DEPARTMENT OF THE AIR FORCE

AIR FORCE REAL PROPERTY AGENCY

FEB 09 2006

MEMORANDUM FOR SEE DISTRIBUTION

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

SUBJECT: Final Groundwater Operable Unit (GWOU) Phase III Remedial Action Report, On-Base Construction (DSR# 875)

1. The attached Final GWOU Phase III Remedial Action Report, On-Base Construction, is forwarded for your use. The subject report has an assigned McClellan Deliverable Status Report (DSR) # 875-3, is considered a "category C document", and is due on 12 February 2006.

2. This Remedial Action Report describes the implementation of the On-Base portion of the Phase III groundwater remediation program. This On-Base portion of the Phase III expansion is designed to expand control of on-base groundwater contaminant plumes in operable units (OU) A, OU B, OU C, OU G, and OU H. On-Base Phase III activities included the following:

a. Installation of 32 extraction wells, 14 monitoring wells, 31 piezometers, and the conversion of 9 additional wells (7 MWs to EWs, 1 EW to DPE, 1 EW re-routed to GWTP).

b. Installation of over 24,000 feet of conveyance lines, 39 well vaults, and over 41,000 feet of electrical conduit for the wells.

c. Modifying the existing operation and control system (OCS), which includes the supervisory control and data acquisition (SCADA) system.

d. Collecting baseline and start-up prove out samples from Phase III on-base extraction wells.

3. If you have any questions, please contact Don Gronstal at (916) 643-3672 ext 211.

STEVE MAYER
BRAC Environmental Coordinator

Attachment:
Final GWOU Phase III On-Base Remedial Action Report

18600916.41001

FORMER McCLELLAN AIR FORCE BASE
GROUNDWATER OPERABLE UNIT
PHASE III REMEDIAL ACTION REPORT
ON-BASE CONSTRUCTION EFFORT

FINAL

USAF Contract No. FA8903-04-D-8679
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ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFBCA	McClellan AFB Conversion Agency
AFCEE	Air Force Center for Environmental Excellence
AFRPA	Air Force Real Property Agency
ARCH	air rotary casing hammer
ASTM	American Society for Testing and Materials
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
COR	contracting officer's representative
CTCL	carbon tetrachloride
DCA	dichloroethane
DCE	dichloroethene
EPA	United States Environmental Protection Agency
ERP	environmental remedial plan
FAA	Federal Aviation Administration
FPR	fiberglass-reinforced pipe
FS	feasibility study
gpm	gallons per minute
GWMP	groundwater monitoring program
GWOU	groundwater operable unit
GWTP	groundwater treatment plant
HDD	horizontal directional drilling
HDPE	high-density polyethylene
HSA	hollow-stem auger
IDW	investigation-derived waste
IROD	interim record of decision
LCP	local control panel
LGAC	liquid-phase granular activated carbon
LRA	land reuse authority
MCL	maximum contaminant level
MWH	MWH Americas, Inc.
NEC	National Electric Code
NEMA	National Electrical Manufacture Associate
NPDES	National Pollutant Discharge Elimination System
NFPA	National Fire Protection Association

ACRONYMS AND ABBREVIATIONS (Continued)

O&M	operation and maintenance
OU	operable unit
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PLC	programmable logic controller
psi	pounds per square inch
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
RAR	remedial action report
ROD	record of decision
RWQCB	California Regional Water Quality Control Board
SAP	sampling and analysis plan
SCADA	supervisory control and data acquisition
SMUD	Sacramento Municipal Utility District
SOP	standard operating procedure
SVE	soil vapor extraction
TAAR	technology application analysis report
TCA	trichloroethane
TCE	trichloroethene
UBC	Uniform Building Code
UPRR	Union Pacific Railroad
USA	Underground Services Alert
VOC	volatile organic compound

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1.0 INTRODUCTION

This remedial action report (RAR) documents the construction of the on-base portion of Phase III of the interim remedial action for groundwater at the former McClellan Air Force Base (McClellan AFB), Sacramento County, California. The scope and purpose of the interim remedy is documented in the *Basewide Groundwater Operable Unit Interim Record of Decision for McClellan AFB* (GWOU IROD) (McClellan AFB, 1995, pp 21–22). The remedy has been implemented in a phased approach; see Section 2.0 of this RAR for a description of each phase. Phase III was constructed in off-base and on-base phases, as well.

The selected interim remedy for groundwater described in the GWOU IROD comprises groundwater extraction by pumping and surface treatment. The on-base portion of the Phase III expansion was designed to:

1. Control the on-base groundwater contaminant plumes by preventing further downgradient lateral migration off base and vertical migration to deeper monitoring zones;
2. Limit potential public exposure by halting the migration of volatile organic compounds (VOCs) toward drinking water sources (production wells) and reducing concentrations of contaminants of concern (COCs) in groundwater to maximum contaminant levels (MCLs); and
3. Complete capture of groundwater plumes that exceed State of California MCLs.

The Phase III on-base activities included the following:

- Installing 77 wells (32 extraction wells, 14 monitoring wells, and 31 piezometers);
- Upgrading 9 existing wells to Phase III extraction wells (conversion of 7 existing monitoring wells to operational extraction wells, conversion of 1 well to dual-phase operation, and rerouting of 1 well to the Groundwater Treatment Plant [GWTP]);
- Installing conveyance lines, well vaults, and electrical services for the wells;
- Modifying groundwater treatment systems to accommodate additional flow from Phase III extraction wells; and
- Collecting baseline and start-up/proveout samples from Phase III on-base extraction wells.

This RAR describes the implementation of the on-base portion of the Phase III groundwater remediation program. The work was performed in general accordance with the *GWOU Phase III Environmental Remediation Plan, On-Base Expansion* (On-Base ERP) (MWH Americas, Inc. [MWH], 2004a), the *On-Base Groundwater Phase III Implementation Construction Work Plan* (On-Base Work Plan) (URS Group, Inc., 2005a), and with requirements for the Phase III construction identified in the final *GWOU Phase III Sampling and Analysis Plan* (GWOU Phase III SAP) (CH2M HILL, 2003). Deviations from the On-Base ERP are discussed in this RAR.

