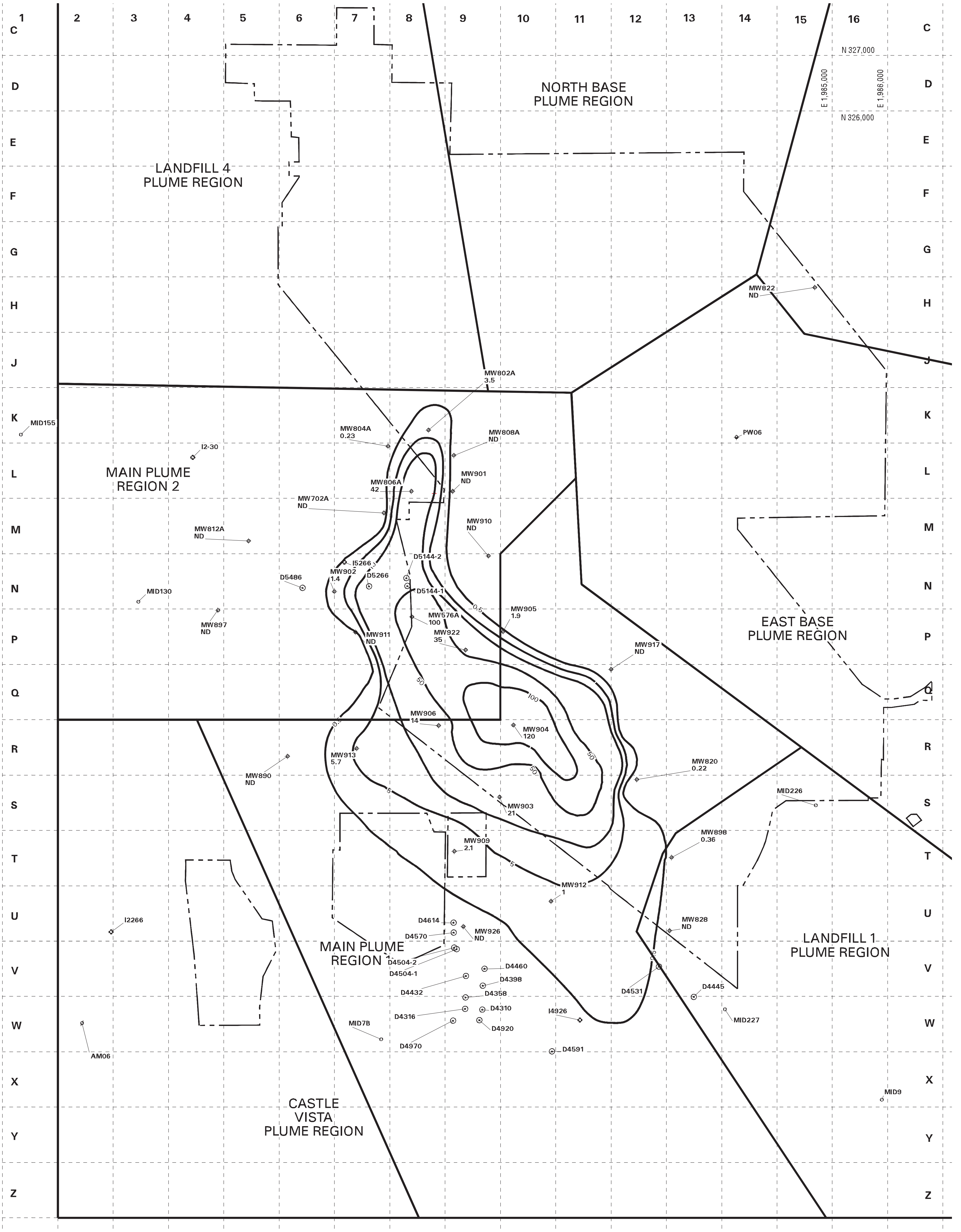
N

0 1700

Scale in Feet
1:20400

TCE Plume Delineation Map, Second Quarter 1994
Shallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport



LEGEND

MW001	Monitoring well		Property boundary
D4740	Domestic well		Isoconcentration contour of TCE in $\mu g/L$
PW15	Production well		
I1-01	Irrigation well-private		
MID1	Irrigation well-public		
EW01	Extraction well	MW875 6.4	Well location with TCE concentration in $\mu g/L$
JI6	Injection well		
AM11	Municipal well		
PZ03	Piezometer		

Note:
Hydropunch data used for contouring not shown on map.

N

0 1700

Scale in Feet
1:20400

TCE Plume Delineation Map, Second Quarter 1994
Upper Subshallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport

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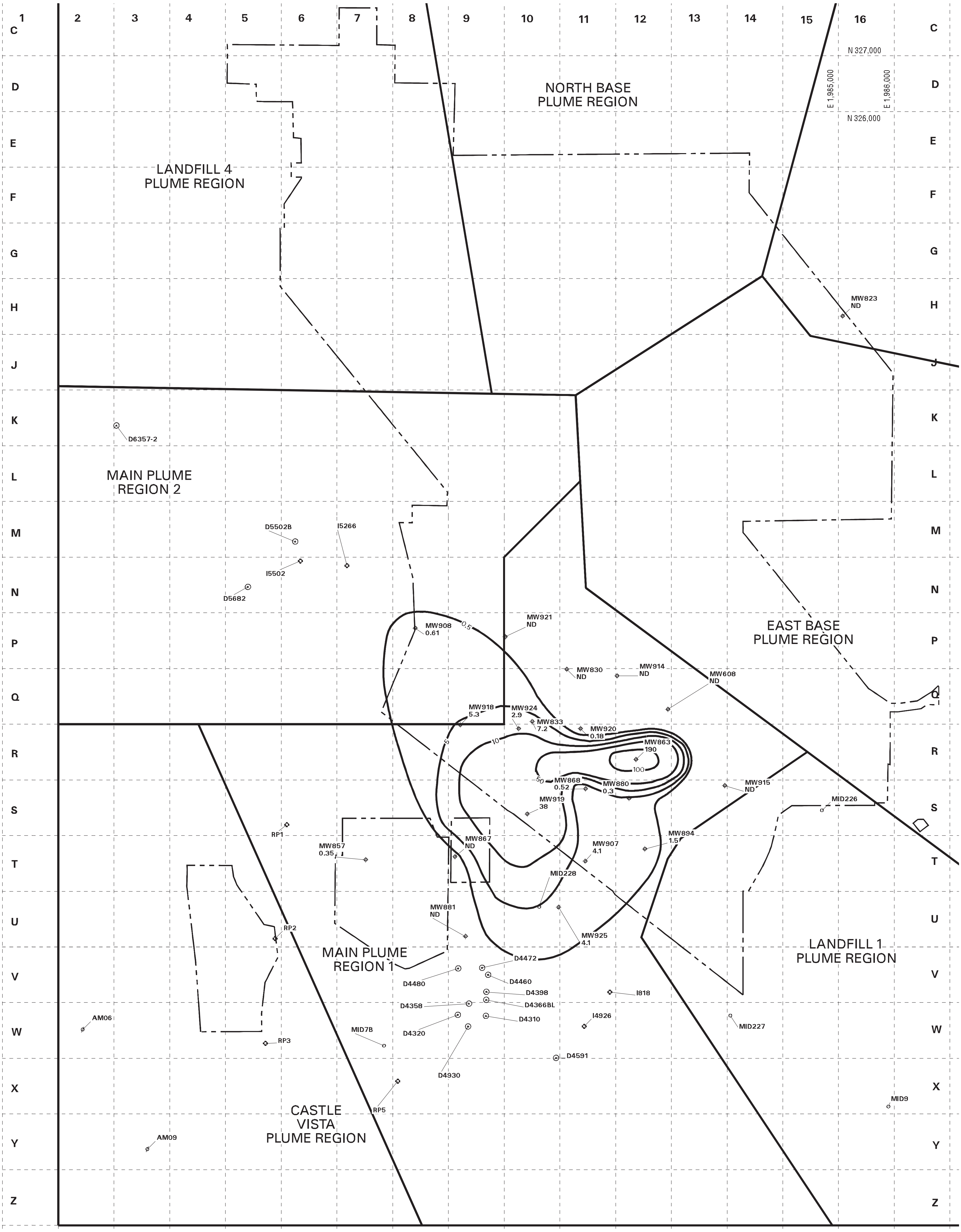
Figure 3-5



LEGEND

MW001	Monitoring well	Property boundary
D4740	Domestic well	Isoconcentration contour of TCE in μg/L
I1-01	Irrigation well-private	
MID1	Irrigation well-public	
JI6	Injection well	
AM11	Municipal well	MW875 6.4 Well location with TCE concentration in μg/L
EW01	Extraction well	

Note:
Hydropunch data used for contouring not shown on map.

N

0 1700

Scale in Feet
1:20400

TCE Plume Delineation Map, Second Quarter 1994
Lower Subshallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport

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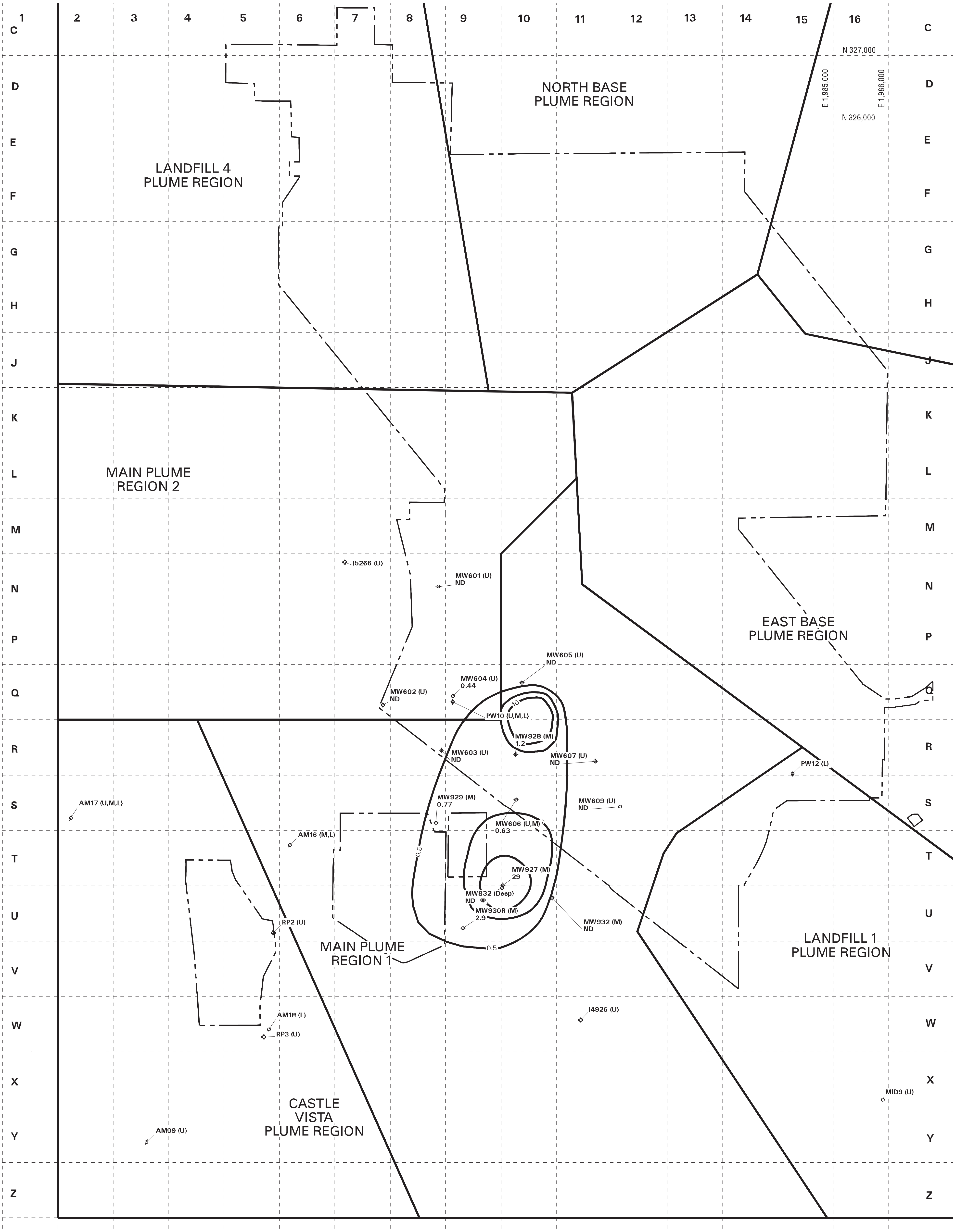
Figure 3-6



LEGEND

MW001	Monitoring well
D4740	Domestic well
PW15	Production well
I1-01	Irrigation well-private
MID1	Irrigation well-public
AM11	Municipal well
EW01	Extraction well

Property boundary

Isoconcentration contour of TCE in μg/L

Well location with TCE concentration in μg/L

(U) Well located in the upper (U), middle (M), and/or lower (L) layer of the Confined HSZ

(Deep) Well screened in the Deep HSZ

Note:
Hydropunch data used for contouring not shown on map.

* Data not used in contouring

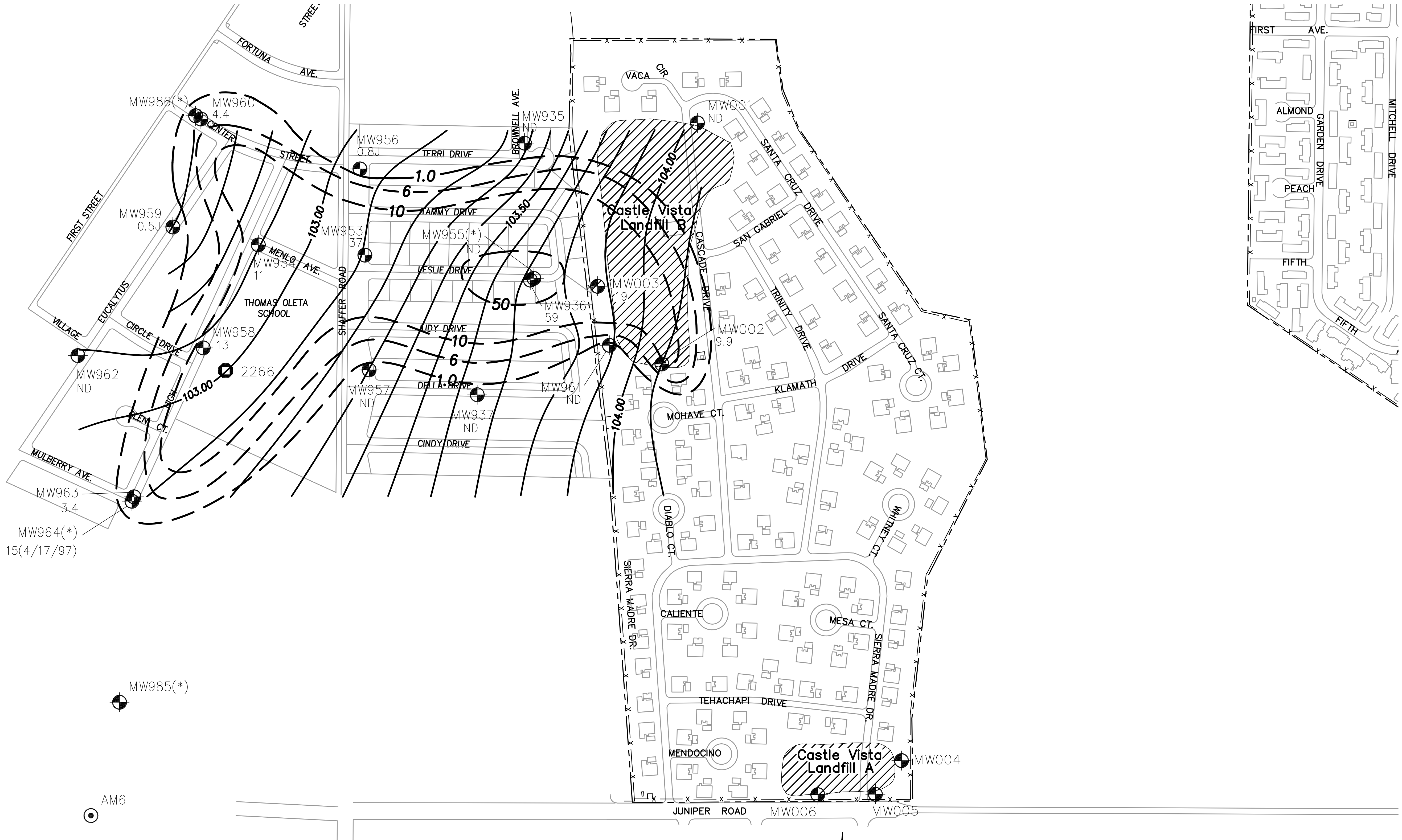
N

0 1700

Scale in Feet
1:20400

TCE Plume Delineation Map, Second Quarter 1994
Confined Hydrostratigraphic Zone

Five-Year Review
Castle Airport



LEGEND

—x— Fence Line	**—104.00—** Groundwater Elevation Contours in Feet Above Mean Sea Level Contour Interval = 0.10 Feet	*ND*	Not Detected Above Reporting Limits
Monitoring Well Location		*J*	Estimated Value Due to Trace Concentration on Quality Control Deficiency
Municipal Well Location	— — *cis*–1,2–DCE Isoconcentration Contours (inferred)	(*)	Upper Subshallow HSZ Monitoring Well
Irrigation Well Location	19 *cis*–1,2–DCE concentrations in ug/L		

Groundwater Elevation Contours and *cis*-1,2-DCE Plume Delineation Map First Quarter 1997 Shallow Hydrostratigraphic Zone

Five–Year Review
Castle Airport

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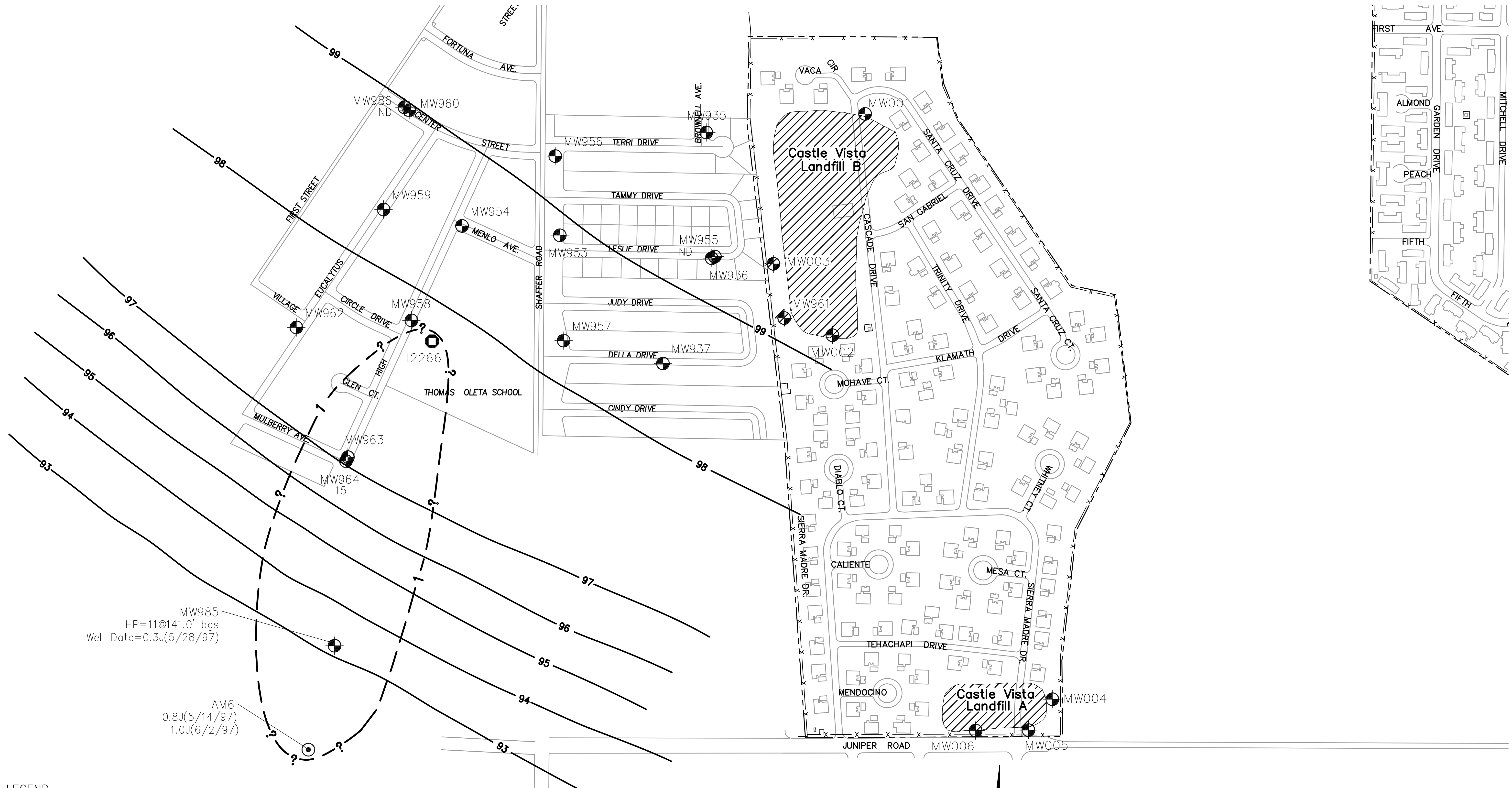
FIGURE 3–8



LEGEND

—x— Fence Line	**— 93 —** Groundwater Elevation Contours in Feet Above Mean Sea Level Contour Interval = 1 Foot
Monitoring Well Location	— — *cis*–1,2–DCE Isoconcentration Contours (inferred)
Municipal Well Location	15 *cis*–1,2–DCE concentrations in ug/L
Irrigation Well Location	

ND Not Detected Above Reporting Limits

J Estimated Value Due to Trace Concentration on Quality Control Deficiency

Groundwater Elevation Contours and *cis*-1,2-DCE Plume Delineation Map First Quarter 1997 Upper Subshallow Hydrostratigraphic Zone

Five–Year Review
Castle Airport

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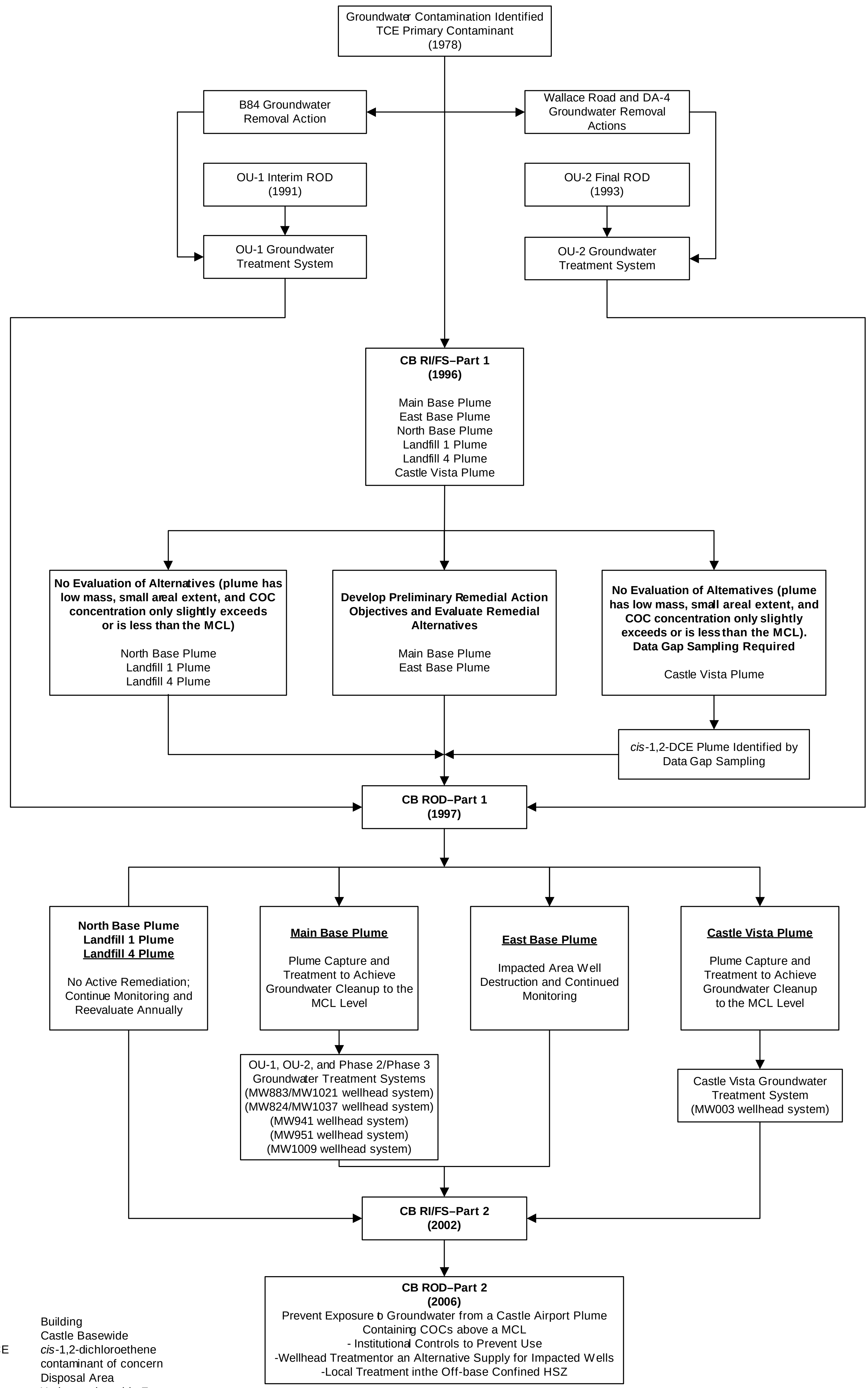
FIGURE 3–9

DISPOSITION OF GROUNDWATER PLUMES AT CASTLE AIRPORT



LEGEND

B	Building
CB	Castle Basewide
cis-1,2-DCE	*cis*-1,2-dichloroethene
COC	contaminant of concern
DA	Disposal Area
HSZ	Hydrostratigraphic Zone
MCL	Maximum Contaminant Level
OU	Operable Unit
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
TCE	trichloroethene

Disposition of Groundwater Plumes at Castle Airport

Five-Year Review
Castle Airport

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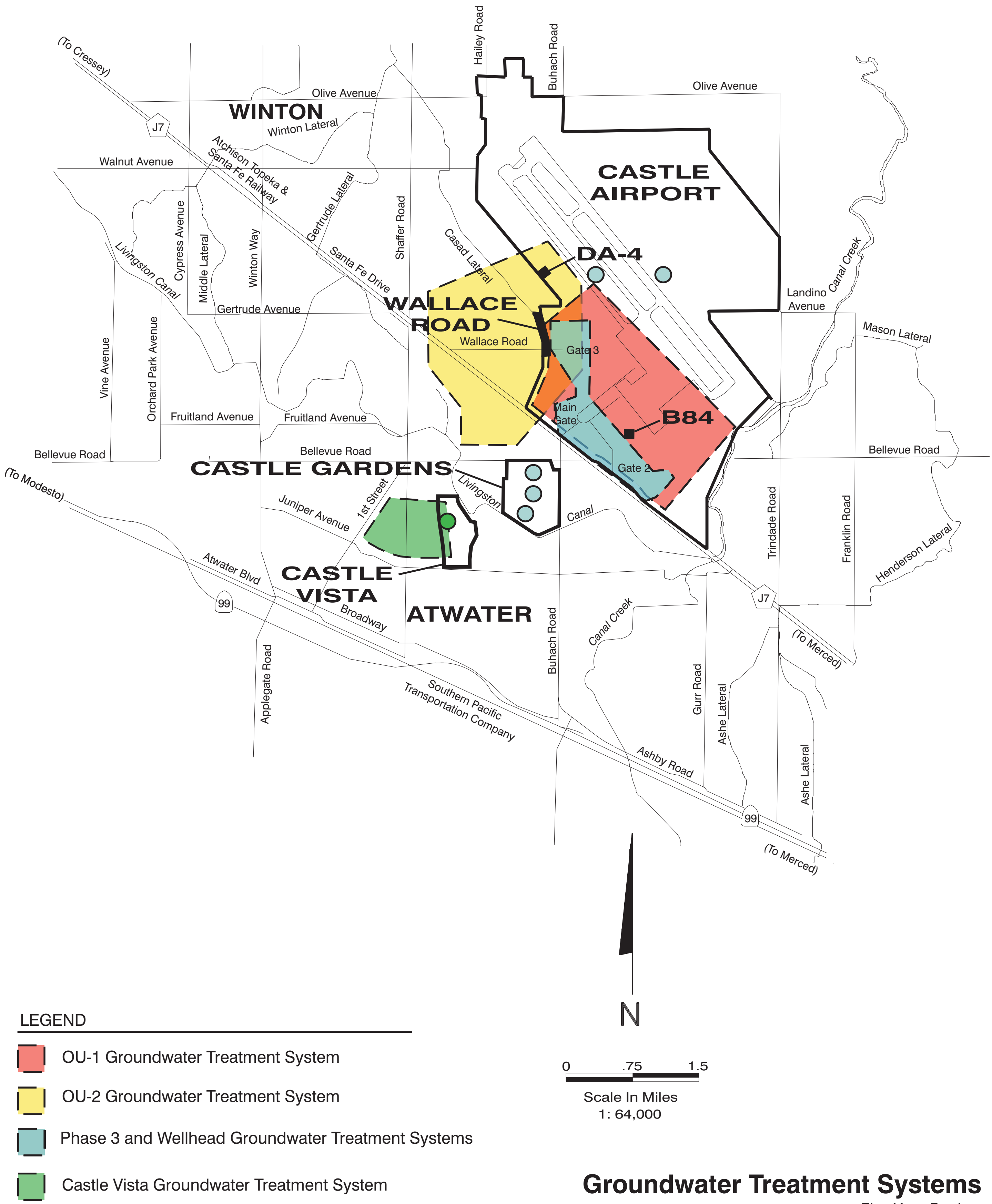
Figure 4-1



Groundwater Treatment Systems

Five-Year Review
Castle Airport

FIGURE 4-2

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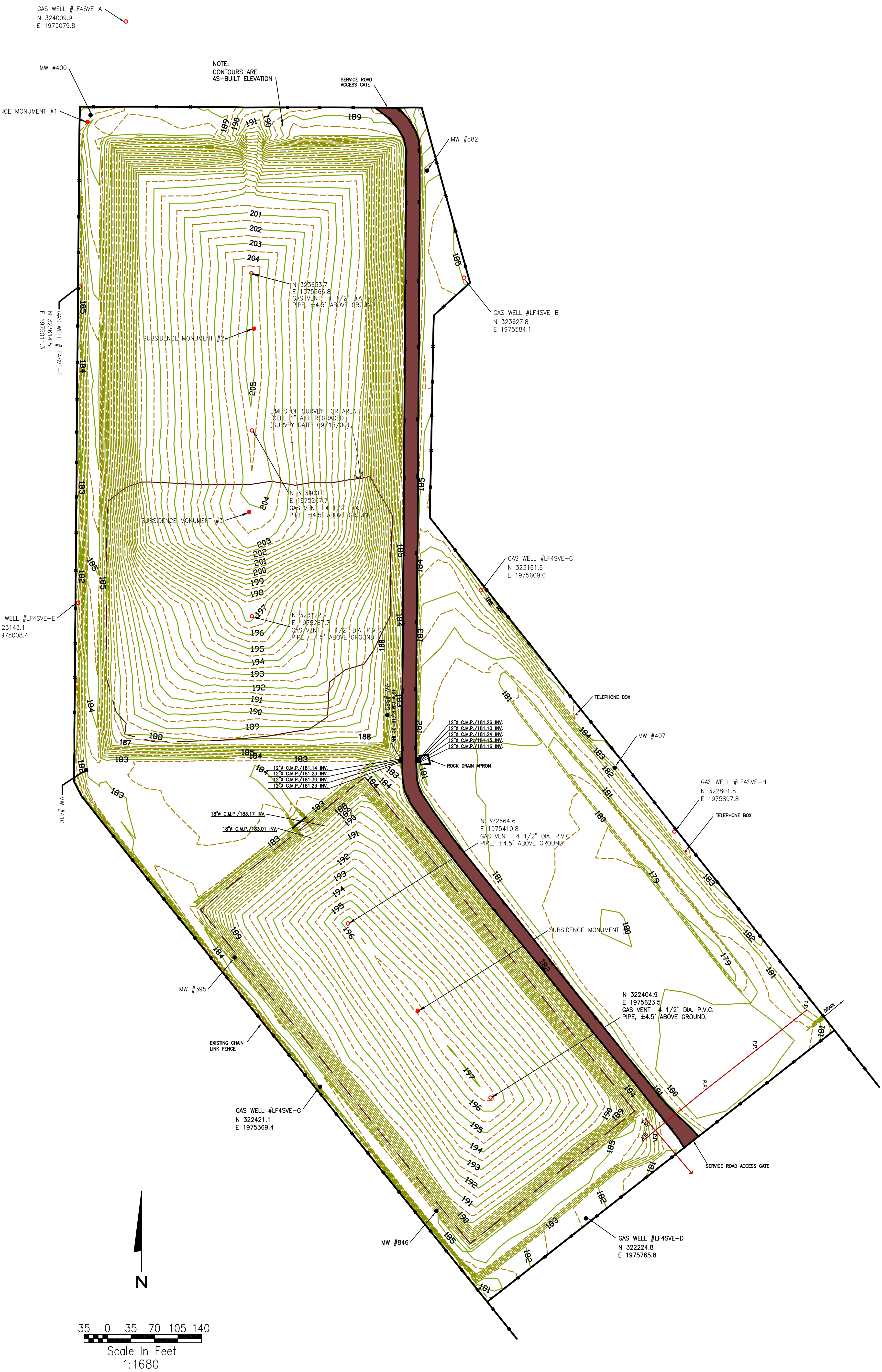

Landfill 4 Surface Features

Five-Year Review

Castle Airport

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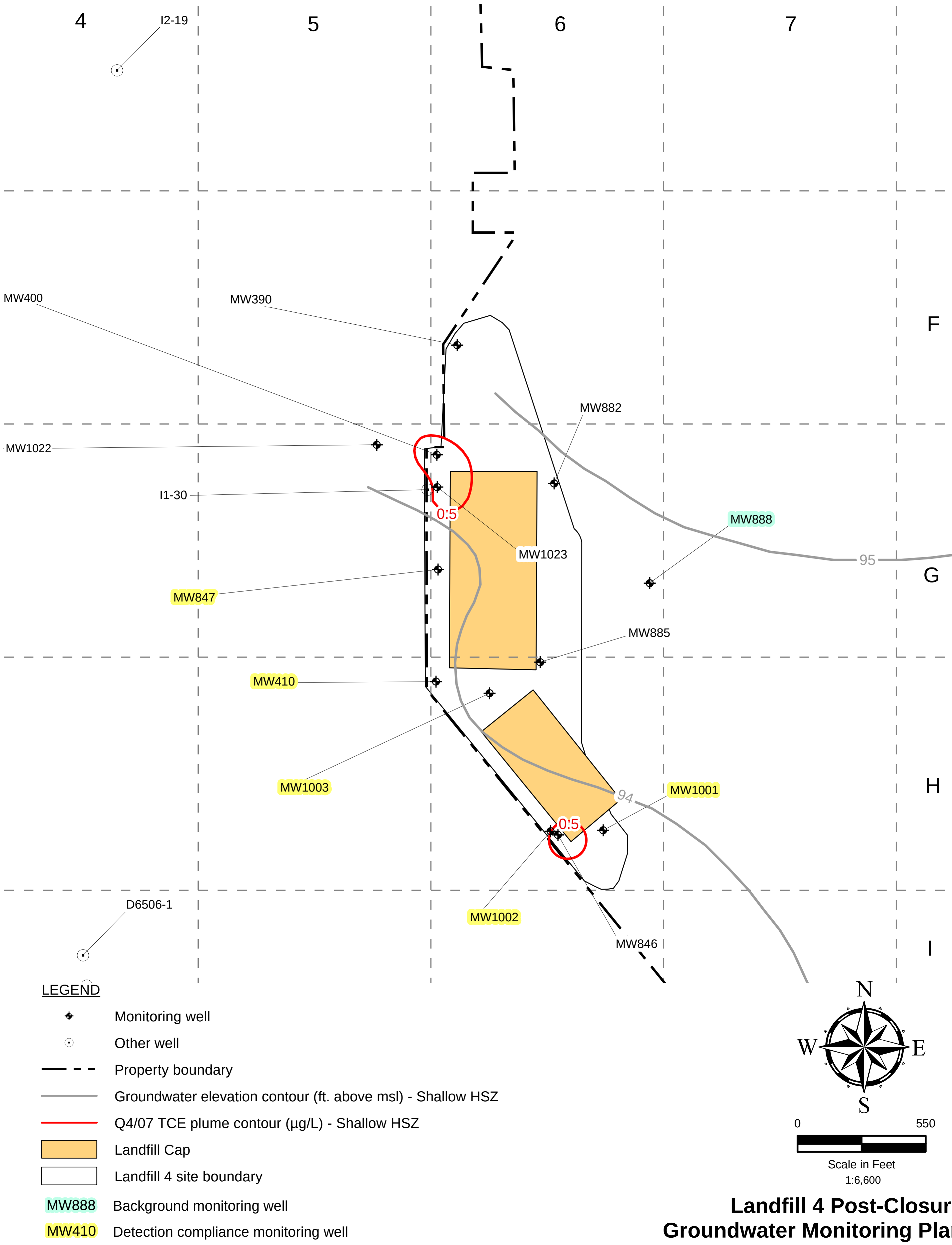
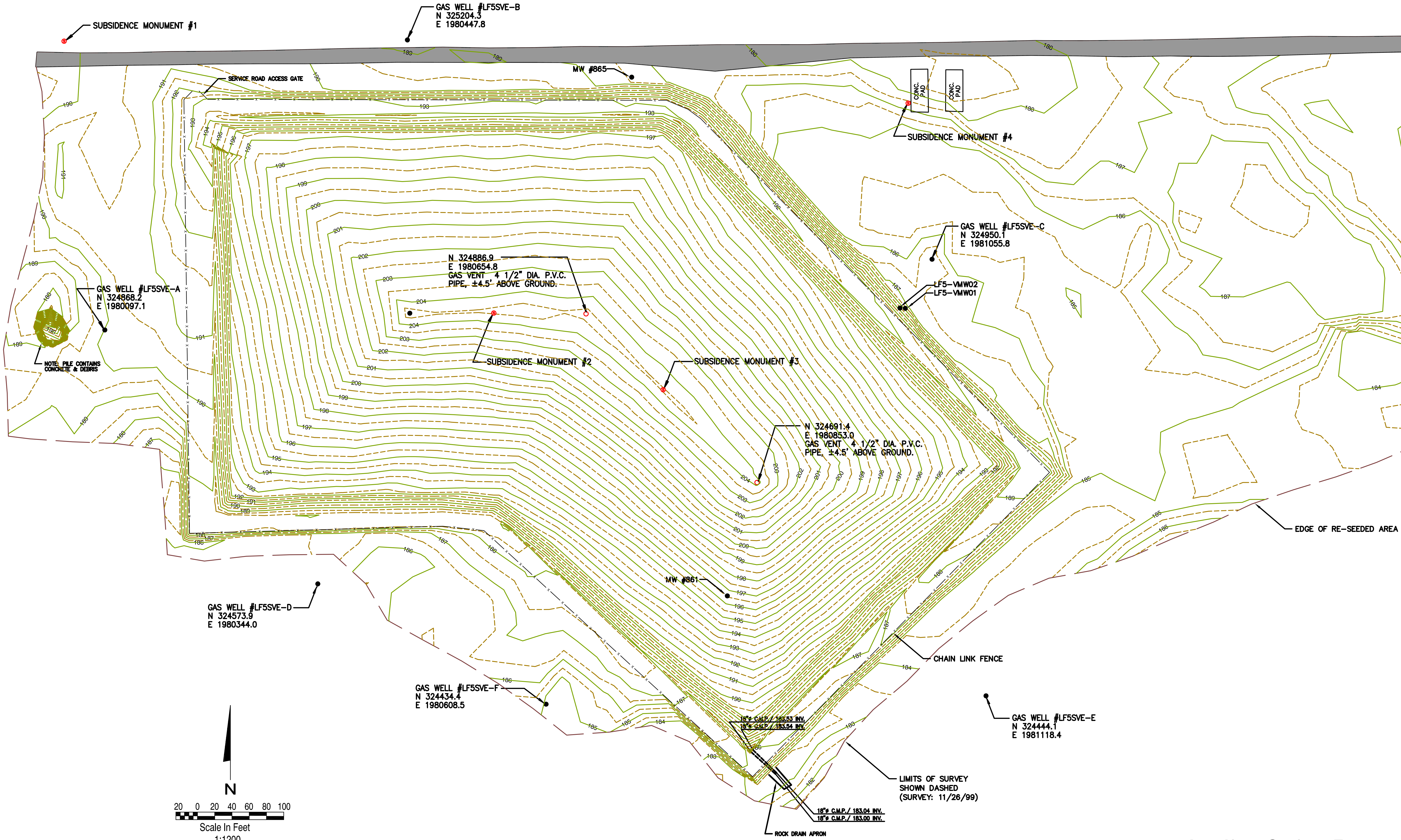
FIGURE 4-3



Landfill 4 Post-Closure Groundwater Monitoring Plan

Five-Year Review
Castle Airport



Landfill 5 Surface Features
Five-Year Review
Castle Airport

Figure 4-5

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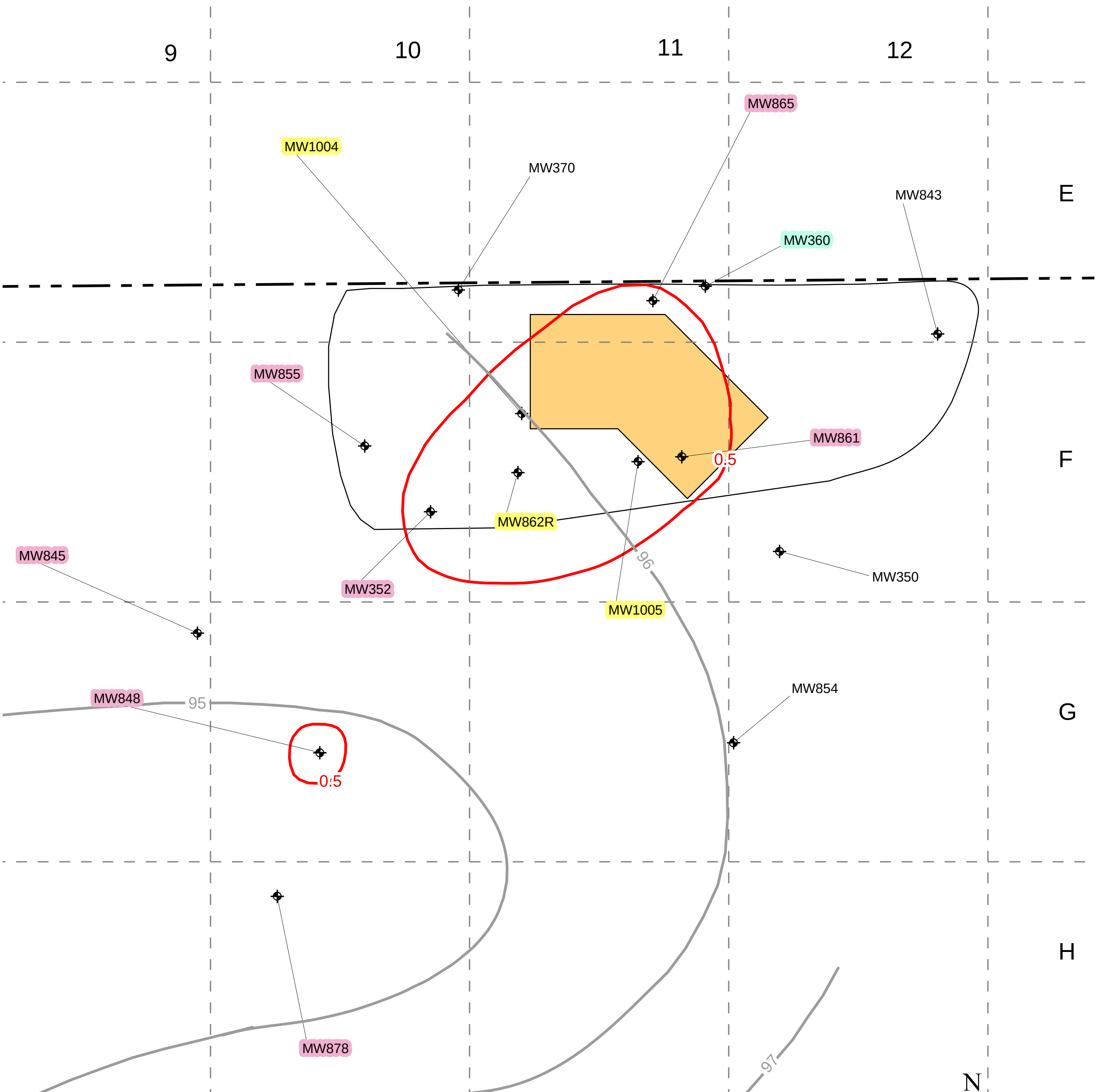
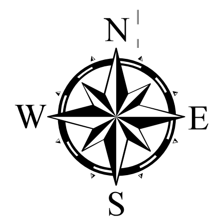


LEGEND

⌖	Monitoring well
⊙	Other well
— — —	Property boundary
(grey line)	Groundwater elevation contour (ft. above msl) - Shallow HSZ
(red line)	Q4/07 TCE plume contour (µg/L) - Shallow HSZ
(orange box)	Landfill Cap
(white box)	Landfill 5 site boundary
MW360	Background monitoring well
MW1004	Detection and corrective action compliance monitoring well
MW855	Corrective action compliance monitoring well



0 550

Scale in Feet
1:6,600

Landfill 5 Post-Closure
Groundwater Monitoring Plan

Five-Year Review
Castle Airport

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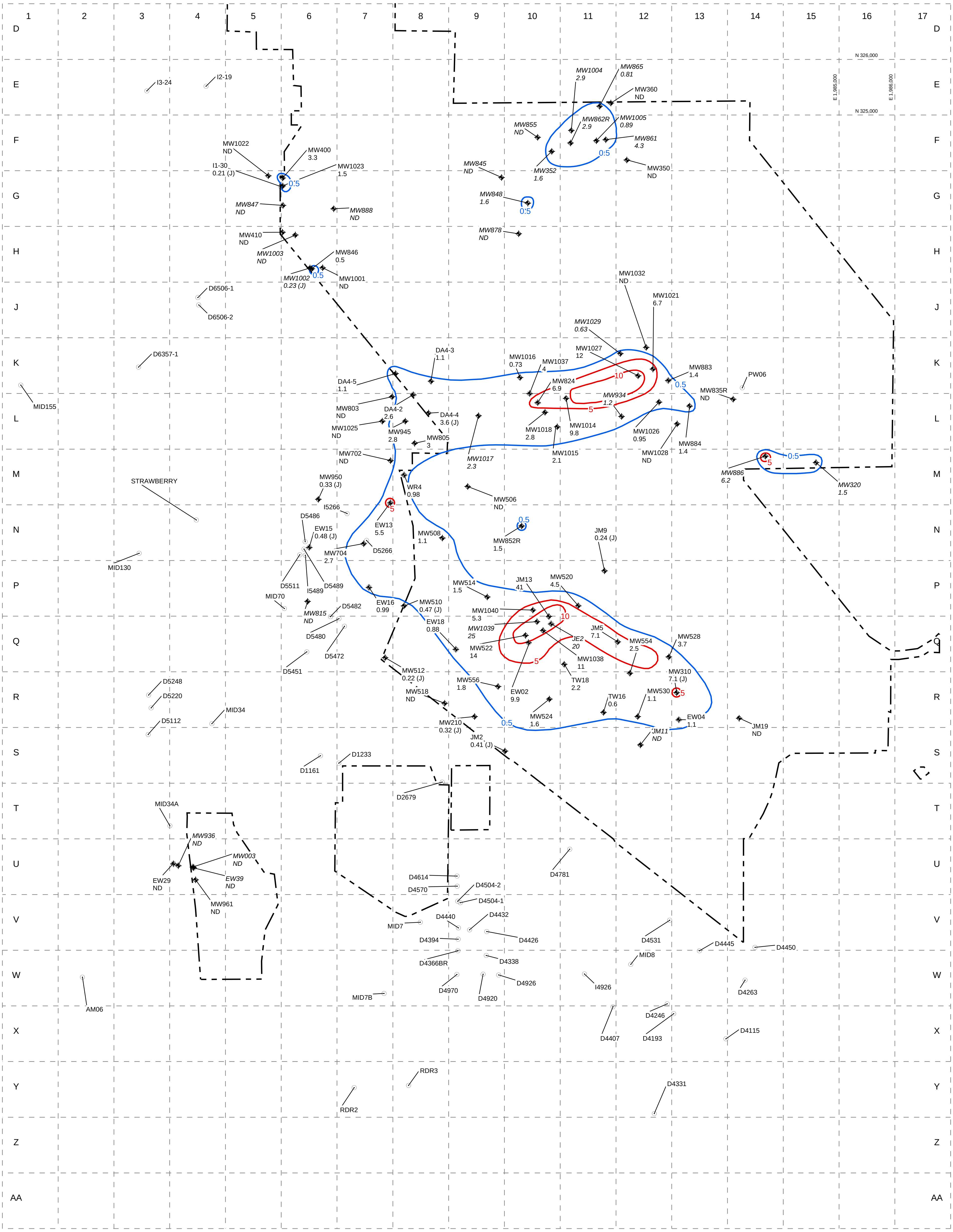
Figure 4-6



LEGEND

- Extraction well
- Injection well
- Monitoring well
- Other well
- Property boundary
- TCE isoconcentration (≥ 5 µg/L) - hand drawn
- TCE isoconcentration (0.5 µg/L) - hand drawn
- * Data not used in contouring
- (J) Estimated value due to trace concentration or quality control deficiency

Note:
Data in italics represent sample results from current quarter

Monitoring, extraction and injection wells not in sampling program are not shown on map.

