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Record of Decision:

Castle Air Force Base (6 Areas)
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Final Record

of

Decision

Comprehensive Basewide Program-Part 1
(Groundwater)

Castle Air Force Base

31 January 1997

FINAL RECORD OF DECISION
COMPREHENSIVE BASEWIDE PROGRAM-PART 1 (GROUNDWATER)
CASTLE AIR FORCE BASE

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Reference List for Castle Air Force Base
Comprehensive Basewide-Part 1 Record of Decision

1. Castle Air Force Base Draft Comprehensive Basewide Groundwater Remedial Investigation/Feasibility Study - Part 1, Jacobs Engineering Group Inc., December 21, 1995.

2. Castle Air Force Base Final Comprehensive Basewide Groundwater Remedial Investigation/Feasibility Study - Part 1, Jacobs Engineering Group Inc., June 12, 1996.

3. Interim Record of Decision, Operable Unit No. 1, Castle Air Force Base, Merced County, California, August 7, 1991.

4. Record of Decision, Operable Unit No. 2, Castle Air Force Base, Merced County, California, November 1993.

5. Interim Guidance on Preparing Superfund Decision Document: The Proposed Plan, the Record of Decision, the Explanation of Significant Difference, the Record of Decision Amendment, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, EPA/540/G-007, July 1989.

6. The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board Central Valley Region, The Sacramento River Basin and the San Joaquin River Basin, Third Edition, 1994.

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FINAL RECORD OF DECISION

CASTLE AIR FORCE BASE

COMPREHENSIVE BASEWIDE PROGRAM-PART 1

1.0 INTRODUCTION

This decision document presents the remedial actions (RAs) selected for the comprehensive cleanup of groundwater at the formerly active Castle Air Force Base (AFB), Merced County, California. The RAs under this Comprehensive Basewide Program-Part 1 (CB-Part 1) are being carried out to complete the cleanup of all groundwater plumes at Castle AFB as the first of a two part process leading to the final comprehensive cleanup of all soil and groundwater contamination at the site (CB-Part 2).

The selected RAs for CB-Part 1 were developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). These decisions, documented herein, are based on the information contained in the Administrative Record File for Castle AFB. The Administrative Record Index (Appendix A) identifies documents that were considered or relied upon to make these decisions.

The purpose of this Record of Decision (ROD) is to decide the appropriate level of groundwater remediation necessary to protect human health and the environment, and to determine what requirements are applicable or relevant and appropriate requirements (ARARs) based on the groundwater beneficial use designation and site-specific conditions.

This ROD has been divided into five sections to address the selected RAs for groundwater remediation at Castle AFB. These five sections are:

- Section 1.0 Introduction. This section serves as an overall introduction to the ROD.
- Section 2.0 Declaration For The Record of Decision. This section documents the Ras selected for groundwater cleanup at Castle AFB and serves as an abstract for the key information contained in the ROD. It provides signatures of concurrence by the U.S. Air Force (AF), the U.S. Environmental Protection Agency (EPA), and the State of California Environmental Protection Agency (Cal/EPA).
- Section 3.0 Decision Summary. This section provides an overview of the site characteristics, the alternatives evaluated, and the analysis of those options. It also identifies the selected remedy and explains how the remedy fulfills statutory requirements.
- Section 4.0 Listing of Applicable or Relevant and Appropriate Requirements (ARARs) and To-Be-Considereds (TBCs). This section describes the Federal and State ARARs required to be complied with under this ROD.
- Section 5.0 Responsiveness Summary. This section contains a summary of comments received during the public comment period and responses to those comments. In addition, a summary of agency comments on the Preliminary Draft and Draft Final ROD, and responses to these comments, are included. The Responsiveness Summary can be found at Tab 5.

Appendix A provides the Administrative Record Index and can be found at Tab 6. Figures and tables referenced in the ROD can be found at Tabs 7 and 8, respectively.

2.0 DECLARATION FOR THE RECORD OF DECISION

This section documents the RAs selected for groundwater cleanup at Castle AFB and serves as an abstract for the key information contained in the ROD. It provides signatures of concurrence by the AF, the EPA, and the Cal/EPA.

For the groundwater plumes selected for RAs under CB-Part 1, the following determinations are in effect:

- Statutory Preference for Treatment as a Principal Element is Met and a Five-Year Review is Required for the Main Base and Castle Vista Plumes.
- Statutory Preference for Treatment as a Principal Element is Not Met and a Five-Year Review is Required for the East Base Plume.

2.1 SITE NAME AND LOCATION

Castle AFB (currently known as Castle Airport) is a National Priorities List (NPL) Site located in Merced County, California.

2.2 STATEMENT OF BASIS AND PURPOSE

This ROD presents and documents the RAs selected for the cleanup of groundwater at Castle AFB. CB-Part 1 is intended to address the full range of contaminated groundwater under both the Castle AFB site and the contiguous areas where contaminated groundwater has migrated off base.

The objective of the Castle AFB CB-Part 1 RAs is to capture the contaminated groundwater plume(s) within the Maximum Contaminant Level (MCL) boundary of the most restrictive contaminant present, and clean up the contaminated groundwater to MCL levels. This ROD supersedes previous groundwater RODs (i.e., the Operable Unit (OU) 1 Interim ROD and the OU 2 ROD), and the ongoing and planned actions under these two prior RODs are integrated into the selected remedy for the comprehensive cleanup of Castle AFB groundwater contamination.

These RAs were chosen in accordance with the CERCLA, as amended by the SARA (42 U.S.C. Section 9601 et seq.,) and, to the extent practicable, the NCP (40 Code of Federal Regulations (CFR) Part 300). The Castle AFB CB-Part 1 ROD is based on information contained in the Administrative Record. An Administrative Record Index (Attachment A) identifies the documents upon which the decision is based. The Cal/EPA and the EPA concur on the selected remedy.

2.3 ASSESSMENT OF THE SITE

The contamination of groundwater at Castle AFB was investigated under the Castle AFB Installation Restoration Program (IRP) and is described and evaluated in the CB-Part 1 Remedial Investigation/Feasibility Study (RI/FS). As a result of past AF operations conducted between 1941 and 1995, groundwater contamination exists at Castle AFB. Contamination affects groundwater beneath the base and extends to off-base areas in the immediate vicinity of the base. The main sources of contamination include industrial activities, equipment maintenance, landfill disposal, and fuels storage and delivery.

The IRP at Castle AFB resulted in the identification and characterization of numerous potential sources of groundwater contamination, and the division of the contaminated areas into three OUs.

Two of these OUs, OU 1 and OU 2, were location-specific areas representing groundwater contamination, and the third OU, known as the Source Control Operable Unit (SCOU) was defined to address soil contamination at a wide variety of locations.

The CB program was subsequently defined to provide a comprehensive approach to groundwater and soil cleanup, with the CB-Part 1 dealing with all groundwater contamination at Castle AFB. Under CB-Part 1, seven plume regions were identified and evaluated in the CB-Part 1 RI/FS. Two of these (Main Plume Regions 1 and 2) correspond to the OU 1 and OU 2 areas, and are collectively referred to as the Main Base Plume. The other plume regions evaluated are East Base Plume, Castle Vista Plume , North Base Plume, Landfill 1 Plume, and Landfill 4 Plume.

Although groundwater cleanup actions are underway at Castle AFB in the OU 1 and OU 2 areas, there are additional areas of groundwater contamination that are not currently being addressed under these OUs. Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response actions selected in this ROD, may present a current or potential threat to public health, welfare or the environment.

2.4 DESCRIPTION OF THE REMEDY

The CB-Part 1 RI/FS considered all groundwater contamination plumes at Castle AFB and performed detailed analyses of potential remedial options to clean up elevated levels of Trichloroethylene (TCE) and other contaminants for two of the plumes. The two plumes evaluated in detail are the Main Base Plume and the East Base Plume. In addition, further action was recommended in the RI/FS for the Castle Vista Landfill Plume, although detailed analyses were not carried out. Table 2-1 provides a summary of the remediation decisions for groundwater plumes at Castle AFB.

The Main Base Plume regions contain most of the TCE present in the groundwater beneath Castle AFB. The bulk of the contamination will be captured by a currently-operating system (OU 1), a system that is scheduled to begin operating in 1996 (OU 2), and planned enhancements and expansion of the OU 1 system. A pump and treat approach, building on the existing and planned OU 1 and OU 2 systems, was recommended in the RI/FS and is the selected remedy for the Main Base Plume.

The East Base Plume consists of a TCE-plume region associated with a source known as Fire Training Area 1 (FTA-1), and an isolated area of contamination east of the main runway that may be associated with the Main Base Plume. The remedy for the East Base Plume is the sealing and abandonment of wells to protect against further cross contamination of groundwater zones and monitoring to develop a more complete definition of the plume. The need for future active remediation (i.e., pump and treat) will be determined through an annual reevaluation of the monitoring information, in accordance with trigger language established in this ROD.

The Castle Vista Plume was not identified in the RI/FS for RA, but has been included for active remediation because of additional data from data gap wells. This data indicates that groundwater contamination exceeds MCLs and presents a greater extent of contamination than was previously evaluated in the RI/FS. Because of this new information, an active pump and treat remedy, similar to that of the Main Base Plume, has been selected as a presumptive remedy for this plume.

No further active remediation is planned for the other remaining plume areas.

2.4.1 Selected Remedy: Main Base Plume. The selected remedy for the Main Base Plume consists of plume capture and treatment to achieve groundwater cleanup to the MCL, implemented with a phased approach; this remedy includes and integrates the ongoing and planned remedial activities authorized in the OU 1 Interim ROD and the OU 2 Final ROD. The phased approach was chosen in

order to collect technical information from operation of OU 1 and OU 2 systems and the Long-Term Groundwater Sampling Program (LTGSP). This information will be used as input to the evaluation of technical and economic factors associated with the design of subsequent system expansion.

The selected remedy for the Main Base Plume consists of the following three sequential phases of pump and treat groundwater remediation:

Phase 1: The first phase takes advantage of existing OU 1 treatment capacity, to expand the treatment of groundwater in the OU 1 area to remove TCE and control migration of TCE "hot spots" in the shallow hydrostratigraphic zone (HSZ) of OU 1. This is being accomplished by expanding the OU 1 extraction system through installation of new extraction wells in the shallow HSZ. Granular Activated Carbon (GAC) and/or air stripping groundwater treatment systems will be utilized to achieve treated water release levels identified in Table 4-3 of this ROD. Design of the OU 1 expansion is included in the ongoing effort known as the Revised Basis of Design Report (RBDR). In addition, the OU 2 groundwater extraction network will be completed and operations initiated.

Phase 2: Phase 2 will enhance the OU 1 extraction network to a multiple HSZ groundwater remediation system with the addition of extraction wells and the utilization of GAC or air stripper treatment systems to achieve effluent release levels stipulated in this ROD (see Table 4-3 at Tab 5). A water reuse study will be conducted to determine the most appropriate combination of reinjection, canal discharge, and water reuse to be utilized for the disposal of treated groundwater. Pump tests will be conducted to obtain necessary hydrologic information on HSZ properties.

Phase 3: Data collected from the first two phases will be evaluated and a Phase 3 Technical Evaluation and Design Study will be prepared to determine what additional wells will be needed to achieve the overall cleanup objectives. By the onset of Phase 3, both Phase 1 and 2 pump and treat systems will have been installed, data gap wells and the LTGSP network will be in place, pump tests will have been evaluated, and the flow and transport models will have been updated. That information will facilitate better predictions of the hydraulic control of the HSZs and plume remediation time periods, and will provide the basis for design decisions regarding Phase 3 expansion of the groundwater remediation system. The Phase 3 Technical Evaluation and Design Study is scheduled for completion in draft form in August 1998, with finalization in January 1999. Construction on the Phase 3 groundwater system expansion is scheduled to begin in January 1999, with completion in October 1999.

The selected remedy is expected to cost-effectively remove TCE and other contaminants in the Castle AFB groundwater to the MCL cleanup objective and prevent further plume migration. Based on the concepts evaluated in the CB-Part 1 FS, the preliminary range of the estimated present worth costs of the selected remedy (not including OU 1 and OU 2 costs) is from $15.7 million to $33.4 million over a period of 15 years.

The three phases of groundwater remediation will be fully defined during remedial design (RD) and RA stages. Based on current information, the selected remedy will address the principal threat of hazardous material groundwater contamination. TCE in the groundwater at Castle AFB will be removed to or below 5 micrograms per liter.

2.4.2 Selected Remedy: East Base Plume. To achieve the overall objective for cleanup of groundwater at Castle AFB, the selected remedy for the East Base Plume (Impacted Area Well Destruction and Monitoring) utilizes the sealing and abandonment of wells to protect against further cross contamination of HSZs in the East Base Plume area, and monitoring to develop a more complete definition of the contamination. If further active remediation is needed,

appropriate RA will be implemented based on the conditions that trigger the need for remediation; in particular, a pump and treat approach will be implemented as the presumptive remedy for further cleanup action. The need for and design of this additional action will be determined through an annual reevaluation of monitoring information. The criteria defining the need for future pump and treat RA (i.e., the trigger conditions) are specified in Section 3 of this ROD.

The estimated present worth cost of the Impacted Area Well Destruction and Monitoring alternative for the East Base Plume, exclusive of additional action under the presumptive remedy, is $0.5 million. Additional active remedial measures have not been estimated, but would be significantly greater than this value.

2.4.3 Selected Remedy: Castle Vista Plume. Although detailed analysis was not conducted for the Castle Vista Plume, it was recognized in the RI/FS that the Castle Vista Plume had not been fully characterized. Additional data collection is continuing in this plume area, and analysis of the data collected to date indicates that active groundwater remediation in this area is necessary. A presumptive remedy of pump and treat, similar to the remedy selected for the Main Base Plume, will be used to meet the groundwater clean up requirements of the Castle Vista Plume. The present remedy, established in this ROD, consists of capturing the contaminant plume and remediating the groundwater to MCL levels. For the Castle Vista Plume, further analysis will be conducted to determine the appropriate cleanup level, consistent with Section IIIG of SWRCB Resolution 92-49. This evaluation will be carried out as part of the RD/RA activities. For reasons of operational and reporting convenience and efficiency, this additional RA will be integrated into the phase approach of the CB-Part 1 RD/RA, described under the remedy for the Main Base Plume.

2.4.4 Selected Remedy: Other Plumes. The AF, with the concurrence of the EPA and Cal/EPA, has determined that active remediation of the North Base, Landfill I, and Landfill 4 Plumes is not warranted at this time because action is being taken to remediate the sources, and because removing the low concentration contaminants from the groundwater would provide little benefit while incurring high costs. However, because several of the contaminants are above primary drinking water standards, institutional controls will be implemented to prevent the installation of groundwater supply wells on Castle AFB that would jeopardize public health or the environment from North Base, Landfill 1 and Landfill 4 Plumes. Additionally, long-term monitoring will be performed under the LTGSP to monitor contaminant concentrations in these plume areas. Contaminant concentration levels in the groundwater will be reevaluated annually. If the contaminant concentrations drop below the MCL and beneficial use concentrations for one year, any institutional controls may be removed. If, at any time, monitoring or modeling indicates that the contaminants will not meet the MCL and beneficial use concentrations within a reasonable time, or at least forty years from the date of the ROD, or that significant migration of the contaminants may occur at levels above MCL and beneficial use concentrations which impact public health or the environment, active remediation will be considered.

2.5 STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate for the RAs, and is cost-effective. This remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

2.6 SIGNATURES FOR LEAD AND SUPPORT AGENCIES

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- State signature indicates concurrence with the selected remedy

3.0 DECISION SUMMARY

This decision summary provides an overview of the environmental concerns posed by groundwater plume regions at Castle AFB and the remedies selected to address them. It includes a description of the site characteristics and the remedial alternatives considered in the Castle AFB CB-Part 1 RI/FS. It summarizes the analysis of these alternatives when compared to criteria set forth in the NCP. This Decision Summary explains the rationale for the remedy selections for the Main Base, East Base, and Castle Vista Plumes, and how the selected remedies satisfy the statutory requirements of CERCLA.

3.1 SITE NAME, LOCATION AND DESCRIPTION

3.1.1 Site Name and Location. Castle AFB (currently referred to as Castle Airport) is located in Merced County, California (Figure 3-1). The site covers an area of 2,777 acres, and is comprised of a runway and airfield, industrial areas, housing, recreational facilities, and several noncontiguous parcels.

3.1.2 Land and Water Use. Land use within a two-mile radius of Castle AFB is primarily agricultural, with the exception of residential areas in the community of Atwater. Crops grown in the area consist mostly of almonds, peaches, and grapes. Several small dairies and a large chicken farm are located to the east. Open pasture lands are located to the north and east. Residential areas are located primarily west of Castle AFB and include former base housing, trailer parks, recently constructed residential suburban housing, and rural farm residences. Land use along Wallace Road is mixed residential and agricultural (i.e., orchards). Land use on the airport currently includes a mixture of industrial and light-industrial facilities and offices. Potential future land uses at Castle AFB include schools, as well as residential and recreational uses.

3.1.3 Regional Topography. Castle AFB is located in the east central part of the San Joaquin Valley. Neighboring communities include Atwater, located to the immediate west; Winton, located to the north-west; and Merced which is approximately five miles to the east south-east of Castle AFB.

The San Joaquin Valley forms the southern half of the Great Valley Geomorphic Province of California. This province is approximately 400 miles long and averages about 40 miles in width. It is bounded by the Sierra Nevada Mountain Range to the east, the Coastal Mountain Range to the west, and is drained by the San Joaquin River. This river flows from the southeast to the Sacramento-San Joaquin Delta region, which lies between the Central Valley and the San Francisco Bay.

Castle AFB is located about halfway between the Merced River and Black Rascal Creek, two southwest-flowing tributaries of the San Joaquin River. The valley floor in the vicinity of the airport area slopes gently to the west-southwest. Natural drainage is to the southwest; however, surface flow patterns are locally controlled by a system of drainage and irrigation canals.

The total difference in elevation across Castle AFB is approximately 35 feet, ranging from 200 feet above mean sea level (MSL) at the northwestern corner to 165 feet above MSL at the southern corner.

3.1.4 Geology/Hydrology. A description of the geologic setting, surface water conditions, HSZs, groundwater flow conditions, and groundwater usage which comprise the conceptual hydrogeologic model for Castle AFB is presented in this section.

3.1.4.1 Geology. The eastern San Joaquin Valley of Central California is underlain by a basement complex composed of metamorphic and granitic rocks. In the vicinity of Castle AFB, the basement is overlain by a thick sequence of sedimentary deposits of Tertiary/Quaternary age (Figure 3-2).

Consolidated sedimentary units overlie the basement complex and have a minimum combined thickness of over 700 feet. These consolidated units include, from oldest to youngest, the Ione, Valley Springs, and Mehrten Formations.

Unconsolidated sediments overlie these formations from an elevation of approximately 450 feet below MSL to an elevation of 165 feet above MSL. Beneath Castle AFB, the unconsolidated units include the Laguna, Turlock Lake, Riverbank, and Modesto Formations. Recent surficial dune deposits, which attain a maximum thickness of approximately 10 feet, have occurred at the ground surface.

Castle AFB is located on an old Merced River flood plain that has been exposed and leveled by progressive down-cutting of the Merced River and its tributaries and by wind erosion. Quaternary-age sediments extend from the ground surface to about 350 feet below ground surface (bgs). The upper 20 feet of these deposits consist of eolian and flood plain sediments of Holocene age. The transition from Holocene age to Pleistocene age occurs at the base of the eolian and flood plain sediments.

3.1.4.2 Nature and Occurrence of Groundwater. The migration and fate of dissolved contaminants in groundwater at Castle AFB depends largely on natural hydrogeologic conditions and pumping influences due to use of groundwater as a resource. The site-wide conceptual model is presented schematically as Figure 3-2. The figure depicts major water-bearing zones, contaminant sources, migration pathways, and potential receptors of contaminated groundwater on and near Castle AFB.

The Merced River and Black Rascal Creek, two tributaries of the San Joaquin River, are the major surface drainages near Castle AFB. Regional surface drainage is to the southwest, but is substantially altered by a network of agricultural drains and canals. These drains and canals include Canal Creek near the eastern boundary of Castle AFB, Escaladian Canal in the north, and Livingston Canal in the southwest.

Drainage on Castle AFB is controlled through a system of storm drains and open channels. Runoff is diverted to the southern tip of the site where the water accumulates behind a weir. Except for periods of prolonged or heavy rain, runoff does not discharge from Castle AFB. Water collected behind the weir dissipates by evaporation and percolation. During heavy rainfall, water overflows the weir and discharges through culverts to either Livingston Canal or Canal Creek.

3.1.4.3 Hydrostratigraphic Zones. The sedimentary deposits in the upper 600 feet beneath Castle AFB are heterogeneous. Most sediments appear deposited in a fluvial system, though eolian and alluvial deposits are not uncommon. These sediments are typically deposited through an aggradational system of cutting and filling. This type of system is characterized by laterally discontinuous lenses of channel-fill sands and gravels surrounded by less permeable

overbank deposits.

Prior to the CB-Part 1 RI/FS, the stratigraphy beneath the site was thought to be divided into three general water-bearing zones: the shallow, subshallow, and confined. Based on the results of the CB-Part 1 RI/FS, the stratigraphy was redefined into five HSZs: the shallow HSZ, upper subshallow HSZ, lower subshallow HSZ, confined HSZ, and deep HSZ, as shown on Figure 3-2.

Hydraulically isolated stratigraphic zones or aquifers are not generally found beneath Castle AFB because of the complex fluvial/alluvial stratigraphy dominated by localized stream channel deposits. Each HSZ is a sequence of sediments with the finer sediments generally occurring at the top and the predominant water-bearing sections or lenses at the bottom. The HSZs do not represent isolated aquifers, but provide the general stratigraphic correlation (which can often be recognized during drilling) to guide the installation of monitoring wells within correlative predominant water-bearing units. Significant vertical hydraulic connection between HSZs is postulated to exist at certain locations.

The relatively high permeability coarse grained sands and gravels which generally occur near the base of each HSZ make up the predominant water-bearing sections (PWBS) of the HSZs, have little or no fines, and have been classified using the Unified Soil Classification System (USCS) as GW or GP (clean gravels) and SW or SP (clean sands).

A brief description of each of the HSZs is presented in the following paragraphs:

Shallow Hydrostratigraphic Zone. The shallow HSZ extends from the water table (typically 60 to 80 feet bgs) to the top of a clay layer at approximately 95 feet bgs. The PWBS of the shallow HSZ is composed of fluvial deposits of sand and gravel which trend in a northwest to southeast direction. To the southwest the sands and gravels "pinch out" transitioning to finer grained, less permeable deposits.

Upper Subshallow Hydrostratigraphic Zone. The upper subshallow HSZ occurs at about 95 to 160 feet bgs and is stratigraphically equivalent to the upper portions of the Turlock Lake Formation (Jacobs, 1995a). At Castle AFB, the upper subshallow HSZ is heterogeneous both laterally and vertically, consisting mostly of fine-grained flood plain deposits with medium-grained channel sands to the south of the airport. Upper subshallow HSZ sands are lenticular and intermittent, but appear to broaden, thicken and grade into the channel sands to the south of Castle AFB. These sand units comprise what is considered the PWBS for the upper subshallow HSZ and appear to trend in a northwest to southeast direction as in the shallow HSZ.

Lower Subshallow Hydrostratigraphic Zone. The lower subshallow HSZ occurs from about 160 to 220 feet bgs, and is stratigraphically equivalent to the middle portions of the Turlock Lake Formation (Jacobs, 1995a). This HSZ consists of laterally semi-continuous segments of interbedded fine-grained sands, silts and clays between 160 and 180 feet bgs. It contains more gravel and coarse-grained sands between 180 and 220 feet bgs. The sand/gravel units of the lower subshallow HSZ also trend northwest to southeast.

Confined Hydrostratigraphic Zone. The confined HSZ occurs from approximately 220 to 350 feet bgs. It contains thicker, more continuous zones of water-bearing sands than the upper and lower subshallow HSZs. Most of the older Castle AFB production wells on site produce from the confined HSZ. The lower part of the confined HSZ consists of the North Merced Gravel (Jacobs, 1995a) which is the PWBS of the confined HSZ. The name "confined" was used by previous investigators at Castle AFB. The HSZ as a whole is not confined; however, the North Merced Gravel at the base of the confined HSZ is hydraulically confined locally and trends in a north to south direction.

Deep Hydrostratigraphic Zone. The top of the deep HSZ is approximately 350 feet bgs. Its vertical extent is not known. The deep HSZ is an important water source in the San Joaquin Valley (Weston, 1988). The PWBS of the deep HSZ occurs in the Laguna Formation, about 510 feet bgs and extends into the upper part of the Mehrten Formation at about 650 feet bgs (Jacobs, 1995a). The Laguna Formation consists of a poorly consolidated mixture of clay, silt, sand, and conglomerate, while the Mehrten Formation is mainly a mixture of consolidated claystone, sandstone, siltstone, and conglomerate.

3.1.4.4 Groundwater Flow Direction and Movement. The general horizontal groundwater flow direction beneath Castle AFB is west-southwest toward the San Joaquin River. This is consistent with the regional groundwater flow in the eastern part of the San Joaquin Valley. Two regional pumping centers, located to the northwest and south-southwest of Castle AFB influence local groundwater flow directions in the Atwater-Merced area.

3.1.4.5 Description of Horizontal and Vertical Gradients. Groundwater elevations have been determined from data collected during the fourth quarter sampling event in November 1995. Based on calculations from this data, the horizontal gradient for the shallow, upper subshallow, and lower subshallow HSZs is generally 0.001 feet/foot (ft/ft).

There is a small, natural vertical component of groundwater flow beneath Castle AFB (Jacobs, 1995a). Hydrographs indicate that there is a relatively consistent downward vertical gradient between the shallow and upper subshallow HSZs and that these two HSZs are in relatively close hydraulic connection.

Hydrographs also indicate that there is essentially no difference in water elevation between the lower subshallow and shallow HSZs, except during the third or fourth quarters of 1995, when water levels in the lower subshallow HSZ dropped, creating a downward gradient.

The cyclic seasonal pattern observed in elevations in the confined HSZ is due to the pumping of large volumes of groundwater for irrigation purposes during the late summer and fall. The dissimilarity in water level fluctuations between the shallow and confined HSZs suggests there is little direct hydraulic connection between these zones.

3.1.4.6 Groundwater Usage. Castle AFB, the City of Atwater, and the Merced Irrigation District are three principal groundwater utilizing entities on or near Castle AFB. In addition to on-site production wells, there are more than 100 municipal, domestic, irrigation, and production wells within one mile of Castle AFB. The deepest well (City of Atwater well, AM19, grid Q,3) is completed to 670 feet bgs while the shallowest wells are completed to less than 100 feet bgs. Total groundwater pumping in the Atwater-Merced area ranged from about 47,000 to 120,000 acres-feet per year during the 10-year period between 1963 and 1973 (Jacobs, 1996).

In 1988, 11 wells belonging to the City of Atwater were in service and produced about 6,300 acre-feet of water (see Figure 3-3). AM-16 near Castle AFB is considered a prime potential conduit/receptor. Well AM-16 is screened from 330 to 600 feet bgs within the confined and deep HSZs. The well is located about 1,700 feet west (downgradient) of the estimated boundary of the TCE plume in the confined HSZ. Well AM-16 has a pumping capacity of approximately 2,000 gallons per minute (gpm) and produces an average monthly volume of approximately 70 million gallons. The significant groundwater drawdown observed in the confined HSZ in the southwest portion of the site is in part due to pumping from AM-16.

Castle AFB operates on base groundwater production wells. The production wells are capable of producing 4,900 gpm. Based on data from the past year (when the base was still open), summer usage is approximately 2,000 gpm, while winter usage is approximately 1,000 gpm. Currently,

water usage is much less. The principal groundwater wells at the site are PW-10, and PW-12. They extract groundwater from the confined and deep HSZs. The only other active production wells at Castle AFB are PW-6 and PW-11.

3.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

Castle AFB was first used as a military air base in December 1941. The primary mission of the base through World War II was the training of Army air crews. The Strategic Air Command (SAC) assumed responsibility of the base in 1946 and occupied the base with the 93rd Bombardment Wing until the base closed in September 1995. Fuels (JP-4), solvents (TCE), and chemicals were handled at the base since the 1940s. Municipal and chemical wastes were also generated as a result of maintenance operations, fuel management, fire training, and other base activities. In the 1950s, expanded industrial activities related to the SAC mission resulted in increased waste generation rates.

Originally, the major industrial activities related to aircraft maintenance centered in two hangers (Buildings 47 and 51) and the machine shop (Building 52, later demolished in 1977), located on the southwestern side of Apron Avenue. In 1955, an additional parking apron, hanger (Building 1550), and other structures were added to support the newly arrived 456th Fighter Interceptor Squadron. Since 1955, Building 1550 has been used extensively for industrial activities. Buildings 1253 and 1260 were built in the late 1970s and assumed the majority of the industrial activities previously performed in Building 52. These activities included metal pllating and processing, and jet engine maintenance.

In 1978, following the sampling of several water production wells, the AF determined that the groundwater beneath Castle AFB was contaminated with TCE and other volatile organics. During the routine sampling of several base and private wells in 1980, trace levels of TCE were detected in the four base water production wells. Seven test wells were then installed in the shallow aquifer by the base as part of the investigation. The results of this sampling program prompted the base to construct a new deep aquifer water supply well (PW-10) and provided the impetus for the AF's aggressive strategy to address the problem of groundwater contamination under the IRP at Castle AFB. This strategy included extensive investigations leading to the initiation of groundwater cleanup actions at Castle AFB designed to control migration of contaminated groundwater and to protect human health and the environment.

The initial phase of the IRP at Castle AFB was conducted in 1981, at which time 35 potential contaminant source sites were identified. Follow-on activities confirmed and partially delineated the extent of the TCE groundwater contamination. Seven previously unknown potential source sites were also defined.

In March 1984, the California Regional Water Quality Control Board - Central Valley Region issued Cleanup and Abatement Order Number 84-027. This order required the base to provide users of the base water supply and impacted off-base wells with potable water supplies. Also, the base was required to implement remedial measures to correct identified and future groundwater degradation from waste discharges.

In September 1984, an additional field investigation was begun including the installation of 27 monitoring wells and 11 unsaturated zone lysimeters into the shallow aquifer to sample for groundwater contamination and to test for perched water zones. This investigation determined that the soils and sediments at the base had not been significantly impacted at the majority of the sites investigated, but that the groundwater needed further evaluation. This conclusion was considered preliminary and was evaluated in the RI/FS for the overall base. Significant TCE concentrations were detected in the central or Main Base Sector. The final report of this field investigation recommended additional investigations of the landfill, fire training areas, fuel

spills, and disposal areas, and for further evaluation of the TCE plume in the Main Base Sector.

Results of the investigation and the base's groundwater sampling program indicated that TCE contamination may be present not only in the Main Base Sector, but also in the South Base Sector and Disposal Areas Nos. 2 and 4. As a result of these findings, further investigation was conducted which included additional evaluations of the landfills, fuel spills and leaks, and selected disposal areas. These field investigations included soil organic vapor (SOV) monitoring at 205 points, the drilling of 48 soil borings, the installation of 27 monitoring wells and 5 lysimeters or perched wells, and conducting two rounds of groundwater sampling. These investigations were completed in April 1987, and the final report was issued in August 1988.

Castle AFB fell under the provisions of CERCLA when amended in 1986. Castle AFB was proposed for the NPL of hazardous waste sites on July 22, 1987. The base was officially listed as an NPL site on November 21, 1989. The AF, the EPA, and the state signed an interagency agreement, now known as the Castle AFB Federal Facility Agreement (FFA) on July 21, 1989. The FFA is a legal document that outlines the basic CERCLA process required of the AF, including CERCLA procedures to address state requirements, and documents the regulatory agency enforcement authority.

Results of all the above field investigations and data collection activities were used to develop the initial RI/FS program. The first phase of RI field activities was initiated in August 1988. These activities included the installation of 63 monitoring wells in the upper and lower zone of the shallow aquifer and nine monitoring wells in the confined aquifer. In June 1989, the second phase of the RI was initiated and included conducting two rounds of quarterly groundwater sampling in 160 wells. These wells included previously installed base and Phase II wells, new RI base wells, and off-base private wells. In addition, 77 soil borings were drilled and sampled to assist in the future characterization of various investigative sites. Two rounds of groundwater level measurements were made, and 15 short-term (4-hour) pump tests were also conducted. The second phase of the RI field activities was completed in February 1990. The results of the above field activities are described in the Preliminary Site Characterization Report, which is the basis for the Interim OU 1 Interim ROD.

The third phase of RI field activities began in March 1990 and continued through May 1991. These activities included quarterly groundwater sampling, 30-day aquifer pump tests a preliminary site assessment of Castle Vista landfills, six water level snapshots, development of Work Plan No. 2, quarterly groundwater samplings, water level snapshots, and a sewer line TV camera survey.

During the third phase, Castle AFB was divided into two OUs, known as OU 1 and OU 2. OU 1 and OU 2 are location-specific areas defined in an attempt by the AF to identify groundwater contamination plumes and their related source areas. The geographical location and areal extent of OU 1 and OU 2 are depicted in Figure 3-4. An Interim ROD for OU 1 was finalized in August of 1991 that addresses the principal Main Base TCE Plume groundwater threat posed by TCE concentrations in the shallow HSZ beneath the central portion of the Main Sector of the base and contiguous areas to the south and southwest of the base. The selected remedy for the OU 1 Interim ROD involves 1) groundwater extraction from a series of shallow wells, 2) surface treatment of the extracted groundwater by air stripping, 3) reinjection of treated groundwater back to the shallow HSZ, 4) application of natural biological enhancement to accelerate degradation of hazardous constituents and 5) abating the air stripper emissions with granular activated charcoal. A Dispute Resolution document for OU 1 and subsequent correspondence from the Regional Water Quality Control Board provided the basis for the quantitative requirements for treatment of groundwater for the OU.

A final ROD for OU 2 addressing RAs for groundwater contamination in the Wallace Road and DA-4

areas was signed in December 1994. The selected remedy in the OU 2 ROD consisted of 1) design, construction, and operation of a groundwater extraction and treatment system to treat extracted groundwater with air stripping technology, 2) discharge by reinjection of treated groundwater to the same aquifer from which it was extracted, and 3) groundwater monitoring to demonstrate that the extraction system is effectively capturing the volatile organic compound (VOC) contaminant plume, attainment of cleanup standards established for OU 2, and compliance with ARARs. Subsequently, the treatment technology for OU 2 was changed to GAC treaatment, documented in an Explanation of Significant Difference (ESD).

The SCOU was separately identified to characterize soil (vadose zone) contamination, and the LTGSP was established to monitor groundwater contamination. From a total of 209 sites considered in the initial draft SCOU RI/FS, the soil at 38 sites or groups of sites was identified as having the potential to affect the underlying groundwater quality. Additional investigation work under the SCOU Action Plan is currently in progress, and an update to the initial RI/FS is scheduled following completion of the Action Plan investigations.

In an attempt to control off-base migration of contaminated groundwater and to protect human health and the environment, RD/RA (Phase IV) began in 1992 and is currently underway at OU 1 and OU 2. The CB Program was established to incorporate the final evaluation and cleanup of both soil and groundwater. Because of an extension of the investigation activities under the SCOU, the CB program was segmented into two parts. The CB-Part 1 addresses groundwater contamination, one of the principal threats posed by the site, and CB-Part 2 will be the final integration of all cleanup activities for soil and groundwater at Castle AFB.

The CB-Part 1 RI/FS was conducted to extend the results of previous groundwater investigations to address all groundwater plumes at Castle AFB. The objectives of the CB-Part 1 RI/FS were 1) to investigate the nature and extent of groundwater contamination, 2) to assess the risks which the groundwater contamination poses to human health and the environment, 3) to evaluate the feasibility of various groundwater RA alternatives, and 4) to recommend a preferred alternative. The site-wide soil and groundwater cleanup decisions at Castle AFB will be culminated with the final cleanup decisions of CB-Part 2.

3.3 HIGHLIGHTS OF COMMUNITY INVOLVEMENT

The Community Relations Plan (CRP) for Castle AFB was completed in 1990 and officially updated in 1992 and again in May 1995 by Castle AFB's Office of Public Affairs, in accordance with EPA guidance. Consistent with the base's CRP, the AF established a Restoration Advisory Board (RAB) composed of EPA, Cal/EPA, the AF, Merced County, and local representatives from adjacent communities. The RAB meets on a quarterly basis to provide the community representatives with up-to-date information on recent milestone events. Castle AFB publishes and distributes "Environmental Update," a community newsletter, which serves to keep the community informed of recent activities.

The CB-Part 1 RI/FS and Proposed Plan were released to the public in June 1996. These two documents were made available to the public in both the Administrative Record and an information repository at the Merced Public Library. The initial public comment period for the Castle CB-Part 1 RI/FS and Proposed Plan was held between June 25, 1996 and July 25, 1996. This initial comment period was subsequently extended through August 25, 1996. The public notice for the Proposed Plan was published in the Merced Sun on June 22, 1996 and July 12, 1996; and in the Atwater Signal and the Livingston Chronicle on June 22, 1996 and July 17, 1996. In addition, public meetings were held on July 23, 1996 in which representatives from the AF, Cal/EPA and the EPA participated to answer questions about problems at the site and the remedial alternatives under consideration.

A response to the comments received during this period has been prepared as the Responsiveness Summary, which is included as Section 5 of this ROD. This decision document presents the selected RA for the Castle CB-Part 1 in Merced, California chosen in accordance with CERCLA, as amended by SARA and, to the extent practicable, the NCP. The decision for this site is based on information contained in the Administrative Record.

The public participation requirements of CERCLA Sections 113(K)(2)(B)(I-v) and 117 have been met.

3.4 SCOPE AND ROLE COMPREHENSIVE BASEWIDE-PART 1

The CB Program was originally established to combine final evaluation and cleanup of both soil and groundwater at Castle AFB. Because of an extension of the investigation activities under SCOU, the CB program was segmented into two parts. The CB-Part 1 addresses groundwater contamination, one of the principal threats posed by the site, and CB-Part 2 addresses final integration and implementation of all cleanup activities for soil and groundwater at Castle AFB.

The CB-Part 1 RI/FS was conducted to complete the groundwater investigations at Castle AFB. The objectives of the CB-Part 1 RI/FS were 1) to investigate the nature and extent of groundwater contamination, 2) to assess the risks which groundwater contamination poses to human health and the environment, 3) to evaluate the feasibility of various groundwater RA alternatives, and 4) to recommend a preferred alternative. The CB-Part 1 RI/FS incorporates data through the second quarter of 1994 from the LTGSP; field investigations for OU 2; the SCOU RI; and the CB-Part 1 groundwater investigation. RAs under the SCOU and CB-Part 1 will be integrated with the final cleanup decisions of CB-Part 2.

The CB-Part 1 ROD addresses basewide groundwater contamination, including all groundwater plumes resulting from past activities at Castle AFB, both within the original boundaries of Castle AFB and extending beyond the boundaries where off-site plume migration has taken place. Seven groundwater plume regions (representing six plumes, since Main Base Plume Regions 1 and 2 are treated as a single plume) were identified and evaluated as part of the CB-Part 1 RI/FS and remedies were recommended for three of these plumes: Main Base Plume; East Base Plume; and Castle Vista Plume.

The Main Base Plume, the East Base Plumes, and the Castle Vista Plume (Figure 3-5), represent the principal groundwater contamination problems among the seven groundwater contamination plume regions. TCE is the most significant contaminant at the Main Base and East Base Plumes; other contaminants at the Main Base Plume include Benzene; Carbon Tetrachloride; cis-1,2-dichloroethene (cis-1,2-DCE); and Perchloroethylene (PCE). At the East Base Plume, bis (2-ethylhexyl) phthalate (DEHP) is present in addition to TCE. The major contaminants at the Castle Vista Plume are PCE and cis-1,2 DCE. Contaminants at the North Base, Landfill 1 and Landfill 4 Plumes include TCE, DEHP, PCE and Antimony.

Remedial actions at OU 1 and OU 2 are being conducted to address the majority of the mass of the Main Base Plume groundwater contamination. The intent of CB-Part 1 is to address all groundwater contamination associated with Castle AFB, including the OU 1 and OU 2 areas as well as the other plumes not associated with the Main Base Plume.

CB-Part 1 consolidates the groundwater cleanup activities at Castle AFB by expanding the RAs currently underway at OU 1 and OU 2 to address the additional groundwater contamination at the base. CB-Part 2 is planned to finalize and close out any remaining issues associated with the cleanup of Castle AFB.

3.5 NATURE AND EXTENT OF GROUNDWATER CONTAMINATION

The principal Chemical of Concern (COC) in groundwater at Castle AFB is TCE. An estimated 6,605 pounds of TCE is in the groundwater at Castle AFB. Other contaminants detected at lower concentrations include benzene, toluene, ethylbenzene, and xylenes (BTEX), petroleum hydrocarbons, inorganics, and other VOCs. Small areas of contamination were detected at various locations throughout the base, but in general, were very close to MCL or beneficial use criteria levels, and do not pose significant risks. The majority of the contamination significantly above MCL levels is contained within the larger TCE plumes and will be remediated by the remedy for the TCE plumes.

Groundwater contamination at Castle AFB; has been divided into seven plume regions based on geographic location and source of contamination (see Table 3-1). These regions are defined as: Main Base Plume 1, Main Base Plume 2, Landfill 4, North Base Plume, East Base Plume, Landfill 1 Plume, and Castle Vista Plume. Groundwater contamination is limited to the shallow HSZ in all plume regions except for Main Base Plume Regions 1 and 2. Contamination is present in the shallow, upper subshallow, lower subshallow, and confined HSZs within the Main Base Plume regions.

