UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
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September 28, 2006

To: Mr. Steve Ross, DTSC
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Ms. Pam Nieberg, FFSOG
Mr. Steve Deverel, FFSOG
Ms. Sue Gedestad, City of Davis Public Works

Attached is the Record of Decision, dated September 28, 2006. Please call me at (415) 972-3030 if you have any questions.

Sincerely,

Bonnie Arthur
Remedial Project Manager

Attachment

United States Environmental Protection Agency
Region 9

RECORD OF DECISION

SOIL AND GROUNDWATER
FRONTIER FERTILIZER SUPERFUND SITE

CERCLIS ID # CAD071530380
Davis, California

September 28, 2006

RECORD OF DECISION
SOIL AND GROUNDWATER
FRONTIER FERTILIZER SUPERFUND SITE

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LIST OF ABBREVIATIONS AND ACRONYMS

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
ARARs	Applicable or Relevant and Appropriate Requirements
bgs	below ground surface
Cal EPA	California Environmental Protection Agency
CCl_4	carbon tetrachloride
CCR	*California Code of Regulations*
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFR	*Code of Federal Regulations*
COC	chemical of concern
COPC	chemical of potential concern
CPT	cone penetration test
CSM	conceptual site model
DBCP	1,2-dibromo-3-chloropropane
DCP	1,2-dichloropropane
DTSC	California Environmental Protection Agency Department of Toxic Substances Control
EDB	1,2-dibromoethane
EPA	U.S. Environmental Protection Agency
FFSOG	Frontier Fertilizer Site Oversight Group
FS Report	Feasibility Study Report
ft/d	feet per day
GAC	granular activated carbon
gpm	gallons per minute
GTI	Groundwater Technology, Inc.
HI	Hazard Index
in situ	in place
LSCE	Luhdorff and Scalmanini, Consulting Engineers
M&E	Metcalf and Eddy
MCLG	maximum contaminant level goal
MCL	maximum contaminant level
mg/L	milligrams per liter
MUN	municipal supply
MW	monitoring well
NAPL	non-aqueous phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
O&M	Operations and Maintenance
OMP	Operations and Monitoring Plan
ppb	parts per billion
ppm	parts per million
PRG	preliminary remediation goal
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act

RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RWQCB	Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act of 1986
SDWA	Safe Drinking Water Act
STLC	Soluble Threshold Limit Concentration
SWRCB	State Water Resources Control Board
TAG	Technical Assistance Grant
TCLP	toxicity characteristic leaching procedure
TCP	1,2,3-trichloropropane
TDS	total dissolved solids
TTLC	Total Threshold Limit Concentration
VOCs	volatile organic compounds

PART 1 DECLARATION

1.1 Site Name and Location

The Frontier Fertilizer Site is located in Davis, California (Yolo County). The Frontier Fertilizer Superfund Site includes a triangular shaped 11.43-acre parcel, Assessor's Parcel Number 071-412-031, owned by Pine Tree Properties; and an adjacent 7-acre parcel which is part of a 10.98-acre parcel, Assessor's Parcel Number 071-411-07, known as the "Remainder Parcel." The National Superfund Database Number (CERCLIS) is # CAD071530380.

1.2 Statement of Basis and Purpose

This decision document presents the selected remedial action for soil and groundwater for the Frontier Fertilizer Superfund Site (Site) located in Davis, California. This document was developed in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), 42 United States Code et seq. 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), 40 CFR Part 300, as amended. The selected remedy (described in detail in Section 2.12.2 of this Record of Decision [ROD]) is in situ heating of source area soil and groundwater; groundwater extraction and treatment; a restrictive covenant as an institutional control; wood chip, pavement, or gravel cap to prevent ecological receptors from contacting surface soils; and possible secondary biological treatment of nitrate.

This decision is based on the Administrative Record that has been developed in accordance with Section 113 (k) of CERCLA, 42 United States Code 9613 (k). The California Environmental Protection Agency Department of Toxic Substances Control (DTSC) concurs with the selected remedy as documented by correspondence included in Appendix A.

1.3 Assessment of the Site

The remedial actions selected in this ROD are necessary to protect the public health or welfare or environment from actual or threatened releases of hazardous substances into the environment.

1.4 Description of Selected Remedy

The selected remedy is a permanent solution that includes treating source area groundwater and soil to meet Remedial Action Objectives (RAOs). It is estimated to cost $18,413,000. The alternative is described in detail in Section 2.12.2 (Selected Remedy) of this ROD. The major components of the selected remedy are:

- In situ (in place) heating using electrical energy to heat source area soil and groundwater up to 60-90 feet below ground surface that are a continuing source of groundwater contamination. Vapor controls include ambient air monitoring and an impermeable layer of plastic over the source area. Soil vapor generated will be collected, treated, and monitored;

- Continued operation of groundwater pump-and-treat system. Groundwater extraction and treatment will continue until monitoring indicates that the RAOs are achieved. The monitoring will also determine if additional pumping (extraction) wells or monitoring wells, or modifications to the system are necessary;

- Secondary enhanced anaerobic biological treatment of the source area to treat nitrate based on the following evaluation planned for the design phase. This evaluation will include a comparison of nitrate levels in Site groundwater and City monitoring/drinking water wells in addition to discussions with the City of Davis to determine whether any changes are anticipated for the Site's nitrate discharge requirements.

- Institutional Controls to prevent exposure to soil above acceptable cleanup levels and to prevent exposure to contaminated groundwater.

- Wood chip, pavement, or gravel cap to prevent ecological receptors from contacting surface soil.

1.5 Statutory Determinations

The selected remedy attains the mandates of CERCLA 121, and to the extent practicable, the regulatory requirements of the NCP. This remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost effective, and utilizes permanent solutions to the maximum extent possible.

The selected remedy also satisfies the statutory preference for treatment as a principal element of the remedy to permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances. The soils contaminated with pesticides in the source area of the Site are considered to be "principal threat wastes" because dibromochloropropane and ethylene dibromide are present at levels that pose a significant risk under industrial and residential use scenarios.

Land use and groundwater restrictions are necessary to prevent exposure to hazardous substances in soil and groundwater both during and after remedy implementation. A 5-year review will be conducted after initiation of the remedial action to assure that it continues to provide adequate protection of human health and the environment and is achieving remediation goals.

1.6 Data Certification Checklist

The following information is included in the Decision Summary (Part 2) of this ROD:

- Chemicals of concern (COCs) and their respective concentrations (see Section 2.7.1.1, Identification of Chemicals of Concern);
- Baseline risk presented by the COCs (see Section 2.7.1.2, Exposure Assessment subsection);
- Remediation goals (that is, cleanup goals) established for the COCs and the basis for the goals (see Section 2.8, Remedial Action Objectives);
- How source materials constituting principal threats are addressed (see Section 2.12, Selected Remedy);
- Current and reasonably anticipated future land use assumptions and current and future beneficial uses of groundwater used in the Baseline Risk Assessment and this ROD (see Sections 2.6.1, Current and Potential Future Land Uses and 2.6.2, Current and Potential Future Groundwater Uses;
- Estimated capital, annual operations and maintenance, and total present worth costs, discount rate and number of years over which remedy cost estimates are projected (see Section 2.12.3, Cost Estimate for the Selected Remedy and Appendix B, Cost Estimate for the Selected Remedy);
- Key factors that led to selecting the remedy (see Section 2.12, Selected Remedy).

Additional information can be found in the Administration Record file for this Site.

1.7 Authorizing Signatures

This ROD documents the selected remedy for contaminated soil and groundwater at the Frontier Fertilizer Superfund Site. The remedy was selected by EPA with concurrence by the California Department of Toxic Substances Control. The Branch Chief (EPA, Region 9) has been delegated the authority to approve and sign this ROD.

By: [signature] Date: 9/28/06

Kathleen Johnson, Chief
Federal Facilities and Site Cleanup Branch
U.S. Environmental Protection Agency, Region 9

PART 2 DECISION SUMMARY

This Decision Summary provides a description of the Site-specific factors and analyses that led to the selection of the soil and groundwater remedies. It includes background information about the Site, nature and extent of contamination, and the identification and evaluation of remedial action alternatives.

2.1 Site Name, Location, and Brief Description

The Frontier Fertilizer Superfund Site is located in Davis, California (Yolo County) and includes a triangular shaped 11.43-acre parcel, Assessor's Parcel Number 071-412-031 owned by Pine Tree Properties and a 7-acre undeveloped parcel north of the Site that is part of a 10.98-acre parcel, Assessor's Parcel Number 071-411-07, known as the "Remainder Parcel." The National Superfund Database Number (CERCLIS) is # CAD071530380. The parcels contain contaminated soil and a groundwater plume that extends in a northerly direction. Contaminated groundwater extends beyond the Remainder Parcel under residential housing (see Figure 1). The nearest residence is approximately 600 feet north of the property boundary.

The Pine Tree Properties and Remainder parcels are located in an area zoned for light industrial development at the eastern edge of Davis. The 11.43-acre parcel is located at 4301 Second Street (formerly known as Road 32A) in Davis, Yolo County, California (Figure 2).

EPA is the lead agency for the Site removal and remedial activities. The DTSC is the lead State agency with support from the California Regional Water Quality Control Board, Central Valley Region (RWQCB). In 1993, EPA determined that the potentially responsible parties were not financially viable and since that time the investigations and removal actions have been funded from the Superfund budget.

In 2000, the warehouses, shops, "pole barn," a labor camp complex, a tomato grading station, aboveground storage tanks, and underground storage tanks were removed from the Site leaving only the warehouse that houses the groundwater treatment plant.

2.2 History and Enforcement Activities

This section of the ROD provides the history of the Site and a brief description of EPA's and DTSC's removal, remedial, and enforcement activities. The Frontier Fertilizer Site was placed on the Superfund National Priorities List in 1994.

The Site was first developed in the 1950s as an area to store agricultural equipment. The Barber and Rowland Company operated a pesticide and fertilizer distribution facility on the parcel from 1972 to 1982, and the Frontier Fertilizer Company continued operations from 1982 to 1987. Both companies handled chemicals on the western 4 acres of the parcel. Chemical-related operations consisted of storing, mixing, and loading pesticides and fertilizers into mobile tanks for farm application. Used tanks and containers were rinsed prior to re-use. It appears from the quantity of pesticides found that waste chemicals, mainly pesticides and fertilizer tank or container rinsate, were discharged into one or more disposal basins. Pesticide handling was discontinued during the 1980s when Yolo County discovered high levels of pesticides in an unlined disposal basin.

The first groundwater extraction and treatment system was installed in 1993 by DTSC and in 1995 EPA significantly upgraded the system to treat more groundwater, commonly referred to as a "pump-and-treat" system. The system uses 16 groundwater extraction wells to remove contaminated groundwater. Granular activated carbon (GAC) is contained in three aboveground vessels and is used to remove volatile organic compounds (VOCs) from the extracted water. The EPA samples and discharges the water to the City of Davis sanitary sewer system under a discharge permit (User Permit 15-04).

The first cleanup activities began at Frontier Fertilizer in 1983. Until 1994, investigative and cleanup activities were performed by property owners or under the remedial orders issued by the State of California. In 1994, EPA took over management of the Frontier Fertilizer investigation after Frontier Fertilizer was added to the National Priority List. A summary of investigative activities and remedial measures are presented in Table 1.

2.3 Highlights of Community Participation

A community relations plan was finalized in January 1, 1998 to document concerns identified during community interviews and to provide a detailed description of community relations activities planned in response to information received from the community. The community relations program includes specific activities for obtaining community input and keeping the community informed. These activities include holding public meetings, issuing fact sheets to provide updates on current investigations and remediation activities, maintaining an information repository where the public can access technical documents and program information, and making presentations to the community and smaller local groups. Periodic fact sheets have been mailed to over 1,000 community members since 1995. More recently the fact sheets also have been posted on EPA's website. A brief chronology of community meetings and Fact Sheets are included in Appendix C. The purpose of the information repository is to provide the public a location near their community to review and copy background and current information about the Site, including the Administrative Record. The Administrative Record is available at two locations near the Site;

Yolo County Library, Davis Branch
Attn: Marilyn Corocan
315 East 14th Street
Davis, California 95616
(530) 757-5593

Shields Library,
Government Documents Department
Attn: Linda Kennedy
University of California
Davis, California 95616
(530) 752-6561