N
W E
S

0 1,700
Scale in Feet
1:20,400

TCE Plume Delineation Map, Fourth Quarter 2007
Shallow Hydrostratigraphic Zone
Five-Year Review
Castle Airport

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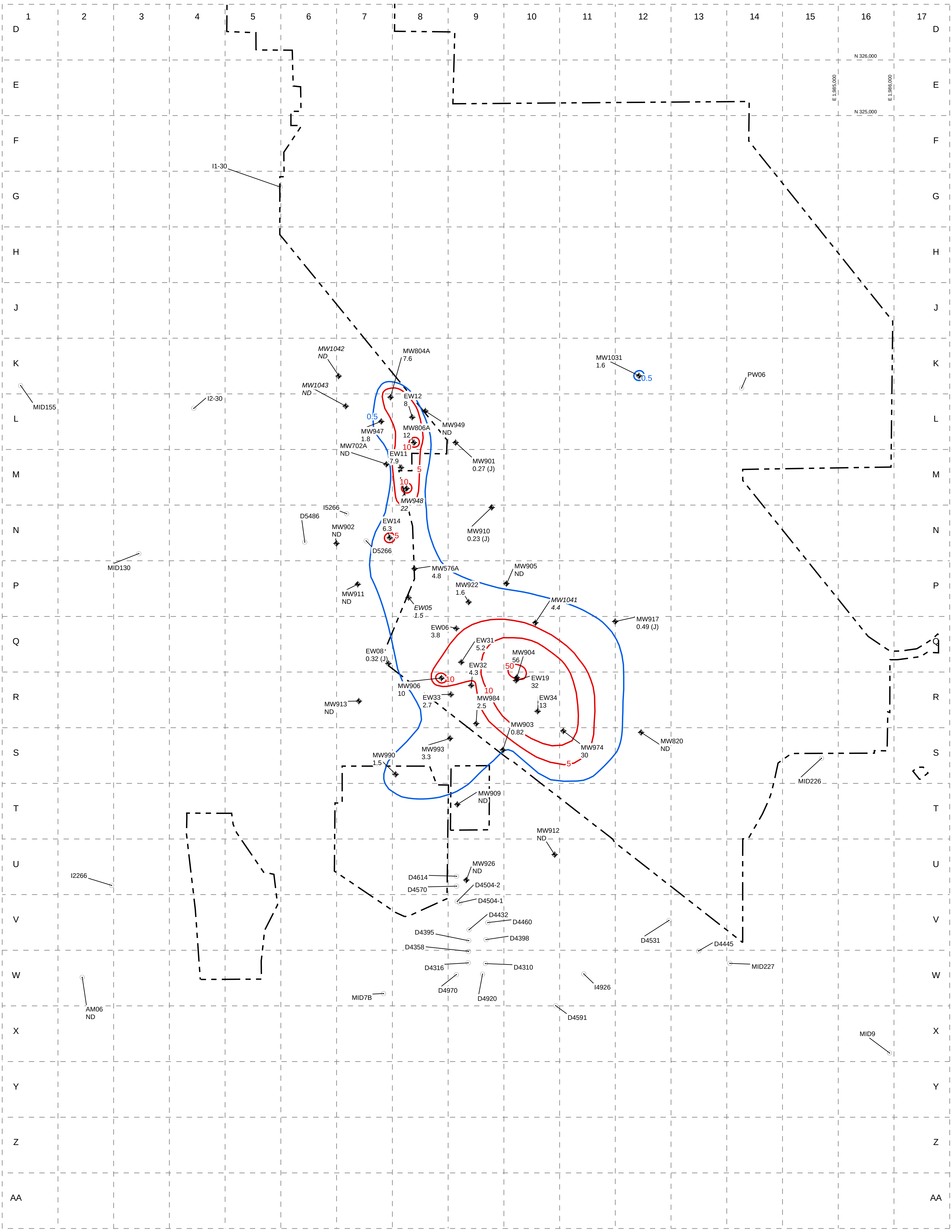
Figure 7-1

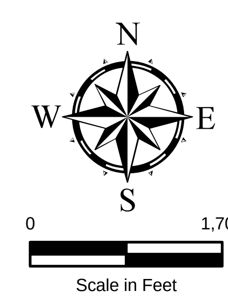


LEGEND

- Extraction well
- Injection well
- Monitoring well
- Other well
- Property boundary
- TCE isoconcentration (≥ 5 µg/L) - hand drawn
- TCE isoconcentration (0.5 µg/L) - hand drawn
- * Data not used in contouring
- (J) Estimated value due to trace concentration or quality control deficiency

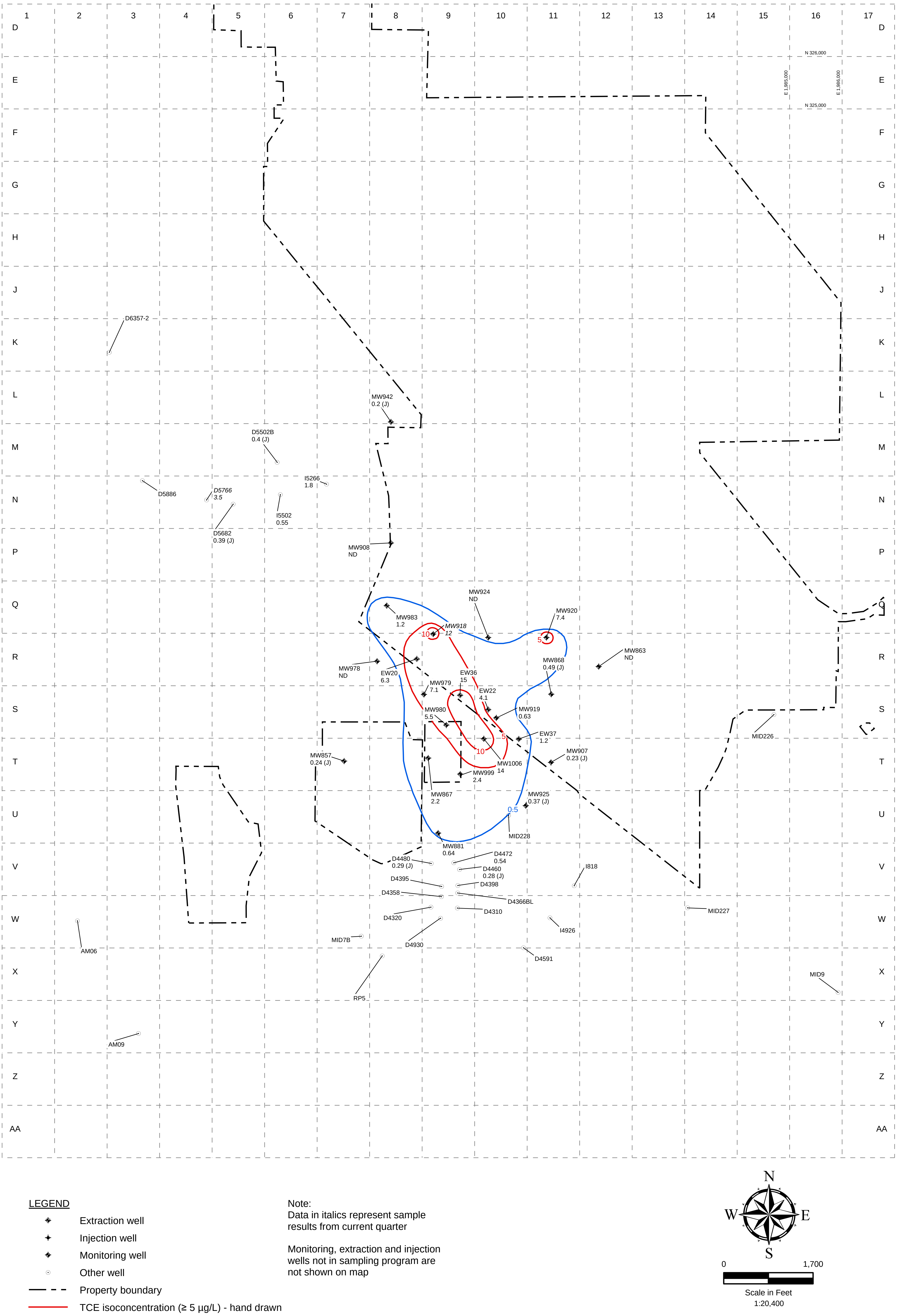
Note:
Data in italics represent sample results from current quarter

Monitoring, extraction and injection wells not in sampling program are not shown on map



TCE Plume Delineation Map, Fourth Quarter 2007
Upper Subshallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport



LEGEND

- Extraction well
- Injection well
- Monitoring well
- Other well
- Property boundary
- TCE isoconcentration (≥ 5 µg/L) - hand drawn
- TCE isoconcentration (0.5 µg/L) - hand drawn
- * Data not used in contouring
- (J) Estimated value due to trace concentration or quality control deficiency

Note:
Data in italics represent sample results from current quarter

Monitoring, extraction and injection wells not in sampling program are not shown on map

TCE Plume Delineation Map, Fourth Quarter 2007
Lower Subshallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport

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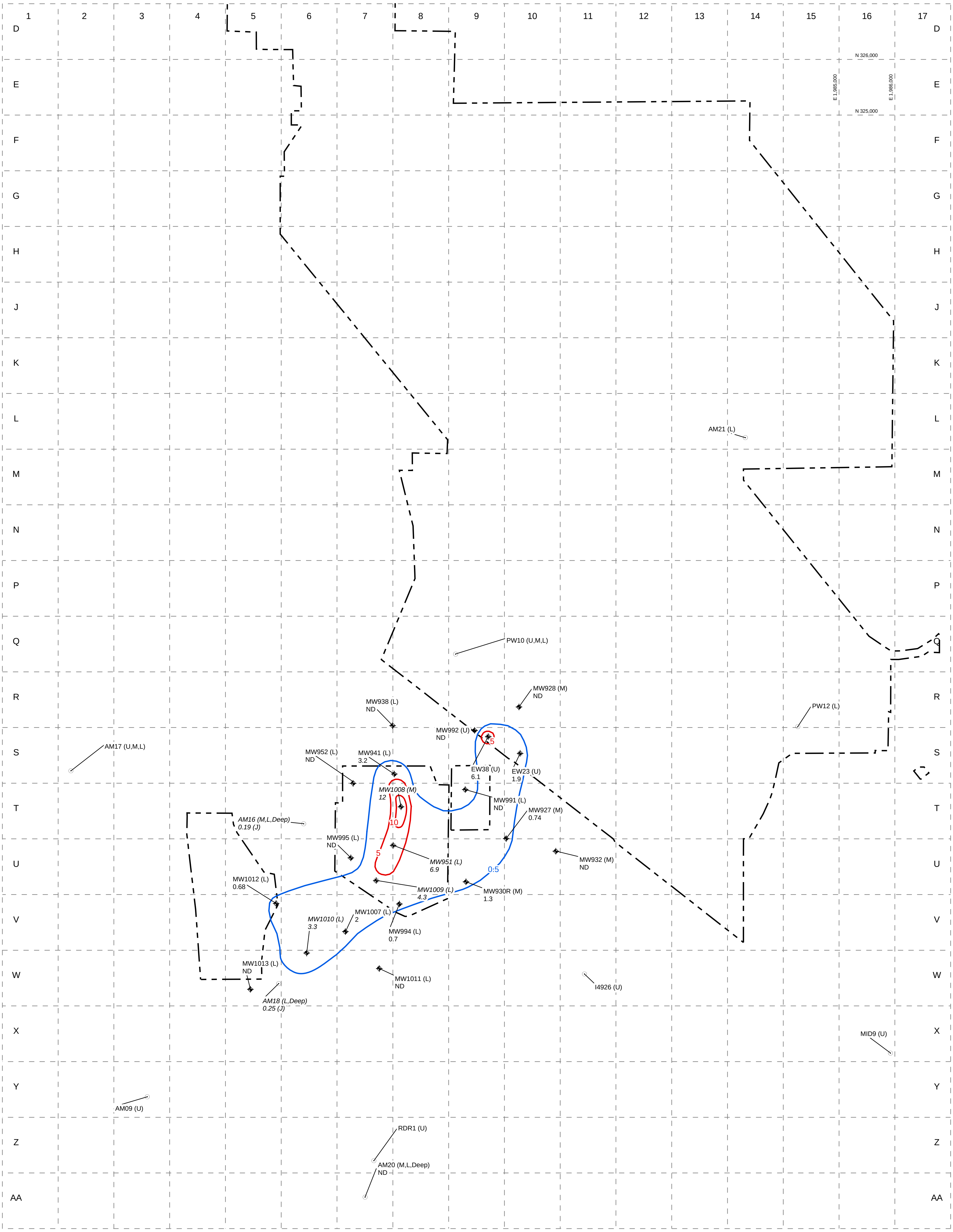
Figure 7-3

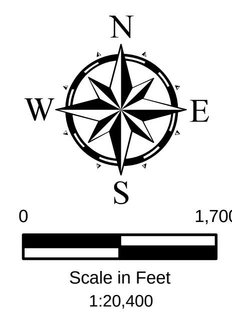


LEGEND

- Extraction well
- Injection well
- Monitoring well
- Other well
- Property boundary
- TCE isoconcentration (≥ 5 µg/L) - hand drawn
- TCE isoconcentration (0.5 µg/L) - hand drawn
- * Data not used in contouring
- (U) Well screened in the upper (U), middle (M), and/or lower (L) layer of the Confined HSZ
- (Deep) Well screened in Deep HSZ
- (J) Estimated value due to trace concentration or quality control deficiency

Note:
Data in italics represent sample results from current quarter

Monitoring, extraction and injection wells not in sampling program are not shown on map



TCE Plume Delineation Map, Fourth Quarter 2007
Confined Hydrostratigraphic Zone
Five-Year Review
Castle Airport

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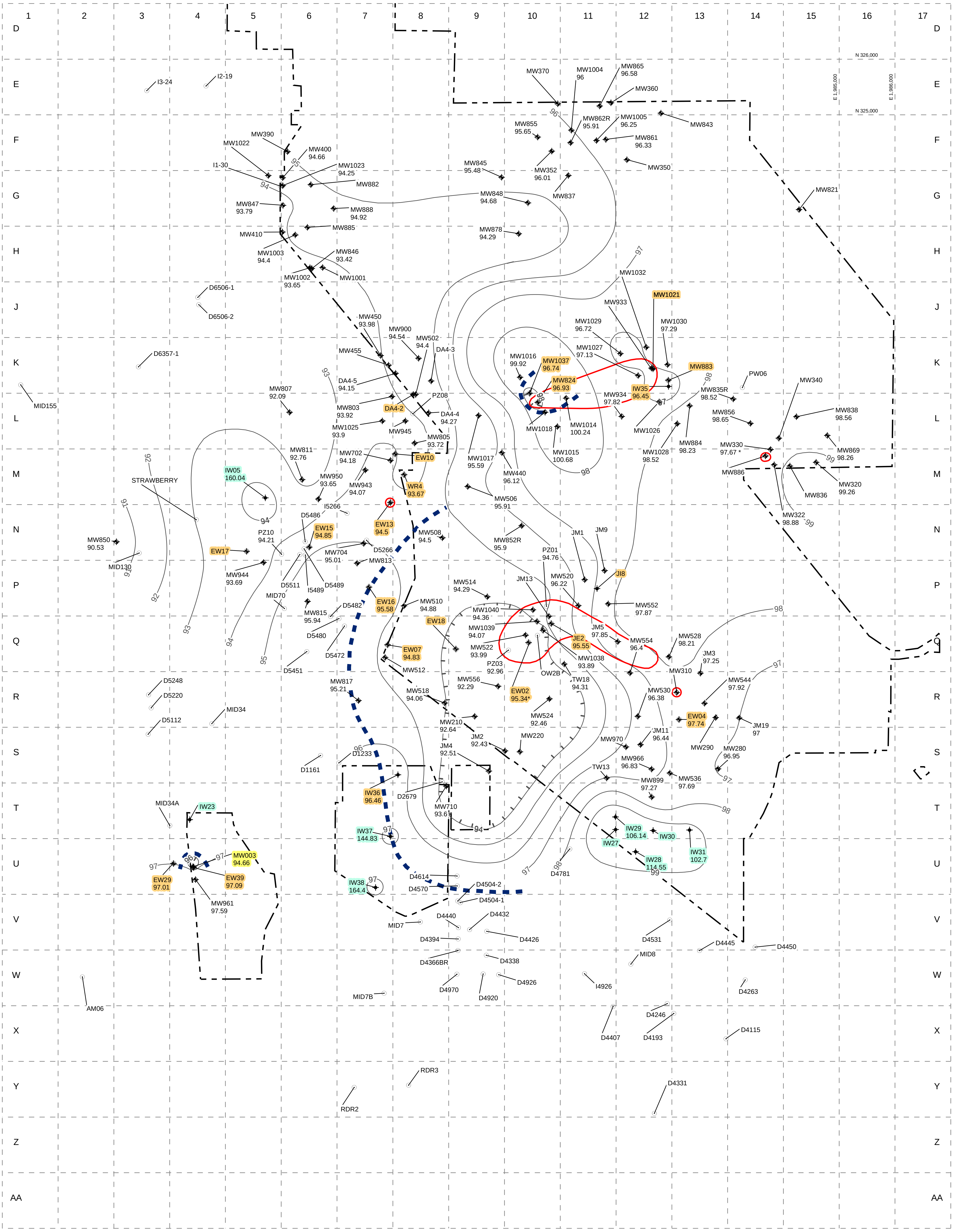
Figure 7-4



LEGEND

- Extraction well
- Injection well
- Monitoring well
- Other well
- Property boundary
- Estimated zone of capture
- Groundwater elevation (ft. above msl)
- Groundwater depression
- 5 µg/L TCE isoconcentration contour

- EW01 Extraction well - on line
- EW02 Extraction well - off line
- IW01 Injection well - on line
- IW02 Injection well - off line
- * Data not used in contouring

Note:
Water levels measured during the first week of October

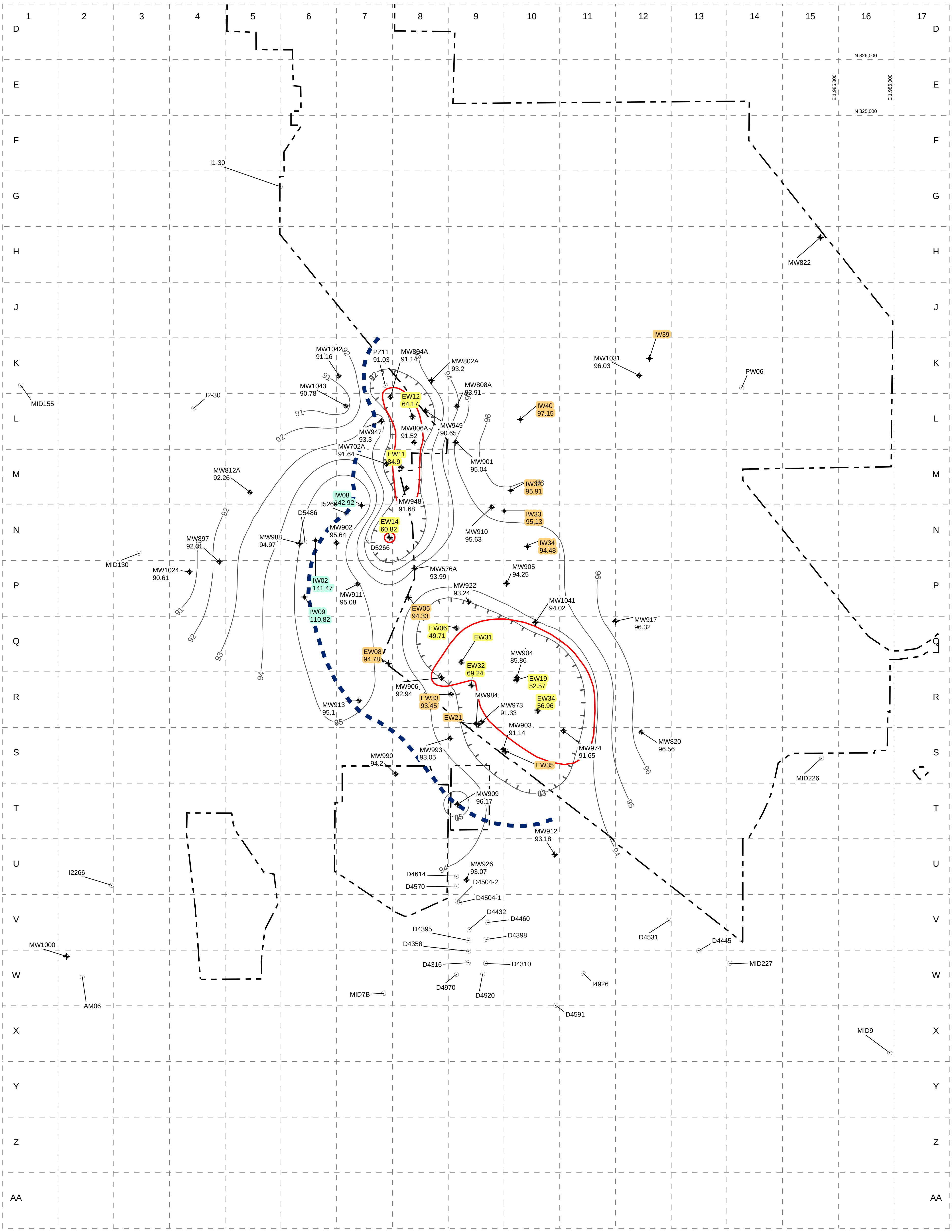
N W E S

0 1,700

Scale in Feet
1:20,400

Estimated Plume Capture, Fourth Quarter 2007
Shallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport

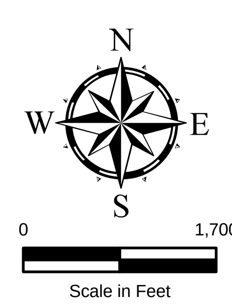


LEGEND

	Extraction well
	Injection well
	Monitoring well
	Other well
	Property boundary
	Estimated zone of capture
	Groundwater elevation (ft. above msl)
	Groundwater depression
	5 µg/L TCE isoconcentration contour

EW01	Extraction well - on line
EW02	Extraction well - off line
IW01	Injection well - on line
IW02	Injection well - off line
*	Data not used in contouring

Note:
Water levels measured during the first week of October



Estimated Plume Capture, Fourth Quarter 2007
Upper Subshallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport

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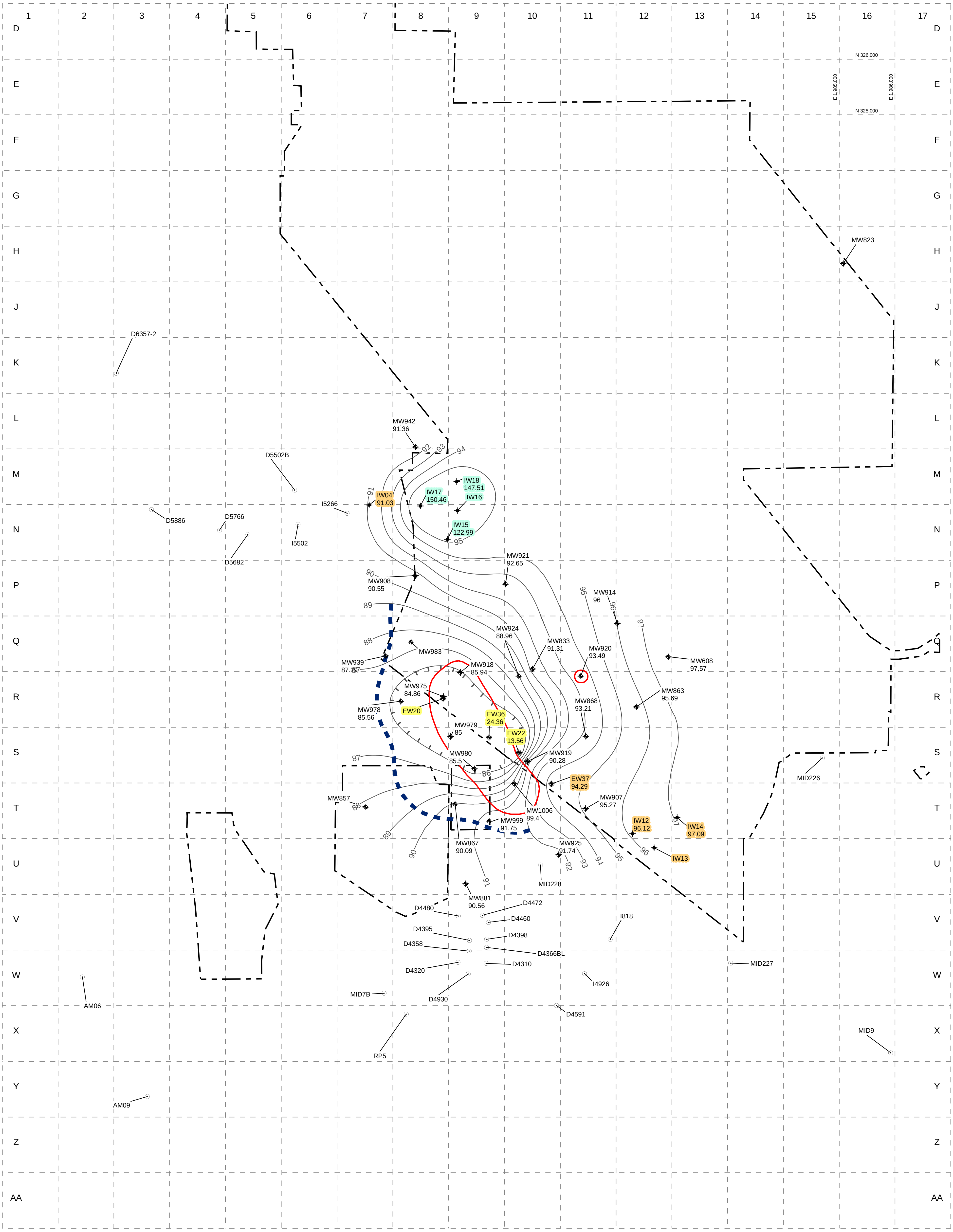
Figure 7-6



LEGEND

- Extraction well
- Injection well
- Monitoring well
- Other well
- Property boundary
- Estimated zone of capture
- Groundwater elevation (ft. above msl)
- Groundwater depression
- 5 µg/L TCE isoconcentration contour

EW01 Extraction well - on line

EW02 Extraction well - off line

IW01 Injection well - on line

IW02 Injection well - off line

* Data not used in contouring

Note:
Water levels measured during the first week of October

N W E S

0 1,700

Scale in Feet
1:20,400

Estimated Plume Capture, Fourth Quarter 2007
Lower Subshallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport

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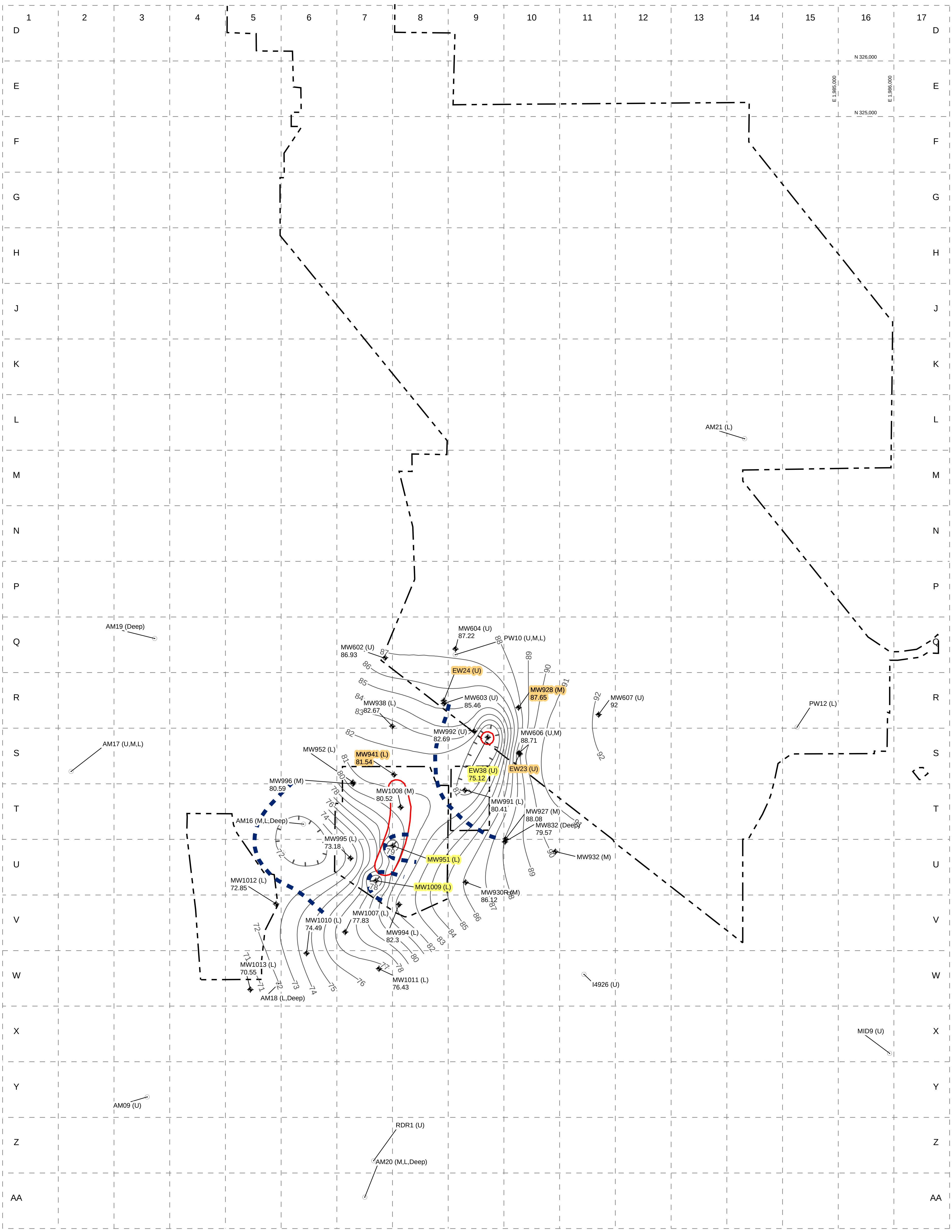
Figure 7-7



<u>LEGEND</u>

Extraction well
Injection well
Monitoring well
Other well
Property boundary
Estimated zone of capture
Groundwater elevation (ft. above msl)
Groundwater depression
5 µg/L TCE isoconcentration contour

EW01 Extraction well - on line
EW02 Extraction well - off line
IW01 Injection well - on line
IW02 Injection well - off line
* Data not used in contouring

Note:
Water levels measured during
the first week of October

N
W E
S

0 1,700
Scale in Feet
1:20,400

Estimated Plume Capture, Fourth Quarter 2007
Confined Hydrostratigraphic Zone

Five-Year Review
Castle Airport

06/09/08 xv h:\castle\ltgsp\2007\2008 Five-year review\cap_cf.mxd 12BC8601

Figure 7-8

APPENDICES

APPENDIX A

Response to Agency Comments

EPA Comments and Responses

**Response to EPA Comments on the
Draft Five-Year Review Report**

For convenience, this response repeats EPA's original comment in standard type, followed by the Air Force response in **bold**.

1. Based on the information presented in this document with respect to the shallow hydrostratigraphic zone ("shallow zone"), the Air Force is currently not in compliance with the Record of Decision for Comprehensive Basewide- Part 1 Groundwater ("CB ROD-Part 1"), which selected "plume capture and treatment to achieve groundwater cleanup to the MCL" for the entire Main Base Plume. While current information suggests that the plume is not migrating off-base, thus, suggesting capture, the Air Force is not actively treating the groundwater in the shallow portion of the Main Base plume. This report should include discussion as to why the Air Force is no longer actively treating groundwater in the shallow zone. The Five-Year Review Report should also include information about the long term strategy for achieving the RAO of treatment to the MCLs. While issues with the Castle Vista plume near MW003 are discussed in detail, no issues with the shallow zone of the main base plume have been discussed. Please add a discussion about the long term strategy for the shallow zone of the Main Base Plume. Also, please highlight this deviation from the ROD as one of the issues that will need to be addressed in the long term.

Response: Concur. The pump-and-treat remedy is no longer active for the Shallow HSZ because of the significant reductions to date in TCE concentration and regulator approved shutdown of extraction wells and the fact that capture of residual contamination is provided by continuing pumping downgradient in the underlying USS HSZ. Given these results and conditions, the Air Force believes that the remedy remains protective. Further complicating the situation, the recent and ongoing decline of water levels has caused several Shallow HSZ extraction wells to go dry and has limited future pump-and-treat options. Because of this, other remedial options to achieve cleanup to MCL levels are being evaluated, such as the in-situ chemical oxidation (ISCO) pilot test planned at MW003 in the off-base Castle Vista area.

A detailed discussion as to why the Air Force is no longer actively treating groundwater from the Shallow HSZ has been added to Section 7.1. In addition, the limited ability to maintain pump-and-treat in the Shallow HSZ and the consequent lack of capture in the Shallow HSZ has been identified as a potential issue for the Main Base Plume in Section 7.1.1.4 and other appropriate sections of the five-year review report. A discussion of plans to test/implement alternative technologies to achieve established cleanup levels has also been added to Section 7.1.1.4 and other appropriate sections.

2. As stated in the previous comment, the Air Force is deviating from the "pump and treat" remedy selected for the shallow zone of the Main Base Plume. Likewise, in the Five-Year Review Report, the Air Force acknowledges that the MW003 wellhead treatment system is currently off. In order to evaluate the long-term protectiveness for both of these cases, the Air Force will need to discuss why the system deviates from the remedy selected in CB ROD – Part 1. For each site, if the Air Force is no longer actively pumping and treating the groundwater because the current system will not achieve MCLs, then the remedy is not protective in the long term until another remedy is selected. If instead, the Air Force is deviating from the remedy in order to optimize the treatment and save time and resources, then the remedy is probably still protective in the long term as long as the old pump and treat system can still be re-activated in the future. Although the ICs currently protect exposure in the short term, they are not considered part of the long term remedy at the site, and cannot be used to justify long term protectiveness.

Response: Concur. See response to General Comment #1. The Air Force views the deviation from the pump-and-treat remedy in the Shallow HSZ as a reflection of the reality of changing site conditions (declining water levels and dry wells) and a means to optimize the treatment process and save time and resources. Reactivation of the OU-1 groundwater treatment system is not realistic but individual components could be reactivated as wellhead systems if appropriate and conditions warrant to maintain capture and/or achieve ROD cleanup levels.

As noted above, a detailed discussion as to why the Air Force is no longer actively treating groundwater from the Shallow HSZ has been added to Section 7.1. In addition, the limited ability to maintain pump-and-treat in the Shallow HSZ and the consequent lack of capture in the Shallow HSZ has been identified as a potential issue for the Main Base Plume in Section 7.1.1.4 and other appropriate sections of the five-year review report. A discussion of plans to test/implement alternative technologies to achieve established cleanup levels has also been added to Section 7.1.1.4 and other appropriate sections.

The Air Force disagrees with the EPA's contention that ICs are not part of long-term protectiveness. The ICs are part of the groundwater remedy established in the CB ROD – Part 2.

3. The protectiveness statements for the Main Base Plume and the Castle Vista Plume are not consistent in the document (ES-2, 5YR Summary Form, 10-1). The executive summary and the Summary Form both state that the remedies are "protective" while in Section 10, these remedies are indicated as "expected to be protective of human health and the environment upon completion". From an editorial standpoint, it is typical that the final protectiveness statements that appear in Section 10 are copied verbatim into the 5YR Summary Form. However, the protectiveness statements in Sections 10.3 to 10.8 are not as clear as the statements in the 5YR Summary Form. Please modify and make consistent the protectiveness statements in the document.

Response: Concur. The protectiveness statements throughout the document have been reviewed and revised to be consistent (Summary Form, Executive Summary and Section 10).

4. The language used to describe the current knowledge about TCE toxicity is confusing. Instead of the explanation that simply states, "Toxicity parameters for trichloroethene (TCE), the primary contaminant, have been withdrawn from the Integrated Risk Information System (IRIS)," please add the following language:

> *Since the 1996 Comprehensive Basewide Remedial Investigation/ Feasibility Study-Part 1 Baseline Human Health Risk Assessment, EPA initiated a re-assessment of TCE toxicity; this assessment is currently under review. In the interim, EPA is using toxicity values developed by Cal/EPA, because they meet the criteria outlined in Superfund's policy on provisional peer-reviewed toxicity values. The Cal/EPA toxicity value is reflected in EPA's 2008 Regional Screening Level (RSL) table. The RSL table was developed using the latest toxicity values, default exposure assumptions and physical and chemical properties and is consistent with the OSWER chemical toxicity hierarchy. For TCE, the current MCL is 5 ug/L and the concentrations at either end of EPA's risk range using the Cal/EPA toxicity values are 1.7 ug/L to 170 ug/L.*

As written the document is unclear as to why the toxicity information is not currently available in IRIS.

Response: Concur. The suggested language has been added to the five-year review report and has replaced the current discussion of TCE toxicity.

5. There are several references in the document that indicate that groundwater levels are decreasing in the area (p. 4-9, 5-2, 7-12) leading, for example, to the shut down of the MW003 system and the MW824/MW1037 system. If water levels in the region are declining, the five-year review should address the potential that contamination is being left in the vadose zone that could be a source of groundwater recontamination should water levels rise again.

   Response: Concur. Discussion of the fact that water levels in the Shallow HSZ at Castle AFB are declining have been expanded in selected areas of Section 4. An expanded discussion of the consequences of declining water levels, including the potential for relatively low concentrations of TCE being left in the vadose zone, has been added to Section 7.1.1.

6. The EPA recommends that the Air Force implement a round of screening level sampling to test for 1,4-dioxane, since it has not been tested for previously. This is particularly important for discharge of the effluent from the Phase 3 treatment system.

   Response: Concur. The Air Force will conduct a round of sampling for 1,4-dioxane as part of the LTGSP Q1/09 sampling event. A list of plants/wells to be sampled will be prepared and submitted for regulatory agency review and concurrence prior to the sampling event. At a minimum, all treatment plant influents and/or effluents will be sampled. In addition, monitoring wells where past reported concentrations of 1,1,1-TCA have exceeded 1 µg/L will be sampled (based on preliminary review, about 5-10 wells). Sampling results will be presented to the regulatory agencies along with Air Force recommendations.

7. In this Five-Year Review, the Air Force recommends no further ecological monitoring for the SCOU sites where LTEM was selected as part of the remedy. The data do not lead the EPA to conclude there is any problem with the remedy, but the data are not conclusive enough to justify the termination of long term monitoring. Thus, the EPA requires at least one more round of ecological monitoring in order to obtain more robust data. Unfortunately, there were two problems with this monitoring event which prevent the EPA from agreeing that further monitoring is unnecessary. First, the weather last winter produced a generally poor vernal pool community. This was especially true of the pools which could serve as reference sites. Second, it is clear the monitoring event was not sufficiently coordinated with the Bureau of Prisons in that pools which could have been used as reference sites were declared off limits by the prison guards.

   In order to address both of these problems with the next round of monitoring, the EPA suggests the following. The monitoring should not be linked to an inflexible schedule of years. Instead, the Air Force should be prepared to perform the monitoring once more during the next five years following a winter and spring of rainfall and temperature adequate to produce vigorous biological activity in the vernal pools. The Air Force must also communicate early and often with the Bureau of Prisons during the planning and execution of the monitoring events. This communication must include the warden and guards at the prison so there are no restrictions placed on the selection of reference pools. If a second round of ecological monitoring is performed without climatic or law enforcement restrictions and this monitoring again demonstrates no difference between reference and contaminated pools, the EPA will agree to the suspension of subsequent monitoring.

   Response: Concur. The Air Force agrees to conduct one additional round of LTEM for the five listed sites and the recommendation to cease LTEM has been removed

from all sections of the document. Within the constraints of contracts and contracting cycles, the Air Force will attempt to conduct this next round of LTEM at any point during the next five years when moisture conditions are more optimal.

The Air Force will make every effort to communicate early and often to coordinate the next LTEM event. Even given "perfect" communication timing and substance, the Air Force cannot guarantee that the BoP will place no restrictions on the selection of reference pools.

Specific Comments

1. Five-year Review Summary Form: The protectiveness statements for ETC-10, ETC-12, FTA-1, LF-3, and LF-5 all include the following sentence "Based on these results, it is recommended that LTEM be discontinued." Please remove this monitoring program recommendation from the protectiveness statement as it does not pertain to remedy protectiveness.

Response: Concur. The statement regarding LTEM has been removed from the protectiveness statements in the Review Summary Form for ETC-10, ETC-12, FTA-1, LF-3 and LF-5.

2. Section 3, Background, Page 3-11, First Paragraph: The phrase "produce pathway" seems to be out of place. Please revise this sentence.

Response: Concur. The phrase at the end of the last sentence of Section 3.5.2 ("without consideration of the produce pathway") has been deleted as it is not necessary.

3. Section 3, Background, Page 3-12, 4th paragraph: The document states "However, the Scoping and Phase I ERA (Jacobs, 1995) identified LF-3 as one of 25 SCOU sites…" It is likely that this is a typographical error as focus of the section is ETC-12.

Response: Concur. In the third line of the last paragraph of Section 3.5.2.2, "LF-3" has been changed to "ETC-12."

4. Section 3, Background, Page 3-15: For consistency with the discussion of Landfills 3 and 5, please include information about the ecological risk at Landfill 4. This may simply be a statement as to why the Phase 1 ERA did not consider Landfill 4 potential habitat.

Response: Concur. A third paragraph has been added to Section 3.5.2.5. This paragraph indicates that the Scoping and Phase 1 ERA (Jacobs, 1995) did not identify LF-4 as a site with the potential to impact ecological habitat. The primary reason was the lack of sensitive ecological habitat at and in the vicinity of LF-4.

5. Section 4, Removal/Remedial Actions, Page 4-4, last paragraph, 2nd sentence: This sentence is unclear as to what is being referred to, either the Phase 3 system or the wellhead treatment systems, as the "final system." Please reword this sentence.

Response: Concur. The sentence has been revised to read "Although completely independent of the Phase 3 system, these wellhead systems are defined as components of the Phase 3 system as the Phase 3 system has been identified as the "final" system for Main Base Plume remediation."

6. Section 4, Removal/Remedial Actions, Page 4-14, last full paragraph, fourth to the last sentence: The sentence that "[I]n addition, implementation of the selected remedy will not threaten sensitive ecological habitats" seems out of place here since the focus of this paragraph is mostly institutional controls. This sentence should probably be placed after the first sentence of the paragraph and tied into the wetlands at the site before the discussion of ICs to protect human health.

Response: Concur. The listed sentence has been moved to the beginning of the last full paragraph on page 4-14.

7. Section 5, Progress Since Last Review, Page 5-3: The SCOU ROD issues section discusses lead and benzo(a)pyrene concentrations remaining in place. While it states that ICs were identified as the preferred alternative, it is not clear whether the ICs are now in place.

Response: Concur. ICs for the ETC-10 site were already in place as part of the transfer of property to the BoP. The letter of transfer includes the stipulation that ETC-10 and vicinity (and the rest of the buffer area surrounding the prison) must remain as open space. This information has been added to the Section 5.2 discussion of ETC-10.

8. Section 5, Progress Since Last Review, Page 5-3: Section 5.2 discusses which SCOU sites were assessed in the previous review. This list appears to leave out ETC-8, which was mentioned in the Executive Summary. Also, this section should mention that ETC-8 and DP-4 are no longer being evaluated as a part of the five-year review process since their final remedies do not leave contamination in place at levels of concern.

Response: Concur but assume that the reference to DP-4 (a disposal pit at Landfill 4) is a typographical error and that EPA meant to cite DA-4. A brief summary of the ETC-8 action has been added to Section 5.2. For both ETC-8 and DA-4, text has been added to Section 5.2 stating that these sites are no longer being evaluated as part of the five-year review process because no contaminants precluding unlimited use and unrestricted exposure were left in place.

9. Section 6, Five-year Review Process: The date of distribution and a copy of the community notification should be included with the five-year review, perhaps in an appendix. The statement “Consequently, formal document review, data review and interview tasks were not required for this five-year review” is not correct. Please explain how the Air Force satisfied these requirements.

Response: Concur. The date of the distribution of community notification has been added to Section 6 and a copy of the initial community notification has been included as Appendix C.

The second paragraph of Section 6 was an oversimplification and has been revised. Because Jacobs is on site, coordinates frequently with other base contractors and is aware of all ongoing actions and issues at the former base, formal interviews with other base contractors were not conducted. All CERCLA site closure reports and landfill monitoring reports completed by other contractors during this five-year review period were reviewed and the information used in preparation of the five-year review document.

Formal interviews with possibly interested parties were not conducted because Jacobs’ on-site personnel are in regular contact with representatives of the property owner (Merced County Department of Commerce, Aviation and Economic Development), the site developer (Castle Commerce Center) and airfield operations personnel. The local Restoration Advisory Board (RAB) was disbanded over a year ago because on-site operations were winding down and community interest was minimal. Jacobs’ on-site personnel do maintain regular contact with owners of property adjacent to the base

because many are interested in the wells on their property – mainly when those wells will be abandoned.

10. Section 7, Main Base Plume, Question A: As noted in General Comment 1, the remedy at this site is not completely functioning as intended since the Air Force is no longer actively pumping and treating the shallow zone contamination. While this may not affect the short term protectiveness of the remedy, EPA guidance specifically recommends that the AF evaluate whether the performance standards are likely to be met.

    Response: Concur. The pump-and-treat remedy is no longer active for the Shallow HSZ because of the significant reductions to date in TCE concentration and regulator approved shutdown of extraction wells and the fact that capture of residual contamination is provided by continuing pumping downgradient in the underlying USS HSZ. Given these results and conditions, the Air Force believes, as is stated in the comment, that the remedy remains protective. Further complicating the situation, the recent and ongoing decline of water levels has caused several Shallow HSZ extraction wells to go dry and has severely limited any future pump-and-treat options. Because of this, other remedial options to achieve cleanup to MCL levels are being evaluated, such as the in-situ chemical oxidation (ISCO) pilot test planned at MW003 in the of-base Castle Vista area.

    To address EPA guidance, the limited ability to maintain pump-and-treat in the Shallow HSZ has been identified as a potential issue for the Main Base Plume in Section 7.1.1.4 and other appropriate sections of the five-year review report. Plans to test/implement alternative technologies to achieve established cleanup levels are mentioned.

11. Section 7, Main Base Plume, Question B: In the assessment of the Main Base Plume remedial action, the document states: "There have been no changes to exposure parameters, potential exposure pathways or site/land use conditions since the last five-year review." However, it appears that the Air Force has not conducted a screening level evaluation of the vapor intrusion exposure pathway. The Air Force should include a screening level assessment of the vapor intrusion pathway for the Main Base Plume in this Five-Year Review Report.

    Response: Concur. The Air Force has conducted a screening level assessment of the vapor intrusion pathway for the Main Base Plume. The screening level assessment was conducted using the DTSC automated screening tool (automated Excel spreadsheet), recent depth-to-water information for Shallow HSZ monitoring wells and recent contaminant concentration data (TCE) for the Main Base Plume. The results of this screening level assessment have been added to the Five-Year Review Summary Form, the Executive Summary, Section 7.1.2.4, Section 8.1 and Section 10.1.

12. Section 9, Recommendations and Follow-up actions: The Air Force should include a schedule of when the recommendations will be implemented. Also, the Air Force should state which entity is responsible for implementing the recommendations.

    Response: Concur. Schedule and responsible party information has been included in each of the individual write-ups in Section 9 with recommended actions (Main Base and Castle Vista plumes – alternative remedial approach evaluation; ETC-10, ETC-12, FTA-1, LF-3 and LF-5 – continue LTEM).

13. Section 10, Protectiveness Statements, Page 10-3. The signatory for EPA needs to be changed. Michael Montgomery is now the signatory. In addition, the title for that position is now "assistant director" instead of "branch chief."

Response: Concur. The signature block for the EPA has been changed to "Michael Montgomery, Assistant Director.

RWQCB Comments and Responses

Response to RWQCB Comments on the
Draft Five-Year Review Report

For convenience, this response repeats RWQCB's original comment in standard type, followed by the Air Force response in **bold**.

California Regional Water Quality Control Board, Central Valley Region (Regional Water Board) staff has reviewed the Draft Five-Year Review Report (Draft 5YRR) received on 15 August 2008. The purpose of the Draft 5YRR is to determine if the ROD-selected remedies are protective of human health and the environment, and if not, identify any issues and provide recommendations to address them. The Regional Water Board staff's General and Specific Comments are presented below.

General Comments

1. Remedial actions were completed and/or regulatory occurrence on no further action (NFA) was obtained for several Source Control Operable Unit (SCOU) sites, including ETC-8, B51/54 Group, DA-4, and DA-5, during the past five years. However, the Draft 5YRR does not discuss these sites. Revise the Draft 5YRR to include discussion of the actions conducted at these sites and whether they continue to pose a threat to human health and the environment.