The largest extent of TCE contamination is within the Main Base Plume Regions 1 and 2 (Figure 3-6). They contain approximately 98 percent, by mass, of the TCE contamination beneath Castle AFB. TCE is also present at the East Base, Castle Vista, North Base, Landfill 1, and Landfill 4 Plume regions. Volumes and contaminant masses are estimated for the plumes containing TCE in Table 3-2a.

Three plumes in the East Base Plume Region are estimated to contain approximately 1.8 percent, by mass, of the TCE contamination beneath Castle AFB. One of these plumes in the East Base Region, the plume under Buildings 1762 and 1709, has been incorporated as part of the Main Base Plume and will be addressed by the selected remedy for the Main Base Plume. The TCE plumes in the other five regions account for less than 0.2 percent of the total TCE mass beneath the site. The lateral extent of the plumes and the TCE concentrations generally decrease with increasing depth. Contaminants have not been detected in the deep HSZ.

Plumes of organic contaminants of concern other than TCE have been identified in the shallow HSZ within the Main Base, North Base and Castle Vista Plume regions and in the shallow, upper subshallow and confined HSZs within the Main Base Plume regions. In general, the extent of the other plumes are within the extent of the TCE Plume regions.

Exceptions are DEHP in the North Base Plume regions in the shallow HSZ, and benzene in the Main Plume Region 1 in the confined HSZ. Volume and contaminant mass are estimated for Groundwater Plumes of organic compounds identified in the CB-Part 1 RI (other than TCE) in Table 3-2b.

Of the seven regions, three were considered for RA in the CB-Part 1 RI/FS (Main Base Plume Region 1, Main Base Plume Region 2, and East Base Plume). However, Regions 1 and 2 of the Main Base Plume are considered a single plume resulting from two different sources and the existing and planned remedial systems (OU 1 and OU 2) will capture contaminants from both regions. The screening and selection of groundwater plumes for consideration of RA is discussed in Section 3.6.3. In addition, although active remediation was not planned for the Castle Vista Plume, additional data has been collected and a pump and treat presumptive remedy is now planned for this plume.

Ongoing activities at Castle AFB include the monitoring of these plume regions (under the LTGSP) and the investigation of identified data gaps. Surface and near-surface sources of groundwater contamination are being addressed under the SCOU.

As part of the CB-Part 1 RI/FS, wells upgradient from Castle AFB were sampled and evaluated to determine background concentrations of inorganic contaminants in groundwater unaffected by historic Castle AFB actions, but potentially impacted by regional activities in the San Joaquin Valley (agriculture, forestry, etc.). This data was statistically analyzed to determine a background level such that 95 percent of the naturally occurring inorganic concentrations from non-AF operations would be below this value. Some inorganics (metals), such as aluminum, antimony, lead, and selenium were detected above the statistically derived background number. However, further analysis of these evaluated concentrations of metals determined that they are also part of the background, based upon the geologic depositional environment at Castle AFB.

As detailed in Table 3-3, the shallow, upper subshallow, and lower subshallow groundwater zones within the plumes noted above, contain TCE, petroleum hydrocarbons, and other organic and inorganic contaminants. These contaminants generally decrease in concentrations with depth of the zone. The confined groundwater zones contain contaminants at lower concentrations, and in fewer regions; and the deep groundwater zone contains no contaminants in any of the regions. The nature and extent of contaminants in groundwater beneath Castle AFB is discussed below by HSZ.

3.5.1 Shallow HSZ. Nine TCE plumes have been identified within the seven plume regions. Figure 3-6 shows the lateral extent of TCE in the shallow HSZ. The plume identified in the Main Plume Regions is by far the most extensive. It contains the highest concentrations of TCE with a maximum reported value of 740 Ig/L. The extent of TCE plumes in the other plume regions is much smaller. TCE concentrations in the other plume regions are much less with a maximum reported TCE concentration of 45 Ig/L in the East Base Plume Region.

PCE, chloroform, carbon tetrachloride, cis-1,2-DCE, and 1,2-dibromo-3-chloropropane (DBCP) plumes are also present in the Main Plume regions. These other plumes are within the TCE plume of the Main Plume regions, with the exception of the DBCP plumes. DBCP is an agricultural chemical regionally present in the groundwater and for which no Castle AFB sources have been identified and is consequently not considered a COC.

A plume of cis-1,2-DCE, PCE, and TCE was identified in the Castle Vista Plume region, cis-1,2-DCE being the primary contaminant of concern. Small plumes of PCE and DEHP were identified in the North Base Plume region. The PCE plume is within the TCE plume in this region, while the DEHP plume is located southwest of the TCE plume. TCE is the only organic compound for which plumes were identified in the Landfill 1, Landfill 4, and East Base Plume regions. Within all seven plume regions, other organic chemicals were detected at concentrations exceeding MCLs and Preliminary Remediation Goals (PRGs). However, in most cases, these were isolated occurrences with insufficient data to define plumes. In addition, the TCE plumes encompass the locations of these isolated occurrences.

3.5.2 Upper Subshallow HSZ. Groundwater contamination in the upper subshallow HSZ is limited to the Main Plume Regions 1 and 2. TCE is the principal contaminant. The TCE plume in the upper subshallow HSZ is smaller than the extent of the TCE plume in the shallow HSZ. The concentrations of TCE in the upper subshallow HSZ (maximum reported value of 160 Ig/L) are lower than the concentrations in the shallow HSZ.

PCE and DBCP plumes are present in the Main Plume regions. The PCE plume is small and occurs within the TCE plume. The DBCP plume extends west of the TCE plume. Other organic chemicals detected at concentrations exceeding MCLs and PRGs included chloroform and DEHP. These are isolated occurrences with insufficient data to define mappable plumes.

3.5.3 Lower Subshallow HSZ. TCE is the only mappable plume identified in the lower subshallow HSZ and contamination is confined to the Main Plume regions. Concentrations of TCE were

generally lower than in the upper two HSZs, with the exception of a 190 Ig/L concentration in well MW863 (grid R,12).

3.5.4 Confined HSZ. Contamination in the confined HSZ is limited to the Main Plume regions with mappable plumes of TCE and benzene identified. The TCE plume in the confined HSZ is smaller in size and relative concentration (maximum detected concentration 29 Ig/L) than the TCE plume in the lower subshallow HSZ. Two small plumes of benzene are present in the confined HSZ with a maximum reported concentration of 1.6 Ig/L. Other BTEX constituents are also reported, but none exceed MCLs or PRGs.

3.5.5 Deep HSZ. Contaminants were not detected in the groundwater from the deep HSZ well.

3.6 SUMMARY OF GROUNDWATER PLUME RISKS

The CB-Part 1 RI/FS includes a Baseline Human Health Risk Assessment (BHHRA) that includes 1) contaminant identification information, 2) potential exposure pathways, 3) the toxicity of the Chemicals of Potential Concern (COPCS), and 4) an evaluation of the potential human health risks and hazards associated with contaminated groundwater at Castle AFB in the absence of RAs or institutional controls. Therefore, risk estimates are conservative in that they do not reflect reductions in contamination arising from ongoing cleanup efforts where groundwater remediation is currently in progress (e.g., OU 1). Ecological risks associated with potential exposures of biota to soil and groundwater contaminants at Castle AFB have been evaluated in the first of three phases of the Ecological Risk Assessment (ERA). It should be noted that BHHRA uses conservative (i.e., health protective) hypothetical assumptions to identify COPCs and to assess the possible im pact of exposure to those chemicals.

3.6.1 Human Health Risk Assessment. The following discussion on Human Health Risk Assessment for Castle AFB groundwater is based on the Castle CB-Part 1 RI/FS Volume 2 - BHHRA Sections 4, 5, 6, 7, and 8. The results of the BHHRA are summarized in Table 3-4.

3.6.1.1 Contaminant Identification Information. Groundwater sampling data obtained from the RI was validated for usability in the risk assessment. Only the laboratory analytical data that met or exceeded the EPA Level III Quality Control guidelines were utilized.

A total of 66 analytes were reported as detected in groundwater samples collected on and off base during field investigations; inorganics, VOCs, semi-volatile organic compounds (SVOCs), Total Petroleum Hydrocarbons (TPH) (as gasoline and diesel) and radioactivity (gross alpha and beta). Only contaminants detected in groundwater were included, with soil contaminants being addressed in the SCOU BHHRA.

Not all analytes were selected as COPCs for evaluation in the risk assessment. EPA provides several rationales for excluding chemicals from consideration as COPCs in the risk assessment. These include the following: 1) reported concentrations of the chemical are due to laboratory contamination, 2) reported concentrations of the chemical are representative of naturally occurring levels, and 3) the chemical is an essential nutrient and is present at concentrations that are unlikely to cause adverse health effects.

Certain detected analytes were thus excluded as COPCs. These were TPH (as gasoline and diesel) and gross beta radiation. Data reported as TPH is not suitable for risk assessment purposes, as the toxicological effects of the individual constituents must be evaluated individually rather than as a group (i.e., hydrocarbons). Similarly, to evaluate health effects due to exposure to radiation, it is necessary to identify individual radioisotopes in order to quantitatively evaluate their health effects. Radionuclide levels identified at Castle AFB are within the range expected from naturally-occurring sources.

Of the 66 analytes detected in groundwater, a total of 53 chemicals (13 inorganic and 40 organics) were identified as COPCs in groundwater at Castle AFB. The COPCs are presented in Table 3-5. The contaminant of greatest concern is TCE. TCE is a colorless liquid that has been widely used as a metal degreasing agent in dry-cleaning processes; as a solvent in refrigerants; and as a fumigant in pesticide activities. It is a probable human carcinogen; therefore, it is a contaminant that is associated with cancer risk.

3.6.1.2 Potential Exposure Pathways. In order to determine the magnitude, frequency, duration, and route of exposure to the groundwater contaminants, potential exposure pathways were developed by identifying populations that currently, or may in the future, contact chemicals at the site and the potential routes of exposure. Exposure is the contact of a chemical with a receptor; in this case a person. Magnitude is determined by estimating the amount (concentration) of the chemical at the point of contact over a specified time period (exposure duration) as well as the actual intake (dose) of the chemical.

The current land uses on Castle AFB proper are predominantly industrial with limited residential use. Residential areas are located west of Castle AFB and include off-base housing, trailer parks, suburban housing, and rural farm residences. However, within the 2-mile radius around Castle AFB, the adjacent land use is primarily agricultural. Dependent on land use, potential receptors representative of the reasonable maximum exposure include the on-site industrial worker, and on-site resident (adult and child).

Actual future land use of a site should also be considered when using risk estimates to drive site RAs. Residential land use allows for the greatest exposure to contaminants; thus, compliance with the most stringent standards are required. Therefore, if a site is not planned for use as a residential area, and is unlikely to be considered desirable for development as a residential area, the residential use scenarios may not be appropriate for developing cleanup goals.

Currently, human receptors at Castle AFB are exposed only to groundwater that has been filtered and treated to reduce groundwater contaminants to levels below those mandated by federal and state drinking water standards (e.g., MCLs). However, hypothetical future human receptors may potentially be exposed through ingestion of untreated groundwater, ingestion of produce irrigated with contaminated groundwater, dermal (skin) contact, and inhalation of chemicals volatilized from household uses of untreated groundwater. Exposure pathways evaluated in the BHHRA are presented in Table 3-6. Exposure point concentrations, duration, and doses were estimated for 1) ingestion, 2) inhalation of volatiles while showering, 3) dermal contact while showering, and 4) ingestion of produce.

3.6.1.3 Toxicity of Chemicals of Potential Concern. The toxicity of the COPCs was assessed in two steps; hazard identification and dose-response assessment. For each COPC, it was determined whether exposure to that chemical may result in a deleterious health effect in humans. This was done by characterizing the nature of the effect and the strength of the evidence that the chemical will cause the observed effect. Dose-response assessment characterizes the relationship between the dose and the incidence and/or severity of the adverse health effect in the exposed population.

Some of the COPCs identified in groundwater at Castle AFB are considered to be potential human carcinogens. However, both cancer risks and noncancer health hazards due to exposure to these compounds were evaluated in the BHHRA.

Cancer potency factors (CPFs) have been developed by EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. CPFs, which are expressed in units of (mg/kg-day), are multiplied by the estimated

intake of a potential carcinogen, in (mg/kg-day), to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper-bound" reflects the conservative estimate of the risks calculated from the CPF. Use of this approach makes underestimation of the actual cancer risk unlikely. CPFs are derived from results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied.

Reference doses (RfDs) have been developed by the EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects. RfDs, which are expressed in units of mg/kg-day, are estimates of lifetime daily exposure levels for humans, including sensitive individuals. Estimated intakes of chemicals from environmental media (e.g., the amount of a chemical ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans). These uncertainty factors help ensure that RfDs will not underestimate the potential for adverse noncarcinogenic effects to occur.

Toxicity values for COPCs used in the CB-Part 1 BHHRA are presented in Tables 3-7 and 3-8.

3.6.1.4 Potential Human Health Risks and Hazards Associated with Contaminated Groundwater. Risk characterization presents both quantitative and qualitative expressions of the likelihood of adverse effects on the potentially exposed populations. This is achieved through integration of the information gathered in the exposure assessment and toxicity assessment.

Risk characterization is performed separately for carcinogenic and noncarcinogenic effects. Carcinogenic risk is expressed as the probability that an individual will develop cancer over a lifetime as a result of exposure to the potential carcinogen. Noncarcinogenic hazards are characterized by comparing the estimated exposure level over a specified period of exposure with RfDs to provide a numeric estimate of the likelihood of a toxic response.

Excess lifetime cancer risks are determined by multiplying that intake level with the CPF. These risks are probabilities that are generally expressed in scientific notation (e.g., 1.0 x 10 -6 or 1E-6). An excess lifetime cancer risk of 1.0 x 10 -6 indicates that, as a plausible upper-bound, an individual has a one in one million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the specific conditions at a site.

Cancer risk is expressed as the probability that an individual will develop cancer over a lifetime as a result of exposure to the potential carcinogen for a long period (30 years). The guidance for calculating risks to human populations uses a range of cancer risk as a target for establishing health protection goals. The target risk range for cancer is 100 in one million (10 -4) to one in one million (10 -6).

Potential concern for noncarcinogenic effects of a single contaminant in a single medium is expressed as a hazard quotient (HQ) (or the ratio of the estimated intake derived from the contaminant concentration in a given medium to the contaminant's RfD). By adding the HQ for all contaminants within a medium or across all media to which a given population may reasonably be exposed, the Hazard Index (HI) can be generated. The HI provides a useful reference point for gauging the potential significance of multiple contaminant exposures within a single medium or across media.

An HI above one indicates that someone exposed to the contamination may experience some adverse health effects.

As indicated in Table 3-6, three exposure scenarios were evaluated. The results of the risk characterization show that VOCs in general and TCE in particular are the primary contributors to the estimated carcinogenic risk and hazard basewide. Ingestion and dermal absorption are the primary exposure routes contributing to the overall risk. Risks resulting from ingestion comprise between 25 to 60 percent of the total risk, while risks from the dermal pathway account for between 30 and 60 percent of the total. Inhalation of volatilized chemicals and food chain transfer via plant uptake are minor pathways, and account for approximately 4 and 8 percent, respectively, of die total risk.

In the following sections, the risks/hazards resulting from exposure to COPCs are described for each of the plumes and HSZs.

Main Plume Region 1: Shallow HSZ. TCE is the most prevalent organic contaminant found in the Main Plume Region 1 shallow HSZ. The total estimated upper-bound carcinogenic risk for the adult residential receptor is 9.0 x 10 -5. TCE is the primary contributor and accounts for 72 percent of the total estimated risk. The estimated risk associated with 1,1-dichloroethene (1,1-DCE), hexa-chlorobutadiene, and PCE contribute to 5 percent or more of the total risk. The total HI is 2.67 and the primary contributor to the total HI is TCE, which has an individual HQ greater than 1.

The total estimated upper-bound carcinogenic risk for the child residential receptor is 4.2 x 10 -5. TCE is the primary contributor to the estimated risk total. The total HI is 6.54.

The total estimated upper-bound carcinogenic risk for the adult occupational scenario is 4.1 x 10 -5. TCE is the primary contributor to the total with 1,1-DCE and PCE having individual contributions of 5 percent or greater to the total estimated risk. The total HI is 1.42 and TCE is the only COPC with an individual HQ greater than 1.

Main Plume Region 1: Upper Subshallow HSZ. TCE is the most widespread organic contaminant found in the upper subshallow HSZ. The total estimated upper-bound carcinogenic risk for the adult residential receptor is 2.2 x 10 -4. The primary contributors to the estimated risk are arsenic, TCE, and DBCP. The total HI is 4.15, and TCE is the primary contributor to the total HI.

The total estimated upper-bound carcinogenic risk for the child residential receptor is 4.2 x 10 -5. Arsenic, TCE, and DBCP are the primary contributors to the total risk. The total HI is 9.81, and TCE is the primary contributor to the HI, although arsenic and DBCP also have individual HQs greater than 1.

The total estimated upper-bound carcinogenic risk for the adult occupational scenario is 8.6 x 10 -5. Arsenic and TCE are the primary contributors to the total estimated risk with the individual risk associated with DBCP greater than 5 percent of the total. The total HI is 2.12, and TCE is the only COPC with an individual HQ greater than 1.

Main Plume Region 1: Lower Subshallow HSZ. Carbon tetrachloride, cis-1,2-DCE, PCE, and TCE are the most commonly reported organic analytes in the Main Plume 2 lower subshallow HSZ. The total estimated upper-bound carcinogenic risk for the adult residential receptor is 1.9 x 10 -5. PCE and TCE are the primary contributors to this risk, although carbon tetrachloride also contributes greater than 5 percent of the total. The total HI is less than 1 and TCE is the primary contributor to the total HI.

The total estimated upper-bound carcinogenic risk for the child residential receptor is 8.4 x 10 -5. PCE and TCE are the primary contributors to the total risk, although benzene and carbon tetrachloride also have individual risks that contribute 5 percent or greater of the total.

The total HI is 1.44, and TCE contributes more than half of the estimated HI, although its individual HQ is less than 1.

The total estimated upper-bound carcinogenic risk for the adult occupational scenario is 8.9 x 10 -6. PCE and TCE are the primary contributors to the total estimated risk with the individual risk associated with carbon tetrachloride greater than 5 percent of the total. The total HI is less than 1, and TCE is the primary contributor to the HI.

Main Plume Region 1: Confined HSZ. The total estimated upper-bound carcinogenic risk for the adult residential receptor is 2.6 x 10 -4. Arsenic is the primary contributor to this risk, although TCE also has an individual risk of 5 percent or greater of the total risk. The total HI is 3.90, and arsenic is the only COPC with an individual HQ greater than 1.

The total estimated upper-bound carcinogenic risk for the child residential receptor is 1.2 x 10 -4. Arsenic is the primary contributor to the total estimated risk, although TCE has an individual risk that contributes 5 percent or greater of the total. The total HI is 9.23, and both arsenic and TCE have individual HQs greater than 1.

The total estimated upper-bound carcinogenic risk for the adult occupational scenario is 8.3 x 10 -5. Arsenic is the primary contributor to the total estimated risk with the individual risk associated with TCE greater than, 5 percent of the total. The total HI is 1.55. Although no single COPC has an individual HQ greater than 1, arsenic is the primary contributor to the estimated total hazard.

Main Plume Region 2: Shallow HSZ. TCE is the most prevalent organic contaminant found in the Main Plume Region 2 shallow HSZ. The total estimated upper-bound carcinogenic risk for the adult residential receptor is 1.9 x 10 -4. Ethylene dibromide (EDB) and TCE are the primary contributors and together account for 86 percent of the total estimated risk. DBCP also accounts for greater than 5 percent of the total estimated risk. The total HI is 2.87, and the primary contributors to the total HI are DBCP and TCE, with the HQ for TCE greater than 1.

The total estimated upper-bound carcinogenic risk for the child residential receptor is 9.1 x 10 -5. EDB and TCE are the primary contributors to the estimated risk total, and together account for 95 percent of the total risk. DBCP also accounts for greater than 5 percent of the total estimated risk. The total HI is 6.95, and both DBCP and TCE have individual Hqs greater than 1.

The total estimated upper-bound carcinogenic risk for the adult occupational scenario is 7.0 x 10 -5. EDB and TCE are the primary contributors to the total and together account for 96 percent of the total estimated risk. DBCP also accounts for greater than 5 percent of the total estimated risk. The total HI is 1.51, and TCE is the primary contributor to the HI and the only COPC with an individual HQ greater than 1.

Main Plume Region 2: Upper Subshallow HSZ. DBCP and TCE are the most prevalent organic contaminants found in the Main Plume Region 2 upper subshallow HSZ. The total estimated upper-bound carcinogenic risk for the adult residential receptor is 1.8 x 10 -4. TCE is the primary contributor to the total estimated risk. DBCP and EDB, although less widely distributed than TCE, have individual contributions of 18 and 33 percent, respectively, to the cumulative total. The total HI is 3.21, and the primary contributors to the total HI are DBCP and TCE, with each having an individual HQ greater than 1.

The total estimated upper-bound carcinogenic risk for the child residential receptor is 9.1 x 10 -5. DBCP, EDB, and TCE are the primary contributors to the estimated risk total. The total HI is 8.19, and both DBCP and TCE have individual HQs greater than 1.

The total estimated upper-bound carcinogenic risk for the adult occupational scenario is 6.3 x 10 -5. EDB and TCE are the primary contributors to the total risk. The total HI is 1.59, and TCE is the primary contributor to the HI and the only COPC with an individual HQ greater than 1.

Main Plume Region 2: Lower Subshallow HSZ. Only one well was screened in the Main Plume Region 2 lower subshallow HSZ, and TCE was the only COPC identified. Because of this limited amount of data, the spatial distribution of TCE in the HSZ is unknown, and the calculated risks and hazards are based on an assumed plume-wide exposure to the single measured concentration. The estimated upper-bound carcinogenic risks are 2.9 x 10 -6 for the adult residential receptor, 1.3 x 10 -6 for the child residential receptor, and 1.4 x 10 -6 for the occupational receptor. The HI is less than 1 for all evaluated exposure scenarios.

Main Plume Region 2: Confined HSZ. Three monitoring wells were screened in the Main Plume Region 2 confined HSZ. Because of the limited amount of data, statistical analyses were not performed, and the estimated risk and hazard is based on an assumed plume-wide exposure to the maximum detected concentration for each analyte. Benzene is the primary contributor to the total estimated risk and accounts for 60 percent or more of the cumulative total in all exposure scenarios evaluated. The estimated upper-bound carcinogenic risks are 3.0 x 10 -6 for the adult residential receptor, 1.4 x 10 -6 for the child residential receptor, and 1.2 x 10 -6 for the occupational receptor. The HI is less than 1 for all evaluated exposure scenarios.

Landfill 4 Plume Region. PCE and TCE are the most commonly reported organic contaminants found in the Landfill 4 region shallow HSZ. The total estimated upper-bound carcinogenic risk for the adult residential receptor is 1.7 x 10 -4. Arsenic and DEHP are the primary contributors to the total estimated risk. The total HI is 4.05, and arsenic is the only COPC with an individual HQ greater than 1.

The total estimated upper-bound carcinogenic risk for the child residential receptor is 9.3 x 10 -5. Arsenic and DEHP are the primary contributors to the estimated risk total. The total HI is 9.34, and antimony, arsenic, DEHP, and DBCP have individual HQs greater than 1.

The total estimated upper-bound carcinogenic risk for the adult occupational scenario is 4.4 x 10-5. Arsenic and DEHP are the primary contributors to the total risk. The total HI is 1.70.

North Base Plume Region. DEHP and dichlorodifluoromethane are the most frequently reported organic COPCs found in the North Base Plume region shallow HSZ. The total estimated upper-bound carcinogenic risk for the adult residential receptor is 5.2 x 10 -5. DEHP, PCE, and vinyl chloride are the primary contributors to the total estimated risk. The total HI is less than 1.

The total estimated upper-bound carcinogenic risk for the child residential receptor is 3.6 x 10 -5. DEHP, PCE, and vinyl chloride are the primary contributors to the estimated risk total. The total HI is 1.40, and DEHP is the only COPC with an individual HQ greater than 1.

The total estimated upper-bound carcinogenic risk for the adult occupational scenario is 1.0 x 10 -5. DEHP, PCE and vinyl chloride are the primary contributors to the total risk, although methylene chloride and TCE also have individual risks greater than 5 percent of the cumulative total. The total HI is less than 1.

East Base Plume Region. TCE is the most frequently reported organic COPC found in the East Base Plume region shallow HSZ. The total estimated upper-bound carcinogenic risk for the adult residential receptor is 8.7 x 10 -5. The total HI is less than 1.

The total estimated upper-bound carcinogenic risk for the child residential receptor is 4.2 x 10 -5. The total HI is 1.61, and arsenic is the greatest contributor to the total HI although

its individual HQ is less than 1.

The total estimated upper-bound carcinogenic risk for the adult occupational scenario is 2.6 x 10 -5. The total HI is less than 1.

Landfill 1 Plume Region: Shallow HSZ. Chloroform and PCE are the most frequently reported organic COPCs found in the Landfill Plume Region 1 shallow HSZ. The total estimated upper-bound carcinogenic risk for the adult residential receptor is 2.9 x 10 -4. Arsenic 1) accounts for greater than 95 percent of the estimated carcinogenic risk, 2) is the most significant contributor to the HI for all three scenarios, and 3) has an individual HQ greater than 1 in all three scenarios.

The total estimated upper-bound carcinogenic risk for the child residential receptor is 1.4 x 10 -4. The total HI is 4.36.

The total estimated upper-bound carcinogenic risk for the adult occupational scenario is 8.6 x 10 -5. The total HI is less than 1.

Landfill 1 Plume Region: Upper Subshallow HSZ. Two monitoring wells were screened in the Landfill 1 upper subshallow HSZ. Because of the limited amount of data, statistical analyses were not performed, and the estimated risk and hazard is based on an assumed plume-wide exposure represented by the well with maximum detected concentration for each analyte. In all three exposure scenarios evaluated, TCE is the primary contributor to the total risk.

The estimated carcinogenic risks are 4.7 x 10 -7 for the adult residential receptor, 2.3 x 10 -7 for the child residential receptor, and 2.2 x 10 -7 for the occupational receptor. The HI is less than 1 for all three evaluated exposure scenarios.

Castle Vista Plume Region: Cis-1,2-DCE and PCE were each detected in two wells and were the only contaminants detected in more than one well in the Castle Vista Plume region shallow HSZ. The estimated carcinogenic risks are 1.1 x 10 -4 for the adult residential receptor, 5.2 x 10 -5 for the child residential receptor, and 4.2 x 10 -5 for the occupational receptor. The HI is less than 1 for all three evaluated exposure scenarios.

Uncertainty Analysis. The presence of uncertainty is inherent in the risk assessment process. The sources of uncertainties in risk assessment range from the assumptions and methodologies used in the evaluation of exposures and risks to data gaps in the qualitative and quantitative information used to characterize site COPCs. Acknowledgment of the uncertainties present is necessary to appropriately evaluate risk assessment results, and assists in the identification of any further investigations that may be required. The uncertainties associated with the CB-Part 1 BHHRA for Castle AFB result from limitations in the available methods, information, and data.

Human Health Risks and Hazards Summary. The human health risk assessment evaluated the current and future risks to exposed populations under several different scenarios. Table 3-4 summarizes the results of the risk assessment for the plumes identified in the RI/FS. The table identifies the highest calculated cancer risks and hazards for the scenarios evaluated: the adult residential, the child residential, and the adult occupational scenarios. In this table, it can be seen that some plume regions have cancer risk estimates that are above the upper limit of the target risk range (1.0 x 10 -4), while others are below this limit. In addition, some of the plume regions have HIs that exceed 1.0, suggesting that a health hazard may be posed under the scenario considered.

Other factors, besides risk and hazard index, were taken into consideration when determining the need to implement RAs for groundwater plumes. These factors include contaminant mass, areal extent of the contaminant plume, and other plume characteristics. Based on all factors considered, the Main Base Plume and East Base Plume were advanced for further detailed evaluation in the CB-Part 1 FS. In addition, the Castle Vista Plume was recognized in the RI/FS as requiring additional characterization to determine whether or not RA was warranted.

For the North Base, Landfill 1, and Landfill 4 Plumes, the mass of contaminants and the areal extent of contamination are small and are associated with isolated detections. Remediation would not be technically or economically feasible, nor would it significantly enhance the beneficial uses of groundwater. As a result of these factors, no further active remediation is planned for the North Base, Landfill 1, and Landfill 4 plumes. However, these plumes will continue to be monitored under the LTGSP.

If the actual or threatened migration of contaminated groundwater at Castle AFB is not addressed by implementing the remedial response actions selected in this ROD, contaminated groundwater at Castle AFB may present an imminent and substantial endangerment to public health, welfare, and/or the environment. Although groundwater cleanup actions are underway in the area of OU 1 and OU 2, there are additional areas of groundwater remediation that are not currently being addressed; it is the purpose of CB-Part 1 to address the need for further groundwater remediation.

3.6.2 Ecological Risk Assessment (ERA). The scoping and Phase I ERA was completed in December 1995 as a portion of the CB-Part 1 RI/FS. The goal of the Phase I ERA was to evaluate the possible adverse ecological effects of past and current on-site chemical contaminants to ecological receptors. The ERA contains two other phases, each dependent on the results of the preceding phase. Phase II is the Validation/Verification Assessment, which reduces the uncertainty in Phase I. Phase III is the Remedial Assessment, which is a focused investigation to identify the remedial objectives. The Phase II ERA is scheduled to be completed in December 1996 and will be included in the final documentation of CB-Part 2 RI/FS.

The groundwater at Castle AFB is located approximately 70 to 80 feet below ground level and does not recharge to the surface. Since it is too deep for ecological receptors to contact, groundwater is not considered a medium of concern for the ERA. However, this medium may need to be considered in the future if reuse plans for Castle AFB are changed to include agricultural uses, which could expose surface receptors to groundwater via irrigation. Institutional controls prohibiting pumping from contaminated groundwater plumes should preclude exposure of surface receptors to the contaminated water.

3.6.3 Screening of Contaminants and Groundwater Plume Regions. The seven groundwater plumes and contaminants identified in Section 3.5 were screened for consideration of RA by using the following five step process illustrated in Figure 3-7. For those plumes and contaminants identified for consideration of RA, preliminary RA options were formulated. The following conclusions were derived from the results that are summarized in Section 2 of the CB-Part 1 FS.

3.6.3.1 Groundwater Plume and Contaminant Screening Process. The screening process for evaluating groundwater plumes and contaminants for further consideration of remedial analysis included the following interrogative steps.

- Step 1. Chemicals which occur regionally in groundwater either naturally (e.g., arsenic) or due to regional contamination (e.g., DBCP and EDB), and are not due to Castle AFB sources were eliminated from the list of potential COCs.

- Step 2. Within each plume region and HSZ, the risks and hazards associated with individual COPCs were evaluated and the concentrations of the COPCs were compared to ARARs. The individual COPCs for which the risk exceeds 10 -6, the HI exceeds 1.0, or the exposure point concentration exceeds the associated ARARs were retained. All other COPCs not previously excluded were eliminated in this step.

- Step 3. Those COPCs determined to have mappable groundwater plumes were identified. COPCs which were only detected in isolated locations and for which no mappable plumes were identified were forwarded for consideration in the LTGSP for filling of data gaps and continuation of monitoring.

- Step 4. The groundwater plumes of COCs identified, following the screening process in the first three steps, were evaluated to determine plumes for the development and analysis of RA alternatives. This evaluation included consideration of the areal extent and mass of the plume, the plume location, and comparison of the contaminant concentration to the associated MCL. Plumes for which development of RA alternatives was not considered appropriate at this time were forwarded for consideration in the LTGSP for filling of data gaps and continuation of monitoring.

- Step 5. Preliminary Remedial Action Options (PRAOs) were developed for those COC plumes retained after the four screening steps described above. These PRAOs were utilized as the basis for development of potential RA alternatives in the FS.

The following sections present the application of this screening process to each of the seven plume regions at Castle AFB.

With respect to step 1 of this process, arsenic, DBCP, and EDB were eliminated as COCs for the reasons discussed in the following paragraphs.

Arsenic was chosen as an analyte during the CB Groundwater RI because it could have been released during routine aircraft maintenance operations or from common solid wastes in landfills, and it had been detected previously in groundwater at Castle AFB. Arsenic and other metals were detected in wells located in all parts of Castle AFB, including background monitoring wells. Arsenic has also been detected in a significant number of shallow wells in the San Joaquin Valley. The City of Atwater Annual Water Quality Report for 1995 reports arsenic concentrations in eleven water supply wells ranging from nondetect to 9 Ig/L, with an average of 2.9 Ig/L.

Although several inorganic analytes with concentrations exceeding the TBV 95 values may be found in single wells, no definable plumes of arsenic or other inorganic constituents have been identified in any of the HSZs at Castle AFB. Where arsenic is detected, concentrations tend to be highest in the shallow HSZ, as is the case for all of the detected inorganics. The highest concentrations (20 and 17 Ig/L) of arsenic occur beneath Landfill 1. Other elevated concentrations appear beneath Landfill 4 (12 Ig/L) and at the east boundary of the base (11 Ig/L). All other concentrations are well below 10 Ig/L, generally in the 2 to 5 Ig/L range, and do not appear to be from Castle AFB sources. Exposure point concentrations do no exceed the MCL of 50 Ig/L. The close relationship among the metal concentrations suggest that there has not been and should not be a significant amount of metals transport via advection of groundwater in the future. Based on 1) the low concentrations (below MCL) of arsenic at Castle AFB, 2) the constituent relationship of these detections with other metals, 3) the fact that the metals concentrations are conservative due to being total metals, and 4) the general occurrence of arsenic at detectable concentrations below the MCL throughout the San Joaquin Valley, arsenic is considered to be present as a regionally-occurring groundwater characteristic, and the concentrations reported in groundwater at Castle AFB, with the exception of the Landfill 1 and

Landfill 4 Plume regions, are attributed to the regional occurrence. Although past activities at Landfill 1 and Landfill 4 may have contributed arsenic to groundwater, the concentrations are below the MCL of 50 Ig/L, the plumes are relatively small, and the mass of contaminants possibly related to Castle AFB is small.

DBCP and EDB have no remedial goals, and they are not considered COCs. No PRAOs were developed for these chemicals because they are agricultural contaminants commonly found in groundwater in the area around Castle AFB (Step 1).

3.6.3.2 Main Base Plume Regions. The organic COPCs that individually exceed carcinogenic risks of 1.0 x 10 -6 or a hazard index of 1, include benzene, carbon tetrachloride, EDB, DEHP, 1,1-DCE, cis-1,2-DCE, hexachlorobutadiene, methylene chloride, PCE, TCE, and DBCP. The exposure point concentrations of carbon tetrachloride, DEHP, EDB, 1,2-DCE, TCE, and DBCP exceed MCLs. The inorganic COPC that individually exceeds a carcinogenic risk of 1.0 x 10-6 or a hazard index of 1 is arsenic. For the reasons discussed above, arsenic, DBCP and EDB are not considered COCs based on step 1 of the screening process.

The COCs for the Main Base Plume regions are benzene, chloroform, carbon tetrachloride, cis-1,2-DCE, PCE, and TCE. Based on total mass and associated risk, the principal COC for the Main Plume region is TCE. Contamination occurs in the shallow, upper subshallow, lower subshallow, and confined HSZs. The extent of the TCE plume encompasses the extent of other organic contaminants present, with the exception of DBCP, which is not considered a COC, and benzene.

Two groundwater extraction systems have either been installed (OU 1) or are under construction (OU 2) to address TCE contamination within the shallow and upper subshallow HSZs in the Main Base Plume regions. The Main Base Plume accounts for 98 percent of the TCE mass and 95 percent of the TCE-contaminated groundwater volume at Castle AFB based on the 0.5 Ig/L (detection limit) plume boundaries (Table 3-1).

Three PRAOs for TCE were defined for the Main Base Plume:

- Capture and cleanup of TCE to the MCL of 5 Ig/L
- Capture and cleanup of TCE to 3 Ig/L
- Capture and cleanup of TCE to the detection limit of 0.5 Ig/L

These PRAOs were based on an agreement between the AF and the regulatory agencies to consider these levels; as documented in the ROD for OU 2 (AF 1993). The ultimate basis for the first of these levels is the chemical-specific ARAR that defines the MCL for TCE. The third PRAO was based on the detection limit for TCE, and the second PRAO represents the EPA Alternative Water Quality Criteria (AWQC) for health and welfare protection.

The PRAOs for the other COCs were set at their respective MCLs.

3.6.3.3 East Base Plume Region. The East Base Plume region is located beneath two sites with known soil contamination; FTA-1 and B1762 sites. Groundwater contamination is limited to the shallow HSZ.

The organic COPCs that individually exceed a carcinogenic risk of 1.0 x 10 -6 or an HI of 1 include bromodichloromethane, DEHP, carbon tetrachloride, PCE, and TCE. Exposure point concentrations exceed the MCL for DEHP. The inorganic COPC that exceeds a carcinogenic risk of 1.0 x 10 -6 or an HI of 1 is arsenic. Based on the above screening criteria, arsenic (step 1) was excluded from consideration as a COC.

DEHP, bromodichloromethane, carbon tetrachloride, and PCE were also excluded from remediation because they are only detected in isolated locations defining small plumes with low concentration and small total mass. Remediation of these plumes has been determined to be economically or technically infeasible and impractical. Further, beneficial uses of the groundwater have not been significantly impacted. These contaminants will be monitored under the LTGSP.

The COC identified for the East Base Plume region is TCE. Three PRAOs for TCE are defined for the East Base Plumes:

- Capture and cleanup of TCE to the MCL of 5 Ig/L
- Capture and cleanup of TCE to 3 Ig/L
- Capture and cleanup of TCE to the detection limit of 0.5 Ig/L

The rationale for the selected PRAOs is similar to that for the Main Base Plume.

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There are no COCs for the Landfill 4 Plume region based on these results. Therefore, no RAs are considered necessary for the Landfill 4 Plume and no PRAOs are defined. Remediation of these plumes has been determined to be economically or technically infeasible and impractical. Further, beneficial uses of the groundwater have not been significantly impacted. This plume region would be forwarded to the LTGSP.

3.6.3.5 North Base Plume Region. The North Base Plume region is located beneath Landfill 5 in the North Base Sector. Contamination has been detected in the shallow HSZ. The organic COPCs that individually exceed a carcinogenic risk of 1.0 x 10 -6 or an HI of 1 include benzene, DEHP, 1,4-dichlorobenzene, methylene chloride, PCE, TCE, and vinyl chloride. The exposure point concentration of DEHP exceeds the MCL.

Benzene, 1,4-dichlorobenzene, methylene chloride, and vinyl chloride are not considered to be COCs because they are only detected in isolated locations defining small plumes with low concentration and small total mass. Remediation of these plumes has been determined to be economically or technically infeasible and impractical and would not significantly enhance the beneficial uses of groundwater. Further, beneficial uses of the groundwater have not been significantly impacted. These contaminants will be monitored under the LTGSP.

3.6.3.6 Landfill 1 Plume Region. The Landfill 1 Plume is located beneath Landfill 1 in the South Base Sector. Contamination is in the shallow HSZ.

PCE is the only organic COPC that individually exceeds a carcinogenic risk of 1.0 x 10 -6 or an HI of 1. Arsenic is the only inorganic COPC that individually exceeds a carcinogenic risk of 1.0 x 10 -6 or an HI of 1. Exposure point concentrations do not exceed MCLs for any COPCs. No further active remediation was selected for Landfill 1.

For the reasons discussed above, arsenic is not considered to be a COC, based on step 1 of the screening process. PCE was excluded from remediation because it was detected only in isolated locations defining small plumes with low concentration and small total mass.

TCE was identified as the COC for Landfill 1.

3.6.3.7 Castle Vista Plume Region. The Castle Vista Plume is located beneath Castle Vista Landfill B in the off-base sector. Contamination is in the shallow HSZ.

The COPCs that individually exceed a carcinogenic risk of 1.0 x 10 -6 or an HI of 1 are benzene, EDB, and PCE. Exposure point concentrations exceed MCLs for cis-1,2-DCE, EDB, and PCE. EDB and benzene are excluded from consideration for the following reasons.

Benzene is excluded because it is only detected in isolated locations and it is not possible to define a plume. This contaminant will be monitored under the LTGSP. PRAOs were not developed for EDB because it is an agricultural contaminant commonly found in groundwater in the Castle AFB area.

The COCs for the Castle Vista Plume region based on these results are cis-1,2-DCE and PCE. There is less than 3 pounds of either compound present, and the areal extent of the plumes is limited. Therefore, no active RAs were originally recommended in the RI/FS for the Castle Vista Landfill Plume and no PRAOs were defined.

Subsequent to the completion of the RI/FS, new monitoring information from data gap wells indicated the need for active remediation. In April and May 1996, three monitoring wells (MW935, 936 and 937) were installed in the shallow HSZ, downgradient of the Castle Vista Plume to fill data gaps that had been previously identified in the LTGSP and in the CB-Part 1 RI/FS. Two initial rounds of sampling were carried out at these wells; in addition, groundwater samples were collected from two existing monitoring wells (MW002 and 003) in the Castle Vista area.