1.1 Report Organization

The remainder of the RAR is organized as follows:

- Section 1.0 summarizes the base history, regulatory and enforcement site history, location, contaminants of concern, and project and report objectives.

- Section 2.0 summarizes the background and outline of the groundwater remediation program under the framework of the McClellan AFB GWOU IROD.
- Section 3.0 presents the work completed during the construction of the Phase III on-base groundwater wells and conveyance systems.
- Section 4.0 presents the chronological order of events completed during the Phase III on-base construction effort.
- Section 5.0 presents the performance standards and construction quality control measures implemented throughout the project.
- Section 6.0 presents final inspection and certification procedures.
- Section 7.0 summarizes operation and maintenance activities related to the new wells.
- Section 8.0 is a summary of project costs.
- Section 9.0 presents observations and lessons learned during the project.
- Section 10.0 lists contact information for the Phase III on-base construction effort.
- Appendices A though J provide data collected during the installation of Phase III on-base extraction wells, monitoring wells, and piezometers and for the treatment system modifications completed to accommodate additional flow at the McClellan AFB GWTP.
  - Appendix A—Cost and Performance Summary;
  - Appendix B—Phase III On-Base Extraction Well, Monitoring Well, and Piezometer Boring and Construction Logs;
  - Appendix C—Phase III On-Base Well Development Records, Mini-Step/Drawdown Tests Data Sheets, Construction Approval Logs, and Extraction Well Pump Sizing Sheets;
  - Appendix D—As-Built Drawings for Conveyance Lines, Vaults, Pull Boxes, and Electrical;
  - Appendix E—Baseline Analytical Sampling Data and Field Forms;
  - Appendix F—Analytical Data and Management of Investigation-Derived Waste;
  - Appendix G—Double-Blind Quality Assurance/Quality Control (QA/QC) Laboratory Proficiency Testing Program;
  - Appendix H—Inspection and Certification Documentation;
  - Appendix I—Survey Reports; and
  - Appendix J—Photographic Log.

1.2 Location and Setting

McClellan AFB is 7 miles northeast of downtown Sacramento, California (Figure 1-1). The base comprises approximately 3,000 acres and is bounded by the city of Sacramento on the west and southwest, the unincorporated areas of Antelope on the north, Rio Linda on the northwest, and North Highlands on the east (Figure 1-2).