Response: Per EPA guidance, five-year reviews are to address long-term or ongoing remedial actions and sites where residual contamination does not allow for unlimited use and/or unrestricted exposure. ETC-8 and DA-4 are mentioned in the Executive Summary as sites closed (no further action required) during the current five-year review period. A similar brief mention of B51/B54 and DA-5 has been added to the Executive Summary (end of second paragraph). The summary status of every Castle IRP site is included in Table 1-1

2. Most of the remedial actions completed at the SCOU sites were conducted without consideration of potential vapor intrusion into existing and/or future buildings constructed on these sites. Please add a section to the Draft 5YRR that discusses the potential risk posed by residual volatile constituents of concern at the former Castle AFB. This new section should discuss and assess the threat posed by residual volatile CoCs in both soil and groundwater (off-gassing).

Response: The Air Force does not believe that a section discussing the potential vapor intrusion risk posed by residual volatile constituents in the vadose zone at Castle is warranted. SVE or other appropriate removal/remedial actions have been implemented at all Castle vadose zone or soil contamination sites with significant VOC contamination. The majority of VOC mass has been removed from all sites. Potential vapor intrusion was evaluated for sites remediated during the latter part of the CERCLA process (generally those sites with higher levels of contamination or those that proved more difficult to remediate, e.g., DA-4, F-4, B51/B54) and no significant indoor air risk was identified for any of these sites. Given the standardization of the removal/remedial actions at Castle and the fact that similar cleanup standards were applied to all vadose zone removal/remedial actions, it is reasonable to assume that vadose zone sites addressed earlier in the CERCLA process would also have no significant vapor intrusion or indoor air risk.

Concur regarding the potential vapor intrusion risk posed by volatile constituents in the groundwater. The Air Force has conducted a screening level assessment of the vapor intrusion pathway for the Main Base Plume. The screening level assessment was conducted using the DTSC automated screening tool (automated Excel spreadsheet),

recent depth-to-water information for the Shallow HSZ and recent contaminant concentration data (TCE) for the Main Base Plume. The results of this screening level assessment have been added to the Five-Year Review Summary Form, the Executive summary, Section 7.1.2.4, Section 8.1 and Section 10.1.

3. As discussed at the 22 October 2008 Castle BCT meeting, the Air Force has never tested groundwater or effluent from operating pump and treat systems for 1,4-dioxane because it is typically associated with 1,1,1-trichloroethane, which is not a primary contaminant of concern at the former Castle AFB. However, 1,4-dioxane has been detected at several sites within our region, including the Tracy Defense Distribution Depot and Aerojet, and these detections do not appear to be associated with 1,1,1-trichloroethane. Please add a recommendation to the Final 5YRR to investigate the potential occurrence of this emerging chemical of concern.

Response: Concur. The Air Force will conduct a round of sampling for 1,4-dioxane as part of the LTGSP Q1/09 sampling event. A list of plants/wells to be sampled will be prepared and submitted for regulatory agency review and concurrence prior to the sampling event. At a minimum, all treatment plant influents and/or effluents will be sampled. In addition, monitoring wells where past reported concentrations of 1,1,1-TCA have exceeded 1 µg/L will be sampled (based on preliminary review, about 5-10 wells). Sampling results will be presented to the regulatory agencies along with Air Force recommendations.

4. In several sections on that discuss the Main Base plume, it is noted that the "toxicity parameters for trichloroethene (TCE) have been withdrawn from the Integrated Risk Management System (IRIS), but the MCL has not changed". This seems to identify a potential significant issue during a future five-year review, so revise the Draft 5YRR to briefly discuss how future changes in the toxicity parameters may affect Castle's remedial objective for TCE.

Response: Concur. The EPA, in their review comments, suggested that the following language be used in place of the current language for toxicity parameters for TCE:

"Since the 1996 Comprehensive Basewide Remedial Investigation/ Feasibility Study-Part 1 Baseline Human Health Risk Assessment, EPA initiated a re-assessment of TCE toxicity; this assessment is currently under review. In the interim, EPA is using toxicity values developed by Cal/EPA, because they meet the criteria outlined in Superfund's policy on provisional peer-reviewed toxicity values. The Cal/EPA toxicity value is reflected in EPA's 2008 Regional Screening Level (RSL) table. The RSL table was developed using the latest toxicity values, default exposure assumptions and physical and chemical properties and is consistent with the OSWER chemical toxicity hierarchy. For TCE, the current MCL is 5 ug/L and the concentrations at either end of EPA's risk range using the Cal/EPA toxicity values are 1.7 ug/L to 170 ug/L."

This language has replaced the existing text in each location where toxicity parameters for TCE are discussed. The Air Force does not see a need or benefit of speculating on what future possible changes or the affects of those changes may be.

5. New sites that were identified and investigated during the past five years, like the Practice Grenade Range, should be briefly discussed in the Draft 5YRR. Add a new section to the Final 5YRR that addresses these new sites.

Response: See the response to General Comment #1. Non-CERCLA sites closed during the past five years (fuel SVE sites, practice grenade range) are not appropriate for evaluation in a five-year review.

6. The Draft 5YRR proposes to terminate long-term ecological monitoring at ETC-10, ETC-12, FTA-1, Landfill 3, and Landfill 5. Regional Water Board staff defer to the EPA and DTSC on these ecological issues.

Response: Concur. The EPA and the DTSC have both requested that one round of LTEM be conducted sometime during the next five-year review period to better confirm that there are no ecological impacts. The Air Force agrees to conduct one additional round of LTEM for the five listed sites.

7. The Draft 5YRR provides a detailed discussion of the changes in Castle's groundwater plumes since 1994. Although it is not clear in all sections of the document, this discussion is directed at changes to the MCL plume boundaries and not the full extent of the plumes. To avoid misleading the reader, revise the Draft 5YRR to clarify that the discussion of groundwater plumes or changes to groundwater plumes over time is applicable only to those portions of the plumes exceeding the MCL.

Response: Concur. Text throughout the five-year review document has been updated to make it clear that discussion of plume extent is related to MCL plume boundaries and not the 0.5 µg/L TCE contours.

8. After the MCL was achieved and no rebound of TCE was observed for a year, the Air Force terminated monitoring of the Landfill 1 groundwater plume in 2001, the East Base groundwater plume in 2003, the Landfill 4 groundwater plume in 2006, and the North Base groundwater plume in 2007. Recently, we have observed a few areas where TCE concentrations have increased or rebounded above the MCL such as monitoring wells MW320 and MW886 near Site FTA-1. Regional Water Board staff recommends sampling a few selected wells from these areas as part of the five-year review process to further confirm rebound has not occurred. The Draft 5YRR should be revised to include a recommendation to conduct verification sampling in selected wells within the former hotspot areas of these plumes during the next five-year period. The results should be reported in the annual groundwater monitoring reports and briefly summarized in the next five-year review report.

Response: Concur. The Air Force agrees that limited confirmatory sampling in the areas of the former Landfill 1, Landfill 4, and North Base plumes is reasonable. As noted, such sampling has already been conducted and is ongoing in the area of the former East Base Plume/FTA-1. Such sampling will be conducted as part of the 2009 LTGSP and results will be reported in the LTGSP semiannual or annual reports. The Air Force does not agree that the sampling or the recommendation for such sampling should be included in the five-year review document. It is further noted that sampling options may be severely limited because of declining water levels in the Shallow HSZ and the fact that several Shallow HSZ monitoring wells in areas where plumes have been eliminated have been destroyed, with regulatory agency approval, in recent years.

9. Exceedances of ROD-specified discharge standards for calcium, chloride, and total dissolved solids were identified as an issue during the previous five-year review period. The Draft 5YRR indicates exceedances are still occurring, but provides no data to support this statement and does not discuss whether the exceedances are more or less frequent than occurred during the previous five-year review period. Many extraction wells have been shutdown during the past five years including all of the shallow hydrostratigraphic zone (HSZ) extraction wells, so changes to the effluent concentrations of these three constituents are expected. Revise the Draft 5YRR to discuss this issue in detail and provide a table showing the background concentrations for each HSZ versus the discharge concentrations over the past five years.

Additionally, please tabulate all of the calcium, chloride, electrical conductivity and total dissolved solids data collected from effluent samples and monitoring/extraction wells to date and send it to me in an Excel™ file. Also, send a copy of the *Project Note* (Jacobs, April 2002) that supports the statement "studies have documented the prohibitive cost of treating extracted groundwater to reduce calcium, chloride, and total dissolved solids concentrations in plant effluent". Regional Water Board staff will review the data and assess whether a new waste discharge order is now warranted

Response: Concur. A discussion and table of calcium, chloride and total dissolved solids (TDS) background data and data for the past five years have been added to the five-year review document.

Separate from the five-year review process, an Excel file including all calcium, chloride, electrical conductivity and TDS data will be provided to the RWQCB (and DTSC and EPA upon request). Assuming it can be found, a copy (electronic or hard) of the project note referenced in the comment will also be provided to the RWQCB.

Specific Comments

1. Executive Summary, Page ES-1: The second paragraph indicates remedial actions were completed and regulatory concurrence on "no further action (NFA)" achieved during the previous five-year review for sites DA-4 and ETC-8. Remedial actions and/or concurrence on NFA actually occurred during the present five-year review period, so please revise this section accordingly.

   Response: Concur. The text of the second paragraph of the Executive Summary has been modified to reflect the fact that the DA-4 site was addressed in the previous five-year review but the ETC-8 site was not. The closing sentences for the discussions of both the DA-4 site and the ETC-8 site now read "- - - - - completed and the site closed (no further action) with regulatory agency approval during this five-year review period."

2. Section 1, Page 1-2: The last paragraph in this section indicates the second five-year review report was not signed by the regulatory team. Revise this section to include a brief discussion of why the regulatory team did not sign this report.

   Response: Concur. The sentence in question was poorly worded in that it could be interpreted that the second five-year review was not signed by the regulatory agencies. The next-to-last sentence in the paragraph has been revised to read "The second five-year review was completed in September 2002, and, following an extended period of discussion, was signed by the EPA and the state regulatory agencies and issued as final on 23 January 2004 (Jacobs, 2004a)."

3. Table 1-1: For Site DA-5, the table should be revised to indicate institutional controls were placed on the site due to Non-CERCLA residual contaminants.

   Response: Concur. The "Rationale for Exclusion" column for DA-5 in Table 1-1 has been revised to read as follows: Site is NFA (SVE remedial action completed; no E&D and BV); ICs were placed on the site due to non-CERCLA residual contaminants

4. Table 2-1: Provide references for the termination of Landfill 4 plume monitoring in December 2006 and the termination of monitoring of the North Base plume in December 2007.

Response: Concur. The following references have been added to Table 2-1:

- **Landfill 4 plume monitoring terminated – Jacobs, 2007a (Long-Term Groundwater Sampling Program 2006 Annual Report)**
- **North Base Plume monitoring terminated – Jacobs, 2008 (Long-Term Groundwater Sampling Program 2007 Annual Report)**

5. Section 3.5.1, Page 3-9: The first paragraph on this page states benzene was detected in the deeper hydrostratigraphic zones, but was located within larger TCE plumes. What is the current status of these benzene plumes today? Are they still present, and if so, are they still being captured by Castle's groundwater extraction system?

Response: Concur. The text of Section 3.5.1 discussing benzene has been expanded to note that benzene is no longer an issue. During 2007, benzene was only detected in one well (trace concentration of 0.32 µg/L at Shallow HSZ monitoring well MW1003) and benzene was not detected in any well sampled during 2006. The last reported detection of benzene above the MCL was at Shallow HSZ monitoring well JM11 (14 µg/L) in 2001; samples from JM11 in 2006 and 2007 were ND for all VOCs. The last detection of benzene above the MCL in the LSS HSZ was a reported 5.4 µg/L at MW863 in 1995. The last detections of benzene above the MCL in the Confined HSZ were a reported 5.7 µg/L at MW929 in 1994 and a reported 17 µg/L at MW606 in 1995.

6. Section 3.5.2.2, Page 3-12: In the last paragraph in this section, replace "LF-3" with "ETC-12".

Response: Concur. In the third line of the last paragraph of Section 3.5.2.2, "LF-3" has been changed to "ETC-12."

7. Section 4.1.2.1.1, Page 4-3: In the third paragraph in this section, it states that OU-1 was brought online to address a TCE hotspot. For clarity, highlight the hotspot on the referenced figure or identify the monitoring well(s) that are located in the center of the hotspot.

Response: Concur. The following monitoring wells, grid locations and TCE concentrations have been added to the callout for Figure 3-4 in the third paragraph of Section 4.1.2.1.1: JM13, grid Q10, 110 µg/L; MW516, grid Q10, 57 µg/L; MW556, grid R10, 93 µg/L; MW220, grid S10; 92 µg/L; TW16, grid R11, 56 µg/L; MW873, grid R12, 52 µg/L; and MW310, grid R13, 83 µg/L.

8. Section 4.1.3, Page 4-10: This section discusses the operation and maintenance of the groundwater treatment plants and refers to the *Castle Groundwater Treatment Systems Operation and Maintenance Plan, Change 3 to Final* (Jacobs 2006). Regional Water Board staff is unfamiliar with this document reference. It was not logged into our document database, so was it sent to the Castle regulatory team for review/concurrence? If not, please send us a copy.

Response: Concur. The document was issued on 06 June 2006 but only transmittal documentation was provided to the regulatory agencies. An electronic version of the document (CD) has been sent to the EPA, DTSC and the RWQCB.

9. Section 6, Page 6-1: The second paragraph seems to imply that because the contractor (Jacobs) who prepared the Draft 5YRR is also the contractor responsible for the operation of the groundwater remediation systems and many of the completed SCOU site remedial actions, formal document review, data review, and interview tasks were not necessary. Some of the remedies implemented over the past five years were conducted by other consultants, so explain why these tasks are not required.

Also, most five-year reviews at active or former DoD facilities include interviews with site tenants, neighboring property owners, and/or other residents that may be concerned about the status of remedial efforts. Please explain why these interviews were not necessary.

Response: Concur. The second paragraph of Section 6 was an oversimplification and has been revised. Because Jacobs is on site, coordinates frequently with other base contractors and is aware of all ongoing actions and issues at the former base, formal interviews with other base contractors were not conducted. All CERCLA site closure reports and landfill monitoring reports completed by other contractors during this five-year review period were reviewed and information used in preparation of the five-year review document.

Formal interviews with possibly interested parties were not conducted because Jacobs' on-site personnel are in regular contact with representatives of the property owner (Merced County Department of Commerce, Aviation and Economic Development), the site developer (Castle Commerce Center) and airfield operations personnel. The local Restoration Advisory Board (RAB) was disbanded over a year ago because on-site operations were winding down and community interest was minimal. Jacobs' on-site personnel do maintain regular contact with owners of property adjacent to the base because many are interested in the wells on their property – mainly when those wells will be abandoned.

10. Section 7.1.1.1.1, Page 7-4: The full extent of the TCE plume in the on-base portion of the Confined HSZ has not changed appreciably since 1994. For clarity, insert "of the MCL plume" after "shows there has been a significant reduction in areal extent" in the second paragraph on this page.

    Response: Concur. The first sentence of the second paragraph on page 7-5 has been revised to read "Comparison of Figure 3-7 (Q2/94) with Figure 7-4 (Q4/07) shows that there has been a significant reduction in areal extent <u>of the MCL plume</u> and TCE concentration in the on-base portion of the - - - - - - -."

11. Section 7.1.1.1.2, Page 7-5: The last paragraph on this page concludes that the MCL plume is fully captured in the Shallow HSZ even though no extraction wells currently operate in this HSZ. While this may be true for the two larger main base plumes, the small plume centered on EW13 does not appear to be captured (see Figure 7-5). Explain this discrepancy.

    Response: The text on page 7-6 has been revised to state that the small, intermittent MCL plume at EW13 is not subject to capture from pumping in the Shallow HSZ but does fall well within the estimated capture zone for the immediately underlying USS HSZ. Because of the small and intermittent nature of this plume segment and the fact that capture by pumping from the underlying HSZ is likely, the residual contamination at EW13 is not seen as a significant issue. The reported TCE concentration at EW13 last exceeded 10 µg/L in Q1/00. The reported TCE concentration of 5.5 µg/L shown on Figure 7-1 was from a January 2007 sample (well sampled annually). A special sample collected in May 2007 had a reported TCE concentration of 3.2 µg/L. Since 2005, the reported TCE concentration at EW13 has ranged from ND to 7.3 µg/L.

12. Section 7.1.1.14, Page 7-8: Revise the Draft 5YRR to briefly explain why shutting down municipal well AM18 may trigger additional remedial actions by the Air Force.

    Response: Concur. The text on page 7-10 has been revised. The Air Force committed to evaluating and possibly implementing additional remedial action if AM18 became

inoperative (broke down) for an extended period at a time when the TCE concentration immediately upgradient of AM18 in the Confined HSZ (i.e., at MW1010) was measurably greater than it is as of Q4/07 (20 µg/L throughout 2001 and 2002 vs. 3 µg/L as of Q4/07). If AM18 became inoperative when upgradient TCE concentrations were 20 µg/L, downgradient migration beyond AM18 may have occurred and additional remedial action (perhaps wellhead treatment) may have been appropriate to prevent it. With upgradient TCE concentrations greatly decreased, the possible need for additional remedial action is now minimal. It is further noted that the City of Atwater has no plans to shut down AM18 and if the well were to become inoperative due to pump failure or other problems, it would be repaired quickly.

13. Section 7.5.3, Page 7-25: The recent detections of TCE in monitoring wells MW320 and MW886 provide data that may "Call into Question the Protectiveness of the Remedy" for site FTA-1. While only monitoring is currently warranted, further increases in TCE at these wells or other wells in the vicinity of FTA-1 may trigger additional remedial actions. Revise this section to briefly discuss this potential concern with the protectiveness of the remedy.

    Response: Concur. The text of Section 7.5.3 has been revised to state that the recent detections of TCE in MW320 and MW886 at concentrations slightly exceeding the MCL is a possible protectiveness issue for the FTA-1 remedy. Regular monitoring will continue per the LTGSP decision tree. The discussion also notes that the TCE concentration in all four samples collected from MW320 during 2007 were less than the MCL.

14. Section 7.8.2.2, Page 7-34: This section states vapor intrusion is not an issue for future buildings constructed at the site due to institutional controls prohibiting construction. However, Landfill 5 is located near the margin of the Federal Bureau of Prisons property and, presumably, buildings have been or could be constructed adjacent to the BoP parcel. Was potential exposure of occupants of existing or future buildings adjacent to Landfill 5 considered, and if not, why?

    Response: Potential exposure of occupants of existing or future buildings adjacent to Landfill 5 was not considered. The text of Section 7.8.2.2 will be expanded to include the following information. The Atwater prison was constructed in the central portion of the BoP parcel. The remainder of the parcel, including LF-5, constitutes a buffer for the prison and is always to remain open space. In addition, LF-5 sits along the northern edge (fence) of the BoP parcel and certainly no buildings will ever be considered or allowed to be built near the fence defining prison property – either inside or outside of the fence. In addition, the Federal-to-Federal transfer letter requires the BoP to consult with the Air Force and the regulatory agencies if they plan to construct any facility at/adjacent to LF-5.

15. Section 9, Pages 9-1 and 9-2: The recommendations in this section can be interpreted as recommending NFA for all but the Castle Vista Plume. For clarity, in subsections 9.1, 9.3, 9.4, 9.5, 9.6, 9.7, and 9.8, Regional Water Board recommend changing "there are no recommended actions" to "there are no recommended changes to the remedy" or "there are no recommended corrective actions", or something similar.

    Response: Concur. The text in Sections 9.1, 9.3, 9.4, 9.5, 9.6, 9.7 and 9.8 has been changed to state that "there are no recommended changes to the remedy."

16. Plate 1: Please add the 0.5 µg/L contour for each groundwater plume depicted on this figure.

    Response: Concur. The "combined" 0.5 µg/L TCE contour has been added to Plate 1.

DTSC Comments and Responses

**Response to DTSC Comments on the
Draft Five-Year Review Report**

For convenience, this response repeats DTSC's original comment in standard type, followed by the Air Force response in **bold**.

1. That the Air Foce investigate the potential for the presence of 1, 4-dioxane (typically associated with 1, 1, 1-trichloroethan) since the groundwater has never been tested for this chemical.

Response: Concur. The Air Force will conduct a round of sampling for 1,4-dioxane as part of the LTGSP Q1/09 sampling event. A list of plants/wells to be sampled will be prepared and submitted for regulatory agency review and concurrence prior to the sampling event. At a minimum, all treatment plant influents and/or effluents will be sampled. In addition, monitoring wells where past reported concentrations of 1,1,1-TCA have exceeded 1 µg/L will be sampled (based on preliminary review, about 5-10 wells). Sampling results will be presented to the regulatory agencies along with Air Force recommendations.

2. That the Air Force assess the carrying on of the "pump and treat" system for the shallow zone of the Main Base Plume to see if this would significantly reduce contaminant concentrations to MCLs sooner.

Response: Concur. The pump-and-treat remedy is no longer active for the Shallow HSZ because of the significant reductions to date in TCE concentration and regulator approved shutdown of extraction wells and the fact that capture of residual contamination is provided by continuing pumping downgradient in the underlying USS HSZ. Given these results and conditions, the Air Force believes that the remedy remains protective. Further complicating the situation, the recent and ongoing decline of water levels has caused several Shallow HSZ extraction wells to go dry and has limited future pump-and-treat options. Because of this, other remedial options to achieve cleanup to MCL levels are being evaluated, such as the in-situ chemical oxidation (ISCO) pilot test planned at MW003 in the off-base Castle Vista area.

A detailed discussion as to why the Air Force is no longer actively treating groundwater from the Shallow HSZ has been added to Section 7.1. In addition, the limited ability to maintain pump-and-treat in the Shallow HSZ and the consequent lack of capture in the Shallow HSZ has been identified as a potential issue for the Main Base Plume in Section 7.1.1.4 and other appropriate sections of the five-year review report. A discussion of plans to test/implement alternative technologies to achieve established cleanup levels has also been added to Section 7.1.1.4 and other appropriate sections.

3. That the Air Force continue with an additional round of ecological monitoring to confim there are no impacts.

Response: Concur. The Air Force agrees to conduct one additional round of LTEM for the five listed sites and the recommendation to cease LTEM has been removed from all sections of the document. Within the constraints of contracts and contracting cycles, the Air Force will attempt to conduct this next round of LTEM at any point during the next five years when moisture conditions are more optimal.

4. That the Air Force provides an explanation of its evaluation for potential vapor intrusion from chemicals in both groundwater and soils into existing and/or future buildings at the various sites.

Response: The Air Force does not believe that a section discussing the potential vapor intrusion risk posed by residual volatile constituents in the vadose zone at Castle is warranted. SVE or other appropriate removal/remedial actions have been implemented at all Castle vadose zone or soil contamination sites with significant VOC contamination. The majority of VOC mass has been removed from all sites. Potential vapor intrusion was evaluated for sites remediated during the latter part of the CERCLA process (generally those sites with higher levels of contamination or those that proved more difficult to remediate, e.g., DA-4, F-4, B51/B54) and no significant indoor air risk was identified for any of these sites. Given the standardization of the removal/remedial actions at Castle and the fact that similar cleanup standards were applied to all vadose zone removal/remedial actions, it is reasonable to assume that vadose zone sites addressed earlier in the CERCLA process would also have no significant vapor intrusion or indoor air risk.

Concur regarding the potential vapor intrusion risk posed by volatile constituents in the groundwater. The Air Force has conducted a screening level assessment of the vapor intrusion pathway for the Main Base Plume. The screening level assessment was conducted using the DTSC automated screening tool (automated Excel spreadsheet), recent depth-to-water information for the Shallow HSZ and recent contaminant concentration data (TCE) for the Main Base Plume. The results of this screening level assessment have been added to the Five-Year Review Summary Form, the Executive Summary, Section 7.1.2.4, Section 8.1 and Section 10.1.

APPENDIX B

ECOLOGICAL MONITORING RESULTS

(ETC-10, ETC-12, FTA-1, LF-3 and LF-5)

1.0 INTRODUCTION

This appendix describes the procedures used and the results of ecological monitoring of wetland invertebrates (fairy shrimp) and wetland plants at reference or background wetlands (vernal pools) and at vernal pools potentially impacted by contaminants from sites Earth Technology Corporation 10 (ETC-10), ETC-12, Fire Training Area 1 (FTA-1), Landfill 3 (LF-3) and LF-5 at Castle Airport (former Castle Air Force Base), California.

1.1 PROJECT BASIS AND DESCRIPTION

Ecological risk assessment findings for all Castle Airport sites are presented in the *Comprehensive Basewide Scoping and Phase I Ecological Risk Assessment* (Jacobs, 1995) and the *Comprehensive Basewide Phase II Ecological Risk Assessment* (Jacobs, 1997). Long-term ecological monitoring was the selected remedy in the *Source Control Operable Unit Record of Decision Part 3* (SCOU ROD Part 3) (Jacobs, 2005) to address ecological risk for ETC-10, ETC-12, FTA-1, LF-3 and LF-5; the remedy to address ecological risk at all other Castle Airport sites was no further action. Site outlines for ETC-10, ETC-12, FTA-1, LF-3 and LF-5 and the location of sampled vernal pools (reference and potentially impacted) are shown on Figure B-1.

Contaminants of concern (COCs) representing a potential adverse risk to ecological receptors at the five sites are metals and polynuclear aromatic hydrocarbons (PAHs; at LF-3 only). The ROD requires long-term ecological monitoring consisting of wetlands invertebrate and plant surveys every five years for up to 30 years. In general, plant and invertebrate surveys of contaminated and uncontaminated wetlands are required to be conducted to ensure site contaminants have not impacted wetland habitats. Evaluation of survey results will depend upon three measurements: plant abundance, plant diversity, and invertebrate (fairy shrimp) abundance. If results show that these three factors are not statistically lower (at a 0.05 significance level or 95 percent confidence level) in the contaminated wetlands as compared to the uncontaminated wetlands, then it will be concluded that there is no impact. If no impact is found, monitoring can be discontinued at any time after the first five year survey, in mutual agreement with the U.S. Air Force (Air Force), the U.S. Environmental Protection Agency (EPA), and the California Environmental Protection

Agency, Department of Toxic Substances Control (DTSC). If an impact is observed, then the Air Force (in consultation with the EPA and DTSC) will evaluate potential remedial alternatives.

1.2 VERNAL POOLS

Vernal pools are described as seasonal ponding areas that form within depressions and are typically underlain by a confining layer retarding downward movement of water. The vernal pools at Castle Airport are located within areas mapped as containing Alamo clay soils with a low permeability, alkaline and calcareous hardpan, and San Joaquin loam which have an iron-silicon cemented hardpan at a depth of 6 to 16 inches (Louis Berger Group, 1998). The hydrology of vernal pools within the Central Valley of California is produced primarily through direct precipitation and surface runoff during the cool and rainy season from October through May. The period of inundation will vary from several weeks to several months depending upon the size and structure of the vernal pool, its drainage area, and climatic patterns. This seasonal precipitation has resulted in the development of an annual and perennial assemblage of plant species characteristic of vernal pools which support several endemic fauna and flora taxa.

Northern hardpan vernal pools (Sawyer & Keeler-Wolf, 1995) are scattered throughout the project site, many of which are interconnected by swales. A northern hardpan vernal pool is recognized by the California Department of Fish and Game (CDFG) as a "significant natural community" due to its rarity, its vulnerability to disturbance and its relatively high potential as habitat for rare, threatened, and endangered species, such as the vernal pool fairy shrimp.

Dominant flora species in the shallow vernal pools include Mediterranean barley (*Hordeum marinum*) and in deeper vernal pools include coyote thistle (*Eryngium vaseyi*), stipitate popcorn flower (*Plagiobothrys stipitatus* or *Allocarya stipitata*), and annual rabbit's-foot grass (*Polypogon monspeliensis*). Annual hair grass (*Deschampsia danthonioides*) and smooth cat's-ears (*Hypochaeris glabra*) have also been found in vernal pools. Other common wetland plant species reported in vernal pools in the area include pillwort (*Pilularia americana*), hyssop loosestrife (*Lythrum hyssopifolium*), smooth boisduvalia (*Biosduvalia cleistagamum*), Oregon wooly marbles (*Psilocarphus oreganus*), and the perennial creeping spikerush (*Eleocharis macrostachya*). The federally-listed threatened succulent owl's-clover (*Castilleja campestris* ssp. *Succulenta*) has been found in a vernal pool mitigation site in the Federal Bureau of Prisons (BoP) Vernal Pool Preservation Area (see Figure B-1). Federally-listed threatened Colusa grass (*Neostapfia colusana*) has been reported elsewhere on the former base. The vernal pools in the monitoring area appear to provide suitable habitat although none has been reported.

The special-status species found in vernal pools in the monitoring area and within the Vernal Pool Preservation Area include the federally-listed (threatened) vernal pool fairy shrimp (*Branchinecta lynchi*), which belong to the Class Crustacea, the subclass Branchipoda, and the order Anostraca. They range in size from ½ to one inch (one to 2.5 centimeters [cm]) long and are characterized by having a delicate, 20-segmented elongated body, eleven pairs of swimming legs, large stalked compound eyes, and no carapaces. They glide gracefully upside down, swimming by rhythmically beating their legs in a complex, wavelike movement that passes from front to back. Fairy shrimp feed on algae, bacteria, protozoa, rotifers and bits of detritus. The vernal pool fairy shrimp is found throughout the Central Valley and as far south as Riverside County.

Fairy shrimp eggs can be thin-walled "summer" eggs that hatch during the same season almost immediately, which generally occurs when fewer males are available. Eggs can also be thick-walled "winter" eggs that can lay dormant for one or more seasons even in the dry mud. As the water within the vernal pool evaporates, the thick-walled eggs form cysts resisting heat, cold, and desiccation. The dormant eggs can hatch one year or several years later within a few days after flooding when water temperature exceeds 4 degrees Celsius (ºC).

The lifespan of a fairy shrimp is short, lasting for as little as 16 days. Competing crustaceans have longer lifespans, so dominance of species is often correlated between its lifespan and the duration of the vernal pool flooding. Shorter-lived species will tend to become dominant in smaller, shallow vernal pools while longer-lived species will tend to dominate the deeper vernal pools that maintain water longest.

2.0 ECOLOGICAL MONITORING PROGRAM

The objective of the ecological monitoring program is to determine whether the established environmental remedy for the sites (ETC-10, ETC-12, FTA-1, LF-3 and LF-5) remains protective of the environment. Plant and invertebrate surveys of potentially impacted vernal pools (pools within or adjacent to/downgradient from ETC-10, ETC-12, FTA-1, LF-3 and LF-5) and reference vernal pools (pools remote from or upgradient of sites and with no likely impact from Castle Airport site contamination) were conducted. To achieve the program objective, measurements of plant abundance/plant diversity and invertebrate (fairy shrimp) abundance were taken and evaluated to determine whether each is statistically lower (at a 0.05 significance level or 95 percent confidence level) in the potentially impacted pools compared to the reference pools.

Nine potentially impacted vernal pools associated with ETC-10, ETC-12, FTA-1, LF-3 and LF-5 were surveyed. At ETC-10, one vernal pool located within the site boundary was surveyed. At LF-3, two vernal pools located within the site boundary were surveyed. At ETC-12, FTA-1 and LF-5, two vernal pools adjacent and immediately downgradient of each site boundary were surveyed. Six reference pools were surveyed. The locations of all surveyed vernal pools are shown on Figure B-1. The surveys were conducted by qualified and experienced biologists. The lead biologist for the fairy shrimp surveys was a federally permitted biologist approved and authorized by the U.S. Fish and Wildlife Service (USFWS) to capture and identify vernal pool fairy shrimp (Wendy Dexter, Condor Country Consulting; Permit No. TE-016591-05). A wetlands plant biologist familiar with the regional wetland flora completed the plant diversity and abundance surveys (Heath Bartosh, Nomad Ecology). Both subcontract biologists were supported by a Jacobs biologist and field technician.

The number and nature of the vernal pools sampled were constrained by climatic patterns (temperature and precipitation) in the spring of 2008. As stated in the final *Ecological Monitoring Work Plan* (Jacobs, 2008), the intent was to sample potentially impacted and reference pools that were as similar in size and depth as possible to minimize the possible effects of these variables on fairy shrimp and vegetation. Because of the spring 2008 climatic pattern (very cool and less than average precipitation until early February; very warm and essentially no precipitation after early February) the number of vernal pools available for sampling was very limited and the existing pools exhibited considerable variation in pool depth and size (pool size and depth information are included in Attachments B-1 and B-3). The ability to select reference pools immediately south of the prison complex was limited because the prison guards did not allow access to this area.

To meet ROD and work plan objectives, an adequate number of samples were collected to establish a 95 percent confidence level for plant abundance/plant diversity and fairy shrimp abundance at the reference vernal pools. An adequate number of samples were collected at the site-related wetlands to evaluate whether the mean values for any of these three factors (plant abundance, plant diversity and fairy shrimp abundance) are statistically lower within the potentially impacted pools study area than reference pools. Consistent sampling in accordance with established procedures in the work plan was maintained to the extent possible to ensure statistical confidence.

2.1 SURVEY PROCEDURES

The following sections describe the procedures that were followed during completion of the ecological monitoring surveys. The survey procedures described include those for vernal pool fairy shrimp abundance, plant diversity, plant abundance and statistical evaluation of the data.

Vernal pool fairy shrimp abundance surveys were completed on 18 and 19 February 2008. An earlier attempt to perform the surveys was conducted on 4 February but the effort was abandoned when it was determined that the shrimp had yet to hatch because of the cool weather pattern up to that date. Plant abundance and diversity surveys were completed on 16 and 17 April 2008.

Mobilization and field crew access was coordinated with the BoP to ensure that all proper procedures were followed when access and movement within the site was required (specifically the Vernal Pool Preservation Area).

Targeted random surveys were conducted on potentially impacted vernal pools at LF-3, LF-5, FTA-1, ETC-10 and ETC-12 to assess abundance of vernal pool fairy shrimp and the diversity and abundance of plants, each during separate field surveys performed on the same set of vernal pools:

- At ETC-10, one vernal pool located within the boundary of the site was surveyed.

- At ETC-12, FTA-1, LF-3 and LF-5, two vernal pools adjacent and immediately downgradient of each site were surveyed.
- Six reference vernal pools (assumed not impacted by site contaminants) with similar characteristics to those wetlands included in the study sites were identified and surveyed. To the extent possible (see previous discussion) these vernal pools were selected based on habitat characteristics, plants, water depth, size, period of inundation, soil type, etc., similar to the potentially impacted pools.

Selection of the specific locations was made in the field based on the professional judgment of the biological team. Selection of wetlands in or near ETC-10, ETC-12, FTA-1, LF-3 and LF-5 was based on factors of appropriate habitat for the vernal pool fairy shrimp, including size and depth of the vernal pool, the anticipated period of inundation, soil type and other habitat factors. Any other factors observed in the field that could be impacting vernal pool fairy shrimp or vegetation were noted. All parameters of each selected vernal pool were documented.

Six reference vernal pool locations were selected at locations where site impacts were not suspected. Reference pool selections were primarily driven by the presence of water, habitat characteristics and access. Access to some potential reference pools was eliminated by BoP security personnel causing alternate reference pools to be selected.

The potentially impacted and reference vernal pools selected for ecological monitoring were documented on a U.S. Geological Survey (USGS) topographic map (1:24,000 or 1:9,840, if available) with 1-foot interval contour lines, if available, or another available site map. The coordinates of each pool were identified with a GPS using the NAD83 coordinate datum system and recorded in latitude/longitude - degrees and decimal minutes or Universal Transverse Mercator (UTM) coordinates (northings and eastings).

2.1.1 Fairy Shrimp Abundance Survey

Sampling for fairy shrimp was performed at random locations across each selected vernal pool as described below. Water quality parameters were measured using a Horiba U-10 Multi-Parameter Water Quality Monitor for temperature (ºC), conductivity (µs/cm), dissolved oxygen (DO) concentration (milligrams per liter [mg/L]), pH, salinity, and turbidity (nephelometric turbidity units [NTU]). One water sample from each vernal pool was collected using the Horiba supplied water collection cup. Every attempt was made to minimize agitation of the water and disturbance of the fairy shrimp during collection of water quality parameters. Samples were collected near the bottom of the vernal pool, which is where the fairy shrimp tend to live. Water quality parameters were allowed to initially stabilize for up to one minute but the water aliquot was not allowed to stand for periods long enough for ambient air temperature to change the water temperature, which can also affect pH and DO concentration.

In addition to the collection of water quality parameters, the area and depth of each pool were measure and recorded. Each pool was also photographed to document conditions during fairy shrimp collection.

A minimum of 10 locations were sampled for fairy shrimp abundance from each vernal pool, where feasible. In four instances, LF-5 (South), C208, ETC-12/Pool C7A, and 823 (North) less than 10 locations were sampled from each pool. The LF-5 (South), C208, and ETC-12/Pool C7A pools were too small to accommodate 10 distinct sampling locations. At 823 (North), BoP security directed the sampling team to vacate the area before 10 locations had been sampled. At the remaining pools, a minimum of 10 locations and a maximum of 18 locations were sampled for fairy shrimp depending on the size of the pool.

Each attempt to collect fairy shrimp using the following procedures was considered a collected sample even if no fairy shrimp were captured. Failure to capture fairy shrimp in any attempt was recorded as "0". Random samples were collected from each vernal pool. Each sample collected represented an area of 1 m^2. Sample size (1m^2) was the same at each location collected from vernal pool. Sampling bias was minimized by avoiding professional judgment or personal preference in the selection of locations. However, a consistent random approach was used.

Dip-netting for branchiopods was completed using a net with a 9-inch square aperture and a mesh size less than 1/16-inch to capture the fairy shrimp while allowing the net to be moved through the water at a rate high enough to capture the shrimp. The net was attached to 6-foot long extension poles to allow field personnel adequate reach for sampling.

The area within reach was dip-netted by moving the net through the water column in a zig-zag pattern, keeping the net close to the vernal pool bottom where the fairy shrimp are most likely present. The size of the area surveyed was consistent, estimated at approximately 1 m^2 (10.8 ft^2), at each location for statistical evaluation and comparability between potentially impacted and reference vernal pools.

After sample collection a consensus estimate of the number of branchiopods in the net was made quickly by the permitted biologist. The estimated number of fairy shrimp was recorded by the supporting biologist who remained outside the pool during sampling. The count estimates were made as quickly and efficiently as possible to minimize impacts to the collected shrimp. The estimated total number of the various types of collected shrimp was recorded in the logbook. Three species of branchiopods were collected during sampling:

- California Linderiella (*Linderiella occidentalis*) – observed in 9 of 15 pools with 6 of the 9 being potentially impacted pools;
- Vernal Pool Fairy Shrimp (*Branchinecta lynchi*) – observed in 5 of 15 pools in which all 5 were potentially impacted pools; and
- Midvalley Fairy Shrimp (*Branchinecta mesovallensis*) – observed in one potentially impacted pool only.

Attachment B-1 presents the results of the fairy shrimp surveys for all vernal pools sampled. Photo locations are documented in Attachment B-1 but copies of photos are not included.

2.1.2 Plant Diversity Survey

Both plant diversity and abundance were randomly surveyed within each of the vernal pools previously sampled for fairy shrimp. A total of 10 sampling points were monitored in each vernal pool. The sample locations were selected by randomly tossing a 0.5 m^2 (5.4 ft^2) frame into various regions within a pool. The plant diversity within the boundary of the 0.5 m^2 frame was recorded consistently at each sample location. Photographs of each sample effort within each pool were taken and documented.

Each species found within the 0.5 m^2 sampling areas was identified and recorded along with general descriptions and notes about various types of grasses, graminoids, etc. found at each pool. The wetlands plant biologist made all determinations while the assisting biologist recorded all results so that consistency in plant identification was ensured. Attachment B-2 provides a listing of all plant species identified in potentially impacted and reference pools during completion of the plant diversity survey. Attachment B-3 presents the results of the plant diversity surveys for all vernal pools sampled. Photo locations are documented in both Attachments B-2 and B-3 but copies of photos are not included.

2.1.3 Plant Abundance Survey

Abundance of each species found at each sample location was determined by estimating the percent cover for each species within the 0.5 m^2 areas at the same locations used as sample points for the plant diversity study. The plant abundance determination was performed concurrently with the plant diversity survey by the wetlands plant biologist.

Plant abundance included both relative percent cover for each plant species as well as total percent cover for all vegetation within the 0.5 m^2 plot. Plant abundance (relative and total percent cover) was estimated by the biologist using professional judgment. The same wetland plant biologist was used at all locations to ensure consistency in plant abundance determination. Attachment B-3 presents the results of the plant abundance surveys - plant abundance by species and the overall abundance for each sample plot within each of the potentially impacted and reference pools is presented.

2.2 STATISTICAL EVALUATION

All statistical calculations were performed using ProUCL version 4.00.02. Data sets are referred to as being either "reference pools" (no expected impact from contamination) or "potentially impacted pools". A Lower Confidence Limit (LCL), as described below, was computed for the combined samples from all reference pools. Means were computed for each individual potentially impacted pool. Individual potentially impacted pool means were then compared with the combined reference pool LCL. Individual potentially impacted pool means that are lower than the combined reference pool LCL may indicate adverse environmental impacts that are inhibiting plant and/or animal life within the pool. The mean of the combined potentially impacted pools data was also computed and compared to the LCL of the combined reference pool data.

Two-sample hypothesis tests were evaluated, comparing each potentially impacted pool with the combined reference pool data. Two parametric tests, Student's t and Satterthwait, and one non-parametric test, Wilcoxon-Mann-Whitney, were used. The Student's t test requires that both data sets be normally distributed and have approximately the same spread (variance). The Satterthwait test requires that both data sets be normally distributed but do not need to have similar spread (variance). Normality of the data distributions was evaluated using Shapiro-Wilk and Lilliefors tests as selected by ProUCL. The results of these evaluations, showing that almost all of the data sets are not normally distributed, are presented on "Normal Q-Q" plots (Attachment B-4).

LCLs on the mean were computed by using "flipped" data sets. ProUCL computes Upper Confidence Limits (UCLs) but not LCLs. If data sets were normally distributed, LCLs could be computed by taking the offset from the median (UCL-median) and subtracting it from the median. This will work only when data sets are symmetrical like a normal distribution. Since environmental data sets are not necessarily normally distributed, LCLs are computed using "flipped" data as follows:

- Subtract the value for each sample from a number larger than the largest number in the data set. For the data used in this project, the largest value is 95; therefore all sample values were subtracted from a "flipping value" of 100.
- Compute UCL of the flipped data values using standard statistical methods.
- Compute the LCL by subtracting the UCL from the "flipping value". That is: LCL = 100 – UCL.

This procedure correctly accounts for any asymmetry in the data set.

2.3 STATISTICAL EVALUATION RESULTS

The following bullet lists summarize the statistical evaluation of the fairy shrimp, plant diversity and plant abundance or coverage survey results. The null hypothesis for all of the statistical evaluations was that the mean for the potentially impacted pools was greater than or equal to the mean of the reference pools.

California Linderiella (LIOC) Abundance Evaluation

- None of the Wilcoxon-Mann-Whitney tests indicated sufficient evidence to reject the null hypothesis for any of the potentially impacted pools.
- The mean of the combined reference pool data was computed to be 1.9
- The LCL of the combined reference pool data was computed to be 0.70
- The mean of the combined potentially impacted pool data was computed to be 5.3 which is greater than the combined reference pool LCL and the combined reference pool mean. Therefore there is no evidence of adverse environmental impacts at the potentially impacted pools taken as a whole.
- The means at four individual potentially impacted pools, ETC-12/C7, FTA-1/West, LF-3/C204, and LF-5/South, were lower than the combined reference pool LCL.
- The means at five individual reference pools, 823N, 835R, C208, C209, and USP Warehouse/South, were lower than the combined reference pool LCL.
- Student's t tests and Satterthwait tests are probably not valid because the combined reference pool data are not normally distributed.
- Conclusion: at a 95% confidence level and considering only the Wilcoxon-Mann-Whitney tests, there is no evidence that the fairy shrimp abundance (LIOC) in the potentially impacted pools is statistically less than in the reference pools.

Statistical test results for LIOC (summary and for individual pools) are provided in Attachment B-5.

Vernal Pool Fairy Shrimp (BRLY) Abundance

- This shrimp was identified in four potentially impacted pools. No occurrences of this shrimp were identified in any reference pools. No statistics were computed for BRLY. Based only on pattern of occurrence, there is no evidence of adverse environmental impacts on the distribution of the vernal pool fairy shrimp at Castle Airport.

Midvalley Fairy Shrimp (BRME) Abundance

- This shrimp was identified in one potentially impacted pool. No occurrences of this shrimp were identified in any reference pools. No statistics were computed for BRME. Based only on the pattern of occurrence, there is no evidence of adverse environmental impacts on the distribution of the midvalley fairy shrimp at Castle Airport.

Plant Diversity

- None of the Wilcoxon-Mann-Whitney tests indicated sufficient evidence to reject the null hypothesis for any of the potentially impacted pools.
- The mean of the combined reference pool data was computed to be 7.8
- The LCL of the combined reference pool data was computed to be 7.2
- The mean of the combined potentially impacted pool data was computed to be 7.8 which is greater than the combined reference pool LCL and equal to the combined reference pool mean. Therefore, there is no evidence of adverse environmental impacts at the potentially impacted pools taken as a whole.

- The means of five individual potentially impacted pools, FTA-1/East, FTA-1/West, LF-3/C204, LF-3/C4, and LF-5/South, were lower than the combined reference pool LCL.
- The means of two individual reference pools, 835R and C208, were lower than the combined reference pool LCL.
- Student's t tests and Satterthwait tests are probably not valid because the combined reference pool data are not normally distributed.
- Conclusion: at a 95% confidence level and considering only the Wilcoxon-Mann-Whitney tests, there is no evidence that plant diversity in the potentially impacted pools is statistically less than in the reference pools.

Statistical test results for plant diversity (summary and for individual pools) are provided in Attachment B-6.

<u>Plant Abundance or Percent Coverage</u>

- None of the Wilcoxon-Mann-Whitney tests indicated sufficient evidence to reject the null hypothesis for any of the potentially impacted pools.
- The mean of the combined reference pool data was computed to be 59.3
- The LCL of the combined reference pool data was computed to be 43.2
- The mean of the combined potentially impacted pool data was computed to be 61.5 which is greater than the combined reference pool LCL and the combined reference pool mean. Therefore, there is no evidence of adverse environmental impacts at the potentially impacted pools taken as a whole.
- The means at two individual potentially impacted pools, LF-3/C204 and LF-5/South, were lower than the combined reference pool LCL.
- The means at two individual reference pools, 835R and USPWS, were lower than the combined reference pool LCL.
- Student's t tests and Satterthwait tests are probably not valid because the combined reference pool data are not normally distributed.
- Conclusion: at a 95% confidence level and considering only the Wilcoxon-Mann-Whitney tests, there is no evidence that plant abundance (percent plant coverage) in the potentially impacted pools is statistically less than in the reference pools.

Statistical test results for plant abundance or percent coverage (summary and for individual pools) are provided (with plant diversity results) in Attachment B-6.

In summary, data for shrimp abundance, plant diversity and plant abundance or coverage were evaluated. Samples for each of the three data types were collected from nine potentially impacted pools and from six reference or background pools. The background pool data were combined and evaluated as a single sample set for each data type.

There was not sufficient evidence to reject the null hypothesis for any of the 27 data sets (three data types for each of nine sets) when comparing means using the Wilcoxon Rank-Sum (Wilcoxon-Mann-Whitney) test. Of the 27 data sets, there was sufficient evidence to reject the null hypothesis in 11 data sets when comparing site means to the background LCL but these rejections were based on Student's t and/or Satterthwait tests which are probably not valid. Therefore, the overall conclusion of the ecological monitoring is that there is no evidence that soil contamination at any of the five sites has impacted shrimp abundance, plant diversity or plant abundance at any associated vernal pools.

2.4 RECOMMENDATION

Based on the results of the statistical evaluation of the ecological monitoring data, it is recommended that LTEM at ETC-10, ETC-12, FTA-1, LF-3 and LF-5 be discontinued at this time.