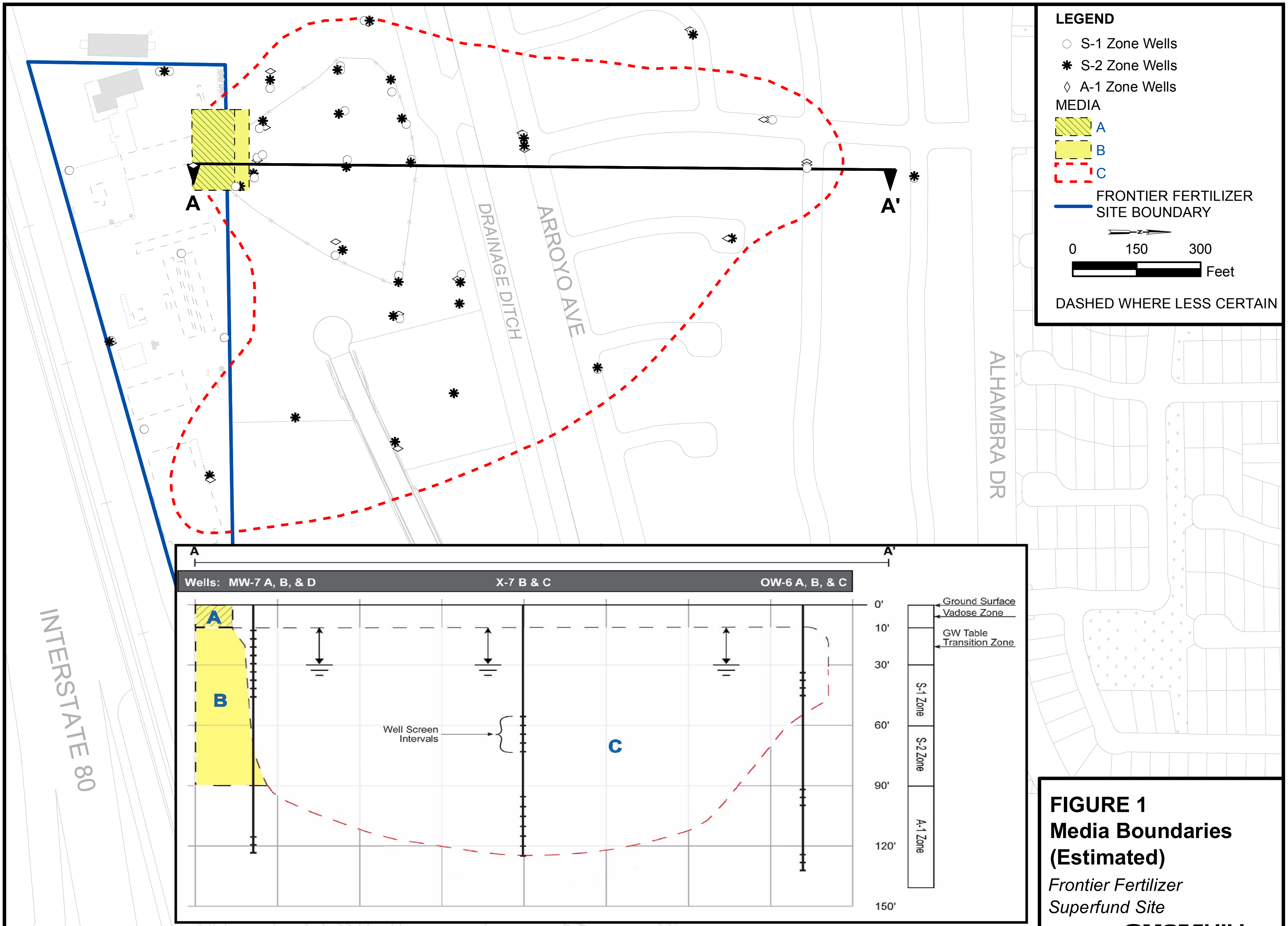

FIGURE 1
Media Boundaries (Estimated)
Frontier Fertilizer Superfund Site

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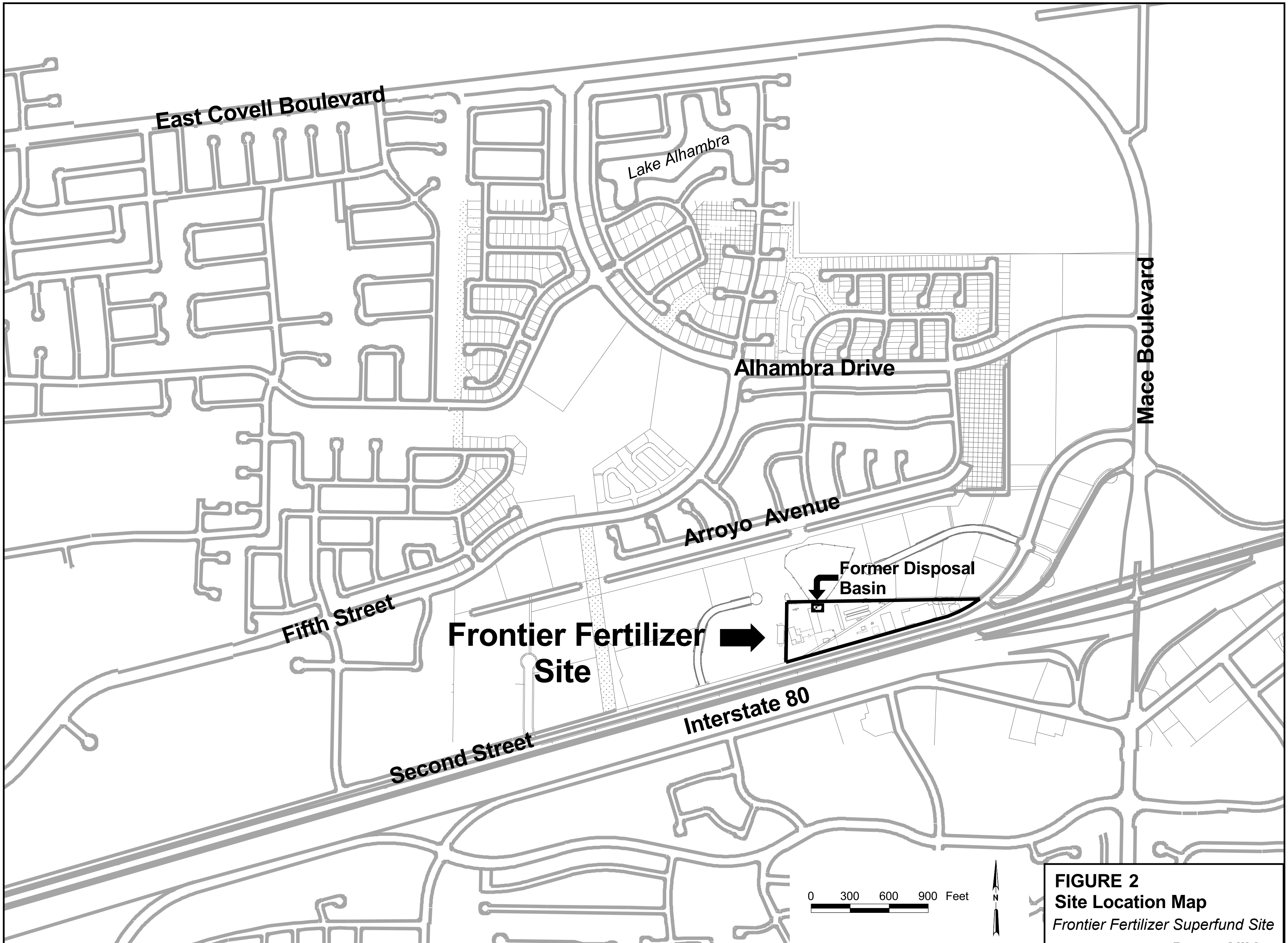


FIGURE 2
Site Location Map
Frontier Fertilizer Superfund Site

CH2MHILL

CH2M Hill SAC ArcView Project File \\Yosemite\SACGIS\frontier\ArcView\Frontier.apr 11:12 a.m. 01-27-2004

Table 1
Previous Investigation and Remedial Activities

Sponsor, Contractor (Year)	Scope of Activity	Key Findings
Yolo County Department of Public Health (1983 and 1984)	Soil samples of disposal basin area were collected after employee's dog died of pesticide poisoning.	Soil was discovered to be contaminated with EDB, DCP, and DBCP.
Frontier Fertilizer Co., Laugenour and Meikle (1985)	Excavation and land farm of 1,100 cubic yards of soil from the disposal basin area.	The excavation did not remove all of the contaminated soil from the disposal basin, but did help to mitigate the immediate threat of exposure to soil contamination.
Frontier Fertilizer Co., LSCE (1987)	Completion of soil and groundwater investigation with the installation of 24 monitoring wells. Completion of a Preliminary Assessment Report.	Groundwater samples collected from well MW-7B, to the north of the site contained up to 24,000 ppb of EDB. Extent of soil and groundwater contamination (particularly to the North) was investigated but not defined.
RAMCO Enterprises Inc., GTI (1990).	Soil sampling and analysis, installation and sampling of 12 additional monitoring wells. Completion of a RI/FS.	Recommended excavation and treatment for soil contamination and pumping wells for control and treatment of groundwater contamination.
Cal EPA, M&E (1992)	Conducted a focused RI in support of an interim remedial measure. Further delineation of groundwater contamination and testing for aquifer hydraulic properties.	CCl_4 detected to the east of the EDB/DBCP/DCP plume.
Cal EPA DTSC, URS (1993)	Installed initial groundwater pump-and-treat system.	Extracted about 0.25 gpm from MW-7B and MW-7C.
EPA, Ecology and Environment (1994)	Investigated levels of pesticide contamination remaining in the soil and attempted to locate source of CCl_4 contamination.	Removal actions considered included vapor extraction and soil excavation. EPA determined that soil with concentrations of EDB, DBCP, and DCP above 1,000 ppb would be considered for removal action.
EPA, CET Environmental Services (1996)	Installed groundwater pump-and-treat system that replaced initial system.	GAC treatment capacity of 80 gpm.17 wells, initially online July 1995 produced approx. 28 gpm; production increased to approx. 50 gpm in April 1996.
EPA, Bechtel (1995 and 1996, 1997, 1999)	Interim RI documenting the nature and extent of COCs at the Frontier Fertilizer. Supplemental RI conducted in 1998-1999.	Interim RI document produced in 1997 and Supplemental RI produced in 1999.
EPA, URS (1999 to 2001)	Upgraded and repaired groundwater extraction system, added three extraction well clusters, three monitoring wells to the northwest, and conducted extensive CPT investigation. Aboveground structures were also removed during the period.	Findings are summarized in the Supplemental RI #2 Report. Monitoring wells to the northwest were added to monitor the northern border of the CCl_4 plume.
EPA, CH2M HILL (2002 to 2005)	Frontier Fertilizer Conceptual Model Update and Capture Zone Analysis. Drilled and sampled four deep soil borings around source area, conducted supplemental CPT investigation to help identify CCl_4 source and site potential extraction wells, expanded the extraction system and refined treatment system performance.	Used recent CPT and boring log data to update subsurface profile and updated site numerical model. Expanded extraction system increased groundwater control and facilitated increased system capacity of 80 gpm. Findings are summarized in the Supplemental RI #2 Report.

Table 1 Previous Investigation and Remedial Activities		
Sponsor, Contractor (Year)	**Scope of Activity**	**Key Findings**
EPA, CH2M HILL (2003-2006)	Preliminary screening of alternatives. Identification of three treatment technologies for further lab testing.	Lab testing of zero valent iron, biological substrates, and thermal treatment. Draft Feasibility Study and Final Feasibility Studies issued in 2006.

CCl_4 = carbon tetrachloride
CPT = cone penetration test
DBCP = 1,2-dibromo-3-chloropropane
DCP = 1,2-dichloropropane
EDB = 1,2-dibromoethane
EPA = U.S. Environmental Protection Agency
gpm = gallons per minute
GTI = Groundwater Technology, Inc.
LSCE = Luhdorff and Scalmanini, Consulting Engineers
M&E = Metcalf and Eddy
ppb = parts per billion
RI = Remedial Investigation
RI/FS = Remedial Investigation/Feasibility Study

To enable the community to become more directly involved in the investigation and cleanup activities, a Technical Assistance Grant (TAG) was awarded to the Frontier Fertilizer Site Oversight Group (FFSOG) in 1995. In addition to receiving all deliverables, the FFSOG's technical advisor attends many technical meetings. EPA and the State also attend FFSOG meetings to provide updates and obtain input.

The public comment period for the Proposed Plan started on June 12, 2006. A two-week extension was granted during the public comment period, which ended on July 26, 2006. A public meeting was held on June 22, 2006 to present the Proposed Plan and EPA's proposed remedy. Following the public meeting, the Proposed Plan was presented to the City of Davis Natural Resources Committee. Two additional meetings were held with the FFSOG and a facilitator from the Natural Resources Committee to resolve community concerns.

EPA's responses to the comments received during the public comment period are included in Section 3.2.

2.4 Scope and Role of Operable Unit or Response Action

This ROD encompasses the entire Site. The State of California referred the Site to EPA for inclusion on the NPL, which occurred in 1994. In 1993, EPA determined that the potentially responsible parties were not financially viable and since that time the investigations and removal actions have been funded from the Superfund budget.

2.5 Site Characteristics

This section of the ROD provides a brief overview of the Site's geographic, geologic, and hydrogeologic situation; the sampling strategy; Conceptual Site Model; and the nature and extent of contamination. Detailed information about the Site's characteristics can be found in the RI reports in the Information Repositories.

The Site is situated in the Central Valley and includes a triangular shaped 11.43-acre parcel owned by Pine Tree Properties and a 7-acre undeveloped parcel, which is part of a 10.98-acre parcel known as the “Remainder Parcel.” The Site has minor topographic relief and surface elevations vary on the order of 5 feet over a distance of several thousand feet. The general surface grade across the Site declines in the east-southeast direction until 2nd Street, which acts as a surface flow barrier. The Mace Ranch Park unlined drainage channel is approximately 500 feet north of the Site and serves as the primary stormwater conveyance and containment for the predominantly developed areas north and west of the parcels. Due to general topography and surface soil permeability, stormwater tends to stay onsite and infiltrate into the soil.

2.5.1 Geology and Hydrogeology

The Site is underlain by Quaternary alluvium to depths exceeding 300 feet bgs. Below this depth, semi-consolidated units of clay and occasional sand/gravel extend to below 2,000 feet bgs. The alluvium deposits represent heterogeneous mixtures of gravel, sand, silt, and clay generated by the changing flowpath of Putah Creek over the past geologic epoch. Fine-grained materials from ancient floodplains predominate in the upper 100 feet, interrupted by discontinuous sand stringers that can be up to 10 feet thick. Between 100 and 300 feet bgs, the subsurface is somewhat more stratified, with permeable sand units displaying greater continuity. Municipal and agricultural wells have historically utilized this depth interval, though recently the City has constructed wells in the deeper semi-consolidated units.

Well and soil boring logs, electric logs, CPT logs, and recent soil boring core analyses, including bulk density, porosity, and specific gravity, were used to classify the subsurface to 155 feet bgs in the source area. Only the upper Quaternary alluvial deposits from ground surface to approximately 155 feet bgs have been analyzed for COCs because soil and groundwater contamination appears to be contained within these deposits.

Four general water-bearing zones have been designated in the monitored area, from shallowest to deepest, as S-1, S-2, A-1, and A-2 zones. Site monitoring wells are screened in the S-1, S-2, and A-1 zones and water level measurements are typically measured on a quarterly basis. Active extraction wells extract groundwater from the S-1 and S-2 zones. The S-1 zone extends to a depth of about 60 feet bgs and the water table fluctuates from approximately 10 to 30 feet bgs. The S-1 zone consists of alluvium stream channel and floodplain sediments deposited to produce interbedded discontinuous clay, silt, and sand lenses. Total dissolved solids (TDS) in the S-1 aquifer, as calculated from the conductivity in various background wells, is approximately 1,000 parts per million (ppm). The S-2 zone has been designated at a depth of about 60 to 90 feet bgs. It is a series of discontinuous sand lenses of variable thickness and permeability. TDS in the S-2 aquifer, as calculated from the conductivity in various background wells, is approximately 810 ppm. The measured horizontal hydraulic gradient across the Site indicates a flow direction to the north/northeast for the S-1 and S-2 groundwater zones and to the south/southeast in the A-1 zone.

Data do not indicate that continuous aquifers or aquitards exist in the top 100 feet, which contains the S-1 and S-2 zones. In these zones, sandy materials tend to be encountered interbedded with clays and silts that act to restrict the movement of groundwater. Well yield and aquifer pumping tests have been performed to estimate groundwater zone properties. Significant variations in aquifer vertical and horizontal conductivities are typical across the S-1 and S-2 zones.

The A-1 zone occurs at a depth interval of about 90 to 140 feet bgs. It appears to be dipping slightly to the south. The A-1 zone also appears to be laterally continuous throughout the area and, reportedly, throughout most of the region. Local agricultural wells reportedly draw from the A-1 and the deeper A-2 zone. This aquifer has a much higher hydraulic conductivity (estimated as high as 100 feet per day [ft/d]) than either of the shallower zones. TDS in the A-1 aquifer, as calculated from the conductivity in various background wells, is approximately 1,200 ppm.

Typically, groundwater potentiometric head, that is, groundwater levels, in the S-1, S-2, and A-1 zones are at an annual low at approximately 30 feet bgs in late summer and following approximately 3 months of irrigation pumping. Groundwater levels are at an annual high at approximately 10 feet bgs in late winter, toward the end of the rainy season and following recovery from agricultural pumping. Seasonal fluctuations in the groundwater surface are largest in the A-1 zone (with fluctuations ranging from 20 to 30 feet between seasons) since it is used as a source of irrigation water for nearby agricultural fields. Historical data indicate that the groundwater surface in the S-1 and S-2 zones typically fluctuate up to 20 feet annually. Operation of the extraction well field just north of the former disposal basin (in the S-1 and S-2 zones) affects the water table elevation. In the area of the extraction well field, shallow groundwater levels vary with extraction rates, with available water in the zone, and with hydraulic conductivity between extraction wells and monitored wells.

A 25- to 30-foot-thick clay layer, designated as the A-1/A-2 aquitard, underlies the A-1 aquifer and appears to separate it from the A-2 aquifer. This aquitard has been investigated at the Site by four soil borings and a few deep borings associated with early monitoring well installations. It may be effectively much thicker than 30 feet in some areas, as most A-2 production well screens occur below 200 feet bgs. The A-2 aquifer is a sequence of discontinuous gravel layers extending from 180 to 350 feet bgs. The A-2 aquifer is the primary water supply aquifer in the Davis area and provides agricultural and municipal supply.