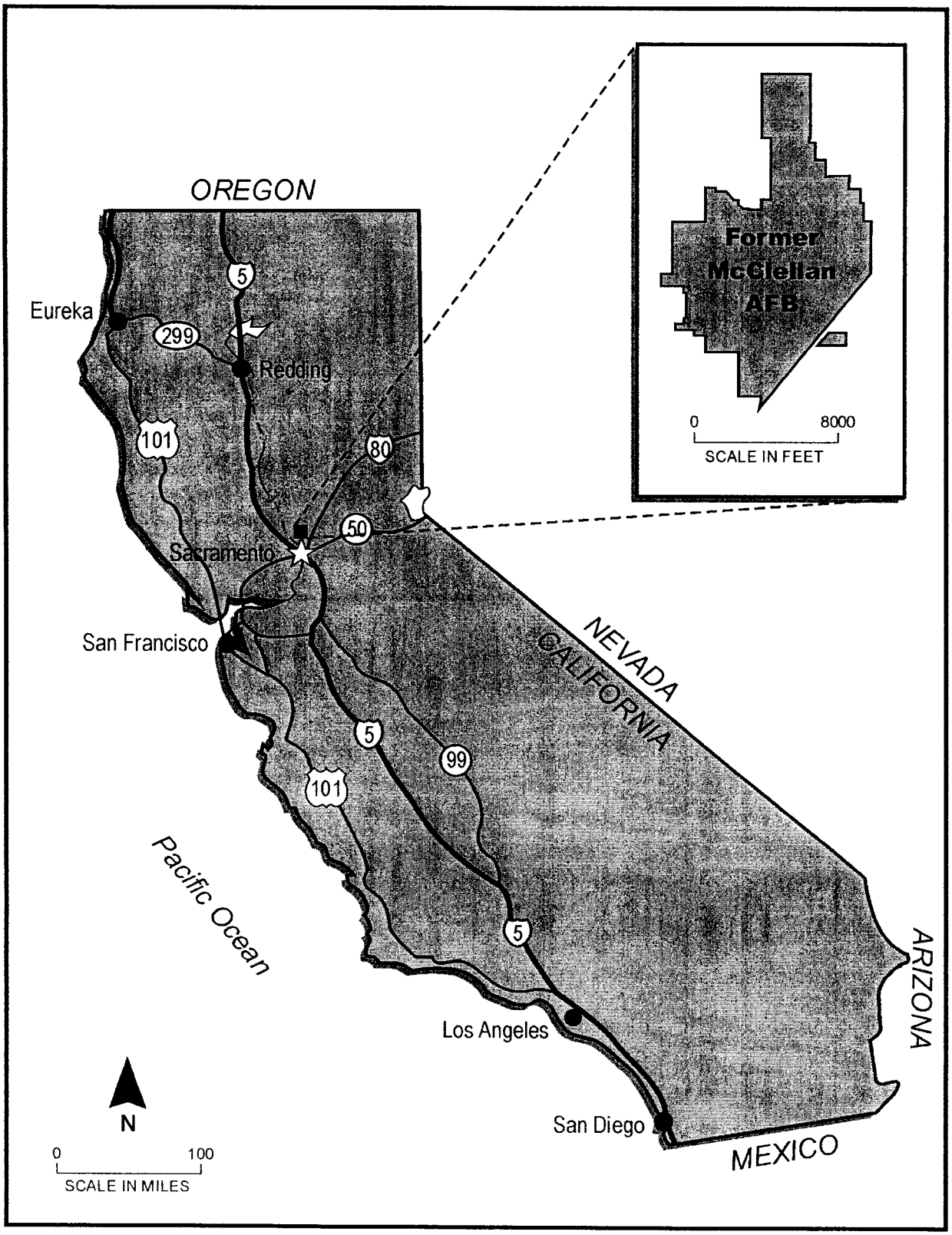
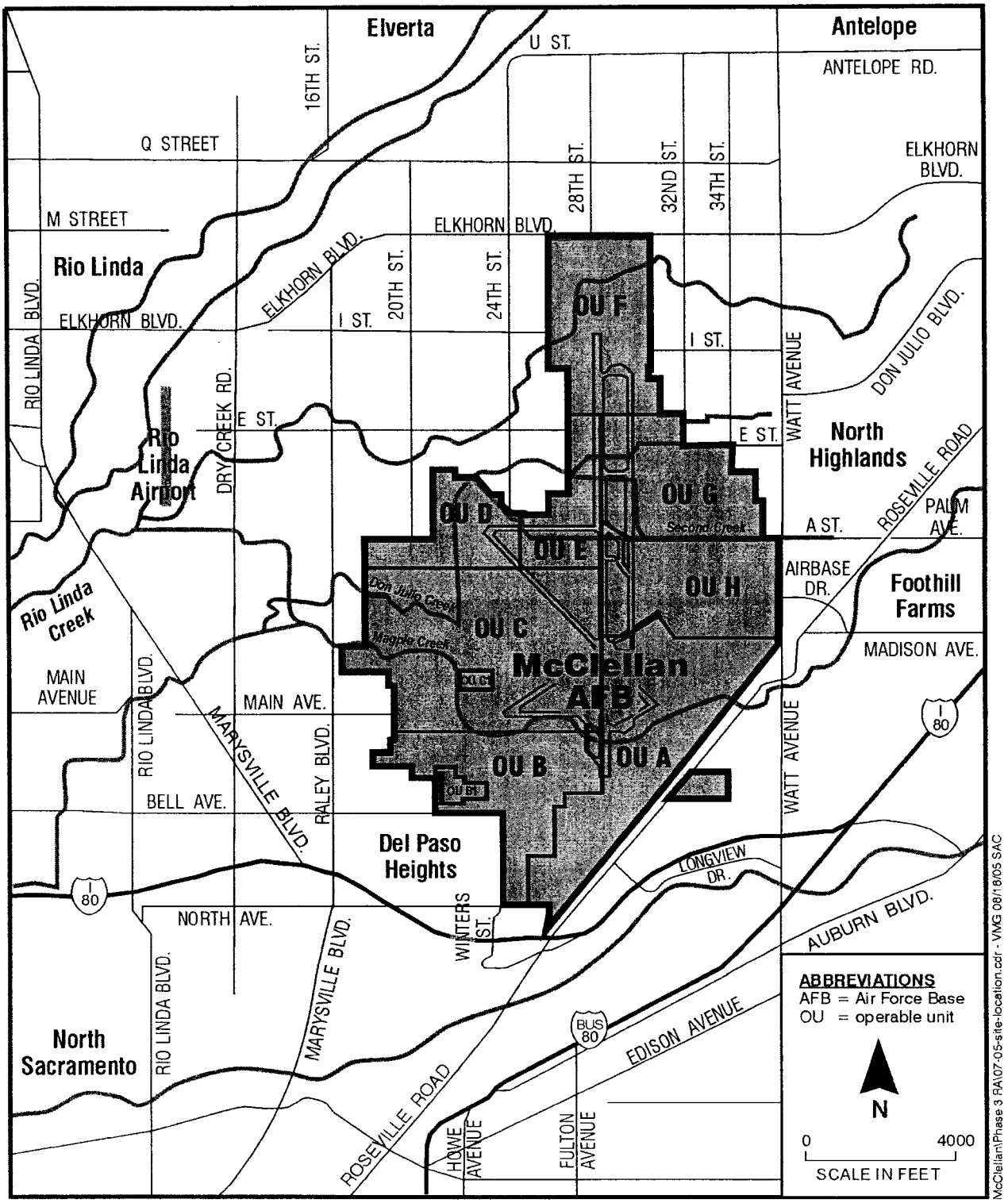


Figure 1-1. Regional Location Map, Former McClellan AFB



Sources: McClellan AFB, 1996; California State Automobile Association, 1993; Thomas Brothers Maps, 1994.

Figure 1-2. Site Location Map, Former McClellan AFB

1.2.1 Environmental Setting

Current land use at McClellan AFB is a combination of open grassland, industrial (aircraft operations/ maintenance), light industrial (warehouse, laboratories, support services), aircraft runways, taxiways and ramps, office buildings, schools, and residential uses. Most of the land surrounding McClellan AFB is zoned for low-density residential and agricultural use. Most residences are connected to municipal water supplies; however, some residences west of McClellan AFB have private water wells for irrigation. Land parcels designated for commercial, office, and industrial use are interspersed around McClellan AFB and include shopping centers, office complexes, and warehouses (CH2M HILL, 1999, Section 1.2.1, p 1-9).

Currently, most industrial facilities are located in the southeastern portion of McClellan AFB. The southwestern portion has both industrial and storage areas. The furthest western part of McClellan AFB has areas of environmentally sensitive vernal pools and wetlands. Between these wetlands and the taxiways, there is an undeveloped area that was historically used for disposal pits, as well as a series of engine test cells. In the northeastern area of McClellan AFB, there are parking areas and washracks; however, only one of the washracks is still in operation (MWH, 2005, Section 1.2.1, p 1-4). Land uses proposed in the Base Land Reuse Authority Conceptual General Reuse Plan are similar to current land uses (CH2M HILL, 1999, Subsection 1.2, pp 1-8–1-19). Additional information on the history and environmental setting is presented in the *Basewide Volatile Organic Compound Feasibility Study Report* (Basewide VOC Feasibility Study [FS] Report) (CH2M HILL, 1999, Section 1.2, pp 1-8–1-19) and in the *Interim Basewide Remedial Investigation Report, Part 1, General Framework* (URS Group, Inc., 2002, Section 2.0, pp 2-1–2-6).