3.0 REFERENCES

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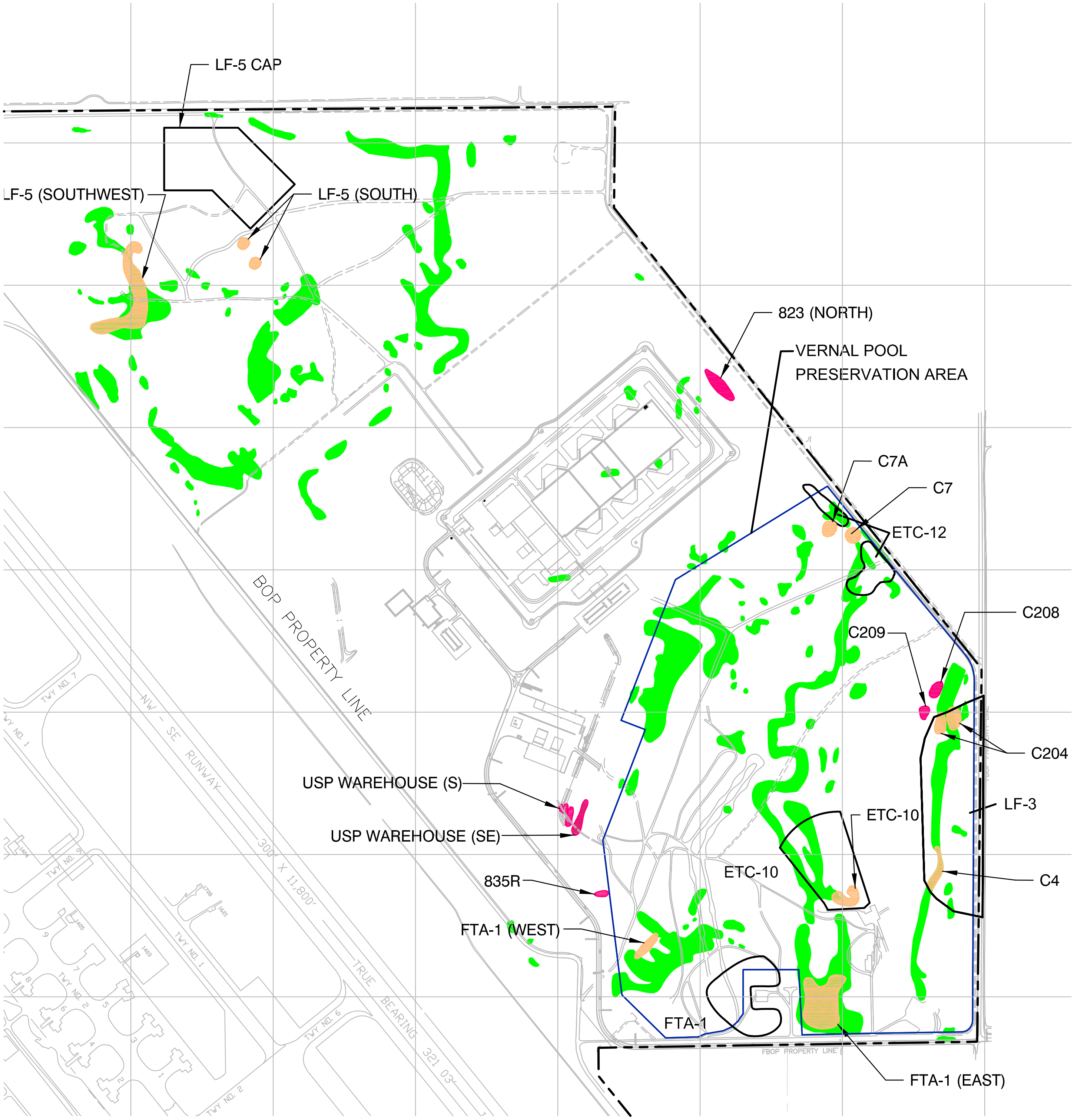


LEGEND

Base Boundary

Vernal Pool Preservation Area

Sites with Potential for Adverse Risk to Ecological Receptors

Wetlands

Reference Pool

Potentially Impacted Pool

Vernal Pools Sampled for Ecological Monitoring

Five–Year Review
Castle Airport

7/09/08 xv ...g:\cadd\12BC8601\2008 Five Year Review\Figure_A-1.dwg
12/22/08 xv

Figure B–1

ATTACHMENT B-1

FAIRY SHRIMP SURVEY RESULTS

(pools presented in the order surveyed)

ETC-10 – Potentially Impacted Site

2/18/08
Time = 1355 hours
Size = 264’ x 112’
Pool depth = average depth = 11”; maximum depth = 16.5”
Total of 18 sample locations
Sample size = 1 meter^2 = 10 passes with net

Water Quality Parameters (13.5” depth):
pH = 8.7
Conductivity = 0.094 ms/cm^3
Turbidity = 10
Dissolved Oxygen = 10.4 mg/L
Water Temp = 17.9 ^{o}C
Salinity = 0

Photos 002 through 008

ETC-10 – Location 1 = LIOC – 1’s (total 3 captured) – pool depth was 14”
ETC-10 – Location 2 = LIOC – 1’s – (<10) pool depth was 16”
ETC-10 – Location 3 = LIOC – 1’s – (<10) pool depth was 16.5”
ETC-10 – Location 4 = LIOC – 10’s (total 17-20 captured) – pool depth was 13”
ETC-10 – Location 5 = LIOC – 0 – pool depth was 12”
ETC-10 – Location 6 = LIOC – 0 – pool depth was 10”
ETC-10 – Location 7 = LIOC – 0 - pool depth was 6”
ETC-10 – Location 8 = LIOC – 0 - pool depth was 7”
ETC-10 – Location 9 = LIOC – 0 – pool depth was 8.5”
ETC-10 – Location 10 = LIOC – 1’s (total 2 captured) – pool depth was 9”
ETC-10 – Location 11 = LIOC – 0 - pool depth was 12”
ETC-10 – Location 12 = LIOC – 0 - pool depth was 13”
ETC-10 – Location 13 = LIOC – 0 – pool depth was 13.5”
ETC-10 – Location 14 = LIOC – 1’s (< 10) - pool depth was 15”
ETC-10 – Location 15 = LIOC – 1’s (total 2 captured) – pool depth was 12”
ETC-10 – Location (Pool A) = LIOC – 1’s (total 3 captured) – pool depth was 1.5”
ETC-10 – Location 16 = LIOC – 0 – pool depth was 6”
ETC-10 – Location 17 = LIOC – 0 – pool depth was 5.5”

FTA -1 (East) – Potentially Impacted Site

2/18/08
Time = 1550 hours
Size = 86' x 50'
Pool depth = average depth = 4"; maximum depth = 5"
Total of 12 sample locations
Sample size = 1 $meter^2$

Water Quality Parameters:
pH = 9.87
Conductivity = 0.015 ms/cm^3
Turbidity = 10
Dissolved Oxygen = 8.58 mg/L
Water Temp = 21.2 ^oC
Salinity = 0

Photos 009 and 010

FTA -1 (East) – Location 1 = BRLY – 1's (total 1 captured) – pool depth was 4"
FTA -1 (East) – Location 2 = 0 - pool depth was 5"
FTA -1 (East) – Location 3 = 0 - pool depth was 3"
FTA -1 (East) – Location 4 = LIOC – 1's (total 1 captured) – pool depth was 5"
FTA -1 (East) – Location 5 = LIOC – 1's (total 4 captured) – pool depth was 12"
BRLY - 1's (total 1 captured)
FTA -1 (East) – Location 6 = LIOC – 1's (total 2 captured) – pool depth was 4"
FTA -1 (East) – Location 7 = BRLY 1's (total 1 captured) - pool depth was 5"
FTA -1 (East) – Location 8 = LIOC – 1's (total 1 captured) - pool depth was 5"
FTA -1 (East) – Location 9 = LIOC – 1's (total 1 captured) - pool depth was 3"
FTA -1 (East) – Location 10 = BRLY – 1's (total 1 captured) – pool depth was 3"
FTA -1 (East) – Location 11 = LIOC – 0 - pool depth was 3"
FTA -1 (East) – Location 12 = LIOC – 1's (total 1 captured) - pool depth was 4"

FTA -1 (West) – Potentially Impacted Site

Two pools that normally form a horseshoe shape. At time of sampling, pools were not connected because of low water depth. One pool but two separate halves measured for pool size. MW 886 is located in the middle of the west pool.

2/18/08
Time = 1550 hours
Size (west pool) = 121' x 15'
Size (east pool) = 100' x 35'
Pool depth = average depth for both pools = 3.5"; maximum depth = 5"
Total of 15 sample locations (7 from west pool and 8 from east pool)
Sample size = 1 $meter^2$

Water Quality Parameters (west pool):
pH = 9.1
Conductivity = 0.125 ms/cm^3
Turbidity = 8
Dissolved Oxygen = 9.02 mg/L
Water Temp = 18.7 ^oC
Salinity = 0

Water Quality Parameters (east pool):
pH = 8.8
Conductivity = 0.122 ms/cm^3
Turbidity = 10
Dissolved Oxygen = 8.97 mg/L
Water Temp = 18.5 ^oC
Salinity = 0

Photos 011 through 014

FTA -1 (West) – Location 1 = 0 - pool depth was 3"
FTA -1 (West) – Location 2 = 0 - pool depth was 3.5"
FTA -1 (West) – Location 3 = 0 - pool depth was 5"
FTA -1 (West) – Location 4 = 0 - pool depth was 5"
FTA -1 (West) – Location 5 = 0 - pool depth was 3.5"
FTA -1 (West) – Location 6 = 0 - pool depth was 3.5"
FTA -1 (West) – Location 7 = 0 - pool depth was 3"

FTA -1 (West) – Location 8 = 0 - pool depth was 3.5"
FTA -1 (West) – Location 9 = 0 - pool depth was 3"
FTA -1 (West) – Location 10 = 0 - pool depth was 2.5"
FTA -1 (West) – Location 11 = 0 - pool depth was 3"
FTA -1 (West) – Location 12 = 0 - pool depth was 4"
FTA -1 (West) – Location 13 = 0 - pool depth was 3"

FTA -1 (West) – Location 14 = 0 - pool depth was 4”
FTA -1 (West) – Location 15 = 0 - pool depth was 4”

LF-5 (South) – Potentially Impacted Site

Pool almost dried up. Pool is very shallow and proved limited habitat at the time of sampling. Only three samples collected.

2/19/08
Time = 0830 hours
Size = 49’ x 10’
Pool depth = average depth = 2”; maximum depth = 3”
Total of 3 sample locations
Sample size = 1 meter^2

Water Quality Parameters:
pH = 7.4
Conductivity = 0.134 ms/cm^3
Turbidity = 10
Dissolved Oxygen = 12.12 mg/L
Water Temp = 8.5 ^{o}C
Salinity = 0

Photos 015 and 016

LF-5 (South) - Location 1 = 0 - pool depth was 3”
LF-5 (South) - Location 2 = 0 - pool depth was 2”
LF-5 (South) - Location 3 = 0 - pool depth was 1.5”

LF-5 (Southwest) – Potentially Impacted Site

2/19/08
Time = 0930 hours
Size = 228’ x 190’
Pool depth = average depth = 11”; maximum depth = 20”
Total of 16 sample locations
Sample size = 1 $meter^2$

Water Quality Parameters (9” depth):
pH = 7.0
Conductivity = 0.092 ms/cm^3
Turbidity = 10
Dissolved Oxygen = 11.2 mg/L
Water Temp = 9.9 ^{o}C
Salinity = 0

Photos 017 through 020

LF-5 (Southwest) – Location 1 = LIOC – 10’s (total 13 captured) – pool depth was 15”
LF-5 (Southwest) – Location 2 = LIOC – 1’s (total 5 captured) – pool depth was 9”
LF-5 (Southwest) – Location 3 = LIOC – 10’s (total 12 captured) – pool depth was 10”
LF-5 (Southwest) – Location 4 = LIOC – 1’s (total 1 captured) – pool depth was 8”
LF-5 (Southwest) – Location 5 = LIOC – 1’s (total 5 captured) – pool depth was 8”
LF-5 (Southwest) – Location 6 = LIOC – 100’s (approx 125 captured) – pool depth was 6”
LF-5 (Southwest) – Location 7 = LIOC – 100’s (approx 175 captured) – pool depth was 5”
LF-5 (Southwest) – Location 8 = 0 - pool depth was 12”
LF-5 (Southwest) – Location 9 = 0 - pool depth was 12”
LF-5 (Southwest) – Location 10 = 0 - pool depth was 8”
LF-5 (Southwest) – Location 11 = 0 - pool depth was 20”
LF-5 (Southwest) – Location 12 = 0 - pool depth was 15”
LF-5 (Southwest) – Location 13 = 0 - pool depth was 5”
LF-5 (Southwest) – Location 14 = 0 - pool depth was 5”
LF-5 (Southwest) – Location 15 = 0 - pool depth was 11”
LF-5 (Southwest) – Location 16 = 0 - pool depth was 11”

C208 – Reference Site

Reference site located to the south of ETC-12. C208 is a man-made pool created in 1999.

2/19/08
Time = 1035 hours
Size = 81’ x 39’
Pool depth = average depth for both pools = 4”; maximum depth = 5”
Total of 6 sample locations
Sample size = 1 $meter^2$

Water Quality Parameters:
pH = 7.5
Conductivity = 0.118 ms/cm^3
Turbidity = 43
Dissolved Oxygen = 10.98 mg/L
Water Temp = 11.1 ^oC
Salinity = 0

Photos 023 and 024

C208 – Location 1 = 0 - pool depth was 2”
C208 – Location 2 = 0 - pool depth was 5”
C208 – Location 3 = 0 - pool depth was 5”
C208 – Location 4 = 0 - pool depth was 3”
C208 – Location 5 = 0 - pool depth was 3”
C208 – Location 6 = 0 - pool depth was 2.5”

C209 – Reference Site

2/19/08
Time = 1100 hours
Size = 71’ x 38’
Pool depth = average depth = 8.25”; maximum depth = 11”
Total of 10 sample locations
Sample size = 1 $meter^2$

Water Quality Parameters:
pH = 7.5
Conductivity = 0.090 ms/cm^3
Turbidity = 56
Dissolved Oxygen = 11.05 mg/L
Water Temp = 11.6 ^oC
Salinity = 0

Photo 026

C209 – Location 1 = LIOC – 0 – pool depth was 9.5”
C209 – Location 2 = LIOC – 1’s (total 2 captured) – pool depth was 9”
C209 – Location 3 = LIOC – 1’s (total 2 captured) – pool depth was 8”
C209 – Location 4 = LIOC – 0 – pool depth was 8”
C209 – Location 5 = LIOC – 0 – pool depth was 11”
C209 – Location 6 = LIOC – 1’s (total 1 captured) – pool depth was 8”
C209 – Location 7 = LIOC – 0 – pool depth was 7”
C209 – Location 8 = 0 - pool depth was 7.5”
C209 – Location 9 = 0 - pool depth was 6”
C209 – Location 10 = 0 - pool depth was 8.5”

ETC-12 (C7) – Potentially Impacted Site

2/19/08
Time = 1140 hours
Size = 50' x 14'
Pool depth = average depth = 2.5"; maximum depth = 3"
Total of 3 sample locations
Sample size = 1 $meter^2$

Water Quality Parameters:
pH = 7.6
Conductivity = 0.072 ms/cm^3
Turbidity = 47
Dissolved Oxygen = 10.92 mg/L
Water Temp = 12.2 ^{o}C
Salinity = 0

Photos 027 and 028

ETC-12/C7 – Location 1 = BRLY – 10's (total 10 captured) – pool depth was 2.5"
ETC-12/C7 – Location 2 = BRLY – 1's (total 9 captured) – pool depth was 2"
ETC-12/C7 – Location 3 = LIOC – 1's (total 2 captured) - pool depth was 3"
BRLY – 1's (total 1 captured)

ETC-12 (C7A) – Potentially Impacted Site

2/19/08
Time = 1220 hours
Size = 40’ x 12’
Pool depth = average depth = 5”; maximum depth = 5”
Total of 3 sample locations
Sample size = 1 meter^2

Water Quality Parameters:
pH = 7.4
Conductivity = 0.088 ms/cm^3
Turbidity = 47
Dissolved Oxygen = 11.08 mg/L
Water Temp = 11.7 ^{o}C
Salinity = 0

Photos 029 and 030

ETC-12/C7A – Location 1 = LIOC – 1’s (total 7 captured) – pool depth was 5”
BRLY – 1’s (< 10 captured)
BRME – 1’s (< 10 captured);
ETC-12/C7A – Location 2 = LIOC – 1’s (< 10 captured) – pool depth was 5”
BRLY - 1’s (< 10 captured)
BRME – 1’s (< 10 captured);
ETC-12/C7A – Location 3 = BRLY – 10’s (> 10 but < 20 captured) – pool depth was 5”
BRME – 1’s (< 10 captured)
LIOC – 1’s (< 10 captured)

LF-3 (C-204) – Potentially Impacted Site

2/19/08
Time = 1300 hours
Size = 35' diameter
Pool depth = average depth = 5"; maximum depth = 6.5"
Total of 10 sample locations
Sample size = 1 meter^2

Water Quality Parameters:
pH = 8.5
Conductivity = 0.078 ms/cm^3
Turbidity = 59
Dissolved Oxygen = 10.0 mg/L
Water Temp = 14.o9 ^{o}C
Salinity = 0

Photo 034

LF-3/C204 – Location 1 = BRLY – 1's (< 10 captured) – pool depth was 6"
LF-3/C204 – Location 2 = BRLY – 1's (< 10 captured) – pool depth was 5"
LF-3/C204 – Location 3 = 0 - pool depth was 5"
LF-3/C204 – Location 4 = 0 - pool depth was 5"
LF-3/C204 – Location 5 = 0 - pool depth was 5"
LF-3/C204 – Location 6 = 0 - pool depth was 6"
LF-3/C204 – Location 7 = 0 - pool depth was 6"
LF-3/C204 – Location 8 = 0 - pool depth was 5"
LF-3/C204 – Location 9 = 0 - pool depth was 5"
LF-3/C204 – Location 10 = BRLY – 1's (< 10 captured) – pool depth was 6"

LF-3 (C4) – Potentially Impacted Site

2/19/08
Time = 1405 hours
Size = 75' x 39'
Pool depth = average depth = 5"; maximum depth = 6"
Total of 10 sample locations
Sample size = 1 $meter^2$

Water Quality Parameters:
pH = 8.2
Conductivity = 0.092 ms/cm^3
Turbidity = 57
Dissolved Oxygen = 10.06 mg/L
Water Temp = 14.8 ^oC
Salinity = 0

Photos 040 through 044

LF-3/C4 – Location 1 = LIOC – 1's (total < 10 captured) – pool depth was 3.5"
LF-3/C4 – Location 2 = LIOC – 1's (total 2 captured) – pool depth was 3.5"
BRLY - 1's (total 7 captured)
LF-3/C4 – Location 3 = LIOC – 10's (> 10 captured but < 20) – pool depth was 4".
BRLY – 1's (< 10 captured)
LF-3/C4 – Location 4 = LIOC – 10's (total 14 captured) – pool depth was 5"
BRLY – 1's (total 5 captured)
LF-3/C4 – Location 5 = LIOC – 10's (> 10 captured but < 20) – pool depth was 6"
BRLY - 1's (total 3 captured)
LF-3/C4 – Location 6 = LIOC – 10's (> 10 captured but < 20) – pool depth was 6"
BRLY – 10's (> 10 captured but < 20)
LF-3/C4 – Location 7 = LIOC – 10s (> 10 captured but < 20) – pool depth was 4"
BRLY - 1's (< 10 captured)
LF-3/C4 – Location 8 = LIOC – 0 – pool depth was 3"
BRLY – 1's (< 10 captured)
LF-3/C4 – Location 9 = LIOC – 0 – pool depth was 5"
BRLY - 1's (< 10 captured)
LF-3/C4 – Location 10 = LIOC – 10's (> 10 captured but < 20) – pool depth was 5"
BRLY – 1's (total 2 captured)

823 (North) – Reference Site

Limited sampling because USP security direct us to vacate premise.

2/19/08
Time = 1455 hours
Size = 180’ x 30’
Pool depth = average depth for both pools = 11”; maximum depth = 12”
Total of 4 sample locations
Sample size = 1 meter^2

Water Quality Parameters:
pH = 8.2
Conductivity = 0.084 ms/cm^3
Turbidity = 56
Dissolved Oxygen = 10.11 mg/L
Water Temp = 14.6 ^{o}C
Salinity = 0

Refer 823N – Location 1 = 0 - pool depth was 10.5”
Refer 823N – Location 2 = 0 - pool depth was 12”
Refer 823N – Location 3 = 0 - pool depth was 11”
Refer 823N – Location 4 = 0 - pool depth was 11”

USP Warehouse (South) – Reference Site

2/19/08
Time = 1530 hours
Size = 177' x 28'
Pool depth = average depth for both pools = 3.7"; maximum depth = 6"
Total of 10 sample locations
Sample size = 1 meter^2

Water Quality Parameters:
pH = 9.8
Conductivity = 0.045 ms/cm^3
Turbidity = 54
Dissolved Oxygen = 9.8 mg/L
Water Temp = 15.6 ^oC
Salinity = 0

Photos 047 and 048

USP Warehouse (S) – Location 1 = 0 - pool depth was 2"
USP Warehouse (S) – Location 2 = 0 - pool depth was 4"
USP Warehouse (S) – Location 3 = 0 - pool depth was 4"
USP Warehouse (S) – Location 4 = 0 - pool depth was 5"
USP Warehouse (S) – Location 5 = 0 - pool depth was 6"
USP Warehouse (S) – Location 6 = LIOC – 1's (< 10 captured) – pool depth was 5"
USP Warehouse (S) – Location 7 = 0 - pool depth was 5"
USP Warehouse (S) – Location 8 = 0 - pool depth was 2.5"
USP Warehouse (S) – Location 9 = 0 - pool depth was 1.5"
USP Warehouse (S) – Location 10 = 0 - pool depth was 2"

USP Warehouse (Southeast) – Reference Site

2/19/08
Time = 1600 hours
Size = 62’ x 40’
Pool depth = average depth = 7.25”; maximum depth = 10”
Total of 10 sample locations
Sample size = 1 $meter^2$

Water Quality Parameters:
pH = 9.6
Conductivity = 0.103 ms/cm^3
Turbidity = 56
Dissolved Oxygen = 9.91 mg/L
Water Temp = 15.1 ^oC
Salinity = 0

Photos 049 and 050

USP Warehouse (SE) – Location 1 = LIOC – 1’s (total 5 captured) – pool depth was 8”
USP Warehouse (SE) – Location 2 = LIOC – 10’s (>10 but < 20) – pool depth was 10”
USP Warehouse (SE) – Location 3 = LIOC – 10’s (>10 but < 20) – pool depth was 10”
USP Warehouse (SE) – Location 4 = LIOC – 20’s (>20 but < 30) – pool depth was 9.5”
USP Warehouse (SE) – Location 5 = LIOC – 1’s (total 5 captured) – pool depth was 10”
USP Warehouse (SE) – Location 6 = LIOC – 0 - pool depth was 3”
USP Warehouse (SE) – Location 7 = LIOC – 1’s (< 10 captured) – pool depth was 5”
USP Warehouse (SE) – Location 8 = LIOC - 10’s (>10 but < 20) – pool depth was 8”
USP Warehouse (SE) – Location 9 = 0 - pool depth was 6”
USP Warehouse (SE) – Location 10 = 0 - pool depth was 3”

835R – Reference Site

Reference site is questionable due to anthropogenic interference. I would not recommend using it in the future if possible. Site was used because USP security escorted us from other reference areas.

2/19/08
Time = 1645 hours
Size = 136' x 40'
Pool depth = average depth for both pools = 6"; maximum depth = 11"
Total of 10 sample locations
Sample size = 1 $meter^2$

Water Quality Parameters:
pH = 9.98
Conductivity = 0.104 ms/cm^3
Turbidity = 52
Dissolved Oxygen = 9.8 mg/L
Water Temp = 14.7 ^oC
Salinity = 0

835R – Location 1 = 0 - pool depth was 5"
835R – Location 2 = 0 - pool depth was 5"
835R – Location 3 = 0 - pool depth was 8"
835R – Location 4 = 0 - pool depth was 4.5"
835R – Location 5 = 0 - pool depth was 4"
835R – Location 6 = 0 - pool depth was 11"
835R – Location 7 = 0 - pool depth was 10"
835R – Location 8 = 0 - pool depth was 3"
835R – Location 9 = 0 - pool depth was 3"

ATTACHMENT B-2

PLANT SPECIES OBSERVED DURING VEGETATION SURVEYS

LIST OF VEGETATIVE SPECIES OBSERVED IN POTENTIALLY IMPACTED AND REFERENCE VERNAL POOLS
2008

Acronym	Species	Wetland Indicator Status[a]	Native Species
ACHY MOLL	*Achyrachaena mollis*	FAC	✓
ALOP CARO	*Alopecurus carolinianus*	FACW	
ANAG ARVE	*Anagallis arvensis*		
AVEN FATU	*Avena fatua*	-	
BRIZ MINO	*Briza minor*	FACW-	
BROM HORD	*Bromus hordeaceus*	FACU-	
BROM MADR	*Bromus madritensis*		
CALL MARG	*Callitriche marginata*	OBL	✓
CAST ATTE	*Castilleja attenuata*	-	✓
CAST CAMP	*Castilleja campestris* ssp. *succulentus*	OBL	✓
CAST SP	*Castilleja sp*		
CENT MINI	*Centunculus minimus*	FACW	✓
CICE QUAD	*Cicendia quadrangularis*	-	✓
CRAS AQUA	*Crassula aquatica*	OBL	✓
DESC DANT	*Deschampsia danthonioides*	FACW	✓
DOWN BICO	*Downingia bicornuta*	OBL	✓
DOWN ORNA	*Downingia ornatissima*	OBL	✓
ELAT CALI	*Elatine californica*	OBL	✓
ELEO MACR	*Elocharis macrostachya*	OBL	✓
EPIL BRAC	*Epilobium brachycarpum*	OBL	✓
EPIL CLEI	*Epilobium cleistogamum*	OBL	✓
EPIL PYGM	*Epilobium pygmaeum*	OBL	✓
EPIL SP	*Epilobium sp*		
EPIL TORR	*Epilobium torreyana*	FACW	✓
EROD BOTR	*Erodium botrys*	-	

Acronym	Species	Wetland Indicator Status[a]	Native Species
ERYN CAST	*Eryngium castrense*	FACW	✓
GALI APAR	*Galium aparine*		
GERA DISS	*Geranium dissectum*		
GRAT EBRA	*Gratiola ebracteata*	OBL	✓
GRIN CAMP	*Grindelia camporum*		
HEMI FITC	*Hemizonia fitchii*	-	✓
HORD MARI	*Hordeum marinum* ssp. *gussoneanum*	FAC	
HYPO GLAB	*Hypochaeris glabra*	-	
ISOE ORCU	*Isoetes orcuttii*	OBL	✓
JUNC BUFO	*Juncus bufonius*	FACW+	✓
JUNC CAPI	*Juncus capitatus*	FACU	
JUNC UNCI	*Juncus uncialis*	OBL	✓
LACT SERR	*Lactuca serriola*	FAC	
LEPI NITI	*Lepidium nitidum*		
LILA SCIL	*Lilaea scilloides*	OBL	✓
LOLI MULT	*Lolium multiflorum*	FAC	
LOTU HUMI	*Lotus humistratus*	–	✓
LYTH HYSS	*Lythrum hyssopifolia*	FACW	
MEDI POLY	*Medicago polymorpha*	–	
MIMU GUTT	*Mimulus guttatus*	OBL	✓
MIMU TRIC	*Mimulus tricolor*	OBL	✓
MONT FONT	*Montia fontana*		
MONT SP	*Montia sp.*		
MYOS MINI	*Myosurus minimus*	OBL	✓
NAVA INTE	*Navarretia intertexta*	OBL	✓
NAVA LEUC	*Navarretia leucocephala*	OBL	✓
NAVA SP	*Navarretia sp*	OBL	✓
PHAL LEMM	*Phalaris lemmonii*	FACW-	✓

Acronym	Species	Wetland Indicator Status[a]	Native Species
PILU AMER	*Pilularia americana*	OBL	✓
PLAG ACAN	*Plagiobothrys acanthocarpus*	OBL	✓
PLAG HUMI	*Plagiobothrys humistratus*	OBL	✓
PLAG STIP	*Plagiobothrys stipitatus*	OBL	✓
PLAN CORO	*Plantago coronopus*		
POA ANNU	*Poa annua*		
POGO ZIZY	*Pogogyne zizyphoroides*		
POLY SP	*Polygonum sp*		
PSIL BREV	*Psilocarphus brevissimus*	OBL	✓
PSIL OREG	*Psilocarphus oregonus*	OBL	✓
PSIL TENE	*Psilocarphus tenellus*	FAC	✓
RANU BONA	*Ranunculus bonariensis*	OBL	✓
RUMEX PULC	*Rumex pulcher*		
SPER RUBR	*Spergularia rubra*	FAC-	
TRIC LANA	*Trichostema lanceolatum*	–	✓
TRIF CILI	*Trifolium ciliolatum*	–	✓
TRIF DEPA	*Trifolium depauperatum*	FAC-	✓
TRIF HIRT	*Trifolium hirtum*		
TRIF MICI	*Trifolium microcephalum*	–	✓
TRIT SP	*Tritileia sp*		
VERE PERE	*Veronica peregrina*	OBL	✓
VICI VILL	*Vicia villosa*		
VULP BROM	*Vulpia bromoides*	FACW	
VULP MYUR	*Vulpia myuros*	FACU	

[a]Wetland Indicator Status:

OBL = Obigate Wetland; occurs almost always in wetlands.

FACW = Facultative Wetland; usually occurs in wetlands.

FAC = Facultative; occurs equally often in wetlands or uplands.

FACU	=	Facultative Upland; usually occurs in uplands.
–	=	No indicator status; presumed to be upland species.
NI	=	More information needed to determine wetland indicator status.
+/-	=	Modifier; + signifies that is found somewhat more often under wetter conditions, – signifies that is found somewhat more often under drier conditions.

ATTACHMENT B-3

PLANT DIVERSITY AND PLANT ABUNDANCE SURVEY RESULTS

(pools presented in the same order as the fairy shrimp survey)

ETC-10 – Potentially Impacted Site

ETC-10 PLOT 1 – 35% VEG/65% BARE

EPIL TORR – 2
PLAG STIP – 5
LYTH HYSS – 5
GRAT EBRA – 1
PLAT HUMI – 1
ELEO MACR – 2
HYPO GLAB - 1
CALL MARG – 2
JUNC BUFO – 2
MIMU GATT – 1
PSIL OREG – 1
BROM HORD – 2
EROD BOTR – 10

ETC-10 PLOT 2 – 80% VEG/20% BARE

BROM HORD – 5
VULP BROM – 5
TRIF MICI – 5
ELEO MACR – 24
MONT FONT – 1
PLAG STI P – 2
CALL MARG – 5
MEDI POLY – 2
CICE QUAD – 2
EROD BOTR – 10
VERE PERE – 2
NAVA LEUC – 2
CRAS AQUA – 2
EPIL TORR – 2
LYTH HYSS – 5
PSIL BREV – 1
CENT MINI – 5

ETC-10 PLOT 3 – 75% VEG/25% BARE

NAVA LEUC – 46
ELEO MACR – 5
DOWN BICO – 1
EPIL SP. – 1
CICE QUAD – 1

MONT FONT – 1
JUNC BUFO – 1
CENT MINI – 1
EROD BOTR – 1
VERE PERE – 2
PLAT STIP – 5
DESC DANT – 5
PSIL BREV – 1
HORD MARI – 1
CRAS AQUA – 1
CALL MARG – 1
ELAT CALI – 1

<u>ETC-10 PLOT 4 – 50% VEG/50% BARE</u>

GRAT EBRA – 10
PLAT STIP – 24
ELEO MACR – 1
CALL MARG – 2
NAVA LEUC – 10
JUNC BUFO – 1
ELAT CALI – 2

<u>ETC-10 PLOT 5 – 50% VEG/50% BARE</u>

PLAG STIP – 33
ELAT CALI – 2
GRAT EBRA – 1
PSIL OREG – 1
ELEO MACR – 1
CRAS AQUA – 1
CALL MARG – 3
EPIL TORR – 1
DOWN BICO – 1
JUNCO BUFO – 3
RANU BONA – 1
NAVA LEUC - 2

<u>ETC-10 PLOT 6 – 80% VEG/20% BARE</u>

PLAG STIP – 30
NAVA LEUC – 30
VERE PERE – 3
EROD BOTR – 1
PSIL BREV – 2
HYPO GLAB – 1

CICE QUAD – 1
JUNC BUFO – 5
CALL MARG – 2
DESC DANT – 1
SPER RUBR – 1
ELAT CALI – 2
EPIL SP. – 1

<u>ETC-10 PLOT 7 – 40% VEG/60% BARE</u>

NAVA LEUC – 10
EPIL SP. – 2
PLAG STIP – 20
CALL MARG – 3
PSIL BREV – 2
JUNC BUFO – 2
CRAS AQUA - 1

<u>ETC-10 PLOT 8 – 80% VEG/20% BARE</u>

ELEO MACR – 40
ERYN CAST – 1
PLAT STIP – 1
PSIL OREG – 2
JUNC BUFO – 5
EPIL SP. – 10
LYH HYSS – 1
NAVA LEUC – 10
GRAT EBRA – 5
CRAS AQUA – 5

<u>ETC-10 PLOT 9 – 30% VEG/20% BARE</u>

DOWN BICO – 1
PLAG STIP – 15
JUNC BUFO – 3
CALL MARG – 1
HEMI FITC – 1
GRAT EBRA – 1
ELAT CALI – 1
PSIL OREG – 1
EPIL SP. – 1
NAVA LEUC – 5

<u>ETC-10 PLOT 10 – 80% VEG/20% BARE</u>

ELEO MACR – 25
DESC DANT – 1
PLAT STIP – 30
NAVA LEUC – 10
VERE PERE – 2
MIMU TRIC – 1
HYPO GLAB – 1
EROD BOTR – 1
PSIL BREV – 1
EPIL SP. – 1
ERYN CAST – 3
HEMI FTIC – 1
CRAS AQUA – 2
JUNC BUFO - 1

FTA-1 (East) – Potentially Impacted Site

FTA-1 (EAST) - PLOT 1 – 30% VEG/70% BARE

ELEO MACR – 25
MIMU GUTT - 1
PSIL OREG – 1
VERE PERE – 1
JUNC BUFO – 2

FTA-1 (EAST) - PLOT 2 – 30% VEG/70% BARE

ELEO MACR – 12
JUNC BUFO – 1
PLAG STIP – 1
LYTH HYSS – 1
VERE PERE – 2
PSIL OREG – 12
PLAG ACAN – 1

FTA-1 (EAST) - PLOT 3 – 90% VEG/10% BARE

ELEO MACR – 10
POLYGONUM SP. – 2
VERE PERE – 5
MIMU GUTT – 1
JUNC BUFO – 1
PSIL OREG – 68
CRAS AQUA – 2
LYTH HYSS – 1

FTA-1 (EAST) - PLOT 4 – 60% VEG/40% BARE

ELEO MACR – 56
JUNC BUFO - 2
PSIL OREG – 1
LYTH HYSS – 1

FTA-1 (EAST) - PLOT 5 – 50% VEG/50% BARE

ELEO MACR – 47
JUNC BUFO - 1
PSIL OREG – 1
LYTH HYSS - 1

FTA-1 (EAST) - PLOT 6 – 85% VEG/15% BARE

ELEO MACR – 40
MIMU GUTT – 1
MONT FONT - 1
PSIL OREG – 10
LYTH HYSS – 25
VERE PERE – 5
CRAS AQUA – 1
JUNC BUFO - 2

FTA-1 (EAST) - PLOT 7 – 80% VEG/20% BARE

ELEO MACR – 54
MIMU GUTT - 5
PSIL OREG – 1
VERE PERE – 10
LYTH HYSS – 5
JUNC BUFO – 2
HYPO GLAB – 2
RUME PULC – 1

FTA-1 (EAST) - PLOT 8 – 90% VEG/10% BARE

EROD BOTR – 50
VERE PERE – 10
PSIL OREG – 13
EPIL BRAC – 3
VULP MYUR – 1
POLYGONUM SP. – 5
MIMU GUTT – 1
LYTH HYSS – 2
JUNC BUFO - 5

FTA-1 (EAST) - PLOT 9 – 50% VEG/50% BARE

ELEO MACR – 25
MIMU GUTT - 1
PSIL OREG – 17
VERE PERE – 1
LYTH HYSS – 3
JUNC BUFO – 3

FTA-1 (EAST) - PLOT 10 – 90% VEG/10% BARE

PHAL LEMM – 25

ELEO MACR – 2
VERE PERE – 40
POLYGONUM SP. – 11
PLAG STIP – 1
PSIL OREG – 2
POA ANNU – 5
LYTH HYSS – 3
EPIL SP. - 1

FTA-1 (West) – Potentially Impacted Site

FTA-1 (WEST) PLOT 1 – 90% VEG/10% BARE

HORD MARI – 10
ERYN CAST – 5
PLAG STIP – 74
LYTH HYSS – 1

FTA-1 (WEST) PLOT 2 – 75% VEG/25% BARE

RUME PULC – 15
ERYN CAST – 1
PLAG STIP – 45
HORD MARI – 1
EPIL SP. – 1
LYTH HYSS – 2
ELEO MACR – 5
MIMU GUTT – 1
RANU BONA – 2
HEMI FITC – 1
PSIL BREV - 1

FTA-1 (WEST) PLOT 3 – 50% VEG/50% BARE

ELEO MACR – 41
RANU BONA – 1
PLAG STIP – 1
ERYN CAST – 5
EPIL SP. – 1
HEMI FITC – 1

FTA-1 (WEST) PLOT 4 – 25% VEG/75% BARE

ELEO MACR – 15
PLAG STIP – 5
RUME PULC – 1
ERYN CAST – 1
HORD MARI – 1
PLAG HUMU – 1
LYTH HYSS – 1

FTA-1 (WEST) PLOT 5 – 60% VEG/40% BARE

ELEO MACR – 25
PLAG STIP – 25

ERYN CAST – 3
JUNC BUFO – 2
CRAS AQUA – 1
LYTH HYSS – 2
RUME PULC – 2

FTA-1 (WEST) PLOT 6 – 95% VEG/5% BARE

ERYN CAST – 20
PLAG STIP – 20
ELEO MACR – 5
GRAT EBRA – 5
PSIL BRAV – 18
LYTH HYSS – 5
NAVA LEUC – 20
RANU BONA – 1
CRAS AQUA – 1

FTA-1 (WEST) PLOT 7 – 90% VEG/10% BARE

ELEO MACR – 8
ERYN CAST – 10
PSIL BREV – 30
PLAG STIP – 30
HORD MARI – 10
CRAS AQUA – 1
GRAT EBRA – 1

FTA-1 (WEST) PLOT 8– 90% VEG/10% BARE

ELEO MACR – 20
PLAG STIP -1
ERYN CAST – 20
HORD MARI – 22
PSIL BREV – 25
RANU BONA – 1
LYTH HYSS – 1

FTA-1 (WEST) PLOT 9 – 90% VEG/10% BARE

ERYN CAST – 20
PSIL BREV – 47
PLAG STIP – 20
RANU BONA – 1
CRAS AQUA – 1
HORD MARI – 1

FTA-1 (WEST) PLOT 10 - 90% VEG/10% BARE

HORD MARI – 30
PLAG STIP – 5
ERYN CAST – 25
PSIL BREV - 30

LF-5 (South) – Potentially Impacted Site

LF-5 (S) PLOT 1 – 20% VEG/80% BARE

HORD MARI - 17%
PLAG STIP – 1%
DESC DANT – 1%
EPIL TORR - 1%

LF-5 (S) PLOT 2 – 35% VEG/65% BARE

HORD MARI - 31%
PLAG STIP – 1%
EPIL TORR - 1%
HEMI FITC – 1%
LOTU HUMI – 1%

LF-5 (S) PLOT 3 – 15% VEG/85% BARE

HORD MARI - 2%
PLAG STIP – 6%
EPIL TORR - 5%
DESC DANT – 1%
LOTU HUMI – 1%

LF-5 (S) PLOT 4 – 30% VEG/70% BARE

HORD MARI - 22%
PLAG STIP – 2%
EPIL TORR - 2%
HEMI FITC – 1%
DESC DANT - 1%
ERYN CAST – 1%
PSIL BREV – 1%

LF-5 (S) PLOT 5 – 50% VEG/50% BARE

HORD MARI - 41%
PLAG STIP – 2%
EPIL TORR - 2%
DESC DANT - 1%
PSIL BREV – 4%

LF-5 (S) PLOT 6 – 25% VEG/75% BARE

HORD MARI - 1%
PLAG STIP – 21%
EPIL TORR - 3%

LF-5 (S) PLOT 7 – 20% VEG/80% BARE

HORD MARI - 2%
PLAG STIP – 12%
EPIL TORR - 5%
DESC DANT - 1%

<u>LF-5 (S) PLOT 8 – 30% VEG/70% BARE</u>

HORD MARI - 28%
PLAG STIP – 1%
LOTU HUMI – 1%

<u>LF-5 (S) PLOT 9 – 70% VEG/30% BARE</u>

HORD MARI - 59%
EPIL TORR - 1%
EROD BOTR - 1%
BRIZ MINO – 1%
BROM HORD – 1%
TRIF MICI – 5%
HYPO GLAB – 1%
HEMI FITC – 1%

<u>LF-5 (S) PLOT 10 – 60% VEG/40% BARE</u>

HORD MARI - 47%
EROD BOTR - 3%
BRIZ MINO – 1%
BROM HORD – 3%
BROM MADR – 1%
TRIF DEPA – 1%
LOTU HUMI – 2%
ACHY MOLL – 1%
VULP MYUR – 1%

LF-5 (Southwest) – Potentially Impacted Site

LF-5 (SW) Plot 1 – 70% VEG/30% BARE

RANU BONA – 46%
ELEO MACR – 4%
PLAT STIP – 5%
PSIL BREV – 1%
JUNC BUFO – 2%
DOWN BICO – 1%
EROD BOTR – 1%
TRIF HIRT – 1%
RUME PULC – 2%
EPIL TORR – 1%
HORD MARI – 5%
ERYN CAST – 1%

LF-5 (SW) Plot 2 – 85% VEG/15% BARE

EROD BOTR – 20%
HORD MARI – 39%
RANU BONA – 10%
MIMU GUTT – 1%
BROM HORD – 1%
VERE PERE – 5%
MONT FONT – 4%
PLAG STIP – 2%
HYPO GLAB – 1%
ERYN CAST – 1%
ELEO MACR - 1 %

LF-5 (SW) Plot 3 – 80% VEG/20% BARE

VULP MYUR – 27%
EROD BOTR – 10%
BROM HORD – 1%
RANU BONA – 3%
HEMI FITC – 2%
MONT FONT – 20%
VERE PERE – 8%
HYPO GLAB – 2%
LYTH HYSS – 1%
ELEO MACR – 5%
MIMU GUTT – 1%

LF-5 (SW) Plot 4 – 90% VEG/10% BARE

ELEO MACR – 4%
ERYN CAST -20%
RANU BONA – 39%
CRAS AQUA – 2%
DOWN BICO – 15%
PLAG STIP – 10%

LF-5 (SW) Plot 5 – 95% VEG/5% BARE

ELEO MACR – 40%
ERYN CAST -2%
RANU BONA – 50%
GERA DISS – 1%
HORD MARI – 2%

LF-5 (SW) Plot 6 – 30% VEG/70% BARE

TRIT SP. – 1%
LOTU HUMI – 1%
GERA DISS – 2%
BROM HORD – 10%
HORD MARI – 10%
GALI APAR – 1%
VULP BROM – 5%

LF-5 (SW) Plot 7 – 95% VEG/5% BARE

BROM HORD – 10%
BROM MADR – 20%
HORD MARI – 38%
GERA DISS – 2%
EPIL BRAC – 1%
LYTH HYSS – 1%
MIMU GUTT – 1%
RANU BONA – 10%
LOTU HUMI – 2%
ELEO MACR - 10 %

LF-5 (SW) Plot 8 – 95% VEG/5% BARE

NAVA LEUC – 1%
DOWN BICO – 40%
PSIL BREV – 5%
CRAS AQUA – 40%
PLAG STIP – 3%

EPIL TORR – 1%
RANU BONA – 5%

LF-5 (SW) Plot 9 – 90% VEG/5% BARE

DOWN BICO – 43%
PLAG STIP – 10%
ELAT CALI – 30%
ERYN CAST – 1%
EPIL SP. – 5%
ELEO MACR – 1%

LF-5 (SW) Plot 10 – 70% VEG/30% BARE

ELEO MACR – 36%
ERYN CASTR – 30%
JUNC BUFO – 1%
LYTH HYSS – 1%
MIMU GUTT – 1%
PLAG STIP – 1%

C208 – Reference Site

ETC-12/C208 – Plot 1 – 90% VEG/10% BARE

HORD MARI – 15
PSIL BREV – 69
PLAT STIP – 5
HEMI FITC - 1

ETC-12/C208 – Plot 2 – 7% VEG/93% BARE

PSIL BREV – 5
PLAG STIP – 1
CRAS AQUA – 1

ETC-12/C208 – Plot 3 – 95% VEG/5% BARE

PLAG ACAN – 69
PLAG STIP – 10
HOR MARI – 10
DESC DANT – 2
CRAS AQUA – 1
PSIL BREV – 1
CICE QUAD - 2

ETC-12/C208 – Plot 4 – 60% VEG/40% BARE

HORD MARI – 27
VULP BROM – 25
EROD BOTR – 1
BROM HORD – 2
HEMI FITC – 1
CAST SP. – 1
EPIL SP. – 1
CRAS AQUA – 1
HYPO GLAB – 1

ETC-12/C208 – Plot 5 – 20% VEG/80% BARE

HORD MARI – 3
PSIL BREV – 2
VERE PERE – 5
LOLI MULT – 1
PLAG STIP – 2
CRAS AQUA – 7

ETC-12/C208 – Plot 6 – 75% VEG/15% BARE

HORD MARI – 65
PSIL BREV – 5
HEMI FITC – 1
PLAG STIP – 3
JUNC BUFO - 1

ETC-12/C208 – Plot 7 – 5% VEG/95% BARE

PLAG STIP – 1
PSIL BREV – 2
HEMI FITC – 1
CRAS AQUA - 1

ETC-12/C208 – Plot 8 – 90% VEG/10% BARE

PLAG STIP – 1
HORD MARI – 60
PSIL BREV – 25
JUNC BUFO – 1
CRAS AQUA – 2
HEMI FITC – 1

ETC-12/C208 – Plot 9 – 90% VEG/10% BARE

LOLI MULT - 1
HORD MARI – 7
PSIL BREV – 50
PLAT STIP – 5
ERYN CAST – 1
HEMI FITC – 1
CRAS AQUA – 25

ETC-12/C208 – Plot 10 – 90% VEG/10% BARE

HORD MARI – 10
PSIL BREV – 50
PLAT STIP – 24
HEMI FITC – 1
CRAS AQUA - 5

C209 – Reference Site

ETC-12/C209 PLOT 1 – 30% VEG/70% BARE

ELEO MACR – 5
PSIL TENN – 10
PLAG STIP – 10
CRAS AQUA – 2
GRAT EBRA – 2
JUNC BUFO – 1

ETC-12/C209 PLOT 2 – 52% VEG/48% BARE

ELEO MACR – 10
PSIL TENN – 25
PLAG STIP – 10
GRAT EBRA – 5
EPIL SP. – 1
CRAS AQUA – 1

ETC-12/C209 PLOT 3 – 86% VEG/14% BARE

HORD MARI – 60
PLAG STIP – 10
PSIL TENN – 2
ACHY MOLL – 5
CRAS AQUA – 2
VERE PERE – 1
HEMI FITC – 1
CICE QUAD – 2
CENT MINI – 1
BRIZ MINO – 1
GRAT EBRA - 1

ETC-12/C209 PLOT 4 – 65% VEG/35% BARE

GRAT EBRA – 6
ERYN CAST – 35
PLAG STIP – 10
PSIL TENN – 2
NAVA LEUC – 10
ELEO MACR – 1
POLYGONUM SP. – 1

ETC-12/C209 PLOT 5 – 50% VEG/50% BARE

GRAT EBRA – 15
PSIL TENN – 10
PLAG STIP – 20
CRAS AQUA – 1
JUNC BUFO – 1
EPIL SP. – 2
ELEO MACR – 1

ETC-12/C209 PLOT 6 – 70% VEG/30% BARE

PSIL TENN - 30
HEMI FITC – 1
PLAG STIP – 13
HORD MARI – 5
CRAS AQUA – 1
GRAT EBRA – 20

ETC-12/C209 PLOT 7 – 60% VEG/40% BARE

GRAT EBRA – 16
PSIL TENN – 10
PLAG STIP – 30
CRAS AQUA – 1
EPIL SP. – 2
JUNC BUFO - 1

ETC-12/C209 PLOT 8 – 75% VEG/25% BARE

ERYN CAST – 1
GRAT EBRA – 20
PSIL TENN – 26
PLAG STIP – 25
CRAS AQUA – 1
JUNC BUFO – 1
HORD MARI – 1

ETC-12/C209 PLOT 9 – 90% VEG/10% BARE

GRAT EBRA – 7
ERYN CAST – 1
PSIL TENN – 5
PLAG STIP – 30
HORD MARI – 40
RUME PULC – 1
JUNC BUFO – 1
CRAS AQUA – 1

CENT MINI – 1
CALL MARG – 2
CICE QUAD - 1

<u>ETC-12/C209 PLOT 10 – 50% VEG/50% BARE</u>

HORD MARI - 10
HEMI FITC – 1
PSIL TENN – 1
TRIT SP. – 1
EPIL SP. – 1
GRAT EBRA – 20
PLAG STIP – 14
CRAS AQUA - 2

ETC-12 (C7) – Potentially Impacted Site

ETC-12/POND C7 PLOT 1 – 80%VEG/20%BARE

ERYN CAST – 10
HORD MARI – 35
DOWN ORNA – 1
PSIL TENN – 1
RANU BONA – 1
ELEO MACR – 1
PLAG STIP – 30
GRAT EBRA – 1

ETC-12/POND C7 PLOT 2 – 75%VEG/25%BARE

HORD MARI – 73
EROD BOTR – 1
GRAT EBRA – 1

ETC-12/POND C7 PLOT 3 – 80%VEG/20%BARE

HORD MARI – 74
GRAT EBRA – 1
PLAG STIP – 1
PSIL TENN – 1
JUNC UNCI – 1
JUNC BUFO – 1
LOTU HUMI – 1

ETC-12/POND C7 PLOT 4 – 75%VEG/25%BARE

GRAT EBRA – 60
HORD MARI – 2
PSIL TENN – 1
SPER RUBR – 2
HEMI FITC – 1
DESC DANT – 1
CRAS AQUA – 1
PLAG STIP – 5
RANU BONA – 1
TRIT SP. – 1