The results of these two rounds of sampling indicated an elevated level of volatile organic compounds in the Castle Vista plume. Samples at MW936 indicated elevated levels of cis-1,2-DCE (48 and 90 Ig/L); TCE (.72 and 1.2 Ig/L); and PCE (4.8 and 8.3 Ig/L). In addition, elevated levels of these compounds were also found at the existing monitoring wells, MWO02 and 003. Because these levels indicate that groundwater contamination exceeds MCLs and presents a greater extent of contamination than was previously evaluated in the CB-Part I RI/FS, the AF, with regulatory agency concurrence, has decided to implement an active pump and treat remedy as a presumptive remedy for this plume.

3.7 DESCRIPTION OF THE ALTERNATIVES

To clean up the contaminated groundwater of the Main and East Base Plumes at Castle AFB, a wide range of possible alternatives were considered in the CB-Part 1 FS. In general, there are many potential options available to remediate groundwater. The most promising options for the Main and East Base Plumes were chosen on the basis of effectiveness, implementability, and cost. Each alternative is discussed on the following pages.

Currently, there are two groundwater treatment systems (OU 1 and OU 2) in the RD/RA phase. The OU 1 groundwater extraction and treatment system began operating in July 1994 to remediate groundwater in the shallow HSZ within the Main Base Plume Region 1. OU 2 RAs are being implemented to address groundwater contamination in the shallow and upper subshallow HSZs within the Main Base Plume regions. The DA-4 removal action operated to remove contaminated groundwater from the shallow HSZ within Main Base Plume Region 2. The Wallace Road groundwater extraction and treatment system began operating in December 1991 to remediate groundwater in the shallow and upper subshallow HSZs within Main Base Plume Region 2. The Wallace Road system is scheduled to be shut down and replaced by the OU 2 extraction and treatment system. This will provide for expanded remediation of groundwater in the shallow and upper subshallow HSZs within Main Base Plume Region 2.

The remedial alternatives selected for analysis in the CB-Part 1 FS include a combination of groundwater extraction and treatment options, generally referred to as pump and treat. Each pump and treat alternative combines processes from the following four categories:

- Groundwater extraction
- Groundwater treatment
- Disposal of treated water
- Monitoring of remedial systems

The groundwater treatment options considered were:

- Air Stripping
- Advanced oxidation using ultraviolet (UV) light and an oxidizing chemical
- Liquid-phase granular activated carbon (L-P GAC) adsorption

After the treated groundwater is discharged from the treatment system, it can be reinjected using injection wells, released to a surface discharge location near the treatment system, or otherwise reused. Reinjection has been included since it gives the option of conserving the groundwater resources in the area, and creating a hydraulic barrier to help contain the plume. Surface discharge to irrigation canals provides seasonal beneficial use of extracted groundwater to local agricultural interests, and the existing irrigation canals have the capacity to handle the large volumes of discharge expected. In addition, the supplying of treated water for beneficial reuse may offset regional production well drawdown of groundwater levels. Groundwater cleanup activities to date at Castle AFB (i.e., those conducted under OU 1 and the removal actions at Wallace Road and DA-4) have included both reinjection and surface discharge. Other reuse options have been the subject of ongoing discussions with local water authorities. The AF is currently conducting a water reuse study to further evaluate future reuse options.

Main Base Plume Remedial Alternatives. The CB-Part 1 FS combined the extraction, treatment, and disposal options selected from screening of the technologies and process options to form the following remedial alternatives for the Main Base Plume.

1. No Action
2. Impacted area well-head treatment
3. Extraction of Groundwater above 5 Ig/L TCE combined with:
   A) Air Stripping and Canal Discharge
   B) Air Stripping with L-P GAC Adsorption and Canal Discharge
   C) UV/Oxidation anO Reinjection
   D) L-P GAC Adsorption and Reinjection
4. Extraction of Groundwater above 0.5 Ig/L TCE combined with:
   A) Air Stripping and Canal Discharge
   B) Air Stripping with L-P GAC Adsorption and Canal Discharge
   C) UV/Oxidation and Reinjection
   D) L-P GAC Adsorption and Reinjection
5. Extraction of Groundwater above 3 Ig/L TCE combined with:
   A) Air Stripping and Canal Discharge
   B) Air Stripping with L-P GAC Adsorption and Canal Discharge
   C) UV/Oxidation and Reinjection
   D) L-P GAC Adsorption and Reinjection
6. Extraction for Plume Control combined with impacted well-head treatment
   A) Air Stripping and Canal Discharge
   B) Air Stripping with L-P GAC Adsorption and Canal Discharge
   C) UV/Oxidation and Reinjection
   D) L-P GAC Adsorption and Reinjection

East Base Plume Remedial Alternatives. The following remedial alternatives were subjected to a detailed analysis in the CB-Part 1 FS for the East Base Plume.

1. No Action
2. Impacted Area Well Destruction and Monitor
3. Extraction of Groundwater above 5 Ig/L TCE combined with:
   A) Air Stripping and Reinjection
   B) UV/Oxidation and Reinjection
   C) L-P GAC Adsorption and Reinjection
4. Extraction of Groundwater above 0.5 Ig/L TCE combined With:
   A) Air Stripping and Reinjection
   B) UV/Oxidation and Reinjection
   C) L-P GAC Adsorption and Reinjection
5. Extraction of Groundwater above 3 Ig/L TCE combined with:
   A) Air Stripping and Reinjection
   B) UV/Oxidation and Reinjection
   C) L-P GAC Adsorption and Reinjection

To reduce redundancy and facilitate review, both the Main and East Base Plume remedial alternatives are discussed together in the following sections.

3.7.1 Alternative 1: No Action.

Main Base Plume. CERCLA requires evaluation of a No Action alternative. However, at Castle AFB, the No Action alternative involves implementation of existing (OU 1) and planned (OU 2) groundwater remediation systems. Long-term groundwater monitoring will also continue throughout the operating systems to ensure that each system attains its remediation goals. Therefore, the Castle AFB CB-Part 1 RI/FS No Action groundwater remediation option/alternative is applicable only to any groundwater contamination not captured by the OU 1 and OU 2 systems. This alternative also assumes 30 years of continued monitoring for the 244 existing monitoring wells associated with the Main Base Plume.

This alternative has the lowest overall cost at approximately $2.9 million. Factors which may affect the cost of this alternative are well maintenance and structural repairs of existing wells due to deterioration over time.

The No Action alternative is not expected to meet PRAOs. Natural intrinsic processes of biodegradation and adsorption may control the spread of the plume. While being technically feasible, acceptance by community and regulatory agencies is unlikely. Costs for the first 15 years of monitoring are included as part of the Castle AFB OU 1 and OU 2 RAs, and the Castle AFB LTGSP.

East Base Plume. The No Action alternative would involve up to 30 years of continued monitoring of the 44 existing monitoring wells associated with the East Base Plume region. Since no action would be taken to contain the contaminant plumes or reduce the TCE concentrations (or other COCs) in the plumes, this alternative would not meet the PRAOs.

This alternative may be considered easier to implement for the East Base Plume region than for the Main Base Plume regions. The maximum concentration of TCE within the largest of the three individual plumes in the East Base Plume region is approximately 45 Ig/L, compared to 740 Ig/L for the Main Base Plume. Additionally, the maximum TCE concentrations within the smaller East Base Plumes are only slightly above MCL levels. This alternative represents a low cost option because of the limited efforts required for implementation.

Natural intrinsic processes of biodegradation and adsorption may control the spread of the plume Although technically feasible, acceptance by community and regulatory agencies is unlikely.

This alternative has an overall cost of approximately $0.5 million. Factors which may affect the cost of this alternative are well maintenance and structural repairs of existing wells due to deterioration over time.

3.7.2 Alternative 2: Impacted Area Well-Head Treatment/Well Destruction and Monitor. Main Base Plume. Under the Impacted Area Well-Head Treatment alternative for the Main Base Plume, action would be taken to provide acceptable quality water at impacted wells. Individual well-head carbon treatment units, similar to those currently in place at five off-base domestic wells, would be installed when future monitoring of domestic and municipal production wells indicates that it is necessary. In addition, administrative restrictions would be instituted to prevent installation of new production wells in impacted areas or areas with the potential to be impacted.

The treatment process options incorporated into this alternative include intrinsic biodegradation, GAC treatment units at individual domestic well-heads, and similar, larger scale, GAC units at the single municipal well effected.

The individual treatment units would be designed to reduce TCE concentrations in water to the detection limit (0.5 Ig/L). Other COCs would be similarly removed. A 16-gpm capacity carbon treatment unit would be sufficient for each of the domestic wells. It was assumed that four carbon treatment units, each with a capacity of 500 gpm, would be used in parallel to treat each municipal well.

The CB-Part 1 RI/FS identifies vertical conduits and downgradient receptor wells, respectively, that may be affected in the future by the migrating TCE plume. Based on an analysis of factors including proximity to the TCE plume, well construction, existing subsurface lithology, and localized hydraulic gradients, it was estimated that a total of 26 domestic wells and one municipal well would require well-head treatment. In addition, seven domestic wells, one irrigation well, and one production well would be sealed because the wells may have been screened across more than one HSZ, and may thus serve as conduits for contamination.

Individual well-head treatment units have been effective in reducing the concentrations of contaminants in groundwater pumped from production wells to levels below MCLs; however, this alternative does not include measures to prevent the migration of the contaminated plumes. A conservative assumption is that this alternative may not meet PRAOs or prevent further migration of contaminant plumes. However, it was considered protective of human health because it would address the toxicity and mobility of the contaminated drinking water source prior to the point of exposure.

This alternative was found to be technically feasible and easily implementable because the individual well-head carbon treatment units are commonly employed, and are based on proven technology that has been used successfully for domesitic well treatment in the past. The domestic well-head treatment units currently in place consist of individual treatment tanks containing one cubic foot of GAC. According to the current Castle AFB domestic well-head treatment maintenance contractor, they are typically backwashed monthly and can last for up to two years without carbon replacement.

This alternative may also be considered feasible because well-head treatment units are currently in place at five domestic wells in the Castle AFB area and appear to be acceptable to the community. However, acceptance by community and regulatory agencies was believed to be unlikely due to the potential for the contaminant plumes to continue spreading.

As with the No Action alternative, the 244 existing monitoring wells associated with the Main Base Plume are assumed to be monitored for 30 years. In addition, twelve new monitoring wells

(including four in the shallow HSZ, two in the USS HSZ, three in the LSS HSZ, and three in the CF HSZ) were proposed to further monitor plume migration. These new monitoring wells were included in this alternative to further assess whether certain off-base domestic, irrigation, and municipal wells would be impacted by the TCE plume. The new monitoring wells would be placed between the plume and the potential receptor wells. Additional sampling for contaminants would also be conducted at the potential receptor wells.

This alternative was considered to be cost-effective with a total present worth estimated to be approximately $12 million. Of the 27 potentially impacted wells assumed in the cost estimate to require the installation of well-head treatment units, only one is a production well requiring the installation of 500-gpm carbon units. A smaller 16-gpm unit, which costs $1,400, would be sufficient for domestic wells.

East Base Plume. The Well Destruction and Monitoring alternative for the East Base Plume would mitigate the potential health risks arising from the East Base Plume region by sealing existing wells that provide a conduit for the introduction of contaminants to the groundwater. The potential impact of the East Base Plume has been identified through consideration of receptor well location and construction, existing subsurface lithology, localized hydraulic gradients, and current plume boundaries. Based on this analysis, certain wells have been identified as potential receptor wells which may be impacted by migration of the East Base Plume beyond 30 years. Two of these wells (PW-5 and PW-11E) are currently out of service. Production wells having the potential for HSZ cross contamination would be sealed and abandoned (following appropriate guidelines) to avoid the potential spread of contamination. This alternative would include 30 years of continued monitoring of the 44 existing monitoring wells associated with the East Base Plume region.

Because no action would be taken to contain the contaminant plumes, this alternative may not meet the PRAOs.

The Well Destruction and Monitoring alternative is considered to be more easily implemented for the East Base Plume region than is the Well-Head Treatment alternative for the Main Base Plume.

3.7.3 Alternative 3: Extraction with TCE Capture Objective of 5 Ig/L. Main Base Plume. The 5 Ig/L Capture alternative includes the design of a groundwater extraction well network to effectively capture and minimize the spread of the TCE-contaminated plume within four contaminated groundwater zones. The extraction wells proposed would be designed and constructed according to State of California Department of Health Services Technical Standards for the Design and Construction of Extraction Wells at Hazardous Waste Sites. The extraction wells should capture and remove the plume of TCE (and other COCs) dissolved in groundwater; however, anticipated plume capture volumes may not be achieved due to subsurface geologic characterization. In addition, TCE adsorbed onto soils may be partially immobilized and escape treatment; however, as the liquid-phase TCE is removed, the adsorbed phase will gradually return into the liquid phase to maintain equilibrium and will eventually enter the treatment system.

This alternative assumes that 12 new monitoring wells will be placed downgradient of the plume to monitor plume movement and hydraulic conditions over the 15-year operation period.

This Main Base Plume alternative requires the following extraction well totals (including those wells implemented under OU 1 and OU 2):

- Nineteen extraction wells for the shallow HSZ with total extraction rate of 2,625 gpm
- Twelve extraction wells for the upper subshallow HSZ with total extraction rate of 1,650 gpm
- One well for the lower subshallow HSZ with an extraction rate of 200 gpm
- Two wells for the confined HSZ with total extraction rate of 250 gpm

The following extraction wells are the new wells that would be included beyond those for OU 1 and OU 2:

- Three new extraction wells for the shallow HSZ with a total extraction rate of 500 gpm
- Seven new extraction wells for the upper subshallow HSZ with a total extraction rate of 850 gpm
- One new extraction well for the lower subshallow HSZ with an extraction rate of 200 gpm
- Two new extraction wells for the confined HSZ with a total extraction rate of 250 gpm

The extraction well numbers, design pumping rates and the initial TCE concentrations for the 5 Ig/L Capture alternative are summarized in Table 3-9. Calculations based on the modeling results indicate that with a cleanup criterion of 5 Ig/L, the groundwater remediation time may range from ten to 60 years, depending on the HSZ that is being remediated. The lower subshallow HSZ has the longest remediation time period (60 years), the shallow HSZ is 20 years, the upper subshallow HSZ is 30 years, and the confined zone has the shortest (ten years). The actual remediation time is dependent on how aggressively (fast) the groundwater is extracted.

The 5 Ig/L TCE Capture alternative is expected to be effective in removing TCE and other COC contamination since both the lithology and types of contaminants identified at Castle AFB are well suited to groundwater pump and treat technologies. However, pump and treat systems have been shown to have limited success in achieving remedial objectives within a reasonable time period. Operation of this remedial alternative to reduce organic contaminant concentrations to MCLs will be protective of public health for potential uses of the groundwater.

This alternative has the potential to meet the PRAOs for treatment of contaminated groundwater to MCLs within eight to 60 years depending on the HSZ. The cleanup period is estimated based on data and assumptions presented in the CB-Part 1 RI and Appendix C of the FS.

All four treatment options considered for this alternative are proven, effective technologies capable of reducing TCE and other COC concentrations below detection limits. Therefore, this alternative appears to protect human health and the environment because it is expected to reduce the toxicity, mobility, and volume of contamination.

The 5 Ig/L TCE Capture alternative is technically feasible since the process options for extraction, treatment, and disposal are proven, accepted, and widely used. The preliminary range of the estimated present worth costs for the 5 Ig/L TCE Capture alternative is from $15 to $34 million, and is dependent on the process options selected for treatment and disposal. The estimated costs for this alternative were developed under the assumption that the RA will operate for a period of 15 years. This assumption was made for the purpose of comparative analysis among the alternatives considered, although it is recognized that RA will likely be necessary over a longer period of time. The extraction well numbers, design pumping rates and the initial TCE concentrations for the 5 Ig/L capture alternative are summarized in Table 3-9. Calculations based on the modeling results indicate that with a cleanup criterion of 5 Ig/L, the groundwater remediation time may range from eight to 60 years, depending on the HSZ that is being remediated. The LSS HSZ has the longest remediation time period (60 years).

The AF is committed to completion of the RA regardless of the required time period of remediation. The actual costs to construct and operate the groundwater extraction system to

achieve the 5 Ig/L TCE cleanup objectives are likely to be significantly higher than the costs presented.

East Base Plume. The 5 Ig/L TCE Capture alternative includes an extraction system designed to meet the PRAOs for the East Base Plume region of capturing all groundwater with TCE concentrations exceeding the MCL. The same treatment options considered for the Main Base Plume regions would be considered for this alternative; for groundwater disposal, only reinjection was considered. This was due to the limited number of injection wells required and the distance of the proposed treatment plant location from an existing irrigation canal. In addition, because the extraction and injection wells proposed for the East Base Plume region would be screened only within the shallow HSZ, the potential implementation difficulties associated with injection of water derived from multiple HSZs does not arise for this alternative.

The overall effectiveness of this alternative, including the treatment and disposal options, is considered good since it will meet the PRAOs and protect public health by reducing the TCE concentrations in groundwater to MCL. The alternative it technically implementable because the extraction, treatment, and disposal technologies are proven and a limited number of extraction and injection wells are required. This alternative may be more acceptable to the regulatory agencies and the public than the similar alternative for the Main Base Plume regions due to the smaller plume volume, lower average TCE concentrations, and reduced potential for impact to receptor wells for the East Base Plume region. The present worth cost range for this alternative is $4 to $6 million (depending on the treatment option).

This capture alternative requires two extraction wells for the shallow HSZ (with total extraction rate of 325 gpm). Calculations based on modeling results indicate that with a cleanup criterion of 5 Ig/L, the groundwater remediation time may range from eight to 60 years. The actual remediation time is dependent on how aggressively (fast) the groundwater is extracted.

3.7.4 Alternative 4: Extraction with TCE Capture Objective of 0.5 Ig/L. Main Base Plume. The 0.5 Ig/L TCE Capture alternative includes an extraction system and various treatment and disposal options designed to capture groundwater with any detectable TCE above 0.5 Ig/L. The rationale for the development of the 0.5 Ig/L Capture alternative is similar to that for the 5 Ig/L Capture alternative. The primary distinction between the two alternatives is the much greater volume of groundwater requiring extraction and treatment, and the associated higher cost.

As with the 5 Ig/L Capture alternative, the 0.5 Ig/L Capture alternative includes the design of a groundwater extraction well network that would effectively capture and prevent the spread of the TCE-contaminant plume within four contaminated groundwater zones, but to a lower residual limit. In addition, this alternative assumes that 12 new monitoring wells will be placed downgradient of the plume to monitor plume movement and hydraulic conditions over the 15-year operation period.

This alternative would require the following wells:

- Twenty-two extraction wells for the shallow HSZ with total extraction rate of 3,225 gpm
- Fourteen extraction wells for the upper subshallow HSZ with total extraction rate of 2,000 gpm
- Three extraction wells for the lower subshallow HSZ with total extraction rate of 400 gpm
- Three extraction wells for the confined HSZ with total extraction rate of 450 gpm

The extraction wells that would be included in addition to those for OU 1 and OU 2 are as follows:

- Seven extraction wells for the shallow HSZ with a total extraction rate of 1,100 gpm
- Nine extraction wells for the upper subshallow HSZ with a total extraction rate of 1,200 gpm
- Three extraction wells for the lower subshallow HSZ with a total extraction rate of 400 gpm
- Three extraction wells for the CF HSZ with a total extraction rate of 450 gpm

This alternative has the potential to reduce concentrations of TCE within groundwater to the 0.5 mg/L detection limit within 18 to 170 years depending on the HSZ. The actual remediation time is dependent on how aggressively (fast) the groundwater is extracted. If the proposed cleanup objective of 0.5 Ig/L can be achieved, this alternative would be effective in restoring groundwater in the Main Base Plume regions to near background conditions.

The 0.5 Ig/L TCE Capture alternative is technically more difficult to implement than the 5 Ig/L and the 3 Ig/L Capture alternatives, primarily because the 0.5 Ig/1 Capture alternative would require the installation of a greater number of extraction and injection wells over a larger area and their operation over a longer period of time. In addition, the presence of the geophysical and geochemical conditions discussed previously are likely to make this remedial alternative technically impractical. This alternative should be acceptable to the regulatory agencies and the public since it attempts to restore groundwater quality to background levels.

The expected overall present worth costs for the 0.5 Ig/L Capture alternative range from approximately $25 to $53 million, depending on the process options selected for treatment and disposal. The estimated costs for this alternative were developed under the assumption that the RA will operate for a period of 15 years. The reasoning for this assumption is that typically, groundwater extraction actions will be reevaluated within 15 years to assess if continued operation is likely to result in achieving the RA objectives within a reasonable time period. However, the estimated time predicted to achieve the cleanup objectives for this alternative may be as long as 170 years. Thus, the actual costs to construct and operate the groundwater extraction system to achieve the 0.5 Ig/L TCE-cleanup objectives are likely to be significantly higher than the costs presented.

This alternative is more costly than the 5 Ig/L Capture alternative because it would capture and treat a much larger volume of groundwater, although the total mass of TCE that would be removed is only 8 percent more. Changing the cleanup objective from the MCL to the detection limit would increase costs by 50 to 60 percent.

East Base Plume. The 0.5 Ig/L TCE Capture alternative includes an extraction system designed to capture all groundwater with TCE concentrations exceeding the detection limit. The same treatment and disposal options considered for the 5 Ig/L TCE alternative were considered for this alternative.

The overall effectiveness of this alternative, including the treatment and disposal options is considered good since it will meet the PRAOs and reduce TCE and other COC concentrations in groundwater to near background level. As discussed previously, the technical feasibility of meeting a cleanup objective near the detection limit for TCE in groundwater is not considered good. The alternative is technically implementable because the extraction, treatment, and disposal technologies are proven and a limited number of extraction and injection wells are required. This alternative should be acceptable to the regulatory agencies and the public since it attempts to restore groundwater quality to background levels. The present worth cost range for this alternative is $6 to $8 million (depending on the treatment option). The estimated

costs for this alternative were developed under the assumption that the RA would operate for a period of 15 years.

This alternative would require two extraction wells for the shallow HSZ with total extraction rate of 350 gpm.

The extraction well numbers, design pumping rates and the initial TCE concentrations for the 0.5 Ig/L Capture alternative are summarized in Table 3-12. This alternative has the potential to reduce concentrations of TCE within groundwater to the 0.5 detection limit within 20 to 90 years. The actual remediation time is dependent on how aggressively (fast) the groundwater is extracted. If the proposed cleanup objective of 0.5 Ig/L can be achieved, this alternative would be effective in restoring groundwater in the East Plume regions to near background conditions.

3.7.5 Alternative 5: Extraction with TCE Capture Objective of 3 Ig/L. Main Base Plume. The 3 Ig/L TCE Capture alternative includes an extraction system along with various treatment and disposal options designed to capture all groundwater with TCE concentrations exceeding 3 Ig/L. The rationale for the development of the 3 Ig/L TCE Capture alternative is similar to those for the 5 Ig/L and 0.5 Ig/L Capture alternatives. However, this alternative has a lower residual limit than 5 Ig/L (Alternative 3) and a higher residual limit than 0.5 Ig/L (Alternative 5).

As with the other capture alternatives, the 3 Ig/L Capture alternative includes the design of a groundwater extraction well network that would effectively capture and prevent the spread of the TCE-contaminant plume within four contaminated groundwater zones. In addition, this alternative assumes that 12 new monitoring wells will be placed downgradient of the plume to monitor plume movement and hydraulic conditions over the 15-year operation period.

This capture alternative would require the following wells:

- Twenty-two extraction wells for the shallow HSZ with total extraction rate of 2,875 gpm
- Thirteen extraction wells for the upper subshallow HSZ with total extraction rate of 1,600 gpm
- Two extraction wells for the lower subshallow HSZ with total extraction rate of 280 gpm
- Two extraction wells for the confined HSZ with total extraction rate of 320 gpm

The extraction wells that would be included in addition to those for OU 1 and OU 2 are as follows:

- Six extraction wells for the shallow HSZ with a total extraction rate of 750 gpm
- Nine extraction wells for the upper subshallow HSZ with a total extraction rate of 1,000 gpm
- Two extraction wells for the lower subshallow HSZ with a total extraction rate of 280 gpm
- Two extraction wells for the confined HSZ with a total extraction rate of 320 gpm

The extraction well numbers, design pumping rates and the initial TCE concentrations for the 3 Ig/L capture alternative are provided in Table 3-10.

This alternative has the potential to reduce concentrations of TCE within groundwater to less than 3 Ig/L within 10 to 150 years, depending on the HSZ. This cleanup period is estimated by interpolating the model results for the 5 Ig/L and 0.5 Ig/L Capture alternatives. The actual remediation time is dependent on how aggressively (fast) the groundwater is extracted. If the

proposed cleanup objective of 3 Ig/L can be achieved, this alternative would result in a marginal increase in reduction of risk over the 5 Ig/L alternative, while significantly increasing the cost and time required for cleanup.

The 3 Ig/L Capture alternative is technically more difficult that the 5 Ig/L Capture alternative, but less difficult technically than the 0.5 Ig/L Capture alternative because it requires an intermediate number of extraction and injection wells.

The overall present worth costs for the 3 Ig/L Capture alternative range from $19 to $41 million. The estimated costs for this alternative were developed under the assumption that the RA will operate for a period of 15 years. The reasoning for this assumption is that typically groundwater extraction actions will be reevaluated within 15 years to assess if continued operation is likely to result in achieving the RA objectives within a reasonable time period. However, the estimated time predicted to achieve the cleanup objectives for this alternative may be as long as 150 years. Thus, the actual costs to construct and operate the groundwater extraction system to achieve the 3 Ig/L TCE-cleanup objectives are likely to be significantly higher than the costs presented. This alternative represents a cost level between those of the 5 Ig/L and 0.5 Ig/L Capture alternatives.

East Base Plume. The 3 Ig/L TCE Capture alternative includes an extraction system designed to capture all groundwater with TCE concentrations exceeding 3 Ig/L TCE. The same treatment and disposal options considered for the 5 Ig/L TCE alternative are considered for this alternative.

The overall effectiveness of this alternative, including the treatment and disposal options is considered good since it will meet the PRAOs. The technical feasibility of achieving the cleanup objective of 3 Ig/L TCE concentration in groundwater is intermediate between the feasibility for the 5 Ig/L and 0.5 Ig/L objectives. The alternative is technically implementable because the extraction, treatment, and disposal technologies are proven and a limited number of extraction and injection wells are required. The estimated present worth cost range for this alternative is $4 to $6 million (depending on the treatment option). The estimated costs for this alternative were developed under the assumption that the RA would operate for a period of 15 years.

This capture alternative would require two extraction wells for the shallow HSZ with a total extraction rate of 325 gpm. In addition, three injections wells would be required to be installed in the shallow HSZ. The extraction well numbers, design pumping rates and the initial TCE concentrations for the 3 Ig/L Capture alternative are summarized in Table 3-11. This alternative has the potential to reduce concentrations of TCE within groundwater to 3 Ig/L within 10 to 80 years. The actual remediation time is dependent on how aggressively (fast) the groundwater is extracted.

3.7.6 Alternative 6: Extraction for Plume Control Combined with Potential Well-Head Treatment.
Main Base Plume. The Plume Control alternative includes an extraction system and various treatment and disposal options designed to control the spread of TCE and other COCs from the shallow groundwater zones to the confined groundwater zone and to provide well-head treatment for any domestic wells impacted by TCE-plume migration, if necessary. This alternative applies to the Main Base Plume regions only.

The Plume Control alternative would be a phased approach which builds on existing groundwater cleanup operations and plans. It includes the completion of planned OU 1 upgrades, and the expansion of the completed construction of OU 2 to mitigate and control the vertical and horizontal migration of the plumes. The analytical results from the LTGSP will be monitored and analyzed to determine the location, extension, and any movement of the plume. The plume would

be characterized in terms of a 5 Ig/L TCE contour line. Furthermore, well-head treatment would be implemented if needed to protect domestic and/or irrigation wells, but would not serve as a primary RA.

The objectives of the Plume Control alternative are to control the plumes in each groundwater zone to their current areas, to mitigate and restrict the vertical migration of the contaminants; and to remove the contaminants cost-effectively. This alternative would continue until the discontinuation of the pump and treat systems would not result in a short-term significant expansion or movement of the plume (5 Ig/L contour) and natural attenuation would be relied upon for further reduction. In addition, this alternative will be accomplished by implementing a treatment system standard of 0.5 Ig/L TCE.

This alternative also includes the abandonment and closure of the seven domestic wells, one irrigation well, and one production well which are contaminated and are screened across multiple groundwater zones and have the potential to act as vertical conduits to allow the vertical migration of TCE and other COCs. In addition, similar to the other extraction alternatives, 12 new monitoring wells will be placed downgradient of the plume to monitor the plume migration and hydraulic conditions over the expected 15 years that this remedial alternative would be in operation.

The Plume Control alternative for the Main Base Plume regions would require the following wells:

- Nineteen extraction wells for the shallow HSZ with a total extraction rate of 2,325 gpm
- Four extraction wells for the upper subshallow HSZ with a total extraction rate of 600 gpm
- Five extraction wells for the lower subshallow HSZ with a total extraction rate of 1,000 gpm

The extraction wells that would be included in addition to those for the OU 1 and OU 2 are as follows:

- Three new extraction wells in the Main Base Plume regions shallow HSZ with a total extraction rate of 200 gpm
- Five new extraction wells in the Main Base Plume regions lower subshallow HSZ with a total extraction rate of 1,000 gpm

The extraction well numbers, design pumping rates and the initial TCE concentrations for the Plume Control alternative are summarized in Table 3-12.

This alternative is expected to be effective in removing TCE and other COCs and controlling TCE-plume migration, since both the subsurface lithology and types of contaminants present at Castle AFB are well suited to groundwater pump and treat technologies. Though pump and treat systems have been shown to have limited success in achieving the remedial objectives within a reasonable time period, this alternative is different from the other pump and treat alternatives since its primary objective is to control vertical TCE plume migration to the confined HSZ rather than meet a TCE-cleanup objective. Based on the analysis of the two-dimensional modeling results, this alternative is expected to be very effective in achieving its primary objective of mitigating the vertical migration of TCE to the confined HSZ. However, this alternative may not achieve the objective of remediating the TCE plume to meet the PRAOs.

The Plume Control alternative is technically feasible since the process options for extraction, treatment, and disposal of groundwater are proven, accepted, and widely used. In addition, the impacted well-head carbon treatment units are commonly employed, and are also based on proven

technology that has been used successfully for domestic well treatment in the past. The administrative feasibility is expected to be good because well-head treatment units are currently in place at five domestic wells and appear to be acceptable to the community, and because the potentially impacted municipal production well will be protected from TCE plume migration. In addition, there will be reduction in the mobility, toxicity, and volume of contamination. There may be opposition from some of the public and regulatory agencies concerned about the possible inability of this alternative to meet TCE and other COC cleanup objectives.

The preliminary range of the estimated present worth costs for the Plume Control alternative is from $12 to $21 million, and is dependent on the process options selected for treatment and disposal. The estimated costs for this alternative were developed under the assumption that the RA will operate for a period of 15 years. The reasoning for this assumption is that typically groundwater extraction action will be reevaluated within 15 years to assess its effectiveness in achieving desired objectives. There is a possibility that the operation will need to extend beyond the 15-year period, so actual costs may be higher than the costs presented in this FS. This alternative is expected to be significantly more cost-effective than the groundwater pump and treat alternatives designed to meet cleanup objectives because of the lower volume of groundwater requiring treatment.

3.8 DETAILED AND COMPARATIVE ANALYSES OF REMEDIAL ALTERNATIVES

This section presents a comparative analysis of the remedial alternatives based on CERCLA criteria (EPA, 1988a) for the Main Base Plume and the East Base Plume regions.

The comparative analysis of alternatives for the Main Base Plume regions and for the East Base Plume regions are presented separately. Summaries of these analyses are presented in Tables 3-16 and 3-17. Each of the remedial alternatives is compared against seven of the nine CERCLA criteria: 1) Overall Protection of Human Health and the Environment, 2) ARARs, 3) Long-Term Effectiveness and Permanence, 4) Reduction of Toxicity, Mobility and Volume through Treatment, 5) Short-Term Effectiveness, 6) Implementability, and 7) Cost. The modifying criteria, 8) State/Support Agency acceptance and 9) Community Acceptance, have also been considered in the selection of remedies, and are discussed in Sections 3.8.3.1 (Main Base Plume) and 3.8.3.2 (East Base Plume).

Each remedial alternative was scored using a range of 1 to 5 for each of the seven evaluation criteria. The basis for scoring each criterion is detailed below:

Overall Protection of Human Health and the Environment: Evaluation according to this criterion provides an overall assessment of how adequately the alternative eliminates risks to human health and the environment. A score of 1 indicates that the remedial alternative would provide an unacceptable level of protection for human health and the environment. A score of 5 indicates that the COCs would be captured and treated to meet the PRAOs. Scores of 2, 3, and 4 were assigned on a relative basis to account for qualitative differences among remedial alternatives that do not warrant a score of 1 or 5.

ARARs: A score of 1 indicates that the remedial alternative would fail to satisfy ARARs, and a score of 5 indicates that the alternative would satisfy all ARARs. A score of 2, 3, or 4 was assigned to those remedial alternatives that would possibly meet all ARARs or would be eligible for one or more of the statutory waiver conditions for an ARAR.

Long-Term Effectiveness and Permanence: Evaluation of alternatives under this criterion addresses the risks posed after the alternative response objectives have been met. This evaluation considers the magnitude of residual risk remaining after completion of the

alternative and the adequacy and reliability of controls, if any, that are used to manage untreated contaminants at the site. A score of 1 indicates that no reduction in potential risk would be achieved. A score of 5 indicates that no unacceptable potential risk remains after the response objectives have been met. Scores of 2, 3 and 4 were assigned on a relative basis, taking into account differences in the site conditions after response objectives have been met.

Reduction of Toxicity, Mobility, and Volume Through Treatment: This evaluation criterion addresses the preference for alternatives that permanently and significantly reduce the toxicity, mobility, or volume of the hazardous substances. A score of 1 indicates that the remedial alternative would not reduce the toxicity, mobility, or volume of contamination at the site. A score of 5 was assigned when the reduction in toxicity, mobility, and volume of contamination would be sufficient to restore the site to near background conditions. Scores of 2, 3, and 4 were assigned on a relative basis to account for qualitative differences between
remedial alternatives that do not warrant a score of 1 or 5.

Short-Term Effectiveness: This evaluation criterion addresses human health and environmental risks arising from implementation of the remedial alternative. The factors considered include protection of workers and the surrounding community, environmental impact, and the length of time required to meet the response objectives. A score of 1 was assigned if the actions to implement the alternative will produce unacceptable health or environmental impacts and the actions will take an unacceptable time to complete. A score of 5 was assigned if the actions to implement the alternative will produce no significant unacceptable health or environmental impacts and the actions can be completed in a short time. Scores of 2, 3, and 4 were assigned on a relative basis to account for qualitative differences between alternatives that do not warrant a score of 1 or 5.

Implementability: This criterion addresses the technical and administrative feasibility of implementing an alternative. Technical feasibility factors include the availability and reliability of equipment and services required to implement the alternative. Administrative feasibility addresses factors such as anticipated difficulties in obtaining access to off-site locations. A score of 1 indicates that significant uncertainty would exist as to the reliability or availability of equipment or services required, or that significant difficulty is anticipated in obtaining required access. A score of 5 indicates that all equipment and services required are proven reliable and are readily available, and that no problems are anticipated in obtaining access. Scores of 2, 3, and 4 were assigned on a relative basis to account for qualitative differences between remedial alternatives that do not warrant a score of 1 or 5.

Cost: Scores are assigned on a relative scale based on the range between zero cost and the most expensive alternative. A score of 5 indicates costs between 0 and 20 percent of the cost of the most expensive alternative; a score of 4 indicates relative costs between 21 and 40 percent; a score of 3 indicates relative costs between 41 and 60 percent; a score of 2 indicates relative costs between 61 and 80 percent; and a score of 1 indicates relative costs between 81 and 100 percent of the most expensive alternative.

The scores in Table 3-13 indicate that the alternatives for the Main Base Plume regions differ significantly in environmental protection and cost. The alternatives emphasizing institutional responses generally cost less, but the alternatives including groundwater remediation provide more environmental protection. Similarly, as indicated in Table 3-14, cost differences between the alternatives considered for the East Base Plume region are significant. However, the alternatives including only institutional responses provide nearly as much environmental protection as the alternatives including groundwater

remediation.

Costs for the Main Base Plume alternatives are summarized in Table 3-15 and costs for the East Base Plume alternatives are summarized in Table 3-16. Detailed cost analyses of the alternatives are presented in Appendix D of the FS.

3.8.1 Main Base Plume Regions. The shallow and USS HSZs within the Main Base Plume regions contain the bulk of the TCE present in the groundwater beneath Castle AFB. The comparative analysis for the Main Base Plume regions considers only the contamination that is outside of the capture zones for the OU 1 and OU 2 systems. About 50 percent (3,000 pounds) of the mass of TCE in the Main Base Plume regions is outside of the capture zones for the OU 1 and OU 2 systems.

The following summary of the comparative analysis of the alternatives for the Main Base Plume regions is structured by the seven evaluation criteria. Under the heading of each of the criteria, the performance of the six alternatives is discussed in descending order from the highest to lowest performance.

3.8.1.1 Overall Protection of Human Health and the Environment. With the exception of the No Action alternative, all of the remedial alternatives considered for the Main Base Plume regions provide some degree of protection of human health and the environment.

The 5 Ig/L TCE Capture alternative, 0.5 Ig/L TCE Capture alternative, and 3 Ig/L TCE Capture alternative provide capture and treatment of the contaminants to the MCL or more stringent standards and each has been assigned a score of 5 for all process options.

The Plume Control alternative removes contaminant mass from the shallow, upper subshallow, and lower subshallow HSZs and controls plume migration in these HSZs. The modeling of TCE transport in the confined HSZ for this alternative (CB-Part 1 FS Appendix C) indicates that existing municipal wells will be protected. Individual well-head treatment units would be installed on any impacted domestic wells. However, this alternative provides less overall environmental protection than the extraction alternatives that would capture and clean up the concentrations of COCs in groundwater to MCL standards. Therefore, this alternative was assigned a score of 4 for all process options.

Alternative 2, Impacted Area Well-Head Treatment may not prevent the Main Base Plume from reaching domestic wells, but it will remove contaminants from the water before it is used. This alternative, however, provides less overall environmental protection than alternatives that will capture and clean up COCs in groundwater to MCL standards, and has therefore been assigned a score of 3.

The No Action alternative will potentially expose users of specific water supply wells to significant ingestion and dermal contact should the Main Base Plume be tapped by their wells. The No Action alternative therefore provides an unacceptable level of protection and was assigned a score of 1.

3.8.1.2 Compliance with Applicable or Relevant and Appropriate Requirements. Tables 3-17 and 3-18 are tables that summarize the RI/FS analysis of alternatives for the Main and East Base Plumes with respect to federal and State of California ARARs. Section 4 provides detailed information regarding ARARs governing groundwater cleanup at Castle AFB.

The AF has determined, with concurrence of the EPA and the State of California, that the 5.0 Ig/L TCE Capture alternative complies with State Water Resources Control Board (SWRCB) Resolution 92-49. This is based on a cost/benefit analysis, public comments on the Proposed Plan, and state review. The benefit to remediate to 0.5 Ig/L and 3 Ig/L concentrations is

determined not to be cost-effective for the additional benefit derived. Therefore, the 5.0 Ig/L TCE Capture alternative meets all chemical- and action-specific ARARs.

The Well-Head Treatment alternative is not expected to comply with state groundwater protection standards. The Well-Head Treatment alternative was therefore assigned a score of 2, indicating that the proposed remedial alternative fails to satisfy some of the ARARs.

3.8.1.3 Long-Term Effectiveness and Permanence. The 5 Ig/L, 3 Ig/L, and 0.5 Ig/L TCE Capture alternatives will capture and clean up the Main Base Plume to MCLs or lower concentrations, and will leave no significant potential health or environmental risks, therefore, these alternatives were assigned a score of 5 for all process options.

The Plume Control alternative will capture and remove most of the contaminant mass from the shallow, upper subshallow, and lower subshallow HSZs that is not within the capture zones of the OU 1 or OU 2 systems. This would allow natural attenuation to mitigate the remaining contamination in these HSZs as well as the confined HSZ. Installation of individual well-head treatment units at any impacted receptor wells would mitigate the potential health impacts from use of groundwater in areas containing concentrations of COCs above MCLs. Therefore, this alternative was assigned a score of 4 for all process options.

Although the Impacted Area Well-Head Treatment alternative would not reduce the extent of groundwater contamination, the installation of individual treatment units at receptor wells will mitigate the potential health impacts from use of groundwater impacted by the contamination. Therefore, this alternative was assigned a score of 2.

The No Action alternative would not reduce the extent of groundwater contamination, aside from any natural attenuation, and no measures would be taken to prevent human exposure or further degradation of the environment. Therefore, the No Action alternative was assigned a score of 1.

3.8.1.4 Reduction of Mobility, Toxicity, or Volume. The 0.5 Ig/L TCE Capture alternative would capture and clean up the plume to near background conditions, achieving significant reductions in plume toxicity, mobility, or volume. Except for air stripping, which would transfer the contaminants to the atmosphere, the associated treatment technologies would directly (UV/oxidation) or indirectly (thermal reactivation of spent GAC) permanently destroy the contaminants. Therefore, while Alternatives 4B, 4C, and 4D were assigned a score of 5, Alternative 4A was assigned a score of 4.

The volumes of the 5 Ig/L and 3 Ig/L TCE plumes are 54 percent and 69 percent, respectively, of the volume of the 0.5 Ig/L TCE plume. However, the associated masses of these plumes are 92 and 94 percent, respectively, of the mass of TCE for the 0.5 Ig/L plume. Therefore, the 5 Ig/L and 3 Ig/L TCE Capture alternatives were assigned a score of 4 for all process options with the exception of the air stripping with canal discharge, which was assigned a score of 3.