Groundwater is encountered approximately 100 feet below ground surface (bgs). Groundwater flow beneath McClellan AFB is generally to the south-southwest. The vadose zone and the shallow groundwater zone, from about 100 feet to 150 feet bgs, are the zones most likely to be affected by contamination. The shallowest portion of the vadose zone to a depth of approximately 10 feet bgs comprises the Riverbank Formation. The deep vadose zone and the saturated zone have been identified as the shallowest portions of the Turlock Lake Formation. For remediation considerations, the groundwater zone under McClellan AFB has been subdivided into five monitoring zones (CH2M HILL, 1999, Subsection 1.3.1, p 1-21):

- Monitoring Zone A (105 to 125 feet bgs on the eastern boundary of McClellan AFB; 107 to 142 feet bgs on the western boundary).
- Monitoring Zone B (125 to 175 feet bgs on the eastern boundary; 142 to 205 feet bgs on the western boundary).
- Monitoring Zone C (175 to 245 feet bgs on the eastern boundary; 205 to 282 feet bgs on the western boundary).
- Monitoring Zone D (245 feet bgs to an unknown depth on the eastern boundary; 282 to 370 feet bgs on the western boundary).
- Monitoring Zone E (unknown depth on the eastern boundary; 370 to 422 feet bgs on the western boundary).

These zones vary in thickness from east to west, reflecting different depositional environments as ancient streams flowed across McClellan AFB from east to west or northeast to southwest. Additional information on site geology and hydrology is presented in the Basewide VOC FS Report (CH2M HILL, 1999, Subsection 1.3.1, pp 1-21–1-27).

1.2.2 Nature and Extent of Contamination

Since 1979, multiple investigations at McClellan AFB have identified and characterized VOCs in the soil, soil gas, and groundwater. VOCs constitute the most widespread and common contaminants at McClellan AFB. The most frequently encountered are trichloroethene (TCE) and tetrachloroethene (PCE), which contribute to the bulk of contaminant mass in some areas, but 1,1,1-trichloroethane (TCA), 1,1-dichloroethene (DCE), and carbon tetrachloride (CTCL) are frequently encountered in other areas (MWH, 2004b). Other detected VOCs include:

- cis-1,2-DCE;
- 1,1-Dichloroethane (DCA);
- Trichlorofluoromethane;
- Dichlorofluoromethane;
- trans-1,2-DCE;
- 1,2-DCA;
- Vinyl chloride;
- Chloroform;
- Methylbenzene;
- Xylenes; and
- Benzene.

An evaluation of the nature and extent of VOC contamination in groundwater identified 20 different compounds that were detected at concentrations greater than MCLs in monitoring zone A at McClellan AFB. The number of compounds exceeding MCLs decreases in the deeper monitoring zones. An evaluation of the average concentration of VOCs in groundwater indicates that contaminant mass could be estimated using only two compounds (TCE and 1,1-DCE). These two compounds account for approximately 90% of the organic contaminant mass in the A monitoring zone, and TCE alone accounts for between 80% and 100% of the organic contaminant mass in monitoring zones B, C, D, and E (CH2M HILL, 1999, Subsection 1.4.1.2, p 1-49).

1.2.3 Site Remediation History

Environmental investigations at McClellan AFB began in 1979 with the discovery of groundwater contamination. After reviewing data collected by McClellan AFB under the Installation Restoration Program, the United States Environmental Protection Agency (EPA) placed McClellan Air Force Base on the National Priorities List in 1987.

For the purpose of investigations, the base has been divided into 11 different operable units (OUs) (see Figure 1-2). Ten of these operable units encompass areas in which soil contamination may exist due to past hazardous waste handling and disposal practices. The eleventh operable unit, the GWOU, is defined as all the contaminated groundwater beneath the entire base, as well as any contaminated groundwater that has migrated beyond the base boundaries.

Groundwater remediation efforts are being guided by the GWOU IROD signed in 1995. The three-phased approach to the GWOU interim remedy was established to control the spread of groundwater contaminated with VOC concentrations greater than State of California MCLs. Remedial activities conducted

under Phases I, II, and III are described in Section 2.0. Currently, three groundwater extraction and treatment systems are in operation at the base. Other remedial activities at McClellan AFB include soil removal actions and the installation and operation of soil vapor extraction (SVE) systems. Table 1-1 presents a chronology of vadose zone and groundwater remedial response actions at McClellan AFB from 1979 to present.