2.5.2 Sampling Strategy

The sampling strategy for the Site addressed these key objectives to determine the nature and extent of soil and groundwater contamination:

- Determine the nature and extent of groundwater contamination
- Determine the nature and extent, including source zone boundaries, of pesticides in soil
- Determine the source of carbon tetrachloride (CCl_4)
- Monitor groundwater flow direction and the effect of the extraction system
- Determine if non-aqueous phase liquids (NAPLs) are present

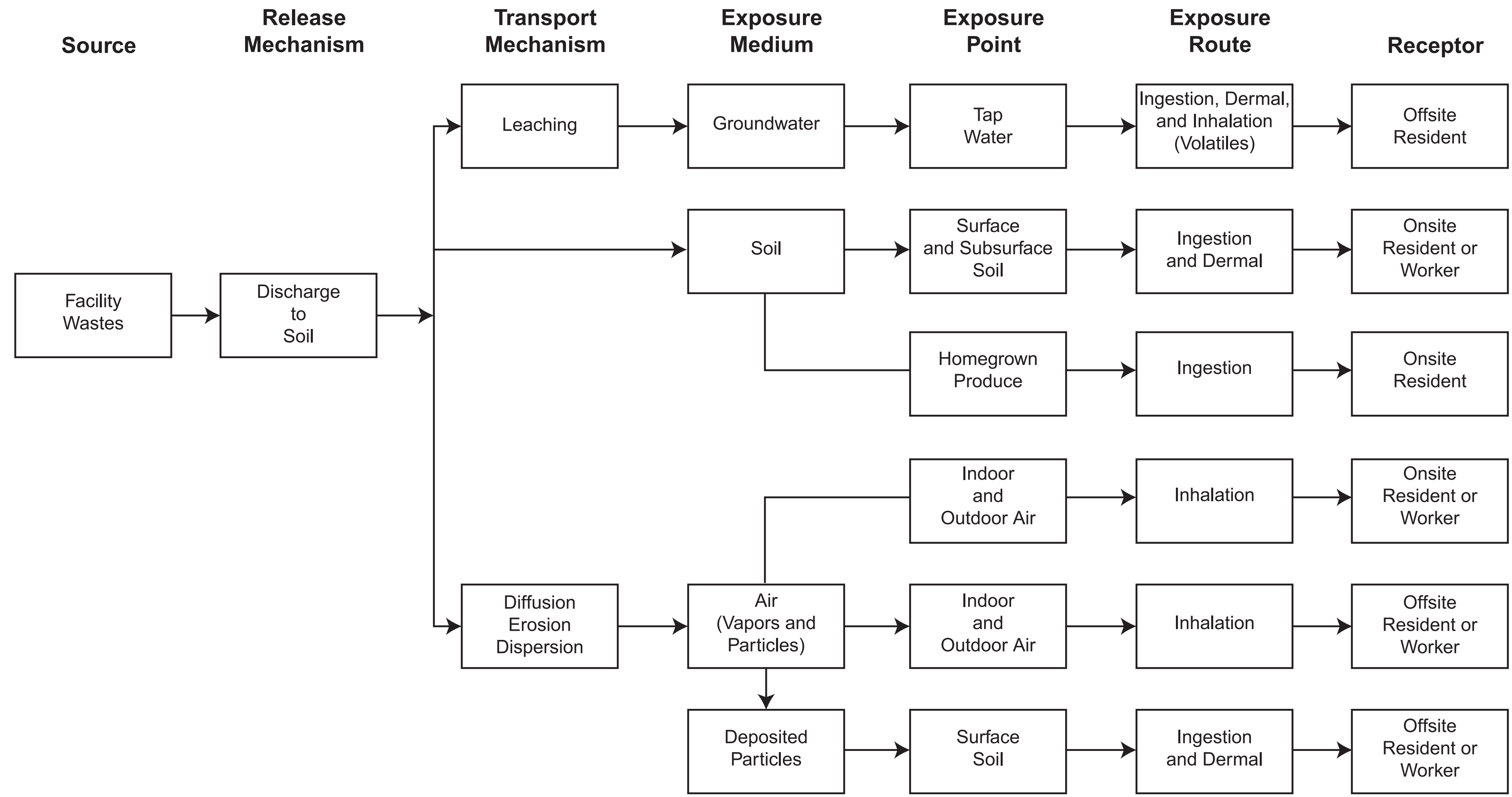
2.5.3 Conceptual Site Model

The conceptual site model (CSM) identifies the sources of contamination: discharge mechanisms; nature and extent of contamination; contamination fate and transport mechanisms, including pathways for contaminant transport; and potential human and ecological receptors (Figure 3). The CSM was developed based on data presented in the RI reports. The CSM evolves as new data become available in order to present a current perspective of Site conditions.

2.5.4 Nature and Extent of Contamination

The RIs identified two major categories of COCs related to Site activities: pesticides and fertilizers. The pesticides, EDB, DCP, 1,2,3-trichloropropane (TCP), and DBCP, are VOCs that were found in soil at concentrations above EPA Region 9 screening-level preliminary remediation goals (PRGs) and detected in groundwater in concentrations above maximum contaminant levels (MCLs). CCl_4, which may have been used onsite as a grain fumigant or parts cleaner, was found in groundwater above the MCL. Other VOCs found in lesser amounts in soil and/or groundwater were 1,2-dichloroethane, 1,3-dichloropropene, and benzene. Other pesticides in the carbamate, organophosphate, and organochlorine families were detected occasionally during investigations. In the fertilizer category, nitrate, nitrite, and sulfate were found in elevated concentrations in the groundwater. In addition to pesticides and fertilizers, diesel, gasoline, and oil range petroleum hydrocarbons, were found in soil below two aboveground storage tanks (CH2M HILL, 2003). The Baseline Risk Assessment Report (Bechtel, 1999a) identified EDB, DBCP, CCl_4, and TCP as the primary Site COCs, based on human toxicity and frequency of detection.

Nitrate is not considered a primary COC; however, it was included as part of the remedial alternatives because it is found in many Site monitoring wells and other wells in the Davis area at concentrations exceeding MCLs. While nitrate is found throughout California's farming communities, the distribution and concentration of nitrate in Site groundwater suggest that the former disposal basin is the source area. Nitrate is captured by the groundwater extraction system but is not treated by the onsite GAC treatment plant. The nitrate is removed at the City of Davis Wastewater Treatment Plant, which receives the nitrate along with the treated groundwater. Nitrate and nitrite analyses were added to the regular quarterly groundwater monitoring events during four consecutive quarterly groundwater events ending with the second quarter 2005. Nitrate and nitrite were not included in the Final Baseline Risk Assessment Report since data were not available at the time the report was written.



Note: Ecological exposure route and receptor data can be found in the SLERA Report (CH2M HILL, 2006b) and in Tables 14, 15, and 16.

Source: Bechtel, 1999a.

FIGURE 3
Conceptual Site Model
Frontier Fertilizer Superfund Site

Sample analytical results indicate that the highest concentrations of COCs in soil are below and adjacent to the former disposal basin. The highest concentrations of EDB, DBCP, and DCP are found between 20 and 40 feet bgs. As shown in Figure 1, this aquifer material lies between seasonal groundwater surface fluctuations. Groundwater saturates this contaminated soil when groundwater rises in the winter and spring months, and drains this soil when it recedes in the late summer and fall months. In groundwater, the highest concentrations of COCs are found beneath and downgradient of the former disposal basin. These COCs are found beneath the former basin in soil samples obtained below the groundwater surface, from depths ranging from 60 to 80 feet bgs. At this depth, DBCP, EDB, DCP, and TCP are found at lower concentrations than those found at 20 to 40 feet bgs. Table 2 depicts the maximum soil concentrations for the Site COCs.

Table 2
Highest COCs Detected in Soil

Contaminant	Soil Screening Level (μg/kg)	Highest Concentration Detected in Soil (μg/kg)	Depth (bgs)
DBCP	30	1,000,000	
EDB	32	50,000	
DCP	340	90,000	
TCP	34	10,000	
CCl_4	250	Not detected	

As with EDB, DBCP, DCP, and TCP, the highest concentrations of nitrate in groundwater are found in monitoring wells closest to the former disposal basin. The primary COCs (see Table 2) are VOCs and, as discussed above, are all found in high concentrations beneath and downgradient of the former disposal basin. These volatile compounds are also found in soil gas beneath the ground surface and in air at or near the ground surface above the former basin. In 1997, the concentrations of these volatile COCs were high enough that if a building were to be constructed above the former disposal basin then vapor barriers or other engineering controls would be required to protect workers in the building (Bechtel, 1997). Currently, there are no occupied buildings at this location.

Investigations have also been completed to determine the presence of NAPL. Although NAPLs were not detected, the elevated volatile COC concentrations found in the S-2 zone are high enough to suggest that NAPL could be present in the S-2. The soil sample analytical results show significant variations in COC concentrations across the source area. These variations contribute to the difficulties of estimating the mass of COCs requiring remediation.

COCs have been detected in groundwater at concentrations exceeding federal or California primary MCLs near the former disposal basin and extending beneath the Mace Ranch residential development. Generally, in the S-1 and S-2 zones, the wells with the highest detected pesticide and fertilizer concentrations are located on the north side or downgradient of the former disposal basin. These wells are included in well clusters X-1, X-6, MW-7, and AW-2. At the former disposal basin, COCs are seldom detected beneath the S-2 zone. S-2 zone geologic characteristics in the source area and groundwater extraction field apparently have impeded vertical migration of COCs.

While concentrations of COCs have been declining in most wells, the exception to the trend exists in three A-1 monitoring wells located approximately 800 feet north of the former disposal basin. Monitoring results for wells screened in the A-1 zone in the X-7 and nearby OW-11 and OW-14 well clusters, show increasing detections of COCs above MCLs. Possible scenarios that could result in the elevated concentrations observed in the area near the X-7 and OW-11 well clusters include the following: (1) the groundwater from the S-2 and A-1 wells in the X-7 and OW-11 clusters may have passed through the source area prior to beginning extraction system operation or (2) a preferential flow path exists between the source area and this area 800 feet downgradient that is not intercepted by the existing monitored wells.

In the S-1 and S-2 zones, the highest concentrations of EDB, DCP, and DBCP are located immediately north of the former disposal basin. These COCs also are consistently found in the S-2 zone about 800 feet north of the basins, although at lesser concentrations than in this zone beneath the basin.

The following sections describe the third quarter 2005 monitoring results of 86 wells, see Figure 4.

EDB

EDB was detected at concentrations that exceeded the MCL of 0.05 micrograms per liter (µg/L) in samples collected from 18 wells. The highest EDB concentration of 160 µg/L was detected in a sample collected from monitoring well X-1B, on the north side of the disposal basin.

DCP

DCP was detected at concentrations that exceeded the MCL of 5 µg/L in samples collected from 15 wells. The highest DCP concentration of 2,000 µg/L was detected in a sample collected from extraction well MW-8B, in the Remainder Parcel north of the basin.

DBCP

DBCP was detected at concentrations that exceeded the MCL of 0.2 µg/L in samples collected from 11 wells. The highest DBCP concentration of 2.8 µg/L was detected in a sample collected from extraction well MW-7B, just north of the basin.

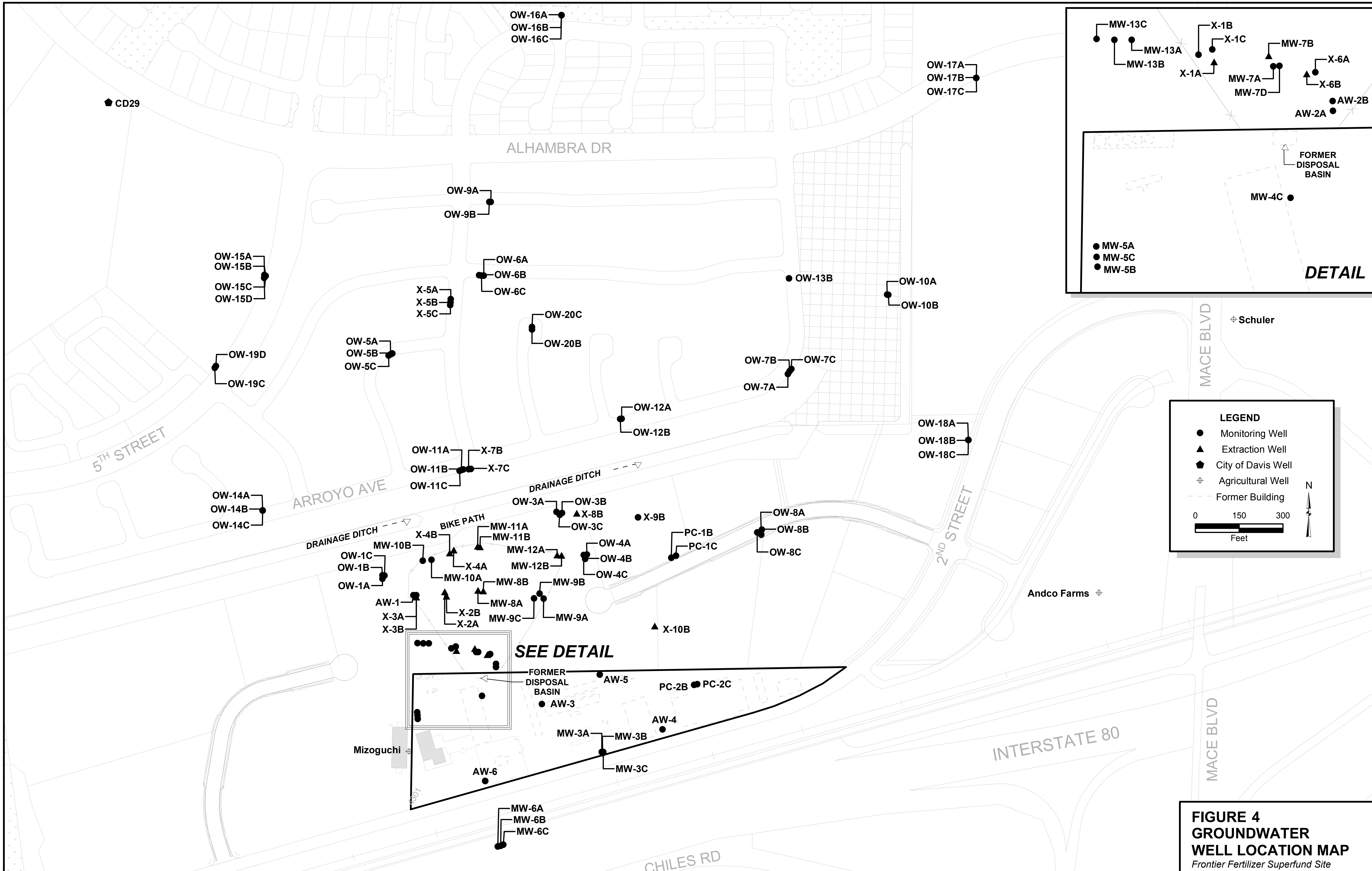


FIGURE 4
GROUNDWATER
WELL LOCATION MAP
Frontier Fertilizer Superfund Site

CH2MHILL

SAC \\GLACIER\SACGIS\FRONTIER\MXD\FIGURE1-2_TABLOID.MXD 09/11/2006 14:17:51

CCl_4

The highest concentrations of CCl_4 continue to be detected in S-1 and S-2 zones in wells located north-northeast of the former disposal basin. CCl_4 was detected at concentrations that exceeded the MCL of 0.5 µg/L in samples collected from 16 wells. The highest CCl_4 concentration of 16 µg/L was detected in a sample collected from monitoring well OW-3B, in the Remainder Parcel.

TCP

TCP was detected above the California Department of Health Services Action Level of 0.005 µg/L in samples collected from 20 wells (note: the analytical method detection limit was 0.5 µg/L, which is higher than the action level). The highest TCP concentration of 50 µg/L was detected in a sample collected from extraction well MW-7B, just north of the disposal basin.

Nitrate

Nitrate concentrations (reported as nitrogen) exceeded the federal MCL of 10 milligrams per liter (mg/L) in samples collected from 68 out of 86 wells during third quarter 2004. Nitrogen samples were collected during four consecutive quarterly events from the third quarter 2004 to second quarter 2005.

2.6 Current and Potential Future Site and Resource Uses

This section of the ROD discusses the current and reasonably anticipated future land uses and current and potential groundwater uses at and adjacent to the Site. This section also discusses the basis for future assumptions.

2.6.1 Current and Potential Future Land Uses

The former operations at the Site were abandoned in 1987. In 2000, EPA removed the warehouses, shops, the “pole barn,” a labor camp complex, a tomato grading station, aboveground storage tanks, and underground storage tanks. The warehouse, containing the groundwater treatment system, is the only building left onsite.