No computer modeling was conducted to predict the capture zone for the Plume Control alternative. However, by considering the number of extraction wells, well locations, and total extraction rates, it is estimated that this alternative will capture and remove at least 70 percent of the volume and mass associated with the 0.5 Ig/L TCE Capture alternative. Therefore, the Plume Control alternative was assigned a score of 3 for all process options.

The Impacted Area Well-Head Treatment alternative would not reduce the volume or mobility of contaminants, but would address potential toxicity to end-users at individual wells. Therefore, this alternative was assigned a score of 2.

The No Action alternative would not, aside from natural attenuation, produce any reduction in the volume, mobility, or toxicity of the Main Base Plume. Therefore, No Action was assigned a score of 1.

3.8.1.5 Short-Term Effectiveness. The No Action alternative does not pose any risk to workers or the public since no actions are taken and this alternative requires no time to complete. Therefore, the No Action alternative is assigned a score of 5.

The Plume Control alternative would require installation of fewer wells and trenches than any of the three TCE Capture alternatives. This alternative is also much more likely to achieve its objectives in a reasonable length of time. Therefore, the Plume Control. alternative was assigned a score of 4 for all process options.

The Impacted Area Well-Head Treatment alternative poses little risk to workers or the public and the time required to implement this alternative is short. However, workers would have some potential for exposure to contaminants during installation of the well-head treatment units, therefore, this alternative was assigned a score of 4.

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3.8.1.6 Implementability. No technical or administrative difficulties are anticipated for the No Action alternative, therefore, it was assigned a score of 5. The Impacted Area Well-Head Treatment alternative poses no technical problems in implementation. However, permission must be obtained from all public and private well owners before the well-head treatment units can be installed and operated. Therefore, this alternative was assigned a score of 4.

The groundwater extraction alternatives all utilize proven technologies for groundwater extraction, treatment, and disposal. Given the extent of the TCE plumes in the Main Base Plume regions and the complex site geology, the AF is concerned that it could be technically impractical and cost prohibitive to capture and clean up to the MCL or lower levels. The uncertainty of ever achieving the cleanup objective increases as the cleanup objective is made more stringent. The injection disposal option may be difficult to implement, particularly if the differences in inorganic chemical concentrations among HSZs create technical problems. The scoring of the extraction alternatives considered these various factors. The scores assigned to the options for each of the four groundwater extraction alternatives were:

- Plume Control alternative: option 6A, score 3; option 6B, score 4; option 6C, score 3; option 6D, score 3.
- 5 Ig/L TCE Capture alternative: option 3A, score 2; option 3B, score 3; option 3C, score 2; option 3D, score 2.
- 3 Ig/L TCE Capture alternative: option 5A, score 2; option 5B, score 3; option 5C, score 2; and option 5D, score 2.
- 0.5 Ig/L TCE Capture alternative: option 4A, score 1; option 4B, score 2; option 4C, score 1; and option 4D, score 1.

3.8.1.7 Cost. Cost comparisons of the alternatives for the Main Base Plume regions are presented in Table 3-15 and in the summary below. No Action has the lowest cost of all alternatives, as the cost of continued groundwater monitoring is all that is included; score 5.

The highest-cost alternative is the 0.5 Ig/L TCE Capture alternative with UV/oxidation treatment and disposal by injection. The estimated costs for the 5, 3, and 0.5 Ig/L TCE Capture alternatives were developed under the assumption that the RA will operate for a period of 15 years. The costs of achieving these cleanup objectives may be affected because of technical impracticability. The actual costs for cleanup to these concentrations would thus be much

higher than the costs presented in this FS. Scores were assigned to each of the alternatives according to the relative-cost method described at the beginning of this section.

Alternative	Cost ($M)	Score
No Action	2.9	5
Impacted Area Well-Head Treatment	2.9	5
The 5 Ig/L TCE Capture Alternative		
(a) Air Stripping with Canal Discharge	15.7	4
(b) L-P GAC with Canal Discharge	22.9	3
(c) UV/Oxidation with Injection	34.5	2
(d) L-P GAC with Injection	33.4	2
The 0.5 Ig/L TCE Capture Alternative		
(a) Air Stripping with Canal Discharge	25.9	3
(b) L-P GAC with Canal Discharge	38.4	2
(c) UV/Oxidation with Injection	53.1	1
(d) L-P GAC with Injection	51.2	1
The 3 Ig/L TCE Capture Alternative		
(a) Air Stripping with Canal Discharge	19.8	4
(b) L-P GAC with Canal Discharge	28.7	3
(c) UV/Oxidation with Injection	41.3	2
(d) L-P GAC with Injection	40.0	2
The Plume Control Alternative		
(a) Air Stripping with Canal Discharge	12.4	4
(b) L-P GAC with Canal Discharge	17.7	4
(c) UV/Oxidation with Injection	21.8	3
(d) L-P GAC with Injection	21.0	4

3.8.2 East Base Plume Region. The East Base Plumes, which are confined to the shallow HSZ, contain approximately 116 pounds of TCE, or less than 5 percent of the TCE estimated to be outside of the capture zones for the OU 1 and OU 2 remedial systems.

In general, the alternatives for the East Base Plumes, including institutional responses, received scores (based on the seven CERCLA criteria) similar to those received by the same alternatives for the Main Base Plume regions. However, there are some differences because the East Base Plume region is much smaller, contains less TCE, and has a lower potential for impacting production wells. In addition, contamination in the East Base Plume region only occurs in the shallow HSZ.

As with the comparative analysis of the alternatives for the Main Base Plume regions, each of the remedial alternatives is compared against seven of the nine CERCLA criteria: 1) Overall Protection of Human Health and the Environment, 2) ARARs, 3) Long-Term Effectiveness and Permanence, 4) Reduction of Toxicity, Mobility and Volume through Treatment, 5) Short-Term Effectiveness, 6) Implementability, and 7) Cost. The modifying criteria, 8) State/Support Agency Acceptance, and 9) Community Acceptance have also been considered in the remedy selection process and are discussed in Section 3.8.3.2. Under the heading of each of the criteria, the performance of the five alternatives is discussed in descending order from highest to lowest performance.

3.8.2.1 Overall Protection of Human Health and the Environment. All of the groundwater extraction and treatment alternatives provide capture and treatment to MCL standards (or more stringent levels), and have therefore been assigned a score of 5 for all process options.

The primary health concern raised by these plumes is that the TCE they contain may be drawn into nearby Castle AFB production wells. Because these wells are screened across the shallow and USS HSZs, they could act as potential vertical conduits for the transfer of contaminants from the shallow to the deeper HSZs. For this reason, these wells are proposed for destruction under the Impacted Area Well Destruction and Monitoring alternative. The East Base Plume region is characterized by much lower TCE mass and concentrations than the Main Base Plume. Following a review of potentially impacted wells, it was assumed that if the production wells identified as having the potential for cross contamination are destroyed, no other wells will require well-head treatment. Should any receptor wells be impacted in the future, well-head treatment would provide adequate protection for end-users. For these reasons this alternative was assigned-a score of 4.

The No Action alternative may not fully protect human health and the environment, since it takes no action to address the existing plume of contamination or potential future impact on water supply wells. For this reason, the No Action alternative was assigned a score of 1.

3.8.2.2 Compliance with Applicable or Relevant and Appropriate Requirements. The East Base Plume was analyzed against federal and State of Califomia ARARs in the RI/FS and the results of this analysis is summarized in Table 3-18. Section 4 provides detailed information regarding ARARs governing groundwater cleanup at Castle AFB.

The AF, with concurrence of the EPA and the state, has decided that active remediation of the East Base Plume is not warranted at this time because removing these contaminants at these low concentrations gives little benefit compared to the high cost and because the aquifer cleanup levels are expected to be reached in a reasonable period of time with the selected Well Destruction and Monitoring alternative. Though some concentrations in the East Base Plume exceed the cleanup levels, the Well Destruction and Monitoring alternative is expected to be able to meet these aquifer cleanup levels in a reasonable period of time and therefore comply with ARARs. This is based on monitoring data showing an overall decreasing trend in contaminant concentration.

If, based on monitoring data, this trend does not continue or the concentrations start to increase, the AF will implement active remediation. The trigger conditions for active remediation are described in more detail in Section 3.8.3.3.

3.8.2.3 Long-Term Effectiveness and Permanence. All of the groundwater extraction alternatives will capture and clean up the East Base Plumes to MCLs or more stringent standards, leaving no significant potential health or environmental risks. Therefore, all were assigned a score of 5 for all process options.

The Impacted Area Well Destruction and Monitoring alternative would not reduce the extent of existing groundwater contamination. However, abandonment of the only existing receptor wells impacted or potentially impacted by the East Base Plumes will eliminate potential health impacts. Operation of the OU 1 and OU 2 extraction systems will prevent off-site migration of the East Base Plumes. Therefore, this alternative was assigned a score of 3.

The No Action alternative would not reduce the extent of groundwater contamination, aside from any natural attenuation, and no measures would be taken to prevent human exposure or further degradation of the environment. Therefore, the No Action alternative was assigned a score of 1.

3.8.2.4 Reduction of Mobility, Toxicity, or Volume. The 0.5 Ig/L TCE Capture alternative would capture and clean up the plumes to near background conditions, achieving a significant reduction in plume toxicity, mobility, and volume. Two of the associated treatment options would directly (UV/oxidation) or indirectly (thermal reactivation of spent GAC) permanently destroy the contaminants. Therefore, for this alternative, these process options are assigned scores of 5. The air stripper would release the contaminants to the atmosphere. Therefore, for this alternative, the air stripper option was assigned a score of 4.

The volumes of the 5 Ig/L and 3 Ig/L TCE plumes are 39 percent and 47 percent, respectively, of the volume of the plumes defined by the 0.5 Ig/L TCE Capture alternative. The associated masses of TCE for these plumes are 56 percent and 67 percent, respectively, of the mass of TCE for the 0.5 Ig/L TCE plumes. Therefore, the 5 Ig/L and 3 Ig/L TCE Capture alternatives were assigned scores of 4 for the UV/oxidation and L-P GAC process options. The air stripper process option was assigned a score of 3 for these two alternatives.

The Impacted Area Well Destruction and Monitoring alternative would not actively reduce the volume or mobility of the East Base Plumes, but may prevent significant cross contamination between the HSZs. Therefore, this alternative was assigned a score of 3.

The No Action alternative would not, aside from natural attenuation, produce any reduction in the volume, mobility, or toxicity of the East Base Plumes. Therefore, the No Action alternative was assigned a score of 1.

3.8.2.5 Short-Term Effectiveness. The No Action alternative does not pose any risk to workers or the public since no actions are taken and the alternative requires no time to complete. Therefore, the No Action alternative was assigned a score of 5. The only anticipated action for the Impacted Area Well Destruction and Monitoring alternative is destruction of on-site wells. These actions will pose no significant risk to workers or the public and can be completed quickly. Therefore, this alternative was also assigned a score of 5.

More significant worker exposure could occur during implementation of the three extraction alternatives, especially during construction of extraction and injection wells and trenching for installation of conveyance piping. The air stripper process option may pose a slight risk due to the emission of VOCs to the atmosphere. The primary differences among the three extraction alternatives are the increase in potential for worker exposure as the capture objective is made more stringent due to the increased number of wells and trenching required and the increased time required to complete the RA. Therefore, the 5 Ig/L TCE Capture alternative was assigned a score of 4; the 3 Ig/L TCE Capture alternative was assigned a score of 3; and the 0.5 Ig/L TCE Capture alternative was assigned a score of 2 for all process options.

3.8.2.6 Implementability. There are no technical or administrative difficulties for the No Action alternative, therefore, it was assigned a score of 5. The only action proposed for the Impacted Area Well Destruction and Monitoring alternative is the destruction of on-site wells and associated monitoring. No technical or administrative difficulties are anticipated for this alternative, therefore, it was assigned a score of 5.

The three extraction alternatives all utilize proven technologies for groundwater extraction, treatment, and disposal. However, the uncertainty of ever achieving the cleanup objectives increases as the concentration set for the cleanup objectives is decreased. Cleanup to 0.5 Ig/L TCE in groundwater may be technically impractical and cost prohibitive. Groundwater extraction and injection is limited to the shallow HSZ for the East Base Plume region. Therefore, few technical problems are anticipated for the injection disposal option alternatives. The scoring of the three extraction alternatives considers these factors. The 5

Ig/L TCE Capture alternative was thus assigned a score of 4 for the UV/oxidation and L-P GAC treatment options, and 3 for the air stripping treatment option. The 3 Ig/L TCE Capture alternative was assigned a score of 4 for the UV/oxidation and L-P GAC treatment options and 3 for the air stripping treatment option. The 0.5 Ig/L TCE Capture alternative was assigned a score of 3 for the UV/oxidation and L-P GAC treatment options and 2 for the air stripping treatment option.

3.8.2.7 Cost. A cost comparison of the alternatives for the East Base Plumes is presented in Table 3-16 and below. No Action has the lowest cost of all alternatives, as costs for continued groundwater monitoring are all that are involved. The 0.5 Ig/L TCE Capture alternative with UV/oxidation treatment has the highest cost. Costs estimated for each of the groundwater extraction and treatment alternatives consistently indicate that the air stripping treatment alternative is the least costly of the three treatment technologies.

Scores were assigned to each of the alternatives based on present worth costs according to the method described in the introduction of this section.

Alternative	Cost ($M)	Score
No Action	0.5	5
Impacted Area Well Destruction and Monitor	l0.5	5
The 5 Ig/L TCE Capture		
(a) Air Stripping with Injection	4.0	3
(b) UV/Oxidation with Injection	6.0	2
(c) L-P GAC with Injection	5.8	2
The 0.5 Ig/L TCE Capture		
(a) Air Stripping with Injection	5.8	2
(b) UV/Oxidation with Injection	7.9	1
(c) L-P GAC with Injection	7.7	1
The 3 pg/L TCE Capture		
(a) Air Stripping with Injection	4.0	3
(b) UV/Oxidation with Injection	6.0	2
(c) L-P GAC with Injection	5.8	2

3.8.3 Summary of Analysis and Remedy Selection. This section provides a summary of the scoring of the alternatives for the Main and East Base Plume regions and more complete descriptions of the selected remedies.

3.8.3.1 Main Base Plume Regions. The total scores for the remedial alternatives analyzed and ranked for the Main Base Plume regions ranged from 21 to 28 (Table 3-13). The highest ranking sub-alternative, with a score of 28, was 3B, the 5 Ig/L TCE Capture alternative using L-P GAC and canal discharge of treated water. A score of 27 was received by several sub-alternatives including 3A, 5 Ig/L TCE Capture with air stripping and canal discharge; 5B, 3 Ig/L TCE Capture with L-P GAC and canal discharge; and 6B, Plume Control with L-P GAC and canal discharge.

Based on these results, the Proposed Plan identified Alternative 3, Plume Capture with a 5 Ig/L TCE-cleanup objective, as the recommended remedy. Community acceptance and state concurrence for the recommended remedy was established through the public comments received during the comment period for the Proposed Plan, and through the incorporation of substantial additional

state input based on comments on the Preliminary Draft and Draft Final ROD. The Responsiveness Summary (found at Tab 3) provides a summary of both public as well as state comments and comment responses.

3.8.3.2 East Base Plume Region. The total scores for the remedial alternatives analyzed and ranked for the East Base Plume region ranged from 23 to 28 (Table 3-14). The highest ranking alternative was Alternative 2; Well Destruction and Monitoring. The Impacted Area Well Destruction and Monitoring alternative for the East Base Plume region consists of destroying production wells that are screened across the shallow and USS HSZs and have the potential to act as vertical conduits to transfer contaminants to the lower HSZs followed by continued monitoring and further action, if necessary.

Based on these results, the Proposed Plan identified Alternative 2, Well Destruction and Monitoring, as the recommended remedy. Community acceptance and state concurrence for the recommended remedy was established through the public comments received during the comment period for the Proposed Plan, and through the incorporation of substantial additional state input based on comments on the Preliminary Draft and Draft Final ROD. The Responsiveness Summary (found at Tab 3) provides a summary of both public as well as state comments and comment responses.

3.8.3.3 Selected Remedy. Main Base Plume. The selected remedy for the Main Base Plume is Alternative 3, Plume Capture with a 5 Ig/L cleanup objective, implemented with a phased approach; this remedy will build on and incorporate the ongoing and planned remedial activities authorized in the OU 1 Interim ROD and the OU 2 Final ROD. Implementation of the selected remedy would be the most effective remedial strategy to capture and clean up the contaminated groundwater to MCLs. The phased approach was chosen in order to allow for the collection and use of information from technical effectiveness studies of OU 1 and OU 2 systems and to provide direction for installation of additional treatment systems.

It is intended that the selected remedy under this ROD will incorporate and therefore supersede the previous groundwater cleanup RODs (i.e., OU 1 and OU 2). Consequently, the selected remedy includes flexibility in the treatment technology and treated water disposal approaches to be applied for the Main Base Plume. The remedy includes a provision for the use of both GAC and Air Stripping treatment technologies and the application of reinjection, surface discharge, and other reuse for the disposal of the treated groundwater. Refer to the RI/FS and the RBDR reports for additional detail on each element of this selected remedy.

The selected remedy for the Main Base Plume consists of the following three sequential phases of pump and treat groundwater remediation:

> **Phase 1:** Phase 1 takes advantage of existing OU 1 treatment capacity as well as additional system expansion, to remove TCE and control migration of TCE "hot spots" in the shallow HSZ. This is being accomplished by expanding the OU 1 extraction system through installation of new extraction wells in the shallow HSZ. GAC and/or air stripping groundwater treatment systems will be utilized to achieve effluent release levels discussed in Section 3.8.3.4 and presented in Section 4 of this ROD. Design of the OU 1 expansion is being included in the RBDR. In addition, the OU 2 groundwater extraction network will be completed and operations initiated.
>
> **Phase 2:** Phase 2 will enhance the OU 1 extraction network to a multiple HSZ groundwater remediation system with the addition of extraction wells and the utilization of GAC or air stripper treatment systems to achieve effluent release levels stipulated in this ROD (see Section 3.8.3.4 and Section 4). A water reuse study will be used to determine the most appropriate combination of reinjection, canal discharge, and water reuse to be utilized

for the disposal of treated groundwater. Pump tests will be conducted to obtain necessary hydrologic information on HSZ properties.

Phase 3: Data collected from the first two phases will be evaluated and a Phase 3 Technical Evaluation and Design Study will be prepared to determine what additional RAs will be needed to achieve the overall cleanup objectives. By the onset of Phase 3, both Phase 1 and 2 pump and treat systems will have been installed, data gap wells and the LTGSP network will be in place, pump tests will have been evaluated, and the flow and transport models will have been updated. That information will facilitate better analysis of the hydraulic control of HSZs and plume remediation time periods and will provide information needed in the design of additional treatment systems.

The selected remedy is expected to cost-effectively remove TCE and other contaminants in the Castle AFB groundwater to the MCL cleanup objective and prevent further plume migration. The preliminary range of the estimated present worth costs of the selected remedy is from $15.7 to $33.4 million over a period of 15 years. The remedy is protective of human health and the environment and is in compliance with all ARARs.

The three phases of groundwater remediation will be fully developed during RD/RA stages. The selected remedy will address the principal threat of groundwater contamination. Contaminants in the Castle AFB groundwater will be captured within the boundary of the 5 Ig/L TCE iso-concentration contour and cleaned up to the MCLs (i.e., 5 Ig/L TCE). Section 4 provides the release levels for treated groundwater.

Groundwater treatment technologies incorporated in this remedy include air stripping and L-P GAC treatment. The optimal combination of these selected treatment technologies will be based on engineering and cost analysis conducted in the RBDR. Selection factors may include the availability of capacity from the OU 1 (air stripping) and OU 2 (L-P GAC) systems, the proximity of well locations to existing systems, and the economics of local versus central treatment. The optimal combination of reinjection, canal discharge and reuse for groundwater disposal will also be evaluated in the RBDR. Similar factors will impact discharge alternatives, namely available capacity of existing systems, proximity to existing systems, alternative discharge locations such as the sewer or canal, economics, and agreements with water resource authorities.

Schedule for Implementation of Three Phase Approach. The approximate schedule for the three phases of the selected remedy will be as follows:

Phase	Year
1	1996
2	1997-1998 (approximately 18 months)
3	1998 to completion of RA

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Castle Vista Plume. Although detailed analysis was not conducted for the Castle Vista Plume in the CB-Part 1 RI/FS, it was recognized that additional data collection was needed. Data collected since the RI/FS indicates the need for active groundwater remediation in the Castle Vista area; therefore, the pump and treat approach will be implemented as the presumptive remedy for the needed further cleanup action. These cleanup requirements, identified in the overall objective of the Castle AFB CB-Part 1 RAS, entail capturing the contaminant plume and cleaning up the contaminated groundwater to the MCL level of the most restrictive contaminant present. For the Castle Vista Plume, further analysis will be conducted to determine the appropriate cleanup level. Consistent with the approach of Section IIIG of SWRCB Resolution 92-49. This evaluation will be carried out as part of the RD/RA activity. For the purpose of operational

and reporting convenience and efficiency, this additional action will be integrated into the phased approach of the CB-PART 1 RD/RA described under the remedy for the Main Base Plume.

Other Plumes. The AF, with the concurrence of EPA and Cal/EPA, has determined that active remediation of the North Base, Landfill 1, and Landfill 4 plumes is not warranted at this time because action is being taken to remediate the sources, and because removing the low concentration contaminants from the groundwater would provide little benefit while incurring high costs. However, because several of the contaminants are above primary drinking water standards, institutional controls will be implemented to prevent the installation of groundwater supply wells on Castle AFB that would jeopardize public health or the environment from these plumes. Additionally, long-term monitoring will be performed under the LTGSP to monitor contaminant concentrations in these plume areas. Monitoring will be conducted pursuant to Title 23, California Code of Regulations (CCR), Section 2550.10 (Corrective Action Monitoring) for at least one year from the date that MCL and beneficial use concentrations for each respective COC are attained. After that time, landfill monitoring will be conducted pursuant to Title 23, CCR, Section 2550.8 (Detection Monitoring), in order to detect potential future releases from Landfill 5, Landfill 4, and Landfill 1 sites. Contaminant concentration levels in the groundwater will be reevaluated annually. If the contaminant concentrations drop below the MCL and beneficial use concentrations for one year, any institutional controls may be removed. If, at any time, monitoring or modeling indicates that the contaminants will not meet the MCL and beneficial use concentrations within a reasonable time, or at least forty years from the date of the ROD, or that significant migration of the contaminants may occur at levels above MCL and beneficial use concentrations which impact public health or the environment, active remediation will be considered.

3.8.3.4 Discharges from the Groundwater Treatment System. The remedies selected for groundwater cleanup of the Main Base and Castle Vista Plumes involve multiple treatment and groundwater disposal options, as described previously. Four other plumes, the East Base, the North Base, Landfill 1 and Landfill 4 plumes, are subject to continued monitoring and trigger conditions to prompt, when necessary, future implementation of pump, treat and discharge systems, after this ROD has been finalized.

Discharges of treated water have the potential to affect beneficial uses of surface and/or groundwater. The ARARs and requirements triggered for any discharge are dependent on many factors, including the constituent composition df the treated water, the location of the discharge, and the quality and beneficial uses of the receiving water.

This ROD encompasses the following four discharges: 1) reinjection of treated groundwater generally upgradient of the OU 1 treatment system (existing discharge); 2) reinjection downgradient of the OU 2 treatment system (existing discharge); 3) discharge to Casad Lateral as backup to the existing OU 2 system (existing permit); and 4) discharges to the storm drain and Canal Creek (new discharge). Alternative discharge methods and/or locations for the Main Base Plumes discharges will be evaluated in the Water Reuse Study and supporting documents in Phase 2. The AF may propose discharges other than those described above in future design reports.

The two existing reinjection systems for the OU 1 and OU 2 groundwater treatment systems discharge treated water into the same aquifer or zone from which the water was extracted.

Both reinjection systems are designed to maintain hydraulic control of the plumes. The OU 1 reinjection system is at the upgradient edge of the Main Base Plume and includes injection wells JI-1 through 9. The OU 2 reinjection system is at the downgradient and northern edges of the OU 2 Plume and includes injection wells HPIW-1 through 11. The discharge limits for reinjection and surface discharge of treated groundwater, regardless of the plume area, are provided in Section 4.

The third discharge of treated groundwater is to the Casad Lateral and is a backup to the OU 2 reinjection system in case this system has operational problems and cannot handle the flow (temporary discharge) or if the reinjection system cannot handle the design flows and additional discharge capacity is needed (long-term discharge). Any discharge to the Casad Lateral will comply with the ARARs identified in Section 4 and regional water board requirements.

The fourth discharge of treated groundwater is a new discharge to the storm drain system that discharges to Canal Creek, a surface water. Stormwater from the base is also collected in this storm drain system. These two discharges will commingle prior to discharge to Canal Creek. The stormwater portion of the discharge is regulated according to a National Pollutant Discharge Elimination System (NPDES) Permit issued by the Regional Water Quality Control Board. The discharge point to Canal Creek is in Section 4, T7S, R13E, MDB&M, at the point latitude N37! 2' 11" and longitude W120! 33' 36".

The present design flow for discharge of treated groundwater to the storm drain is 144,000 gallons per day (100 gpm). The flow is expected to increase in phases in the future. The maximum discharge flow from the groundwater treatment system is 1,440,000 gallons per day (1,000 gpm). In the event of a need to increase surface discharge rates above the present design flow (100 gpm), the AF will submit a technical report, prior to implementing any such increase, as a primary document under the Castle AFB Federal Facility Agreement. The report will demonstrate that the treatment system, the conveyance system (the storm drain) and Canal Creek has sufficient capacity to accommodate the new design flow. The stormwater drain flow will include the effects of the treatment system flow rate and the flow from a 24-hour, 100-year flood. All discharge requirements in this ROD, including effluent limits and receiving water limits, will apply to the new flow rate.

Alternative discharge options will be evaluated during remedial design. The design will incorporate the discharges described in this ROD, and evaluate other discharge options and locations according to the Regional Board's Policy for Reuse that are (a) consistent with attainment of cleanup standards, and (b) cost-effective. The design will include contingency planning to avoid or minimize disruption of treatment operations should the primary discharge options be compromised (i.e., if reinjection capacity declines). Any means of discharge must meet substantive requirements of ARARs, if on site, or be permitted as required if off site. A ROD Amendment or ESD will be prepared for any discharge or disposal alternatives other than the four discharges documented in this ROD. Prior to adoption of a ROD Amendment or ESD, the AF will solicit state and federal ARARs and provide for public notice and comment and response to comments.

Examples of discharge options and locations are:

- injection to a deeper aquifer;
- recharge through the vadose zone using injection wells, infiltration ponds, or infiltration galleries;
- surface water discharge;
- provisions of water to industrial/agricultural users;
- provisions of water to municipal supply; and
- irrigation (landscaping, wetlands).

The selected remedy 1) prohibits the bypass or overflow of untreated or partially treated waste; 2) limits discharge to injection of treated water to those injection systems described above; 3) requires that the pH of any treated water shall be between 6.5 and 8.5 or equivalent to receiving waters.

Prior to any new, discharge, initial background concentrations of all potential pollutants in the receiving water shall be determined (in each water-bearing zone for reinjection, or in the surface discharge). If the data necessitate the establishment of reinjection standards for additional constituents in order to meet ARARs, an amendment to the ROD or other appropriate decision procedure will be considered by the AF, EPA, DTSC and Regional Board. These constituents will be monitored in the effluent during RA to determine that the discharge meets all requirements.

3.8.3.5 Monitoring for Groundwater Treatment Systems. All of the selected remedies include groundwater and groundwater effluent monitoring. The objectives for the Monitoring Program are described below. In addition, the Program will meet ARARs listed in Section 4 of this ROD and will be used to evaluate when the selected remedy will meet the cleanup objectives. Therefore, the monitoring well network and sampling frequency, and treatment system sampling locations and frequency need to be sufficient to meet the monitoring objectives. The following are the Program objectives:

- Demonstrate that the extraction system capture zone is completely containing the plume at the aquifer cleanup standards for each COC.

- Demonstrate the overall effectiveness of the groundwater treatment system (i.e., are the contaminant concentrations being reduced? Is the remedy on schedule to meet aquifer cleanup standards?).

- Demonstrate for plumes that are not being actively remediated, that plume boundaries are not expanding, contaminant concentrations are decreasing, and the aquifer cleanup standards will be met within the prescribed period.

- Demonstrate that the aquifer cleanup level has been met for a sufficient period of time to allow termination of pumping at an extraction well.

- Demonstrate that the treated groundwater is meeting effluent limits, receiving water limitations and all other requirements contained in this ROD.

The demonstration that the monitoring has met these objectives will be presented in the LTGSP reporting.

3.9 STATUTORY DETERMINATIONS

3.9.1 Main Base and Castle Vista Plumes. The selected remedy is protective of human health and the environment as required by Section 121 of CERCLA. The selected RA, when complete, will comply with applicable or relevant and appropriate environmental standards established under federal and state environmental laws. The selected remedy is cost-effective, uses permanent treatment technologies to the maximum extent practicable, and includes treatment as a principal element. The following sections discuss how the selected remedy meets the statutory requirements. (Table 3-13 provides a comparative analysis of alternatives considered for the Main Base Plume.)

3.9.1.1 Protection of Public Health and the Environment. The selected remedy uses proven pump and treat remediation technology to capture the contaminated groundwater plume(s) within the existing boundary and clean up the groundwater to MCLs. This remedy will significantly reduce the threat of exposure to residents and occupational workers. The implementation of this remedy will not create unacceptable short-term risks nor any negative cross-media impacts.

3.9.1.2 Attainment of ARARs. All ARARs will be met by the selected remedy. The remedy will achieve compliance with chemical-specific ARARs by treating groundwater to concentrations equal to or below the chemical-specific effluent standards. Action-specific ARARs will be met for the disposal of groundwater. RCRA requirements will be met for the treatment facility, and storage and handling of spent carbon.

3.9.1.3 Cost-Effectiveness. The AF, the EPA, and the state believe that the selected remedy provides overall effectiveness in relation to its cost. Based on the evaluation of alternative remedial approaches, the selected alternative for the Main Base Plume has a capital cost of approximately $20.1 million and an approximate present value Operations and Maintenance (O&M) cost of $13.3 million. The total net present value is $33.4 million, based on a 15-year estimate for the time required to clean up the Main Base Plume. These cost estimates are based on the concepts evaluated in the CB-Part 1 FS analyses for the Main Base Plume. The actual remedial costs of the CB-Part 1 selected remedy which integrates OU 1 and OU 2 systems may differ significantly from these values, but will represent a cost-effective approach to the cleanup of the Main Base Plume.

3.9.1.4 Use of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable. The selected remedy utilizes permanent solutions and treatment technologies to the maximum extent practicable. Of those alternatives that are protective of human health and the environment (and comply with ARARs), the AF, with concurrence from the EPA and the state, have determined that the selected remedy provides the best balance of long-term effectiveness and permanence; reduction of toxicity, mobility and volume through treatment; short-term effectiveness; implementability and cost-effectiveness.

The groundwater extraction and treatment to be utilized for the selected remedy offers the best long-term effectiveness and permanence for groundwater remediation at Castle AFB. It also offers the second best method for the reduction of groundwater contaminant toxicity, mobility, and volume of those alternatives that included treatment. Short-term effectiveness was highest of any plume capture alternative. With the chosen phased approach, utilizing the pump and treat technology, the selected remedy has moderate implementability, although those alternatives with less aggressive cleanup approaches have higher feasibility. The selected remedy has the lowest costs of any plume capture alternatives considered.

Of the five primary balancing criteria, the most decisive factors in the selection of the remedy were the long-term effectiveness and permanence, reduction of toxicity, mobility, and volume through treatment and cost.

The state and the EPA acceptance of this remedy were factored into the decision by establishing an agreed-upon cleanup objective, and Identifying which alternative(s) met the objective. In addition, state and EPA inputs significantly affected the decisions documented in this ROD. Agency comments and responses to these comments can be found in the Responsiveness Summary at Tab 3.

3.9.1.5 Preference for Treatment as a Principal Element. The selected remedy provides the best balance of trade-offs among the alternatives with respect to the evaluation criteria. The principal threat of current well contamination, plume migration and further contamination of production wells posed by the contaminated groundwater at Castle AFB will be remedied with the pump and treat system utilized by the selected remedy.

3.9.2 East Base Plume. The selected remedy is protective of human health and the environment as required by Section 121 of CERCLA. The selected RA, when complete, will comply with applicable or relevant and appropriate environmental standards established under federal and state environmental laws. The selected remedy is cost-effective, but does not use permanent

treatment technologies or treatment as a principal element unless a pump and treat presumptive remedy is implemented. The following sections discuss how the selected remedy meets the statutory requirements. (Table 3-14 provides a comparative analysis of alternatives considered for the East Base Plume.)

3.9.2.1 Protection of Public Health and the Environment. Alternative 2 provides for protection of the public health and the environment by preventing the flow of contaminants into the groundwater and monitoring to determine the need for further active treatment. In the event further actions are appropriate, pump and treat remediation technology will be implemented as the presumptive remedy. This remedy will significantly reduce the threat of exposure to residents and occupational workers. The implementation of this remedy will not create any short-term risks nor any negative cross-media impacts.

3.9.2.2 Attainment of ARARs. All ARARs will be met by the selected remedy. The remedy will achieve compliance with chemical-specific ARARs by preventing their migration to the groundwater, and to the extent needed, by treating groundwater to concentrations at or below the chemical specific cleanup standards. Action-specific ARARs will be met for the injection of groundwater if the presumptive remedy pump and treat technology is implemented. RCRA requirements will be met for the treatment facility, and storage and handling of spent carbon, if required.

3.9.2.3 Cost-Effectiveness. The AF, the EPA, and the state concur that the selected remedy provides overall effectiveness in relation to its cost. Alternative 2 has a capital cost of approximately $0.01 million and an approximate present value O&M cost of $0.53 million. The total net present value is $0.54 million based on a 30-year estimate for the time required to clean up the East Base Plume.

3.9.2.4 Use of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable. The selected remedy does not utilize permanent solutions and treatment technologies. However, of those alternatives that are protective of human health and the environment (and comply with ARARs), the AF, the EPA, and the state concur that the selected remedy provides the best balance of long-term effectiveness and permanence; reduction of toxicity, mobility and volume through treatment; short-term effectiveness; implementability, and cost-effectiveness.

Of the five primary balancing criteria, the most decisive factors in selection of the remedy were the short-term effectiveness, implementability, and cost.

The state and the EPA acceptance of this remedy were factored into the decision by establishing an agreed-upon cleanup objective, and identifying which alternative(s) met the objective. In addition, state and EPA inputs significantly affected the decisions documented in this ROD. Agency comments and responses to these comments can be found in the Responsiveness Summary at Tab 3.

3.9.2.5 Preference for Treatment as a Principal Element. The selected remedy provides the best balance of trade-offs among the altternatives with respect to the evaluation criteria, but does not meet the preference for treatment as a principal element. In the event further active remediation is indicated, pump and treat technology will be implemented as the presumptive remedy for further cleanup action, and this would meet the preference for treatment as a principal element.

4.0 LIST OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDEREDS

In this section, the ARARs for CB-Part 1 are identified and discussed. The ARARs presented here are based on analyses carried out during the evaluation of remedial alternatives at Castle AFB and on input and discussions between the AF, the EPA and the state.

Pursuant to Section 121(d)(1) of CERCLA, RAs must attain a degree of cleanup which assures protection of human health and the environment. Additionally, RAs that leave hazardous substances, pollutants, or contaminants on site must meet standards, requirements, limitations, or criteria that are ARARs. Federal ARARs include requirements under any federal environmental laws, while state ARARs include promulgated requirements under state environmental or facility-siting laws that are more stringent than federal ARARs, and that have been identified to the AF by the State of California in a timely manner.

Applicable requirements are those cleanup standards, control standards, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, RA, location, or other circumstance at a CERCLA site. In general, on site actions need comply only with the substantive aspects of ARARs, not with corresponding administrative requirements (such as, but not limited to, permits, record keeping, and reporting).

Relevant and appropriate requirements include those that, while not "applicable" to a hazardous substance, pollutant, contaminant, RA, location, or other circumstance at a CERCLA site, nevertheless address problems or situations sufficiently similar to those encountered at the CERCLA site to indicate their use is well suited to the particular site. A requirement must be either applicable or both relevant and appropriate to be an ARAR. If no ARAR addresses a particular situation, or if an ARAR is insufficient to protect human health or the environment, then nonpromulgated standards, criteria, guidance, and TBC advisories may be used to develop a protective remedy.

ARARs are identified on a site-specific basis from information about site-specific chemicals, specific actions that are being considered as remedies, and specific features of the site location. There are three categories of ARARs:

- Chemical-specific ARARs are numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. They are used to determine acceptable concentrations of specific hazardous substances, pollutants, and contaminants in the environment;

- Location-specific ARARS are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because the site occurs in, or may affect, a special location such as a wetland or floodplain; and

- Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken with respect to hazardous waste.

The ARARs and TBCs were developed using the following guidelines and documents: CERCLA Compliance with Other Laws Manual, PART I: Interim Final [EPA 1988]; "CERCLA Compliance with Other Laws Manual, PART II: Clean Water Act and Other Environmental Statutes and state Requirements" [EPA 1989b]; and "California SWRCB ARARs Under CERCLA" [State Water Resources Control Board 1992].

The following sections present the federal and state regulations and guidance under each appropriate ARAR category (i.e., chemical-, location-, and action-specific). Chemical-specific

ARARs and TBCs are addressed in Section 4.1, location-specific ARARs and TBCs in Section 4.2, and action-specific ARARs and TBCs in Section 4.3.

4.1 CHEMICAL-SPECIFIC ARARs AND TBCs

COCs for groundwater plumes are discussed in the following subsections. The chemical-specific ARARs and TBCs for these COCs are presented based on whether they are ARARs or TBCs, the type of contamination, and applicable media. Table 4-1 lists the chemical-specific ARARs for drinking water and groundwater.

4.1.1 Federal Chemical-Specific ARARs and TBCs. Section 121 of CERCLA indicates that RAs shall attain federal water quality guidance (WQG) or AWQC where they are relevant and appropriate. National Primary Drinking Water regulation, 40 CFR Part 141, established MCLs and MCL goals for organic and inorganic constituents as ARARs.

4.1.2 State Chemical-Specific ARARs; and TBCs. The Porter-Cologne Water Quality Control Act is one of the statutory bases for remediation of contaminants that threaten water quality in California. It establishes the authority of the SWRCB and the Central Valley Regional Water Quality Control Board (CVRWQCB) to protect the quality of surface water and groundwater in California.

SWRCB Resolution 68-16 has been identified as an applicable requirement for the protection of surface water and groundwater of the state. The AF and the state do not agree on the full applicability of all the substantive requirements contained within the resolution and the impact on the remedial activities needed to clean up Castle AFB. The AF disagrees with the state's contention that the narrative language establishes chemical-specific ARARs for both soil and groundwater, and that discharges subject to the resolution include post-1968 migration of in situ contamination from the vadose zone to groundwater. The AF believes that only active discharges directly to surface water or groundwater of the state are subject to the provisions of SWRCB Resolution 68-16. However, the remedies selected are intended to control further migration and, therefore, comply with Resolution 68-16 as interpreted by the RWQCB.

Portions of the CVRWQCB Basin Plan [CVRWQCB, 1995] for Sacramento-San Joaquin Basin which are listed in Table 4-2 contain narrative water quality objectives which were used to arrive at chemical-specific requirements that pertain to the Castle AFB area. The Basin Plan [CVRWQCB 1995] designates the beneficial uses of the groundwater in the Castle AFB area as domestic, municipal, irrigation, stock water, process, and service supply waters. Based on these uses, the methodology for arriving at the numeric standards necessary to attain the narrative taste and odor objective (an ARAR) is a TBC requirement. In addition to the TBCs, the Basin Plan establishes the following qualitative chemical-specific ARARs based on the designated use(s) of the groundwater: the domestic or municipal water supply shall not contain concentrations of chemicals in excess of state required MCLs; and the agricultural water supply shall not contain concentrations of constituents that adversely affect its beneficial use.

4.2 LOCATION-SPECIFIC ARARs AND TBCs

Location-specific ARARs and TBCs are requirements that place restrictions on the concentration of a COC or the conduct of activities because of the presence of unique site features such as surface waters and wetlands. The location of the groundwater site for RA was analyzed for unique site features to identify location-specific ARARs. The unique site features considered were:

- surface water;
- floodplain and wetlands;
- habitats of rare, threatened, endangered, and special status species;
- earthquake faults;
- historically or culturally significant properties;
- wilderness areas;
- wild and scenic rivers, and coastal zones.

At Castle AFB, 100-year floodplains occur on Canal Creek; the floodplains overlap the southeastern and southernmost portions of the base. Vernal pools, which may contain an endangered species, have been identified at Castle AFB. Currently there has been documentation that endangered species exist in these pools and investigations are ongoing. No other unique site features were identified.

4.2.1 Federal Location-Specific ARARs. The Endangered Species Act and implementing regulations at 50 CFR 17, 222, 226, 227, and 402 apply to some of the RAs at Castle AFB if they impact endangered wildlife. These impacts may be identified by a final biological assessment finding that the vernal pools on Castle AFB contain an endangered species. No vernal pools have been identified in the vicinity of any of the groundwater sites for which RA is selected in this ROD. The direct cleanup activities are not expected to impact any endangered species; however, associated cleanup activities (i.e., construction of pipelines for groundwater injection) may impact habitat or critical resources. All activities must ensure that regulatory requirements are followed and impacts avoided or mitigated.