ETC-12/POND C7 PLOT 5 – 90%VEG/10%BARE

LOTU HUMI – 1
HORD MARI – 69

VULP BROM – 10
BROM HORD – 1
EROD BOTR – 2
PLAG STIP – 2
PSIL TENN – 1
JUNC BUFO – 2
DESC DANT – 1
CRAS AQUA - 1

ETC-12/POND C7 PLOT 6 – 80%VEG/20%BARE

HORD MARI – 76
PLAG STIP – 1
PLAG ACAN – 1
RANU BONA – 1
GRAT EBRA – 1

ETC-12/POND C7 PLOT 7 – 50%VEG/50%BARE

HORD MARI – 25
PSIL TENN – 1
GRAT EBRA – 5
JUNC BUFO – 1
PLAG STIP – 15
RANU BONA – 1
DESC DANT – 1
CRAS AQUA – 1

ETC-12/POND C7 PLOT 8 – 80%VEG/20%BARE

ERYN CAST – 5
HORD MARI – 72
PSIL TENN – 1
HEMI FITC – 1
RANU BONA – 1

ETC-12/POND C7 PLOT 9 – 35%VEG/65%BARE

PLAG STIP – 17
PLAG ACAN – 1
PSIL TENN – 1
TRIL SP. – 1
GRAT EBRA – 1
DOWN ORNA – 1
JUNC BUFO – 5
CRAS AQUA – 5

HEMI FITC – 1
HORD MARI – 1
DESC DANT – 1

ETC-12/POND C7 PLOT 10 – 80%VEG/20%BARE

ELEO MACR – 5
HORD MARI – 37
PSIL TENN – 20
JUNC BUFO – 3
DESC DANT – 1
PLAG STIP – 10
VERE PERE – 1
GRAT EBRA – 2
PLAG ACAN - 1

ETC-12 (C7A) – Potentially Impacted Site

ETC-12/POOL C7A PLOT 1 – 75% VEG/25% BARE

HORD MARI – 15
PLAG ACAN – 1
PLAG STIP – 1
DESC DANT – 10
PSIL TENE – 5
CICE QUAD – 1
EPIL SP. – 1
LUPI BICO – 1
DOWN ORNA – 1
ELEO MACR - 10
ERYN CAST – 10
CAST ATTE – 1
BRIZ MINO – 1
EROD BOTR – 10
JUNC BUFO – 5
ACHY MOLL – 1
HEMI FITC – 1

ETC-12/POOL C7A PLOT 2 – 63% VEG/37% BARE

ERYN CAST – 20
DOWN ORNA – 5
PSIL TENE – 1
CAST CAMP – 1
EPIL SP. – 1
JUNC BUFO – 1
NAVA LEUC – 1
PLAG STIP – 20
HORD MARI – 5
GRAT EBRA – 1
HEMI FITC – 1
ELEO MACR – 5
DESC DANT – 1

ETC-12/POOL C7A PLOT 3 – 60% VEG/40% BARE

PSIL TENE – 10
HORD MARI – 40
DESC DANT – 1
PLAG STIP – 5
JUNC BUFO – 1

EPIL SP. – 1
DOWN ORNA – 1
HEMI FITC – 1

ETC-12/POOL C7A PLOT 4 – 60% VEG/40% BARE

POGO ZIZY – 1
ERYN CAST – 10
HORD MARI – 1
EPIL SP. – 1
DESC DANT – 1
PSIL TENE – 18
PLAG STIP – 20
DOWN ORNA – 1
GRAT EBRA – 5
JUNC BUFO – 1
CRAS AQUA – 1

ETC-12/POOL C7A PLOT 5 – 50% VEG/50% BARE

PLAG STIP – 9
DOWN ORNA – 1
PSIL TENE – 20
HEMI FITC – 1
CAST CAMP – 1
JUNC BUFO – 1
DESC DANT – 1
HORD MARI – 10
RANU BONA – 1
CRAS AQUA – 1
GRAT EBRA – 2
EPIL SP. – 1
ERYN CAST - 1

ETC-12/POOL C7A PLOT 6 – 60% VEG/40% BARE

HORD MARI – 20
BROM HORD – 1
ELEO MACR – 15
PLAG STIP – 10
PSIL TENE – 1
ERYN CAST – 7
DOWN ORNA – 1
VERE PERE – 1
HEMI FITC – 1
CRAS AQUA – 1

JUNC BUFO – 1
GRAT EBRA – 1

<u>ETC-12/POOL C7A PLOT 7 – 70% VEG/30% BARE</u>

ERYN CAST – 30
HORD MARI – 30
RANU BONA – 1
PLAG STIP – 3
CRAS AQUA – 1
DOWN ORNA – 1
PSIL TENE – 1
HEMI FITC – 1
EPIL SP. – 1
JUNC BUFO – 1

<u>ETC-12/POOL C7A PLOT 8 – 60% VEG/40% BARE</u>

ELEO MACR – 1
ERYN CAST – 20
DOWN ORNA – 1
PLAG STIP – 20
PSIL TENE – 1
CAST CAMP – 1
GRAT EBRA – 12
VERE PERE – 1
JUNC BUFO – 1
CRAS AQUA – 1
HEMI FITC - 1

<u>ETC-12/POOL C7A PLOT 9 – 25% VEG/75% BARE</u>

PSIL TENE – 4
PLAG STIP – 10
DOWN ORNA – 1
GRAT EBRA – 4
ALOP CARO – 1
JUNC BUFO – 1
CRAS AQUA – 1
CAST CAMP – 1
DESC DANT – 1
CALL MARG – 1

<u>ETC-12/POOL C7A PLOT 10 – 40% VEG/60% BARE</u>

DOWN ORNA – 1

DESC DANT – 1
HORD MARI – 10
PLAT STIP – 2
PSIL TENE – 20
POGO ZIZY – 1
EPIL SP. – 1
JUNC BUFO – 1
CRAS AQUA – 1
MIMU TRIC – 1
HEMI FITC - 1

LF3 (C204) – Potentially Impacted Site

LF3/POOL C204 - PLOT 1 – 20% VEG/80%BARE

PLAG STIP – 1
PSIL TENE – 16
CRAS AQUA – 1
EPIL SP. – 1
GRAT EBRA – 1

LF3/POOL C204 - PLOT 2 – 50% VEG/50%BARE

PSIL TENE – 37
EPIL SP. – 5
HEMI FITC – 1
PLAG STIP – 5
CRAS AQUA – 2

LF3/POOL C204 - PLOT 3 – 10% VEG/90%BARE

HORD MARI – 6
PLAG STIP – 1
PSIL TENE – 1
CRAS AQUA – 1
CALL MARG – 1

LF3/POOL C204 - PLOT 4 – 33% VEG/67%BARE

HORD MARI – 10
LOLI MULT – 2
GRAT EBRA – 1
CRAS AQUA – 1
HEMI FITC – 1
PSIL TENE – 10
PLAG STIP – 5
EPIL SP. – 1
JUNC BUFO – 1
CALL MARG – 1

LF3/POOL C204 - PLOT 5 – 20% VEG/70%BARE

PSIL TENE – 15
CRAS AQUA – 1
PLAG STIP – 1
CALL MARG – 1

JUNC BUFO – 1
ERYN CAST - 1

LF3/POOL C204 - PLOT 6 – 60% VEG/40%BARE

HORD MARI – 53
GRAT EBRA – 1
PSIL TENE – 1
VICI VILL – 1
PLAG ACAN – 1
PLAG STIP – 1
CALL MARG – 1
CRAS AQUA – 1

LF3/POOL C204 - PLOT 7 – 70% VEG/30%BARE

ELEO MACR – 10
PSIL TENE – 25
PLAG STIP – 1
CRAS AQUA – 5
GRAT EBRA – 23
EPIL SP. – 5
CALL MARG – 1

LF3/POOL C204 - PLOT 8 – 80% VEG/20%BARE

TRIT SP. – 1
HORD MARI – 40
PLAG ACAN – 10
ANAG ARVE – 1
PLAG STIP – 1
PSIL TENE – 1
GRAT EBRA – 25
CALL MARG – 1

LF3/POOL C204 - PLOT 9 – 7% VEG/93%BARE

PSIL TENE – 1
HORD MARI – 1
CRAS AQUA – 1
GRAT EBRA – 1
CALL MARG – 1
PLAG ACAN – 1
PLAG STIP – 1

LF3/POOL C204 - PLOT 10 – 10% VEG/90%BARE

GRAT EBRA – 1
EPIL SP. – 1
PSIL TENE – 4
CALL MARG – 1
PLAG STIP – 1
CRAS AQUA - 2

LF-3 (C4) – Potentially Impacted Site

LF-3/POOL C4 – PLOT 1 – 50% VEG/50% BARE

ELEO MACR – 23
PLAG STIP – 25
CAST CAMP – 1
PSIL BREV – 1

LF-3/POOL C4 – PLOT 2 – 75% VEG/25% BARE

ERYN CAST – 69
PLAG STIP – 5
HEMI FITC – 1

LF-3/POOL C4 – PLOT 3 – 80% VEG/20% BARE

HORD MARI – 54
ERYN CAST – 1
PSIL BREV – 1
ANAG ARVE – 1
HEMI FITC – 1
PLAG STIP – 20
RUME PULC – 1
ELEO MACR – 1

LF-3/POOL C4 – PLOT 4 – 50% VEG/50% BARE

ELEO MACR – 33
PLAG STIP – 1
ERYN CAST – 15
PSIL BREV – 1

LF-3/POOL C4 – PLOT 5 - 90% VEG/10% BARE

GRIN CAMP – 20
HORD MARI – 50
BROM HORD – 1
ELEO MACR – 2
LUPI BICO – 10
ACHY MOLL – 1
MIMU GUTT – 3
VIVI VILL – 1
VULP BROM – 1
PSIL OREG – 1

LF-3/POOL C4 – PLOT 6 – 80% VEG/20% BARE

ELEO MACR – 5
ERYN CAST – 5
PLAG STIP – 5
HORD MARI – 63
PSIL BREV – 1
ANAG ARVE – 1

LF-3/POOL C4 – PLOT 7 – 55% VEG/45% BARE

ELEO MACR – 10
ANAG ARVE – 1
HORD MARI – 42
PLAG STIP – 1
LOTU HUMI – 1

LF-3/POOL C4 – PLOT 8 – 90% VEG/10% BARE

ERYN CAST - 25
PLAG STIP – 63
HORD MARI – 1
PSIL BREV – 1

LF-3/POOL C4 – PLOT 9 – 80% VEG/20% BARE

PLAG STIP – 45
HORD MARI – 10
ERYN CAST – 20
ELEO MACR - 5

LF-3/POOL C4 – PLOT 10 – 75% VEG/25% BARE

ELEO MACR – 20
LUPI BICO – 1
HORD MARI – 50
GRIN CAMP – 1
EROD BOTR – 1
VICI VILL – 1
TRIF HURT - 1

823 (North) - Reference Site

823 (N) – Plot 1 – 98% VEG/2% BARE

CICE QUAD – 5%
LUPI BICO – 1%
RANU BONA – 25%
PLAG STIP – 2%
LOTU HUMI – 5%
PSIL BREV – 5%
CRAS AQUA – 5%
HEMI FITC – 1%
HORD MARI – 20%
EROD BOTR – 2%
PLAG ACAN – 1%
LYTH HYSS – 5%
BROM HORD – 2%
HYPO GLAB – 10%
CENT MINI – 2%
JUNC UNCI - 2%
JUNC CAPI – 2%
DOWN BICO – 2%
RUME PULC – 1%

823 (N) – Plot 2 – 90% VEG/10% BARE

RANU BONA – 1
LYTH HYSS – 5
CENT MINI – 1
EROD BOTR – 25
HORD MARI – 25
VULP MYUR – 10
LOTY HUMI – 5
EPIL BRAC – 1
HYPO GLAB – 4
CICE QUAD – 1
JUNC CAPI – 5
BROM HORD – 5
BRIZ MINO – 1
DOWN BICO – 1

823 (N) – Plot 3 – 50% VEG/50% BARE

DOWN BICO – 10
ERYN CAST – 15
RANU BONA – 10

PSIL BREV – 1
PLAG STIP – 1
ELEO MACR – 10
DESC DANT – 1
CRAS AQUA -1
LYTH HYSS – 1

<u>823 (N) – Plot 4 – 95% VEG/5% BARE</u>

DOWN BICO – 50
ERYN CAST – 30
ELEO MACR – 5
RANU BONA – 3
PSIL BREV – 2
LYTH HYSS – 2
PLAG STIP – 3

<u>823 (N) – Plot 5 – 90% VEG/10% BARE</u>

DOWN BICO – 55
ERYN CAST – 30
PSIL BREV – 1
LYTH HYSS – 3
CAST CAMP - 1

<u>823 (N) – Plot 6 – 60% VEG/40% BARE</u>

DOWN BICO – 15
ELEO MACR – 35
RUME PULC – 1
RANU BONA – 5
ERYN CAST – 1
LYTH HYSS – 1
JUNC BUFO – 1
PLAG STIP – 1

<u>823 (N) – Plot 7 – 85% VEG/15% BARE</u>

DOWN BICO – 2
ERYN CAST – 1
PLAT STIP – 4
DESC DANT – 1
PSIL BREV – 1
CRAS AQUA – 5
RANU BONA – 20
LYTH HYSS -10

CICE QUAD – 1
JUNC BUFO – 1
HORD MARI – 37
EROD BOTR – 1
HEMI FITC - 1

<u>823 (N) – Plot 8 – 80% VEG/20% BARE</u>

DOWN BICO – 30
ELEO MACR – 40
ERYN CAST – 5
PSIL BREV – 2
EPIL TORR – 1
CRAS AQUA – 1
ELAT CALI – 1

<u>823 (N) – Plot 9 – 85% VEG/15% BARE</u>

DOWN BICO – 1
VICI VILL – 1
RANU BONA – 50
ELEO MACR – 25
ERYN CAST – 2
PLAG STIP – 1
HORD MARI - 5

<u>823 (N) – Plot 10 – 75% VEG/25% BARE</u>

ELEO MACR – 50
RANU BONA – 25

USP Warehouse (South) – Potentially Impacted Site

USP WAREHOUSE (S) PLOT 1 – 35% VEG/65%BARE

ERYN CAST – 2
PLAG STIP – 5
PSIL TENE – 15
CALL MARG – 1
GRAT EBRA – 5
NAVA LEUC – 5
CRAS AQUA – 1
POGO ZIZY – 1

USP WAREHOUSE (S) PLOT 2 – 55% VEG/45%BARE

ERYN CAST – 25
PLAG STIP – 1
POGO ZIZY – 1
CAST CAMP – 1
NAVA LEUC – 2
PSIL TENE – 5
ELEO MACR – 1
GRAT EBRA – 18
CALL MARG – 1

USP WAREHOUSE (S) PLOT 3 – 20% VEG/80%BARE

NAVA LEUC – 1
GRAT EBRA – 3
PSIL BREV – 10
DESC DANT – 1
ERYN CAST – 1
CRAS AQUA – 1
CALL MARG – 1
POGO ZIZY – 1
PLAG STIP - 1

USP WAREHOUSE (S) PLOT 4 – 30% VEG/70%BARE

GRAT EBRA – 10
ERYN CAST – 8
PSIL TENE – 5
POGO ZIZY – 1
NAVA LEUC – 1
DESC DANT – 1
PLAG STIP – 3

CALL MARG – 1

USP WAREHOUSE (S) PLOT 5 – 20% VEG/80%BARE

GRAT EBRA – 3
ERYN CAST – 5
POGO ZIZY – 1
NAVA LEUC – 1
PLAG STIP – 3
PSIL TENE – 5
CRAS AQUA – 1
CALL MARG - 1

USP WAREHOUSE (S) PLOT 6 – 30% VEG/70%BARE

ALOP CARO – 1
POGO ZIZY – 5
PLAG STIP – 2
GRAT EBRA – 8
ERYN CAST – 1
PSIL TENE – 4
NAVA LEUC – 8
CALL MARG – 1

USP WAREHOUSE (S) PLOT 7 – 30% VEG/70%BARE

ERYN CAST – 15
PSIL TENE – 5
NAVA LEUC – 3
GRAT EBRA – 2
PLAG STIP – 2
POGO ZIZY – 1
CALL MARG – 1
CRAS AQUA -1

USP WAREHOUSE (S) PLOT 8 – 40% VEG/60%BARE

DESC DANT – 1
POGO ZIZY – 1
PSIL TENE – 2
PLAG STIP – 2
JUNC BUFO – 1
ELEO MACR – 1
ERYN CAST – 7
HORD MARI – 20
GRAT EBRA – 2

CRAS AQUA – 1
CALL MARG – 1
NAVA LEUC – 1

<u>USP WAREHOUSE (S) PLOT 9 – 45% VEG/65%BARE</u>

POGO ZIZY – 5
NAVA LEUC – 10
PLAG STIP – 8
ERYN CAST – 2
GRAT EBRA – 8
CALL MARG – 1
CRAS AQUA – 1
PSIL TENE – 15

<u>USP WAREHOUSE (S) PLOT 10 – 25% VEG/75%BARE</u>

DESC DANT – 1
POGO ZIZY – 1
PLAG STIP – 1
NAVA LEUC – 1
CALL MARG – 2
CRAS AQUA – 1
HORD MARI – 1
PLAG ACAN – 1
ERYN CAST – 5
GLAT EBRA – 5
PSIL TENE – 5
CAST CAMP - 1

<u>USP Warehouse (Southeast) – Potentially Impacted Site</u>

<u>USP WAREHOUSE (SE) - PLOT 1 – 90%VEG /10% BARE</u>

DOWN ORNA – 1
GRAT EBRA – 20
ERYN CAST – 1
PSIL TENE – 2
DESC DANT – 1
PLAG STIP – 61
POGO ZIZY – 1
ELEO MACR – 1
CRAS AQUA – 2

<u>USP WAREHOUSE (SE) - PLOT 2 – 95%VEG /5% BARE</u>

PLAG STIP – 60
DOWN ORNA – 20
PSIL TENE – 5
GRAT EBRA – 5
CRAS AQUA – 2
POGO ZIZY – 1
ANNA ARVE – 1
ERYN CAST - 1

<u>USP WAREHOUSE (SE) - PLOT 3 – 90%VEG /10% BARE</u>

DOWN ORNA – 2
CRAS AQUA – 3
PLAG STIP – 75
POGO ZIZY – 2
GRAT EBRA – 5
DESC DANT – 1
PSIL TENE - 2

<u>USP WAREHOUSE (SE) - PLOT 4 – 95%VEG /5% BARE</u>

HORD MARI – 81
ELEO MACR – 1
ERYN CAST – 1
GRAT EBRA – 1
PSIL TENE – 1
VERE PERE – 1
ANNA ARVE – 1
CRAS AQUA – 1

PLAG STIP – 5
PLAG ACAN – 1
DOWN ORNA – 1

USP WAREHOUSE (SE) - PLOT 5 – 85%VEG /15% BARE

DOWN ORNA – 15
PLAG STIP – 51
ANNA ARVE – 2
CRAS AQUA – 5
GRAT EBRA – 5
ERYN CAST – 5
POGO ZIZY – 1
PSIL TENE – 1

USP WAREHOUSE (SE) - PLOT 6 – 80%VEG /20% BARE

PLAG STIP – 71
DOWN ORNA – 2
PSIL TENE – 2
ERYN CAST – 3
NAVA LEUC – 1
CALL MARG - 1

USP WAREHOUSE (SE) - PLOT 7 – 71%VEG /29% BARE

JUNC BUFO – 1
DOWN ORNA – 10
GRAT EBRA – 3
ERYN CAST – 1
CRAS AQUA – 5
PSIL TENE – 2
EPIL SP. – 1
ANNA ARVE – 1
NAVA LEUC – 1
PLAG STIP – 46

USP WAREHOUSE (SE) - PLOT 8 – 80%VEG /20% BARE

PLAG STIP – 1
DOWN ORNA – 1
HORD MARI – 51
ERYN CAST – 20
PLAG ACAN – 1
GRAT EBRA – 2
ANNA ARVE – 1

LYTH HYSS – 1
PSIL TENE – 1
RANU BONA – 1

USP WAREHOUSE (SE) - PLOT 9 – 80%VEG /20% BARE

ERYN CAST – 20
PLAG STIP – 5
DOWN ORNA – 1
CRAS AQUA – 2
HORD MARI – 49
LYTH HYSS – 1
PSIL TENE – 1
PLAG ACAN – 1

USP WAREHOUSE (SE) - PLOT 10 – 90%VEG /10% BARE

EPIL SP. – 1
DOWN ORNA – 1
NAVA LEUC – 40
ERYN CAST – 2
CALL MARG – 1
GRAT EBRA – 2
PSIL TENE – 5
PLAG STIP 35
CRAS AQUA – 1
JUNC BUFO – 1
ELEO MACR - 1

835R – Reference Site

835R – PLOT 1 – 80%VEG/20% BARE

ELEO MACR – 5
PLAG STIP – 1
EPIL SP. – 1
PSIL TENE – 72
CRAS AQUA – 1

835R – PLOT 2 – 30%VEG/50% BARE

PLAG STIP – 2
PLAG ACAN – 15
PSIL TENE – 3
JUNC BUFO – 1
PSIL OREG – 1
HORD MARI – 6
ANNA ARVE – 1
CALL MARG – 1

835R – PLOT 3 – 30%VEG/50% BARE

PLAG ACAN – 21
PLAG STIP – 5
PSIL TENE – 1
HORD MARI – 1
ANNA ARVE – 1
POLYGONUM SP. - 1

835R – PLOT 4 – 10%VEG/90% BARE

RUME PULC – 2
PLAG STIP – 3
POLYGONUM SP. – 1
PSIL TENE – 3
HORD MARI – 1

835R – PLOT 5 – 30%VEG/70% BARE

DESC DANT – 11
PLAG STIP – 5
PSIL TENE – 10
PSIL OREG – 1
POLYGONUM SP. – 1
CRAS AQUA – 1

HORD MARI – 1

835R – PLOT 6 – 30%VEG/70% BARE

PLAG STIP – 3
POLYGONUM SP. – 2
PSIL TENE – 24
DESC DANT – 1

835R – PLOT 7 – 30%VEG/70% BARE

DESC DANT – 1
HORD MARI – 10
PSIL TENE – 1
PLAN CORO – 5
LEPI NITI – 1
POA ANNU – 5
PLAG ACAN – 5
LOTU HUMI – 1
PSIL OREG – 1

835R – PLOT 8 – 25%VEG/75% BARE

PLAG ACAN – 10
POLYGONUM SP.- 5
ANNA ARVE – 2
HORD MARI – 5
PLAG STIP – 1
PSIL OREG – 1
PLAN CORO - 1

835R – PLOT 9 – 20%VEG/80% BARE

PLAG ACAN – 12
POLYGONUM SP. – 1
PSIL TENE – 1
DESC DANT – 1
CRAS AQUA – 1
PLAG OREG – 1
PLAN CORO – 1
ANNA ARVE – 1
HORD MARI – 1

835R – PLOT 10 – 30%VEG/70% BARE

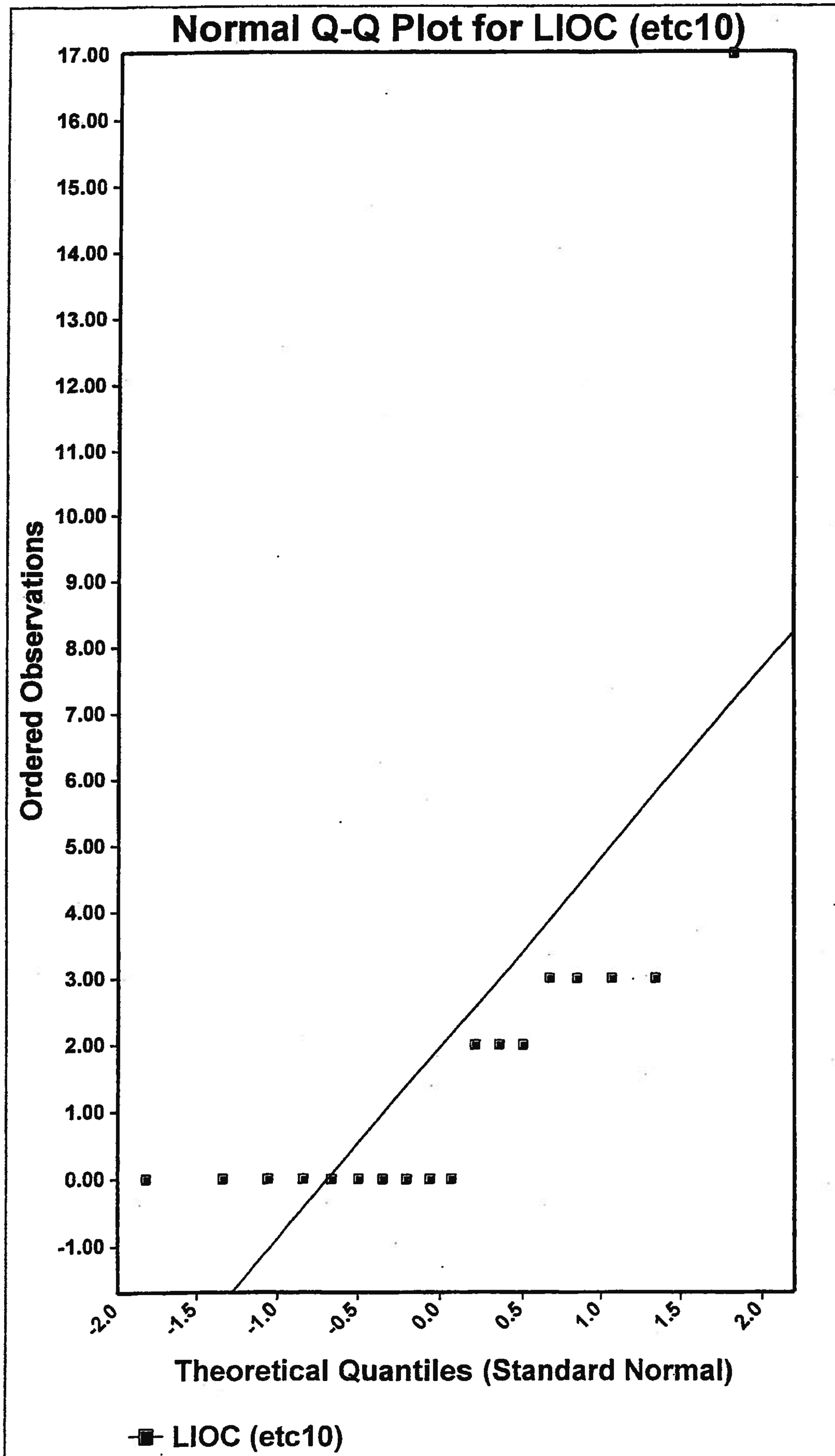
ERYN CAST – 1

PLAG STIP – 5
PLAG ACAN – 10
PSIL TENE – 10
LOTU HUMI – 1
EPIL SP. – 1
CRAS AQUA – 1
POLYGONUM SP. - 1

ATTACHMENT B-4

NORMAL Q-Q PLOTS

SHRIMP NORMALITY EVALUATION



LIOC (etc10)

N = 18

Mean = 1.9444

Sd = 3.9775

Slope = 2.8597

Intercept = 1.9444

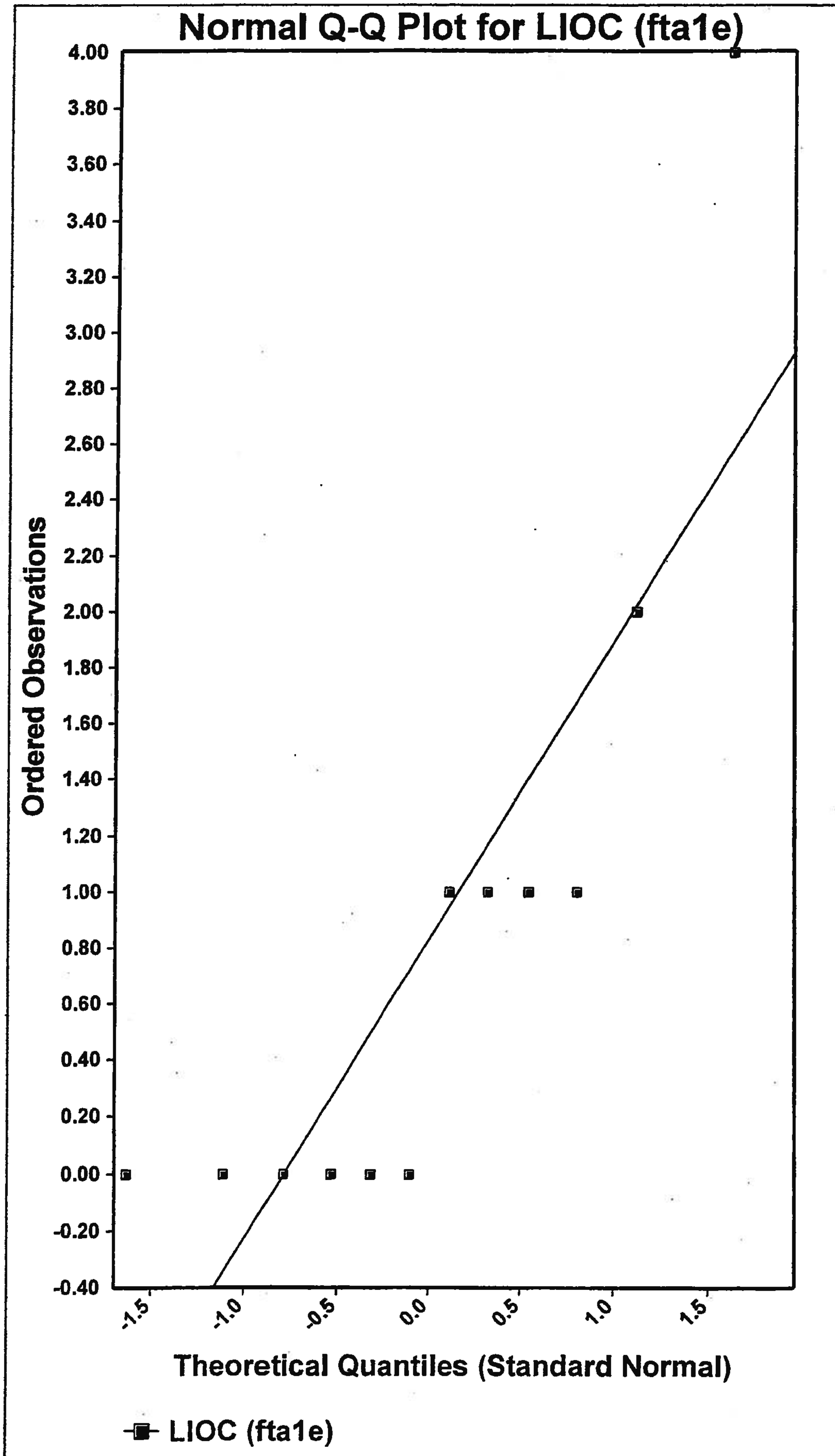
Correlation, R = 0.6906

Shapiro-Wilk Test

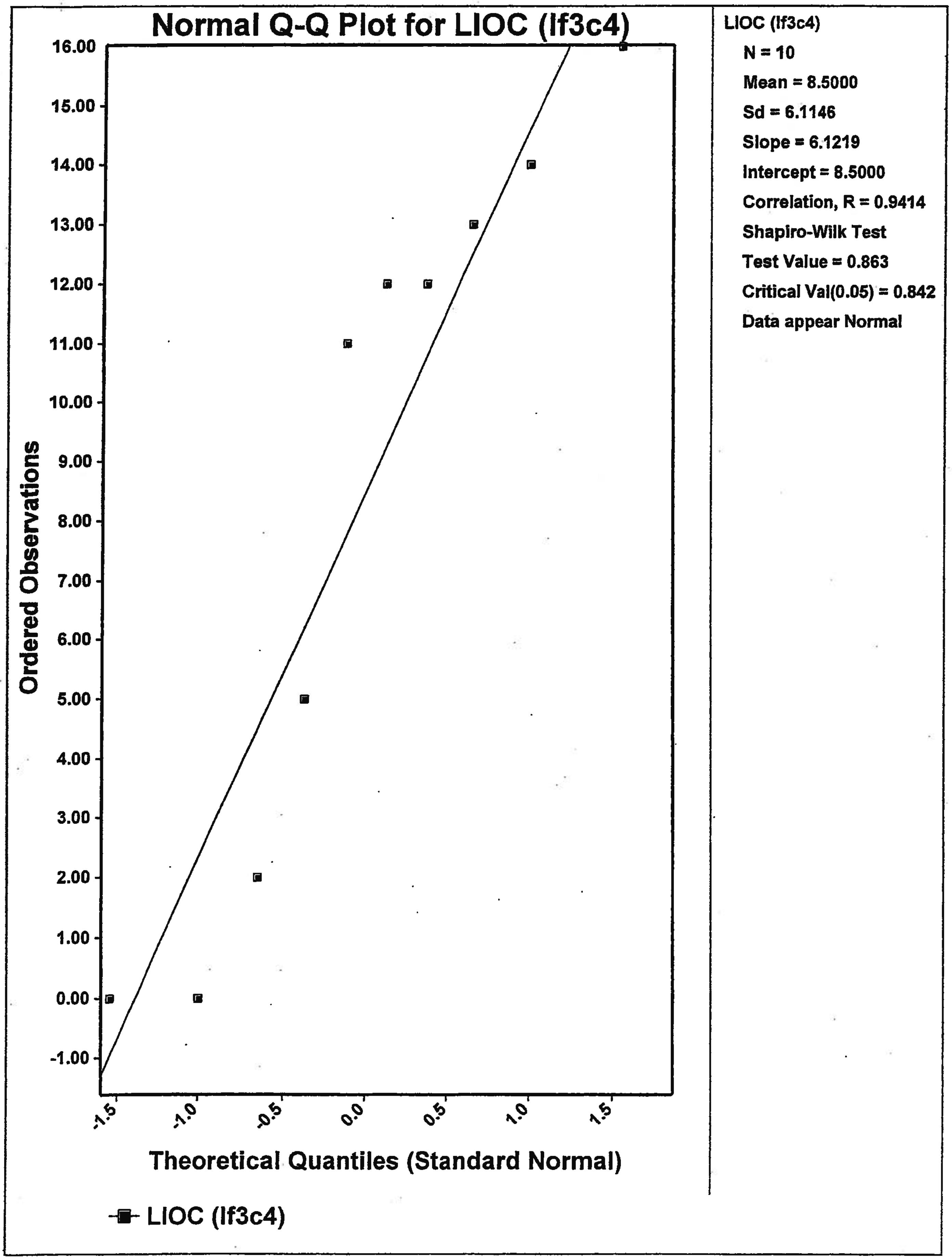
Test Value = 0.504

Critical Val(0.05) = 0.897

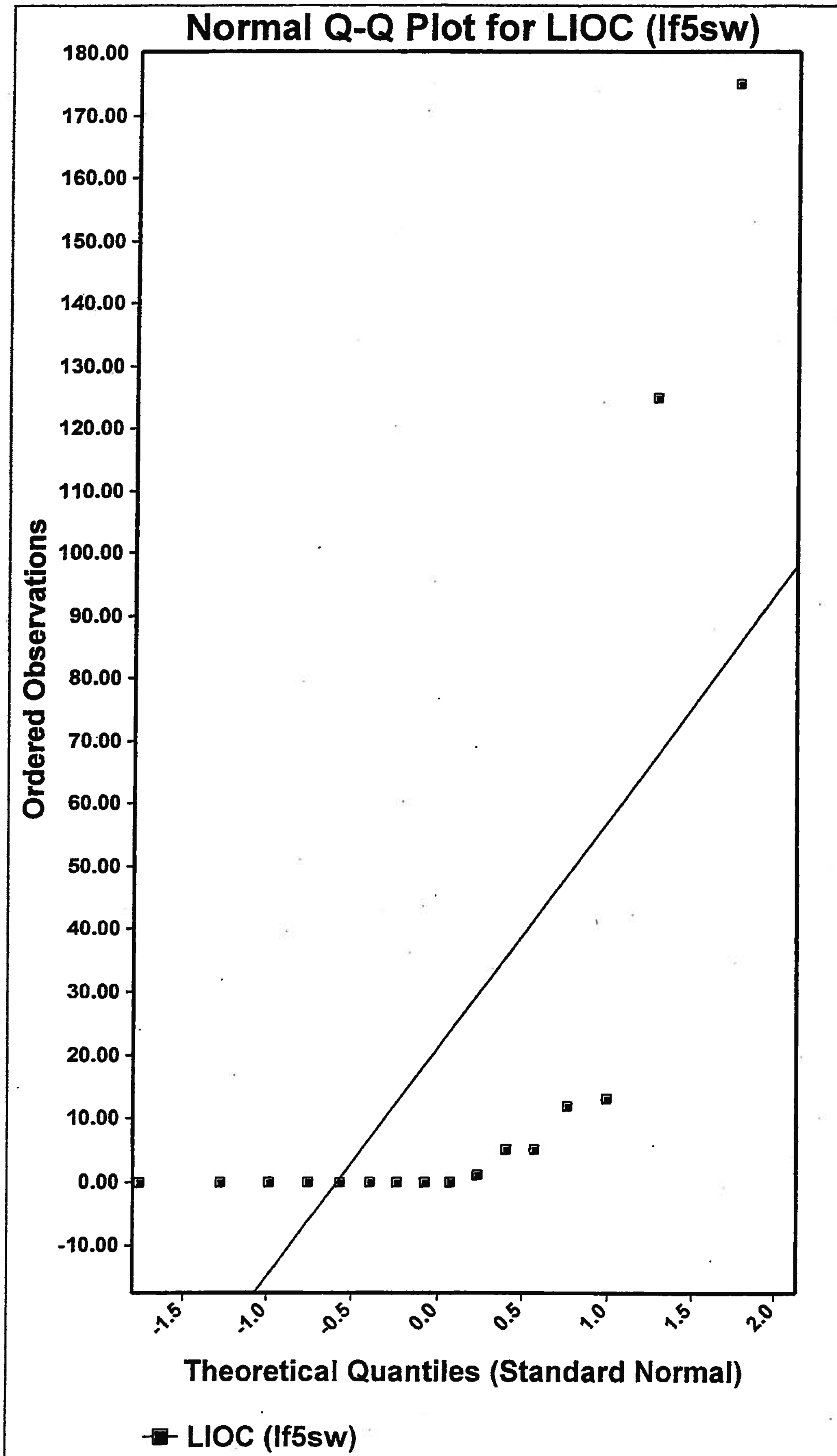
Data not Normal



LIOC (fta1e)
N = 12
Mean = 0.8333
Sd = 1.1934
Slope = 1.0646
Intercept = 0.8333
Correlation, R = 0.8451
Shapiro-Wilk Test
Test Value = 0.725
Critical Val(0.05) = 0.859
Data not Normal



Normal Q-Q Plot for LIOC (lf3c4)
Ordered Observations
16.00
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
LIOC (lf3c4)
LIOC (lf3c4)
N = 10
Mean = 8.5000
Sd = 6.1146
Slope = 6.1219
Intercept = 8.5000
Correlation, R = 0.9414
Shapiro-Wilk Test
Test Value = 0.863
Critical Val(0.05) = 0.842
Data appear Normal



LIOC (lf5sw)

N = 16

Mean = 21.0000

Sd = 51.3537

Slope = 36.1613

Intercept = 21.0000

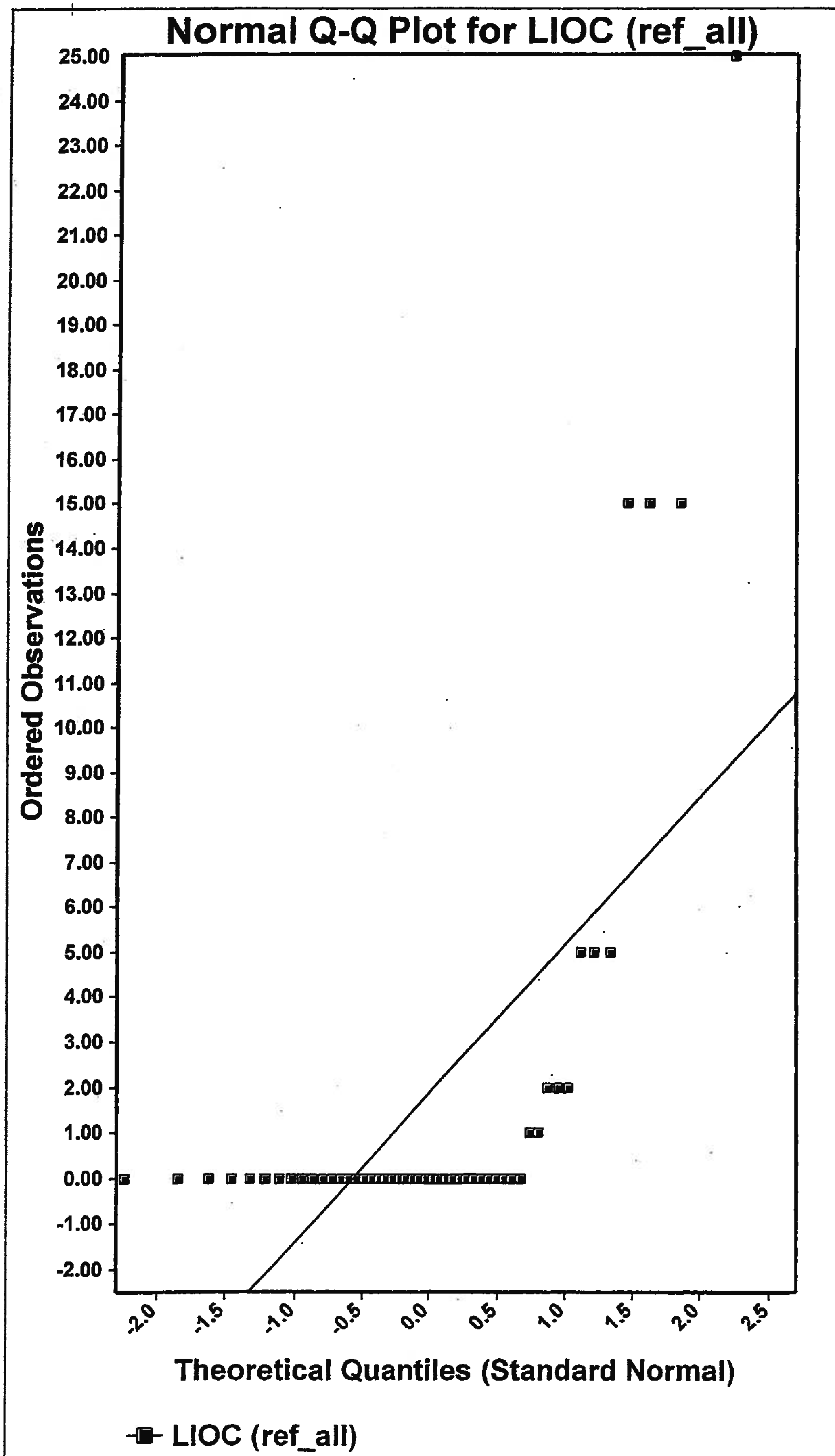
Correlation, R = 0.6739

Shapiro-Wilk Test

Test Value = 0.471

Critical Val(0.05) = 0.887

Data not Normal



LIOC (ref_all)