The Site is in an area zoned for light industrial/business park in the “Mace Ranch Plan Development, #4-88” at the eastern edge of Davis. The parcel is bounded on the south and east by 2nd Street (formerly County Road 32A) and Interstate 80; on the north by the new Mace Ranch Light Industrial/Business Park; and on the west by two metal buildings and the new Mace Ranch Light Industrial/Business Park. Construction of the Mace Ranch Light Industrial/Business Park development has begun and will affect the land north, east, and west of the site. The nearest residence is approximately 600 feet north of the property boundary.

2.6.2 Current and Potential Future Groundwater Uses

There are no drinking water wells installed in the S1, S2, or A1 aquifer zones within the plumes contaminated by Site COCs. At present, these zones are not used for drinking water because of their generally low yield (S1 and S2) and high TDS (S1, S2, and A1). Even though the shallow groundwater is not currently used for drinking water, shallow groundwater at this Site is designated as having the beneficial use of potentially providing municipal and domestic water supply pursuant to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins, Fourth Edition (Basin Plan). As such, the groundwater beneath the Site is subject to remedial action. The RAOs developed for Site groundwater are intended to protect potential future beneficial uses.

Groundwater used for the public water supply comes from the A-2 aquifer found at depths greater than 180 feet bgs. This aquifer does not contain Site contaminants. The nearest drinking water supply well (CD29) is located northwest of the Site and withdraws water from depths deeper than 696 feet bgs.

2.7 Summary of Site Risks

Two risk assessments, the Final Baseline Risk Assessment (Bechtel, 1999a) and the Revised Screening Level Ecological Risk Assessment (CH2M HILL, 2006b) were performed to evaluate potential human health and ecological risk, respectively.

2.7.1 Summary of the Baseline Risk Assessment Report

The *Final Baseline Risk Assessment Report for the Frontier Fertilizer Site* (Bechtel, 1999a) evaluated the potential risk to public health from chemicals detected in the soil and groundwater at the Site. A baseline risk assessment estimates the "baseline risk" or the potential risk of health problems occurring if no cleanup action were taken at the site. To estimate the baseline risk at a Superfund site, EPA undertakes a four-step process:

- Step 1: Identification of Chemicals of Concern
- Step 2: Exposure Assessment
- Step 3: Toxicity Assessment
- Step 4: Risk Characterization

Each of these steps is summarized below.

2.7.1.1 Identification of Chemicals of Concern

To identify COCs, scientists collect environmental samples at locations on and around the site and analyze them in a laboratory. This step reveals what hazardous chemicals are present, and at what concentrations.

Tables 3 to 5 present the COCs and summary statistics for these constituents in soil and groundwater, and estimates for indoor air at the Frontier Fertilizer Site. The tables include the range of concentrations detected for each COC, as well as the frequency of detection, and the exposure point concentrations that were used to estimate risks in the human health risk assessment.

Data Usability

Data usable for risk assessment were identified by analytical chemists and risk assessors in accordance with EPA guidelines (Guidance for Data Usability in Risk Assessment (Part A), Final (EPA, 1992). The process consisted of evaluating the chemical analytical methods used, validating the laboratory results (by an independent team of chemists), and confirming that the analytic methods could reliably detect contaminants at health-based levels of concern.

2.7.1.2 Exposure Assessment

The purpose of the exposure assessment is to evaluate potential current and future exposures to COCs by individuals that could come into contact with Site contaminants if nothing was done to cleanup the Site. Based on the current and potential future land use, the following receptors were selected to assess risk:

- Offsite current residents in the Mace Ranch residential area
- Hypothetical future residents living at the source area, within the 11.43-acre Site
- Hypothetical future workers

To evaluate the current exposure to people living in the Mace Ranch residential area, EPA assessed the groundwater to indoor air pathway, also known as the "vapor intrusion pathway." This is the only exposure pathway that has the potential to affect residents living in the Mace Ranch area under the current land use scenario. Three types of environmental samples were utilized in this evaluation: (1) groundwater from the S-1 zone, (2) soil gas, and (3) flux chamber.

The highest reported concentrations of EDB, DCP, TCP, and CCl_4 in groundwater, soil gas, and flux chamber samples collected in or near the neighborhood were used to estimate potential indoor exposures. The predicted indoor air exposure levels were greatest based on the groundwater samples. However, the indoor exposure levels that were estimated using groundwater or other media samples were all below EPA levels of concern (see risk characterization section below). Thus, different lines of evidence support the conclusion that vapor intrusion is not currently a pathway of concern for offsite residents.

EPA evaluated future onsite exposures based on both industrial and residential land use of the Site. Risks were estimated for a potential worker because a light industrial park is planned for the Site property.

Table 3
Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations - Soil

Scenario Timeframe: Future
Medium: Soil
Exposure medium: Soil

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Soil AOC 1 - Direct Contact	Aldrin	--	0.43	mg/kg	7/169	0.014	mg/kg	95% UCL
	DBCP	--	61	mg/kg	38/226	0.24	mg/kg	95% UCL
	EDB	--	23	mg/kg	64/226	0.38	mg/kg	95% UCL
	DCP	--	5.3	mg/kg	99/226	0.27	mg/kg	95% UCL
	Dieldrin	--	2	mg/kg	11/169	0.043	mg/kg	95% UCL

mg/kg = milligrams per kilogram

-- = not available in the Baseline Risk Assessment (Note: The Baseline Risk Assessment was finalized before the RAGS D table format was established.)

UCL = Upper Confidence Limit

Table 4
Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations - Groundwater

Scenario Timeframe: Future
Medium: Groundwater
Exposure medium: Groundwater

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Groundwater S-2 Water Bearing Zone	Benzene	1.0E-01	9.5E+01	µg/L	--	1.6E+01	µg/L	Mean
	CCl_4	2.0E-01	3.2E+02	µg/L	--	7.5E+01	µg/L	Mean
	Chloroform	2.0E-01	1.5E+01	µg/L	--	4.4E+00	µg/L	Mean
	EDB	1.3E-02	2.1E+04	µg/L	--	1.0E+03	µg/L	Mean
	DBCP	6.0E-03	7.5E+02	µg/L	--	5.5E+01	µg/L	Mean
	DCA	2.0E-01	6.0E+01	µg/L	--	6.9E+00	µg/L	Mean
	DCE	3.0E-01	1.0E+00	µg/L	--	5.3E-01	µg/L	Mean
	DCP	2.0E-01	2.1E+04	µg/L	--	1.7E+03	µg/L	Mean
	1,3-DCP	3.0E-01	7.4E+01	µg/L	--	1.4E+01	µg/L	Mean
	1,3-Dichloropropene	6.0E-01	7.0E+00	µg/L	--	2.8E+00	µg/L	Mean
	1,1,2,2-Tetrachloroethane	3.0E-01	4.0E+00	µg/L	--	1.3E+00	µg/L	Mean
	TCP	5.0E-01	4.4E+02	µg/L	--	6.9E+01	µg/L	Mean
	Vinyl chloride	3.0E-01	3.0E+00	µg/L	--	1.0E+00	µg/L	Mean

µg/L = micrograms per liter

-- = not available in the Baseline Risk Assessment (Note: The Baseline Risk Assessment was finalized before the RAGS D table format was established.)

Table 5
Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations - Indoor Air

Scenario Timeframe: Future
Medium: Groundwater
Exposure medium: Groundwater

Exposure Point	Chemical of Concern	Chemical Input Concentration (Groundwater S-1)	Units	Exposure Point Concentration (Indoor Air)	Exposure Point Concentration Units	Statistical Measure
Indoor Air - Disposal Pit (AOC-1)	EDB	2.80E+04	µg/L	1.20E+00	µg/m^3	Calculated from maximum groundwater concentration
	DCP	2.20E+04	µg/L	6.60E+00	µg/m^3	Calculated from maximum groundwater concentration
	TCP	3.50E+02	µg/L	1.00E-01	µg/m^3	Calculated from maximum groundwater concentration
	CCl_4	6.20E+01	µg/L	6.20E-02	µg/m^3	Calculated from maximum groundwater concentration
Indoor Air - Offsite Residential Area	EDB	9.80E-01	µg/L	4.20E-05	µg/m^3	Calculated from maximum groundwater concentration
	DCP	1.20E+01	µg/L	3.60E-03	µg/m^3	Calculated from maximum groundwater concentration
	TCP	1.00E+00	µg/L	3.00E-04	µg/m^3	Calculated from maximum groundwater concentration
	CCl_4	3.20E+01	µg/L	3.20E-02	µg/m^3	Calculated from maximum groundwater concentration

µg/L = micrograms per liter
µg/m^3 = micrograms per cubic meter

The potential future risk to residents living on the 11.43-acre Site was evaluated, assuming no cleanup is done and assuming there are no restrictions to development. In theory, this hypothetical homeowner could build a house in the most contaminated location of the Frontier Fertilizer Site, install a private drinking water well in the most contaminated portion of the groundwater “hot spot” and eat homegrown vegetables. The highest risks in this hypothetical case would result from installing a groundwater well in the “hot spot” and using the water for drinking, showering, and washing. Although the risk assessment evaluated the use of groundwater for domestic purposes, it is considered highly unlikely. Typically, Davis residents use water that meets safe drinking water standards provided by the local water purveyor.

2.7.1.3 Toxicity Assessment

Toxicity assessment is accomplished in two steps—hazard assessment and dose-response assessment. Hazard assessment is the process of determining whether exposure to a chemical is associated with a health effect and involves characterizing the nature and strength of the evidence of causation. The dose-response assessment is the process of predicting a relationship between the dose received and the incidence of adverse health effects in the exposed population. From this dose-response relationship, toxicity values are derived that can be used to estimate the potential for adverse effects as a function of potential human exposure to the chemical.

Two general groups, carcinogens and non-carcinogens, categorize chemicals depending on the type of effects on human health. Table 6 provides carcinogenic risk information that pertains to the COCs at the Frontier Fertilizer Site and Table 7 provides non-carcinogenic risk information.

2.7.1.4 Risk Characterization

The risk characterization section summarizes and combines outputs of the exposure and toxicity assessments to estimate baseline risks at the Site. Both potential cancer and non-cancer health effects are evaluated that could result from exposures to site contaminants. Cancer risk estimates in EPA’s risk assessment are intended to be health-protective and should be viewed as upper bound or maximum estimates of risk. Cancer risk is expressed as a probability. For example, a lifetime cancer risk of one in a million (1×10^{-6}) means that the probability of developing cancer is expected to be no greater than 1 in 1,000,000 for a lifetime of exposure.

Non-cancer health effects include reproductive effects and organ damage. A non-cancer risk is expressed as a hazard index. Hazard indices are the ratio of an exposure level to a nontoxic level. A hazard index value of 1 or less indicates that lifetime exposure has limited potential for causing an adverse effect in sensitive populations. On the other hand, a hazard index greater than 1 indicates the potential for adverse health effects for the most sensitive individuals in a population.

Table 6
Cancer Toxicity Data Summary

Pathway: Ingestion, Dermal

Chemical of Concern	Oral Cancer Slope Factor	Dermal Cancer Slope Factor	Slope Factor Units	Weight of Evidence/ Cancer Guideline Description	Source	Date
Aldrin	1.70E+01	1.70E+01	(mg/kg-day)-1	B2	IRIS	1998
Benzene	2.90E-02	2.90E-02	(mg/kg-day)-1	A	IRIS	1998
Bromodichloromethane	6.20E-02	6.20E-02	(mg/kg-day)-1	B2	IRIS	1998
CCl_4	1.30E-01	1.30E-01	(mg/kg-day)-1	B2	IRIS	1998
Chloroform	6.10E-03	6.10E-03	(mg/kg-day)-1	B2	IRIS	1998
DBCP	1.40E+00	1.40E+00	(mg/kg-day)-1	B2	EPA	1996
EDB	8.50E+01	8.50E+01	(mg/kg-day)-1	B2	IRIS	1998
DCA	9.10E-02	9.10E-02	(mg/kg-day)-1	B2	IRIS	1998
1,1-Dichloroethene	6.00E-01	6.00E-01	(mg/kg-day)-1	C	IRIS	1998
DCP	6.80E-02	6.80E-02	(mg/kg-day)-1	B2	EPA	1996
1,3-DCP	6.80E-02	6.80E-02	(mg/kg-day)-1	B2	EPA	1996
1,3-Dichloropropene	1.80E-01	1.80E-01	(mg/kg-day)-1	B2	EPA	1996
Dieldrin	1.60E+01	1.60E+01	(mg/kg-day)-1	B2	IRIS	1998
1,1,2,2-Tetrachloroethane	2.00E-01	2.00E-01	(mg/kg-day)-1	C	IRIS	1998
1,1,2-Trichloroethane	5.70E-02	5.70E-02	(mg/kg-day)-1	C	IRIS	1998
TCP	7.00E+00	7.00E+00	(mg/kg-day)-1	B2	EPA	1996
Vinyl chloride	1.90E+00	1.90E+00	(mg/kg-day)-1	A	EPA	1996

Table 6
Cancer Toxicity Data Summary

Pathway: Inhalation

Chemical of Concern	Inhalation Cancer Slope Factor	Slope Factor Units	Weight of Evidence/ Cancer Guideline Description	Source	Date
Aldrin	1.70E+01	(mg/kg-day)-1	B2	IRIS	1998
Benzene	2.90E-02	(mg/kg-day)-1	A	IRIS	1998
Bromodichloromethane	6.20E-02	(mg/kg-day)-1	B2	EPA	1996
CCl_4	5.30E-02	(mg/kg-day)-1	B2	IRIS	1998
Chloroform	8.10E-02	(mg/kg-day)-1	B2	IRIS	1998
DBCP	2.40E-03	(mg/kg-day)-1	B2	IRIS	1998
EDB	7.70E-01	(mg/kg-day)-1	B2	IRIS	1998
DCA	9.10E-02	(mg/kg-day)-1	B2	IRIS	1998
1,1-Dichloroethene	1.80E-01	(mg/kg-day)-1	C	IRIS	1998
DCP	6.80E-02	(mg/kg-day)-1	B2	IRIS	1998
1,3-DCP	6.80E-02	(mg/kg-day)-1	B2	IRIS	1998
1,3-Dichloropropene	1.30E-01	(mg/kg-day)-1	B2	IRIS	1998
Dieldrin	1.60E+01	(mg/kg-day)-1	B2	IRIS	1998
1,1,2,2-Tetrachloroethane	2.00E-01	(mg/kg-day)-1	C	IRIS	1998
1,1,2-Trichloroethane	5.60E-02	(mg/kg-day)-1	C	IRIS	1998
TCP	7.00E+00	(mg/kg-day)-1	B2	IRIS	1998
Vinyl chloride	3.00E-01	(mg/kg-day)-1	A	EPA	1996

EPA 1996: EPA Region 9 PRG Table
IRIS 1998: Integrated Risk Information System; EPA

A = Human carcinogen
B1 = Probable human carcinogen - indicates that limited human data are available
B2 = Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C = Possible human carcinogen
D = Not classifiable as a human carcinogen
E = Evidence of non-carcinogenicity