TABLE 1-1

Remedial Response Actions to Date, Former McClellan AFB

Year	Response Action and Location	Type of Action (Medium)	Purpose of Action
1979	TCE discovered in groundwater; several on-base production wells (including BW-18) shut down.	Groundwater	Prevent possible exposure of residents and base employees to contamination through use of contaminated groundwater.
1980	On-base use of disposal pits curtailed.	Soil and Groundwater	Reduce the source of contamination to soil and groundwater.
1980	Investigation of contamination initiated.	Soil and Groundwater	Determine cause of contamination.
1981	All on-base disposal of industrial wastewater sludge halted.	Soil and Groundwater	Reduce the source of contamination to soil and groundwater.
1981–1984	BW-18 taken out of service.	Groundwater	Prevent possible exposure of residents to contamination through use of contaminated groundwater.
1981–1993	On-base and off-base wells decommissioned.	Groundwater	Prevent possible migration of contaminants to deeper zones.
1982	Base well sealing investigation conducted.	Groundwater	Prevent possible exposure of residents to contamination through use of contaminated groundwater and to prevent possible migration of contaminants to deeper zones.
1982–1985	Bottled water provided to residents.	Other	Prevent possible exposure of residents to contamination.
1983	Organic and inorganic compounds in shallow water-bearing zones detected.	Groundwater	Determine the nature and extent of contamination in the shallow water-bearing zones.
1984	On-base and off-base monitoring wells installed.	Groundwater	Aid in determination of extent of contamination.
1984–1987	Quarterly sampling of off-base wells conducted.	Groundwater	Aid in determination of extent of contamination.
1984–1986	Site characterization of Areas A, B, C, and other areas conducted.	Soil and Groundwater	Aid in determination of extent of contamination.
1985	Carbon treatment system installed at BW-18, and the well reactivated as a production well.	Groundwater	Remove VOCs from water pumped by well. Allows well to be used as production well.
1987	Five hundred fifty off-base residents west of McClellan AFB connected to municipal water supply.	Groundwater	Contaminants had been detected in 13 off-base wells; connected to municipal water supply to prevent possible exposure to contaminants.

TABLE 1-1

(Continued)

Year	Response Action and Location	Type of Action (Medium)	Purpose of Action
1986 to present	Quarterly Groundwater Sampling and Analysis Program initiated (changed to Groundwater Monitoring Program in 1996).	Groundwater	Aid in determination of extent of contamination and evaluation of effectiveness of remediation efforts.
1987	Area D extraction system and groundwater treatment plant operation started.	Groundwater	Contain and treat contaminated groundwater.
1988	Area C extraction system operation started.	Groundwater	Contain and treat contaminated groundwater in Area C.
1990	Two extraction wells with local treatment installed at Building 666 in OU B.	Groundwater	Remediate groundwater and prevent plume of contaminated groundwater from reaching BW-18.
1991–1995	Fourteen production wells on McClellan AFB decommissioned.	Groundwater	Prevent possible migration of contaminants to deeper zones.
1992	Additional OU B extraction wells added; groundwater from three extraction wells piped to the GWTP.	Groundwater	Prevent contaminated groundwater from migrating off base.
1993	SVE (treatability study) initiated in Site S (OU D).	Vadose Zone	Remove VOC contamination from soils to prevent further migration of contaminated soil gas.
1994–1995	2-Phase extraction system replacing two groundwater-extraction-only wells (OU B) installed.	Vadose Zone, Groundwater	Increase the rate of contaminant removal from the vadose zone, capillary fringe, and groundwater, thereby preventing migration to potable water source.
1995	Sixteen extraction wells installed in OUs A, B, and C.	Groundwater	Implement Phase I Groundwater Remedy to contain and treat contaminated groundwater.
1995	Dual-phase extraction well in IC 1 (OU B) installed.	Groundwater	Implement Phase I, IC 1 hot spot containment.
1995	SVE initiated in OU B (ICs 1 and 7) and OU C1.	Vadose Zone	Remove VOC contamination from soils and prevent further migration of contaminated soil gas.
1996	SVE initiated at IC 31 (OU A).	Vadose Zone	Remove VOC contamination from soils and prevent further migration of contaminated soil gas.
1996	Treatment systems at Buildings 336, 341, and 621 installed.	Groundwater	Remediate groundwater and prevent plume of contaminated groundwater from migrating off base.
1997	SVE initiated at IC 19 (OU C).	Vadose Zone	Remove VOC contamination from soils and prevent further

TABLE 1-1

(Continued)

Year	Response Action and Location	Type of Action (Medium)	Purpose of Action
			migration of contaminated soil gas.
1997	SVE initiated at IC 23 (OU A).	Vadose Zone	Remove VOC contamination from soils and prevent further migration of contaminated soil gas.
1996–1997	Dual-phase extraction system at IC 29 (OU A) installed.	Vadose Zone, Groundwater	Increase the rate of contaminant removal from the vadose zone, capillary fringe, and groundwater, thereby preventing migration to potable water source.
1998	SVE initiated at SA 67 in IC 29 (OU A).	Vadose Zone	Remove VOC contamination from soils and prevent further migration of contaminated soil gas.
1998–1999	Twenty-four extraction wells installed in OUs A, B, and C.	Groundwater	Implement Phase II Groundwater Remedy to contain and treat contaminated groundwater.
1999	2-Phase extraction system shut down.	Vadose Zone, Groundwater	Send groundwater from EW-233 to the GWTP.
1999	GWTP modified with new air stripper and off-gas treatment unit.	Groundwater	Increase capability to treat up to 2,000 gpm from groundwater.
1999	SVE initiated at IC 27 (OU A).	Vadose Zone	Remove VOC contamination from soils and prevent further migration of contaminated soil gas.
1999	SVE dual-phase extraction initiated at IC 35 (OU A).	Vadose Zone, Groundwater	Remove VOC contamination from soils and prevent further migration of contaminated soil gas.
1999	SVE initiated at PRL T-44 (OU G).	Vadose Zone	Remove VOC contamination from soils and prevent further migration of contaminated soil gas.
2000	SVE initiated at IC 30, IC 32, IC 34, IC 37, IC 41, IC 42, and IC 43 (all in OU A).	Vadose Zone	Remove VOC contamination from soil and prevent further migration of contaminated soil gas.
2001	SVE initiated at IC 5 (OU B), PRL 66B (OU C), IC 25 (OU A), SSA 2 (OU B), and PRL S-13 (OU B)	Vadose Zone	Remove VOC contamination from soils and prevent further migration of contaminated soil gas.
2001	Two base production wells (BW-18 and BW-29) decommissioned.	Groundwater	Prevent possible migration of contaminants to deeper zones.
2001	EW-309 in the D monitoring zone shut down.	Groundwater	Concentrations of VOCs in groundwater no longer exceed MCLs.