N = 50

Mean = 1.8600

Sd = 4.9816

Slope = 3.2963

Intercept = 1.8600

Correlation, R = 0.6494

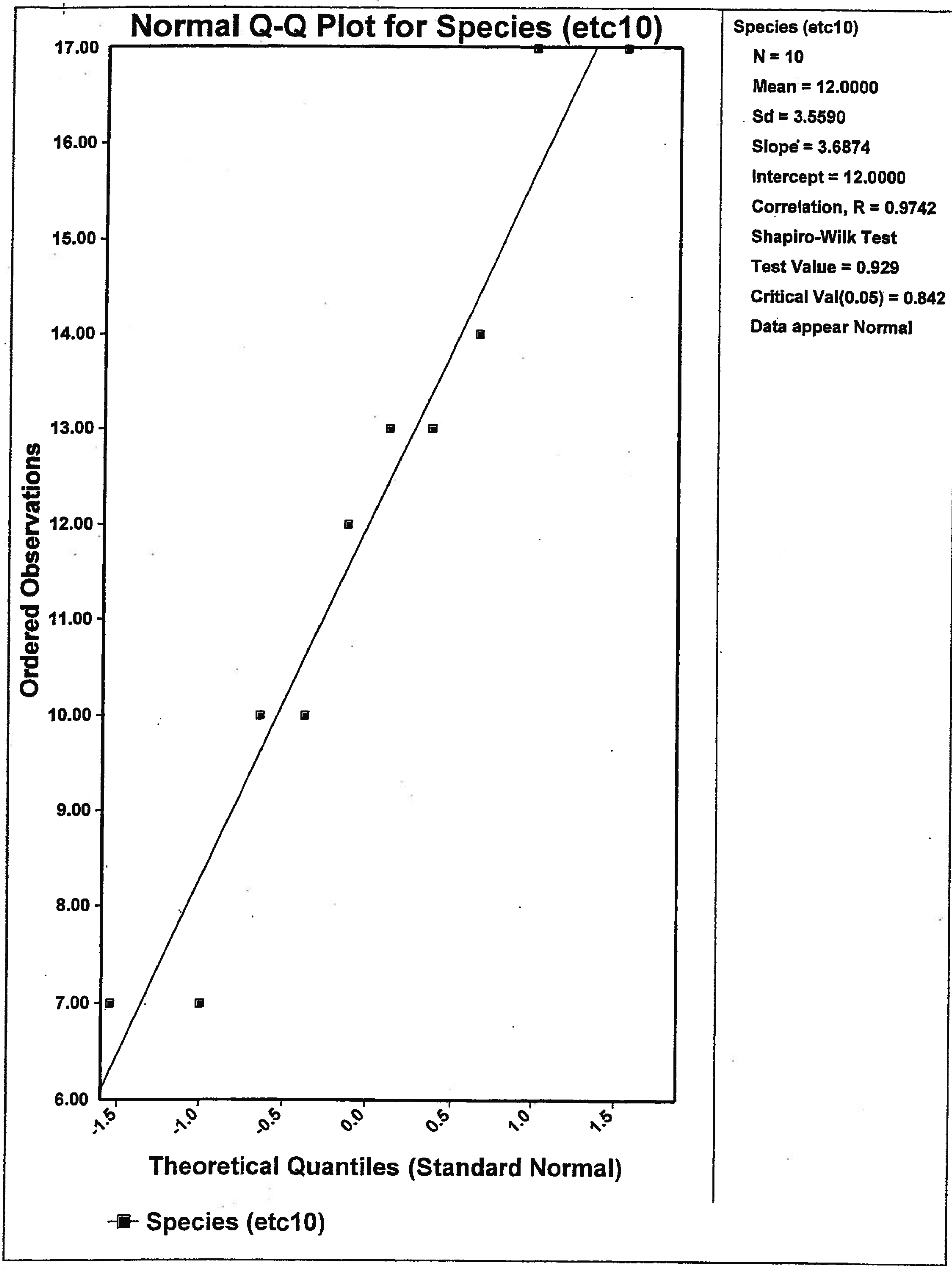
Shapiro-Wilk Test

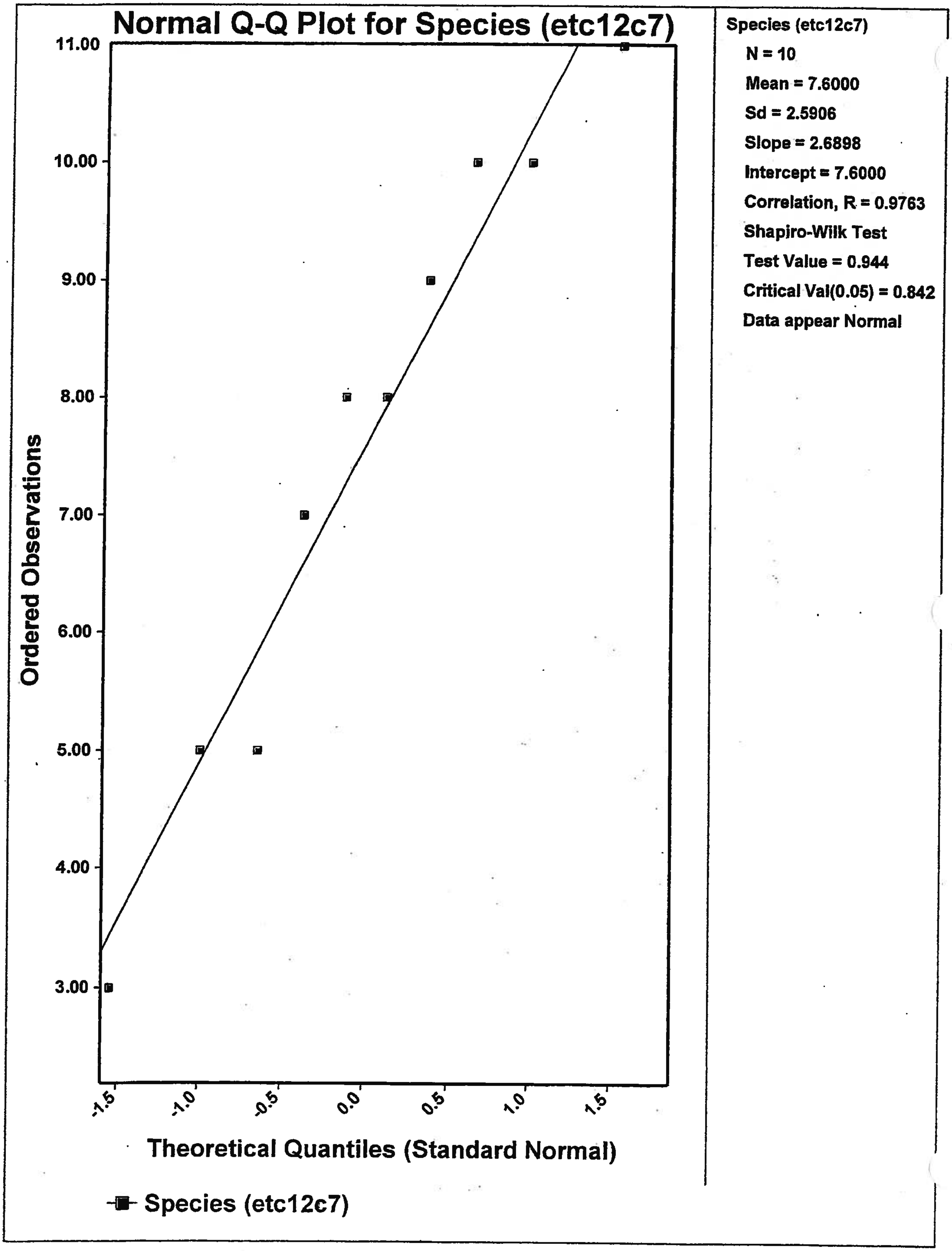
Test Value = 0.444

Critical Val(0.05) = 0.947

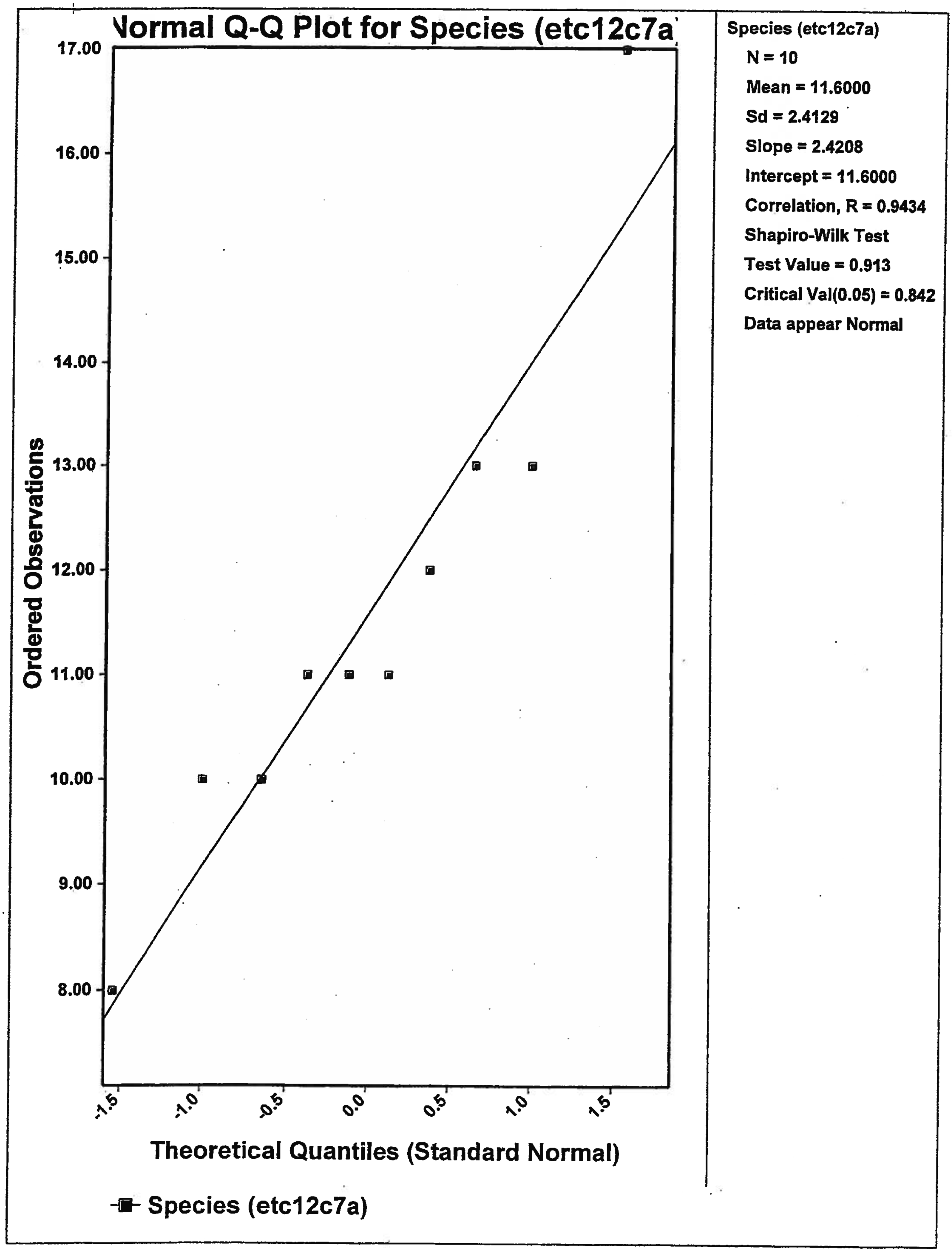
Data not Normal

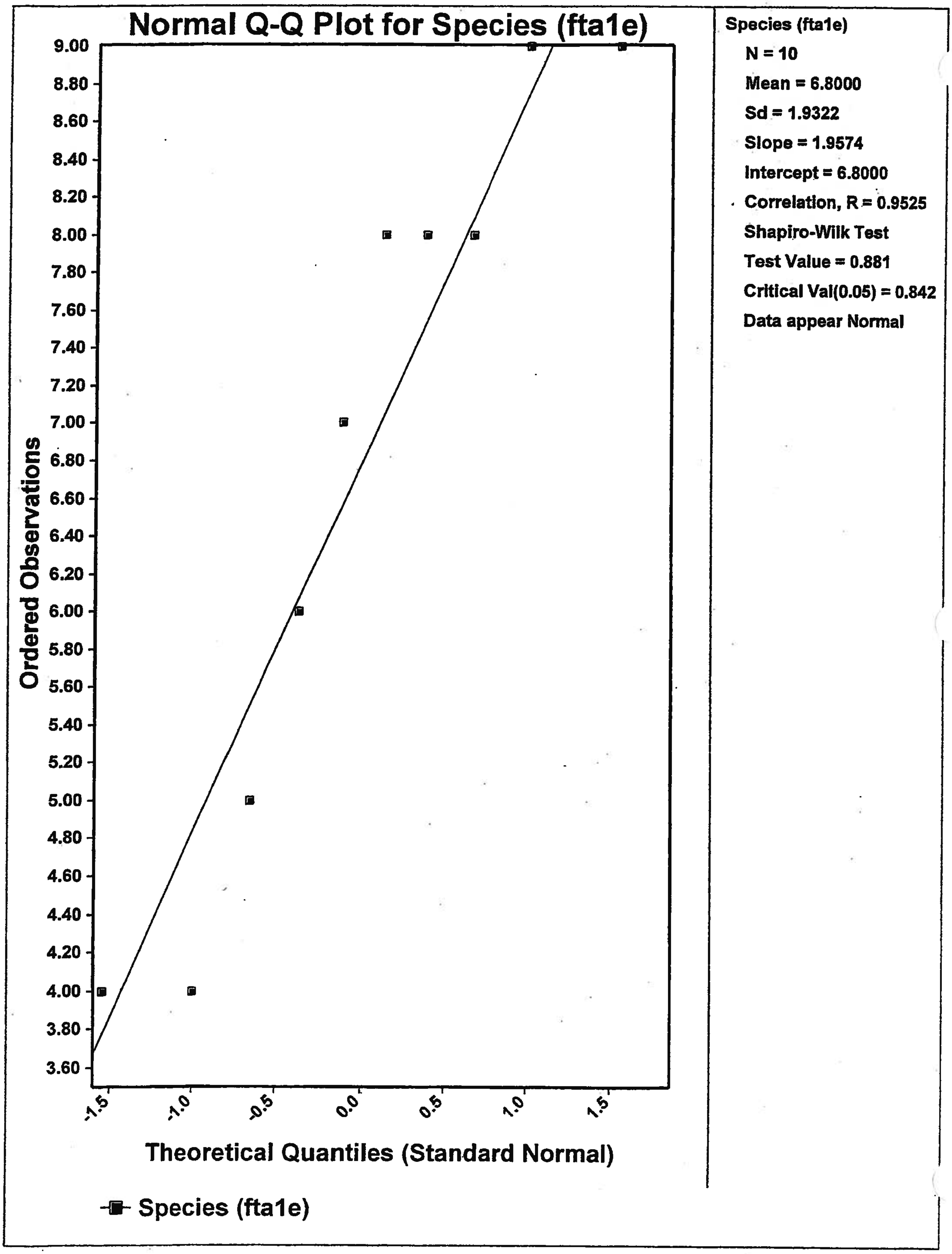
VEGETATION DIVERSITY NORMALITY EVALUATION


Normal Q-Q Plot for Species (etc10)
17.00
16.00
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
Ordered Observations
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Species (etc10)
Species (etc10)
N = 10
Mean = 12.0000
Sd = 3.5590
Slope = 3.6874
Intercept = 12.0000
Correlation, R = 0.9742
Shapiro-Wilk Test
Test Value = 0.929
Critical Val(0.05) = 0.842
Data appear Normal

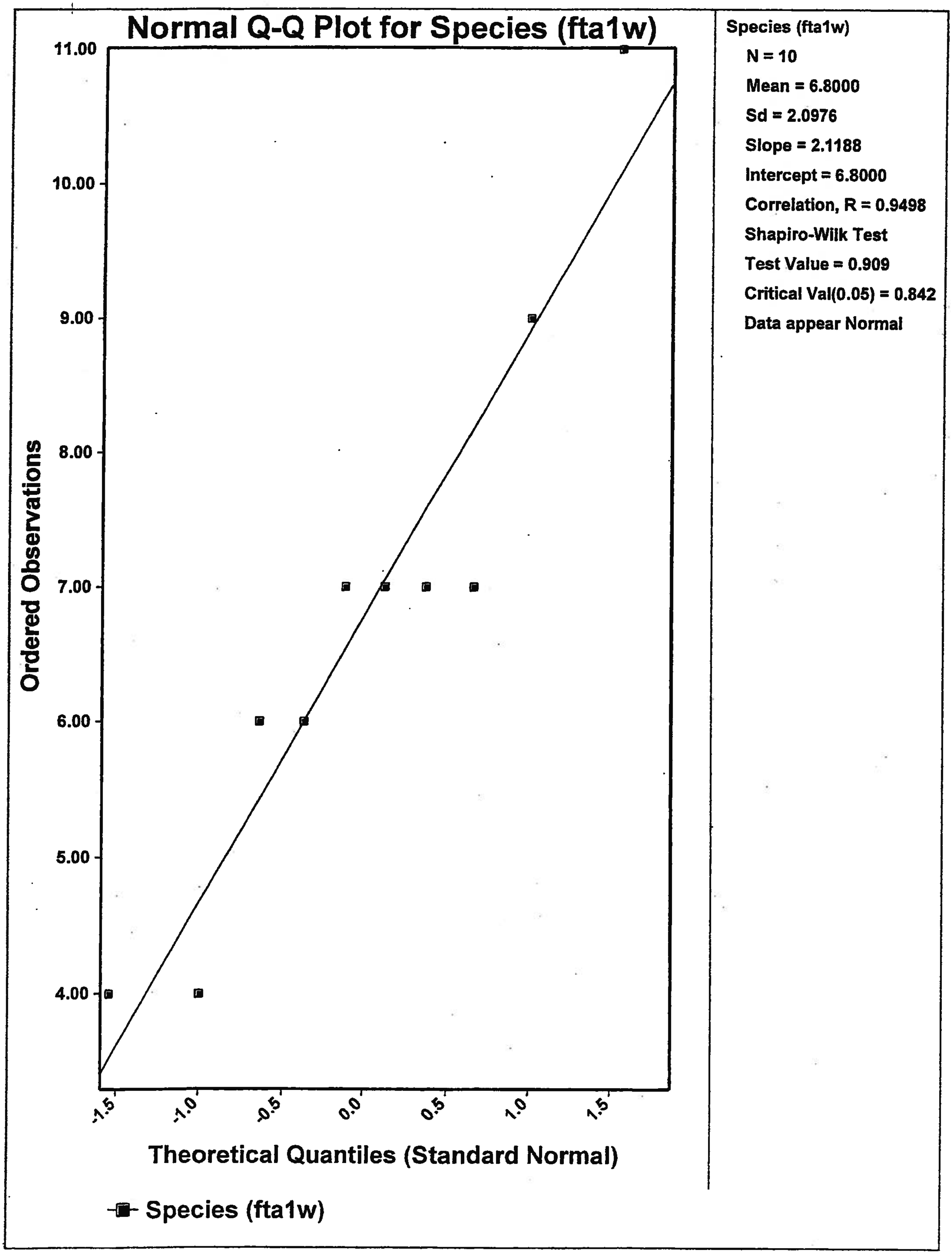


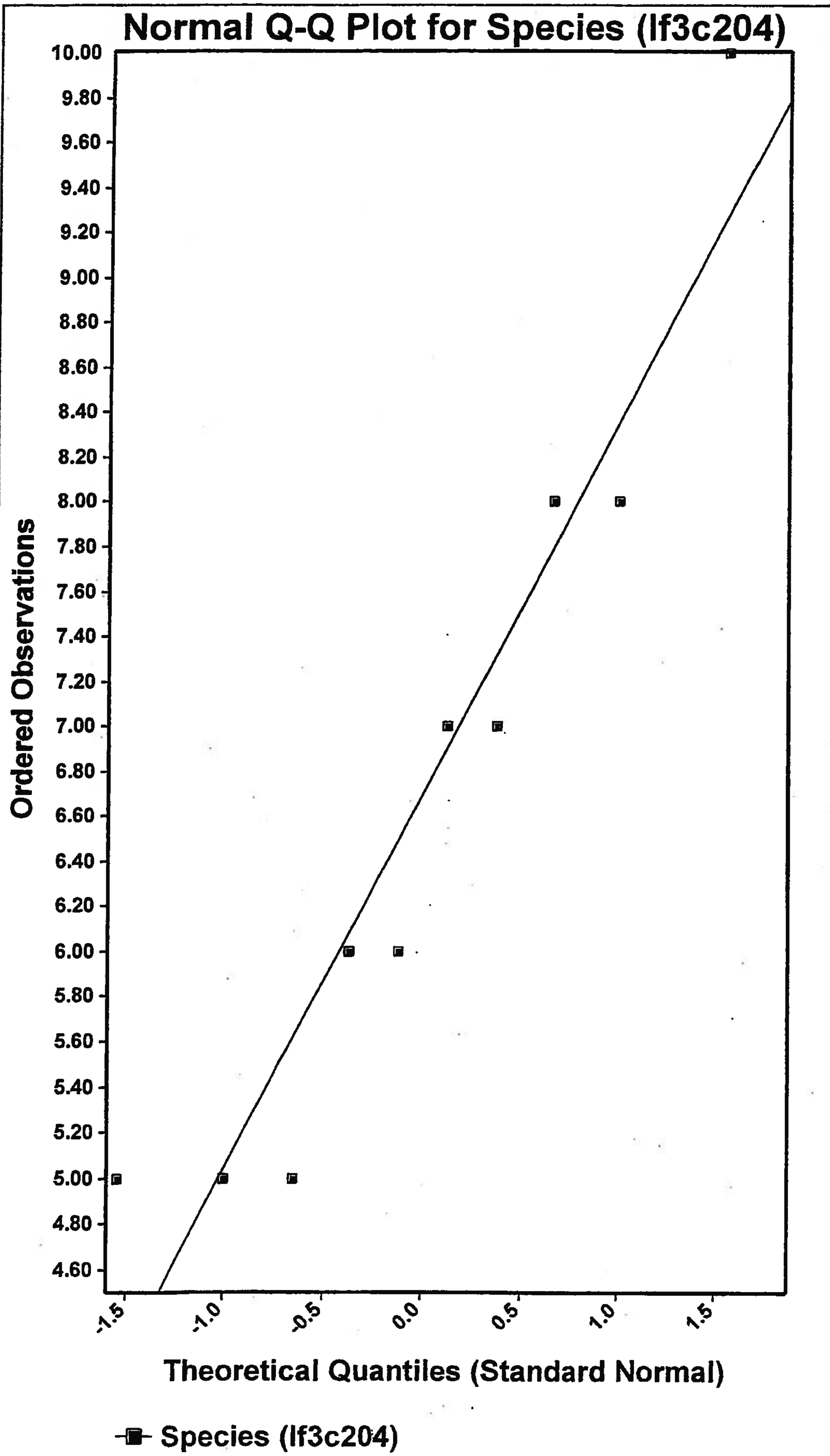
Normal Q-Q Plot for Species (etc12c7)
Ordered Observations
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Species (etc12c7)
Species (etc12c7)
N = 10
Mean = 7.6000
Sd = 2.5906
Slope = 2.6898
Intercept = 7.6000
Correlation, R = 0.9763
Shapiro-Wilk Test
Test Value = 0.944
Critical Val(0.05) = 0.842
Data appear Normal


Normal Q-Q Plot for Species (etc12c7a)
17.00
16.00
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
Ordered Observations
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Species (etc12c7a)
Species (etc12c7a)
N = 10
Mean = 11.6000
Sd = 2.4129
Slope = 2.4208
Intercept = 11.6000
Correlation, R = 0.9434
Shapiro-Wilk Test
Test Value = 0.913
Critical Val(0.05) = 0.842
Data appear Normal



Normal Q-Q Plot for Species (fta1e)
Ordered Observations
9.00
8.80
8.60
8.40
8.20
8.00
7.80
7.60
7.40
7.20
7.00
6.80
6.60
6.40
6.20
6.00
5.80
5.60
5.40
5.20
5.00
4.80
4.60
4.40
4.20
4.00
3.80
3.60
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Species (fta1e)
Species (fta1e)
N = 10
Mean = 6.8000
Sd = 1.9322
Slope = 1.9574
Intercept = 6.8000
Correlation, R = 0.9525
Shapiro-Wilk Test
Test Value = 0.881
Critical Val(0.05) = 0.842
Data appear Normal


Normal Q-Q Plot for Species (fta1w)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
Ordered Observations
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Species (fta1w)
Species (fta1w)
N = 10
Mean = 6.8000
Sd = 2.0976
Slope = 2.1188
Intercept = 6.8000
Correlation, R = 0.9498
Shapiro-Wilk Test
Test Value = 0.909
Critical Val(0.05) = 0.842
Data appear Normal



Species (lf3c204)

N = 10

Mean = 6.7000

Sd = 1.6364

Slope = 1.6587

Intercept = 6.7000

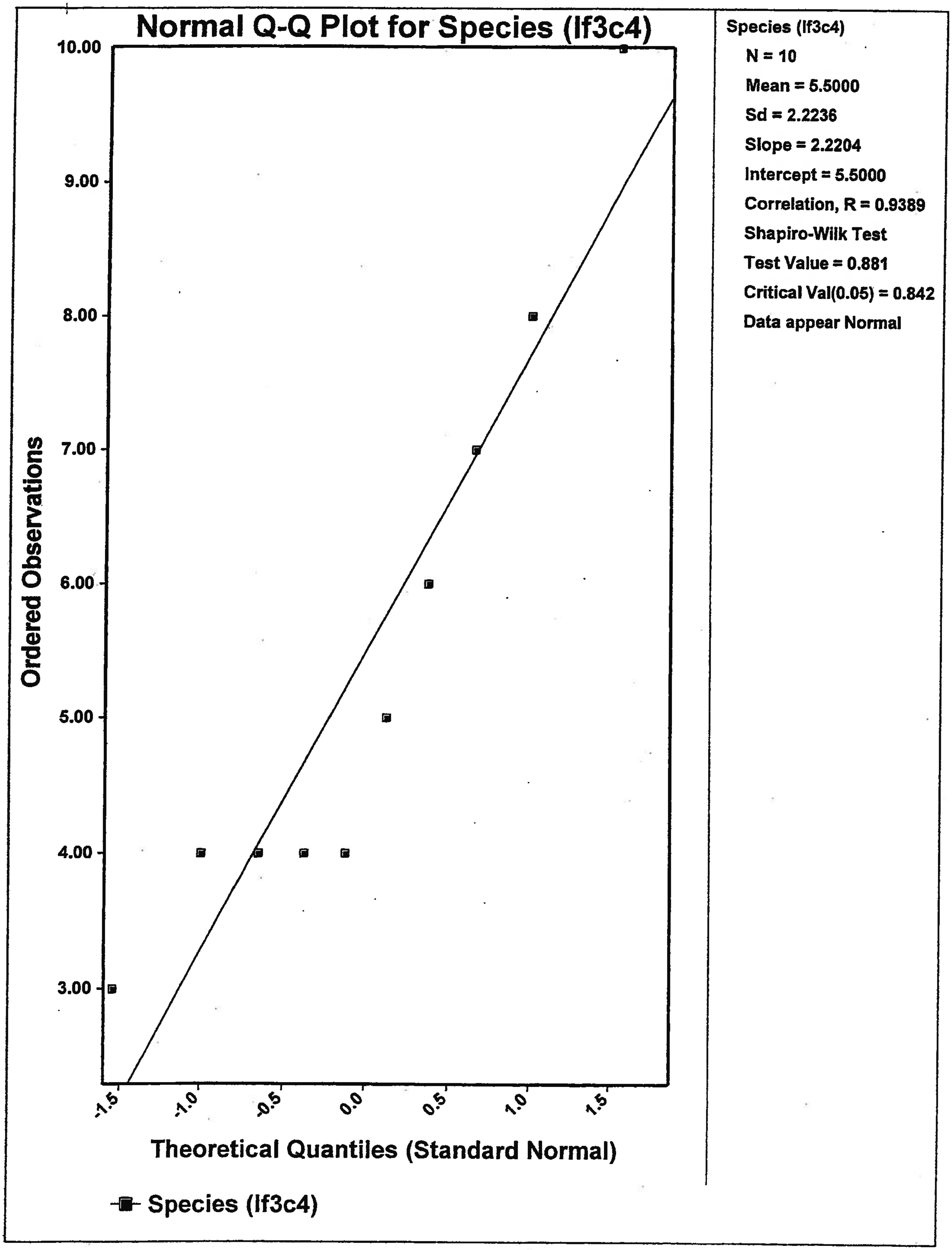
Correlation, R = 0.9531

Shapiro-Wilk Test

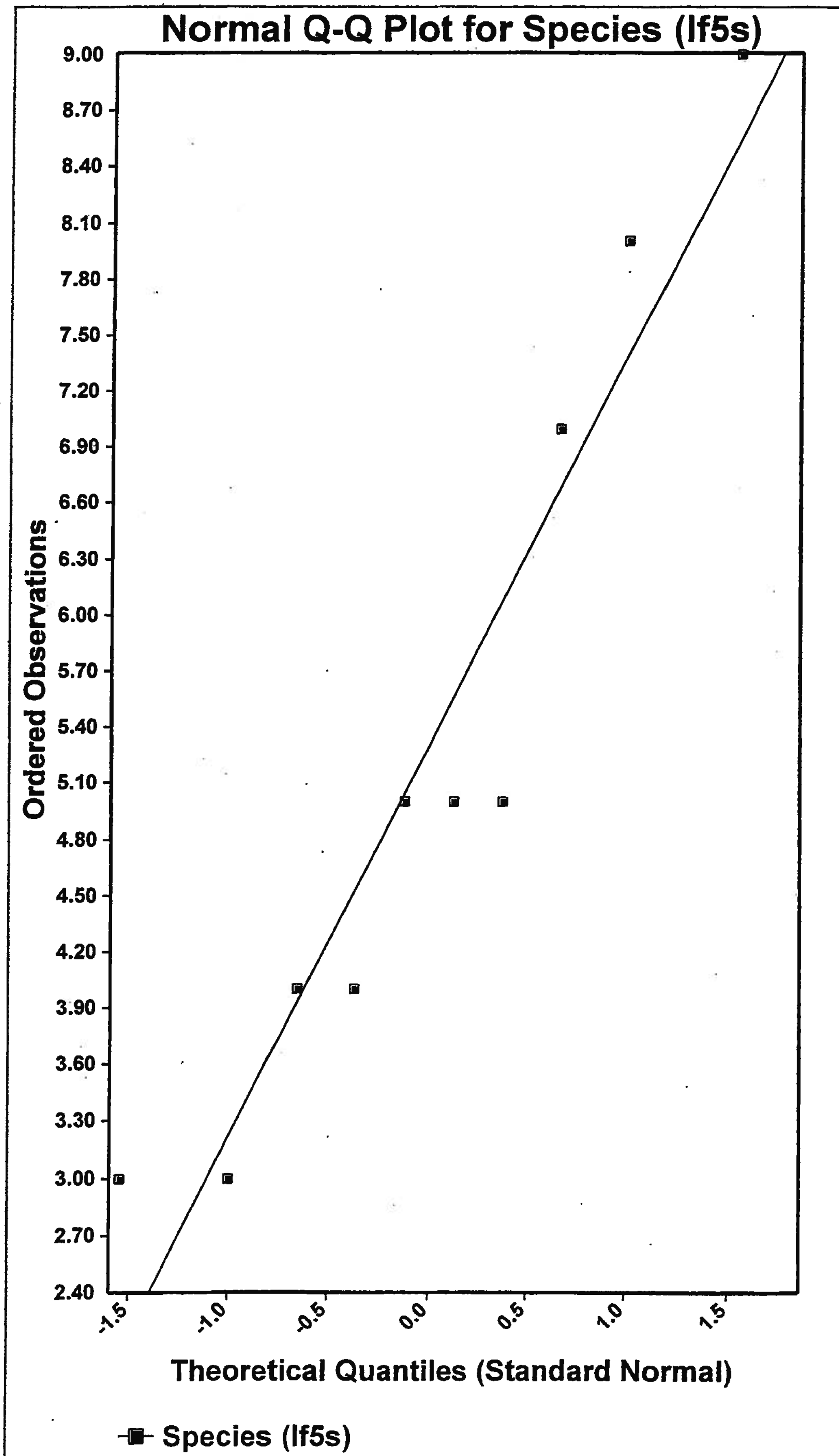
Test Value = 0.902

Critical Val(0.05) = 0.842

Data appear Normal



Normal Q-Q Plot for Species (lf3c4)
Ordered Observations
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Species (lf3c4)
Species (lf3c4)
N = 10
Mean = 5.5000
Sd = 2.2236
Slope = 2.2204
Intercept = 5.5000
Correlation, R = 0.9389
Shapiro-Wilk Test
Test Value = 0.881
Critical Val(0.05) = 0.842
Data appear Normal



Species (lf5s)

N = 10

Mean = 5.3000

Sd = 2.0575

Slope = 2.0892

Intercept = 5.3000

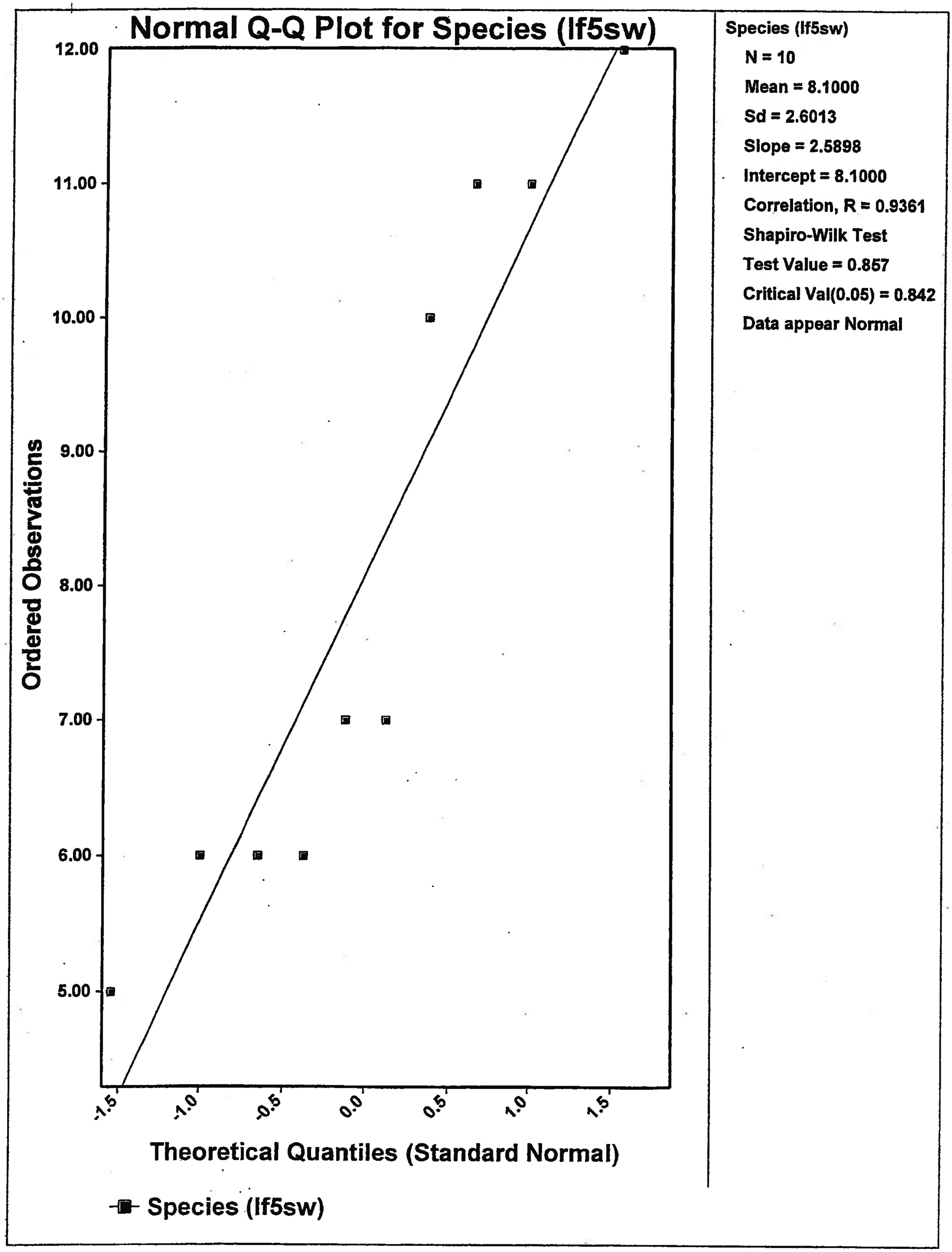
Correlation, R = 0.9548

Shapiro-Wilk Test

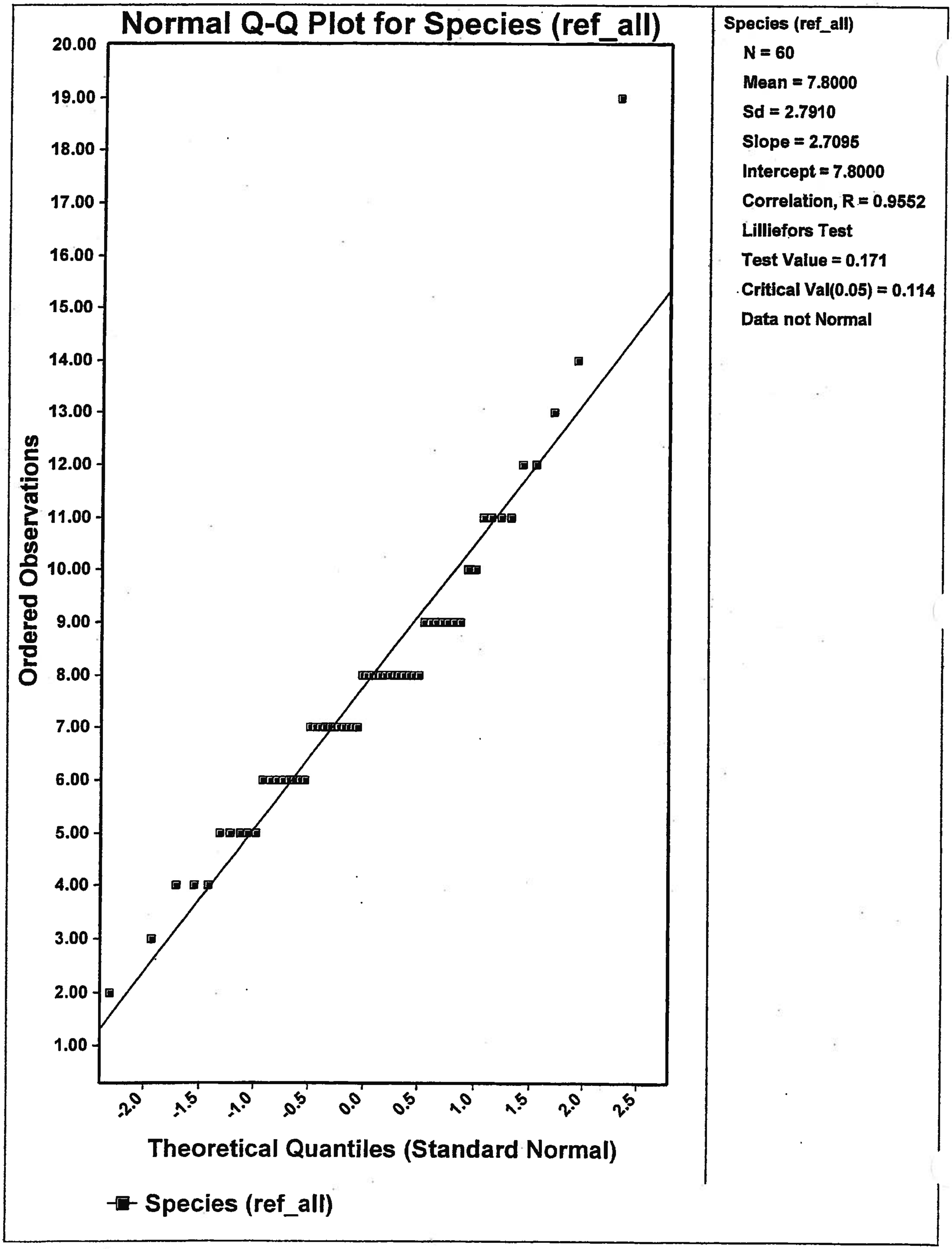
Test Value = 0.899

Critical Val(0.05) = 0.842

Data appear Normal

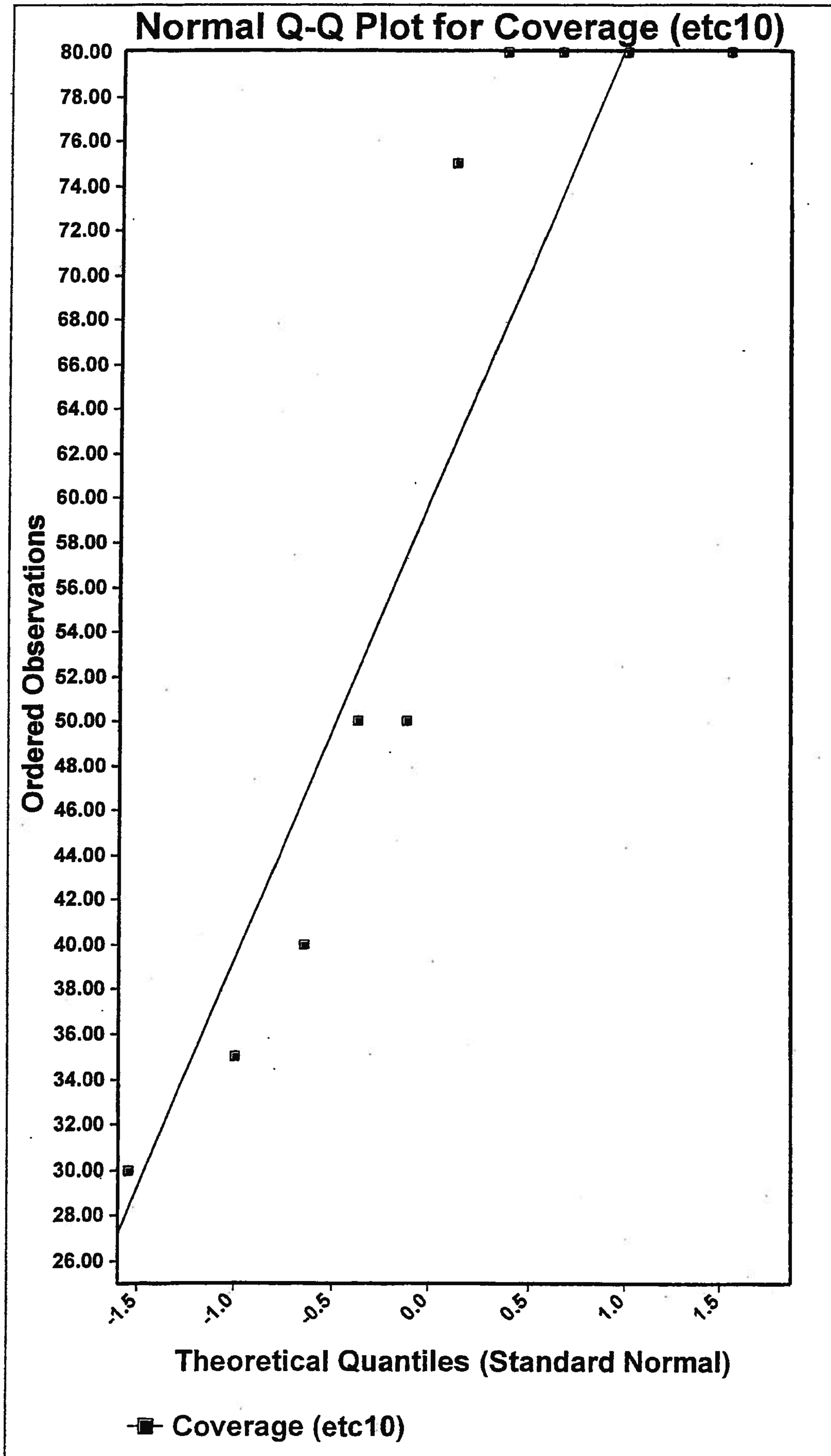


Normal Q-Q Plot for Species (lf5sw)
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
Ordered Observations
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Species (lf5sw)
Species (lf5sw)
N = 10
Mean = 8.1000
Sd = 2.6013
Slope = 2.5898
Intercept = 8.1000
Correlation, R = 0.9361
Shapiro-Wilk Test
Test Value = 0.857
Critical Val(0.05) = 0.842
Data appear Normal



Normal Q-Q Plot for Species (ref_all)
20.00
19.00
18.00
17.00
16.00
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
Ordered Observations
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Theoretical Quantiles (Standard Normal)
Species (ref_all)
Species (ref_all)
N = 60
Mean = 7.8000
Sd = 2.7910
Slope = 2.7095
Intercept = 7.8000
Correlation, R = 0.9552
Lilliefors Test
Test Value = 0.171
Critical Val(0.05) = 0.114
Data not Normal

VEGETATION ABUNDANCE (COVERAGE) NORMALITY EVALUATION



Coverage (etc10)

N = 10

Mean = 60.0000

Sd = 20.9497

Slope = 20.4717

Intercept = 60.0000

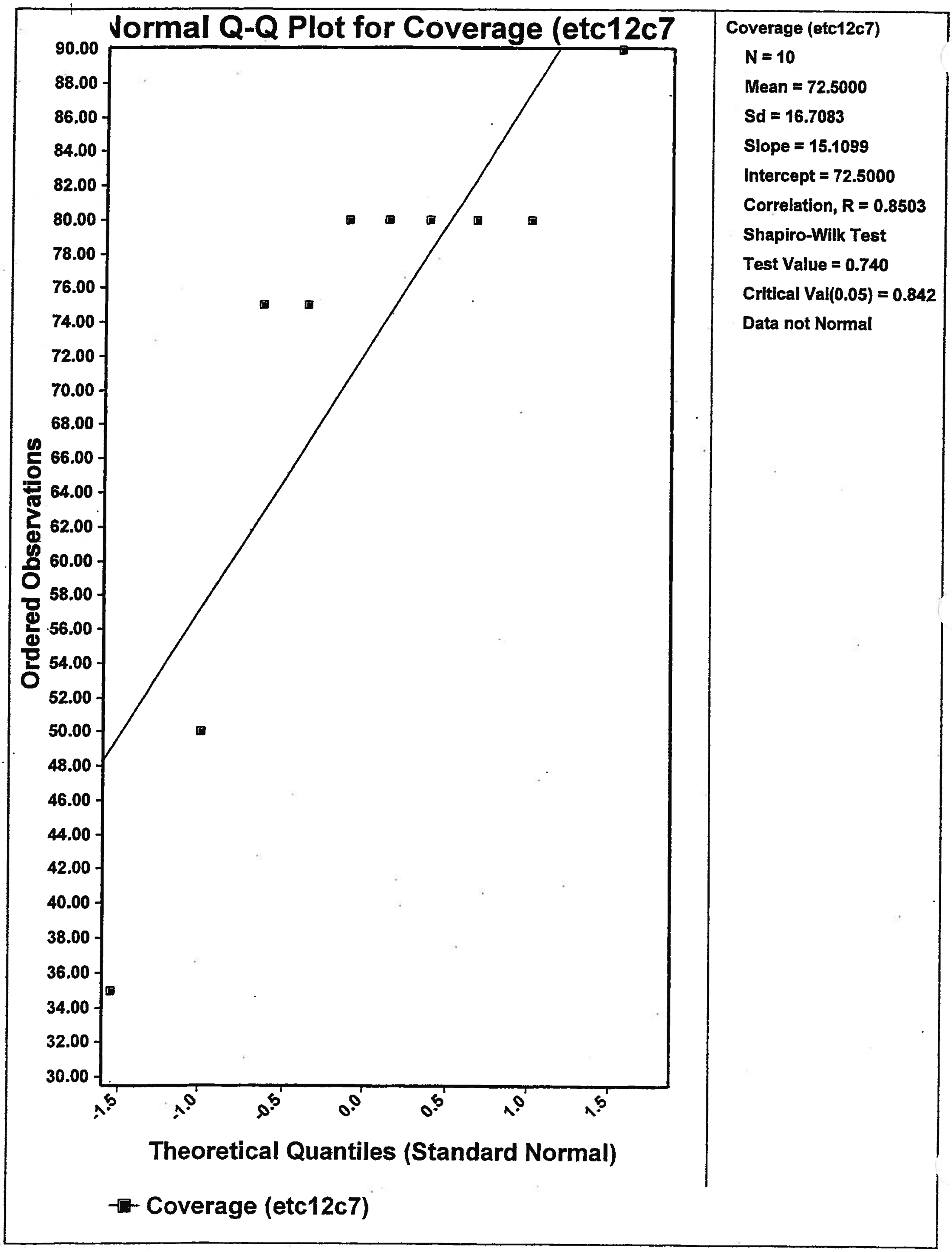
Correlation, R = 0.9188

Shapiro-Wilk Test

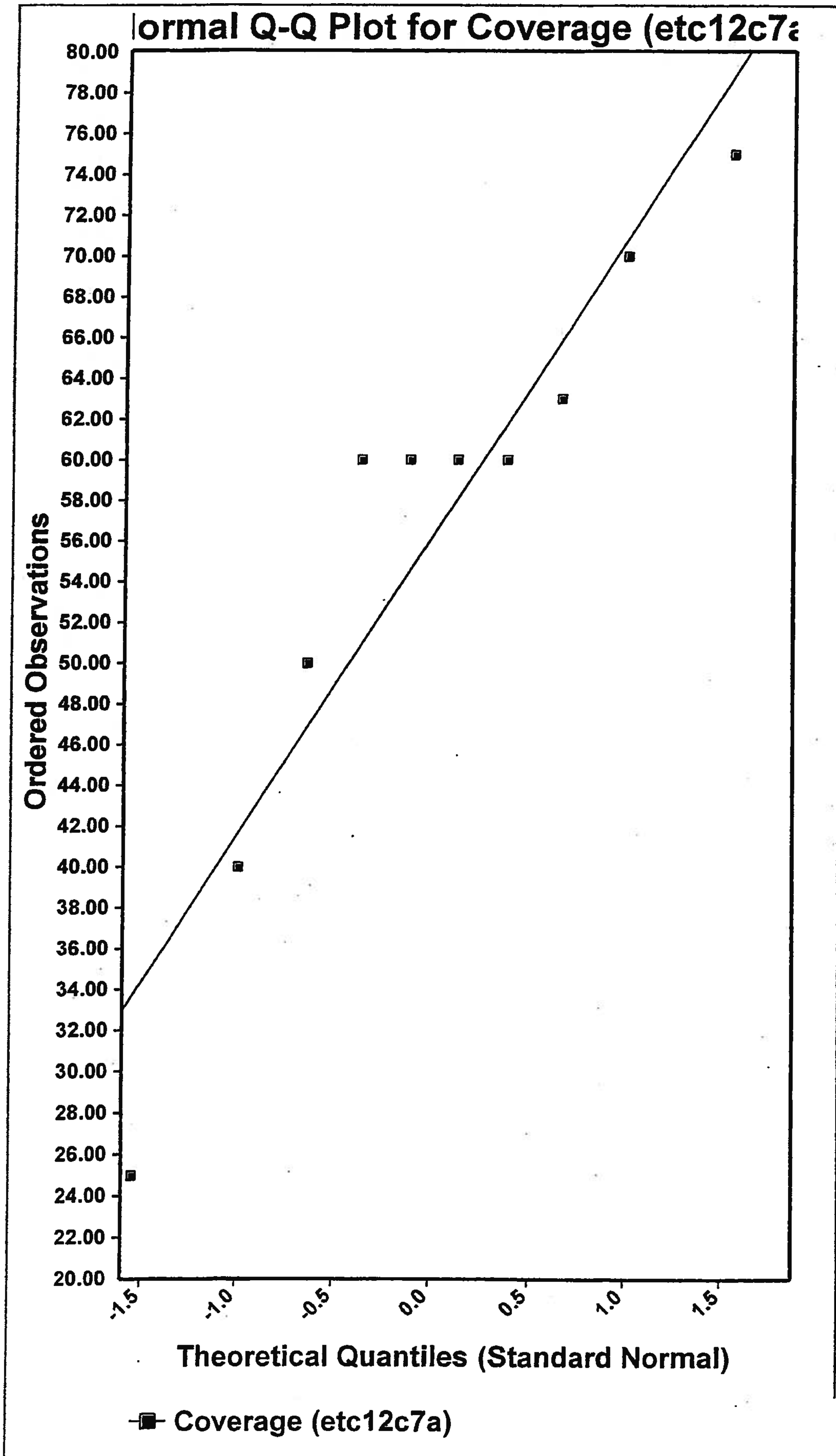
Test Value = 0.815

Critical Val(0.05) = 0.842

Data not Normal



Normal Q-Q Plot for Coverage (etc12c7
Ordered Observations
Theoretical Quantiles (Standard Normal)
Coverage (etc12c7)
Coverage (etc12c7)
N = 10
Mean = 72.5000
Sd = 16.7083
Slope = 15.1099
Intercept = 72.5000
Correlation, R = 0.8503
Shapiro-Wilk Test
Test Value = 0.740
Critical Val(0.05) = 0.842
Data not Normal



Coverage (etc12c7a)