Table 7 Non-Cancer Toxicity Data Summary									
Pathway: Ingestion, Dermal									
Chemical of Concern	**Chronic/ Subchronic**	**Oral RfD Value**	**Oral RfD Units**	**Dermal RfD Value**	**Dermal RfD Units**	**Primary Target Organ**	**Combined Uncertainty/ Modifying Factors**	**Sources of RfD: Target Organ**	**Dates of RfD: Target Organ**
Aldrin	Chronic	3.00E-05	mg/kg-day	3.00E-05	mg/kg-day	--	1,000	IRIS	1998
Benzene	Chronic	3.00E-03	mg/kg-day	3.00E-03	mg/kg-day	--	--	IRIS	1998
Bromodichloromethane	Chronic	2.00E-02	mg/kg-day	2.00E-02	mg/kg-day	--	1,000	IRIS	1998
CCl_4	Chronic	7.00E-04	mg/kg-day	7.00E-04	mg/kg-day	--	1,000	IRIS	1998
Chloroform	Chronic	1.00E-02	mg/kg-day	1.00E-02	mg/kg-day	--	1,000	IRIS	1998
DBCP	Chronic	5.70E-05	mg/kg-day	5.70E-05	mg/kg-day	--	--	IRIS	1998
EDB	Chronic	5.70E-05	mg/kg-day	5.70E-05	mg/kg-day	--	--	EPA	1996
DCA	Chronic	2.90E-03	mg/kg-day	2.90E-03	mg/kg-day	--	--	IRIS	1998
1,1-Dichloroethene	Chronic	9.00E-03	mg/kg-day	9.00E-03	mg/kg-day	--	1,000	IRIS	1998
DCP	Chronic	1.10E-03	mg/kg-day	1.10E-03	mg/kg-day	--	300	EPA	1996
1,3-DCP	Chronic	1.10E-03	mg/kg-day	1.10E-03	mg/kg-day	--	300	EPA	1996
1,3-Dichloropropene	Chronic	3.00E-04	mg/kg-day	3.00E-04	mg/kg-day	--	10,000	IRIS	1998
Dieldrin	Chronic	5.00E-05	mg/kg-day	5.00E-05	mg/kg-day	--	100	IRIS	1998
1,1,2,2-Tetrachloroethane	Chronic	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	Chronic	4.00E-03	mg/kg-day	4.00E-03	mg/kg-day	--	1,000	EPA	1996
TCP	Chronic	6.00E-03	mg/kg-day	6.00E-03	mg/kg-day	--	1,000	IRIS	1998
Vinyl chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 7
Non-Cancer Toxicity Data Summary

Pathway: Inhalation

Chemical of Concern	Chronic/ Subchronic	Inhalation RfD Value	Inhalation RfD Units	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ
Aldrin	Chronic	3.00E-05	mg/kg-day	--	1,000	IRIS	1998
Benzene	Chronic	1.70E-03	mg/kg-day	--	--	IRIS	1998
Bromodichloromethane	Chronic	2.00E-02	mg/kg-day	--	1,000	EPA	1996
CCl_4	Chronic	5.70E-04	mg/kg-day	--	1,000	EPA	1996
Chloroform	Chronic	1.00E-02	mg/kg-day	--	1,000	EPA	1996
DBCP	Chronic	5.70E-05	mg/kg-day	--	--	IRIS	1998
EDB	Chronic	5.70E-05	mg/kg-day	--	--	IRIS	1998
DCA	Chronic	2.90E-03	mg/kg-day	--	--	IRIS	1998
1,1-Dichloroethene	Chronic	9.00E-03	mg/kg-day	--	1,000	EPA	1996
DCP	Chronic	1.10E-03	mg/kg-day	--	300	IRIS	1998
1,3-DCP	Chronic	1.10E-03	mg/kg-day	--	300	IRIS	1998
1,3-Dichloropropene	Chronic	5.70E-03	mg/kg-day	--	30	IRIS	1998
Dieldrin	Chronic	5.00E-05	mg/kg-day	--	100	IRIS	1998
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	Chronic	4.00E-03	mg/kg-day	--	1,000	EPA	1996
TCP	Chronic	5.00E-03	mg/kg-day	--	1,000	IRIS	1998
Vinyl chloride	ND	ND	ND	ND	ND	ND	ND

EPA 1996: EPA Region 9 PRG Table
IRIS 1998: Integrated Risk Information System; EPA

ND = Not determined

-- = Not available in the Baseline Risk Assessment (NOTE: The Baseline Risk Assessment was finalized before the RAGS D table format was established.)

The NCP considers an excess lifetime cancer risk of 1×10^{-6} and/or a non-cancer hazard index of greater than 1 as the points of departure for the analysis, selection, and implementation of remedial alternatives. For example, since there is the possibility of human exposure to COCs if a drinking water well were installed in the contaminated groundwater, the groundwater needs to be cleaned up. The cleanup must protect all beneficial uses of the water, including meeting drinking water standards or MCLs.

Risk Assessment Conclusions for Residents

The risk assessment concluded that for current residents in the Mace Ranch subdivision, the health risks associated with the Frontier Fertilizer Site are negligible (6×10^{-7} for cancer-causing constituents, which is below a one-in-a-million cancer risk and a hazard index estimate of 0.06, which is below the threshold of 1). EPA is required to manage cumulative site risk so that risks fall within or below the range of one in a million to one in 10,000 excess lifetime cancer risks and also to provide an adequate margin of safety for potential non-cancer effects.

In general, for the hypothetical future residents living on the 11.43-acre Site, the risks associated with shallow soil are much less than those associated with domestic use of the groundwater. If residents are not exposed to groundwater, then potential cancer risks for the hypothetical onsite residents were predicted to be highest for indoor vapor inhalation (3×10^{-4}), followed by direct contact with soils (touching and eating the soil [8×10^{-5}]), outdoor vapor inhalation (6×10^{-6}), eating homegrown vegetables (5×10^{-6}), and finally by breathing in dust (1×10^{-10}). Without drinking water from a contaminated well onsite, a hypothetical resident would be exposed to an excess lifetime cancer risk of 4 in 10,000. This risk exceeds EPA's risk management range. If residents also drink the shallow groundwater, the total risk is 1,000 times higher.

The non-cancer risks were similar. Potential non-cancer risks for the hypothetical onsite resident were predicted to be highest for breathing indoor vapor (HI = 24) followed by breathing outdoor vapor (HI = 0.74), soil ingestion and dermal contact (HI = 0.26), eating homegrown vegetables (HI = 0.038), and finally by breathing in dust from the soil (HI = 0.0000088).

Risk Assessment Conclusions for Workers

Risks also were estimated for a potential worker at a light industrial park that is planned for the Frontier Fertilizer Site property. The risk assessment predicted that cancer risks for workers would be highest for breathing indoor vapors (1×10^{-4}), followed by eating soil and skin contact (3×10^{-6}), breathing outdoor vapors (4×10^{-7}), and finally by breathing in dust from soil (2×10^{-11}). Worker non-cancer risks were predicted to be highest for indoor vapor inhalation (HI = 0.9) followed by outdoor vapor inhalation (HI = 0.016), soil ingestion and dermal contact (HI = 0.004), and finally by breathing dust from the soil (HI = 0.0000022). The cumulative cancer risk to a worker is close to 1 in 10,000, which is the upper end of EPA's risk management range.

Tables 8 to 13 summarize the carcinogenic and non-carcinogenic risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account conservative assumptions about the frequency and duration of an exposure to soil and groundwater.

Uncertainty Analysis

Some level of uncertainty is introduced into the risk characterization process each time an assumption is made. It is important to identify and discuss the uncertainties in order to put estimates of risk and hazard in proper perspective. The risk assessment methodology dictates that the assumptions err on overestimating potential exposure and risk. The large number of assumptions made in the risk characterization could potentially introduce a great deal of uncertainty.

The risk assessment evaluated the impacts of the overall uncertainty from the following contributors to uncertainty:

- Identification of chemicals of potential concern (COPCs)
- Exposure point concentrations
- Exposure settings, pathways, and routes
- Carcinogenicity in humans
- Toxicity criteria
- Potentially unevaluated COPCs

2.7.2 Summary of the Screening Level Ecological Risk Assessment

The Screening Level Ecological Risk Assessment (CH2M HILL, 2006b) identified EDB and many other non-VOCs as contaminants of potential ecological concern in Site soil (see Tables 14, 15, and 16). The results of the assessment indicated that there is a risk to ecological receptors from exposure to surface soil. One of the uncertainties in the risk assessment concerns the analytical data that were collected prior to 1999, which might overestimate the current ecological risk due to continuing degradation of the COPCs. The assessment determined that the quality of onsite habitat was generally poor at the 11.43-acre Site due to previous land use activities. There is also limited connectivity to offsite habitat because of concrete slabs and roadways covering the Site and railroad tracks and Interstate 80 across 2nd Street.

Table 8
Risk Characterization Summary – Carcinogens – Residential Scenario

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult + Child

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk				
				Ingestion	Vapor Inhalation	Soil Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil AOC 1 - Direct Contact	Aldrin	3.7E-07	N/A	2.7E-11	1.7E-07	5.4E-07
		Soil AOC 1 - Direct Contact	DBCP	5.3E-07	N/A	6.5E-14	2.3E-07	7.6E-07
		Soil AOC 1 - Direct Contact	EDB	5.1E-05	4.8E-06	3.3E-11	2.2E-05	7.8E-05
		Soil AOC 1 - Direct Contact	DCP	1.1E-06	N/A	7.8E-11	4.8E-07	1.6E-06
		Soil AOC 1 - Direct Contact	Dieldrin	2.9E-08	7.4E-07	2.1E-12	1.3E-08	7.9E-07
	Homegrown Vegetables	Homegrown Vegetable Consumption	Aldrin	1.9E-06	N/A	N/A	N/A	1.9E-06
		Homegrown Vegetable Consumption	Dieldrin	2.7E-06	N/A	N/A	N/A	2.7E-06
							Soil Risk Total =	**8.6E-05**
Indoor Air	Indoor Air	AOC 1 - Inhalation	CCl_4	N/A	4.9E-07	N/A	N/A	4.9E-07
		AOC 1 - Inhalation	EDB	N/A	1.4E-04	N/A	N/A	1.4E-04
		AOC 1 - Inhalation	1.2-DCP	N/A	6.7E-05	N/A	N/A	6.7E-05
		AOC 1 - Inhalation	TCP	N/A	1.1E-04	N/A	N/A	1.1E-04
							Indoor Air Risk Total =	**3.2E-04**

Table 8
Risk Characterization Summary – Carcinogens – Residential Scenario

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult + Child

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk				
				Ingestion	Vapor Inhalation	Soil Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	S-2 Water-Bearing Zone - Tap Water	Benzene	8.9E-06	3.5E-05	N/A	1.6E-06	4.3E-06
		S-2 Water-Bearing Zone - Tap Water	CCl_4	1.5E-04	3.0E-04	N/A	7.4E-08	4.5E-04
		S-2 Water-Bearing Zone - Tap Water	Chloroform	4.0E-07	2.7E-05	N/A	8.2E-09	2.7E-05
		S-2 Water-Bearing Zone - Tap Water	EDB	7.2E-01	5.6E-02	N/A	9.6E-03	7.8E-01
		S-2 Water-Bearing Zone - Tap Water	DBCP	1.1E-03	9.8E-06	N/A	2.6E-05	1.2E-03
		S-2 Water-Bearing Zone - Tap Water	DCA	9.3E-08	4.7E-05	N/A	1.4E-07	5.5E-06
		S-2 Water-Bearing Zone - Tap Water	1,1-Dichloroethene	4.7E-08	7.1E-05	N/A	1.7E-07	1.2E-05
		S-2 Water-Bearing Zone - Tap Water	1.2-DCP	1.7E-03	6.5E-03	N/A	4.0E-05	1.0E-02
		S-2 Water-Bearing Zone - Tap Water	1,3-DCP	1.4E-06	7.1E-05	N/A	3.3E-11	8.5E-05
		S-2 Water-Bearing Zone - Tap Water	1,3-Dichloropropene	7.5E-06	2.7E-05	N/A	9.5E-08	3.5E-05
		S-2 Water-Bearing Zone - Tap Water	1,1,2,2-Tetrachloroethane	3.9E-06	1.9E-05	N/A	9.0E-08	2.3E-05
		S-2 Water-Bearing Zone - Tap Water	TCP	7.2E-03	3.5E-02	N/A	1.7E-04	4.3E-02
		S-2 Water-Bearing Zone - Tap Water	Vinyl chloride	2.8E-05	2.2E-05	N/A	4.8E-07	5.1E-05
							Groundwater Risk Total =	**8.4E-01**
							Total Risk =	**8.4E-01**

N/A = Route of exposure is not applicable to this chemical or medium.

Table 9
Risk Characterization Summary – Carcinogens - Industrial Scenario*

Scenario Timeframe: Future
Receptor Population: Industrial worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk				
				Ingestion	Vapor Inhalation	Soil Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil AOC 1 - Direct Contact	Aldrin	6.2E-08	N/A	6.3E-12	5.7E-08	1.2E-07
		Soil AOC 1 - Direct Contact	DBCP	1.4E-08	N/A	2.5E-15	1.3E-08	2.7E-08
		Soil AOC 1 - Direct Contact	EDB	1.5E-06	1.9E-07	1.4E-12	1.4E-06	3.0E-06
		Soil AOC 1 - Direct Contact	DCP	9.5E-08	N/A	9.6E-12	8.7E-08	1.8E-07
		Soil AOC 1 - Direct Contact	Dieldrin	2.9E-09	1.0E-07	2.9E-13	2.6E-09	1.1E-07
							Soil Risk Total =	**3.5E-06**
Indoor Air	Indoor Air	AOC 1 - Inhalation	EDB	N/A	5.0E-05	N/A	N/A	5.0E-05
		AOC 1 - Inhalation	DCP	N/A	2.4E-05	N/A	N/A	2.4E-05
		AOC 1 - Inhalation	Trichloropropane	N/A	3.9E-05	N/A	N/A	3.9E-05
		AOC 1 - Inhalation	CCl_4	N/A	1.3E-07	N/A	N/A	1.3E-07
							Indoor Air Risk =	**1.1E-04**
							Total Risk =	**1.2E-04**

N/A = Route of exposure is not applicable to this chemical or medium.