TABLE 1-1

(Continued)

Year	Response Action and Location	Type of Action (Medium)	Purpose of Action
2002 and 2003	GWOU Phase III data gaps investigation conducted.	Groundwater	Complete the identification of the vertical and lateral extent of contamination at or exceeding MCL levels in preparation for Phase III extraction.
2003	Time-critical removal action for hexavalent chromium in groundwater completed with the installation of an ion exchange system.	Groundwater	Treat/remove hexavalent chromium from extracted groundwater at GWTP to ensure NPDES permit limits are met. (Time-critical removal action is complete; ion exchange system is now part of the GWTP.)
2003	GWOU Phase III sampling and analysis plan submitted.	Groundwater.	Outline the approach for installing the extraction well and performance well network to achieve the objectives specified in the GWOU interim ROD.
2003	Guard wells around BW-10 installed.	Groundwater	Assess potential threats to groundwater at BW-10 location.
2003	MW-18D, MW-459, MW-492, MW-493, and DG-03 decommissioned.	Groundwater	Decommission groundwater wells that are dry or no longer needed for the Groundwater Monitoring Program.
2003	Data gap wells (48 on-base and 22 off-base locations) installed.	Groundwater	Monitor groundwater quality in key locations.
2003	UV/OX system to treat 1,4-dioxane at the GWTP restarted.	Groundwater	Meet discharge requirements for 1,4-dioxane from the GWTP.
2004	Two monitoring wells installed.	Groundwater	Replace well MW-394.
2004	Six Phase III extraction wells installed	Groundwater	Increase ability to contain VOC-contaminated groundwater.
2004	Three extraction wells in OU D rehabilitated.	Groundwater	Restore extraction capacity to maintain capture in OU D.
2004	Seventeen additional monitoring wells installed.	Groundwater	Monitor groundwater quality in key locations.
2004	Long Pond (PRL 051) re-engineered.	Groundwater	Reconfigure Long Pond for use during GWTP start up.
2005 (planned)	BW-23, EW-233, EW-298, and MW-394 will be decommissioned.	Groundwater	Decommission groundwater wells that are no longer functional or no longer needed for the Groundwater Monitoring Program.
2005 (planned)	Remaining Phase III extraction wells and conveyance pipelines will be installed.	Groundwater	Increase ability to contain VOC-contaminated groundwater.

TABLE 1-1

(Continued)

Year	Response Action and Location	Type of Action (Medium)	Purpose of Action
2005 (planned)	EW-367, currently treated by the IC 23 DPE system, will be plumbed to the GWTP rather than the sanitary sewer (part of Phase III).	Groundwater	Reduce discharge of treated groundwater to the sanitary sewer.

BW = base well
DPE = dual-phase extraction
gpm = gallons per minute
GWOU = groundwater operable unit
GWTP = groundwater treatment plant
IC = investigation cluster
MCL = maximum contaminant level
NPDES = National Pollutant Discharge Elimination System
OU = operable unit
PRL = potential release location
ROD = record of decision
SA = study area
SSA = special study area
SVE = soil vapor extraction
TCE = trichloroethene
UV/OX = ultraviolet/oxidation
VOC = volatile organic compound

Sources:

Air Force Real Property Agency, 2004. *Basewide VOC Groundwater Record of Decision for Industrial Reuse, Former McClellan Air Force Base*. Draft. November
CH2M HILL, 1999. *Basewide Volatile Organic Compound Feasibility Study Report*. Final. January.
Radian International, 1999. *Base Realignment and Closure (BRAC) Cleanup Plan*. Final. April.

2.0 GWOU REMEDIATION HISTORY

The GWOU comprises all of the contaminated groundwater beneath the entire base, together with any contaminated groundwater that has migrated beyond McClellan AFB boundaries (CH2M HILL, 2003, Section 2.3, p 2-2). This section describes the GWOU remediation history.

2.1 GWOU IROD

In 1995, recognizing that information on the nature and extent of groundwater contamination was insufficient to support a final groundwater record of decision (ROD), the Air Force issued the GWOU IROD (McClellan AFB, 1995). The purpose of the IROD was to establish remedial action cleanup goals for groundwater that would be protective of public health and the environment. Implementation of the IROD was designed to capture and contain all groundwater with contaminant concentrations that exceed MCLs derived from McClellan AFB activities that exceed the MCLs, thereby preventing future lateral and vertical migration of the contaminant plumes. The selected remedy described in the IROD comprises the following (McClellan AFB, 1995, Section C.2, p 2):

- **Containment:** Groundwater contaminated at concentrations greater than MCLs will be extracted at pumping rates that prevent its further migration, contain the hot spots, and prevent vertical downward migration. Eventually, all groundwater will be contained so that no water with COC concentrations greater than California MCLs will leave the base boundaries. Groundwater extraction wells will be located in areas with the highest contaminant concentrations (hot spot/sources).
- **Treatment:** Groundwater extracted will be treated at the existing GWTP located on the west side of the base. The GWTP removes the VOCs from the water by air stripping followed by liquid-phase granular activated carbon (LGAC) polishing. The air stripper off-gas is treated by thermal oxidation.

The IROD also contains an objective addressing end-use of treated groundwater, but the final decision on end-use was deferred to the final groundwater ROD.

2.2 IROD Implementation

The IROD outlines a three-phased approach to implement the remedy, each phase being planned and executed to further the containment and remediation of groundwater. Phases I and II are complete. The effort completes the implementation of Phase III.