4.2.2 State Location-Specific ARARs. The Fish and Game Code Section 1600 requires that any work within the 100-year floodplain (consisting of, but not limited to, diversion or obstruction of the natural flow or changes in the channel, bed, or bank of any river, stream or lake) will involve mitigation measures to avoid or minimize impacts on natural resources. Certain provisions of the Fish and Game Code Section 1600 would be relevant and appropriate for this groundwater RA site if the site or any of the associated cleanup activities (i.e., construction of pipelines for groundwater injection) is actually located in the 100-year floodplain.

4.3 ACTION-SPECIFIC ARARs AND TBCs

Action-specific ARARs are technology or activity-based requirements or limitations on actions taken with respect to the hazardous waste. The following sections describe the state and federal action-specific ARARs and TBCs. All ARARs are listed in Table 4-2 with each substantive requirement identified as applicable, relevant and appropriate, or TBC. Several of the requirements are marked with a footnote giving clarification to either their ARAR status or the legal interpretation of why they are considered ARARs for a particular site or RA. The TBCs are discussed in Section 4.3.2.3. Sections 4.3.1 and 4.3.2 include descriptions of the sources of the action-specific ARAR regulations and the authorization the state regulatory agencies have to enforce these requirements. In addition, the AF position on substantive requirements of ARARs and how they apply to the selected RAs are described.

4.3.1 Federal ARARs. The following federal action-specific ARARs have been identified. The federal action-specific ARARs are listed in Table 4-2, and a brief description of the sources of action-specific ARARs are provided in this section.

The Federal Safe Drinking Water Act regulates the injection of waste into injection wells. These wells are identified by unique characteristics such as depth, location of drinking water source, and material injected. The Underground Injection Control Program (40 CFR 144) is the regulation listing the requirements for the operation and use of injection wells.

4-3.2 State ARARs and TBCs. The state action-specific ARARs and TBCs are listed in Table 4-2, and are discussed in the following sections. Included are brief descriptions of the source of the ARARs and identification of the regulations derived under the source. Also presented is the AF position on substantive requirements of these ARARs and how they apply to the selected remedial actions.

4.3.2.1 State Air ARARs. The California Clean Air Act, under the Federal Clean Air Act and 1990 Amendments, authorizes the State of California to develop a State Implementation Plan (SIP) to enforce clean air regulations and laws. The SIP, developed through state legislation, divided the state into local air control districts and allowed each district to enforce the requirements of the Federal and State Clean Air Acts. Castle AFB is located in the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD); state air regulations are the most stringent ARARs. The applicable regulations are: Rule 2201 Sec. 4.1 - Best Available Control Technology; Rule 2201, Sec. 4.2 - Offsets for Stationary Sources; Rule 4101 - Visible Emissions; Rule 4102 - Air Contaminant Discharge; Rule 8010 - Fugitive Dust; Rule 4201 - Particulate Matter; and Rule 4202 - Dust and Condensed Fumes. Table 4-2 contains the applicable or relevant and appropriate sections of these regulations identifying the ARARs' status and a brief description of the substantive requirements and applicability to either the site, RA, or technology used to clean up the site and contaminated material.

4.3.2.2 State Groundwater ARARs. The Federal Clean Water Act regulates discharge to surface waters and groundwater. Under this statute is the 40 CFR 122 - EPA Administrative Permit Program: NPDES regulation for stormwater and other discharges to surface waters. This program has been delegated to the state and is a state ARAR.

The CVRWQCB has issued a stormwater NPDES permit for Castle AFB. It controls stormwater requirements for this ROD.

The Porter-Cologne Water Quality Control Act establishes the authority of the SWRCB and the CVRWQCB to protect the quality of surface water and groundwater. The California Water Code sections used as a source for action-specific ARARs and TBCs are presented in Table 4-2 along with the associated regulatory citations. Under the Porter-Cologne Act, the following regulations or resolutions regulating and protecting the waters of the state are considered either applicable or relevant and appropriate (as indicated in Table 4-2) and are therefore ARARs: Portions of the Central Valley Region (CVR) Basin Plan which establishes numerical and narrative water quality objectives to ensure the reasonable protection of beneficial uses of water; SWRCR Resolution 68-16, SWRCB Resolution 88-63; and Section IIIG of SWRCB Resolution 92-49. Table 4-2 contains the applicable or relevant and appropriate sections of these regulations identifying the ARAR status and a brief description of the substantive requirements and applicability to either the site, RA, or technology used to clean up the site and contaminated material.

SWRCB Resolution 68-16 has been identified as an applicable requirement for the protection of surface waters and groundwater of the state. The AF and the state do not agree on the full substantive requirements of this resolution and the impacts on the RA activities needed to clean up Castle AFB. The AF disagrees with the state's contention that the narrative language establishes chemical-specific ARARs for both soils and groundwater, and that discharges subject to the resolution include post-1968 migration of in situ contamination from the vadose zone to groundwater. The AF believes that discharges encompass only remedial activities that actively discharge to surface water and groundwater of the state. However, the remedies selected are intended to control further migration and, therefore, comply with Resolution 68-16 as interpreted by the RWQCB.

SWRCB Resolution 68-16, the water anti-degradation policy, is a state ARAR for the establishment of numerical limits for the reinjection of treated groundwater into clean areas (i.e., high quality waters) of the aquifer, (i.e., outside of the contaminated plume). The numerical limits established on a monthly median and on a daily maximum basis to meet the requirements of SWRCB Resolution 68-16 are set forth in Table 4-3. With respect to the injection of treated groundwater within the contaminated plume, treatment shall be such that the concentration level of the contaminant in the injection groundwater must not exceed the concentration in the groundwater at the point of injection measured on a monthly median basis, and also not exceed the federal and state ARARs. With respect to injection of treated groundwater outside the contaminated plume, the effluent is required to attain a discharge level for each constituent measured on a monthly median basis, with the maximum enforceable discharge standard not to exceed the federal or state ARARs. To meet the requirement that the selected remedy be protective of human health and the environment, the AF shall maintain hydraulic control of the plume while extracting contaminated groundwater and reinjecting treated groundwater into the contaminant plume or the clean portion of the aquifer.

SWRCB Resolution 92-49 establishes policies and procedures for the Regional Water Boards' oversight of investigations and cleanup activities resulting from discharges which affect or threaten water, including groundwater, quality. In July 1994, the State Water Board duly promulgated Resolution 92-49 in accordance with the state's administrative law requirements to cure defects pertaining to the initial promulgation of the resolution in 1992. For purposes of Castle AFB groundwater contamination, the regional board is directed by Resolution 92-49 to apply Section 2550.4 of Title 23, California Code of Regulations, Div. 3. Chapter 15, Section 2550.4(e) which requires that any alternate concentration level worse than background water quality must be the lowest concentration level the discharger can demonstrate is technologically and economically achievable, but under no circumstances can the alternate concentration level be worse than maximum concentrations allowable under other statutes or regulations.

In September 1995, the Department of Defense (DOD) forwarded a DOD legal position asserting that no portion of Resolution 92-49 was an ARAR because the same cleanup standard of Section 2550.4 incorporated into the resolution was found in Section 66264.94 of Title 22, CCR, Div. 4.5, Chapter 13. Since Section 66264.94 is part of the state's Resource Conservation and Recovery Act (RCRA) Subtitle C program as authorized by EPA, Section 66264.94 was a federal ARAR. Since the cleanup standard incorporated into Resolution 92-49, Section IIIG was not more stringent than the federal ARAR, the federal ARAR is controlling.

The state disagrees with this position, but has determined that the substantive requirements of Resolution 92-49 are being met by the RAs.

In addition, the Air Force has agreed to implement the following requirements:

1: [fr. P.5 - Reuse]
2: [fr. P.5 - Policy for investigation]
3: [fr. P.8 - Compilation of WQ goals)

While EPA and the Air Force do not agree that these requirements rise to the definition of "applicable or relevant and appropriate requirements," the Air Force has nevertheless agreed to implement these requirements. The SWRCB's legal position is that the first two requirements listed above are appficable ARARs since they were promulgated and establishes criteria and limitations that are more stringent than Federal requirements. The RWQCB reserves its legal position but the parties agree that the substantive requirements will be complied with in implementing this ROD.

4.3.2.3 Other State Regulations. The State Fish and Game Code regulates to protect aquatic life living in the waters of the state. All remedial activities that have the potential of causing a discharge to any stream, lake, or other body of water must comply with the requirements of the code.

A sampling and monitoring plan will be prepared in accordance with the ARARs in Table 4-2. Particular attention should be paid to the requirements listed in Table 4-2 under 40 CFR 122. The following requirements are also TBC.

California Well Standards (California Department of Water Resources [DWR], Bulletin 74-90, June 1991) and Sacramento County Code, Title 6, Chapter 6.28 - The California Water Code (Chapters 1152, 1373, and 13801) requires the DWR to establish standards for the construction, operation, and abandonment of water wells, monitoring wells, and cathodic protection wells. Any San Joaquin County-developed well construction regulations based on authority granted to the county through enforcement of the state standards should be considered as TBCs for construction of groundwater wells (injection, extraction, and monitoring).

In addition to these well standards, the guidelines provided by the California Base Closure Environmental Committee (March 1994) in "Long-Term Groundwater Monitoring Guidance" are TBCs for:

- establishing background groundwater quality;
- frequency of water level measurements;
- suite of constituents in the monitoring program;
- sampling frequency; and
- inspection and well maintenance.

Several of the California regulations require certification by a professional geologist or engineer, registered or certified by the State of California. These portions of the regulations are considered procedural rather than substantive requirements. However, to the degree that federal contractors perform and/or supervise the engineering and geotechnical work, they will be certified professionals or under the supervision of certified professionals as appropriate.

RESPONSIVENESS SUMMARY

FOR THE PROPOSED PLAN ON THE

COMPREHENSIVE BASEWIDE--PART 1 (GROUNDWATER)

CASTLE AIR FORCE BASE (AFB), CALIFORNIA

JANUARY 31, 1997

A. OVERVIEW

At the time of the public comment period, the Air Force had already selected preferred alternatives for groundwater plumes at Castle Airport (formerly Castle AFB), California. The Air Force recommended cleanup alternatives for the Main Base and East Base plumes, and potential presumptive remedies for the East Base and Castle Vista plumes.

The Air Force's recommended alternative for the Main Base Plume specified in the Record of Decision (ROD) for the Comprehensive Basewide--PART 1 (CB--Part 1) involved pumping and treating groundwater with two systems, one ongoing (operable unit 1 [OU-1]) and one planned (OU-2). As part of the preferred alternatives, a phased approach was chosen as a clean up program for groundwater at Castle Airport. The phased approach consists of three sequential phases of pump-and-treat groundwater remediation. The three phases were established in order to allow for the collection and use of information from technical effectiveness studies of OU-1 and OU-2 systems, as well as other studies (e.g., long-term monitoring). The phases are explained below:

Phase 1: The first phase will take advantage of existing OU 1 treatment capacity, to expand the treatment of groundwater in the OU 1 area to remove TCE and control migration of TCE "hot spots" in the shallow groundwater zone of OU 1. This will be accomplished by expanding the OU 1 extraction system through installation of new extraction wells in the shallow groundwater zone. Granular Activated Carbon (GAC) and/or air stripping groundwater treatment systems will be utilized to achieve treated water release levels stipulated in this ROD. Design of the OU 1 expansion will be included in the ongoing effort known as the Revised Basis of Design Report. In addition, the OU 2 groundwater extraction network that is planned will be completed and operations initiated.

Phase 2: Phase 2 will enhance the OU 1 extraction network to a multiple groundwater zone remediation system with the addition of extraction wells and the utilization of GAC or air stripper treatment systems to achieve effluent release levels. A water reuse study will be conducted to determine the most appropriate combination of reinjection, canal discharge, and water reuse to be utilized for the disposal of treated groundwater. Pump tests will be conducted to obtain necessary hydrologic information on groundwater zone properties.

Phase 3: Data collected from the first two phases will be evaluated and a Phase 3 Technical Evaluation and Design Study will be prepared to determine what additional wells will be needed to achieve the overall cleanup objectives. By the onset of Phase 3, both Phase 1 and 2 pump and treat systems will have been installed, data gap wells and the Long-term Groundwater Sampling Program network will be in place, pump tests will have been evaluated, and the flow and transport models will have been updated. That information will facilitate better predictions of the hydraulic control of the groundwater zones and plume remediation time periods, and will provide the basis for design decisions regarding Phase 3 expansion of the groundwater remediation system.

The recommended cleanup action for the East Base Plume involves the sealing and abandonment of wells to prevent further cross contamination of groundwater zones. Monitoring will also be accomplished to develop a more complete definition of the plume and to determine the need for active remediation. Evaluation of the data collected during monitoring will be summarized as part of the Technical Evaluation and Design Report, which will be developed during Phase 2 of CB--PART 1 Remedial Design/Remedial Action. If this evaluation indicates further active remediation is required, pump-and-treat technology would be available as the presumptive remedy and this additional action will be integrated into Phase 3.

Detailed analysis was not conducted for the Castle Vista Plume; however, it is recognized that additional data collection is underway to better characterize this area. In the event additional data collected during monitoring events indicates the need for active groundwater cleanup, the pump-and-treat approach would be available as the presumptive remedy. Evaluation and implementation of this additional action will be integrated as appropriate into Phase 3 of the CB--PART 1 Remedial Design/Remedial Action.

Judging from the comments received during the public comment period, the community surrounding Castle Airport supports the pump-and-treat system recommended for the Main Base Plume. However, the community prefers more proactive cleanup actions for the East Base and Castle Vista plumes (such as pump-and-treat) than indicated in the draft ROD for CB--PART 1 as the selected remedies/actions for these plumes.

These sections follow:

- Background on Community Involvement
- Summary of Comments Received During the Public Comment Period and Air Force Responses
- Remaining Concerns
- Attachment A: Community Relations Activities at Castle Airport

B. BACKGROUND ON COMMUNITY INVOLVEMENT

Community interest in groundwater at Castle Airport dates to February 1978, when the base commander notified workers and residents at Castle Air Force Base that trichloroethylene (TCE) was above the 5 parts per billion state action level, and required the boiling and use of bottled water at the base hospital and all food-serving establishments. In late February, the state Regional Water Quality Control Board formally ordered Castle Air Force Base to clean the TCE out of the base water and neighboring property. On-going community concern, generated by the clean-up order, dissipated when work was completed on a new TCE-free well in February 1985.

In November 1985, residents immediately affected by groundwater contamination expressed concern about its effect on their health and property when TCE contamination above the 5 parts per billion action limit was found in two of the three off-base wells at Castle Mobile Home Park. In response to this discovery, the base began supplying bottled water to park residents until activated carbon filtration systems could be installed. Residents were connected to City of Atwater water supply in March 1989.

By 1990, City of Atwater residents demonstrated little interest in the groundwater problem. Part of this was attributed to lack of knowledge about the restoration program, although a strong community relations program had been in place addressing specific contamination problems experienced at Castle Air Force Base. Additionally, City of Atwater residents were served by a municipal water source, which was unaffected by the contamination and closely supervised by the state and local governments.

Community concerns and involvement have remained strong to date. The major concerns expressed during the remedial planning activities by property owners, interested groups, and local officials involve: the possible health effects from contamination at the site; the amount of funding needed for cleanup; and the Air Force's commitment to Castle's remediation which could take 16 to 20 years. These concerns and how the Air Force addressed them are described below:

1) What are the health effects and risks associated with drinking, cooking, and bathing in water contaminated with TCE in various concentrations?

Air Force response: TCE is a chemical of concern identified by EPA in the early 1980s, thus drinking water standards have been set at 5 micro grams per liter and drinking water has been kept below this level. Where TCE has reached or exceeded this level in private wells in the area, the Air Force has installed and maintained individual filter systems or provided an alternate drinking water source.

2) Could funding be cut off before the base has been cleaned up?

Air Force response: Funds for cleanup are programmed and will be included in the annual funding request to congress. We do not attempt to predict what congress will do nor obligate them in any way; but history has shown that proper programming gets adequate results.

3) Will the Air Force continue cleanup after they leave the base in 1995?

Air Force response: Yes, the Air Force has formed the Air Force Base Conversion Agency (AFBCA) to do just that. We are part of that agency and plan to remain until the job is done.

4) Will the plume on base move and destroy my crops?

Air Force response: We have no evidence of TCE affecting crops in any way.

5) Why does the cleanup take so long?

Air Force response; Three reasons: (1) Thorough studies are required to identify the total nature and extent, and potential impact(s) contaminants from the base may have on human health or the environment (2) Clean up timeframes are at the mercy of mother nature. It took the Air Force almost fifty years to effectuate the soil and groundwater problems that exist today. It may take that long for mother nature to give it back. Groundwater clean ups are generally slow. (3) The Air Force wants to thoroughly coordinate action(s) so problems are not created for others and reuse/economic redevelopment can occur as soon as possible.

6) How will TCE in the groundwater affect the City of Merced?

Air Force response: Data indicates TCE from Castle AFB does not have the potential to affect Merced directly.

Recently, the Restoration Advisory Board (RAB) has been particularly vocal in expressing the concerns of the community to the United States Environmental Protection Agency (EPA), Regional Water Quality Control Board, Department of Toxic Substances Control, and Air Force (Base Conversion Agency). They have been successful in changing the ROD to include primary and secondary remedial options for the East Base and Castle Vista plumes. The choice of options will be contingent upon evaluated data received during monitoring of the plumes. The Air Force has been active in disseminating information concerning the groundwater contamination at Castle Airport to the surrounding community. A chronological list of community relations activities concerning groundwater at Castle Airport that has been conducted by the Air Force is presented

in Attachment A.

C. SUMMARY OF COMMENTS RECEIVED DURING THE PUBLIC COMMENT PERIOD AND AIR FORCE RESPONSE

The public comment period on the draft Feasibility Study and proposed plan for CB-PART 1 was held from June 25, 1996, to August 25, 1996. Comments received during this time are summarized below and are categorized by remedial alternative preferences, technical comments, human health concerns, and public participation process. Most comments were received during the public meeting, where the only local citizens in attendance were RAB members. Other comments were received in writing from Merced County, Division of Environmental Health, California Central Regional Water Quality Control Board, and Department of Toxic Substances Control.

Remedial Alternative Preferences and Other Technical Comments

(1) A RAB member questioned the identity of the contaminants in the East Base Plume. The member also expressed concern that the contaminants may not be affected or corrected by the East Base Plume preferred alternative presented in the proposed plan.

Air Force Response: As stated in the Proposed Plan for CB--PART 1 (page 7, Table 1) the principal contaminant identified for the East Base Plume is trichloroethylene (TCE) and it is only found in the shallow groundwater zone. When compared to the Main Base Plume, which contains 98 percent (by weight) of the TCE contamination at Castle Airport, the East Base Plume only contains 1.8 percent (by weight) of TCE contamination, the East Base Plume is minor both in concentration and distribution. However, wells in and downgradient from the East Base Plume will continue to be monitored on a quarterly basis to ensure that contamination does not increase to levels of concern for human health and the environment. When and if the data indicates that the contamination has increased substantially, a presumptive remedy (i.e., pump-and-treat groundwater) exists as a secondary option for the East Base Plume. Data is continually being collected, analyzed, and evaluated for all the plumes at Castle Airport.

(2) A RAB member is concerned that the balancing criteria (e.g., long-term effectiveness) indicates that the selected alternative in the proposed plan for the East Base Plume may not solve all the problems associated with the contamination. More specifically, the proposed plan states that Alternative 2, Well Destruction and Monitoring (proposed remedy for East Base Plume), may not comply with all the groundwater protection standards and does not reduce the extent of groundwater contamination, but will stop the potential movement of additional contamination.

Air Force Response: Long-term effectiveness of the selected remedy does not apply because the preferred alternative will not physically remove the contamination. Since data indicates a small percentage of contamination (1.8 percent) when compared to the Main Base Plume (98 percent), it is assumed that natural processes (i.e., natural attenuation) will reduce the contaminants over time. The preferred alternative will reduce the potential of introducing additional contamination into deeper, uncontaminated groundwater zones.

(3) A RAB member questioned if the EPA agrees that the ROD contains contingency language that provide for two possible options (a primary and secondary option) for the East Base Plume.

Air Force Response: At the public meeting for CB-Part 1, an EPA representative agreed that the ROD should specify two remedial alternative options for the East Base Plume. Contingency language will be ftted in the ROD for a primary remedial option (well destruction and monitoring), and a secondary remedial option (pump-and-treat) for the East Base Plume. The Air Force will continue to collect, analyze, and evaluate data from monitoring wells at the East Base Plume. Evaluation of the data collected during monitoring will be summarized as part of

the Technical Evaluation and Design Report. If data indicates something more than monitoring is required, the community will be consulted for installation of a pump-and-treat system. However, if data indicates that the plume is stable or decreasing in aerial extent, monitoring will continue.

(4) A RAB member is concerned about the two potential options chosen for the East Base Plume. The member stated that it would be "more comfortable" if Alternative 4, pump-and-treat, was chosen as the primary option instead of Alternative 2, Well Destruction and Monitoring. The member continued that if data gaps warrant, the Air Force could downgrade to the less conservative option (Alternative 2), instead of upgrading to the more conservative option (Alternative 4).

Air Force Response: The Regional Water Quality Control Board, California EPA, and Department of Toxic Substances Control entered discussions with this proposition; but the Air Force was able to convince these regulatory agencies that their charter is to protect you (i.e., the community) in these matters and because the plume is minor in both concentration and distribution and that active remediation could provide pathways for deeper contamination; therefore maximum protection is attained with Alternative 2 using Alternative 4 as a backup.

(5) A RAB member questioned if federal, state, and local agencies approved of the proposed plan's selected remedy for the East Base Plume (Alternative 2)

Air Force Response: The agencies are in agreement with the Air Force on the preferred alternative selected for the Main Base Plume. However, a professional difference exists between the Air Force and the agencies on the East Base and Castle Vista plumes. There are two contingent options (primary and secondary) available for each of these plumes: well destruction and monitoring, and pump-and-treat as a presumptive remedy for the East Base Plume; and No Further Action and pump-and-treat as a presumptive remedy for the Castle Vista Plume. The agencies prefer the pump-and-treat alternative as the primary remedy for the plumes and the Air Force prefers the well destruction and monitoring and No Further Action as the primary remedies for the East Base and Castle Vista plumes, respectively. However, both the Air Force and the agencies agree that further evaluation of the data currently being collected at both plumes may indicate implementation of other than the preferred option at either plume.

(6) The Merced County Department of Public Health recommends surface recharge basins for the Merced Irrigation District (MID) as an additional discharge option other than reinjection wells and existing irrigation canal.

Air Force Response: The Air Force will address the possibility of surface recharge basins as a disposal option in a Water Reuse Plan to be prepared in late 1996.

(7) The Regional Water Control Board and Department of Toxic Substances Control recommended that the report described in Phase 3 of the preferred alternative for the Main Base Plume be entitled Technical Evaluation and Design Report. The EPA stated that the purpose of Phase 3 is not to conduct an economic study but to evaluate the data from the previous two phases and incorporate that evaluation into the report.

Air Force Response: The Air Force agrees that the document to be prepared on Phase 3 for the Main Base Plume should be entitled "Technical Evaluation and Design Report." The document will establish the baseline and format of the five year review reports as well as summarize the data evaluated in the first two phases.

(8) The Regional Water Control Board and Department of Toxic Substances Control disagree with the preferred alternative of No Further Action with a presumptive remedy in the event that it is necessary. The action acceptable to the state for the Castle Vista Plume is the presumptive remedy consisting of pump, treat, and data collection unless or until it is demonstrated that the plume is small. In addition, the agencies state that the existing technology [No Further Action] is not cost effective nor is it believed to offer acceleration of clean up beyond that which will occur by natural attenuation.

Air Force Response: The Air Force agrees that reevaluation of existing data and the collection of additional data is in order prior to a final decision. The Air Force is collecting additional information in an attempt to characterize the nature and extent of the groundwater contamination in the area of Castle Vista housing.

(9) A RAB member questioned the acceptable level of contamination and how migration of the plume is determined? Furthermore, the RAB member questioned, "Will the plume migrate and gradually dilute itself to the point where it is not a problem"?

Air Force Response: Currently the Maximum Contaminant Level (MCL) for TCE is 5 micrograms per liter or parts per million. This level has been established by regulatory authority. The migration of a plume is determined by placing monitoring wells in strategic locations on and downgradient with respect to the plume. After analyzing and evaluating groundwater sampling data received from the wells, computer models are used to determine if, how fast, and which direction groundwater is migrating (moving). The migration and dilution of the plume as well as natural attenuation (various natural forces are effective in eliminating contamination) are evaluated. In addition, the data from samples taken during monitoring events is evaluated. If information indicates that the plume is stable and the mass is small, the Air Force will continue monitoring. Monitoring will continue unless the data indicate the plume is increasing in concentration and/or aerial extent at which point the presumptive remedy will be implemented.

(10) A RAB member questioned, after installing a well on adjacent property, if pumping from the well would have adverse effects on the plume.

Air Force Response: The affect of pumping from a potential new well on a contaminant plume would be part of the evaluation stated in the Air Force response to question 16. Technically, pumping from wells creates a cone of depression where groundwater flows towards the well. The shape of the depression depends on many factors including soils, amount of pumpage (e.g., gallons per minute), groundwater flow rate and direction, type of aquifer (i.e., conflned), and hydrogeologic boundaries, including the edge of an aquifer and a source of recharge (i.e., stream or lake). Pumping on a new well could impact the existing plume based on specific conditions of the new well and the plume.

(11) A RAB member is concerned with the computer model/plan that set up extraction wells locations for OU-1 system. In addition, the member is disappointed with the well procurement system that has occurred for the last two years.

Air Force Response: The Air Force would refer to question 9 because modeling (mathematical simulation) is more an art than a science. Again, experts check experts and the Air Force uses the model to help make decisions.

(12) A RAB member questioned if any data from MID on strata and water flow was used when choosing well locations for the OU-2 system.

Air Force Response: The experts and the checking experts used data from every source. The fear of every review panel is that local information will appear to detract from their expert

reputation; therefore, great care to gloss the last bit of data is exercised. This is a contributing factor to the time it takes to do a thorough evaluation of underground remediation efforts.

(13) A RAB member questioned the timeline for drilling additional wells for the East Base Plume.

Air Force Response: The Air Force has no formal timeline for this effort.

(14) A RAB member questioned if data gaps from wells on the East Base and Castle Vista plumes will be completed within the 30-day public comment extension (ending August 25, 1996). Furthermore, the RAB member wanted to know what the timeline was on finishing the data gaps.

Air Force Response: The timeline for the data was within the 30 day period and the secondary option was identified as preferred for the Castle Vista Plume.

(15) A RAB member is concerned that the Installation Restoration Program process (i.e., completing the ROD) is continuing with incomplete information/data.

Air Force Response: Since information/data is continually being collected, it is the Air Force's proactive decision to begin cleanup of the plumes where data currently indicates a contamination exists above regulatory limits. Data is collected, analyzed, and evaluated quarterly. The evaluated data in conjunction with the contingency of primary and secondary options, stated in the ROD for the East Base and Castle Vista plumes, will ensure that groundwater contamination is addressed without an undue expense to the Air Force and indirectly tax payers.

Contaminants Impact on Human Health Concerns

(16) A RAB member questioned the impact of groundwater contamination on a potential irrigation well to be installed on adjacent land.

Air Force Response: Any individual installing a well in Merced County must obtain a permit from the county. Subsequently, the Air Force in conjunction with the county or MID will evaluate the potential impact of the well on the plume. Then the Air Force, the county, and the landowner would determine if the location of well, the rate of pumpage, and the depth of the well is acceptable.

(17) The above response prompted a RAB member to question if the Air Force has an agreement with the Public Health Department to evaluate the adjoining property owners when they apply for permits to drill.

Air Force Response: The Merced County Public Health Department is aware of Castle Airport's contamination problem. The Merced County Public Health Department would seek the Air Force's assistance in making sure that the well would not be affected by any plumes at Castle Airport.

(18) A RAB member is concerned about plumes that are migrating into other areas, such as the Castle Vista Plume. The member is also concerned that there has been additional findings of contaminants in that area.

Air Force Response: The Air Force is also concerned and thus data is being collected. (The data has indicated the need for a pump and treat system for this plume.)

(19) The Department of Public Health commented that the TCE problem in the private wells located at 4460 and 4472 Buckeye Lane are not addressed in the proposed plan for CB--Part 1.

Air Force Response: These wells are outside our normal monitoring zone. These wells were sampled at the request of the RAB along with several others. TCE concentrations well below drinking water standards were encountered at these two wells; but no action is required at this time. Monitoring through the long term groundwater sampling program will continue and if changes occur the county will notify the property owners.

Public Participation Process

(20) A RAB member is concerned that the MID had not been contacted after a suggestion by a member, at a previous RAB meeting, was made to coordinate with the MID. The member was assured by the Air Force that MID was involved in the cleanup process at Castle Airport. In addition, the RAB member stated that water is not pumped from an underground pond, but from strata. The RAB member continued, "MID has extensive information on water strata in the whole area; in fact, there's a comprehensive program going on between the City of Merced, Atwater, and Livingston to insure that there will be water in this area into the future."

Air Force Response: Air Force personnel have coordinated and worked with MID engineering staff over the years. The Air Force and MID have existing agreements in regards to monitoring wells along MID easements and rights of way etc. Base personnel did contact the MID when the Hydrotech memo for the Operable Memo 2 was prepared. The memo documents the conversation with MID. The-point of-contact at MID for the Hydrotech memo was Mr. Eric Abramson. MID and Air Force coordination was extensive during the initial comprehensive surrounding pumping well survey conducted in 1989. MID engineering staff have coordinated with the Air Force regarding the comprehensive planning effort underway. Air Force will continue coordinating with MID as appropriate.

(21) A RAB member questioned community participation with respect to determining what type of program or alternative is going to be used to mitigate problems that exist at Castle Airport. The member additionally stated, "Just as we address the questions today and that they will be given back to us by letter, or whatever, we have no assurances that these concerns are going to be used in altering any decisions that you make." The member is concerned that if the plan is "solidified" and the community does not make an impact, it will be more and more difficult to make an impact in the future.

Air Force Response: The community is continually kept informed of the Installation Restoration Program occurring at Castle Airport. Major community relations activities include the distribution of fact sheets and news letters, tours of the sites at Castle Airport, and communication during RAB meetings. The community's concerns are requested, evaluated, considered, and recorded in this Responsiveness Summary. However, when determining the selected remedy for a site, the community is just one of the participants in the decision making process; other participants include local entities, state agencies, EPA, and Air Force. Further, with differing opinions and solutions the Air Force must select the solution it thinks best and proceed in the interest of all participants.

(22) A RAB member questioned the latest date the community could comment on the proposed plan for CB--PART 1 and could the community obtain an extension of the public comment period.

Air Force Response: The initial 30-day comment period ended on July 25, 1996. A community member can obtain a 30-day extension of the pubflc comment period by an oral statement requesting an extension.

(23) A RAB member expressed the intent of a public meeting is to have the community express their concerns and to have those concerns mean something, and to have that elated into the decision-making process.

Air Force Response: Prior to signing the ROD, all comments and additional data received subsequent to the preparation of the proposed plan will be evaluated and considered. Subsequent to the evaluation of comments and data, the ROD will be normalized and signed by the EPA, California EPA, and Air Force Base Conversion Agency. The signed final ROD will enable remedial work to begin on the subject sites or operable units.

After the ROD is signed, new information may be generated during the Remedial Design/Remedial Action process that could affect the remedy selected in the ROD. The Air Force will analyze the new information to determine if changes should be made to the selected remedy. Three types of changes could occur: non-significant changes, significant changes, or fundamental changes. If non-significant changes are made, they will be recorded in the post-decision document file; if significant changes are made to a component of the remedy in the ROD, these changes will be documented in an Explanation of Significant Differences; and if fundamental changes are made to the overall remedy, these changes should be documented in a ROD amendment. All changes will be reviewed at regular RAB meetings as well as at Public Hearings when required.

(24) A RAB member asked why community acceptance was number nine of the evaluation criteria presented in the proposed plan for CB--Part 1. In addition, the member asked why only the first seven criteria where considered during the evaluation.

Air Force Response: The evaluation criteria are not in order of priority. The first seven criteria are evaluated in the feasibility study, the phase of project progress we are now in. The draft final is issued for state and community comment and as an integral and continual part of the Installation Restoration Program process, from the assessment Phase of the process through the remedial phase, these comments are addressed.

(25) A RAB member stated that based on the community conterns on the East Base and Castle Vista plumes, the member asked for a 30-day extension of the public comment period. The member continued that the extension would allow the RAB and the people in the community to have an opportunity to make impacts that they feel necessary and to insure that the decision is made in a way that will benefit the community.

Air Force Response: The public comment period started on June 25, 1996. During the comment period, the Air Force held a public meeting on July 23, 1996, to receive any questions on the Proposed Plan. The comment period initially allowed 30 days to comments but was extended to allow an additional 30 days. With the extension, the comment period ended on August 25, 1996, but if there are any comments tonight (August 27, 1996) we will accept them.

D. REMAINING CONCERNS

Issues and concerns that the Air Force was unable to address during remedial planning activities include the following:

(1) RAB members had concerns regarding the landfills at Castle Airport.

(2) The Department of Public Health commented that the cleanup of leaking underground storage tanks sites, which are not in the TCE plume areas, are not addressed in the proposed plan for CB--Part 1.

(3) The Department of Public Health questioned if the recommendations of the Lawrence Livermore Report will be used in the cleanup of petroleum contaminated sites.

Air Force Response to above three concerns: These issues are not related to groundwater at Castle Airport. The Air Force will hold a 30-day comment period and public meeting on the Source Control Operable Unit (SCOU) after completion of the Remedial Investigation/Feasibility Study for the SCOU to allow the public to voice their questions and concerns regarding the sources of contamination at Castle Airport.

(4) A RAB member is concerned that contamination is leaking into the ground and the Air Force is putting soil and grass on top of it, and then is pumping the water for the next 100 years. In the meantime, the RAB member indicates, the contaminants are continually leaking into the groundwater.

Air Force Response: The major sources of contamination at Castle Airport have remedial activities in operation or planned (i.e., bioventing, soil vapor extraction). Since this comment is more relevant to the sources of contamination (i.e., SCOU activities), it will be fully responded to during the SCOU public comment period. This may be a perception, and as such must be addressed. Water is being pumped to treat groundwater that is already contaminated. When contamination above standards reaches groundwater it must be removed before it affects citizens. To protect the groundwater after it has been cleaned surface (soil) actions must be taken. These actions generally intercept the pathways contaminants take to get to the groundwater and provide seals to the atmosphere so that soil gases can be extracted and treated accelerating remediation. The Air Force is dedicated to taking these actions where needed and not taking action where it is not needed. We are not perfect, stay with us, help us in our decisions and together we will accomplish cleanup at Castle in a beneficial manner.

ATTACHMENT A
TO THE
RESPONSIVENESS SUMMARY FOR
COMPREHENSIVE BASEWIDE--PART 1 (GROUNDWATER)

COMMUNITY RELATIONS ACTIVITIES

AT CASTLE AIR FORCE BASE

Community relations activities conducted at Castle Airport regarding Comprehensive Basewide-PART 1 (e.g., groundwater) activities have included:

- The Air Force conducted interviews with community leaders and interested residents of the cities of Atwater and Merced, and Merced County (May 16, 1988).
- The Air Force developed an environmental mailing list (1988). The mailing list is updated on a monthly basis.
- The Air Force prepared a Community Relations Plan (1990).
- The Air Force established an Information Repository at the Merced County Library (1990).
- The Air Force conducted interviews with local community officials, residents, and business people (August/September, 1994).
- The Air Force revised the Community Relations Plan (1994).
- The Air Force developed the Restoration Advisory Board (April 22, 1994). Meetings are held every other month to inform the local community of Castle Airport's cleanup and reuse efforts.
- The Air Force conducted interviews with local property owners, a Restoration Advisory Board member, government officials, and a representative from the Sierra Club (March, 1995).
- The Air Force updated the Information Repository (1995).
- The Air Force prepared and distributed a fact sheet entitled, "Air Stripping and Granular Activated Carbon (GAC) Treatment Technologies" (March, 1995).
- The Air Force prepared and distributed a fact sheet entitled, "Information Repository" (June, 1995).
- The Air Force prepared and distributed a fact sheet entitled, "Base Conversion Process" (June, 1995).
- The Air Force revised the Community Relations Plan (1995).
- The Air Force prepared and distributed a fact sheet entitled, "Risk Assessment" (November, 1995).
- The Air Force conducted interviews with the representatives from the Merced Board of Supervisors, Merced Irrigation District, and Merced County Economic Development Corporation, and concerned citizens (January, 1996).
- The Air Force prepared and distributed a fact sheet entitled, "Environmental Laws Affecting IRP" (February, 1996).
- The Air Force prepared and distributed a fact sheet entitled, "Castle Airport IRP Sites" (June, 1996).
- The Air Force conducted a tour of various sites at Castle Airport (1996).
- The Air Force prepared and distributed a fact sheet entitled, "Trichloroethylene, (April, 1996).
- The Air Force revised the Community Relations Plan (June, 1996).
- The Air Force held a public hearing at the Atwater City Council Chambers to record comments by the public (July 23, 1996). A transcript of this meeting is available at the Merced County Library.
- The Air Force extended the public comment period. The comment period was held from June 25 to August 25, 1996.

ATTACHMENT B

TO THE

RESPONSIVENESS SUMMARY FOR

COMPREHENSIVE BASEWIDE--PART 1 (GROUNDWATER)

RESPONSE TO AGENCY COMMENTS

ON

PRELIMINARY AND DRAFT RECORD OF DECISION

AT CASTLE AIR FORCE BASE

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DRAFT RESPONSES TO COMMENTS ON
FINAL DRAFT CB-PART 1 ROD
11/15/96

DTSC-S-5.	Page 18, Section 3.5, Nature and Extent of Groundwater Contamination	Third paragraph. The text should be revised to state that the third plume of the East Base Plume under Buildings 1762 and 1709 has been incorporated as part of the Main Base Plume and selected remedy for this Plume is Alternative 3, same as Main Base Alternative.	Text changes have been made as suggested.
DTSC-S-6.	Page 31, Section 3.6.2, Ecological Risk Assessment	First paragraph, last sentence. Please revise the text to state when the Phase II Expedited Response Action will be completed.	Text has been updated as requested.
DTSC-S-7.	Page 35, Section 3.6.3.4, Landfill 4 Plume Region	Per our discussion at Castle Air Force Base (AFB), please revise this section to state that the listed chemicals will remain as Chemicals of Concern (COCs) even though PRAOs were not defined. Last paragraph. The text states "there are no COCs for Landfill 4 Plume Region based on these results. Therefore, no remedial actions are considered necessary for the Landfill 4 Plume and no PRAOs am defined." This statement is incorrect. As discussed in previous meetings, the rationale for not selecting a remedial action is the predicted high cost and the little benefit obtained for removing small amounts of contamination from the groundwater.	This section has been revised to indicate the correct rationale for dropping this plume from active remediation (i.e., the high cost and little benefit obtained for removing small amounts of contamination from the groundwater). COC discussion has been modified accordingly.
DTSC-S-8.	Page 35. Section 3.6.3.6, Landfill 1 Plume Region	First paragraph, last sentence. Please revise the last sentence to state "No active remediation was selected for following consideration."	Text has been revised to state: "No active remediation was selected based on the following factors."

DTSC-S-9.	Page 35, Section 3.6.3.7, Castle Vista Plume Region	Last paragraph. This paragraph confuses the reader as it does not provide a clear rationale for reaching the final conclusion. First, in the second sentence, it states that no active remedial actions are recommended and no PRAOs are defined and the following sentence, it states that the selected remedial approach is to pump and treat. We suggest that this paragraph be rewritten. It should clearly state that the Remedial Investigation/Feasibility Study and Proposed Plan recommended no further action with the installation of additional wells. It should also discuss the sampling results from the new monitoring well which showed that the Plume is larger than originally believed and hence pump and treat was selected as the remedial action. Additionally, list Trichloroethylene as a COC and list the PRAO for cis-1,2-Dichloroethylene.	The paragraph has been rewritten and additional text has been included to further describe the basis for remediation of Castle Vista plume.
DTSC-S-10.	Page 64, Section 3.8.3.3, selected remedy, Phase 3	First paragraph. Please revise the first sentence to read "Data collected from the first two phases will be evaluated and a Phase 3 Technical and Evaluation and Design Study will be prepared to determine what additional wells will be needed to achieve the overall cleanup objectives."	Text has been modified to state "Data collected from the first two phases will be evaluated and a Phase 3 Technical Evaluation and Design Study will be prepared to determine what additional remedial actions will be needed to achieve the overall cleanup objectives."
DTSC-S-11.	Page 65. Section 3.8.3.3., Selected remedy, East Base Plume	The text states that the Air Force will reassess the need for active remediation. It is not clear if the reassessment will be conducted as part of the LTGSP. If this is the case, then the LTGSP must be modified to present the criteria used for the reassessment. Additionally, the criteria must be agreed upon by the agencies and included as an attachment to the ROD.	The text states that the reassessment will be done under the LTGSP. The basis for these reassessments is also stated in the present text, developed based on agency input and response to comments on the Preliminary Draft ROD.
DTSC-S-12.	Tab 3, Page 2, Draft responsiveness summary	Second paragraph. The text states "In the event additional data collected during monitoring events indicates the need for active groundwater cleanup, the pump and treat approach would be available as the presumptive remedy." This paragraph should be rewritten to state that the AFB will actively pump and treat groundwater.	Text has been changed in accordance with comment.