* Although indoor air risks for workers were not presented in the original risk assessment, the worker risks can be estimated by dividing the residential risks by 2.8 to take into account differences between a residential and indoor worker exposure assumption (an indoor worker is assumed to be exposed 250 days per year for 25 years and have a breathing rate of 15 m^3/day)

Table 10
Risk Characterization Summary – Carcinogens – Indoor Air

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk				
				Ingestion	Vapor Inhalation	Soil Inhalation	Dermal	Exposure Routes Total
Groundwater	Indoor Air	Indoor Air - Disposal Pit (AOC 1)	EDB	N/A	1.4E-04	N/A	N/A	1.4E-04
		Indoor Air - Disposal Pit (AOC 1)	DCP	N/A	6.7E-05	N/A	N/A	6.7E-05
		Indoor Air - Disposal Pit (AOC 1)	TCP	N/A	1.1E-04	N/A	N/A	1.1E-04
		Indoor Air - Disposal Pit (AOC 1)	CCl_4	N/A	4.9E-07	N/A	N/A	4.9E-07
							Indoor Air Risk Total =	**3.2E-04**
Groundwater	Indoor Air	Indoor Air - Offsite Residential Area	EDB	N/A	4.8E-09	N/A	N/A	4.8E-09
		Indoor Air - Offsite Residential Area	DCP	N/A	3.6E-08	N/A	N/A	3.6E-08
		Indoor Air - Offsite Residential Area	TCP	N/A	3.1E-07	N/A	N/A	3.1E-07
		Indoor Air - Offsite Residential Area	CCl_4	N/A	2.5E-07	N/A	N/A	2.5E-07
							Indoor Air Risk Total =	**6.0E-07**

Table 11
Risk Characterization Summary – Non-Carcinogens – Residential Scenario

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult + Child

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient				
					Ingestion	Vapor Inhalation	Soil Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil AOC 1 - Direct Contact	Aldrin	--	6.6E-03	N/A	3.3E-07	2.9E-03	9.5E-03
		Soil AOC 1 - Direct Contact	DBCP	--	6.0E-02	N/A	3.0E-06	2.6E-02	8.6E-02
		Soil AOC 1 - Direct Contact	EDB	--	9.4E-02	6.7E-01	4.7E-06	4.1E-02	8.1E-01
		Soil AOC 1 - Direct Contact	DCP	--	1.2E-02	N/A	6.1E-07	5.3E-03	1.8E-02
		Soil AOC 1 - Direct Contact	Dieldrin	--	3.5E-03	6.2E-02	1.7E-07	1.5E-03	6.7E-02
	Homegrown Vegetables	Homegrown Vegetable Consumption	Aldrin	--	2.0E-02	N/A	N/A	N/A	2.0E-02
		Homegrown Vegetable Consumption	Dieldrin	--	1.8E-02	N/A	N/A	N/A	1.8E-02
								Soil Hazard Index Total =	**1.0E+00**
Indoor Air	Indoor Air	AOC 1 - Inhalation	CCl_4	--	N/A	1.0E-01	N/A	N/A	1.0E-01
		AOC 1 - Inhalation	EDB	--	N/A	1.9E+01	N/A	N/A	1.9E+01
		AOC 1 - Inhalation	1.2-DCP	--	N/A	5.3E+00	N/A	N/A	5.3E+00
		AOC 1 - Inhalation	TCP	--	N/A	1.9E-02	N/A	N/A	1.9E-02
								Indoor Air Hazard Index Total =	**2.4E+01**

Table 11
Risk Characterization Summary – Non-Carcinogens – Residential Scenario

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult + Child

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient				
					Ingestion	Vapor Inhalation	Soil Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	S-2 Water-Bearing Zone - Tap Water	Benzene	--	4.9E-01	4.4E+00	N/A	1.0E-01	5.0E+00
		S-2 Water-Bearing Zone - Tap Water	CCl_4	--	9.8E+00	6.1E+01	N/A	4.6E-01	7.1E+01
		S-2 Water-Bearing Zone - Tap Water	Chloroform	--	4.0E-02	2.0E-01	N/A	7.6E-04	2.5E-01
		S-2 Water-Bearing Zone - Tap Water	EDB	--	1.6E+03	8.2E+03	N/A	1.1E+01	9.8E+03
		S-2 Water-Bearing Zone - Tap Water	DBCP	--	8.8E+01	4.5E+02	N/A	1.9E+00	5.4E+02
		S-2 Water-Bearing Zone - Tap Water	DCA	--	2.2E-01	1.1E+00	N/A	2.5E-03	1.3E+00
		S-2 Water-Bearing Zone - Tap Water	1,1-Dichloroethene	--	5.4E-03	2.7E-02	N/A	1.8E-04	3.3E-02
		S-2 Water-Bearing Zone - Tap Water	1.2-DCP	--	1.4E+02	7.2E+02	N/A	3.0E+00	8.6E+02
		S-2 Water-Bearing Zone - Tap Water	1,3-DCP	--	1.2E+00	5.9E+00	N/A	2.5E-06	7.1E+00
		S-2 Water-Bearing Zone - Tap Water	1,3-Dichloropropene	--	8.5E-01	2.3E-01	N/A	1.0E-02	1.1E+00
		S-2 Water-Bearing Zone - Tap Water	1,1,2,2-Tetrachloroethane	ND	ND	ND	N/A	ND	ND
		S-2 Water-Bearing Zone - Tap Water	TCP	--	1.1E+00	6.4E+00	N/A	2.2E-02	7.5E+00
		S-2 Water-Bearing Zone - Tap Water	Vinyl chloride	ND	ND	ND	N/A	ND	ND
								Groundwater Hazard Index Total =	**1.1E+04**
								Total Hazard Index =	**1.1E+04**

N/A = Route of exposure is not applicable to this medium.

ND = Not determined.

-- = Not available in the Baseline Risk Assessment (Note: The Baseline Risk Assessment was finalized before the RAGS D table format was established).

Table 12
Risk Characterization Summary – Non-Carcinogens – Industrial Scenario*

Scenario Timeframe: Future
Receptor Population: Industrial worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient				
					Ingestion	Vapor Inhalation	Soil Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil AOC 1 - Direct Contact	Aldrin	--	3.4E-04	N/A	3.5E-08	3.1E-04	6.5E-04
		Soil AOC 1 - Direct Contact	DBCP	--	5.0E-04	N/A	5.0E-08	4.5E-04	9.5E-04
		Soil AOC 1 - Direct Contact	EDB	--	8.6E-04	1.2E-02	8.7E-08	7.8E-04	1.4E-02
		Soil AOC 1 - Direct Contact	DCP	--	3.3E-04	N/A	3.4E-08	3.0E-04	6.4E-04
		Soil AOC 1 - Direct Contact	Dieldrin	--	1.1E-04	3.8E-03	1.1E-08	9.7E-05	4.0E-03
								Soil Hazard Index Total =	**2.0E-02**
Indoor Air	Indoor Air	AOC 1 - Inhalation	EDB	--	N/A	1.0E+01	N/A	N/A	6.8E-02
		AOC 1 - Inhalation	DCP	--	N/A	2.8E+00	N/A	N/A	8.4E-01
		AOC 1 - Inhalation	Trichloropropane	--	N/A	1.0E-02	N/A	N/A	1.1E-02
		AOC 1 - Inhalation	CCl_4	--	N/A	5.3E-02	N/A	N/A	1.3E-02
								Indoor Hazard Index Total =	**9.0E-01**
								Total Hazard Index =	**9.0E-01**

N/A = Route of exposure is not applicable to this medium.

-- = Not available in the Baseline Risk Assessment (Note: The Baseline Risk Assessment was finalized before the RAGS D table format was established).

* Although indoor air hazard indices for workers were not presented in the original risk assessment, the worker hazards can be estimated by dividing the adult residential hazard quotient by 1.9 to take into account differences between a residential and indoor worker exposure assumption (an indoor worker is assumed to be exposed 250 days per year for 25 years and have a breathing rate of 15 m^3/day).

Table 13
Risk Characterization Summary - Non-Carcinogens - Indoor Air

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient				
					Ingestion	Vapor Inhalation	Soil Inhalation	Dermal	Exposure Routes Total
Groundwater	Indoor Air	Indoor Air - Disposal Pit (AOC 1)	EDB	--	N/A	1.9E+01	N/A	N/A	1.9E+01
		Indoor Air - Disposal Pit (AOC 1)	DCP	--	N/A	5.3E+00	N/A	N/A	5.3E+00
		Indoor Air - Disposal Pit (AOC 1)	TCP	--	N/A	1.9E-02	N/A	N/A	1.9E-02
		Indoor Air - Disposal Pit (AOC 1)	CCl_4	--	N/A	1.0E-01	N/A	N/A	1.0E-01
Indoor Air Hazard Index Total =									**2.4E+01**
Groundwater	Indoor Air	Indoor Air - Offsite Residential Area	EDB	--	N/A	6.8E-04	N/A	N/A	6.8E-04
		Indoor Air - Offsite Residential Area	DCP	--	N/A	2.9E-03	N/A	N/A	2.9E-03
		Indoor Air - Offsite Residential Area	TCP	--	N/A	5.5E-05	N/A	N/A	5.5E-05
		Indoor Air - Offsite Residential Area	CCl_4	--	N/A	5.1E-02	N/A	N/A	5.1E-02
Indoor Air Hazard Index Total =									**5.5E-02**

N/A = Route of exposure is not applicable to this medium.

-- = Not available in the Baseline Risk Assessment (Note: The Baseline Risk Assessment was finalized before the RAGS D table format was established).

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Table 14
Occurrence, Distribution, and Selection of Chemicals of Concern (COC)

	Media-Based Receptors		Food-Chain Based Receptors																	
	Plant	Soil Invertebrate	Mourning Dove	Burrowing Owl (omnivorous)	Burrowing Owl (insectivorous)	Vole	Mouse (50/50 insectivorous/ herbivorous)	Mouse (insectivorous)	California Ground Squirrel	Retained as COPEC?	Units	Frequency of Detection	Minimum Conc.	Maximum Conc.	Mean	UCL 95	Screening Toxicity Value	Screening Toxicity Value Source	Site Concentration Exceeds Plant-Based Background	Site Concentration Exceeds Invertebrate-Based Background
Metals																				
Arsenic	○	—	—	—	—	○	●	●	○	**Yes**	mg/kg	92%	1.3	37.7	9.85	14.73	37	EPA, 2000 (EcoSSL)	Yes	
Cobalt	●	—	—	—	—	○	○	○	—	**Yes**	mg/kg	92%	2.2	30.1	22.73	26.33	13	EPA, 2000 (EcoSSL)	Yes	
Copper	○	●	○	○	○	○	○	●	○	**Yes**	mg/kg	92%	1.8	245	65.25	96.5	61	EPA, 2000 (EcoSSL)	Yes	Yes
Nickel	●	●	○	○	●	○	○	●	○	**Yes**	mg/kg	92%	9.8	276	215.68	253.2	30	Efroymson et. al., 1997a	Yes	Yes
Selenium	●	—	—	—	—	○	○	●	—	**Yes**	mg/kg	62%	0.22	2.3	1.18	1.48	1	Efroymson et. al., 1997a	Yes	
Vanadium	●	●	—	—	—	○	○	○	○	**Yes**	mg/kg	92%	1.3	78.8	60.5	70.85	2	Efroymson et. al., 1997a	Yes	Yes
Organics																				
TPH-diesel	●	○	—	—	—	○	○	○	○	**Yes**	mg/kg	24%	0.5	4,300	185.79	438.33	0.6	Marwood et al., 1998	-	-
TPH-gasoline	●	●	—	—	—	—	—	—	—	**Yes**	mg/kg	11%	0.5	32	3.571	5.95	4	CCME, 2000	-	-
TPH-motor oil	●	●	—	—	—	—	—	—	—	**Yes**	mg/kg	78%	10	3,000	375.556	1,019.69	10.37	VanGestel et al., 2001	-	-
EDB	—	—	—	—	—	●	●	●	○	**Yes**	µg/kg	10%	4	4,300	30.671	56.91		-		
4,4'-DDD	○	○	●	●	●	—	—	—	—	**Yes**	µg/kg	13%	0.1	980	45.78	56.6	250	CCME, 1999	-	-
4,4'-DDE	○	○	●	●	●	—	—	—	—	**Yes**	µg/kg	22%	0.1	980	41.35	51.27	250	CCME, 1999	-	-
4,4'-DDT	○	○	●	●	●	—	—	—	—	**Yes**	µg/kg	27%	0.1	980	48.65	59.22	250	CCME, 1999	-	-
Aldrin	—	—	—	—	—	—	●	●	—	**Yes**	µg/kg	7%	0.05	490	25.605	32.54	620	Harris 1964		
Delta-BHC	—	—	—	—	—	○	●	●	—	**Yes**	µg/kg	3%	0.05	1,700	32.9	48.06		-		
Dieldrin	—	—	●	●	●	○	●	●	●	**Yes**	µg/kg	15%	0.1	3,600	62.36	92.29	10,000	Neuhauser and Callahan, 1990		
Endosulfan I	—	—	—	—	—	○	●	●	—	**Yes**	µg/kg	24%	0.05	7,700	142.881	227.88	32,000	Adema and Henzen, 2001		
Endosulfan II	—	—	—	—	—	—	○	●	—	**Yes**	µg/kg	26%	0.1	3,900	133.408	184.65	32,000	Adema and Henzen, 2001		
Endrin	—	—	●	—	—	—	—	—	—	**Yes**	µg/kg	6%	0.1	980	41.56	52.37	660	Cathey, 1982		
Endrin aldehyde	—	○	○	—	—	—	—	—	—	No	µg/kg	6%	0.1	980	44.08	55.04	660	Cathey, 1982		-
Endrin ketone	—	—	○	—	—	—	—	—	—	No	µg/kg	3%	0.1	980	46.36	57.61		-		
Gamma-chlordane	●	—	—	—	—	—	—	—	—	**Yes**	µg/kg	17%	0.05	1,200	32.87	45.22	1,000	Ahrens and Kring, 1968	-	
Toluene	—	○	—	—	—	—	—	—	—	No	µg/kg	21%	2	670	38.515	49.94	440	CCME, 1999		-
Toxaphene	—	—	—	—	—	○	●	●	—	**Yes**	µg/kg	3%	5	49,000	1,920.44	2,428.36		-		
Aroclor-1016	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	1	5,100	372.193	455.07	2,510	Rhet et al., 1989		
Aroclor-1221	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	2	5,100	432.524	524.49	2,510	Rhet et al., 1989		
Aroclor-1232	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	1	5,100	417.659	509.94	2,510	Rhet et al., 1989		

Table 14
Occurrence, Distribution, and Selection of Chemicals of Concern (COC)

	Media-Based Receptors		Food-Chain Based Receptors																	
	Plant	Soil Invertebrate	Mourning Dove	Burrowing Owl (omnivorous)	Burrowing Owl (insectivorous)	Vole	Mouse (50/50 insectivorous/ herbivorous)	Mouse (insectivorous)	California Ground Squirrel	Retained as COPEC?	Units	Frequency of Detection	Minimum Conc.	Maximum Conc.	Mean	UCL 95	Screening Toxicity Value	Screening Toxicity Value Source	Site Concentration Exceeds Plant-Based Background	Site Concentration Exceeds Invertebrate-Based Background
Aroclor-1242	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	1	5,100	372.19	455.07	2,510	Rhet et al., 1989		
Aroclor-1248	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	1	5,100	373.5	456.63	2,510	Rhet et al., 1989		
Aroclor-1254	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	1	5,100	373.5	456.63	2,510	Rhet et al., 1989		
Aroclor-1260	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	1	5,100	373.884	456.99	2,510	Rhet et al., 1989		
Acenaphthylene	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	10	420	310	506.49	1,200	Sims and Overcash, 1983		
Acenapthene	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	10	420	273.333	531.96	1,200	Sims and Overcash, 1983		
Anthracene	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	10	420	273.333	531.96	1,200	Sims and Overcash, 1983		
Benzo(g,h,i)perylene	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	10	420	273.333	531.96	1,200	Sims and Overcash, 1983		
Benzo[a]anthracene	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	10	420	273.33	531.96	1,200	Sims and Overcash, 1983		
Benzo[a]pyrene	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	10	420	273.33	531.96	1,200	Sims and Overcash, 1983		
Benzo[b]fluoranthene	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	10	420	273.333	531.96	1,200	Sims and Overcash, 1983		
Benzo[k]fluoranthene	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	10	420	273.333	531.96	1,200	Sims and Overcash, 1983		
Chrysene	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	10	420	273.333	531.96	1,200	Sims and Overcash, 1983		
Dibenz[a,h]anthracene	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	10	420	273.33	531.96	1,200	Sims and Overcash, 1983		
Fluoranthene	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	10	420	273.333	531.96	38,000	Sverdrupetal, 2002		
Fluorene	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	10	420	273.333	531.96	27,000	Sverdrupetal, 2002		
Indeno(1,2,3-cd)pyrene	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	10	420	273.333	531.96	1,200	Sims and Overcash, 1983		
Phenanthrene	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	10	420	273.333	531.96	34,000	Sverdrupetal, 2002		
Pyrene	—	—	—	—	—	—	—	—	—	No[b]	µg/kg	0%	10	420	273.333	531.96	18,000	Sverdrupetal, 2002		

Notes:

Analytes retained as COPECs when there was insufficient information to exclude the analyte from presenting a risk

[a] Ranking is determined by the number of receptors where the potential for risk could not be excluded. Note that burrowing owl and mouse are listed twice for their varying diets, but only count as one receptor.

[b] Confidence in the risk conclusion is low because these analytes were not found at concentrations above their detection limit.

— = Chemical not analyzed in the refinement because it was not retained as a COPEC for this receptor (see Section 1)

○ = Chemical did not exceed NOAEL/NOEC-based TRV

● = Chemical exceeded NOAEL/NOEC-based TRV

- = Not available

UCL 95 = 95% upper confidence level

Screening Toxicity value - minimum between plants and invertebrates. Full citation in CH2M HILL, 2006b.