- **Phase I:** In 1987, a total of 15 extraction wells and 39 monitoring wells were installed to implement Phase I. Extraction wells were installed in hot spot areas in an effort to contain contaminant mass. In addition, extraction wells were installed along the eastern side of the base to capture contaminated groundwater and to prevent it from migrating off base. Phase I also included the installation of extraction wells in OU B and OU C in the C and D monitoring zones (URS Group, Inc., 2005c).
- **Phase II:** In 1999, an additional 24 extraction wells and 21 monitoring wells were installed (URS Group, Inc., 2005c). The extraction wells aid in containing contaminant migration, and the monitoring wells aid in defining the extent of contamination.
- **Phase III:** Phase III consisted of a data gap investigation and two phases of construction (on-base and off-base). The Phase III data gap investigation was executed in two stages during 2002 and 2003, and was designed to complete the identification of the vertical and lateral extent of contamination at or exceeding MCLs in preparation of Phase III expansion.

The Phase III design (off-base and on-base) included the installation of 38 extraction wells, 14 monitoring wells, and 32 piezometers. The off-base construction stage focused on Phase III extraction wells deemed most critical to preventing further migration of contaminants beyond the former base boundaries. As part of that effort, six extraction wells and one piezometer were installed during the Phase III off-base construction effort in June 2004. The on-base construction effort concludes the construction of the remaining Phase III extraction wells. The implementation of the Phase III on-base construction effort is discussed in Section 2.3.

2.3 Phase III On-Base Implementation

The design for the Phase III on-base extraction wells presented in the On-Base ERP (MWH, 2004a) initially included a total of 55 groundwater extraction wells (20 of which were optional and 6 of which were dual-phase extraction wells), 17 monitoring wells (5 of which were optional), and 33 piezometers (4 of which were optional). After evaluating the 60% on-base design document, the Air Force decided to install 32 of the proposed extraction wells, 14 monitoring wells, and 31 piezometers. Additionally, the Air Force decided to upgrade 9 existing wells. The Air Force reserved the option to install optional wells at a later time, as an optimization effort, if field conditions show those wells are warranted to meet IROD requirements. The On-Base Work Plan describes the work that was to be performed as part of this effort and the technical approach taken (URS Group, Inc., 2005a). Section 3.0 of this RAR describes the on-base construction effort in detail.

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General Comments						
1.				EPA (Martin Zeleznik)	EPA has no comments on this document.	No response required.
1.				CV-RWQCB (James D. Taylor)	Regional Water Quality Control Board (Regional Board) staff reviewed the subject document (Report), submitted 14 November 2005. The purpose of the Report is to present the implementation of the on-base portion of the Phase III groundwater remediation program. The on-base portion of the Phase III expansion is designed to expand control of on-base groundwater contaminant plumes in operable units (OUs) A, B, C, G, and H. The Phase III on-base activities included the following: 1) installation of 32 extraction wells, 14 monitoring wells, 31 piezometers, and the conversion of 9 additional wells, including conversion of 7 existing monitoring wells to operational extraction wells, conversion of 1 well to dual-phase operation, and rerouting of 1 well to the groundwater treatment plant (GWTP); 2) installation of over 24,000 feet of conveyance lines, 39 well vaults, and over 41,000 feet of electrical conduit for the wells; 3) modifying the existing operation and control system, which includes the supervisory control and data acquisition system, and; 4) collecting baseline and start-up proveout samples from Phase III on-base extraction wells. We have reviewed the comments on the Report provided by the Department of Toxic Substances Control (Memorandum dated 14 December 2005 by Mr. Harold Duke), and we concur with these comments. We have no further comments on the Report.	No response required.

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1.				DTSC (Kevin Depies)	The Department of Toxic Substances Control (DTSC) has reviewed the *Groundwater Operable Unit Phase III Remedial Action Report On-Base Construction Effort,* Former McClellan Air Force Base (McAFB), Sacramento, California, dated November 2005. Draft comments (DSR 875-2) are attached (memorandum from Mr. Howard Duke) and are being provided electronically to meet the review schedule. Please consider Mr. Duke's recommendations as comments on the document. Final comments are anticipated to be distributed in approximately three weeks.	No response required.
1.				GSU (Howard R. Duke)	Based on a review of the Phase III On-Base ERP, GSU understands that in addition to step drawdown tests on each extraction well, long-term aquifer tests were to be conducted on eight Phase III extraction well locations. The information obtained from the long-term aquifer tests was to be used to improve the predictive capabilities of the McClellan groundwater model, provide data to estimate the hydraulic characteristics of the aquifer in vicinity of the well, and aid in the selection of an appropriate pumping rate at which to operate the well. The GSU notes the inclusion of the test logs and data sheets and a discussion of the step-drawn tests conducted at each extraction well in the Phase III On-Base RAR, however there is no reference to the proposed long-term aquifer tests. (cont'd)	The final version of the Phase III On-Base ERP included long-term aquifer testing as indicated in the comment; however, the final contract for the on-base implementation project did not include long-term aquifer testing in the scope of work. As a result, long-term aquifer testing was not conducted during the field effort. The Phase III RAR includes information about the completed construction field effort items included in the scope for the Phase III field effort. Sufficient aquifer test data exist and were included in the original groundwater flow model to calibrate it. The flow model was recalibrated as part of a separate effort during development of the fate and transport model, and hydraulic conductivity distributions correlate well with the aquifer test (cont'd)