DTSC-S-13.	Tab 7, Table 4.2, action specific Applicable or Relevant and Appropriate Requirement (ARARs), Page 1	Second ARAR. California Hazardous Waste Control Law. The column under the description of ARARs incorrectly defines the ARAR standards as either applicable or relevant and appropriate. The correct description of the standard should be "applicable" as listed under the ARAR Status column.	Table has been changed in accordance with comment.
DTSC-S-14.	Page 76, Section 4.3.2.4, Other State Regulations	The last paragraph states that the California regulations requiring a certification by a professional geologist or engineer registered or certified by the State of California are considered procedural rather than substantive requirements. Department of Toxic Substance Control considers registration or certification by the State of California is a substantive requirement. However, we agree that the CB-PART 1 ROD does not need to be certified since it does not provide a new information requiring review by a professional geologist or engineer.	Substantial changes to the ARARs section (Section 4) have been considered through additional discussions between the Air Force and the Regulatory Agency representatives. As a result of these discussions, agreed-upon modifications to the text have been incorporated.

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RWQCB-S-4.	Section 3.6.3.1 - Groundwater Plume and Contaminant Screening Process	This Section specifies that certain chemicals were eliminated from the list of potential chemicals of concern. While this may be appropriate for determining cleanup levels for the groundwater, the presence of the chemicals should be considered in setting effluent limits for discharges, particularly for surface water discharges. Neither the substantive waste discharge requirements or the ARARs table contains effluent limits for DBCP or EDB. There are several other sections where this issue is raised, for example in section 3.5.3.2. The document should be clarified to state that discharge requirements will address all constituents that may effect receiving water and its beneficial uses, not just constituents of concern.	The ROD contains treatment requirements for constituents other than COCs. Revised language based on input from RWQCB has been incorporated to clarify discharge requirements.
RWQCB-S-5.	Section 3.6.3.3 - East Base Plume Region	It states in this Section that bromodichloromethane, DEHP, carbon tetrachloride and PCE are excluded from consideration because they "occur regionally in groundwater either naturally or due to regional contamination." We do not agree with this conclusion since it is not supported by data. All these constituents exceed the carcinogenic risk or hazard index level and should be included as a COC.	This section has been revised to clarify the basis for not including bromodichloromethane, DEHP, carbon tetrachloride and PCE. For bromodichloromethane and DEHP, the basis is step 3 of the FS screening strategy (COPC does not form a plume as defined in the RI). For carbon tetrachloride and PCE, the basis is the low concentration, mass, plume size and isolated occurrence.
RWQCB-S-6.	Section 3.7.3,4 and 5	These sections describe the extraction alternatives and states, "the groundwater remediation time may range from ten to 60 years, depending on the HSZ that is being remediated." The remediation time is also dependent on how aggressively (fast) the groundwater is extracted. The more aggressive (the higher the pumping rate) the shorter time period for remediation. This concept should be added to this sentence or paragraph.	Text revised as suggested.
RWQCB-S-7.	Section 3.7.3 - Alternative 3 Extraction with TCE Capture Objectives of 5 ug/l	On page 43, last paragraph, twice "5 mg/l" is printed and it should be 5 ug/l, please change.	Text revised as suggested.

RWQCB-S-8.	Section 3.8 - Detailed and Comparative Analyses of Remedial Alternatives	The second paragraph, last sentence, it states, "The modifying criteria, (8) State/Support Agency acceptance and (9) Community Acceptance, will be evaluated during the public review and comment period." This statement should be updated since Community acceptance has already been done, and we are working toward State acceptance.	Text revised as suggested.
RWQCB-S-9.	Section 3.8.2 - East Base Plume	Please see comment 4 on the modifying criteria.	Text revised as suggested.
RWQCB-S-10.	Section 3.8.2.2 - Compliance with Applicable or Relevant and Appropriate Requirements	In this Section, last paragraph, and the East Base Plume discussion on page 65 refer to the trigger for active remediation. The two discussions are inconsistent. Page 60 states that it the trend to decrease does not continue or the concentrations increase active remediation would be implemented. Page 65 refers to an evaluation of whether the concentrations will not fall below the cleanup levels or if "significant" migration occurs then active remediation will be implemented. Page 65 should be changed to be consistent with Page 60. In addition, "significant" migration is vague and therefore, not useful. Migration above the cleanup levels should not be allowed at all.	Text revised as suggested. The word "significant" will be replaced by "plume".
RWQCB-S-11.	Section 3.8.2.4 - Reduction of Mobility, Toxicity, or Volume	The third paragraph of this section states, "...but would reduce the potential for additional contamination to be introduced;" This sentence is unclear on where this "additional contamination" is being introduced. This alternative does not prevent additional contamination from leaching from the vadose zone but, it may prevent significant cross-contamination between the HSZs. This should be made clear in the text.	Text revised as suggested.
RWQCB-S-12.	Section 3.9.2.3 -Cost-Effectiveness	This Section states that the State concurs that the selected remedy fulfills the nine criteria. It is not within the jurisdiction of the State to make any final determination about compliance with CERCLA. The reference to the State should be deleted.	The reference to concurrence on fulfilling nine criteria of the NCP has been deleted.

RWQCB-S-13.	Section 4.1.2-State Chemical-Specific ARARs and TBCs	The second paragraph in Section 4.1.2 should be clarified by adding the following sentence: "However, the remedies selected are intended to control further migration and, therefore comply with Resolution No. 68-16 as interpreted by the SWRCB."	Changes to the ARARs section (Section 4) have been considered through additional discussions between the Air Force and the Regulatory Agency representatives. As a result of these discussions, agreed-upon modifications to the ARARs Table and text have been incorporated.
RWQCB-S-14.	Section 4.2-Location-Specific ARARs and TBCs	Last paragraph states, "no permanent surface water occurs on Castle AFB." This infers that there is no proposed surface water discharge and thereby, no locations specific ARARs for surface water. This ROD proposes surface water discharge. Two specific discharges are proposed currently, the discharge via the West Base Drain (storm drain), to Canal Creek, and alternative discharge to Casad Canal if the OU-2 reinjection field is unable to handle the total flow from the treatment system. Both discharges are to surface water and Location-Specific ARARs apply. This section needs to be changed and subsequently Sections 4.2.1 and 4.2.2	The statement concerning the absence of permanent surface waters on Castle AFB has been deleted.
RWQCB-S-15	Section 4.3.2.2 - State Groundwater ARARs	The third paragraph states that the Central Valley Region Basin Plan, SWRCB Resolution 68-16, SWRCB Resolution 88-63 and SWRCB Resolution 92-49 are relevant and appropriate. We believe that these ARARs are applicable. This paragraph also is not consistent with Table 4-2 of this document, which states that the Central Valley Region Basin Plan, SWRCB Resolution 68-16, and SWRCB Resolution 88-63 are applicable. SWRCB Resolution 92-49 we believe is applicable, not relevant and appropriate for groundwater cleanup. This paragraph needs to be changed to state that Central Valley Region Basin Plan, SWRCB Resolution 68-16, SWRCB Resolution 88-63 and SWRCB Resolution 92-49 are applicable.	Changes to the ARARs section (Section 4) have been considered through additional discussions between the Air Force and the Regulatory Agency representatives. As a result of these discussions, agreed-upon modifications to the ARARs Table and text have been incorporated.

RWQCB-S-16.	Section 4.3.2.2 - State Groundwater ARARs	On Page 74 the following sentence should be added to the end of the second full paragraph on this page: "However, the remedies selected are intended to control further migration and, therefore, comply with Resolution No. 68-16 as interpreted by the SWRCB." In the fourth sentence of the third full paragraph, COC should be deleted and replaced with "constituents." Effluent limits should be specified for all constituents that might impact the ater or its beneficial uses, not just for COCs.	Changes to the ARARs section (Section 4) have been considered through additional discussions between the Air Force and the Regulatory Agency representatives. As a result of these discussions, agreed-upon modificafions to the ARARs Table and text have been incorporated. The recommended change to the fourth sentence of the third full paragraph has also been incorporated. See also response to comment RWQCB-S-4.
RWQCB-S-17.	Section 4.3.2.2 - State Groundwater ARARs	The fourth paragraph needs to be changed to state that SWRCB Resolution 68-16 will be the basis for establishing numerical limits for discharge to surface water. The paragraph discusses only reinjection into groundwater.	Changes to the ARARs section (Section 4) have been considered through additional discussions between the Air Force and the Regulatory Agency representatives. As a result of these discussions, agreed-upon modifications to the ARARs Table and text have been incorporated.
RWQCB-S-18.	Section 4.3.2.2 - State Groundwater ARARs	On Page 75 and 76 the remedies selected in this ROD are for groundwater not vadose zone so this discussion about the interpretation of Resolution No. 92-49 as it applies to the vadose zone seems out of place. It should be clarified in the first full paragraph that the State believes that there are sections of Resolution No. 92-49 that are substantive in addition to Section III.G. The second full paragraph should state that the State responded with a legal position that Resolution No. 92-49 is an applicable State ARAR.	Changes to the ARARs section (Section 4) have been considered through additional discussions between the Air Force and the Regulatory Agency representatives. As a result of these discussions, agreed-upon modifications to the ARARs Table and text have been incorporated.
RWQCB-S-19.	Section 4.3.2.2 - State Groundwater ARARs	On Page 76 the use of professionals licensed and/or certified in California should be a substantive requirement.	Changes to the ARARs section (Section 4) have been considered through additional discussions between the Air Force and the Regulatory Agency representatives. As a result of these discussions, agreed-upon modifications to the ARARs Table and text have been incorporated.
RWQCB-S-20.	TAB 4 - Substantive Requirements	There should be effluent limits for pesticides, such as DBCP, EDB and DEHP. They are found in the groundwater and should not be removed and transported to areas with lower concentrations or no detectable levels. This will comply with SWRCB Resolution 68-16.	The Substantive Requirements document has been removed and replaced by revised text in the ROD.

RWQCB-S-21.	Table 4-3 - Groundwater Discharge Treatment Standards	Table 4-3 is specific to groundwater reinjection not to surface water discharge. Surface water discharged is planned as one of the alternatives and needs to be included. Also, this table does not include the different chemical characteristics of the HSZs. For example DBCP, EDB, nitrates and some metals are found at higher concentrations in the Shallow HSZ than in Confined HSZ, a major drinking water aquifer. Reinjection of water containing nitrates, DBCP etc. into Confined HSZ would affect the high quality of the Confined HSZ and is therefore, not acceptable. We concur with the concentrations in the tables but, the table does not cover the complete spectrum of chemical constituents found in the groundwater. This is required for establishing receiving water and effluent discharge limits and may be impossible to do at this time without knowing the specific discharge.	Table 4-3 indicates its applicability to surface discharge as well as reinjection. The title of the table has been modified to refer to "Treated Groundwater Discharge Standards' Discharge limitations have been addressed in revised text added to the ROD based on input from RWQCB.
RWQCB-S-ATTCH 2	Section 2.8.3.3a Monitoring	Suggests incorporation of monitoring requirements summary	Suggested changes based on input from RWQCB have been incorporated to address monitoring.

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EPA-S1-6.	p.19	First full paragraph mentions a pump and treat prescriptive remedy for the Castle Vista Plume. What are the cleanup levels for this plume?	The overall cleanup objective for CB-PART 1 is stated elsewhere as MCL for the plume contaminants. "Prescriptive remedy" has been changed to "Presumptive remedy".
EPA-S1-7.	p.20	Section 3.5.4 does not state what the TCE levels are in the confined HSZ.	TCE concentration in the confined HSZ have been added.
EPA-S1-8.	p.21	First paragraph states that the risk estimates do not reflect reductions in contamination arising from ongoing cleanup efforts where groundwater remediation is currently in progress. Do we mean here that the risk estimates are conservative because it does not take into account the fact that there are ongoing cleanup efforts?	Yes. The risk values are conservative for this reason.
EPA-S1-9.	p.22	Section 3.6.1.2, second paragraph, last sentence - it is unclear as to which of the land uses identified earlier was used for the risk assessment.	The risk assessment values summarized in Table 3-4 are the most conservative of the calculated risk values.

EPA-S1-10.	p.28	Landfill 4 Plume Region states that the total HI is 9.34. Yet, this is a no-action site. Please explain why. Conversely, in the East Base Plume Region (on the same page), the risk is within the acceptable range and HI is below 1. Yet, remedial action is being taken at this site. Explain why.	This section summarizes the results of the risk assessments. The disposition of each plume is discussed in section 3.6.3.
EPA-S1-11.	p.29	Again, in Landfill 1 Plume Region, the total HI is over 1, yet this is a no-action site. On the same page, the risk range is acceptable for Castle Vista Plume Region, yet a remedial action (presumptive pump and treat) is begin taken at this site.	This section summarizes the results of the risk assessments. The disposition of each plume is discussed in section 3.6.3.
EPA-S1-12.	p.30	Second paragraph last sentence states that Castle Vista requires additional characterization to determine whether remedial action is warranted. Elsewhere in the ROD, it states that a presumptive pump and treat remedial action will be taken at this site.	This statement refers to the findings of the RI/FS.
EPA-S1-13.	p.30	Second to the last paragraph, last sentence states that there are additional areas of groundwater remediation that are currently not being addressed. What are these?	This statement will be clarified to indicate that it is the purpose of CB-PART 1 to address the remaining areas of groundwater remediation.
EPA-S1-14.	p.37	First paragraph, last sentence refers to current monitoring information which indicates the need for active remediation at the Castle Vista Plume. What is this information?	Additional text has been included to describe the new information and the rationale for the remedial action at Castle Vista plume.
EPA-S1-15.	p.38	First paragraph partly addresses my concern regarding the limited information in the ROD regarding the reasons for leaving the discharge options open. [Please see general comment above.] Why don't we state in this section that the Air Force is conducting a reuse study?	This has been updated to refer to the water reuse study.
EPA-S1-16.	p.38	This section only addresses the alternatives for the Main Base Plume and the East Base Plume. What about the Castle Vista Plume?	This section summarizes the Feasibility Study findings which were limited to these two plumes.
EPA-S1-17.	p.42	There is a statement that "[b]because no action would be taken to contain the contaminant plumes, this alternative may not meet the PRAOs." What is this referring to? Is it referring to the selected remedy for this plume, which is well destruction?	Yes.

EPA-S1-18.	p.44	East Base Plume - it states that only disposal by injection was considered for this plume. Does this mean that the other discharge options discussed elsewhere are only being contemplated for the Main Base Plume Region. This should be made clear.	This section summarizes the results of the Feasibility Study with respect to the alternatives considered. The selected remedy is detailed elsewhere.
EPA-S1-19.	p.49	How long will this alternative take?	The projected time for active remediation (15 years) is provided in paragraph 4; the last paragraph of this section also notes that there is a possibility that the operation may extend beyond this period.
EPA-S1-20.	p.54	Compliance with ARARs - second paragraph states that the 5.0 ug/1 TCE capture alternative complies with 92-49. What about plume control? Delete reference to location-specific ARARs here and in the next paragraph as I don't believe there are any location-specific ARARs here.	Reference is made to the 5 ug/1 capture alternative as the selected alternative, and does not provide discussion of the other, non-selected alternatives, including the plume control alternative. Reference to location-specific ARARs has been deleted in both paragraphs and in the referenced tables.
EPA-S1-21.	p.55	Reduction of Mobility - second paragraph is difficult to understand. Third paragraph, second sentence refers to "this" alternative. Which one?	The second paragraph has been re-worded to improve readability. The first sentence of the third paragraph identifies the "Plume Control alternative".
EPA-S1-22.	p.56	Implementability - bullet for Plume Control Alternative refers to options 6A, 6B, 6C, and 6D. Which are these? Perhaps, there should be some narrative description of these alternatives.	The Description of Alternatives, including sub-alternatives, is presented in Section 3.7.
EPA-S1-23.	p.60	Last paragraph - see comment 21 above.	This paragraph has been re-worded to improve readability.
EPA-S1-24.	p.64	Phase 3, third paragraph, refers to release levels for treated groundwater. Aren't these levels only for land/surface discharge?	No; the levels in Table 4-3 include both reinjection and surface discharge.
EPA-S1-25.	p.65	East Base Plume - states that within one year of the ROD, the AF will provide a reassessment of the need for remediation. Is this because we expect to have monitoring data then? The sentence following this states that reassessment will continue annually until active remediation is initiated or the level of contamination falls below cleanup levels for a period of at least one year. How long does the AF need to maintain this level (below cleanup levels) before the AF will not be required to conduct any more reassessment?	No; this refers to the Air Force's commitment to reassess on an annual basis, with the first assessment being that of the ROD. The text states that the Air Force would continue the annual reassessment until either active reffiediation begins, or the levels fall below the cleanup levels and remain there for a petiod of one year. If the second condition is met, there would be no requirement to continue annual reassessments.

EPA-S1-26.	p.65	Castle Vista Plume - again, refers to "data" without specifying what this data shows.	Additional text has been included to describe the findings at Castle Vista Plume and the rationale for the remedial action.
EPA-S1-27.	p.66	Second line from the top of the page refers to corrective action monitoring under Chapter 15. Why are we not using the monitoring in Title 22, instead of Title 23? In the same paragraph, last sentence, states that "if at any time" monitoring or modeling indicates that contaminants will not meet mcls within a reasonable time..." Is this after the one year (see comment 25 above)?	The issue of the basis for monitoring is under review and appropriate text changes will be implemented. With regard to the second point, this is not necessarily "after the first year," but in effect will likely be coordinated as part of the LTGSP annual reevaluation.
EPA-S1-28.	p.66	Attainment of ARARs - states that action-specific ARARs will be met for the reinjection of groundwater. What about the ARARs for the other disposal options?	Modify text to include ARAR compliance for all water disposal options.
EPA-S1-29.	p.72	First bullet, surface water, should be deleted here and moved to the action-specific ARARs. Likewise, in the paragraph following these bullets, delete first sentence which refers to surface water.	Changes to the ARARs section (Section 4) have been considered through additional discussions between the Air Force and the Regulatory Agency representatives. As a result of these discussions, agreed-upon modifications to the ARARs Table and text have been incorporated
EPA-S1-30.	p.74	First full paragraph refers to the CVR Basin Plan. Please add the following phrase: "which establishes numerical and narrative water quality objectives to ensure the reasonable protection of beneficial uses of water."	Text has been changed as suggested.
EPA-S1-31.	p.74	Last paragraph - identifies the ARARs for reinjection into clean areas and the plume. Should we leave these out for the future ROD amendment/ESD when the Air Force determines it will reinject?	No. Reinjection is included as part of the selected remedy.
EPA-S1-32.	p.75	First paragraph, beginning with the sentence "[f]or any alternative cleanup levels less stringent than background,..." until the end of the paragraph. This language identifies Chapter 15 as the ARAR. This language should be deleted (or rewritten) to make it clear that 92-49 is the ARAR here which directs establishment of cleanup levels that are above background levels based on the factors enumerated in 2550.4(e).	Changes to the ARARs section (Section 4) have been considered through additional discussions between the Air Force and the Regulatory Agency representatives. As a result of these discussions, agreed-upon modifications to the ARARs Table and text have been incorporated.

EPA-S1-33.	p.75	Last full paragraph on this page through the first paragraph on the next page should be deleted. These paragraphs address vadose zone remediation which is not relevant to this ROD.	Changes to the ARARs section (Section 4) have been considered through additional discussions between the Air Force and the Regulatory Agency representatives. As a result of these discussions, agreed-upon modifications to the ARARs Table and text have been incorporated
EPA-S1-34.	Table 3-17	Compliance with ARARs: alternative 6 - states "probably" not comply with state groundwater protection ARARs. Why not just state it will not comply?	This table is a summary of the RI/FS evaluation that says "probably" won't comply.
EPA-S1-35.	Table 4-1	Chemical-Specific ARARs for Drinking and Groundwater: Are these the cleanup levels for the groundwater or the treatment levels for the water that will be discharged? Since this ROD will not specify what discharge option the AF will take, we should just have aquifer cleanup levels.	These are drinking water standards, regardless of discharge source. Note that the selected remedy does not state that the discharge option will be selected later, only that the most appropriate design mix of reinjection, surface discharge and reuse will be determined in RD/RA. The remedy will include both reinjection and surface discharge, but in an as-yet undetermined mix.

EPA-S1-36.	Table 4-2	Action-Specific ARARs: p.4: second row, NPDES - only an ARAR if there will be a surface water discharge. If we are going to keep this in, please delete second sentence in first paragraph. Change second paragraph (single sentence) to read: "These sections of the regulation governing impacts to water quality apply to the discharge of treated water to surface water." p.4: third row, Order 92-08 - clarify that the substantive requirements of this general stormwater permit apply to the remedial activities at Castle AFB. It may help if the fourth paragraph is moved to the beginning of the description column, making it the first paragraph. p.5: first row, Water Quality Objectives - unless SMCIs have been promulgated by the State, these are not ARARs, just TBCs. Last sentence which reads "California standards which may be ARARs for the site include 22 CCR 6444 Tables A and B and 22 CCR 64449 Tables A and B." should be deleted, First, what are these standards? Second, if these standards are ARARs, they should be set out. p.5: second row, Wastewater reuse policy - rewrite first sentence to read: "Requires evaluation of land disposal as an alternative to discharge to surface waters.' p.6: first row - second paragraph seems redundant and should be deleted. If we keep this paragraph, delete last sentence, or specify what these requirements are and state whether they are ARARs, instead of the present statement which is that they "may be ARARs for the site." p.6: second row - second paragraph should be deleted. Last paragraph should be rewritten to read: "Subject to the limitations described above, this requirement is relevant and appropriate for establishing cleanup levels of groundwater affected by releases of contaminants."	Table 4-2 has been revised based on discussions between legal staff of USAF, US/EPA and Cal/EPA.

EPA-S1-37.	Table 4-3	Groundwater Discharge Treatment Standards: Again, since we don't specify what is the chosen discharge option, we should take this table out. If we decide to keep this table, I have the following questions: 1) why are we using CA EPA cancer potency factors for the daily maximum standard for injection into the clean portion of the aquifer. Are these standards promulgated, and are they more stringent than Federal standards? 2) Am I correct in assuming that when we use the CA MCL for the standard for injection into the contaminated portion of the aquifer, this standard is more stringent than the Federal MCL?	1) The use of Cal/EPA potency factors was based on the approach taken in the previously-approved ROD at Mather AFB. 2) Yes
EPA-S1-38.	RE: DTSC's Comments	p.4, #11: shouldn't the criteria for reassessing the need for active remediation be in the ROD?	See response to comment DTSC-S-11.
EPA-S1-39.	RE: Regional Board's Comments:	p.1, Major Comment #II: Are there detailed monitoring requirements in the ROD? What is attachment 2?	The text of the ROD has been revised to include monitoring requirements. Attachment 2 to the RWQCB comments was an initial draft of their suggested language.
EPA-S1-40.		p.2, Major Comment #V: I'm not sure I understand the reason for the distinction being made here regarding State "acceptance" versus "concurrence." Regardless, of the language chosen, it should be clear in the ROD that the State agrees with the remedy	Concur.
EPA-S1-41.		p.2, #3: secondary mcls for taste and odor thresholds should be TBCs.	Changes have been made to the ARARs section of the ROD to address SMCLs.
EPA-S1-42.		p.4, #15: only those portions of the Basin Plan which establish water quality objectives, including numerical and narrative standards that protect the beneficial use of surface and groundwater are potential ARARs.	Changes have been made to the ARARs section of the ROD in consultation with the agencies.
EPA-S1-43.		p.4, #17: Res. 68-16 is the basis for setting the limits for reinjection while the Basin Plan is the basis for establishing the limits for discharge to surface water.	Changes have been made to the ARARs section of the ROD in consultation with the agencies.
EPA-S1-44.		p.4,#19: The use of professionals licensed in CA is not a substantive requirement.	Concur. The text for the ARARs section has been revised based on discussions between agency and Air Force representatives.

DRAFT RESPONSES TO COMMENTS ON
FINAL DRAFT CB-PART 1 ROD
11/15/96

EPA Specific Comments (2nd set)

EPA-S2-1.	Page 5, Phase I	The text in this section should be edited to reflect that the Main Base Plume work described here has been completed.	Text clarification has been incorporated.
EPA-S2-2.	Page 6, Section 2.4.2	The statement, "If further active remediation is needed,.....", should be modified to indicate simply that appropriate remedial action will be selected based on the conditions that trigger the need for remediation and existing technology at the time.	Text clarification has been incorporated as suggested.
EPA-S2-3.	Page 6, Section 2.4.3	The second sentence needs to be rewritten so it makes sense. The third sentence will need to be revised since the decision has been made to treat the Castle Vista plume contamination.	Revisions have been made as suggested.
EPA-S2-4.	Page 7	The signature name for Chief, Federal Facilities Branch should be changed to Dan Opalski.	Revision have been made as suggested.
EPA-S2-5.	Page 13, Last Paragraph	The Installation Restoration Program (IRP) phases I, II, and III described here may be confused with the three phases of groundwater cleanup identified for the Main Base Plume that are introduced in Section 2.0 (Declaration For The Record Of Decision). It may be helpful to include a parenthetical comment "(not to be confused with the three phases of the Main Base plume RD/RA)" or to rewrite the text to better differentiate between the IRP phases and the CB PART 1 remedial design and remedial action (RD/RA) phases.	Text clarification has been incorporated as suggested.
EPA-S2-6.	Page 17, Last Paragraph	Figure 3-5 does not show the Castle Vista Plume. Figure 3-5 should be modified to show the location of the Castle Vista Plume.	Figure 3-5 has been modified to show the location of Castle Vista plume.
EPA-S2-7.	Page 18, Section 3.5, First Paragraph	Since the ROD identifies the need to clean up the Castle Vista Plume, cis-1,2-dichloroethene (cis-1,2-DCE) also should be identified as at Chemical of Concern in this section.	Text has been changed as suggested.

EPA-S2-8.	Page 19, Second Paragraph, Last Sentence	"Prescriptive" remedy should be replaced with "presumptive" remedy. It should be noted that an addendum should be prepared for the CB Part 1 Remedial Investigation/Feasibility Study (RI/FS) Report to describe the additional data obtained on Castle Vista Plume and why the decision was made to remediate this plume.	The term "prescriptive" has been corrected. No addendum is planned for the RI/FS; however, new text has been added to the ROD to describe the additional data and rationale for remediation of Castle Vista plume.
EPA-S2-9.	Page 31, Second Paragraph, Second Sentence	This sentence should be changed to reflect that institutional controls prohibiting pumping from contaminated groundwater should preclude exposure of surface receptors to the contaminated water.	Text clarification added as suggested.
EPA-S2-10.	Page 37, First Paragraph, Last Sentence	There needs to be a fuller explanation of why remedial action is justified for the Castle Vista plume.	See response to comment EPA-S2-8
EPA-S2-11.	Page 42, Third paragraph	This paragraph is very unclear. It implies is that well destruction and monitoring is more implementable for the east base plume than well head treatment is for the main base plume. This statement should be clarified.	The interpretation of the text is correct; nevertheless, the text has been rewritten for better clarity.
EPA-S2-12.	Page 42, Main Base Plume	The first sentence of the second paragraph is redundant with the beginning of the first paragraph and should be removed. The second sentence of the first paragraph does not make sense. The other existing extraction process options other than extraction wells should be clarified. This sentence should be rewritten or deleted.	Text changes made as suggested.
EPA-S2-13.	Page 43, Last Paragraph, Last Sentence	It is unclear what is meant by administrative feasibility, and how administrative feasibility influences the remedy selection.	Reference to administrative feasibility has been removed from this discussion.
EPA-S2-14.	Page 44, Third Paragraph, Second Sentence	It is unclear whether the same treatment options evaluated for the Main Base plume were considered for the East Base plume, and whether reinjection was considered as the only option for disposal. It is believed that canal discharge or possible reuse also were considered as disposal options for the East Base, but were judged to be too costly or impractical. This section should be rewritten to make it more clear and accurate.	Sentence revised for clarity.

EPA-S2-15.	Page 44, Last Paragraph, Last Sentence; Page 45, First Sentence	It is unclear why the lower subshallow (LSS) hydrostratigraphic zone (HSZ) is mentioned in conjunction with the East Base plume since there is not any contamination in the LSS HSZ. The correct remediation time for the East Base plume is that time estimated for the shallow HSZ.	Text has been revised as suggested.

LISTING OF ADMINISTRATIVE RECORDS

FOR

CASTLE AIR FORCE BASE

Castle AFB, CA - AR DOCUMENTS
Sorted by:
Date of Report: 04/25/96

DOC. DATE	SUBJECT OR TITLE	AUTHOR or CORP. AUTHOR	FILE NUMBER
04 Jan 84	HQ SAC Letter to USAF OEHL Regarding Final Phase I Report Completion, Oct 83, and Request for Phase II to Begin ASAP	Burnett, Ronald D, Col HQ SAC/SGPB	10
04 Jan 84	CDHS Letter to HQ SAC Regarding Phase I Completion and Phase II Progression	Sandhu, Mohinder S California Department of Health Services	11
16 Jan 84	Base Letter to HQ SAC Regarding Community Understanding and Support for Phase II IRP	Astorino, Loring R, Col 93 BMW/CC	13
02 Feb 84	Base Letter to HQ SAC Regarding Jan 84 TCE Sample Results Collected from Wells 1-4 and Four Distribution Points	Hedrick, Stephen P, Capt 93 MG/SGPB	14
03 Feb 84	Base Letter to CRWQCB Regarding Estimated Timetable for Phase II	Dempsey, Robert E, Col 93 BMW/CV	15
28 Feb 84	Phase II Presurvey Meeting Minutes	Hedrick, Stephen P, Capt 93 MG/SGPB	18
Mar 84	Phase II, Problem Confirmation and Quantification Presurvey Report, Vol I, Technical Work Plan	Roy F Weston, Inc.	17
05 Mar 84	Water Analysis Results, 02 Feb 84: Wells 1-9 and 11, Test Wells 12-18, and Four Distribution Points	Hedrick, Stephen P, Capt 93 MG/SGPB	19
05 Mar 84	Internal Base Letter Regarding Phase II Presurvey RPM Meeting Minutes, 28 Feb 84	Hedrick, Stephen P, Capt 93 MG/SGPB	32

26 Mar 84	TCE Sample Results, Between 24 Oct 83 and 06 Mar 84	Hedrick, Stephen P, Capt 93 MG/SGPB	20
26 Mar 84	TCE Sample Results, Mar 84	Hedrick, Stephen P, Capt 93 MG/SGPB	21
01 May 84	TCE Sample Results, Apr 84	Hedrick, Stephen P, Capt 93 MG/SGPB	1018
04 Jun 84	TCE Sample Results, May 84	Hedrick, Stephen P, Capt 93 MG/SGPB	22
18 Jun 84	HQ SAC Letter to 14Q AFESC/DEV Transmitting Phase II Stage 1, Task Description and Presurvey Report	Hauver, Robert C, Col HQ SAC/SGPB	25
27 Jun 84	TCE Sample Results, Jun 84	Hedrick, Stephen P, Capt 93 MG/SGPB	23
24 Jul 84	CDHS Letter to HQ SAC Regarding Review of Phase II Stage 1	Norman, William F Merced County Department of Health	26
28 Aug 84	HQ SAC Letter to USAF OEHL Regarding Comments on Phase II Stage 1 Task Description	Burnett, Ronald D, Col HQ SAC/SGPB	27
20 Mar 85	Tox Summary Report	Hansen, Earl M, PhD Weston Analytical Laboratories	34
19 Apr 85	TOC and Phenols Results - Water Samples	Hansen, Earl M, PhD Weston Analytical Laboratories	35
Nov 85	Phase II Stage 1, Confirmation/Quantification Technical Report, Vol I of II	Roy F Weston, Inc.	38
Nov 85	Phase II Stage 1, Confirmation/Quantification Appendices, Vol II of II	Roy F Weston, Inc.	39
17 Dec 85	MCDH Letter to HQ SAC Regarding Review of Phase II Stage 1	Norman, William F Merced County Department of Health	43

22 Jan 86	Base Message to HQ SAC Requesting Initiation of Phase IVA Action Coordination Meeting	Buzak, Jan Kaiser, Donald W, LtCol 93 CSG/DE	44
24 Jan 86	HQ SAC Memorandum Regarding Meeting, 29 Jan 86	Brown, Doug, Maj HQ SAC/DEPV	45
31 Jan 86	Newspaper Article, "CAFB Will Fund New Water Well"	De La Cruz, Mike The Merced Sun Star	33
05 Feb 86	Meeting Minutes of Phase IV Coordination Meeting, 29 Jan 86	Kaiser, Donald W, LtCol 93 CSG/DE	46
23 Apr 86	EPA Comments on Phase IVA RAP Task Report No 1, Site Characterization Plan for Main Base, South and West Flightline Sectors	EPA Region IX	48
Jun 86	Phase-IVA, Statement of Work RAP	Hazardous Materials Technical Center	51
30 Jul 86	EPA Comments on Phase IVA RAP SOW	EPA Region IX	53
30 Jul 86	EPA Letter to Base Regarding Comments on Draft Memorandum of Understanding of Agreement for City of Atwater Potable Water Well, 20 Jun 86	Seraydarian, Harry EPA Region IX	911
Aug 86	EPA Letter to Base Regarding EPA Final Comments on Phase II Stage 1 Confirmation/Quantification Technical Report and Phase IVA RAP SOW	Takata, Keith EPA Region IX	55
21 Aug 86	Summary of Meeting Regarding Domestic Well and Bellevue Road Water Main Project	Reitz, Mark Boyle Engineering Corp.	56
11 Sep 86	Internal Base Letter Transmitting Copies of Phase IVA Kickoff Meeting Minutes, 29-30 Jul 86	Kaiser, Donald W, LtCol 93 CSG/DEEV	57
18 Sep 86	Agreement for Installation of TCE Filtration System at Homeowners Residence	Kirbie, Darrel G, LtCol 93 CSG/DEV	59
18 Sep 86	Phase IVA, RAP, Draft Task Report No 7 CRP	Oak Ridge National Laboratory	60
30 September 1986	PCB Spill Site -PCB Storage Facility Building 1203	Volz, David E. Air Force HQ Combat Support Group	1049

15 October 1986	PCB; Clean-up Level for Spill Site Located Next to PCE Storage Facility, Building 1203	Landis, Anthony J. P.E. Chief Site Mitigation Unit	1048
13 Nov 86	MCDH Letter to Base Petroleum Contaminated Soils at East Perimeter Road	Palsgaard, Jeff H Merced County Department of Health	65
18 Dec 86	Base Conversation with USACE Regarding Procedures to Obtain Permit to Install Monitoring Wells in MID Property	Randall, Steven G 93 CSG/DEEV	68
23 Dec 86	Base Letter to MID Requesting Permit to Construct and Maintain Pollution Monitoring on MID Rights of Way	Kaiser, Donald W, LtCol 93 CSG/DE	70
87	Base Letter to Atwater Signal in Response to Concerns of Resident	Wilson, James F, Col 93 CSG/CC	164
22 Jan 87	Phase IVA Meeting Minutes, 22 Jan 87	93 CSG/DEEV	87
28 Jan 87	ORNL Letter to HQ SAC Submitting Alternatives for Removal of TCE from Groundwater	Loyd, John R Oak Ridge National Laboratory	88
11 Mar 87	City of Atwater Letter to Base Regarding Status of Groundwater Investigation	Haug, John A City of Atwater	899
09 Apr 87	CDHS Memo Regarding Preliminary Review of Phase IVA, RAP, Task Report No 1, Site Characterization for Main Base and South and West Sectors	Buell, Reid California Department of Health Services	71
24 Apr 87	EPA Letter to Base Transmitting Comments on Phase IVA Site Characterization Plan	Takata, Keith EPA Region IX	74
22 May 87	CDHS Letter to Base Submitting Memos Summarizing Meeting/Conference Calls Addressing Phase IVA work Plan	Wang, David California Department of Health Services	84
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06 Aug 87	Base Letter to EPA Transmitting Replies to Comments on Phase IVA Work Plan	Hodges, Harold W, LtCol 93 BMW/CVE	97

16 Oct 87	EPA Letter to Base Regarding Comments on Sample Plan for Site Characterization Activities, Appendix D of Revised Phase IVA Site Characterization Plan	Martyn Goforth, Kathleen A EPA Region IX	102
19 Oct 87	RI/FS and RD, Statement of Work Energy Systems, Inc.	Martin Marietta	103
05 Nov 87	Newspaper Article, "Haug Clarifies CAFB Well Delay"	UNK	905
09 Nov 87	Base Letter to Resident Regarding Whether or not TCE is Absorbed into Skin and Inhaled While Bathing	Chan, Arthur D 93 BMW/CVE	106
09 Nov 87	CDHS Letter to Base Transmitting Review of Phase IVA Site Characterization Work Plan	Wang, David California Department of Health	107
13 Nov 87	EPA Letter to Base Transmitting Comments on Phase IVA Site Characterization Plan	Zimpfer, Amy K EPA Region IX	108
16 Nov 87	DOI Letter to Base Transmitting Plots of TCE Concentrations Sampled in Base Test Wells 13-18	Avon, Lizanne US Department of the Interior - Water Resources Division	113
23 Nov 87	CDHS Letter to Base Transmitting Health and Safety Plan for Phase IVA Site Characterization Plan, Appendix B, Aug 87	Wang, David California Department of Health Services	112
08 Dec 87	Base Letter Transmitting Agenda and Summary Regarding Meeting with Regulatory Agencies on Phase IVA Site Characterization Plan	Chan, Arthur D 93 BMW/CVE	111
15 Dec 87	RI, SOW for Proposed JP-4 Fuel Distribution System and Update of Phase IVA Site Characterization Plan	Martin Marietta Energy Systems, Inc.	110
30 Dec 87	Base Letter to EPA Transmitting Minutes of Phase IVA Work Plan Discussion Meeting, 17 Dec 87	Chan, Arthur D 93 BMW/CVE	114
08 Jan 88	EPA Letter to Base Regarding Receipt of Phase IVA Site Characterization Plan Aug 87 and Sending of Comments 16 Oct 87 and 13 Nov 87	Anderson, Julie EPA Region IX	125

21 Jan 88	CDHS Thank You Letter to Base for Responding to Comments on Phase IVA Work Plan, SP, and QAPP on TCE Plume Characterization Containing Concerns and Outstanding Issues	Wang, David California Department of Health Services	124
03 Feb 88	EPA Letter to Base Regarding Receipt of 21 Jan 88 Letter Regarding Phase IVA Work Plan	Anderson, Julie EPA Region IX	122
04 Feb 88	CDHS Letter to Atwater City Administrator Concerning Proposed Placement of Production Well Near Bellevue Elementary	Wang, David California Department of Health Services	910
07 Mar 68	EPA Letter to City of Atwater Regarding oversight of Superfund RI Activities	Anderson, Julie EPA Region IX	904
28 Mar 88	Base Letter to EPA Regarding Response to Letters	Chan, Arthur D 93 BMW/CVE	116
Apr 88	RI/FS, Work Plan, Vol I of IV	IT Corp.	126
Apr 88	RI/FS, Sampling and Analysis Plan, Vol II of IV	IT Corp.	127
Apr 88	RI/FS, Health and Safety Plan, Vol IV of IV	IT Corp.	129
May 88	Groundwater Investigation, Northeast Quadrant, Technical Report, Vol I of II	Boyle Engineering Corp.	135
May 88	Groundwater Investigation, Northeast Quadrant, Appendices, Vol II of II	Boyle Engineering Corp.	136
26 May 88	EPA Letter to Base Transmitting Comments on Revised Basewide RI/FS Work Plan of Apr 88	Seid, Raymond EPA Region IX	138
27 May 88	CDHS Letter to Base Transmitting Staff Review of Basewide RI/FS Work Plan of Apr 88	Wang, David California Department of Health Services	139
23 Jun 88	Base Letter to CDHS Transmitting Well Installation Procedures used for Test Wells 12-18	Amerasinghe, S Felix 93 CSG/CVE	142
01 Jul 88	IT Corp. Letter to Base Transmitting Responses to EPA and CDHS Comments on RI/FS Work Plans of Apr 88	IT Corp.	147
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14 Jul 88	EPA Letter to Base Transmitting Documentation Requirements for Data Validation of Non-CLP Laboratory Data for Organic and Inorganic Analysis	Seid, Raymond EPA Region IX	151
15 Jul 88	CDHS Letter to Base Encouraging Implementation of Toxic Waste Site Characterization Phase of RI/FS, Apr 88	Wang, David California Department of Health Services	152
18 Jul 88	Base Letter to EPA Transmitting Minutes from 03 Jun 88 Meeting on RI/FS Work Plans and Minutes from Subsequent Conference Calls on 14 and 27 Jun 88	Amerasinghe, S Felix 93 BMW/CVE	154
19 Aug 88	CDHS Letter to Base Regarding Receipt and Review of 18 Jul 88 Transcript of 03 Jun 88 Meeting on RI/FS Work Plans and Subsequent Conference Calls on 14 and 27 Jun 88	Wang, David California Department of Health Services	155
29 Aug 88	IT Corp. Letter to Martin Marietta Transmitting Final Clarifications of Regulatory Comments Received Jun 88 on Work Plan, Sampling Plan, Health and Safety Plan, and Quality Assurance Project Plan Submitted Apr 88 for Upcoming RI/FS	Erikson, Dwight G IT Corp.	156
Sep 88	RI/FS, Quality Assurance Project Plan, Vol III of IV	IT Corp.	128
01 Sep 88	EPA Letter to Base Regarding Failure to Receive Addendum to Work Plan Addressing Comments in Lieu of Revised Work Plan	Anderson, Julie EPA Region IX	159
14 Sep 88	Newspaper Article, "TCE Evaluation Programs Under Way at CAFB"	The Atwater Signal	165
15 Sep 88	Newspaper Article: "Please Output for Bill K" Regarding Air Force Article in Signal, 14 Sep 88 "TCE Evaluation Under Way at Castle"	Burke, William J	163
Oct 88	EPA Letter to Base Concerning Location of City of Atwater Proposed Production Well	Anderson, Julie EPA Region IX	903
10 Oct 88	EPA Memorandum Regarding Review of Groundwater Documents	Joma, Hannibal EPA Region IX	909