Table 15
Ecological Exposure Pathways of Concern

Exposure Medium	Sensitive Environment Flag (Y or N)	Receptor	Threatened/ Endangered Species Flag (Y or N)	Exposure Routes	Assessment Endpoints	Measurement Endpoints
Soil	N	Terrestrial plants	N	Direct exposure, ingestion	Plant productivity or species composition	Seed germination, growth, or survival
Soil	N	Terrestrial invertebrates, herbivorous mammals, and birds) available to secondary and tertiary consumers	N	Direct exposure, ingestion	Abundance of prey species available to secondary and tertiary consumers	Macroinvertebrate survival; Reproductive success, growth, or survival of birds and mammals
Soil	N	Avian and mammalian consumers using terrestrial areas	N	Direct exposure, ingestion	Population levels of avian and mammalian consumers using terrestrial areas	Reproductive success, growth, or survival of birds and mammals

Table 16
COC Concentrations Expected to Provide Adequate Protection of Ecological Receptors

Exposure Medium	COC	Protective Level (mg/kg)[a]	Basis[b]	Assessment Endpoint
Soil	Arsenic	5.29 - 7.7	Benchmark	Abundance of prey species (insectivorous and omnivorous mammals) available to secondary and tertiary consumers
Soil	Cobalt	13	Benchmark	Plant productivity or species composition
Soil	Copper	32.3 - 61	Benchmark	Abundance of prey species (invertebrates, insectivorous mammals) available to secondary and tertiary consumers
Soil	Nickel	30 - 200	Benchmark	Plant productivity or species composition; Abundance of prey species (invertebrates) available to secondary and tertiary consumers; Population levels of avian and mammalian consumers using terrestrial areas
Soil	Selenium	0.36 - 1	Benchmark	Abundance of prey species (invertebrates, insectivorous mammals) available to secondary and tertiary consumers
Soil	Vanadium	2 - 4.6	Benchmark	Plant productivity or species composition; Abundance of prey species (invertebrates) available to secondary and tertiary consumers
Soil	TPH-diesel	0.6	Benchmark	Plant productivity or species composition;
Soil	TPH-gasoline	4 - 5.85	Benchmark	Plant productivity or species composition; Abundance of prey species (invertebrates) available to secondary and tertiary consumers
Soil	TPH-motor oil	10.37 - 27.11	Benchmark	Plant productivity or species composition; Abundance of prey species (invertebrates) available to secondary and tertiary consumers
Soil	EDB	0.007 - 0.23	Benchmark	Population levels of mammalian consumers using terrestrial areas
Soil	4,4'-DDD	1.05 - 3.52	Benchmark	Abundance of prey species (herbivorous bird available to secondary and tertiary consumers; Population levels of avian consumers using terrestrial areas
Soil	4,4'-DDE	1.05 - 3.51	Benchmark	Abundance of prey species (herbivorous birds) available to secondary and tertiary consumers; Population levels of avian consumers using terrestrial areas
Soil	4,4'-DDT	1.02 - 3.42	Benchmark	Abundance of prey species (herbivorous birds) available to secondary and tertiary consumers; Population levels of avian consumers using terrestrial areas
Soil	Aldrin	13.57 - 27.1	Benchmark	Population levels of mammalian consumers using terrestrial areas
Soil	Delta-BHC	0.003 - 0.005	Benchmark	Population levels of mammalian consumers using terrestrial areas

Table 16 COC Concentrations Expected to Provide Adequate Protection of Ecological Receptors				
Exposure Medium	**COC**	**Protective Level (mg/kg)[a]**	**Basis[b]**	**Assessment Endpoint**
Soil	Dieldrin	1.07 - 101	Benchmark	Abundance of prey species (herbivorous birds) available to secondary and tertiary consumers; Population levels of avian and mammalian consumers using terrestrial areas
Soil	Endosulfan I	0.38 - 0.66	Benchmark	Population levels of avian and mammalian consumers using terrestrial areas
Soil	Endosulfan II	114.1	Benchmark	Population levels of avian and mammalian consumers using terrestrial areas
Soil	Endrin	3.52	Benchmark	Abundance of prey species (herbivorous birds) available to secondary and tertiary consumers
Soil	Gamma-chlordane	1	Benchmark	Plant productivity or species composition
Soil	Toxaphene	0.1 - 0.21	Benchmark	Population levels of mammalian consumers using terrestrial areas

[a] Protective levels expressed in terms of soil concentration
[b] Exceedance criteria for plants and soil invertebrates were based on NOEC benchmarks (Tables 1-4 and 1-5 of SLERA), while the criteria for vertebrate species (birds and mammals) were obtained by back-calculating from bird and mammal benchmarks (Tables 1-6 and 1-7 of SLERA), which were in doses of mg/kg-d, to soil-based concentration (mg/kg).

2.7.3 Recommendations and Basis for Risk Management Decisions

On the basis of results of the baseline risk assessment, the response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment. The remedial action will reduce concentrations of contaminants in groundwater and soil at the Frontier Fertilizer Site. The baseline human health risk assessment showed that the following exposure pathways may present an unacceptable human health risk and hazards if not addressed by implementing the response action selected in the ROD:

- **Vapor Inhalation:** Carcinogenic risk (1×10^{-4}) and non-carcinogenic hazard (HI approximately = 24) risk estimates are highest associated with indoor vapor inhalation for the potential worker at a light industrial business. The light industrial business park is the reasonably anticipated future land use.

- **Groundwater Consumption:** The highest carcinogenic risk for a hypothetical resident, living at the Site, would result from installing a groundwater well in the "hot spot" and using the water for domestic purposes (drinking, showering, and washing) (8×10^{-1}).

Ecological Habitat

To protect ecological receptors from the contamination in the surface soil, each of the alternatives considered includes a cap of wood chips, pavement, or gravel for the area not included in the remedy. The cap will provide a barrier to the soil until the proposed development occurs. If the proposed development does not occur, the surface soil can be resampled to assess the current risk.

2.8 Remedial Action Objectives

RAOs define the extent that sites require cleanup to meet the objectives of protecting human health and the environment. RAOs incorporate the COCs, exposure routes and receptors, and a risk-based acceptable contaminant level for each medium of concern at the Site. The specific RAOs for the Frontier Fertilizer Site (listed in Table 17) include the following:

- Reduce levels of chemicals in onsite soil to prevent future exposures to chemicals in soil above health-protective levels.
- Reduce levels of chemicals in groundwater (and soil sources to groundwater) so that the groundwater could ultimately be used for domestic purposes.
- Prevent future onsite exposures (workers and/or residents) to chemical vapors in indoor air above health-protective levels.
- Reduce risks to plants and animals to a level consistent with habitat quality and proposed future use of the Site.

Table 17
Remedial Action Objectives

Contaminant of Concern	Soil Cleanup Values (µg/kg)[a]	Groundwater MCL (µg/L)	ARAR	Cancer Risk at MCL[b]	Non-cancer Hazard at MCL[c]
DBCP	1.20	0.2	MCL	4×10^{-6}	0.6
EDB	0.18	0.05	MCL	9×10^{-6}	0.003
DCP	20	5	MCL	3×10^{-5}	0.7
CCl_4	90 [d]	0.5 [e]	CA MCL	3×10^{-6}	0.1
TCP	2.5	0.5[f]	Detection Limit	9×10^{-5}	0.05
Cumulative Risk				1×10^{-4}	1

[a] Soil depth to 10 feet bgs for protection of groundwater
[b] Cumulative site risk must fall within or below the cancer risk range at 1×10^{-4} to 1×10^{-6}
[c] A non-cancer risk at 1 or less indicates that a lifetime exposure has limited potential for causing adverse effect on sensitive populations
[d] CCl_4 has not been detected in soil in past investigations
[e] California MCL, which is more stringent than the Federal MCL
[f] Detection limit for TCP; there is no MCL for TCP

EPA has identified cleanup goals for soil beneath the Site and contaminated groundwater as part of the cleanup objectives. The Site groundwater and soil cleanup goals are based on an evaluation of potential chemical-specific ARARs and TBC criteria. Based on the ARARs evaluation, the cleanup goals for groundwater are set at MCLs. The soil cleanup values are based on the protection of groundwater and were calculated using vadose zone modeling documented in the Supplemental Remedial Investigation Report (Bechtel, 1999b).

The feasibility of cleaning up groundwater to background concentrations was evaluated in the Feasibility Study (CH2M HILL, 2006a). Compared with estimates of the time and cost to clean up groundwater to meet MCLs (see Section 2.9), the timeframe and cost for cleanup to background would be significant and technically infeasible at this time, given Site conditions and COCs. For these reasons, restoration of the aquifers to pristine conditions was not included as an RAO, nor was background considered a practical remediation goal for pesticides and CCl_4 in groundwater.

2.9 Description of Alternatives

This section describes the remedial alternatives selected for detailed analysis in the FS Report (CH2M HILL, 2006a). Remedial alternatives were developed to meet the RAOs in accordance with CERCLA, as amended by SARA, 42 United States Code (U.S.C.) 9602 et seq, and the NCP.

2.9.1 Common Components of Each Remedial Alternative

All of the remaining alternatives with the exception of the no action alternative have the following four components in common:

- **Institutional Control (Restrictive Covenant):** Descriptions of contaminated groundwater and soil and their respective restrictions are incorporated into the property deeds to minimize risk until cleanup action objectives are reached. Restrictions include prohibiting residential use and groundwater extraction. Excavating, grading, and trenching may also be limited in the soil source area. Specific building requirements in the source area, such as ventilation systems, may also be included in the restrictive covenant.

- **Groundwater Monitoring:** Groundwater monitoring continues until cleanup action objectives are achieved.

- **Access Restrictions:** Access to the contaminated surface soil is restricted with fencing and signage to prevent access by unauthorized personnel until cleanup action objectives are reached.

- **Cap:** Wood chips, pavement, or gravel will cover the Site to prevent animals from contacting contaminated surface soil until the proposed development takes place. Pavement could also be used to prevent exposure to surface soils. If the proposed development does not occur, the surface soil can be resampled to assess the current risk. If soil sampling demonstrates that COCs are below ecological screening levels, then the cap will not be needed to protect ecological receptors.

2.9.2 Alternatives for Soil and Groundwater Cleanup

The following alternatives were considered for detailed analysis during the FS:

- No action alternative
- Groundwater pump and treat
- In situ biological treatment plus groundwater pump and treat
- In situ heating plus groundwater pump and treat; possible secondary biological treatment of nitrate

2.9.3 Media Descriptions

The following volume descriptions are used in the alternative discussion and comprise the media impacted by chemicals released during Site activities:

- **Media A:** Unsaturated source volume. Soil from the surface to the water table where COCs have been detected, and is at or immediately adjacent to the former disposal basin location. The water table elevation fluctuates between 10 and 30 feet bgs on an annual cycle and the uppermost 10 feet was removed during an interim measure as described in the RI report (Bechtel, 1997).

- **Media B:** Saturated source volume. Saturated soil where COCs were detected in soil samples, which is below and extends slightly north of the unsaturated source soil. As with Media A, Media B is at or immediately adjacent to the former disposal basin.

- **Media C:** Dissolved groundwater plume volume. Includes the volume where COCs are detected in groundwater above RAOs, excluding the saturated soil in Media B. The dimension of the dissolved plume is based on monitoring data. COCs have been detected in all of the three shallowest monitored groundwater zones (S-1, S-2, and A-1).

Media A, B, and C are shown on Figure 1.

2.9.4 No Action

The no action alternative is required by CERCLA to provide a basis for developing and evaluating the other remedial alternatives. This alternative assumes that no action is taken to clean up contaminated soil and groundwater and that the current pump-and-treat system, groundwater monitoring, and access restrictions are not continued. Because no remedial activities are implemented with the no action alternative, long-term human health and environmental risks for the Site essentially will be the same as those identified in the baseline risk assessment.

The no action alternative does not meet EPA's cleanup action objectives and does not comply with state and federal requirements (ARARs). Without any remedial action, RAOs are not expected to be achieved.

Discontinuance of the existing groundwater pump-and-treat system operation and groundwater monitoring in addition to unlimited Site access will result in increased exposure to COCs. Termination of the pump-and-treat system will allow contaminants to migrate and probably increase the COC concentrations and volume of Media C. Termination of the groundwater monitoring also prevents monitoring of COC migration. Elimination of fencing and posting will likely result in worst-case exposure to contaminated soil and groundwater as defined in the risk assessment.

2.9.5 Groundwater Pump-and-Treat System

Groundwater Contamination

- Groundwater extraction and treatment and groundwater monitoring to determine if additional pumping (extraction) wells or monitoring wells, or modifications to the system are necessary. This treatment will continue until monitoring indicates that the MCLs are achieved. MCLs are the cleanup levels for groundwater based on ARARs.

- The system pumps contaminated water from extraction wells and pipes it to a treatment plant. GAC units are currently used for treatment; however, other available technologies could be used to treat the groundwater, if they are determined to be effective and result in cost savings. Once the GAC adsorbs COCs, it loses capacity and is replaced with fresh GAC. The spent GAC is sent offsite for treatment and ultimately is reused.

- The treated water will continue to be discharged to the City of Davis sanitary sewer.

Because there is no upfront treatment of the contaminated source area, COCs are leached from the source area by rainwater and groundwater movement. A model, used for cost estimating in the feasibility study, estimates it will take at least six decades to restore the area to beneficial uses. A cost estimate for the groundwater pump-and-treat system is provided in Table 18.

Table 18
Cost Estimate for Groundwater Pump and Treat

Cost Elements	Non-Discounted Cost ($)	Present Value Cost ($)
Capital cost elements	1,430,000	1,430,000
Total annual operations and maintenance (O&M)*	39,353,000	9,655,000
Total periodic cost	2,684,000	257,000
Total	**43,467,000**	**11,342,000**

* Estimated average annual O&M is $690,400.

2.9.6 Enhanced Anaerobic Biological Treatment Plus Groundwater Pump and Treat

Soil Contamination

- In situ (in place) enhanced anaerobic biological degradation of COCs in the source area to reduce the continuing source of groundwater contamination. The source area comprised of the unsaturated and saturated soils of Media A and B includes approximately 89,000 cubic yards. The treatment involves injecting or applying a substrate, such as beer fermentation byproducts, to the subsurface to serve as an electron donor and a readily consumable carbon source to support growth and metabolism of indigenous microorganisms. Microbial metabolism of the carbon substrate can create and maintain anaerobic conditions, reduce nitrate, deplete competing electron acceptors, and enhance biological reductive dehalogenation of COCs. The potential for biological treatment to reach cleanup action objectives at this Site is uncertain; however, there has been some success at other sites with similar contaminants. Laboratory testing using groundwater and soil from the Frontier Fertilizer Site was inconclusive for pesticide degradation during a five-month test period, although nitrate degraded rapidly. Because of the effectiveness uncertainty, EPA estimates that 10 years will be required for biological treatment, assuming that enhanced biological reductive dehalogenation occurs. After bioremediation is complete, it is estimated that pump and treat will continue for at least four decades because the microorganisms cannot reach all of the soil regions. The soil cleanup levels are based on protection of groundwater for future beneficial uses.

Groundwater Contamination

- Groundwater extraction and treatment continues with groundwater monitoring to determine if additional pumping (extraction) wells or monitoring wells, or modifications to the GAC treatment system are necessary. Biological treatment of the source area will reduce COC concentrations available to migrate to groundwater, resulting in less GAC usage needed to treat the groundwater. Once the GAC adsorbs COCs, it loses capacity and therefore is replaced with fresh GAC. The spent GAC is sent offsite for treatment and ultimately is reused.

- This treatment will continue until monitoring indicates that the MCLs are achieved. MCLs are the cleanup levels for groundwater based on EPA’s analysis of ARARs.

A cost estimate for in situ biological treatment plus groundwater pump and treat is provided in Table 19.