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1. (cont'd)				GSU	(cont'd) **GSU Recommendation #1:** **The GSU recommends the Phase III On-Base RAR be revised to address the lack of a reference to the long-term aquifer tests proposed in the Phase III On-Base ERP.**	(cont'd) results. In addition, the performance of the Phase III extraction wells will be evaluated over time to evaluate capture. The groundwater flow model and fate and transport model may be used in the future to optimize flow rates. However, additional data from aquifer testing is not currently needed for these purposes.
					Based on a review of the Phase III On-Base WP, GSU's understands that soil gas samples were to have been collected from the boring advanced for proposed extraction well P3OBEW1AB at 10 foot intervals from 10 feet below ground surface (bgs) to 100 feet bgs to characterize soil gas composition throughout the vadose zone. The GSU sees no reference to the proposed soil gas sampling in the Phase III On-Base RAR. Well P3OBEW1AB was located in an area off-base suspected to have been impacted by historic McAFB activities. Soil gas data from well P3OBEW1AB was to be used to characterize contamination as well as to aid the design of remedial alternatives. **GSU Recommendation #2:** **The GSU recommends revising the Phase III On-Base RAR to address the lack of a reference to the soil gas sampling proposed in the Phase III On-Base WP.**	The following text has been added to the report in the first paragraph, page 3-11, to further explain that soil gas samples were collected at P3OBEW1AB for soil gas characterization: *To characterize the soil gas beneath the Taco Bell parking lot as per the Phase III On-Base ERP, soil gas samples were collected at P3OBEW1AB from 10 to 100 feet bgs prior to installing extraction well EW-455. The soil gas results are scheduled to be included in the 4Q05 SVE Quarterly Reports.*

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Specific Comments						
1.	5.1 (Overall Performance)	5-1	Para 1 Sentence 4	GSU	It is noted here that "All extraction wells installed were able to produce their designed flow rate". Based on a review of the Extraction Well Pump Sizing forms included in Appendix C, it appears that for three of the existing wells converted during the Phase III activities to extraction wells (EW-330, EW-383, and EW-337) that pumping rates proposed in the Phase III On-Base RAR (and included in the groundwater flow model) could not be achieved. In addition, although the proposed pumping rate provided in the Phase III On-Base WP (10 gallons per minute [gpm]) was achieved for Phase III extraction well P30BEW1AB (EW-455), a higher pumping rate (15 gpm) was applied for this well in the groundwater model as presented in the Final GWOU Phase III ERP. The GSU questions whether modeling was conducted to show that capture of the contaminant plume would be attained at a pumping rate of 10 gpm in extraction well EW-455. **GSU Recommendation #3:** **The GSU recommends revising the Phase III On-Base RAR to include a discussion of the consequences of the disparity between the proposed and actual pumping rates for extraction wells EW-330, EW-383, EW-337, and EW-455, and the ability to capture and control all groundwater plumes that exceed State of California MCLs, with particular attention paid to well EW-455.**	The production rates of the 32 newly installed extraction wells, per the pump sizing forms in Appendix C, met or exceeded the design production rates indicated in the final Phase III On-Base ERP. Three wells, as indicated in Comment 1, could not attain the rates stated in the design document. The well testing, as documented in Appendix C, was conducted to evaluate well performance and thereby confirm the pump size specified in the design. Testing was not performed to evaluate capture or provide modeling data. Modeling and capture were not considerations during this construction effort. A discussion of the capture of which the extraction wells are capable is beyond the scope of this document. However, after startup of the Phase III wells, the pumping rates of all of the extraction wells were checked as part of the ongoing O&M project and were adjusted, if necessary, to ensure the entire system operated optimally. For clarity, the sentence, "All extraction wells installed were able to produce their designed flow rate," has been changed to read *Each of the 32 newly installed extraction wells is capable of producing its design flow rate.*

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2.	Table 3-1			GSU	**Well Construction Details:** The screen slot size presented for well EW-431 in Table 3-1 (0.020 inch) does not match the screen slot size presented for this well in Table 3-2 (0.010 inch). **GSU Recommendation #4:** **The GSU recommends revising the Phase III On-Base RAR such that Tables 3-1 and 3-2 are in agreement and accurately presents the constructed screen slot size for well EW-431.**	Table 3-1 was corrected for EW-431 (0.02 to *0.01*), EW-439 (0.02 to *0.02/0.01*), and EW-462 (0.01 to *0.02*).
3.	Table 3-2			GSU	**Variations in Construction of Extraction Wells:** As presented in Table 3-2, no explanation is given for the variance from the proposed screen slot size for extraction wells EW-431 and EW-456 (0.010 inch rather than the proposed 0.020 inch). Also, as dielectric couplers were not installed on extraction wells EW-499 through EW-453 and EW-456, these wells will need to be especially scrutinized in the future to detect potential corrosion problems. **GSU Recommendation #5:** **The GSU recommends revising the Phase III On-Base RAR to include in Table 3-2 a reference to the reason for the variation in screen slot size for wells EW-431 and EW-456 from that originally proposed. In addition, special attention during future monitoring events will need to be given to wells EW-499 through EW-453 and EW-456 to look for signs of corrosion due to the lack of dielectric couplers on these wells.**	Screen slot size was removed from Tables 3-2 through 3-4, which describe variations from proposed well construction specifications for extraction wells, monitoring wells, and piezometer wells, respectively. The choice of either 0.010- or 0.020-inch screen slot sizes is not a variation from design, but the prerogative of the contractor based on lithology encountered at the depth of the proposed screen interval. The wells were accepted by the Air Force and regulatory agencies prior to demobilization from the field effort. The joint at which the dielectric couplers were to be installed exists above the groundwater level for each well. This reduces the potential of corrosion and was determined to be low risk; however, if necessary, the wells could be checked for corrosion at a later time by the McClellan AFB Groundwater Monitoring Program.

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4.	Table 3-3			GSU	**Variations in Construction of Monitoring Wells:** As presented in Table 3-3, no explanation is given for the variance from the proposed screen slot size for monitoring wells MW-580 through MW-583 and MW-588 (0.010 inch rather than the proposed 0.020 inch). **GSU Recommendation #6:** **The GSU recommends revising the Phase III On-Base RAR to include in Table 3-2 a reference to the reason for the variation in screen slot size for wells MW-580 through MW-583 and MW-588 from that originally proposed.**	Screen slot size was removed from Tables 3-2 through 3-4, which describe variations from proposed well construction specifications for extraction wells, monitoring wells, and piezometer wells, respectively. The choice of either 0.010- or 0.020-inch screen slot sizes is not a variation from design, but the prerogative of the contractor based on lithology encountered at the depth of the proposed screen interval.