19 Oct 88	Geo/Resource Consultants Letter to EPA Regarding Review of Letter to Martin Marietta Concerning Clarifications of Responses to EPA and CDHS Comments on Work Plan	Tryhorn, Alan D Vanek, Eva Geo/Resource Consultants, Inc.	169
27 Oct 88	Preliminary Health Assessment	Agency for Toxic Substances and Disease Registry	170
28 Oct 88	EPA Letter to City of Atwater Regarding Location of Proposed Production Well	Anderson, Julie EPA Region IX	908
31 Oct 88	EPA Letter to Base Regarding Completion of Review of QAPP for work Plan	Flaherty, Michael S EPA Region IX	171
22 Nov 88	EPA Letter to Base Concerning Measures Taken to Mitigate Exposure to TCE Contaminated Water at Castle Mobile Home Park	Flaherty, Michael S EPA Region IX	902
Dec 88	RI/FS, Work Plans, Addendum	IT Corp.	176
26 Jan 89	Newspaper Article, "Mobile Home Park Taps City Water"	De La Cruz, Mike The Atwater Signal	334
08 Feb 89	Newspaper Article, "H2O Spells Happiness for Park Residents"	De La Cruz, Mike The Atwater Signal	172
28 Feb 89	TCE Sampling Analysis Data	California water Labs	187
10 May 89	Martin Marietta Letter to CDHS Regarding Addendum to RI/FS Work Plan	Loyd, John R Martin Marietta Energy Systems, Inc.	203
29 Jun 89	Newspaper Article: "Family Sues AF Over Tainted Well"	McCarthy, Charles The Fresno Bee	209
20 Jul 89	EPA Letter to Base Transmitting Comments Concerning Changes to Groundwater Sampling Events and Soil Boring Locations	Flaherty, Michael S EPA Region IX	213
10 Aug 89	EPA Letter to Base Regarding Ongoing RI Activities	Flaherty, Michael S EPA Region IX	217
15 Sep 89	Geo/Resource Consultants Letter to EPA Regarding Review of Recent Water Level Data for Monitoring Wells	Vanek, Eva Tryhorn, Alan D Geo/Resource Consultants, Inc.	221

20 Sep 89	CRWQCB Letter to Base Regarding Review of GAC Filtration Pump Test Results	Mosbacher, Michael H California Regional Water Quality Control Board	223
16 Oct 89	Base Letter to HQ SAC Regarding RPM Meeting, 20 Sep 89	Chan, Arthur D 93 BMW/CVE	225
03 Nov 89	Boyle Engineering Letter to Base Transmitting Letter Report Regarding 72 Hour Pump Test	Reitz, Mark Boyle Engineering Corp.	228
21 Nov 89	Base Letter to CDHS Transmitting 3rd Quarter Results from Production Wells 5, 6, 9, 10, and 11 for Review	Bernier, David R 93 MG/SGPB	230
28 Nov 99	RI/FS, SOW for Step 3 Tasks	Martin Marietta Energy Systems, Inc.	369
01 Dec 89	Base Letter to Resident Regarding Drinking Water Samples	Oyelowo, Layi A 93 CSG/EM	232
22 Dec 89	Base Letter to EPA and CDHS Transmitting RPM Meeting Minutes of RI/FS, Nov 89	Chan, Arthur D 93 CSG/EM	239
03 Jan 90	Certificate of Analysis, CAC Title 22 Drinking Water Compliance	California Water Labs	242
09 Feb 90	Martin Marietta Letter to Base Transmitting Minutes of RI/FS Review Meeting, 25 Jan 90	Loyd, John R Martin Marietta Energy Systems, Inc.	251
28 Feb 90	Base Letter to EPA and CDHS Regarding Agenda for Next RPM Meeting	Chan, Arthur D 93 CSG/EM	255
07 Mar 90	RI/FS, Minutes of Project Status Meeting	93 BMW/PA	257
21 Mar 90	CDHS Letter to Base Regarding Rationale for MW 713 and 714 Placements	Mosbacher, Michael H California Regional Water Quality Control Board	259
23 Mar 90	CDHS Letter to Base Regarding Rationale for Locating MW 713 and 714 in Order to Determine Potential TCE Source Areas	O'Kane, John A, Jr California Department of Health Services	260
06 Apr 90	EPA Letter to Base Confirming Agreement with Rationale Provided by Air Force for Locating MW 713 and 714	Flaherty, Michael S EPA Region IX	264

09 Apr 90	Base Letter to EPA and CDHS Transmitting Minutes of Project Managers' RI/FS Status Meeting, 07 Mar 90	Ridenour, Charles B 93 CSG/EM	265
17 Apr 90	Base Letter to EPA and CDHS Transmitting Agenda for Next RPM Meeting, Technical Memo for Proposed Pilot Treatment Plant System for Review, and Map of Meeting Place	Chan, Arthur D 93 CSG/EM	269
25 Apr 90	Base Letter Transmitting Minutes of TRC Meeting, 25 Apr 90	93 CSG/EM	273
02 May 90	Martin Marietta Letter to Base Transmitting Minutes of 24 Apr 90 RI/FS Project Status Review Meeting	Loyd, John R Martin Marietta Energy Systems, Inc.	272
18 May 90	MID Letter to Base Regarding Request for Use of Casad Canal Right of Way to Drill/Test for Monitoring Wells	Reta, Tom Merced Irrigation District	277
23 May 90	Base Letter to EPA and CDHS Regarding Next RPM Meeting	Chan, Arthur D 93 CSG/EM	278
30 May 90	CDHS Letter to Base Regarding Comments on Technical Memorandum for Proposed Long Term Pumping Test	O'Kane, John A, Jr California Department of Health Services	283
31 May 90	Base Letter Transmitting RPM Meeting Minutes, 31 May 90	Chan, Arthur D 93 CSG/EM	284
31 May 90	CDHS Letter to DoD Transmitting DSMOA	Kizer, Kenneth W California Department of Health Services	359
Jun 90	SOW, TCE Filtration System for Wallace Road Residents	93 CES/CEVR	72
Jun 90	Base Letter to Residents Regarding Monthly TCE Samples Taken from Drinking Water	Sassaman, Brian L, Lt 93 MG/SGPB	287
Jun 90	Base Letter to Residents Regarding Monthly TCE Samples Taken at OT-30 to Monitor Drinking Water Quality	Sassaman, Brian L, Lt 93 MG/SGPB	288
Jun 90	Base Letter to Resident Regarding Installation of GAC Filter at OT-30 to Remove TCE	Sassaman, Brian L, Lt 93 MG/SGPB	289

Jun 90	Base Letter to Resident Regarding Installation of GAC Filter at Residence to Remove TCE	Sassaman, Brian L, Lt 93 MG/SGPE	290
Jun 90	Base Letter to Resident Regarding Monthly TCE Samples Taken at Residence to Monitor Drinking Water Quality	Sassaman, Brian L, Lt 93 MG/SGPB	252
Jun 90	Base Letter to Resident Regarding Monthly TCE Samples Taken at Residence to Monitor Drinking Water Quality	Sassaman, Brian L, Lt 93 MG/SGPB	293
Jun 90	Base Letter to Resident Regarding Installation of GAC Filter at OT-30 to Remove TCE	Sassaman, Brian L, Lt 93 MG/SGPB	294
Jun 90	Base Letter to Paul Harrison Co. Regarding Water Sample Collected from Well by Bioenvironmental Engineering	Sassaman, Brian L, Lt 93 MG/SGPB	295
Jun 90	Base Letter to Residents Regarding Water Sample Collected from Well by BioEnvironmental Engineering	Sassaman, Brian L, Lt 93 MG/SGPB	299
11 Jun 90	Base Letter to EPA and CDHS Transmitting Meeting Agenda for Next RPM Meeting	Chan, Arthur D 93 CSG/EM	301
29 Jun 90	Base Letter to EPA and CDHS Transmitting Draft Work Plan II for Review and Comment	Chan, Arthur D 93 CSG/EM	308
Jul 90	Base Letter Regarding TRC Meeting Minutes with Talking Paper, 14 Jun 90	93 BMW/PA	303
17 Jul 90	RPM Meeting Minutes, 22 Jun 90 and Meeting Agenda, 24 Jul 90	Chan, Arthur D 93 CSG/EM	312
30 Jul 90	Base Letter to Resident Regarding Merced Union High School Site	Oyelowo, Layi A 93 CSG/EM	314
06 Aug 90	RPM Meeting Minutes, 24 Jul 90	Chan, Arthur D 93 CSG/EM	320
08 Aug 90	EPA Letter to Base Regarding Need for TCE Removal Action	Work, Michael EPA Region IX	321
13 Aug 90	RPM Meeting Agenda, 16 Aug 90	Chan, Arthur D 93 CSG/EM	325
22 Aug 90	Internal Martin Marietta Letter Transmitting SOW for Step 3 Tasks, Revision 2	Loyd, John R Martin Marietta Energy Systems, Inc.	326

31 Aug 90	EPA Letter to Base Regarding Completion of Review of Draft RI/FS Work Plan No 2, Jul 90	Work, Michael EPA Region IX	329
Sep 90	SOW, Maintenance and Servicing of Three Existing Culligan Activated Carbon Water Filtration Systems	93 CSG/DEEV	907
20 Sep 90	Base Letter to EPA Transmitting Agenda for Meeting 26-27 Sep 90	Baker, Thomas R, LtCol 93 CSG/EM	336
27 Sep 90	RI/FS, Project Status meeting minutes, 26-27 Sep 90	93 CSG/EM	337
28 Sep 90	RPM Meeting Minutes, 16 Aug 90	Chan, Arthur D 93 CSG/EM	338
Oct 90	Environmental Update	93 BMW/PA	340
Oct 90	Ambient Air Monitoring Report	California Department of Health Services	1003
12 Oct 90	Base Letter to EPA and CDHS Transmitting Draft Final of Work Plan 2	Chan, Arthur D 93 CSG/EM	345
16 Oct 90	RPM Meeting Minutes, 26-27 Sep 90	Chan, Arthur D 93 CSG/EM	348
24 Oct 90	RPM Meeting Agenda, 30 Oct 90	Chan, Arthur D 93 CSG/EM	350
24 Oct 90	EPA Letter to Base Regarding Failure to Submit Draft Final Work Plan No 2 Before 15 Oct 90	Work, Michael EPA Region IX	351
02 Nov 90	EPA Letter to Base Transmitting Comments on RI/FS Long Term Sampling Program	Work, Michael EPA Region IX	357
15 Nov 90	Soil Remediation Report	Horizon Technologies	361
Dec 90	RFA, Facility Assessment Report	California Department of Health Services	373
05 Dec 90	TRC Meeting Minutes with Slides and Talking Papers	Vician, Todd M B, Lt 93 BMW/PA	377
11 Dec 90	RPM Meeting Agenda, 18 Dec 90	Oyelowo, Layi A 93 CSG/DEV	379

18 Dec 90	RI/FS, Project Status Meeting Minutes, 18 Dec 90	93 CSG/DEV	383
27 Dec 90	Residents Vs. USAF Court Document, First Set of Interrogatories and Request for Production of Documentation	US District Court of California	983
Jan 91	Technical memorandum, Long Term Pumping Test	IT Corp.	382
08 Jan 91	RPM Meeting Minutes, 18 Dec 90	Cole, John R, LtCol 93 CSG/DE	389
24 Jan 91	RI/FS, Project Status Meeting Minutes, 23-24 Jan 91	93 CSG/DEEV	395
30 Jan 91	EPA Letter to Base Regarding Timeframe for Responding to OU-2 Proposed Schedule	Work, Michael EPA Region IX	396
11 Feb 91	RPM Meeting Minutes, 23-24 Jan 91	Chan, Arthur D 93 CSG/DEV	398
01 Mar 91	TRC Meeting Minutes, 23 Jan 90	Vician, Todd M B, Lt 93 BMW/PA	407
06 Mar 91	RPM Meeting Agenda, 13 Mar 91	Baker, Thomas R, LtCol 93 CSG/DEV	408
26 Mar 91	Base Letter to EPA Regarding Naming of OUs	Baker, Thomas R, LtCol 93 CSG/DEV	415
Apr 91	Castle AFB Environmental Update	93 BMW/PA	417
23 Apr 91	Base Letter Transmitting Minutes of RI/FS Project Status Meeting, 13 Mar 91	Baker, Thomas R, LtCol 93 CSG/DEV	427
29 Apr 91	RPM Meeting Agenda, 08 May 91	Baker, Thomas R, LtCol 93 CSG/DEV	431
15 May 91	EPA Letter to Base Transmitting Meeting Minutes, 23-24 Jan 91	Work, Michael EPA Region IX	443
16 May 91	Base Letter to Martin Marietta Transmitting EPA and CRWQCB Comments on Jan RPM Meeting Minutes	Baker, Thomas R, LtCol 93 CSG/DEV	445

21 May 91	CRWQCB Letter to Base Regarding Completion of Review of Proposed Schedule Changes for OU-2 and Basewide RI/FS	Mosbacher, Michael H California Regional Water Quality Control Board	446
22 May 91	EPA Letter to Base Transmitting Draft RPM Meeting Minutes, 08 May 91	Work, Michael EPA Region IX	447
29 May 91	Base Letter to IT Corp Transmitting Comments on Draft RPM Meeting Minutes, 08 May 91	Baker, Thomas R, LtCol 93 CSG/DEV	452
01 Jun 91	TRC Meeting Minutes, 24 Apr 91	Leong, Linda L, Maj 93 BMW/PA	454
27 Jun 91	RPM Meeting Minutes, 27 Jun 91	93 CSG/DEVR	464
Jul 91	Data Report, 15 VOC Probes Drilled in OT-30 Area	IT Corp.	467
12 Jul 91	Base Letter to EPA and CDHS Transmitting Draft RPM Meeting Minutes, 28 Jun 91	Baker, Thomas R, LtCol 93 CSG/DEV	472
12 Jul 91	Base Letter to EPA and CDHS Regarding Failure to Identify Requirement to Consultant Preparing RI/FS Report, OU-2	Baker, Thomas R, LtCol 93 CSG/DEV	473
18 Jul 91	EPA Letter to Base Regarding Late Receipt of Draft Risk Assessment for OU-2 and FFA Schedule	Work, Michael EPA Region IX	475
Aug 91	Draft Soil Management Plan for Waste in Drums and RI Derived Waste Originating from VOC Probes	CDM Federal Programs Corp.	483
08 Aug 91	Base Letter Transmitting Final RPM Meeting Minutes, 27 Jun 91	Baker, Thomas R, LtCol 93 CSG/DEV	488
15 Aug 91	Newspaper Article: "CRWQCB Public Hearing and Notice of Application for Waste Discharge Requirements"	Pearson, J Lawrence The Merced Sun Star	490
20 Aug 91	Base Letter to EPA Transmitting Draft RPM Meeting Minutes, 01 Aug 91	Baker, Thomas R, LtCol 93 CSG/DEV	491
26 Aug 91	Base Letter to CDHS Transmitting Summary Sheet of Monthly TCE Results	Baker, Thomas R, LtCol 93 CSG/DEV	430
Sep 91	RI/FS, Draft Report, OU-2	Metcalf & Eddy, Inc.	495

04 Sep 91	EPA Comments on Draft RPM Meeting Minutes, 01 Aug 91	Work, Michael EPA Region IX	498
11 Sep 91	CDHS Letter to Base Regarding Review of Draft Soil Management Plan for Wastes in Drums and RI Derived Waste Originating from VOC Probes, Aug 91	Wang, David California Department of Health Services	1021
16 Sep 91	Base Letter to EPA Transmitting Final RPM Meeting Minutes, 01 Apr 91	Baker, Thomas R, LtCol 93 CSG/DEV	500
17 Sep 91	EPA Letter to Base Transmitting Preliminary Comments on Draft RI/FS for OU-2	Work, Michael EPA Region IX	502
25 Sep 91	Base Letter to EPA Transmitting Draft RPM Meeting Minutes, 11 Sep 91	Baker, Thomas R, LtCol 93 CSG/DEV	505
Oct 91	Draft Work Plan/Technical Memorandum, Scoping Memorandum for OU-2	Metcalf & Eddy, Inc.	506
09 Oct 91	Base Letter to CDM Transmitting Comments on RPM Meeting Minutes, 17 Sep 91	Baker; Thomas R, LtCol 93 CSG/DEV	510
15 Oct 91	CDTSC Letter to Base Regarding Completion of Review of Draft RI/FS for OU-2	Wang, David California Department of Toxic Substances Control	516
15 Oct 91	EPA Letter to Base Regarding Comments on Draft RI/FS for OU-2	Work, Michael EPA Region IX	517
21 Oct 91	CDTSC Letter to Base Regarding Revised Comments for Draft RI/FS for OU-2	Wang, David California Department of Toxic Substances Control	521
21 Oct 91	CRWQCB Letter to Base Regarding Completion cf Review of Draft Final RI/FS for OU-2	Mosbacher, Michael H California Regional Water Quality Control Board	522
25 Oct 91	EPA Letter to Base Regarding Completeness of RI/FS for OU-2	Work, Michael EPA Region IX	524
31 Oct 91	Summary of Conference Call Between Representatives to Discuss Critical Issues from EPA Comments on Draft OU-2 RI/FS Report	Wilder, William L Oak Ridge National Laboratory	529

19 Nov 91	Base Letter to EPA Transmitting Draft RPM Meeting Minutes, 22 Oct 91	Baker, Thomas R, LtCol	535
20 Nov 91	EPA Letter to Base Regarding Review and Comment of Action Plan for Additional Domestic Well Sampling Southwest of Base	Work, Michael EPA Region IX	537
22 Nov 91	Scoping Meeting Minutes on OU-2 Work Plan, 22 Nov 91	Baker, Thomas R, LtCol 93 CSG/DEV	542
Dec 91	RI/FS, Draft Final BRA, Vol I of II, OU-2	Metcalf & Eddy, Inc.	545
Dec 91	RI/FS, Draft Final BRA, Vol II of II, OU-2	Metcalf & Eddy, Inc.	546
03 Dec 91	EPA Letter to Base Transmitting Comments on Draft Work Plan/Technical Memorandum/Scoping Memorandum for OU-2	Work, Michael EPA Region IX	547
06 Dec 91	CDTSC Letter to Base Regarding Receipt and Review of EPA Comments Concerning OU-2 Work Plan/Technical Memorandum	O'Kane, John A, Jr California Department of Toxic Substances Control.	550
16 Dec 91	EPA Letter to Base Regarding Review of Draft Final RI/FS for OU-2	work, Michael EPA Region IX	555
16 Dec 91	Base Letter to EPA Transmitting Final RPM Meeting Minutes, 22 Oct 91	Baker, Thomas R, LtCol 93 CSG/DEV	556
18 Dec 91	EPA Letter to Base Regarding Review of Draft Proposed Plan for OU-2	Work, Michael EPA Region IX	557
18 Dec 91	TRC Meeting Minutes, 13 Nov 91	Kehoe, Michael J, Col 93 BMW/CV	558
20 Dec 91	CDTSC Letter to Base Requesting 30 Day Extension to Comment and Response California Period in Order to Resolve Differences with Regard to Content of Draft Final RI/FS and Proposed Plan, OU-2	Wang, David Department of Toxic Substances Control	559
20 Dec 91	CDTSC Letter to EPA Requesting 30 Day Extension to Comment and Response California Period in order to Resolve Differences With Regard to Content of Draft Final RI/FS and Proposed Plan, OU-2	Wang, David Department of Toxic Substances Control	561

Jan 92	RI/FS, Draft Final BRA, Vol I of II, OU-2	Metcalf & Eddy, Inc.	564
Jan 92	RI/FS, Draft Final BRA, Vol II of II, OU-2	Metcalf & Eddy, Inc.	565
07 Jan 92	CDTSC Letter to Base Regarding Comments on Draft Final RI/FS and Proposed Plan, OU-2	Mosbacher, Michael H O'Kane, John A, Jr California Department of Toxic Substances Control	566
09 Jan 92	EPA Letter to Base Requesting Delivery of Revised RI/FS Prior to. Expiration Date of 21 Jan 92 and Draft Final Proposed Plan by 15 Feb 92	Work, Michael EPA Region IX	567
16 Jan 92	EPA Comments on Draft Work Plan for Groundwater Plume Characterization, Scoping Memorandum for OU-3, Dec 91	EPA Region IX	544
21 Jan 92	EPA Letter to Base Transmitting Review and Comment on Draft RPM Meeting Minutes, 17 Dec 91	Work, Michael EPA Region IX	569
22 Jan 92	Base Letter to Different Residents Regarding TCE Sampling Near Their Residences to Monitor Quality of Drinking Water	Baker, Thomas R, LtCol 93 CSG/DEV	571
22 Jan 92	Base Letter to Resident Regarding Monthly TCE Samples Taken to Monitor Quality of Drinking Water	Baker, Thomas R, LtCol 93 CSG/DEV	572
22 Jan 92	Base Letter to CDHS Transmitting Monthly TCE Test Results for Months of Oct, Nov, and Dec 91	Baker, Thomas R, LtCol 93 CSG/DEV	573
22 Jan 92	Base Letter to CDTSC Transmitting Summary Sheet of Monthly TCE Results	Baker, Thomas R, LtCol 93 CSG/DEV	574
22 Jan 92	Base Letter to Resident Transmitting TCE Samples Taken to Monitor Drinking Water Quality	Baker, Thomas R, LtCol 93 CSG/DEV	576
22 Jan 92	Base Letter to EPA Transmitting Summary Sheet of Monthly TCE Results	Baker, Thomas R, LtCol 93 CSG/DEV	577
22 Jan 92	Base Letter to EPA Regarding Amendments to Draft Final RI/FS for OU-2	Baker, Thomas R, LtCol 93 CSG/DEV	578

27 Jan 92	EPA Letter to Base Transmitting Comments on 22 Jan 92 Revisions to Draft Final RI/FS, OU-2	Work, Michael EPA Region IX	582
29 Jan 92	CDTSC Letter to Base Regarding Review of Draft Final RI/FS and Proposed Plan for OU-2, Jan 92	O'Kane, John A, Jr California Department of Toxic Substances Control	585
30 Jan 92	CRWQCB Letter to Base Regarding Review of Draft Final RI/FS, Jan 92 and Proposed Plan, 27 Nov 92 for OU-2	Vorster, Antonia K J California Regional Water Quality Control Board	586
30 Jan 92	CDTSC Letter to Base Requesting for Extension of IAG Schedule, 29 Jan 92	Wang, David California Department of Toxic Substances Control	587
Feb 92	VOC Probe Results	IT Corp.	589
06 Feb 92	EPA Letter to Base Regarding Receipt of Letter Requesting Extensions to FFA Schedules for Draft Final RI/FS for OU-2, Draft work Plan for OU-3, and Draft Final Proposed Plan for OU-2	Work, Michael EPA Region IX	585
10 Feb 92	CDTSC Letter Regarding Base Request for Identification of Applicable, Relevant and Appropriate Requirements for Remediation of Groundwater Contamination at OU-2	O'Kane, John A, Jr California Department of Toxic Substances Control	597
11 Feb 92	California Department of Public Works Letter to CDHS Regarding ARARs for Remediation of Groundwater Contamination for OU-2	Fillebrown, Paul A California Department of Public Works	600
12 Feb 92	Base Letter to EPA Regarding Working Session and RPM Meeting Minutes, 04 Feb 92	Baker, Thomas R, LtCol 93 CSG/DEV	601
12 Feb 92	Newspaper Article: "Carbon Filters Help Castle with Groundwater Cleanup"	The Atwater Signal	602
13 Feb 92	Newspaper Article: "Castle Clean-up Steps Forward"	The Winton Times	605
14 Feb 92	MID Letter to Base Regarding Water Quality Results, DA-4 and Wallace Road	Selb, E C Ted, III Merced Irrigation District	606

14 Feb 92	Base Letter to EPA Regarding Proposed Plan for OU-2	Baker, Thomas R, LtCol 93 CSG/DEV	607
21 Feb 92	EPA Letter to Base Regarding Delinquent Draft Final Proposed Plan for OU-2	Work, Michael EPA Region IX	608
24 Feb 92	Base Letter to EPA Transmitting Final Minutes, RPM Meeting, 17 Dec 91	Baker, Thomas R, LtCol 93 CSG/DEV	610
25 Feb 92	EPA Letter to Base Regarding Draft Minutes of RPM Meeting, 04 Feb 92	Work, Michael EPA Region IX	612
02 Mar 92	EPA Letter to Base Regarding RD for OU-2	Work, Michael EPA Region IX	614
04 Mar 92	CRWQCB Letter to Base Regarding Draft Work Plan and Field Sampling Plan, Groundwater Plume Characterization OU-3	Izzo, Victor J California Regional Water Quality Control Board	615
05 Mar 92	Newspaper Article: "Castle Cleans Groundwater"	The Atwater New Times	617
10 Mar 92	CRWQCB Letter to CDTSC Regarding ARARs for OU-2	Izzo, Victor J California Regional Water Quality Control Board	621
11 Mar 92	EPA Letter to Base Transmitting Comments on Draft Final Proposed Plan for OU-2	Work, Michael EPA Region IX	622
15 Mar 92	Castle AFB Environmental Update	93 BMW/PA	626
17 Mar 92	EPA Letter to Base Regarding Cal EPA Letters on RI/FS for OU-2	Work, Michael EPA Region IX	627
23 Mar 92	CDTSC Comments to Base Regarding Draft Final Proposed Plan for OU-2	O'Kane, John A, Jr California Department of Toxic Substances Control	629
24 Mar 92	CRWQCB Letter to Base Regarding Draft Final Proposed Plan for OU-2	Izzo, Victor J California Regional Water Quality Control Board	630
30 Mar 92	EPA Letter to Base Regarding Public Comment Period for OU-2	Work, Michael EPA Region IX	633

30 Mar 92	CRWQCS Letter to Base Regarding Data Needs for ROD, OU-2	Izzo, Victor J California Regional Water Quality Control Board	634
Apr 92	Proposed Plan for Remediation of Groundwater Contamination in Area of Wallace Road and DA-4	93 CES/DEVR	638
01 Apr 92	EPA Letter to Base Regarding Proposed Plan for OU-2	Work, Michael EPA Region IX	640
02 Apr 92	Newspaper Article: "Lack of Money for Water Clean-up"	The Winton Times	641
08 Apr 92	EPA Letter to Base Regarding EPA Review of Aerial Photo Analysis and Draft CSA Report	Work, Michael EPA Region IX	646
16 Apr 92	EPA Letter to Base in order to Clarify EPA Positions on OU-2	Anderson, Julie EPA Region IX	648
17 Apr 92	EPA Letter to Base Regarding Draft Proposed Plan Fact Sheet, Public Comment Period and ROD, OU-2	Work, Michael EPA Region IX	649
29 Apr 92	Newspaper Article: "Base Facilities to Tie into Atwater Waste Water Treatment Plant"	Sanders, Tammy S The Atwater Signal	653
08 May 92	Newspaper Article: "Cleanup Plan Urged"	The Modesto Bee	663
12 May 92	Newspaper Article: "Public Meeting Planned"	The Merced Sun Star	665
13 May 92	Base Letter to EPA Regarding RPM Meeting, 14 May 92	Baker, Thomas R, LtCol 93 CSG/DE	666
14 May 92	Newspaper Article: "Castle's Proposed Water Clean-up Plan"	The Atwater New Times	667
29 May 92	EPA Letter to Base Regarding Draft ROD for OU-2 and Requested Extension	Anderson, Julie EPA Region IX	676
03 Jun 92	CDTSC. Comments to Base on Proposed Plan for OU-2	Austreng, James C California Department of Toxic Substances Control	682
03 Jun 92	CRWQCB Comments to Base on Proposed Plan for OU-2	Izzo, Victor J California Regional Water Quality Control Board	683

15 Jun 92	Draft ROD, OU-2	EPA Region IX	681
16 Jul 92	SAF Letter to EPA Region IX and CDTSC Regarding Dispute Resolution	Vest, Gary D Deputy Assistant Secretary of the Air Force	688
29 Jul 92	Newspaper Article: "Atwater in Line for Big Federal Grant, $1.5 Million Would Pay to Connect Castle AFB Sewer Lines to Treatment Plant"	De La Cruz, Mike The Merced Sun Star	700
05 Aug 92	EPA Letter to Base, CRWQCB, and CDTSC Regarding Review of Draft ROD for OU-2	Work, Michael EPA Region IX	702
07 Aug 92	Base Letter to EPA Transmitting ROD Responsiveness Summary, OU-2	Parker, Scarlette P, TSgt 93 BMW/CVE	703
11 Aug 92	CRWQCB Letter to EPA Regarding Review Comments Due Date for Draft ROD for OU-2	Izzo, Victor J California Regional Water Quality Control Board	707
11 Aug 92	CDTSC-Letter to EPA Regarding Draft ROD for OU-2 with Comments	Austreng, James C California Department of Toxic Substances Control	708
11 Aug 92	PRC.Letter to Base Transmitting Response to EPA Comments on Draft 100% Design Documents and Draft RA Work Plan for OU-1	Scruggs, Mary PRC Environmental Management, Inc.	709
13 Aug 92	Base Letter to EPA Concerning Comments on Draft ROD, OU-2	Hicks, Brad 93 CES/DEVR	712
14 Aug 92	CRWQCB Letter to Base Transmitting Comments on Draft ROD, OU-2	Izzo, Victor J California Regional Water Quality Control Board	713
18 Aug 92	EPA Letter to Base and Cal EPA Requesting Review of Draft Responsiveness Summary for OU-2, 09 Sep 92	Work, Michael EPA Region IX	715
03 Sep 92	CRWQCB Letter to Base Transmitting Comments on Draft OU-2 Responsiveness Summary	Izzo, Victor J California Regional Water Quality Control Board	721
16 Sep 92	EPA Letter to Base, CDTSC, and CRWQCB Transmitting Draft Final ROD for OU-2	Work, Michael EPA Region IX	726

21 Sep 92	EPA Letter to Base Regarding Draft Final ROD for OU-2 on Diskette	Work, Michael EPA Region IX	728
24 Sep 92	Base Letter to EPA, CDTSC, and CRWQCB Regarding Retraction of Draft Final ROD for OU-2 (Reference EPA Letter, 16 Sep 92)	Cole, John R, LtCol 93 BMW/CVE	730
25 Sep 92	EPA Letter to Base Regarding Base Cleanup Information	Takata, Keith EPA Region IX	732
26 Sep 92	Base Letter to EPA, CDTSC, and CRWQCB Regarding Proposed FFA Schedule	Cole, John R, LtCol 93 BMW/CVE	733
Oct 92	Draft Final ROD, OU-2	93 CES/CEV	739
02 Oct 92	Base Letter to EPA, CDTSC, and CRWQCB Regarding Transmission of Draft Final ROD for OU-2	Cole, John R, LtCol 93 SG/DE	197
09 Oct 92	EPA Letter to Base Transmitting Draft Meeting Minutes, 16 Sep 92	Work, Michael EPA Region IX	742
13 Oct 92	EPA Letter to Base Regarding Draft Proposed FFA Schedule	Work, Michael EPA Region IX	743
21 Oct 92	Base Letter to EPA, CDTSC, and CRWQCB Transmitting Proposed Agenda for RPM Meeting, 04 Nov 92	Cole, John R, LtCol 93 BMW/CVE	748
23 Oct 92	Base Letter to EPA, CDTSC, and CRWQCB Transmitting RPM Meeting Minutes, 16 Sep 92	Cole, John R, LtCol 93 BMW/CVE	749
29 Oct 92	EPA Letter to Base Regarding Draft Final ROD for OU-2	Work, Michael EPA Region IX	752
02 Nov 92	Base Letter to EPA, CDTSC, and CRWQCB Regarding EPA's Comments on OU-2 Draft Final ROD, 29 Oct 92	Baker, Thomas R, LtCol 93 CES/CEVR	759
04 Nov 92	RPM Meeting Minutes, 04 Nov 92	Reith, Charles Jacobs Engineering Group, Inc.	761
O5 Nov 92	CDTSC Letter to EPA and HQ ACC Regarding Dispute Resolution	Ward, Daniel T California Department of Toxic Substances Control	767
05 Nov 92	CRWQCB Letter to Base Regarding Approval of Building 84 Removal Action	Izzo, Victor J California Regional Water Quality Control Board	768

09 Nov 92	Castle AFB Environmental Update	93 BW/PA	769
09 Nov 92	Castle AFB Environmental Update	93 BW/PA	784
20 Nov 92	EPA Letter to Base Regarding Draft Preliminary Accelerated RD/RA Schedule for OU-2	Work, Michael EPA Region IX	772
25 Nov 92	EPA Letter to HQ ACC, CDTSC, and CRWQCB Regarding Dispute Resolution, ROD for OU-2	Takata, Keith EPA Region IX	774
10 Dec 92	Newspaper Article: "Castle AFB Receives $21 Million for Cleanup"	The Winton Times	779
14 Dec 92	SOW, Title I Services for Groundwater Treatment, OU-2 and Title II Services for Groundwater Treatment, OU-1	Jacobs Engineering Group, Inc.	946
15 Dec 92	CRWQCB-Letter to Base Regarding Draft Update of Monitoring and Reporting Program of Board Order Number	Izzo, Victor J California Regional Water Quality Control Board	785
16 Dec 92	Newspaper Article: "Castle Gets Cleanup Funding"	Parker, Scarlette P, TSgt The Atwater Signal	786
05 Jan 93	TRC Meeting Minutes, 18 Nov 92	Bishop, Raymond C, Col 93 BW/CV	788
06 Jan 93	Base Letter to EPA, CDTSC, and CRWQCB Transmitting Proposed Agenda for RPM Meeting, 20 Jan 93	Cole, John R, LtCol 93 BW/CVE	789
11 Jan 93	EPA Letter to Base Regarding Draft Quality Assurance Project Plan, Nov 92	Work, Michael EPA Region IX	790
12 Jan 93	EPA Letter to HQ ACC, CDTSC, and CRWQCB Regarding Dispute Resolution, ROD for OU-2	Takata, Keith EPA Region IX	791
14 Jan 93	CDTSC Letter to EPA Regarding Dispute Resolution, ROD for OU-2	Wang, David California Department of Toxic substances Control	792
Feb 93	RD, Draft Work Plan, OU-2	Jacobs Engineering Group, Inc.	798
Feb 93	Draft Conceptual Design Support Document Technical Memorandum for OU-2	Jacobs Engineering Group, Inc.	799

Feb 93	RI, Comprehensive Basewide Groundwater Health and Safety Plan	Jacobs Engineering Group, Inc.	959
03 Feb 93	Base Letters to Residents Regarding sampling Results	Baker, Thomas R, LtCol 93 CES/CEV	801
08 Feb 93	Base Letter to EPA, CDTSC, and CRWQCB Regarding Draft Final RD/RA Schedule for OU-2	Cole, John R, LtCol 93 BW/CVE	803
09 Feb 93	EPA Letter to Base Regarding Draft Meeting Minutes, 20 Jan 93	Work, Michael EPA Region IX	805
19 Feb 93	CDTSC Letter to EPA Regarding Extension of Review Period for OU-2	Wang, David California Department of Toxic Substances Control	813
23 Feb 93	Base Letter to EPA, CDTSC, and CRWQCB Documenting Phone Conversation on Approval of Contaminated Groundwater Disposal	Baker, Thomas R, LtCol 93 CES/CEV	816
01 Mar 93	MCDH Letter to Resident Responding to Comments	Palsgaard, Jeff H Merced County Department of Public Health	821
08 Mar 93	EPA Letter to MCDPH Regarding MCDPH Letters of Feb 9 and 11, 93	Work, Michael EPA Region IX	825
22 Mar 93	EPA Letter to HQ ACC, CDTSC, and CRWQCB Regarding Dispute Resolution, ROD for OU-2	Takata, Keith EPA Region IX	835
22 Mar 93	Base Letter to Residents Transmitting Results from well Water Sampling	Baker, Thomas R, LtCol 93 CES/CEV	836
23 Mar 93	Newspaper Article: "Cleanup Efforts at Castle Continue"	Lindsay, Alvie The Modesto Bee	838
24 Mar 93	CDTSC Letter to EPA Regarding Extension of Review Period for OU-2	Wang, David California Department of Toxic Substances Control	839
01 Apr 93	Base Letter to Residents Transmitting Monthly TCE Samples	Baker, Thomas R, LtCol 93 CES/CEV	843
07 Apr 93	HQ ACC Letter to EPA Region IX on Dispute Resolution, ROD for OU-2 Regarding EPA Letter, 22 Mar 93	Mogge, John W, Col HQ ACC/CEV	847

14 Apr 93	EPA Letter to Base Regarding OU-2 Conceptual Design Support Technical Memorandum	work, Michael EPA Region IX	851
23 Apr 92	EPA Letter to Resident Regarding Resident's Letter to Merced County Department of Public Health	Work, Michael EPA Region IX	854
29 Apr 93	Base Letter to Resident Regarding Well Sampling	Baker, Thomas R, LtCol 93 CES/CEV	856
May 93	Draft Final Conceptual Design Support Document Technical Memorandum for OU-2	Jacobs Engineering Group, Inc.	858
10 May 93	Draft -RPM Meeting Minutes, 29 Apr 93	Watkin, Geoff W Jacobs Engineering Group, Inc.	866
13 May 93	HQ ACC Letter to EPA Regarding Dispute Resolution, ROD for OU-2	Mogge, John W, Col HQ ACC/CEV	871
14 May 93	Base Letter to CRWQCB Regarding OU-2 Waste Soil Disposal	Cole, John R, LtCol 93 BW/CVE	872
18 May 93	Base Letter to CRWQCB Regarding OU-2 Waste Water Disposal	Cole, John R, LtCol 93 BW/CVE	87S
21 May 93	EPA Letter to Base Regarding Revised OU-2 Conceptual Design Support Technical Memorandum, May 93	Work, Michael, EPA Region IX	878
26 May 93	HQ ACC Letter to EPA Regarding Dispute Resolution, ROD for OU-2, Cost to Comply Summary	Mogge, John W, Col HQ ACC/CEV	881
03 Jun 93	Base Letter to Jacobs Regarding Disposition of Waste Generated by OU-2 Activities	Baker, Thomas R, LtCol 93 BW/CVE	890
11 Jun 93	HQ ACC Letter to EPA Regarding Dispute Resolution, ROD for OU-2	Burnet, Gilbert N HQ ACC/CEV	4
15 Jun 93	HQ ACC Letter to EPA Regarding Dispute Resolution, ROD for OU-2, Cost to Comply Summary	Mogge, John W, Col HQ ACC/CEV	30
22 Jun 93	EPA Letter to HQ ACC, CDTSC, and CRWQCB Regarding Dispute Resolution, ROD for OU-2	Takata, Keith EPA Region IX	218
22 Jun 93	Base Letter to CRWQCB Regarding Temporary Shut Down of DA-4 and Wallace Road	Baker, Thomas R, LtCol 93 CES/CEV	219

29 Jun 93	CDTSC Letter to EPA Regarding Extension of Review Period for OU-2	Wang, David California Department of Toxic Substances Control	258
12 Jul 93	Right of Entry Between Government and Landowner	Kotyk, Jack W AFBDA/OL	342
12 Jul 93	HQ ACC Letter to EPA Regarding Dispute Resolution, ROD for OU-2, Cost to HQ ACC/CEV Comply Summary	Mogge, John W, Col	346
13 Jul 93	Base Letter to CRWQCB Regarding Summary Sheet of All Monthly TCE Results	Baker, Thomas R, LtCol 93 CES/CEV	380
16 Jul 93	Base Letter to Resident Regarding Their Culligan Water Filter	Baker, Thomas R, LtCol 93 CES/CEV	400
30 Jul 93	Right of Entry for Environmental Testing and Monitoring	93 CES/CEVR	457
03 Aug 93	RPM Meeting Minutes, 22 Jul 93	Watkin, Geoff W Jacobs Engineering Group, Inc.	474
06 Aug 93	CRWQCB Letter to HQ ACC Regarding OU-2 Dispute Remaining Issues	Pearson, J Lawrence California Regional Water Quality Control Board	484
09 Aug 93	Base Letter to Resident Transmitting Water Sample Results	Fraher, Jeffrey T, Maj 93 CES/CEV	494
09 Aug 93	EPA Letter to CRWQCB Regarding Dipute Issues of OU-2 ROD	Anderson, Julie EPA Region IX	504
12 Aug 93	Base Letter to CRWQCB, CDTSC, and EPA Regarding waste Water Disposal	Baker, Thomas R, LtCol 93 CES/CEV	508
16 Aug 93	EPA Letter to Base Regarding Updated Long-Term Groundwater Sampling Plan	Work, Michael EPA Region IX	533
19 Aug 93	CRWQCB Draft Memo Regarding OU-2 Dispute Resolution Meeting Minutes, 10 Aug 93	Vorster, Antonia K J California Regional Water Quality Control Board	540
25 Aug 93	EPA Letter to CRWQCB Regarding Draft Minutes of OU-2 Meeting, 10 Aug 93	Work, Michael EPA Region IX	581