N = 10

Mean = 56.3000

Sd = 14.6139

Slope = 14.5611

Intercept = 56.3000

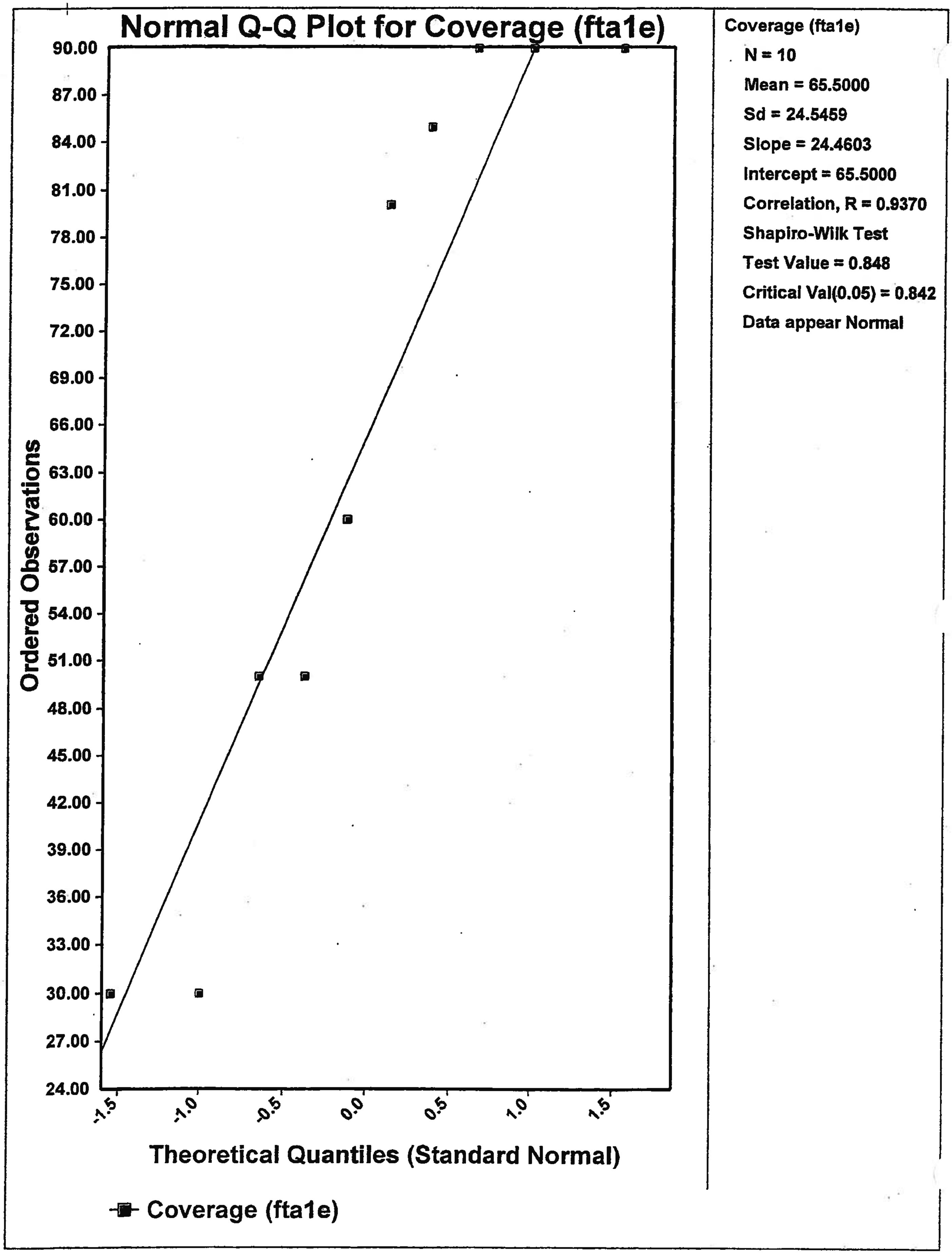
Correlation, R = 0.9369

Shapiro-Wilk Test

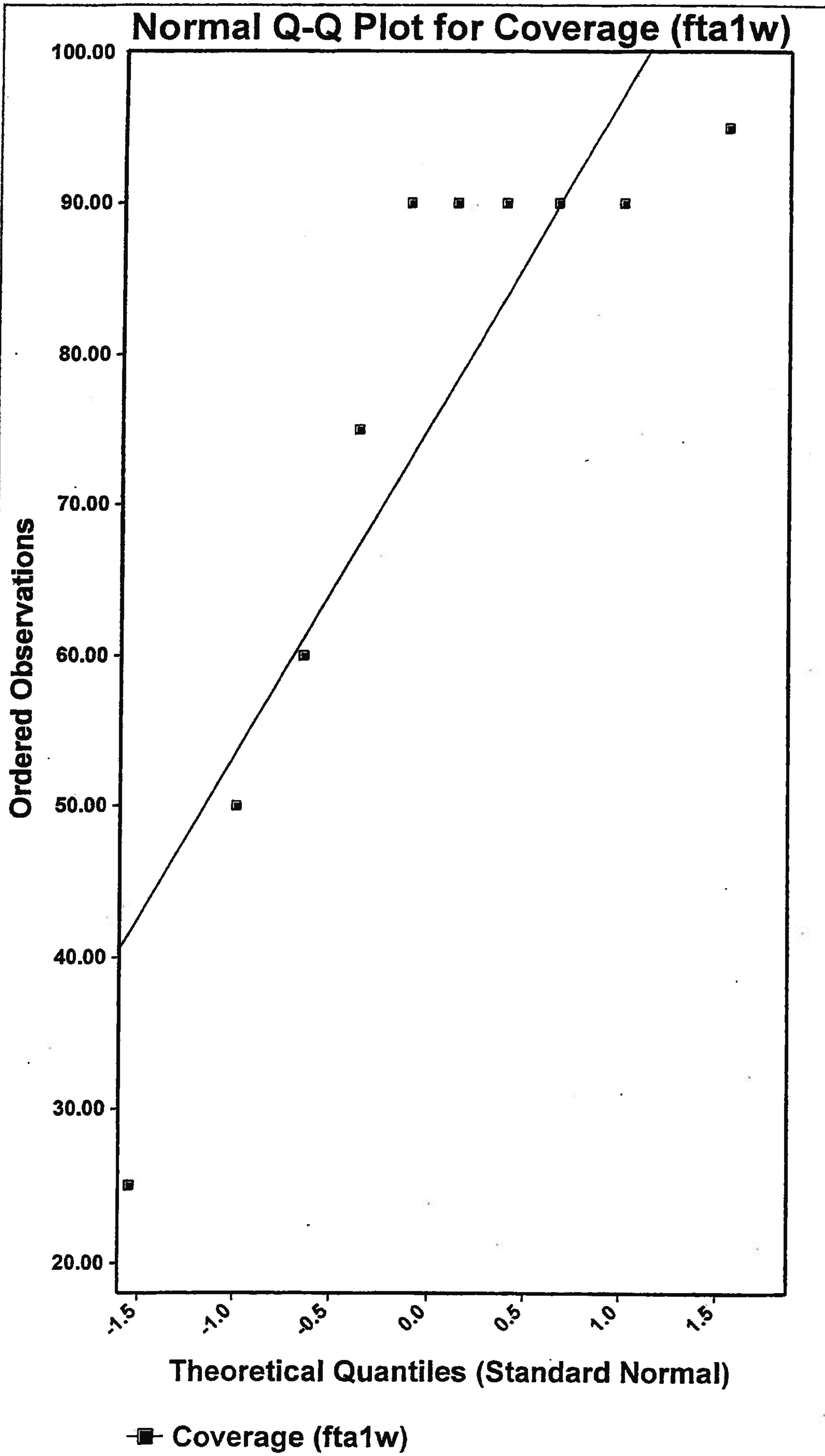
Test Value = 0.890

Critical Val(0.05) = 0.842

Data appear Normal



Normal Q-Q Plot for Coverage (fta1e)
Ordered Observations
90.00
87.00
84.00
81.00
78.00
75.00
72.00
69.00
66.00
63.00
60.00
57.00
54.00
51.00
48.00
45.00
42.00
39.00
36.00
33.00
30.00
27.00
24.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Coverage (fta1e)
Coverage (fta1e)
N = 10
Mean = 65.5000
Sd = 24.5459
Slope = 24.4603
Intercept = 65.5000
Correlation, R = 0.9370
Shapiro-Wilk Test
Test Value = 0.848
Critical Val(0.05) = 0.842
Data appear Normal



Coverage (fta1w)

N = 10

Mean = 75.5000

Sd = 23.2678

Slope = 21.8138

Intercept = 75.5000

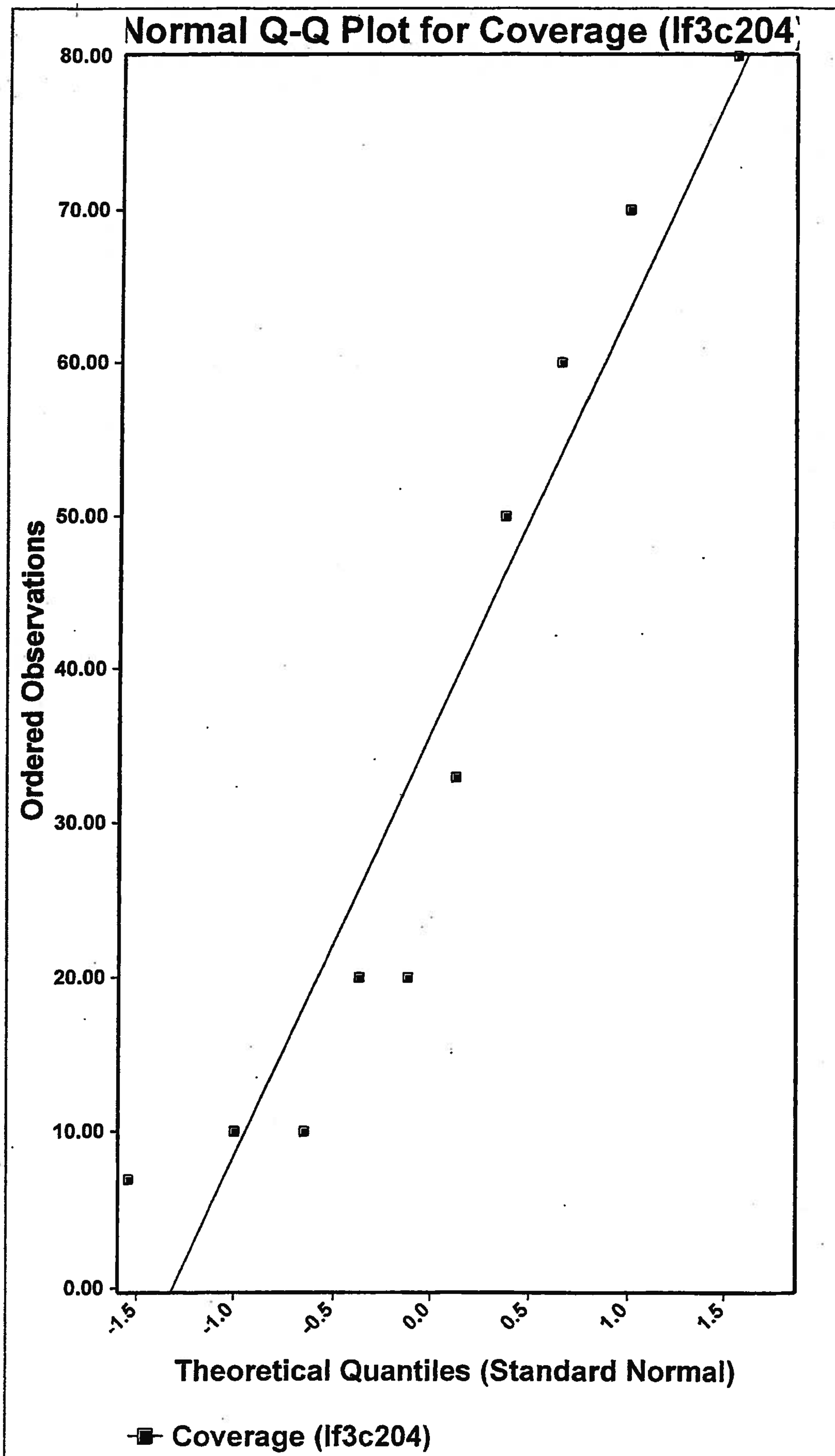
Correlation, R = 0.8815

Shapiro-Wilk Test

Test Value = 0.779

Critical Val(0.05) = 0.842

Data not Normal



Coverage (lf3c204)

N = 10

Mean = 36.0000

Sd = 27.0350

Slope = 27.4670

Intercept = 36.0000

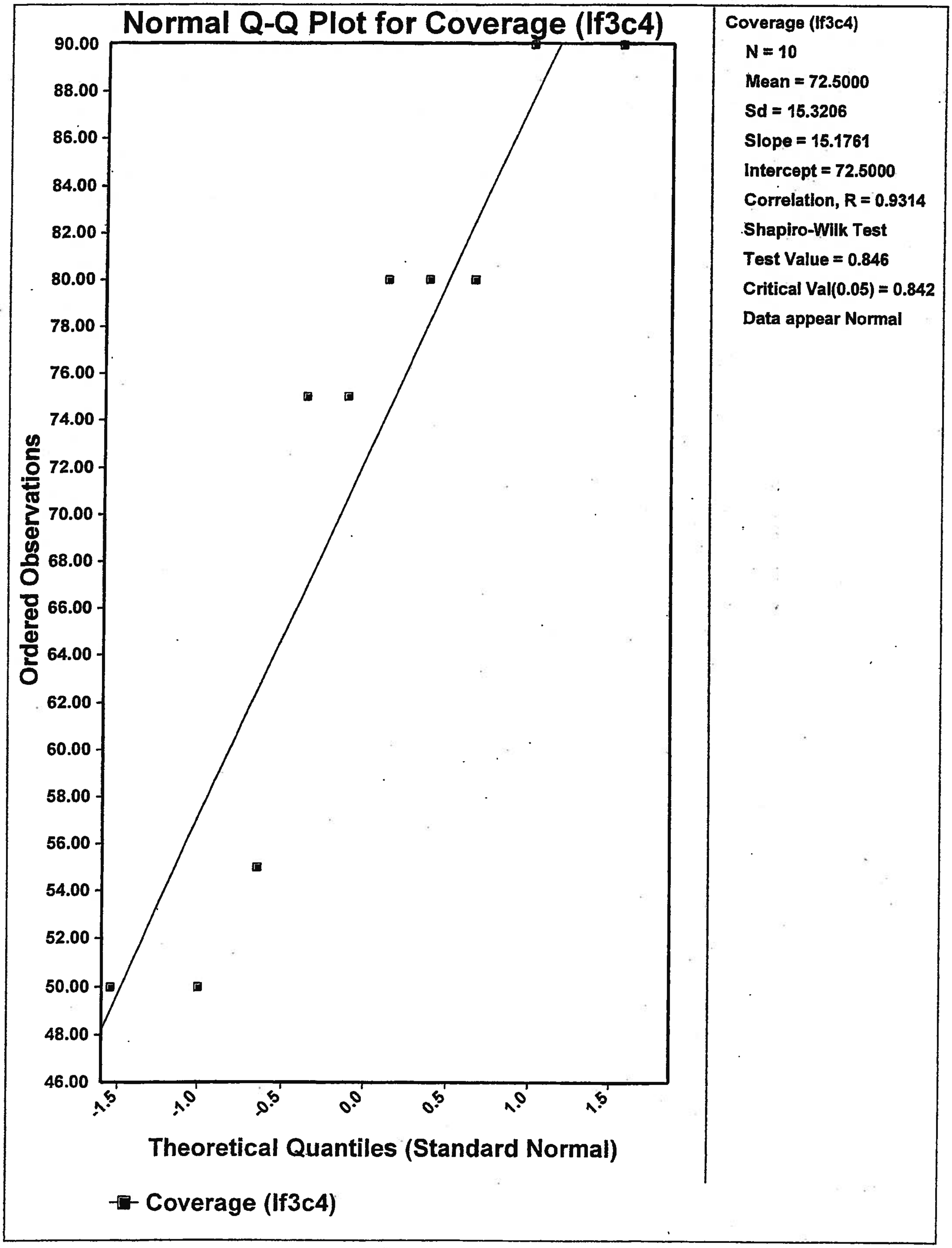
Correlation, R = 0.9553

Shapiro-Wilk Test

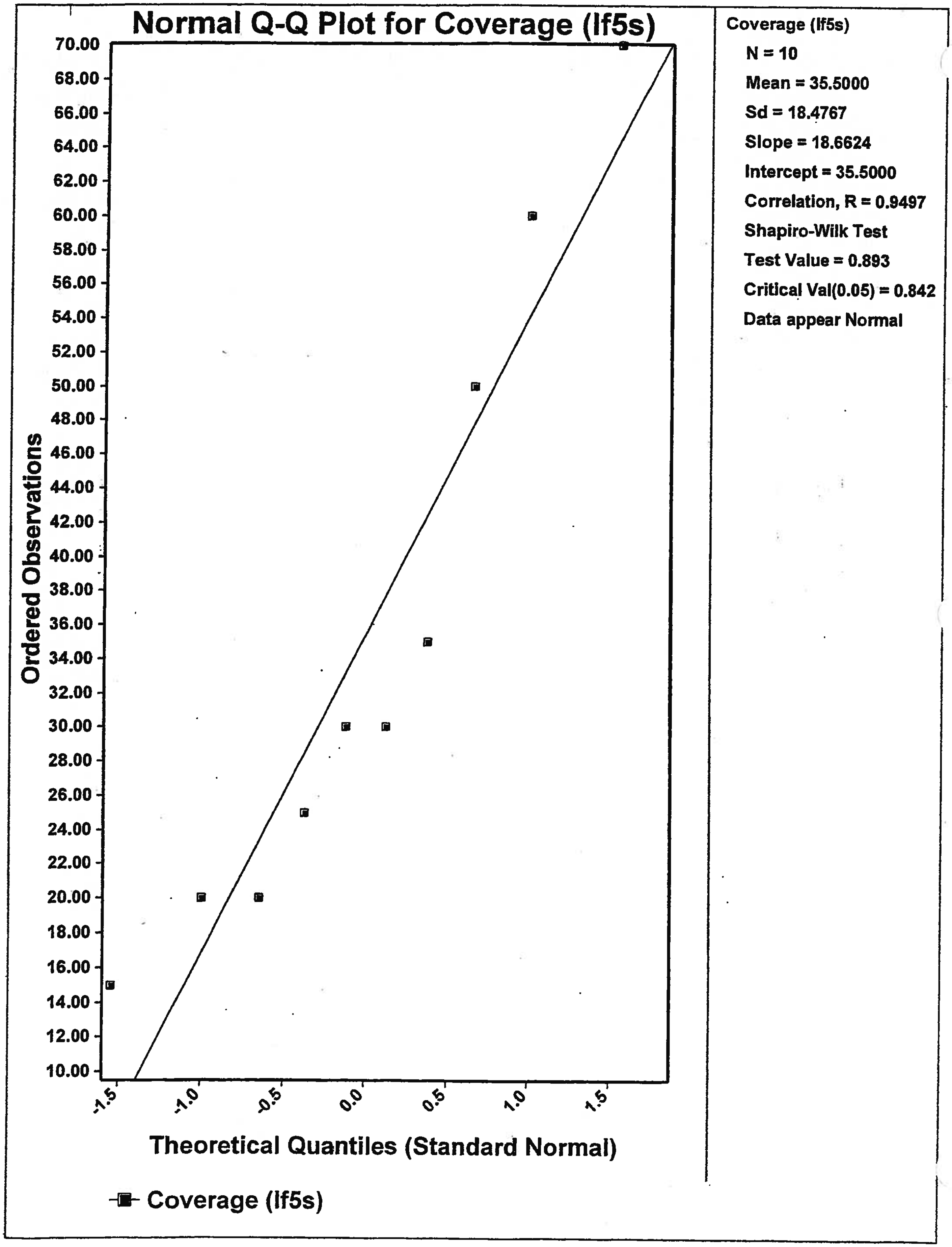
Test Value = 0.891

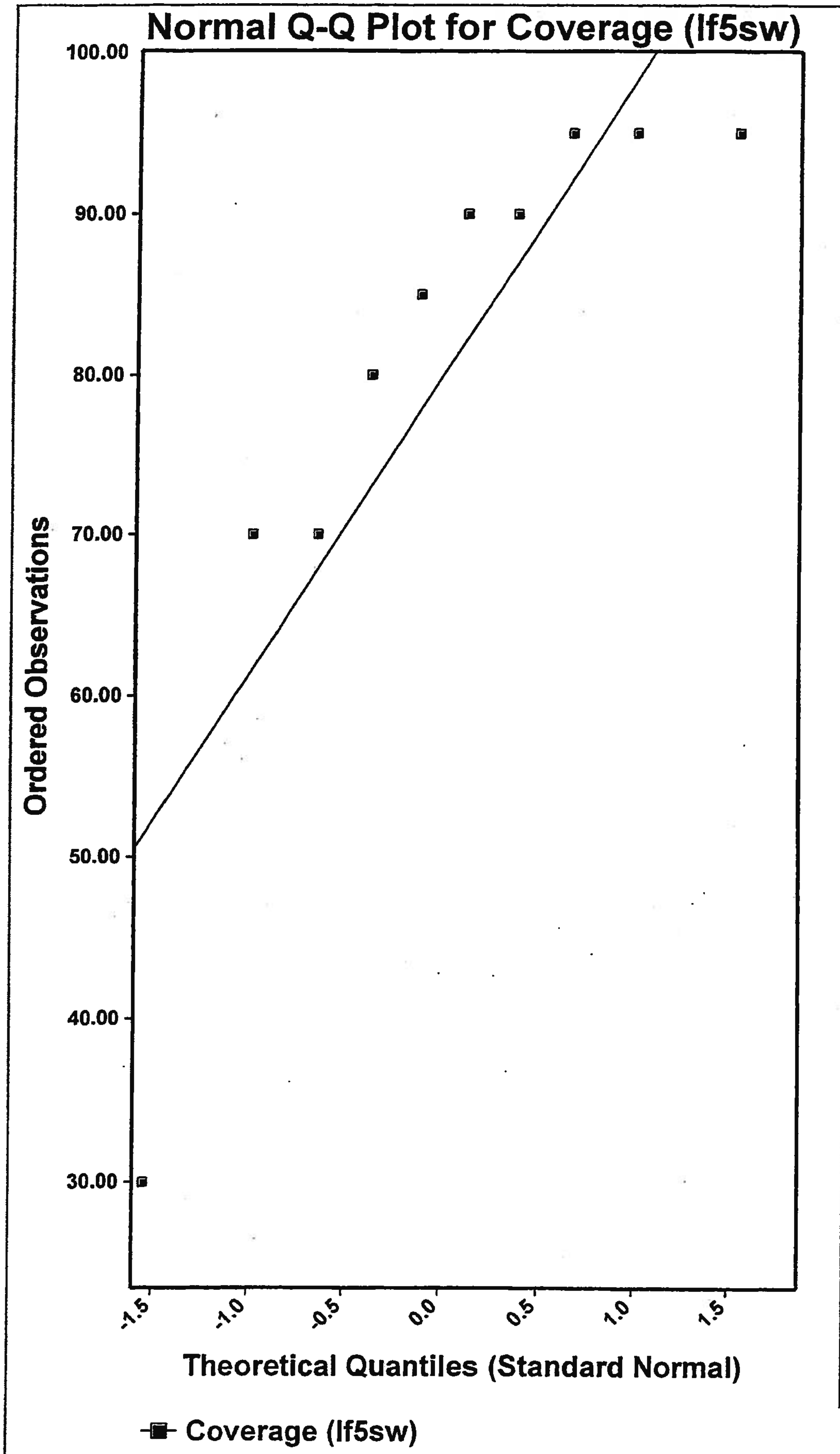
Critical Val(0.05) = 0.842

Data appear Normal



Normal Q-Q Plot for Coverage (lf3c4)
Ordered Observations
90.00
88.00
86.00
84.00
82.00
80.00
78.00
76.00
74.00
72.00
70.00
68.00
66.00
64.00
62.00
60.00
58.00
56.00
54.00
52.00
50.00
48.00
46.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Coverage (lf3c4)
Coverage (lf3c4)
N = 10
Mean = 72.5000
Sd = 15.3206
Slope = 15.1761
Intercept = 72.5000
Correlation, R = 0.9314
Shapiro-Wilk Test
Test Value = 0.846
Critical Val(0.05) = 0.842
Data appear Normal


Normal Q-Q Plot for Coverage (lf5s)
Ordered Observations
70.00
68.00
66.00
64.00
62.00
60.00
58.00
56.00
54.00
52.00
50.00
48.00
46.00
44.00
42.00
40.00
38.00
36.00
34.00
32.00
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Coverage (lf5s)
Coverage (lf5s)
N = 10
Mean = 35.5000
Sd = 18.4767
Slope = 18.6624
Intercept = 35.5000
Correlation, R = 0.9497
Shapiro-Wilk Test
Test Value = 0.893
Critical Val(0.05) = 0.842
Data appear Normal



Coverage (lf5sw)

N = 10

Mean = 80.0000

Sd = 20.0000

Slope = 18.3853

Intercept = 80.0000

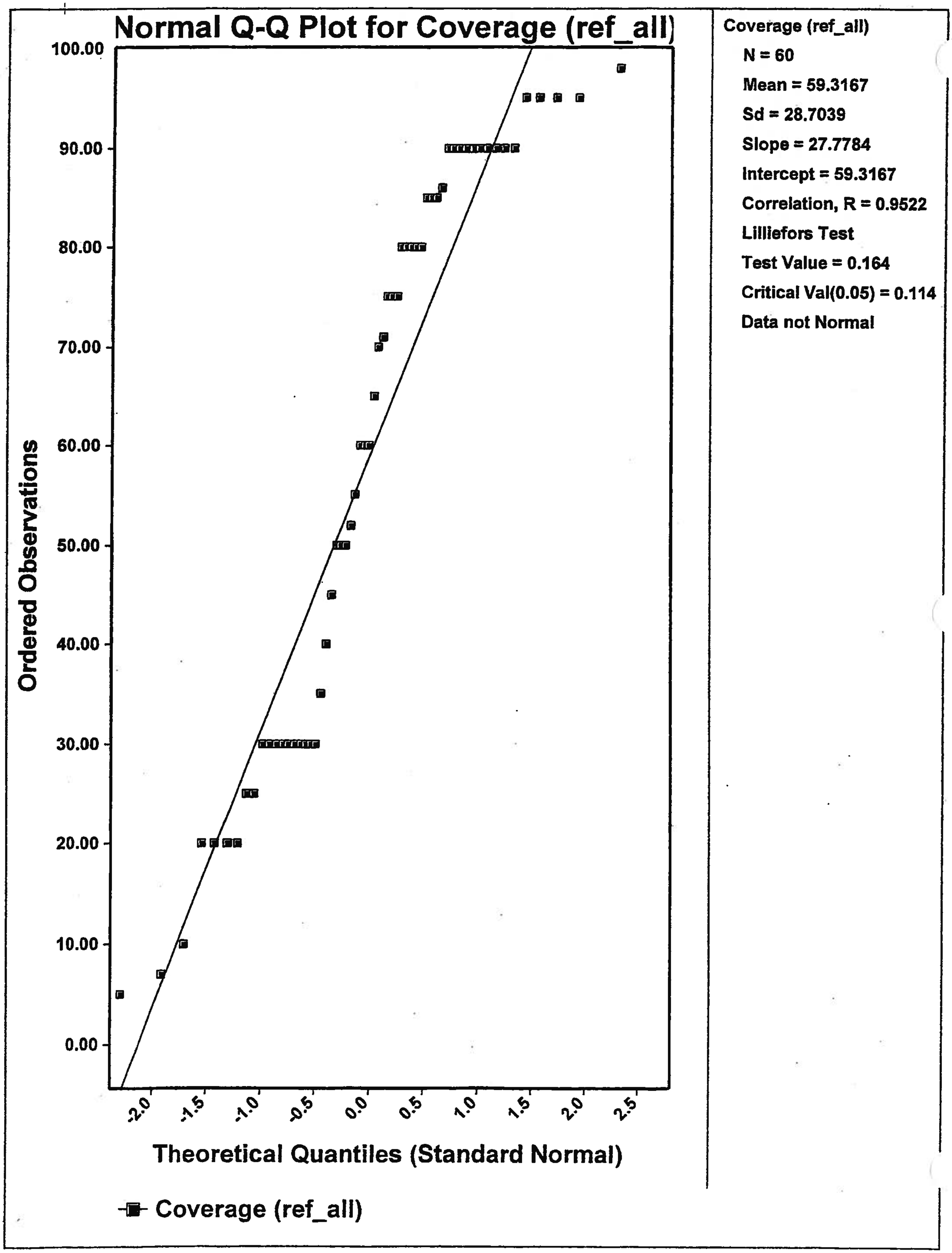
Correlation, R = 0.8644

Shapiro-Wilk Test

Test Value = 0.760

Critical Val(0.05) = 0.842

Data not Normal



Normal Q-Q Plot for Coverage (ref_all)
Ordered Observations
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Theoretical Quantiles (Standard Normal)
Coverage (ref_all)
Coverage (ref_all)
N = 60
Mean = 59.3167
Sd = 28.7039
Slope = 27.7784
Intercept = 59.3167
Correlation, R = 0.9522
Lilliefors Test
Test Value = 0.164
Critical Val(0.05) = 0.114
Data not Normal

ATTACHMENT B-5

FAIRY SHRIMP SURVEY
RESULTS OF STATISTICAL ANALYSIS

SHRIMP SUMMARY

Statistics Summary - LIOC Shrimp Abundance

Site	Number of Observations	Minimum	Maximum	Mean	Median	Reference Ponds Lower Conficence Limit	t-Test Results	Satterthwaite Test results	Wilcoxon-Mann-Whitney Results	Comments
ETC10	18	0	17	1.9	0	0.70	OK	OK	OK	
ETC12 C7	3	0	2	0.67	0	0.70	OK	OK	OK	Site mean is < reference ponds LCL, but WMW test does not support rejecting H0.
ETC12 C7a	3	2	7	4.3	4	0.70	OK	OK	OK	
FTA1 East	12	0	4	0.83	0.5	0.70	*OK	OK	OK	
FTA1 West	15	0	0	0	0	0.70	OK	Reject H0	OK	Site mean is < reference ponds LCL, but WMW test does not support rejecting H0.
LF3 C204	10	0	0	0	0	0.70	OK	Reject H0	OK	Site mean is < reference ponds LCL, but WMW test does not support rejecting H0.
LF3 C4	10	0	16	8.5	11.5	0.70	OK	OK	OK	
LF5 South	3	0	0	0	0	0.70	OK	Reject H0	OK	Site mean is < reference ponds LCL, but WMW test does not support rejecting H0.
LF5 Southwest	16	0	175	21	0	0.70	*OK	OK	OK	
Combined Sites	90	0	175	0.97	0	0.70	*OK	OK	OK	Data are not normally distributed.

H0 -- null hypothesis: site coverage is greater than or equal to reference pool coverage
OK -- do not reject null hypothesis
*OK -- do not reject null hypothesis, but site and reference variances are not equal

(shaded) Questionable results -- normality requirement not met. Recommend non-parametric tests.

SHRIMP UCL FLIPPED

General UCL Statistics for Full Data Sets

User Selected Options

From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Flip LIOC (reference)

General Statistics

Number of Valid Observations	50	Number of Distinct Observations	6

Raw Statistics		Log-transformed Statistics	
Minimum	175	Minimum of Log Data	5.165
Maximum	200	Maximum of Log Data	5.298
Mean	198.1	Mean of log Data	5.289
Median	200	SD of log Data	0.0262
SD	4.982		
Coefficient of Variation	0.0251		
Skewness	-3.275		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.444	Shapiro Wilk Test Statistic	0.439
Shapiro Wilk Critical Value	0.947	Shapiro Wilk Critical Value	0.947
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	199.3	95% H-UCL	N/A

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL	199
95% Modified-t UCL	199.3

Gamma Distribution Test

k star (bias corrected)	1436
Theta Star	0.138
nu star	143574
Approximate Chi Square Value (.05)	142694
Adjusted Level of Significance	0.0452
Adjusted Chi Square Value	142668
Anderson-Darling Test Statistic	12.26
Anderson-Darling 5% Critical Value	0.748
Kolmogorov-Smirnov Test Statistic	0.406
Kolmogorov-Smirnov 5% Critical Value	0.125

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	199.4
95% Adjusted Gamma UCL	199.4

95% Chebyshev (MVUE) UCL	201.3
97.5% Chebyshev (MVUE) UCL	202.7
99% Chebyshev (MVUE) UCL	205.5

Data Distribution

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

95% CLT UCL	199.3
95% Jackknife UCL	199.3
95% Standard Bootstrap UCL	199.3
95% Bootstrap-t UCL	199.1
95% Hall's Bootstrap UCL	199
95% Percentile Bootstrap UCL	199.2
95% BCA Bootstrap UCL	199
95% Chebyshev(Mean, Sd) UCL	201.2
97.5% Chebyshev(Mean, Sd) UCL	202.5
99% Chebyshev(Mean, Sd) UCL	205.1

Potential UCL to Use

Use 95% Student's-t UCL	199.3
or 95% Modified-t UCL	199.3

unflip: LCL = 200 - 199.3 = 0.7

SHRIMP GROUPED BY POOL

From File: I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp.wst

Summary Statistics for Raw Full Data Sets

Variable	NumObs	Minimum	Maximum	Mean	Median	Variance	SD	MAD/0.675	Skewness	Kurtosis	CV
LIOC (823n)	4	0	0	0	0	0	0	0	N/A	N/A	N/A
LIOC (835r)	10	0	0	0	0	0	0	0	N/A	N/A	N/A
LIOC (c208)	6	0	0	0	0	0	0	0	N/A	N/A	N/A
LIOC (c209)	10	0	2	0.5	0	0.722	0.85	0	1.358	0.107	1.7
LIOC (etc10)	18	0	17	1.944	0	15.82	3.977	0	3.517	13.64	2.046
LIOC (etc12c7)	3	0	2	0.667	0	1.333	1.155	0	1.732	N/A	1.732
LIOC (etc12c7a)	3	2	7	4.333	4	6.333	2.517	2.965	0.586	N/A	0.581
LIOC (fta1e)	12	0	4	0.833	0.5	1.424	1.193	0.741	1.918	4.147	1.432
LIOC (fta1w)	15	0	0	0	0	0	0	0	N/A	N/A	N/A
LIOC (lf3c204)	10	0	0	0	0	0	0	0	N/A	N/A	N/A
LIOC (lf3c4)	10	0	16	8.5	11.5	37.39	6.115	5.189	-0.465	-1.653	0.719
LIOC (lf5s)	3	0	0	0	0	0	0	0	N/A	N/A	N/A
LIOC (lf5sw)	16	0	175	21	0	2637	51.35	0	2.631	6.054	2.445
LIOC (uspws)	10	0	2	0.3	0	0.456	0.675	0	2.277	4.765	2.25
LIOC (uspwse)	10	0	25	8.5	5	72.5	8.515	7.413	0.753	-0.37	1.002

From File: I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp.wst

Summary Statistics for Raw Full Data Sets

Variable	NumObs	Minimum	Maximum	Mean	Median	Variance	SD	MAD/0.675	Skewness	Kurtosis	CV
BRLY (823n)	4	0	0	0	0	0	0	0	N/A	N/A	N/A
BRLY (835r)	10	0	0	0	0	0	0	0	N/A	N/A	N/A
BRLY (c208)	6	0	0	0	0	0	0	0	N/A	N/A	N/A
BRLY (c209)	10	0	0	0	0	0	0	0	N/A	N/A	N/A
BRLY (etc10)	18	0	0	0	0	0	0	0	N/A	N/A	N/A
BRLY (etc12c7)	3	1	10	6.667	9	24.33	4.933	1.483	-1.652	N/A	0.74
BRLY (etc12c7a)	3	2	4	3	3	1	1	1.483	0	N/A	0.333
BRLY (fta1e)	12	0	1	0.333	0	0.242	0.492	0	0.812	-1.65	1.477
BRLY (fta1w)	15	0	0	0	0	0	0	0	N/A	N/A	N/A
BRLY (lf3c204)	10	0	3	0.6	0	1.156	1.075	0	1.691	1.864	1.792
BRLY (lf3c4)	10	0	13	4.8	4.5	12.4	3.521	2.224	1.333	2.986	0.734
BRLY (lf5s)	3	0	0	0	0	0	0	0	N/A	N/A	N/A
BRLY (lf5sw)	16	0	0	0	0	0	0	0	N/A	N/A	N/A
BRLY (uspws)	10	0	0	0	0	0	0	0	N/A	N/A	N/A
BRLY (uspwse)	10	0	0	0	0	0	0	0	N/A	N/A	N/A

Potentially Contaminated Sites

SHRIMP GROUPED BY TYPE

From File: I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp.wst

Summary Statistics for Raw Full Data Sets

Variable	NumObs	Minimum	Maximum	Mean	Median	Variance	SD	MAD/0.675	Skewness	Kurtosis	CV
LIOC (c)	90	0	175	5.344	0	511.6	22.62	0	6.546	44.35	4.232
LIOC (r)	50	0	25	1.86	0	24.82	4.982	0	3.275	10.92	2.678
BRLY (c)	90	0	13	0.967	0	5.471	2.339	0	3.15	10.79	2.42
BRLY (r)	50	0	0	0	0	0	0	0	N/A	N/A	N/A

Reference ponds (combined)

SHRIMP (LIOC) t-TEST

	t-Test Site vs Background Comparison for Full Data Sets without NDs
User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: LIOC(lf5sw)

Background Data: LIOC(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	16	50
Number of Distinct Observations	7	6
Minimum	0	0
Maximum	175	25
Mean	21	1.86
Median	0	0
SD	51.35	4.982
SE of Mean	12.84	0.705

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	64	2.64	-1.669	0.995
Satterthwaite (Unequal Variance)	15.1	1.489	-1.753	0.921

Pooled SD: 25.241

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
15	49	106.267	0

Conclusion with Alpha = 0.05

* Two variances are not equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: LIOC(lf5s)

Background Data: LIOC(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	3	50
Number of Distinct Observations	1	6
Minimum	0	0
Maximum	0	25
Mean	0	1.86
Median	0	0
SD	0	4.982
SE of Mean	0	0.705

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	51	-0.641	-1.675	0.262
Satterthwaite (Unequal Variance)	49	-2.64	-1.677	0.006

Pooled SD: 4.883

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Reject H0, Conclude Site < Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
49	2	1.7977E+308	2.7E+308

Conclusion with Alpha = 0.05

* Two variances appear to be equal

1		t-Test Site vs Background Comparison for Full Data Sets without NDs
2	User Selected Options	
3	From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst
4	Full Precision	OFF
5	Confidence Coefficient	95%
6	Substantial Difference (S)	0
7	Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
8	Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean
9		
10		
11	Area of Concern Data: LIOC(lf3c4)	
12	Background Data: LIOC(ref_all)	
13		
14		

Raw Statistics

	Site	Background
Number of Valid Observations	10	50
Number of Distinct Observations	8	6
Minimum	0	0
Maximum	16	25
Mean	8.5	1.86
Median	11.5	0
SD	6.115	4.982
SE of Mean	1.934	0.705

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	58	3.705	-1.672	1
Satterthwaite (Unequal Variance)	11.5	3.226	-1.782	0.996

Pooled SD: 5.174

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
9	49	1.507	0.344

Conclusion with Alpha = 0.05

* Two variances appear to be equal

	t-Test Site vs Background Comparison for Full Data Sets without NDs
User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: LIOC(lf3c204)

Background Data: LIOC(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	50
Number of Distinct Observations	1	6
Minimum	0	0
Maximum	0	25
Mean	0	1.86
Median	0	0
SD	0	4.982
SE of Mean	0	0.705

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	58	-1.173	-1.672	0.123
Satterthwaite (Unequal Variance)	49	-2.64	-1.677	0.006

Pooled SD: 4.579

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Reject H0, Conclude Site < Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
49	9	1.7977E+308	2.7E+308

Conclusion with Alpha = 0.05

* Two variances appear to be equal

	t-Test Site vs Background Comparison for Full Data Sets without NDs
User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: LIOC(fta1w)

Background Data: LIOC(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	15	50
Number of Distinct Observations	1	6
Minimum	0	0
Maximum	0	25
Mean	0	1.86
Median	0	0
SD	0	4.982
SE of Mean	0	0.705

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	63	-1.438	-1.669	0.078
Satterthwaite (Unequal Variance)	49	-2.64	-1.677	0.006

Pooled SD: 4.393

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Reject H0, Conclude Site < Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
49	14	1.7977E+308	2.7E+308

Conclusion with Alpha = 0.05

* Two variances appear to be equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: LIOC(fta1e)

Background Data: LIOC(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	12	50
Number of Distinct Observations	4	6
Minimum	0	0
Maximum	4	25
Mean	0.833	1.86
Median	0.5	0
SD	1.193	4.982
SE of Mean	0.345	0.705

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	60	-0.705	-1.671	0.242
Satterthwaite (Unequal Variance)	60	-1.309	-1.671	0.098

Pooled SD: 4.531

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
49	11	17.425	0

Conclusion with Alpha = 0.05

* Two variances are not equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: LIOC(etc12c7a)

Background Data: LIOC(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	3	50
Number of Distinct Observations	3	6
Minimum	2	0
Maximum	7	25
Mean	4.333	1.86
Median	4	0
SD	2.517	4.982
SE of Mean	1.453	0.705

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	51	0.848	-1.675	0.8
Satterthwaite (Unequal Variance)	3	1.532	-2.353	0.889

Pooled SD: 4.908

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
49	2	3.918	0.448

Conclusion with Alpha = 0.05

* Two variances appear to be equal

1		t-Test Site vs Background Comparison for Full Data Sets without NDs
2	User Selected Options	
3	From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst
4	Full Precision	OFF
5	Confidence Coefficient	95%
6	Substantial Difference (S)	0
7	Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
8	Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean
9		
10		
11	Area of Concern Data: LIOC(etc12c7)	
12	Background Data: LIOC(ref_all)	
13		
14		

15	Raw Statistics		
16		Site	Background
17	Number of Valid Observations	3	50
18	Number of Distinct Observations	2	6
19	Minimum	0	0
20	Maximum	2	25
21	Mean	0.667	1.86
22	Median	0	0
23	SD	1.155	4.982
24	SE of Mean	0.667	0.705
25			

26	Site vs Background Two-Sample t-Test				
27					
28	H0: Mu of Site - Mu of Background >= 0				
29			t-Test	Critical	
30	Method	DF	Value	- t (0.050)	P-Value
31	Pooled (Equal Variance)	51	-0.411	-1.675	0.342
32	Satterthwaite (Unequal Variance)	8.5	-1.23	-1.833	0.126
33	Pooled SD: 4.888				
34	Conclusion with Alpha = 0.050				
35	* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background				
36	* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background				
37					
38					

39	Test of Equality of Variances			
40				
41	Numerator DF	Denominator DF	F-Test Value	P-Value
42	49	2	18.613	0.105
43	Conclusion with Alpha = 0.05			
44	* Two variances appear to be equal			
45				

	t-Test Site vs Background Comparison for Full Data Sets without NDs
User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: LIOC(etc10)

Background Data: LIOC(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	18	50
Number of Distinct Observations	4	6
Minimum	0	0
Maximum	17	25
Mean	1.944	1.86
Median	0	0
SD	3.977	4.982
SE of Mean	0.937	0.705

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	66	0.065	-1.668	0.526
Satterthwaite (Unequal Variance)	37.5	0.072	-1.687	0.529

Pooled SD: 4.743

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
49	17	1.569	0.31

Conclusion with Alpha = 0.05

* Two variances appear to be equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: LIOC(site)

Background Data: LIOC(reference)

Raw Statistics

	Site	Background
Number of Valid Observations	90	50
Number of Distinct Observations	15	6
Minimum	0	0
Maximum	175	25
Mean	5.344	1.86
Median	0	0
SD	22.62	4.982
SE of Mean	2.384	0.705

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	138	1.073	-1.656	0.857
Satterthwaite (Unequal Variance)	103.8	1.402	-1.66	0.918

Pooled SD: 18.406

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
89	49	20.617	0

Conclusion with Alpha = 0.05

* Two variances are not equal

SHRIMP (LIOC) WILCOXON-MANN-WHITNEY TEST

	Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs
User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median

Area of Concern Data: LIOC(lf5sw)

Background Data: LIOC(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	16	50
Number of Distinct Observations	7	6
Minimum	0	0
Maximum	175	25
Mean	21	1.86
Median	0	0
SD	51.35	4.982
SE of Mean	12.84	0.705

Wilcoxon-Mann-Whitney (WMW) Test

Site Rank Sum W-Stat	627
WMW Test U-Stat	491
WMW Critical Value (0.050)	108
Approximate P-Value	0.915

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

	Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs	
User Selected Options		
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst	
Full Precision	OFF	
Confidence Coefficient	95%	
Substantial Difference	0	
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)	
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median	

Area of Concern Data: LIOC(lf5s)

Background Data: LIOC(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	3	50
Number of Distinct Observations	1	6
Minimum	0	0
Maximum	0	25
Mean	0	1.86
Median	0	0
SD	0	4.982
SE of Mean	0	0.705

Wilcoxon-Mann-Whitney (WMW) Test

Site Rank Sum W-Stat	63
WMW Test U-Stat	57
WMW Critical Value (0.050)	12
Approximate P-Value	0.25

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

	Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs
User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median

Area of Concern Data: LIOC(lf3c4)

Background Data: LIOC(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	50
Number of Distinct Observations	8	6
Minimum	0	0
Maximum	16	25
Mean	8.5	1.86
Median	11.5	0
SD	6.115	4.982
SE of Mean	1.934	0.705

Wilcoxon-Mann-Whitney (WMW) Test

Site Rank Sum W-Stat	458
WMW Test U-Stat	403
WMW Critical Value (0.050)	63
Approximate P-Value	0.999

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

	Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs	
User Selected Options		
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst	
Full Precision	OFF	
Confidence Coefficient	95%	
Substantial Difference	0	
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)	
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median	
Area of Concern Data: LIOC(lf3c204)		
Background Data: LIOC(ref_all)		
Raw Statistics		
	Site	Background
Number of Valid Observations	10	50
Number of Distinct Observations	1	6
Minimum	0	0
Maximum	0	25
Mean	0	1.86
Median	0	0
SD	0	4.982
SE of Mean	0	0.705
Wilcoxon-Mann-Whitney (WMW) Test		
Site Rank Sum W-Stat	245	
WMW Test U-Stat	190	
WMW Critical Value (0.050)	63	
Approximate P-Value	0.119	
Conclusion with Alpha = 0.05		
Do Not Reject H0, Conclude Site >= Background		

	Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs	
User Selected Options		
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst	
Full Precision	OFF	
Confidence Coefficient	95%	
Substantial Difference	0	
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)	
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median	

Area of Concern Data: LIOC(fta1w)

Background Data: LIOC(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	15	50
Number of Distinct Observations	1	6
Minimum	0	0
Maximum	0	25
Mean	0	1.86
Median	0	0
SD	0	4.982
SE of Mean	0	0.705

Wilcoxon-Mann-Whitney (WMW) Test

Site Rank Sum W-Stat	405
WMW Test U-Stat	285
WMW Critical Value (0.050)	101
Approximate P-Value	0.0817

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

1		Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs	
2	User Selected Options		
3	From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst	
4	Full Precision	OFF	
5	Confidence Coefficient	95%	
6	Substantial Difference	0	
7	Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)	
8	Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median	
9			
10			
11	Area of Concern Data: LIOC(fta1e)		
12	Background Data: LIOC(ref_all)		
13			
14	Raw Statistics		
15		Site	Background
16	Number of Valid Observations	12	50
17	Number of Distinct Observations	4	6
18	Minimum	0	0
19	Maximum	4	25
20	Mean	0.833	1.86
21	Median	0.5	0
22	SD	1.193	4.982
23	SE of Mean	0.345	0.705
24			
25	Wilcoxon-Mann-Whitney (WMW) Test		
26			
27			
28			
29	Site Rank Sum W-Stat	432.5	
30	WMW Test U-Stat	354.5	
31	WMW Critical Value (0.050)	78	
32	Approximate P-Value	0.836	
33			
34	Conclusion with Alpha = 0.05		
35	Do Not Reject H0, Conclude Site >= Background		
36			

1		Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs	
2	User Selected Options		
3	From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst	
4	Full Precision	OFF	
5	Confidence Coefficient	95%	
6	Substantial Difference	0	
7	Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)	
8	Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median	
9			
10			
11	Area of Concern Data: LIOC(etc12c7a)		
12	Background Data: LIOC(ref_all)		
13			
14	Raw Statistics		
15		Site	Background
16	Number of Valid Observations	3	50
17	Number of Distinct Observations	3	6
18	Minimum	2	0
19	Maximum	7	25
20	Mean	4.333	1.86
21	Median	4	0
22	SD	2.517	4.982
23	SE of Mean	1.453	0.705
24			
25	Wilcoxon-Mann-Whitney (WMW) Test		
26			
27			
28			
29	Site Rank Sum W-Stat	136.5	
30	WMW Test U-Stat	130.5	
31	WMW Critical Value (0.050)	12	
32	Approximate P-Value	0.984	
33			
34	Conclusion with Alpha = 0.05		
35	Do Not Reject H0, Conclude Site >= Background		
36			

	Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs	
User Selected Options		
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst	
Full Precision	OFF	
Confidence Coefficient	95%	
Substantial Difference	0	
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)	
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median	

Area of Concern Data: LIOC(etc12c7)

Background Data: LIOC(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	3	50
Number of Distinct Observations	2	6
Minimum	0	0
Maximum	2	25
Mean	0.667	1.86
Median	0	0
SD	1.155	4.982
SE of Mean	0.667	0.705

Wilcoxon-Mann-Whitney (WMW) Test

Site Rank Sum W-Stat	85.5
WMW Test U-Stat	79.5
WMW Critical Value (0.050)	12
Approximate P-Value	0.576

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

	Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs
User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median

Area of Concern Data: LIOC(etc10)

Background Data: LIOC(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	18	50
Number of Distinct Observations	4	6
Minimum	0	0
Maximum	17	25
Mean	1.944	1.86
Median	0	0
SD	3.977	4.982
SE of Mean	0.937	0.705

Wilcoxon-Mann-Whitney (WMW) Test

Site Rank Sum W-Stat	706.5
WMW Test U-Stat	535.5
WMW Critical Value (0.050)	124
Approximate P-Value	0.884

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

	Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs
User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL_Shrimp\Shrimp_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median

Area of Concern Data: LIOC(site)

Background Data: LIOC(reference)

Raw Statistics

	Site	Background
Number of Valid Observations	90	50
Number of Distinct Observations	15	6
Minimum	0	0
Maximum	175	25
Mean	5.344	1.86
Median	0	0
SD	22.62	4.982
SE of Mean	2.384	0.705

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC >= Mean/Median of Background

Site Rank Sum W-Stat	6621
WMW Test U-Stat	1.202
WMW Critical Value (0.050)	-1.645
P-Value	0.885

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

P-Value >= alpha (0.05)

ATTACHMENT B-6

PLANT DIVERSITY SURVEY
AND
PLANT ABUNDANCE OR PERCENT COVERAGE SURVEY

RESULTS OF STATISTICAL ANALYSIS

VEGETATION DIVERSITY AND ABUNDANCE SUNMMARIES

Statistics Summary - Plant Diversity

Site	Number of Observations	Minimum	Maximum	Mean	Median	Reference Ponds Lower Conficence Limit	t-Test Results	Satterthwaite Test results	Wilcoxon-Mann-Whitney Results	Comments
ETC10	10	7	17	12	12.5	7.2	OK	OK	OK	
ETC12 C7	10	3	11	7.6	8	7.2	OK	OK	OK	
ETC12 C7a	10	8	17	11.6	11	7.2	OK	OK	OK	
FTA1 East	10	4	9	6.8	7.5	7.2	OK	OK	OK	Site mean is < reference ponds LCL, but WMW test does not support rejecting H0.
FTA1 West	10	4	11	6.8	7	7.2	OK	OK	OK	Site mean is < reference ponds LCL, but WMW test does not support rejecting H0.
LF3 C204	10	5	10	6.7	6.5	7.2	OK	OK	OK	Site mean is < reference ponds LCL, but WMW test does not support rejecting H0.
LF3 C4	10	3	10	5.5	4.5	7.2	Reject H0	Reject H0	OK	Site mean is < reference ponds LCL, but WMW test does not support rejecting H0.
LF5 South	10	3	9	5.3	5	7.2	Reject H0	Reject H0	OK	Site mean is < reference ponds LCL, but WMW test does not support rejecting H0.
LF5 Southwest	10	5	12	8.1	7	7.2	OK	OK	OK	
Combined Sites	90	3	17	7.8	7	7.2	OK	OK	OK	Data are not normally distributed.