27 Aug 93	CRWQCB Letter to HQ ACC, CDHS, and EPA Regarding Resolution of OU-2 Dispute	Pearson, J Lawrence California Regional Water Quality Control Board	654
Sep 93	Advance Draft Hydrogeological Technical Memorandum for OU-2	Jacobs Engineering Group, Inc.	668
01 Sep 93	Base Letter to TRC Members Transmitting Meeting Agenda	Parker, Scarlette P, Tsgt 93 BW/PA	711
01 Sep 93	EPA Letter to CRWQCB, Regarding EPA Comments on Draft Minutes of OU-2 Meeting, 10 Aug 93, and Draft Waste Discharge Requirement, 19 Aug 93	Work, Michael EPA Region IX	738
02 Sep 93	EPA Letter to HQ ACC, CDTSC, and CRWQCB Regarding Dispute Resolution, ROD for OU-2	Takata, Keith EPA Region IX	849
03 Sep 93	HQ ACC Letter to CDTSC and CRWQCB Regarding Dispute Resolution, ROD for OU-2	Burnet, Gilbert N HQ ACC/CEV	183
08 Sep 92	Base Letter to EPA, CDTSC, and CRWQCB Transmitting RPM Meeting Minutes, 19 Aug 93	Fraher, Jeffrey T, Maj 93 BW/CVE	233
15 Sep 93	Base Letter to Resident Regarding Well Sampling Information	Morris, Brett, Capt 93 BW/CVE	758
17 Sep 93	Base Letter to EPA, CDTSC, and CRWQCB Regarding Proposed Agenda for RPM Meeting, 14 Oct 93	Cole, John R, LtCol 93 BW/CVE	824
20 Sep 93	EPA Letter to Base Regarding Revised Draft Final ROD for OU-2	Work, Michael EPA Region IX	831
22 Sep 93	EPA Letter to Base Regarding Delayed Draft Preliminary Conceptual Design Document for OU-2	Work, Michael EPA Region IX	725
22 Sep 93	HQ ACC Letter to Base Regarding Revised Draft Final ROD for OU-2	Battaglia, Michael R HQ ACC/CFVR	780
22 Sep 93	EA Letter to HSC Transmitting Hard Copy of Requested Modeling of Groundwater Flow and Contaminant Dispersion at OU-1	Bugica, David M EA Engineering, Science, and Technology, Inc.	953
24 Sep 93	HQ ACC Letter to EPA, CDTSC, and CRWQCB Regarding Dispute Resolution, Draft Final ROD Submission for OU-2	Burnet, Gilbert N HQ ACC/CEV	677

22 Oct 93	EPA Letter to Base Regarding Revised Draft Final ROD for OU-2	Work, Michael EPA Region IX	271
27 Oct 93	CDTSC Letter to Base Regarding Review Comments on Revised Draft Final ROD for OU-2, Oct 93	Ward, Daniel T California Department of Toxic Substances Control	562
Nov 93	Final ROD, OU-2	93 CES/CEVR	206
Nov 93	Hydrogeological Technical Memorandum, Raw Field Data, OU-2	Jacobs Engineering Group, Inc.	968
08 Nov 93	EPA Letter to Base Regarding Revised Draft Final ROD for OU-2, Nov 93	Work, Michael EPA Region IX	181
10 Nov 93	Base Letter to EPA, CDTSC, and CRWQCB Transmitting Requested Ammended Pages of Final ROD for OU-2	Cole, John R, LtCol 93 BW/CVE	184
12 Nov 93	CDTSC Letter to Base Regarding Review Comments on OU-2 Hydrogeologic Technical Memorandum, Oct 93	Ward, Daniel T California Department of Toxic Substances Control	185
15 Nov 93	EPA Letter to Base Regarding OU-2 Draft Hydrogeological Technical Memo	Work, Michael EPA Region IX	99
15 Nov 93	Finalized Boring Logs, OU-2 (Revised Appendix A)	Jacobs Engineering Group, Inc.	969
19 Nov 93	EPA Letter to Base Regarding OU-2 Draft Preliminary Conceptual Design	Work, Michael EPA Region IX	101
23 Nov 93	Final Record of Decision for Operable Unit-2	AFBCA/0L-I	1064
14 Dec 93	Base Letter to CDHS, CRWQCB, and Jacobs Engineering Transmitting Monthly TCE Results	Chan, Arthur D 93 BW/CV	1024
Jan 94	Final Hydrogeological Technical Memorandum, Vol I of II, OU-2	Jacobs Engineering Group, Inc.	975
05 Jan 94	Jacobs Engineering Conversation with CRWQCB Regarding Upper Subshallow HSZ Data Gaps, Off Base OU-2	Heller, Noah R Jacobs Engineering Group, Inc.	932
05 Jan 94	RPM Meeting Minutes. 09 Dec 94	Watkin, Geoff W Jacobs Engineering. Group, Inc.	951
08 Feb 94	RPM Meeting Minutes, 27 Jan 94	Watkin, Geoff W Jacobs Engineering Group, Inc.	950

Mar 94	Internal Base Memorandum Transmitting Proposed Agenda and Draft Charter for RAB for Review and Comment	Bishop, Raymond C, Col 93 BWICV	957
02 Mar 94	Base Letter to EPA, CDTSC, and CRWQCB Transmitting RPM Meeting Minutes, 27 Jan 94	Salgado, Rogelio R 93 BW/CVE	926
07 Mar 94	Castle AFB Environmental Update	93 BW/PA	984
09 Mar 94	Newspaper Article, "Advisory Board Meets"	The Merced Sun Star	985
21 Mar 94	Base Letter to EPA, CDTSC, and CRWQCB Transmitting Final RPM Meeting Minutes from 02 Mar 94 and Meeting Agenda from 22 Mar 94	Cole, John R, LtCol 93 BW/CV	1029
22 Mar 94	SOW, Title I Services for Groundwater Treatment, OU-2 and Title II Services for Groundwater Treatment, OU-1	Jacobs Engineering Group, Inc.	947
01 Apr 94	RAB Meeting Minutes, 09 Mar 94	Bishop, Raymond C, Col 93 BW/CV	1032
19 Apr 94	RPM Meeting Minutes, 24 Mar 94	Cole, John R, LtCol 93 BW/CVE	954
28 Apr 94	AFBCA Letter to EPA Transmitting OU-2 ROD Signature Page	Carr, John P AFBCA/NW	929
28 Apr 94	EPA Letter to Base Regarding Interim Removal Action, Extraction Well #SE-7 95% Design Review, OU-2	Roberts, David E EPA Region IX	1035
29 Apr 94	Conceptual Design Report, Vol I of II, OU-2	Jacobs Engineering Group, Inc.	979
29 Apr 94	Conceptual Design Report, Outline Specification, Vol II of II, OU-2	Jacobs Engineering Group, Inc.	980
06 May 94	CDTSC Letter to Base Transmitting Comments on Long Term Groundwater Sampling Plan, Draft Final Waste Management Plan, Draft VLEACH Benzene Results, and Specifications for Construction of TCE Extraction Well	Austreng, James C California Department of Toxic Substances Control	1037
09 May 94	Jacobs Engineering Response to EPA Comments on Draft Conceptual Design Report, Groundwater Treatment, OU-2	Leach, James D Jacobs Engineering Group, Inc.	928

10 May 94	Draft RPM Meeting Minutes, 28 Apr 94	Watkin, Geoff W Jacobs Engineering Group, Inc.	927
20 May 94	Final RPM Meeting Minutes, 28 Apr 94 and Meeting Agenda, 26 May 94	Cole, John R, LtCol 93 BW/CVE	1038
23 May 94	Newspaper Article, "Public Notice/Notice of Availability"	The Merced Sun Star	1039
26 May 94	Base Letter to EPA, CDTSC, and CRWQCB Regarding Documentation of Meetings with Local Property Owners impacted by Environmental Cleanup Efforts	Gaddy, Armon T, Jr, TSgt 93 BW/PA	923
Jun 94	Phase II, Comprehensive Basewide OU Risk Assessment, Technical Memorandum	Jacobs Engineering Group, Inc.	931
Jun 94	Jacobs Engineering Response to EPA and CRWQCB Comments on Draft Final Conceptual Design Report, OU-2	Jacobs Engineering Group, Inc.	1041
01 Jun 94	Castle AFB Environmental Update	93 BW/PA	971
13 Jun 94	Meeting Minutes from AFBCA and ATSDR Health consultations and Data Gap Reviews	Stokes, Mark H, Col AFBCA-AL/OEM	1042
15 Jun 94	RA, Work Plan, OU-2	Jacobs Engineering Group, Inc.	897
17 Jun 94	EPA Letter to Base Concerning Selection of Service Center to Administer RD/RA Contract for OU-2	Roberts, David E EPA Region IX	930
03 Aug 94	EPA Letter to Brooks AFB Regarding Basic Concerns with SOWs	Roberts, David E EPA Region IX	1045
25 Aug 94	Summary of Modeling Recommendations and Anticipated Actions to be Performed: Concerning OU-2	Utah State University	997
13 Sep 94	RAB Meeting Minutes, 13 Sep 94	93 BW/CV	1000
06 Oct 94	Final RPM Meeting Minutes, 22 Sep 94 and Meeting Agenda, 02 Nov 94	Hicks, Brad 93 CES/CEVR	1006
25 Oct 94	EPA Letter to Base Regarding Review of Preliminary Draft Explanation of Significance Difference for ROD, OU-2	Roberts, David E EPA Region IX	1010
27 Oct 94	RAB Meeting Minutes, 13 Sep 94	Mollison, John C, Jr, Col 93 SPTG/CC	1011

11 Nov 94	Long Term Groundwater Sampling Program, Summary of Groundwater Monitoring, Quarter 3, 94	Jacobs Engineering Group, Inc.	1012
28 Nov 94	Final-RPM Meeting Minutes, 02 Nov 94 and Meeting Agenda, 07 Dec 94	Pohlmeier, mark A, Capt 93 BW/CEW	1014
07 Dec 94	Explanation of Significant Difference for the ROD for OU-2	Mollison, John C., Col Roberts, David E Ghazi, Rizgar A AFBCA/OL-I EPA Region IX California Department of Toxic Substances Control	1063
15 Dec 94	CDTSC Letter to Base Regarding Review of Draft Comprehensive Basewide RI/FS Report	Ghazi, Rizgar A California Department of Toxic Substances Control	1017
15 Mar 95	Meeting minutes of Remedial Project Managers Meeting held on 15 Mar 95	Kumanchik, Cynthia Gutierrez-Palmenberg, Inc.	1090
27 Mar 95	Meeting Minutes for 27 Mar 95 Restoration Advisory Board Meeting	Kumanchik, Cynthia Gutierrez-Palmenberg Inc.	1091
11 Apr 95	Summary of March 1995 Domestic Well Sampling Results	McLeod, Campbell Jacobs Engineering Group, Inc.	1103
May 95	Environmental Baseline Survey for Twenty-Five Parcels of Land Located Near Castle AFB	ACC CES/ESV (Geo Marine, Inc.)	1069
12 May 95	Draft Summary of Domestic well Monitoring January Through April 1995	McLeod, Campbell Jacobs Engineering Group, Inc.	1075
18 Jul 95	July 18 1995 Remedial Project Managers Meeting Minutes	AFBCA/OL-I	1112
21 Jul 95	July 1995 Draft Remedial Project Managers and Technical Working Group Sessions Meeting Minutes	AFBCA/OL-I	1114
31 Jul 95	Jacobs Engineering Group, Inc. Stop Work Order	Smith, Alice R. Tacobs Engineering Group, Inc.	1118

24 Aug 95	Assumptions for Revised Design Basis Report (RDBR) Groundwater Model Development	Hobbins, Christopher AFCEE/ESB	1123
12 Sep 95	12 September 1995 Remedial Project Managers' Meeting Minutes	AFBCA/OL-I	1145
29 Sep 95	12 September 1995 Restoration Advisory Board Meeting Minutes	AFBCA/OL-I	1135
15 Dec 95	21 November 1995 Restoration Advisory Board Meeting Minutes	Kumanchik, Cynthia Gutierrez - Palmenberg , Inc.	1151
14 Feb 96	Final January 1996 Remedial Project Managers' Meeting Minutes	AFBCA/0L-I	1175
19 Feb 96	Data Gap Well Installation for Long Term Groundwater Sampling Program	Hobbins, Christopher AFCEE/ERB	1172
22 Feb 96	21 February 1996 Draft Remedial Project Managers Meeting Minutes	Kumanchik, Cynthia Gutierrez-Palmenberg , Inc.	1171
12 Mar 96	CDTSC Geological Services Unit review of Draft Revised Basis of Design Report (RBDR)	Scruggs, Mary California Department of Toxic Substances Control	1167
14 Mar 96	CDTSC's review of Draft Revised Basis of Design Report	Ghazi, Rizgar California Department of Toxic Substances Control	1166
15 Mar 96	U.S. EPA comments on Draft Revised Basis of Design Report (RBDR)	Roberts, David EPA Region IX	1165
UNK	Newspaper Article, "Meeting Today on TCE in Mobile Home Park"	De La Cruz, Mike The Merced Sun Star	47
UNK	Phase II, SOW, Construct Water Line Located at Wallace Road and Nearby Hospital Road	UNK	906

TABLE 2-1
SELECTED REMEDIAL ACTIONS

Plume	Selected Remedial Action
Main Base Plume	Plume capture and treatment to achieve groundwater cleanup to the MCL level. Extraction of contaminated groundwater; treatment using a combination of air stripping and carbon adsorption; disposal of treated groundwater using reinjection, canal discharge, and/or reuse. Remedial action to be implemented in a phased approach.*
East Base Plume	Impacted area well destruction and monitoring utilizing the sealing and abandonment of wells to protect against further cross contamination of HSZs, and monitoring to develop more complete definition of the contamination. If further active remediation is needed, a pump and treat approach will be implemented as the presumptive remedy.*
Castle Vista Plume	Implementation of active pump and treat as a presumptive remedy. The remedy consists of plume capture and treatment to achieve groundwater cleanup to the MCL level; extraction of contaminated groundwater; treatment using a combination of air stripping and carbon adsorption; and disposal of treated groundwater using reinjection, canal discharge, and/or reuse. Remedial action to be implemented in a phased approach.*
North Base Plume	No further active remediation**
Landfill 1 Plume	No further active remediation**
Landfill 4 Plume	No further active remediation**

*Administrative controls, in addition to the indicated remedy, will be implemented as necessary.
**Active remediation of the North Base, Landfill 4, and Landfill 1 Plume Regions is not warranted because action is being taken to remediate the sources, and because removing the low- concentration contaminants from the groundwater would provide little benefit while incurring high costs. However, because several of the contaminants are above the primary drinking water standards, institutional controls (such as deed restrictions) will be applied to prohibit the installation of groundwater supply wells on Castle AFB that would jeopardize public health or the environment from North Base, Landfill 4 and Landfill 1 Plume areas. Additionally, long-term monitoring will be continued and modified as necessary to monitor contaminant concentrations. Contamination concentration levels in the groundwater will be monitored as part of the LTGSP and will be reevaluated annually.

TABLE 3-1
GROUNDWATER ZONES AND PLUME REGIONS AT CASTLE An, CA

Plume/Region	Location	Principal Contaminant(s)	Zones 3 of Contamination
Main Base Plume 1	Beneath the Main Base sector, corresponding to the OU-1 remediation area (installed treatment system)	TCE 1 and other VOCS	shallow, upper subshallow, lower subshallow, and confined
Main Base Plume 2	Beneath the Main Base sector, corresponding to the OU-2 remediation area (treatment system under construction)	TCE and other VOCS	shallow, upper subshallow, lower subshallow, and confined
Landfill 4 Plume	Beneath Landfill 4 in the West Base sector	Vocs	shallow
North Base Plume	Beneath Landfill 5 in the North Base sector	TCE and other Vocs	shallow
East Base Plume	Beneath the East Base sector	TCE and other Vocs	shallow
Landfill 1 Plume	Beneath Landfill 1 in the South Base sector	VOCs and arsenic 2	shallow and upper subshallow
Castle Vista Plume	Beneath the Castle Vista Landfill B in the off-base sector	Vocs	shallow

1 Tricholorethylene(TCE) is a volatile organic compound (VOC) however, since TCE is the major groundwater contaminant at Castle Airport, it is identified separately from the VOC grouping.

2 A naturally occurring chemical with elevated levels common in the region's groundwater.

3 The depth of groundwater zones at Castle Airport are as follows: Shallow - 60 to 95 feet below ground surface (bgs); Upper Subshallow - 96 to 160 feet bgs; Lower Subshallow - 161 to 220 feet bgs; Confined - 220 to 350 feet bgs, Deep - 351 feet bgs.

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TABLE 3-4. RISK ASSESSMENT SUMMARY

Plume Region	Groundwater	Principal Contaminants 1	Exposure Point Concentration (ug/L) 2	Standard (ug/L) 3	Cancer Risk 4	Hazard Index 4
Main Plume 1	Shallow	TCE	91	5	9.0x10 -5	2.7
		HCBD	0.66	-		
		1,1 DCE	0.73	6		
	Upper Subshallow	TCE	156	5	2.2xl0 -4	4.1
		cis 1,2 DCE	0.91	-		
	Lower Subshallow	TCE	17.4	5	1.9x10 -5	0.6
	Confined	TCE	33.6	5	2.6x10 -5	3.9
Main Plume 2	Shallow	TCE	105	5	1.9x10 -4	2.9
	Upper Subshallow	TCE	208	5	1.8x10 -4	3.2
		DEHP	15	4		
	Lower Subshallow	TCE	4	5	2.9x10 -6	0.08
	Confined	Benzene	0.5	1	3.0x10 -6	0.05
East Base	Shallow	TCE	2.25	5	8.7x10 -5	0.6
		DEHP	37	4		
Castle Vista	Shallow	PCE	11	5	1.1x10 -4	0.3
North Base	Shallow	DEHP	37	4	5.2x10 -5	0.4
Landfill 1	Shallow	PCE	0.56	5	2.9x10 -4	1.8
Landfill 4	Shallow	DEHP	39	4	1.7x10 -4	3.7
	Antimony					

1 Contaminants listed are the principal contributor to the total cancer risk and/or hazard index.

2 Exposure point concentration is the concentration of the contaminant at the point of human exposure, as analyzed in the Risk Assessment

3 Standards are the more restrictive of federal or California standards for safe drinking water.

4 The cancer risk and hazard index are the total risk/hazard for all contributions under the adult residential exposure scenario that leads to the highest value.

ug/L	Micrograms of contaminant per liter of water	DCE	Dichloroethene
TCE	Trichloroethylene	DEHP	Bis-(2-ethythexyl)phthalate
PCE	Perchloroethylene	HCBD	Hexachlorobutadiene

Table 3-5
Chemicals of Potential Concern (COPCs) in Groundwater by Plume Region

Detected Chemical	Main Plume Region 1 (shallow HSZ)	Main Plume Region 1 (upper sub-shallow HSZ)	Main Plume Region 1 (lower sub-shallow HSZ)	Main Plume Region 1 (confined HSZ)	Main Plume Region 2			Castle Vista Plume Region	East Base Plume Region	Landfill 1 Plume Region (shallow HSZ)	Landfill 1 Plume Region (uppersub-shallow HSZ)	Landfill 4 Plume Region	North Bass Plume Region
					S	U	L CF						
ORGANICS													
1,1-Dichloroethene	ò												
1,2-Dibromo-3-chloropropans (DBCP)		ò			ò	ò						ò	
1,2-Dibromoethane (ethylene dibromide)					ò	ò		ò					
1,2-Dichlorobenzene					ò	ò							
1,3-Dichlorobenzene	ò												
1,4-Dichlorobenzene	ò												ò
1,1-Dichloroethane	ò												ò
1,2-Dichloroethane	ò												
1,2-Dichloroethene													
1,2-Dichloropropane			ò		ò		ò						
1,2,3-Trichlorobenzene					ò		ò		ò			ò	ò
1,2,4-Trichlorobenzene	ò				ò							ò	
1,1,1-Trichloroethane				ò			ò		ò				
1,2,4-Trimethylbenzene	ò		ò	ò	ò		ò		ò			ò	
1,3,5-Trimethylbenzene(mesitylene)	ò			ò			ò						
2-Chlorotoluene	ò												
Benzene	ò		ò	ò		ò	ò	ò	ò			ò	ò
bis(2ethythexyl)phthalate						ò			ò			ò	ò
Bromodichloromethane													
Bromoform												ò	
Carbon Tetrachloride	ò	ò	ò	ò					ò				
Chlorobenzene							ò						
Chloroform	ò	ò	ò		ò	ò		ò	ò	ò	ò	ò	ò
cis-1,2-Dichloroethene	ò	ò	ò	ò	ò			ò	ò			ò	ò
Dibromochloromethane									ò			ò	
Dichlorodifluoromethane	ò		ò		ò				ò	ò		ò	ò
Ethylbenzene	ò		ò	ò			ò		ò			ò	
Hexachlorobutadiene	ò												
Isopropylbenzene	ò		ò	ò			ò						ò
Methylene Chloride	ò				ò	ò	ò		ò				ò
Naphthalene	ò											ò	
n-Butylbenzene	ò												
n-Propylbenzene	ò		ò	ò			ò					ò	
p-Isopropyltoluene	ò		ò										
t-Butylbenzene	ò		ò	ò									
Tetrachloroethene	ò	ò	ò	ò	ò			ò	ò	ò	ò	ò	ò

Table 3-5
Chemicals of Potential Concern (COPCs) in Groundwater by Plume Region

Detected Chemical	Main Plume Region 1 (shallow HSZ)	Main Plume Region 1 (upper sub-shallow HSZ)	Main Plume Region 1 (lower sub-shallow HSZ)	Main Plume Region 1 (confined HSZ)	Main Plume Region 2	Castle Vista Plume Region	East Base Plume Region	Landfill 1 Plume Region (shallow HSZ)	Landfill 1 Plume Region (upper sub-shallow HSZ)	Landfill 4 Plume Region	North Bass Plume Region
					S U L CF						
Toluene	ò	ò	ò	ò	ò ò ò	ò	ò			ò	ò
Trichloroethene	ò	ò	ò	ò	ò ò ò	ò	ò	ò	ò	ò	ò
Trichlorofluromethane	ò						ò				ò
Vinyl chloride											ò
Xylenes	ò	ò	ò	ò	ò ò		ò			ò	ò
INORGANICS											
Aluminum	ò		ò	ò						ò	
Antimony										ò	
Arsenic		ò		ò			ò	ò		ò	
Barium		ò	ò	ò					ò		
Boron		ò						ò	ò		
Chromium	ò	ò	ò	ò	ò ò		ò	ò		ò	
Cobalt	ò	ò	ò	ò						ò	ò
Lead		ò	ò								
Molybendum	ò	ò			ò ò		ò				
Nickel					ò ò		ò	ò			ò
Silica	ò				ò ò			ò		ò	ò
Silver							ò				
Vanadium	ò	ò	ò	ò				ò		ò	

S=shallow HSZ
U=Upper subshallow HSZ
L=lower subshallow HSZ
C=confined HSZ

Table 3-6

Groundwater Exposure Pathways Matrix for CAFB

Exposure Route	Residential Adult	Residential Child	Industrial Adult
Ingestion	X	X	X
Dermal Contact (Showering)	X	X	X
Inhalation of Volatiles	X	X	
Ingestion of Homegrown Produce	X	X	

TABLE 3-7

Toxicity Criteria for Contaminants of Potential Concern: Carcinogenicity

Chemical	Weight-of-Evidence	SF 0 (mg/kg-day) 1	Reference	SF 1 (mg/kg-day) 1	Reference	Target
Inorganics						
Arsenic	A	1.5E+00	IRIS	-1.5E+01	IRIS	human: skin, lungs
Lead	B2	ND	IRIS	ND	IRIQ	rat, mouse: kidney
Organics						
Benzene	A	1.0E-01	Cal/EPA	1.0E-01	Cal/EPA	human: leukemia, lymphomas
Bis(2-ethythexyl)phthalate	B2	1.4E-02	IRIS	1.4E-02(R)	IRIS	rat: liver
Bromodichloromethane	B2	1.3E-01	Cal/EPA	1.3E-01	Cal/EPA	rat, mouse: liver, kidney
Bromoform	B2	7.9E-03	IRIS	3.9E-03	HEAST	rat: liver
Carbon tetrachloride	B2	1.3E-01	IRIS	5.3E-02	IRIS	rat: liver
Chloroform	B2	6.1E-03	IRIS	8.0E-02	IRIS	rat: liver, kidney
1,2,-Dlbromo-3-dichloropiropane	B2	1.4E+00	HEAST	2.4E-03	HEAST	rat, mouse: stomach, liver, kidney
Dibromochloromethane	C	8.4E-02	IRIS	8.4E-02(R)	IRIS	mouse: liver
1,2-Dibromoethane	B2	8.5E+01	IRIS	7.7E-01	IRIS	rat: stornach, nasal cavity
1.4-Dichlorobenzone	B2	4.0E-02	Cal/EPA	4.0E-02	Cal/EPA	mouse: liver
1,1-Dichloroethane	C	5.7E-03	Cal/EPA	5.7E-03	Cal/EPA	rat, mouse: liver, mammary
1,2-Dichloroethane	B2	9.1E-02	IRIS	9.1E-02	IRIS	rat: lung, stomach, circulatory system
1,1-Dichloroethene	C	6.0E-01	IRIS	1.8E-01	IRIS	mouse: kidney
1,2-Dichloropropane	B2	6.8E-02	HEAST	6.8E-02(R)	HEAST	mouse: liver
Hexachlorobutadiene	C	7.8E-02	IRIS	7.8E-02	HEAST	rat: kidney
Methylene chloride	B2	1.4E-02	Cal/EPA	3.5E-03	Cal/EPA	rat, mouSe: liver, lung
Tetrachloroethene	--	5.1E-02	Cal/EPA	2.1E-02	Cal/EPA	rat, mouse: liver, leukemia
Trichloroethene	B2/C	1.5E-02	Cal/EPA	1.0E-02	Cal/EPA	rat:, mouse: liver, lung
Vinyl chloride	--	1.9E+00	HEAST	3.0E-01	HEAST	rat: liver, lung

ND = No date are available
-- = Indicated that the chemical is not located in the references
Toxicity criteria developed by ECAO were obtained from EPA Region IX
R = indicates that the value for the inhalation pathway was extrapolated from the oral SF/RID

TABLE 3-8
To city Criteria for Contaminants of Potential Concern: Chronic Toxicity

Chemical	RfD 0 mg/kg-day	UF	Reference	RfD 1 mg/kg-day	UF	Reference	Target and Critical Effect
Inorganics							
Aluminum	1.0E+00		ECAO				
Antimony	4.0E-04	1000	IRIS				rat: blood glucose
Arsenic	3.0E-04	3	IRIS	ND		IRIS	human: hyperpigmentation, vascular complications
Barium	7.0E-02	3	IRIS				human: increased blood pressure
Boron	9.0E-02	100	IRIS	5.7E-03			dog: testicular atrophy, human: bronchial irritation
Chromium	1.0E+00	100	IRIS				rat: no effect
Cobalt	6.0E-02		ECAO	2.9E-04		ECAO	
Lead	ND		IRIS	ND		IRIS	
Molybdenum	5.0E-03	30	IRIS				human: increased uric acid levels
Nickel	2.0E-02	300	IRIS	ND		IRIS	rat: decreased organ weights
Selenium	5.0E-03	3	IRIS				human: selenosis
Silica							
Silver	5.0E-03	3	IRIS				human: argyria
Vanadium	7.0E-03	100	HEAST				
organics							
Benzene	1.7E-03(R)		IRIS	1.7E-03		ECAO	
Bis(2-ethylhexyl)phthalate	2.0E-02	1000	IRIS	2.0E-02(R)		IRIS	guinea pig: increased liver weight
Bromnodichloromethane	2.0E-02	1000	IRIS	2.0E-02(R)		IRIS	mouse: renal cytomegaly
Bromoform	2.0E-02	1000	IRIS	2.OE-02(R)		IRIS	rat: hepatic lesions
n-Butylbenzene	--			--			
t-Butylbenzene	--			--			
Carbon tetrachloride	7.0E-04	1000	IRIS	5.7E-04		ECAO	rat: liver lesions
Chlorobenzene	2.0E-02	1000	IRIS	5.7E-03		ECAO	dog: histopathological liver and kidney effects
Chloroform	1.0E-02	1000	IRIS	1.0E-02(R)		IRIS	dog: fatty cyst formation in liver
2-Chlorotoluene	2.0E-02	1000	IRIS	2.0E-02(R)		IRIS	rat: decreased whole body weight gain
1,2-Dibromo-3-chloropropane	5.7E-05(R)			5.7E-05	1000	IRIS	rabbit: testicular effects
Dibromochloromethane	2.0E-02	1000	IRIS	2.0E.02(R)		IRIS	rat: reduced whole body weight gain, liver lesions
1,2-Dibromoethane	5.7E-02(R)			5.7E-02	1000	HEAST	human: spermatic effects
1,2-Dichlorobenzene	9.0E-02	1000	IRIS	9.0E-02(R)		IRIS	rat: no observed effects
1,3-Dichlorobenzene	--			--			
1,4-Dichlorobenzene	2.3E-01(R)		IRIS	2.3E-01	100	IRIS	rat: Increased liver weights
Dichlorodifluoromethane	2.0E-01	100	IRIS	5.7E-02	10000	HEAST	rat: reduced body weight
1,1-Dichloroethane	1.0E-01	1000	HEAST	1.4E-01	1000	HEAST	rat: no observed effects
1,2-Dichloroethane	ND		IRIS	ND		IRIS	

TABLE 3-8 (continued)
To city Criteria for Contaminants of Potential Concern: Chronic Toxicity

Chemical	RfD 0 mg/kg-day	UF	Reference	RfD 1 mg/kg-day	UF	Reference	Target and Critical Effect
Inorganics							
Aluminum	1.0E+00		ECAO				
Antimony	4.0E-04	1000	IRIS				rat: blood glucose
Arsenic	3.0E-04	3	IRIS	ND		IRIS	human: hyperkpigmentaion, vascular complications
Barium	7.0E-02	3	IRIS				human: increased blood pressure
Boron	9.0E-02	100	IRIS	5.7E-03			dog: testicular atrophy, human: bronchial irritation
Chromium	1.0E+00	100	IRIS				rat: no effect
Cobalt	6.0E-02		ECAO	2.9E-04		ECAO	
Lead	ND		IRIS	ND		IRIS	
Molybdenum	5.0E-03	30	IRIS				human: increased uric acid levels
Nickel	2.0E-02	300	IRIS	ND		IRIS	rat: decreased organ wieghts
Selenium	5.0E-03	3	IRIS				human: selenosis
Silica							
Silver	5.0E-03	3	IRIS				human: argyria
Vanadium	7.0E-03	100	HEAST				
Organics							
Benzene	1.7E-03(R)		IRIS	1.7E-03		ECAO	
Bis(2-ethythexyl)phthalate	2.0E-02	1000	IRIS	2.0E-02(R)		IRIS	guinea pig: increased liver weight
Bromodichloromethane	2.0E-02	1000	IRIS	2.0E-02(R)		IRIS	mouse: renal cytomegaly
Bromoform	2.0E-02	1000	IRIS	2.0E-02(R)		IRIS	rat: hepatic lesions
n-Butylbenzene	--			--			
t-Butylbenzene	--			--			
Carbon tetrachloride	7.0E-04	1000	IRIS	5.7E-04		ECAO	rat: liver lesions
Chlorobenzene	2.0E-02	1000	IRIS	5.7E-03		ECAO	dog: histopathological liver and kidney effects
Chloroform	1.0E-02	1000	IRIS	1.0E-02(R)		IRIS	dog: fatty cyst formation in liver
2-chlorotoluene	2.0E-02(R)	1000	IRIS	2.0E-02(R)		IRIS	rat: decreased whole body weight gain
1,2-Dibromo-3-chloropropane	5.7E-05(R)			5.7E.05-	1000	IRIS	rabbit: testicular effects
Dibromochloromethane	2.0E-02	1000	IRIS	2.0E-02(R)		IRIS	rat: reduced whole body weight gain, liver lesions
1,2-Dibromoethane	5.7E-02(R)			5.7E-02	1000	HEAST	human: spermatic effects
1,2-Dichlorobenzene	9.0E-02	1000	IRIS	9.0E-02(R)		IRIS	rat: no observed effects
1,3-Dichlorobenzene	--			--			
1,4-Dichlorobenzene	2.3E-01(R)		IRIS	2.3E-01	100	IRIS	rat: increased liver weights

TABLE 3-8 (continued)
To city Criteria for Contaminants of Potential Concern: Chronic Toxicity

Chemical	RfD 0 mg/kg-day	UF	Reference	RfD 1 mg/kg-day	UF	Reference	Target and Critical Effect
Dichlorodifluoromethane	2.0E-01	100	IRIS	5.7E-02	10000	HEAST	rat: reduced body weight
1,1-Dichloroethane	1.0E-01	1000	HEAST	1.4E-01	1000	HEAST	rat: no observed effects
1,2-Dichloroethane	ND		IRIS	ND		IRIS	
1,1-Dichloroethene	9.0E-03	1000	IRIS	9.0E-03(R)		IRIS	rat: hepatic lesions
cis- 1,2-Dichloroethene	1.0E-02	3000	HEAST	1.0E-02(R)		IRIS	rat: decreased hematocrit and hemoglobin
1,2-Dichloropropane	1.14E-03(R)		IRIS	1.14E-03	300	IRIS	rat: hyperplasia, irritation of nasal mucosa
Ethylbenzene	1.0E-01	1000	IRIS	2.9E-01	300	IRIS	rat: liver and kidney toxicity
Hexachlorobutadiene	2.0E-04	1000	HEAST	2.0E-04(R)		HEAST	mouse: reanal tubule regeneration
Isopropylbenzene	4.0E-02	3000	IRIS	4.0E-02(R)		IRIS	rat: increased kidney weight
p-Isopropyltoluene	--			--			
Methylene chloride	6.0E-02	100	IRIS	8.6E-01	100	HEAST	rat: liver toxicity
Naphthalene	4.0E-02		EGAO	4.0E-02(R)			
n-Propylbenzene	--			--			
Tetrachloroethene	1.0E-02	1000	IRIS	1.0E-02(R)		IRIS	mouse: hepatotoxicity
Toluene	2.0E-01	1000	IRIS	1.1E-01		IRIS	rat: changes in kidney and liver weights
1,2,3-Trichlorobenzene	--			--			
1,2,4-Trichlorobenzene	1.0E-02	1000	IRIS	1.0E-02(R)		IRIS	rat: increased adrenal wieghts
1,1,1-Trichloroethane	ND		IRIS	ND		IRIS	
Trichloroethene	6.0E-03		ECAO	6.0E-03(R)		IRIS	
Trichlorofluoromethane	3.0E-01	1000	IRIS	2.0E-01	10000	HEAST	rat,mouse: increased mortality
1,2,4-Trimethylbenzene	--			--			
1,3,5-Trimethylbenzene	--			--			
Vinyl chloride	ND		IRIS	ND		IRIS	
Xylenes	2.0E+00	100	IRIS	2.0E+00(R)		IRIS	rat: hyperactivity

ND = No data are available
-- = Indicated that the chemical is not located in the references
Toxcity criteria developed by ECAO were obtained from EPA Region IX
R = indicates that the value for the inhalation pathway was extrapolated from the oral SF/RfD

Table 3-9

Summary of New Extraction Wells, Designed Extraction Rates, and Initial TCE Concentrations in Each HSZ in Main Base Plume (5 Ig/L TCE Capture Alternative)

Total No. of Extraction Wells	No. of New Extraction Wells	HSZ	Total New Extraction Well Rate (gpm)	Estimated Initial TCE Conc. (ug/L)
19	3	Shallow	500	.40-60
12	7	Upper Subshallow	850	60-80
1	1	Lower Subshallow	200	10-25
2	2	Confined	250	6-7

Table 3-10

Summary of New Extraction Wells, Designed Extraction Rates, and Initial TCE Concentrations in Each HSZ in Main Base Plume (5 Ig/L TCE Capture Alternative)

Total No. of Extraction Wells	No. of New Extraction Wells	HSZ	Total New Extraction Well Rate (gpm)	Estimated Initial TCE Conc. (ug/L)
22	6	Shallow	750	25-45
13	9	Upper Subshallow	1,000	30-65
2	2	Lower Subshallow	280	8-12
2	2	Confined	320	6-13

Table 3-11

Summary of New Extraction Wells, Designed Extraction Rates, and Initial TCE Concentrations in Each HSZ in Main Base Plume (5 Ig/L TCE Capture Alternative)

Total No. of Extraction Wells	No. of New Extraction Wells	HSZ	Total New Extraction Well Rate (gpm)	Estimated Initial TCE Conc. (ug/L)
22	7	Shallow	3,225	10-20
14	9	Upper Subshallow	2,000	40-60
3	3	Lower Subshallow	400	3-6
3	3	Confined	450	2-5

Table 3-12

Summary of New Extraction Wells, Designed Extraction Rates, and Initial TCE Concentrations in Each HSZ in Main Base Plume (5 Ig/L TCE Capture Alternative)

Total No. of Extraction Wells	No. of New Extraction Wells	HSZ	Total New Extraction Well Rate (gpm)	Estimated Initial TCE Conc. (ug/L)
19	3	Shallow	200	.25-45
4	0	Upper Subshallow	0	30-65
5	5	Lower Subshallow	1,000	8-12
0	0	Confined	0	6-13

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Table 3-17
Compliance with Applicable or Relevant and Appropriate Requirements
Main Base Plume

Alternative	Compliance with ARARs
Alternative 1	Not a remedial action under the Comprehensive Environmental Response, Compensation, and Liability Act
Alternative 2	Not expected to comply with state groundwater protection standards that require cleanup and abatement of effects of discharge to attain background water quality or best water quality if background is not technically or economically feasible
Alternative 3	Comply with state groundwater protection standards if it is determined that achieving lower levels of cleanup is not technically or economically feasible
Alternative 4	Meets all chemical- and action-specific ARARs
Alternative 5	Comply with state groundwater protection standards if it is determined that achieving lower levels of cleanup is not technically or economically feasible
Alternative 6	Probably not comply with state groundwater protection ARARs

Table 3-18
Compliance with Applicable or Relevant and Appropriate Requirements
East Base Plume

Alternative	Compliance with ARARs
Alternative 1	Not a remedial action under the Comprehensive Environmental Response, Compensation, and Liability Act
Alternative 2	Not expected to comply with state groundwater protection standards that require cleanup and abatement of effects of discharge to attain background water quality or best water quality if background is not technically or economically feasible
Alternative 3	Comply with state groundwater protection standards if it is determined that achieving lower levels of cleanup is not technically or economically feasible
Alternative 4	Meets all chemical- and action-specific ARARs
Alternative 5	Comply with state groundwater protection standards if it is determined that achieving lower levels of cleanup is not technically or economically feasible

Table 4-1. Chemical-Specific ARARs for Drinking and Groundwater

Chemical	Concentration (Ig/L)		Plumes
Benzene	1.0	1	MBP
Carbon Tetrachloride	0.5	1	MBP
Chloroform	100	2	MBP
cis- 1,2-Dichloroethene (cis 1,2-DCE)	6.0	1	MBP, CVP
Di-ethylhexyl phthalate (DEHP)	4.0	1	NBP
Tetrachloroethylene (PCE)	5.0	2	MBP,CVP,NBP
Trichloroethene (TCE)	5.0	2	MBP, EBP, NBP, LF1

Ig/L = micrograms per liter
MBP = Main Base Plume
CVP =Castle Vista Plume
EBP=East Base Plume
ARARs =applicable or relevant and appropriate requirements
NBP= North Base Plume
LFI=Landfill 1 Plume

(1) California MCL
(2) Federal MCL

California Regional Water Quality Control Board Central Valley Region (CVRWQB), "A Compilation of Water Quality Goals," July 1995.

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<IMG 971341Z1>

TABLE 4-3
TREATED GROUNDWATER DISCHARGE STANDARDS

Constituent	COC	Standards for Discharge* 30 Day Median (Ig/L)	Daily Maximum (Ig/L)
Acetone		1	-
Benzene	YES 1	0.5	1
Bromoform		0.5	1
Carbon Tetrachloride	YES 1	0.5	0.5
Chloroethane		0.5	1
Chloroform	YES 1	0.5	1
Chloromethane		0.5	1
Chlorobenzene		0.5	1
Dibromochloropropane (DBCP)		0.35	5
Diethylhexyl phthalate (DEHP)	YES 6	0.5	1
Dichlorobenzene (ortho)		0.5	1
Dichlorbenzene (para)		0.5	1
Dichlorodifluoromethane		0.5	1
1,1 DCE		0.5	1
1,2, DCE (cis)	YES 1.3	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
Ethlylene Dibromide		0.14	0.5
Methylene Chloride		0.5	1
PCE	YES 1.3.6	0.5	1
Toluene		0.5	42
Trichlorofluoromethane		0.54	1
TCE	YES 1.2.4.6	0.5	1
VOCs		1	5
Xylene		0.5	17
Diesel or Kerosene		10	10
TPH (gas)		10	100
TPH (Diesel)		50	100
Iron		-	300**
Manganese		-	50**
Nitrates		-	10 mg/L as Nitrogen**
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.	

1 COC for Main Base Plume
2 COC for East Base Plume
3 COC for Castle Vista Plume
4 COC for Landfill 1 Plume
5 COC for Landfill 4 Plume
6 COC for North Base Plume

ò 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 cleanup level or the actual concentrations in the aquifer at the point of discharge, whichever is lower. For constituents where no aquifer cleanup level has been specified, treated water cannot be discharged at constituents concentrations that exceed the actual concentrations at the point of discharge for that constituents prior to any discharge.

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

General Note: All COC's will be included in routine Long-Term Groundwater Monitoring; other constituents will be sampled according to the approved LTGSP sampling plan.

Figures