H0 -- null hypothesis: site diversity is greater than or equal to reference pool diversity
OK -- do not reject null hypothesis
*OK -- do not reject null hypothesis, but site and reference variances are not equal

Questionable results -- normality requirement not met. Recommend non-parametric tests.

Statistics Summary - Percent Plant Coverage

Site	Number of Observations	Minimum	Maximum	Mean	Median	Reference Ponds Lower Conficence Limit	t-Test Results	Satterthwaite Test results	Wilcoxon-Mann-Whitney Results	Comments
ETC10	10	30	80	60	62.5	43.2	OK	OK	OK	
ETC12 C7	10	35	90	72.5	80	43.2	OK	OK	OK	
ETC12 C7a	10	25	75	56.3	60	43.2	OK	OK	OK	
FTA1 East	10	30	90	65.5	70	43.2	OK	OK	OK	
FTA1 West	10	25	95	75.5	90	43.2	OK	OK	OK	
LF3 C204	10	7	80	36	26.5	43.2	Reject H0	Reject H0	OK	Site mean is < reference ponds LCL, but WMW test does not support rejecting H0.
LF3 C4	10	50	90	72.5	77.5	43.2	OK	OK	OK	
LF5 South	10	15	70	35.5	30	43.2	Reject H0	Reject H0	OK	Site mean is < reference ponds LCL, but WMW test does not support rejecting H0.
LF5 Southwest	10	30	95	80	87.5	43.2	OK	OK	OK	
Combined Sites	90	7	95	61.5	70	43.2	OK	OK	OK	Data are not normally distributed.

H0 -- null hypothesis: site coverage is greater than or equal to reference pool coverage
OK -- do not reject null hypothesis
*OK -- do not reject null hypothesis, but site and reference variances are not equal

Questionable results -- normality requirement not met. Recommend non-parametric tests.

VEGETATION DIVERSITY AND ABUNDANCE UCL FLIPPED

General UCL Statistics for Full Data Sets

User Selected Options

From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Flip Coverage (reference)

General Statistics

Number of Valid Observations	60	Number of Distinct Observations	23

Raw Statistics		Log-transformed Statistics	
Minimum	2	Minimum of Log Data	0.693
Maximum	95	Maximum of Log Data	4.554
Mean	40.68	Mean of log Data	3.348
Median	37.5	SD of log Data	0.96
SD	28.7		
Coefficient of Variation	0.706		
Skewness	0.274		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.164	Lilliefors Test Statistic	0.142
Lilliefors Critical Value	0.114	Lilliefors Critical Value	0.114
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	46.88	95% H-UCL	87.11
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	72.86

95% Adjusted-CLT UCL 46.92

95% Modified-t UCL 46.9

Gamma Distribution Test

k star (bias corrected) 1.476

Theta Star 27.56

nu star 177.1

Approximate Chi Square Value (.05) 147.4

Adjusted Level of Significance 0.046

Adjusted Chi Square Value 146.7

Anderson-Darling Test Statistic 1.791

Anderson-Darling 5% Critical Value 0.768

Kolmogorov-Smirnov Test Statistic 0.158

Kolmogorov-Smirnov 5% Critical Value 0.117

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL 48.91

95% Adjusted Gamma UCL 49.13

97.5% Chebyshev (MVUE) UCL 85.09

99% Chebyshev (MVUE) UCL 109.1

Data Distribution

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

95% CLT UCL 46.78

95% Jackknife UCL 46.88

95% Standard Bootstrap UCL 46.85

95% Bootstrap-t UCL 46.96

95% Hall's Bootstrap UCL 46.41

95% Percentile Bootstrap UCL 46.73

95% BCA Bootstrap UCL 46.72

95% Chebyshev(Mean, Sd) UCL 56.84

97.5% Chebyshev(Mean, Sd) UCL 63.83

99% Chebyshev(Mean, Sd) UCL 77.55

Potential UCL to Use

Use 95% Chebyshev (Mean, Sd) UCL 56.84

unflip: LCL = 100-49.95 = 43.16

Flip Species (reference)

General Statistics

Number of Valid Observations 60

Number of Distinct Observations 14

Raw Statistics

Minimum 81

Log-transformed Statistics

Minimum of Log Data 4.394

Maximum	98	Maximum of Log Data	4.585
Mean	92.2	Mean of log Data	4.523
Median	92	SD of log Data	0.0309
SD	2.791		
Coefficient of Variation	0.0303		
Skewness	-1.181		

Relevant UCL Statistics

Normal Distribution Test

Lilliefors Test Statistic	0.171
Lilliefors Critical Value	0.114

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Lilliefors Test Statistic	0.178
Lilliefors Critical Value	0.114

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	92.8

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL	92.73
95% Modified-t UCL	92.79

Assuming Lognormal Distribution

95% H-UCL	N/A
95% Chebyshev (MVUE) UCL	93.8
97.5% Chebyshev (MVUE) UCL	94.5
99% Chebyshev (MVUE) UCL	95.86

Gamma Distribution Test

k star (bias corrected)	1028
Theta Star	0.0897
nu star	123323
Approximate Chi Square Value (.05)	122507
Adjusted Level of Significance	0.046
Adjusted Chi Square Value	122488
Anderson-Darling Test Statistic	1.323
Anderson-Darling 5% Critical Value	0.748
Kolmogorov-Smirnov Test Statistic	0.175
Kolmogorov-Smirnov 5% Critical Value	0.114

Data Distribution

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

95% CLT UCL	92.79
95% Jackknife UCL	92.8
95% Standard Bootstrap UCL	92.79
95% Bootstrap-t UCL	92.77
95% Hall's Bootstrap UCL	92.75
95% Percentile Bootstrap UCL	92.78
95% BCA Bootstrap UCL	92.77

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL 92.81

95% Adjusted Gamma UCL 92.83

95% Chebyshev(Mean, Sd) UCL 93.77

97.5% Chebyshev(Mean, Sd) UCL 94.45

99% Chebyshev(Mean, Sd) UCL 95.79

Potential UCL to Use

Use 95% Student's-t UCL 92.8

or 95% Modified-t UCL 92.79

unflip: LCL = 100-92.8 = 7.2

VEGETATION DIVERSITY AND ABUNDAANCE GROUPED BY POOL

From File: I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege.wst

Summary Statistics for Raw Full Data Sets

Variable	NumObs	Minimum	Maximum	Mean	Median	Variance	SD	MAD/0.675	Skewness	Kurtosis	CV
Coverage (823n)	10	50	98	80.8	85	235.3	15.34	11.12	-1.107	0.515	0.19
Coverage (835r)	10	10	80	31.5	30	333.6	18.27	0	2.332	6.968	0.58
Coverage (c208)	10	5	95	62.2	82.5	1382	37.17	14.83	-0.831	-1.283	0.598
Coverage (c209)	10	30	90	62.8	62.5	334.6	18.29	18.53	-0.135	-0.272	0.291
Coverage (etc10)	10	30	80	60	62.5	438.9	20.95	25.95	-0.261	-1.992	0.349
Coverage (etc12c7)	10	35	90	72.5	80	279.2	16.71	3.706	-1.686	2.224	0.23
Coverage (etc12c7a)	10	25	75	56.3	60	213.6	14.61	9.637	-1.141	1.366	0.26
Coverage (fta1e)	10	30	90	65.5	70	602.5	24.55	29.65	-0.399	-1.596	0.375
Coverage (fta1w)	10	25	95	75.5	90	541.4	23.27	3.706	-1.394	1.134	0.308
Coverage (lf3c204)	10	7	80	36	26.5	730.9	27.03	26.69	0.515	-1.395	0.751
Coverage (lf3c4)	10	50	90	72.5	77.5	234.7	15.32	11.12	-0.623	-1.156	0.211
Coverage (lf5s)	10	15	70	35.5	30	341.4	18.48	14.83	0.909	-0.356	0.52
Coverage (lf5sw)	10	30	95	80	87.5	400	20	11.12	-1.992	4.449	0.25
Coverage (uspws)	10	20	55	33	30	123.3	11.11	11.12	0.785	0.236	0.337
Coverage (uspwse)	10	71	95	85.6	87.5	60.27	7.763	11.12	-0.511	-0.426	0.0907

From File: I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege.wst

Summary Statistics for Raw Full Data Sets

Variable	NumObs	Minimum	Maximum	Mean	Median	Variance	SD	MAD/0.675	Skewness	Kurtosis	CV
Species (823n)	10	2	19	9.1	7.5	24.32	4.932	2.965	0.8	0.567	0.542
Species (835r)	10	4	9	6.8	7	3.067	1.751	2.224	-0.242	-1.232	0.258
Species (c208)	10	3	9	5.6	5.5	3.156	1.776	2.224	0.464	0.0539	0.317
Species (c209)	10	6	11	7.5	7	3.833	1.958	1.483	1.332	0.423	0.261
Species (etc10)	10	7	17	12	12.5	12.67	3.559	3.706	-0.0185	-0.87	0.297
Species (etc12c7)	10	3	11	7.6	8	6.711	2.591	2.965	-0.502	-0.738	0.341
Species (etc12c7a)	10	8	17	11.6	11	5.822	2.413	1.483	1.063	2.353	0.208
Species (fta1e)	10	4	9	6.8	7.5	3.733	1.932	2.224	-0.457	-1.412	0.284
Species (fta1w)	10	4	11	6.8	7	4.4	2.098	1.483	0.6	0.828	0.308
Species (lf3c204)	10	5	10	6.7	6.5	2.678	1.636	2.224	0.791	0.222	0.244
Species (lf3c4)	10	3	10	5.5	4.5	4.944	2.224	1.483	1.023	0.246	0.404
Species (lf5s)	10	3	9	5.3	5	4.233	2.058	2.224	0.741	-0.556	0.388
Species (lf5sw)	10	5	12	8.1	7	6.767	2.601	2.224	0.432	-1.768	0.321
Species (uspws)	10	8	12	9	8	2.667	1.633	0	1.531	0.817	0.181
Species (uspwse)	10	6	11	8.8	8.5	2.844	1.687	2.224	-0.132	-0.989	0.192

Potentially Contaminated Sites

VEGETATION DIVERSITY AND ABUNDAANCE GROUPED BY TYPE

From File: I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege.wst

Summary Statistics for Raw Full Data Sets

Variable	NumObs	Minimum	Maximum	Mean	Median	Variance	SD	MAD/0.675	Skewness	Kurtosis	CV
Coverage (reference)	60	5	98	59.32	62.5	823.9	28.7	40.77	-0.274	-1.42	0.484
Coverage (site)	90	7	95	61.53	70	624.3	24.99	29.65	-0.504	-0.952	0.406
Species (reference)	60	2	19	7.8	8	7.79	2.791	1.483	1.181	3.561	0.358
Species (site)	90	3	17	7.822	7	10.53	3.245	2.965	0.786	0.425	0.415

Reference ponds (combined)

VEGETATION DIVERSITY t-TESTS

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Species(lf5sw)

Background Data: Species(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	6	14
Minimum	5	2
Maximum	12	19
Mean	8.1	7.8
Median	7	8
SD	2.601	2.791
SE of Mean	0.823	0.36

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	68	0.317	-1.668	0.624
Satterthwaite (Unequal Variance)	12.7	0.334	-1.771	0.628

Pooled SD: 2.767

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	9	1.151	0.884

Conclusion with Alpha = 0.05

* Two variances appear to be equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Species(lf5s)

Background Data: Species(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	6	14
Minimum	3	2
Maximum	9	19
Mean	5.3	7.8
Median	5	8
SD	2.058	2.791
SE of Mean	0.651	0.36

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	68	-2.705	-1.668	0.004
Satterthwaite (Unequal Variance)	15.1	-3.361	-1.753	0.002

Pooled SD: 2.705

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Reject H0, Conclude Site < Background
* Satterthwaite Test: Reject H0, Conclude Site < Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	9	1.84	0.326

Conclusion with Alpha = 0.05

* Two variances appear to be equal

	t-Test Site vs Background Comparison for Full Data Sets without NDs
User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Species(lf3c4)

Background Data: Species(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	7	14
Minimum	3	2
Maximum	10	19
Mean	5.5	7.8
Median	4.5	8
SD	2.224	2.791
SE of Mean	0.703	0.36

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	68	-2.473	-1.668	0.008
Satterthwaite (Unequal Variance)	14.2	-2.911	-1.761	0.006

Pooled SD: 2.723

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Reject H0, Conclude Site < Background
* Satterthwaite Test: Reject H0, Conclude Site < Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	9	1.575	0.474

Conclusion with Alpha = 0.05

* Two variances appear to be equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Species(lf3c204)

Background Data: Species(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	5	14
Minimum	5	2
Maximum	10	19
Mean	6.7	7.8
Median	6.5	8
SD	1.636	2.791
SE of Mean	0.517	0.36

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	68	-1.207	-1.668	0.116
Satterthwaite (Unequal Variance)	19.2	-1.744	-1.729	0.049

Pooled SD: 2.667

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	9	2.909	0.088

Conclusion with Alpha = 0.05

* Two variances appear to be equal

	t-Test Site vs Background Comparison for Full Data Sets without NDs
User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Species(fta1w)

Background Data: Species(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	5	14
Minimum	4	2
Maximum	11	19
Mean	6.8	7.8
Median	7	8
SD	2.098	2.791
SE of Mean	0.663	0.36

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	68	-1.081	-1.668	0.142
Satterthwaite (Unequal Variance)	14.9	-1.325	-1.753	0.103

Pooled SD: 2.709

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	9	1.77	0.36

Conclusion with Alpha = 0.05

* Two variances appear to be equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Species(fta1e)

Background Data: Species(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	6	14
Minimum	4	2
Maximum	9	19
Mean	6.8	7.8
Median	7.5	8
SD	1.932	2.791
SE of Mean	0.611	0.36

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	68	-1.087	-1.668	0.14
Satterthwaite (Unequal Variance)	16.1	-1.41	-1.746	0.089

Pooled SD: 2.693

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	9	2.087	0.234

Conclusion with Alpha = 0.05

* Two variances appear to be equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Species(etc12c7a)

Background Data: Species(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	6	14
Minimum	8	2
Maximum	17	19
Mean	11.6	7.8
Median	11	8
SD	2.413	2.791
SE of Mean	0.763	0.36

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	68	4.054	-1.668	1
Satterthwaite (Unequal Variance)	13.4	4.503	-1.771	1

Pooled SD: 2.744

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	9	1.338	0.671

Conclusion with Alpha = 0.05

* Two variances appear to be equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Species(etc12c7)

Background Data: Species(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	7	14
Minimum	3	2
Maximum	11	19
Mean	7.6	7.8
Median	8	8
SD	2.591	2.791
SE of Mean	0.819	0.36

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	68	-0.212	-1.668	0.416
Satterthwaite (Unequal Variance)	12.7	-0.223	-1.771	0.413

Pooled SD: 2.765

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	9	1.161	0.872

Conclusion with Alpha = 0.05

* Two variances appear to be equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Species(etc10)

Background Data: Species(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	6	14
Minimum	7	2
Maximum	17	19
Mean	12	7.8
Median	12.5	8
SD	3.559	2.791
SE of Mean	1.125	0.36

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	68	4.234	-1.668	1
Satterthwaite (Unequal Variance)	10.9	3.554	-1.796	0.998

Pooled SD: 2.904

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
9	59	1.626	0.258

Conclusion with Alpha = 0.05

* Two variances appear to be equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Species(site)

Background Data: Species(reference)

Raw Statistics

	Site	Background
Number of Valid Observations	90	60
Number of Distinct Observations	13	14
Minimum	3	2
Maximum	17	19
Mean	7.822	7.8
Median	7	8
SD	3.245	2.791
SE of Mean	0.342	0.36

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	148	0.043	-1.655	0.517
Satterthwaite (Unequal Variance)	138.6	0.045	-1.656	0.518

Pooled SD: 3.072

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
89	59	1.352	0.217

Conclusion with Alpha = 0.05

* Two variances appear to be equal

VEGETATION DIVERSITY WILCOXON-MANN-WHITNEY TESTS

	Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs	
User Selected Options		
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst	
Full Precision	OFF	
Confidence Coefficient	95%	
Substantial Difference	0	
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)	
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median	

Area of Concern Data: Species(lf5sw)

Background Data: Species(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	6	14
Minimum	5	2
Maximum	12	19
Mean	8.1	7.8
Median	7	8
SD	2.601	2.791
SE of Mean	0.823	0.36

Wilcoxon-Mann-Whitney (WMW) Test

Site Rank Sum W-Stat	363.5
WMW Test U-Stat	308.5
WMW Critical Value (0.050)	63
Approximate P-Value	0.56

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median

Area of Concern Data: Species(lf3c4)

Background Data: Species(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	7	14
Minimum	3	2
Maximum	10	19
Mean	5.5	7.8
Median	4.5	8
SD	2.224	2.791
SE of Mean	0.703	0.36

Wilcoxon-Mann-Whitney (WMW) Test

Site Rank Sum W-Stat	201
WMW Test U-Stat	146
WMW Critical Value (0.050)	63
Approximate P-Value	0.00499

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

	Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs	
User Selected Options		
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst	
Full Precision	OFF	
Confidence Coefficient	95%	
Substantial Difference	0	
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)	
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median	

Area of Concern Data: Species(lf3c204)

Background Data: Species(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	5	14
Minimum	5	2
Maximum	10	19
Mean	6.7	7.8
Median	6.5	8
SD	1.636	2.791
SE of Mean	0.517	0.36

Wilcoxon-Mann-Whitney (WMW) Test

Site Rank Sum W-Stat	273.5
WMW Test U-Stat	218.5
WMW Critical Value (0.050)	63
Approximate P-Value	0.087

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

1		Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs	
2	User Selected Options		
3	From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst	
4	Full Precision	OFF	
5	Confidence Coefficient	95%	
6	Substantial Difference	0	
7	Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)	
8	Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median	
9			
10			
11	Area of Concern Data: Species(fta1w)		
12	Background Data: Species(ref_all)		
13			
14	Raw Statistics		
15		Site	Background
16	Number of Valid Observations	10	60
17	Number of Distinct Observations	5	14
18	Minimum	4	2
19	Maximum	11	19
20	Mean	6.8	7.8
21	Median	7	8
22	SD	2.098	2.791
23	SE of Mean	0.663	0.36
24			
25	Wilcoxon-Mann-Whitney (WMW) Test		
26			
27			
28			
29	Site Rank Sum W-Stat	282.5	
30	WMW Test U-Stat	227.5	
31	WMW Critical Value (0.050)	63	
32	Approximate P-Value	0.113	
33			
34	Conclusion with Alpha = 0.05		
35	Do Not Reject H0, Conclude Site >= Background		
36			

	Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs	
User Selected Options		
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst	
Full Precision	OFF	
Confidence Coefficient	95%	
Substantial Difference	0	
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)	
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median	

Area of Concern Data: Species(fta1e)

Background Data: Species(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	6	14
Minimum	4	2
Maximum	9	19
Mean	6.8	7.8
Median	7.5	8
SD	1.932	2.791
SE of Mean	0.611	0.36

Wilcoxon-Mann-Whitney (WMW) Test

Site Rank Sum W-Stat	304.5
WMW Test U-Stat	249.5
WMW Critical Value (0.050)	63
Approximate P-Value	0.201

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

	Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs	
User Selected Options		
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst	
Full Precision	OFF	
Confidence Coefficient	95%	
Substantial Difference	0	
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)	
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median	
Area of Concern Data: Species(etc12c7a)		
Background Data: Species(ref_all)		
Raw Statistics		
	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	6	14
Minimum	8	2
Maximum	17	19
Mean	11.6	7.8
Median	11	8
SD	2.413	2.791
SE of Mean	0.763	0.36
Wilcoxon-Mann-Whitney (WMW) Test		
Site Rank Sum W-Stat	579.5	
WMW Test U-Stat	524.5	
WMW Critical Value (0.050)	63	
Approximate P-Value	1	
Conclusion with Alpha = 0.05		
Do Not Reject H0, Conclude Site >= Background		

	Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs	
User Selected Options		
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst	
Full Precision	OFF	
Confidence Coefficient	95%	
Substantial Difference	0	
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)	
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median	

Area of Concern Data: Species(etc12c7)

Background Data: Species(ref_all)

Raw Statistics		
	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	7	14
Minimum	3	2
Maximum	11	19
Mean	7.6	7.8
Median	8	8
SD	2.591	2.791
SE of Mean	0.819	0.36

Wilcoxon-Mann-Whitney (WMW) Test

Site Rank Sum W-Stat	364.5
WMW Test U-Stat	309.5
WMW Critical Value (0.050)	63
Approximate P-Value	0.567

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median

Area of Concern Data: Species(etc10)

Background Data: Species(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	6	14
Minimum	7	2
Maximum	17	19
Mean	12	7.8
Median	12.5	8
SD	3.559	2.791
SE of Mean	1.125	0.36

Wilcoxon-Mann-Whitney (WMW) Test

Site Rank Sum W-Stat	549.5
WMW Test U-Stat	494.5
WMW Critical Value (0.050)	63
Approximate P-Value	0.999

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median

Area of Concern Data: Species(site)

Background Data: Species(reference)

Raw Statistics

	Site	Background
Number of Valid Observations	90	60
Number of Distinct Observations	13	14
Minimum	3	2
Maximum	17	19
Mean	7.822	7.8
Median	7	8
SD	3.245	2.791
SE of Mean	0.342	0.36

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC >= Mean/Median of Background

Site Rank Sum W-Stat	6711
WMW Test U-Stat	-0.322
WMW Critical Value (0.050)	-1.645
P-Value	0.374

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

P-Value >= alpha (0.05)

VEGETATION ABUNDANCE t-TESTS

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Coverage(lf5sw)

Background Data: Coverage(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	6	23
Minimum	30	5
Maximum	95	98
Mean	80	59.32
Median	87.5	62.5
SD	20	28.7
SE of Mean	6.325	3.706

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	68	2.185	-1.668	0.984
Satterthwaite (Unequal Variance)	16	2.822	-1.746	0.994

Pooled SD: 27.709

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	9	2.06	0.243

Conclusion with Alpha = 0.05

* Two variances appear to be equal

	t-Test Site vs Background Comparison for Full Data Sets without NDs
User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Coverage(lf5s)

Background Data: Coverage(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	8	23
Minimum	15	5
Maximum	70	98
Mean	35.5	59.32
Median	30	62.5
SD	18.48	28.7
SE of Mean	5.843	3.706

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

		t-Test	Critical	
Method	DF	Value	- t (0.050)	P-Value
Pooled (Equal Variance)	68	-2.529	-1.668	0.007
Satterthwaite (Unequal Variance)	17.3	-3.442	-1.74	0.002

Pooled SD: 27.569

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Reject H0, Conclude Site < Background
* Satterthwaite Test: Reject H0, Conclude Site < Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	9	2.413	0.155

Conclusion with Alpha = 0.05

* Two variances appear to be equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Coverage(lf3c4)

Background Data: Coverage(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	5	23
Minimum	50	5
Maximum	90	98
Mean	72.5	59.32
Median	77.5	62.5
SD	15.32	28.7
SE of Mean	4.845	3.706

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	68	1.413	-1.668	0.919
Satterthwaite (Unequal Variance)	21.5	2.161	-1.721	0.979

Pooled SD: 27.312

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	9	3.51	0.047

Conclusion with Alpha = 0.05

* Two variances are not equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Coverage(lf3c204)

Background Data: Coverage(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	8	23
Minimum	7	5
Maximum	80	98
Mean	36	59.32
Median	26.5	62.5
SD	27.03	28.7
SE of Mean	8.549	3.706

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	68	-2.396	-1.668	0.01
Satterthwaite (Unequal Variance)	12.6	-2.502	-1.771	0.013

Pooled SD: 28.489

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Reject H0, Conclude Site < Background
* Satterthwaite Test: Reject H0, Conclude Site < Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	9	1.127	0.916

Conclusion with Alpha = 0.05

* Two variances appear to be equal

	t-Test Site vs Background Comparison for Full Data Sets without NDs
User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Coverage(fta1w)

Background Data: Coverage(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	6	23
Minimum	25	5
Maximum	95	98
Mean	75.5	59.32
Median	90	62.5
SD	23.27	28.7
SE of Mean	7.358	3.706

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

		t-Test	Critical	
Method	DF	Value	- t (0.050)	P-Value
Pooled (Equal Variance)	68	1.689	-1.668	0.952
Satterthwaite (Unequal Variance)	14	1.964	-1.761	0.965

Pooled SD: 28.045

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	9	1.522	0.513

Conclusion with Alpha = 0.05

* Two variances appear to be equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Coverage(fta1e)

Background Data: Coverage(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	6	23
Minimum	30	5
Maximum	90	98
Mean	65.5	59.32
Median	70	62.5
SD	24.55	28.7
SE of Mean	7.762	3.706

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

		t-Test	Critical	
Method	DF	Value	- t (0.050)	P-Value
Pooled (Equal Variance)	68	0.642	-1.668	0.739
Satterthwaite (Unequal Variance)	13.5	0.719	-1.771	0.758

Pooled SD: 28.189

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	9	1.367	0.643

Conclusion with Alpha = 0.05

* Two variances appear to be equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Coverage(etc12c7a)

Background Data: Coverage(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	7	23
Minimum	25	5
Maximum	75	98
Mean	56.3	59.32
Median	60	62.5
SD	14.61	28.7
SE of Mean	4.621	3.706

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

		t-Test	Critical	
Method	DF	Value	- t (0.050)	P-Value
Pooled (Equal Variance)	68	-0.324	-1.668	0.373
Satterthwaite (Unequal Variance)	22.9	-0.509	-1.714	0.308

Pooled SD: 27.260

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background

* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	9	3.858	0.034

Conclusion with Alpha = 0.05

* Two variances are not equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Coverage(etc12c7)

Background Data: Coverage(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	5	23
Minimum	35	5
Maximum	90	98
Mean	72.5	59.32
Median	80	62.5
SD	16.71	28.7
SE of Mean	5.284	3.706

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	68	1.408	-1.668	0.918
Satterthwaite (Unequal Variance)	19.3	2.043	-1.729	0.973

Pooled SD: 27.419

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	9	2.951	0.084

Conclusion with Alpha = 0.05

* Two variances appear to be equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Coverage(etc10)

Background Data: Coverage(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	6	23
Minimum	30	5
Maximum	80	98
Mean	60	59.32
Median	62.5	62.5
SD	20.95	28.7
SE of Mean	6.625	3.706

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	68	0.072	-1.668	0.529
Satterthwaite (Unequal Variance)	15.3	0.09	-1.753	0.535

Pooled SD: 27.802

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	9	1.877	0.31

Conclusion with Alpha = 0.05

* Two variances appear to be equal

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Greater Than or Equal to Background Mean (Form 2)
Alternative Hypothesis	Site or AOC Mean Less Than the Background Mean

Area of Concern Data: Coverage(site)

Background Data: Coverage(reference)

Raw Statistics

	Site	Background
Number of Valid Observations	90	60
Number of Distinct Observations	19	23
Minimum	7	5
Maximum	95	98
Mean	61.53	59.32
Median	70	62.5
SD	24.99	28.7
SE of Mean	2.634	3.706

Site vs Background Two-Sample t-Test

H0: Mu of Site - Mu of Background >= 0

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	148	0.501	-1.655	0.692
Satterthwaite (Unequal Variance)	114.3	0.488	-1.658	0.687

Pooled SD: 26.530

Conclusion with Alpha = 0.050

* Student t (Pooled) Test: Do Not Reject H0, Conclude Site >= Background
* Satterthwaite Test: Do Not Reject H0, Conclude Site >= Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
59	89	1.32	0.234

Conclusion with Alpha = 0.05

* Two variances appear to be equal

VEGETATION ABUNDANCE WILCOXON-MANN-WHITNEY TESTS

1		Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs	
2	User Selected Options		
3	From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst	
4	Full Precision	OFF	
	Confidence Coefficient	95%	
	Substantial Difference	0	
7	Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)	
8	Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median	
9			
10			
11	Area of Concern Data: Coverage(lf5sw)		
12	Background Data: Coverage(ref_all)		
13			
14	Raw Statistics		
15		Site	Background
16	Number of Valid Observations	10	60
17	Number of Distinct Observations	6	23
18	Minimum	30	5
19	Maximum	95	98
20	Mean	80	59.32
21	Median	87.5	62.5
22	SD	20	28.7
23	SE of Mean	6.325	3.706
24			
25	Wilcoxon-Mann-Whitney (WMW) Test		
27			
28			
29	Site Rank Sum W-Stat	484	
30	WMW Test U-Stat	429	
31	WMW Critical Value (0.050)	63	
32	Approximate P-Value	0.985	
33			
34	Conclusion with Alpha = 0.05		
35	Do Not Reject H0, Conclude Site >= Background		
36			

1		Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs
2	User Selected Options	
3	From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
4	Full Precision	OFF
5	Confidence Coefficient	95%
6	Substantial Difference	0
7	Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)
8	Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median
9		
10		
11	Area of Concern Data: Coverage(lf5s)	
12	Background Data: Coverage(ref_all)	
13		

14	Raw Statistics		
15		Site	Background
16	Number of Valid Observations	10	60
17	Number of Distinct Observations	8	23
18	Minimum	15	5
19	Maximum	70	98
20	Mean	35.5	59.32
21	Median	30	62.5
22	SD	18.48	28.7
23	SE of Mean	5.843	3.706
24			
25	Wilcoxon-Mann-Whitney (WMW) Test		
26			
27			
28			
29	Site Rank Sum W-Stat	207	
30	WMW Test U-Stat	152	
31	WMW Critical Value (0.050)	63	
32	Approximate P-Value	0.00665	
33			
34	Conclusion with Alpha = 0.05		
35	Do Not Reject H0, Conclude Site >= Background		
36			

	Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs		
User Selected Options			
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst		
Full Precision	OFF		
Confidence Coefficient	95%		
Substantial Difference	0		
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)		
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median		
Area of Concern Data: Coverage(lf3c4)			
Background Data: Coverage(ref_all)			
Raw Statistics			
	Site	Background	
Number of Valid Observations	10	60	
Number of Distinct Observations	5	23	
Minimum	50	5	
Maximum	90	98	
Mean	72.5	59.32	
Median	77.5	62.5	
SD	15.32	28.7	
SE of Mean	4.845	3.706	
Wilcoxon-Mann-Whitney (WMW) Test			
Site Rank Sum W-Stat	413		
WMW Test U-Stat	358		
WMW Critical Value (0.050)	63		
Approximate P-Value	0.837		
Conclusion with Alpha = 0.05			
Do Not Reject H0, Conclude Site >= Background			

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median

Area of Concern Data: Coverage(lf3c204)

Background Data: Coverage(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	8	23
Minimum	7	5
Maximum	80	98
Mean	36	59.32
Median	26.5	62.5
SD	27.03	28.7
SE of Mean	8.549	3.706

Wilcoxon-Mann-Whitney (WMW) Test

Site Rank Sum W-Stat	212.5
WMW Test U-Stat	157.5
WMW Critical Value (0.050)	63
Approximate P-Value	0.00858

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

	Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs
User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median

Area of Concern Data: Coverage(fta1w)

Background Data: Coverage(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	6	23
Minimum	25	5
Maximum	95	98
Mean	75.5	59.32
Median	90	62.5
SD	23.27	28.7
SE of Mean	7.358	3.706

Wilcoxon-Mann-Whitney (WMW) Test

Site Rank Sum W-Stat	456.5
WMW Test U-Stat	401.5
WMW Critical Value (0.050)	63
Approximate P-Value	0.957

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median

Area of Concern Data: Coverage(fta1e)

Background Data: Coverage(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	6	23
Minimum	30	5
Maximum	90	98
Mean	65.5	59.32
Median	70	62.5
SD	24.55	28.7
SE of Mean	7.762	3.706

Wilcoxon-Mann-Whitney (WMW) Test

Site Rank Sum W-Stat	389.5
WMW Test U-Stat	334.5
WMW Critical Value (0.050)	63
Approximate P-Value	0.722

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

1		Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs	
2	User Selected Options		
3	From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst	
4	Full Precision	OFF	
	Confidence Coefficient	95%	
	Substantial Difference	0	
7	Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)	
8	Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median	
9			
10			
11	Area of Concern Data: Coverage(etc12c7a)		
12	Background Data: Coverage(ref_all)		
13			
14	Raw Statistics		
15		Site	Background
16	Number of Valid Observations	10	60
17	Number of Distinct Observations	7	23
18	Minimum	25	5
19	Maximum	75	98
20	Mean	56.3	59.32
21	Median	60	62.5
22	SD	14.61	28.7
23	SE of Mean	4.621	3.706
24			
25	Wilcoxon-Mann-Whitney (WMW) Test		
27			
28			
29	Site Rank Sum W-Stat	317	
30	WMW Test U-Stat	262	
31	WMW Critical Value (0.050)	63	
32	Approximate P-Value	0.265	
33			
34	Conclusion with Alpha = 0.05		
35	Do Not Reject H0, Conclude Site >= Background		
36			

1		Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs	
2	User Selected Options		
3	From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst	
4	Full Precision	OFF	
5	Confidence Coefficient	95%	
6	Substantial Difference	0	
7	Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)	
8	Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median	
9			
10			
11	Area of Concern Data: Coverage(etc12c7)		
12	Background Data: Coverage(ref_all)		
13			
14	Raw Statistics		
15		Site	Background
16	Number of Valid Observations	10	60
17	Number of Distinct Observations	5	23
18	Minimum	35	5
19	Maximum	90	98
20	Mean	72.5	59.32
21	Median	80	62.5
22	SD	16.71	28.7
23	SE of Mean	5.284	3.706
24			
25	Wilcoxon-Mann-Whitney (WMW) Test		
26			
27			
28			
29	Site Rank Sum W-Stat	409.5	
30	WMW Test U-Stat	354.5	
31	WMW Critical Value (0.050)	63	
32	Approximate P-Value	0.822	
33			
34	Conclusion with Alpha = 0.05		
35	Do Not Reject H0, Conclude Site >= Background		
36			

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege_mod.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median

Area of Concern Data: Coverage(etc10)

Background Data: Coverage(ref_all)

Raw Statistics

	Site	Background
Number of Valid Observations	10	60
Number of Distinct Observations	6	23
Minimum	30	5
Maximum	80	98
Mean	60	59.32
Median	62.5	62.5
SD	20.95	28.7
SE of Mean	6.625	3.706

Wilcoxon-Mann-Whitney (WMW) Test

Site Rank Sum W-Stat	344.5
WMW Test U-Stat	289.5
WMW Critical Value (0.050)	63
Approximate P-Value	0.433

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options	
From File	I:\CASTLE\Datamgmt\VernalPools_Monitoring\ProUCL\Vege.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median (Form 2)
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median

Area of Concern Data: Coverage(site)

Background Data: Coverage(reference)

Raw Statistics

	Site	Background
Number of Valid Observations	90	60
Number of Distinct Observations	19	23
Minimum	7	5
Maximum	95	98
Mean	61.53	59.32
Median	70	62.5
SD	24.99	28.7
SE of Mean	2.634	3.706

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC >= Mean/Median of Background

Site Rank Sum W-Stat	6834
WMW Test U-Stat	0.15
WMW Critical Value (0.050)	-1.645
P-Value	0.559

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site >= Background

P-Value >= alpha (0.05)

APPENDIX C

Five-Year Review Public Notification
June 2008

Environmental Cleanup
Five-Year Review begins at
former Castle Air Force Base

The Five-Year Review is a formal evaluation of the ongoing environmental cleanup activities at Castle AFB, located in Atwater, CA. The report is expected to be issued in late 2008 and the Air Force is informing you the process has begun.

If you have any issues or concerns about Castle's cleanup systems, or if you have direct knowledge regarding the cleanup remedies, the Air Force would like to talk to you. Please contact Stanley Pehl, Air Force Environmental Program Manager, at the contact information listed below.

The review is basically a report card for the Air Force's cleanup operation, underway at Castle since the 1980s. Past disposal of hazardous materials, such as solvents and other chemicals, resulted in soil and groundwater contamination. Numerous systems are operating and removing the contamination. While the Air Force is the lead agency responsible for the cleanup activities, the U.S. Environmental Protection Agency and the State of California (Department of Toxic Substances Control and the California Regional Water Quality Control Board) review the Five-Year report, which includes a determination whether the cleanup remedies in place are protective of human health and the environment. The report also provides recommendations if any deficiencies are found.

The last Five-Year Review for Castle was completed in 2004 and determined that all remedies, including groundwater pump and treat and soil vapor extraction, were protective and working as intended. This Five-Year Review will evaluate whether the groundwater remedy of plume capture and contaminant reduction, plus institutional controls, long-term maintenance and monitoring (for caps), and long-term ecological monitoring are protective of human health and the environment.

The Five-Year Review is scheduled to be completed in late 2008 and another public notice will be issued informing the community the review is complete. The Five-Year Review will then be made available for public review at http://www.safie.hq.af.mil/afrpa/legacybrac/formercastle.asp and at the Merced County Library, 2100 O Street, Merced, CA 95340. Call (209) 385-764 for library hours. The report can also be reviewed at the Castle Information Repository located at 3411 Olson Street, McClellan, CA 95652. You can contact the Information Repository by calling (916) 643-1250 ext. 201.

For more information, contact:

Stanley Pehl, *Air Force Center for Engineering and the Environment*

(210) 536-5232

stanley.pehl@brooks.af.mil

APPENDIX D

Screening Assessment – Vapor Intrusion from Groundwater

Assumed Sand Vadose Zone

DATA ENTRY SHEET

GW-SCREEN
Version 3.0; 04/03

Reset to Defaults

DTSC
Vapor Intrusion Guidance
Interim Final 12/04
(last modified 1/21/05)

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	2.50E+01	Trichloroethylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	2,313	S	24	5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
S			S	1.66	0.375	0.054

MORE ↓

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	30	350

Used to calculate risk-based groundwater concentration.

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.1E-06	2.1E-03

MESSAGE SUMMARY BELOW:

END

]

Assumed Silt Vadose Zone

DATA ENTRY SHEET

GW-SCREEN
Version 3.0; 04/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

DTSC
Vapor Intrusion Guidance
Interim Final 12/04
(last modified 1/21/05)

ENTER Chemical CAS No. (numbers only, no dashes)	**ENTER** Initial groundwater conc., C_W (μg/L)	Chemical
79016	2.50E+01	Trichloroethylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	**ENTER** Depth below grade to water table, L_{WT} (cm)	**ENTER** SCS soil type directly above water table	**ENTER** Average soil/ groundwater temperature, T_S (°C)	**ENTER** Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	2,313	SI	24	5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	**ENTER** User-defined vandose zone soil vapor permeability, k_v (cm^2)	**ENTER** Vadose zone SCS soil type (Lookup Soil Parameters)	**ENTER** Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	**ENTER** Vadose zone soil total porosity, n^V (unitless)	**ENTER** Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
SI			SI	1.35	0.489	0.167

MORE ↓

ENTER Target risk for carcinogens, TR (unitless)	**ENTER** Target hazard quotient for noncarcinogens, THQ (unitless)	**ENTER** Averaging time for carcinogens, AT_C (yrs)	**ENTER** Averaging time for noncarcinogens, AT_{NC} (yrs)	**ENTER** Exposure duration, ED (yrs)	**ENTER** Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	30	350

Used to calculate risk-based groundwater concentration.

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

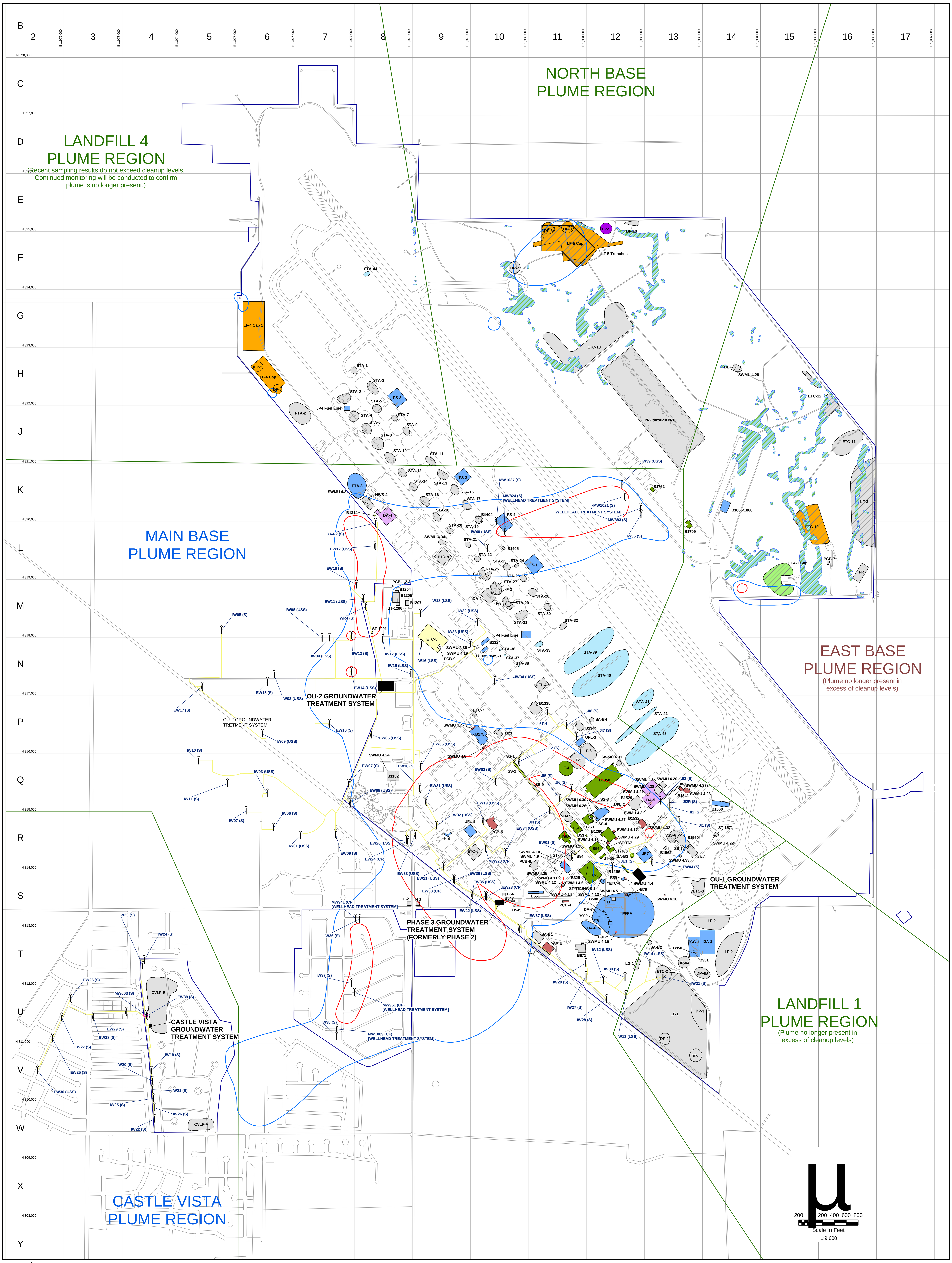
INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
2.2E-07	4.3E-04

MESSAGE SUMMARY BELOW:

END

]



Legend

- Base Boundary
- MCL Contour for cis-1,2-DCE (6 µg/L) (Q4 2007; Shallow HSZ only)
- MCL Contour for TCE (5 µg/L) (Q4 2007; All HSZs)
- MCL Contour for TCE (0.5 µg/L) (Q4 2007; All HSZs)
- Groundwater Conveyance System
- Groundwater Treatment System
- Extraction Well
- Injection Well
- Wetlands

BV	Bioventing
CB	Comprehensive Basewide
CB-1	CB ROD - Part 1
CF	Confined HSZ
E&D	Excavation and Disposal
HSZ	Hydrostratigraphic Zone
IC	Institutional Controls
IC&M	Institutional Controls and Monitoring
LSS	Lower Subshallow HSZ
LTEM	Long-Term Ecological Monitoring
LTM	Long-Term Cap Monitoring
NFA	No Further Action
P&T	Pump and Treat
PHO	Petroleum Hydrocarbon Only
ROD	Record of Decision
S	Shallow HSZ
SCOU	Source Control Operable Unit
SCOU-1	SCOU ROD Part 1
SCOU-2	SCOU ROD Part 2
SCOU-3	SCOU ROD Part 3
SVE	Soil Vapor Extraction
USS	Upper Subshallow HSZ
WD&M	Well Destruction and Monitoring

ROD, Remedy

- Plume — CB-1, IC&M
- Plume — CB-1, P&T
- Plume — CB-1, WD&M
- SCOU-1, NFA
- SCOU-1, PHO
- SCOU-2, CERCLA Exclusion
- SCOU-2, E&D
- SCOU-2, E&D/SVE
- SCOU-2, NFA
- SCOU-2, SVE
- SCOU-3, BV/E&D/IC/LTM/SVE
- SCOU-3, IC/LTM
- SCOU-3, E&D
- SCOU-3, IC
- SCOU-3, LTEM
- SCOU-3, NFA

SCOU ROD 1 (169 Sites)

NFA						PHO	
B23	DA-8	H-2	SA-B4	STA-13	SWMU 4.9	B59	H-4
B47	DBF	H-3	SDS *	STA-14	SWMU 4.10	B79	JP4 Fuel Line
B84	DP-1	HWS-4	SS-1	STA-15	SWMU 4.11	B175	JP7
B541	DP-2	IWL *	SS-3	STA-16	SWMU 4.12	B325	PFFA
B545	DP-3	LF-1	SS-5	STA-17	SWMU 4.13	B508	SS-8
B547	DP-4A/4B	LF-2	SS-6	STA-18	SWMU 4.19	B551	ST-T61/HWS-1
B871	DP-7	LF-3	SS-7	STA-19	SWMU 4.20	B909	UFL-1
B1182	DP-10	LG-1	SS-9	STA-20	SWMU 4.24	B917	UFL-2
B1204	ETC-2	N-2	ST-1201	STA-21	SWMU 4.25	B950	UFL-3
B1205	ETC-3	N-3	ST-1206	STA-22	SWMU 4.26	B951	
B1207	ETC-6	N-4	ST-1571	STA-23	SWMU 4.27	B1324	
B1319	ETC-7	N-5	STA-1	STA-24	SWMU 4.28	B1325/HWS-3	
B1335	ETC-11	N-6	STA-2	STA-25	SWMU 4.30	B1560	
B1344	ETC-12	N-7	STA-3	STA-26	SWMU 4.31	B1865/1868	
B1404	ETC-13	N-8	STA-4	STA-27	SWMU 4.32	DA-1/TCC-1	
B1405	F-1	N-9	STA-5	STA-28	SWMU 4.33	DA-6	
B1529	F-2	N-10	STA-6	STA-29	SWMU 4.34	DA-7	
B1550	F-3	PCB-1,2,3	STA-7	STA-30	SWMU 4.35	ETC-4	
B1562	F-5	PCB-7	STA-8	STA-31	SWMU 4.36	FS-1	
CVLF-A	F-6	PCB-8	STA-9	STA-32	SWMU 4.37 *	FS-2	
CVLF-B	FR	PCB-9	STA-10	ST-T85	SWMU 4.38	FS-3	
DA-2	FTA-2	SA-B1	STA-11	SWMU 4.1	UFL-4	FS-4	
DA-3	H-1	SA-B2	STA-12	SWMU 4.2		FTA-3	

SCOU ROD 2 (53 Sites)

CERCLA Exclusion	E&D	SVE
STA-33	SWMU 4.3(+BV)	B51
STA-34 **	SWMU 4.4	B52
STA-35 **	SWMU 4.6	B53
STA-36	SWMU 4.16	B54
STA-37	SWMU 4.21(+BV)	B1253
STA-38	SWMU 4.22	B1260
STA-39		B1266
STA-40	**NFA**	B1314
STA-41	B1532	B1350
STA-42	B1541	B1709
STA-43	PCB-4	B1762
STA-44	PCB-5	ETC-5
	PCB-6	F-4
	SWMU 4.5	SA-B3
	SWMU 4.7	SS-2
	SWMU 4.8	SS-4
	SWMU 4.14	ST-55
	SWMU 4.15	ST-T66
	SWMU 4.17	ST-T67
	SWMU 4.18	**E&D/SVE**
	SWMU 4.23	DA-4
	SWMU 4.29	DA-5(+BV)

SCOU ROD 3 (11 Sites; all 233 Sites for Ecological Risk)

IC/LTM	NFA (Ecological)
DP-5	ALL SCOU SITES NOT LISTED BELOW
DP-6	**LTEM**
DP-8	DP-8
DP-8A	DP-8A
LF-4	ETC-10
LF-5	ETC-12
LF-5 Trenches	FTA-1
NFA	LF-3
DP-9	LF-5
IC	LF-5 Trenches
ETC-10	
E&D	
ETC-8	
BV/E&D/IC/LTM/SVE	
FTA-1	

* Basewide sites not shown on map
** Location unknown

Notes:

Basewide Sites (IWL, JP4 Pipeline and SDS) not shown -
All are SCOU ROD Part 1 NFA.

Soil and Groundwater Remedial Actions at Castle Airport

Five-Year Review
Castle Airport

12/22/08 XV G:CADD\12BC8601\2008 Five-Year Review\SiteDesignations.mxd

01/16/04 XV

PLATE 1