Table 19 Cost Estimate for In Situ Biological Treatment Plus Groundwater Pump and Treat		
Cost Elements	**Non-Discounted Cost ($)**	**Present Value Cost ($)**
Capital cost elements	1,798,000	1,798,000
Total annual O&M*	38,607,000	10,292,000
Total periodic cost	2,716,000	284,000
Total	**43,121,000**	**12,374,000**
* Estimated average annual O&M is $742,450.		

2.9.7 EPA's Selected Alternative

Soil Contamination

- In situ (in place) heating using electrical energy to heat the soil and groundwater down to 60-90 feet bgs (Media A and B) that are a continuing source of groundwater contamination. The total source area soil targeted for cleanup is approximately 89,000 cubic yards (see Figure 1). Since a three-week laboratory test indicated that heating degrades Site COCs at temperatures both below (90 degrees centigrade) and above (110 degrees centigrade) the boiling point of water, both temperature ranges are being considered. The temperature will be determined during the design phase prior to construction. The soil cleanup levels are based on protection of groundwater for future beneficial uses.

- Vapor controls include air monitoring, an impermeable layer of plastic over the source area, and soil vapor collection and treatment (see Figure 5). A soil vapor collection system will collect extracted soil vapor from the subsurface that will require gas phase and liquid treatment, respectively. Vapor and liquid phase GAC or other available technologies may be utilized to treat vapor and condensate emissions generated by heating the source area.

Groundwater Contamination

- Groundwater extraction and treatment along with groundwater monitoring to determine if additional pumping (extraction) wells or monitoring wells, or modifications to the system are necessary. Currently, the COCs in extracted groundwater are treated with GAC; however, other treatment methods could be used if data indicated greater effectiveness or reduced cost. Source treatment will reduce COC concentrations available to enter the groundwater, resulting in less GAC usage. Once the GAC adsorbs COCs, it loses capacity and therefore is replaced with fresh GAC. The spent GAC is sent offsite for treatment and ultimately is reused.

- This treatment will continue until monitoring indicates that the MCLs are achieved. MCLs are the cleanup levels for groundwater based on EPA's analysis of ARARs.

- Possible secondary enhanced anaerobic biological treatment of the source area to treat nitrate and residual pesticides. Nitrate is not treated by in situ heating. The biological degradation occurs naturally onsite but is limited by available electron donors. The treatment of nitrate with enhanced anaerobic biological treatment of the source area will take place based on an evaluation planned for the design phase. This evaluation will include a comparison of nitrate levels in Site groundwater and City monitoring/drinking water wells in addition to discussions with the City of Davis to determine whether any changes are anticipated for the Site's nitrate discharge requirements. Nitrate is currently treated by the City of Davis wastewater treatment plant; however, the City of Davis has indicated that they may lower the nitrate discharge requirements in the future. This will require treatment either in situ or as part of the groundwater treatment plant.

It is predicted to take approximately 1 year for heating treatment to be completed and an additional 5 years with the biological treatment to significantly reduce nitrate concentrations. The pump-and-treat system will be needed during and after the heating is completed to treat the remaining groundwater to drinking water standards. Groundwater COC levels are expected to decline sharply after the heating portion is finished; however, it is expected to take approximately 38 years to reach drinking water standards.

A cost estimate for in situ heating plus groundwater pump and treat (possible secondary biological treatment of nitrate) is provided in Table 20.

Table 20
Cost Estimate for In Situ Heating Plus Groundwater Pump and Treat; Possible Secondary Biological Treatment of Nitrate

Cost Elements	Non-Discounted Cost ($)	Present Value Cost ($)
Capital cost elements	7,520,000	7,520,000
Total annual O&M*	34,245,000	10,552,000
Total periodic cost	2,636,000	341,000
Total	**44,401,000**	**18,413,000**

* Estimated average annual O&M is $778,300.

Frontier Fertilizer Preferred Remedy

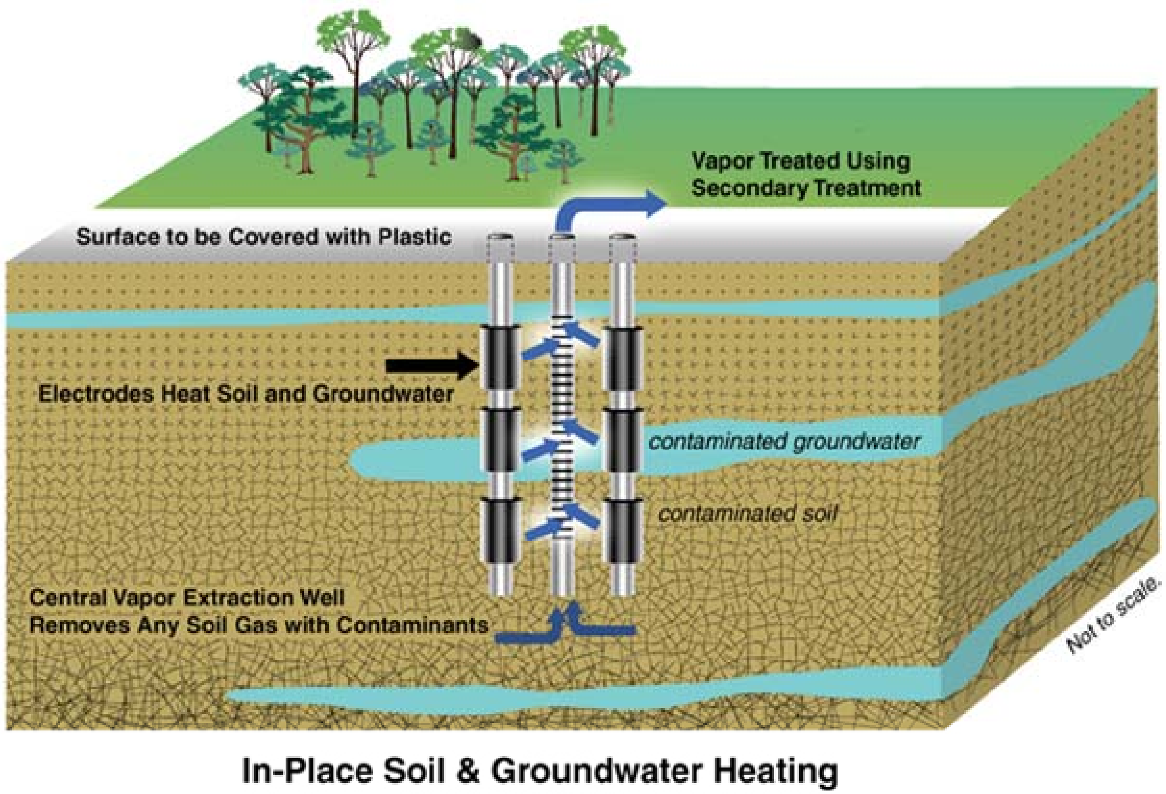

FIGURE 5
Frontier Fertilizer Preferred Remedy
Frontier Fertilizer Superfund Site

2.10 Comparative Analysis of Alternatives

This section summarizes results from the comparative analysis conducted to evaluate the relative advantages and disadvantages of each remedial alternative in relation to the nine evaluation criteria outlined in CERCLA Section 121 (b), as amended. A more detailed discussion of the alternatives evaluated is presented in the Feasibility Study (CH2M HILL, 2006a).

CERCLA evaluation criteria are based on requirements promulgated in the NCP. As stated in the NCP (40 C.F.R. 300.430 (f)), evaluation criteria are arranged in the following hierarchical manner: threshold criteria, primary balancing criteria, and modifying criteria. Threshold criteria must be satisfied in order for an alternative to be eligible for selection. Primary balancing criteria are used to weigh major trade-offs among alternatives. Generally, modifying criteria are taken into account after public comments are received on the Proposed Plan.

Threshold Criteria:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs

Primary Balancing Criteria:

- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume
- Short-term Effectiveness
- Implementability
- Cost

Modifying Criteria:

- State Acceptance
- Community Acceptance

2.10.1 Threshold Criteria

2.10.1.1 Overall Protection of Human Health and the Environment

This evaluation criterion assesses how each remedial alternative provides and maintains adequate protection of human health and the environment. Remedial alternatives are assessed to determine whether they can adequately protect human health and the environment from unacceptable risks posed by the Site COCs, in both the short and long term.

The no action alternative is not evaluated further because it does not provide adequate protection of human health and the environment. The Groundwater Pump-and-Treat Alternative includes groundwater extraction and treatment with GAC or another effective treatment method. Both the In Situ Biological and Heating Alternatives include groundwater extraction and treatment. Since these two alternatives treat the source volume of COCs they are expected to meet the source area cleanup goals sooner than the pump-and-treat only alternative. The primary difference between the In Situ Biological and Heating Alternatives is that the In Situ Heating Alternative includes source area media heating, which is more effective at reducing the COCs than the biological treatment without heat treatment.

Institutional controls will be implemented to prevent exposure to contaminated soil and groundwater until conditions allow for unrestricted use. All three alternatives will be protective of human health by reducing potential for direct (dermal or ingestion) or indirect (vapor intrusion) contact to COCs in soil and groundwater but there are significant differences in the timeframes for groundwater and soil COC reductions.

In situ heating of the source area results in the highest initial mass removal from the source area and COC concentrations in groundwater will decrease faster as a result of the reduction of COCs in the source area. This will result in a smaller amount of mass in the groundwater that needs to be treated than if the source area contaminants are not reduced initially.

All three alternatives include groundwater extraction to control migration of contaminated groundwater and include groundwater monitoring to evaluate process effectiveness. A gravel, pavement, or wood chip cap is included as a “Common Component” of all three alternatives to prevent ecological receptors from contacting contaminated surface soil until development occurs.

Construction and implementation of the in situ biological and heating source treatments present minimal additional risks to human health and the environment. The electrode or casing installation associated with the in situ heating generates contaminated soil cuttings that must be managed in accordance with health and safety and waste management procedures to prevent exposure to VOCs. Vapor controls will include an impermeable layer cap on top of the source area, soil vapor extraction, treatment, and monitoring.

2.10.1.2 Compliance with ARARs

This evaluation criterion is used to determine if each technology will attain federal and state regulatory requirements. Other information, such as advisories, criteria, or guidance, is considered where appropriate during the regulatory requirements analysis.

Only the no-action alternative appears to be incapable of achieving compliance with potential chemical-specific, action-specific, and location-specific ARARs. All other alternatives will achieve compliance with ARARs. The length of time for reaching MCLs, which are ARAR and groundwater cleanup goals, will depend upon the alternative.

2.10.2 Primary Balancing Criteria

2.10.2.1 Long-Term Effectiveness and Permanence

This evaluation criterion addresses the long-term effectiveness and permanence of maintaining the protection of human health and the environment after implementing the remedial alternative. The primary components of this criterion are the magnitude of residual risk remaining at the Site after RAOs have been met and the extent and effectiveness of controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes. Institutional controls will be implemented to prevent exposure to contaminated soil and groundwater until conditions allow for unrestricted use.

Implementation of all three alternatives will reduce the mass of COCs in the saturated and unsaturated soils of Media A and B, and ultimately in groundwater (Media C), although the In Situ Heating Alternative will reduce the mass much more quickly. The biological and heat in situ alternatives will degrade VOCs that would otherwise desorb or diffuse into groundwater or into soil gas. The Groundwater Pump-and-Treat Alternative relies solely on water moving through the source volume to transport COCs to the extraction system, where they are removed. All alternatives rely on groundwater monitoring to determine implementation effectiveness and whether continued monitoring will be necessary after RAOs are achieved.

2.10.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

This evaluation criterion addresses the anticipated performance of the remedial alternative's treatment technologies to permanently and significantly reducing toxicity, mobility, and/or volume of hazardous materials at the Site.

All three alternatives treat COCs at various rates to protect human health. The Groundwater Pump-and-Treat Alternative uses active groundwater extraction and ex-situ treatment to reduce toxicity, mobility, and volume of contaminants. In addition to these groundwater pump-and-treat processes, the In Situ Heating will effectively remove the bulk of COCs in Media A and B, while In Situ Biological Treatment is inconclusive at treating the halogenated COCs. Remaining COCs in groundwater (Media C) will be treated with ex situ treatment, such as GAC. Natural processes also will reduce the concentration of COCs existing outside the zone of influence of the in situ treatment processes and ex situ extraction system. All three remedial alternatives meet the statutory preference for treating contaminants, as opposed to relocating contaminants, as a principle element to address primary threats posed by the Site.

2.10.2.3 Short-Term Effectiveness

This evaluation criterion considers the effect of each remedial alternative on the protection of human health and the environment during the construction and implementation process. The short-term effectiveness evaluation only addresses protection of human health prior to meeting the RAO.

Minimal construction is required to implement the Groundwater Pump-and-Treat Alternative since the groundwater treatment system is currently in operation. Construction of either of the in situ alternatives presents minimal threat and risks to the community and construction personnel because contaminated media is treated in situ. Any construction on the undeveloped property negatively impacts native animal and plant species habitat. This would also occur with the industrial development that has been proposed.

The Groundwater Pump-and-Treat Alternative processes present minimal threat and risks to the community and operations and maintenance personnel, although the potential for exposure is increased due to the long time period anticipated to meet RAOs. Implementation of either of the in situ alternatives presents minimal threat and risks to the community and operations and maintenance personnel by treating contaminated media in situ. Ambient air monitoring and a soil vapor collection and treatment system will be used to identify and mitigate any VOC emission hazards. During implementation of any of the three remedial alternatives, groundwater leaving the contaminated source area is monitored, collected, and treated by the groundwater pump-and-treat system.

The length of time needed to treat the contaminants with any of the remedial alternatives will be determined by the rate that the mass and mobility of COCs in Media A and B are reduced. For the purpose of evaluating the Groundwater Pump-and-Treat Alternative, an implementation period of 57 years is assumed for the purpose of estimating costs in the Feasibility Study. For the In Situ Biological Alternative, approximately 52 years is used to estimate the treatment period. This timeframe includes 10 years of active bioremediation and an additional 42 years of groundwater pump and treat. It is assumed that bioremediation will remove approximately 50 percent of the COC mass in Media A and B. It was assumed that the biological treatment would reach only half of the COCs since the Site geology is heterogeneous. The remaining mass will be treated by the groundwater extraction and treatment system once the mass diffuses into groundwater.

Institutional controls will be implemented to prevent exposure to contaminated soil and groundwater until conditions allow for unrestricted use.

For the purpose of evaluating the In Situ Heating Alternative, it is assumed that the implementation period to heat and degrade VOCs will be approximately 1 year and the secondary treatment of nitrate, if it proceeds, will be approximately 5 years. Five years will be needed to significantly decrease the nitrate concentrations in the unsaturated and saturated source zones. The heating treatment is estimated to remove 80 percent of the COC mass in Media A and B. Groundwater pump and treat will need to be continued for approximately 38 additional years, for a total timeframe of 44 years.

Noise related to operating the in situ heating process equipment and the capture and treatment of VOC emissions may present a minor nuisance during the treatment timeframe. Working hours can be modified to mitigate this nuisance.

2.10.2.4 Implementability

This criterion evaluates the technical feasibility and administrative feasibility of implementing each remedial alternative and the availability of required services and materials.

All three alternatives appear to be technically feasible, although ultimately their efficacy will be determined by groundwater monitoring during the implementation and post-implementation periods. In situ heating is expected to reduce the groundwater concentrations most significantly. In situ biological treatment will have some impact on the source area concentrations. Groundwater pump-and-treat processes that are currently operating onsite appear to be effective in most areas, and, if needed, additional extraction wells could be added to remove and treat groundwater containing COCs. In situ heating is more challenging to construct than the other alternatives; however, there is a proven track record for implementation at many different sites. Construction of the biological treatment process, which is included in both the in situ alternatives, is relatively easy; however, the effectiveness is less assured. Construction of the in situ heating includes installation of borings to between 60-90 feet bgs to accommodate electrodes, and includes power supply equipment, soil vapor treatment equipment, and soil vapor extraction wells. It is also assumed that existing utility lines and transformers that service the Site will be capable of supplying power for either in situ alternative. An engineering analysis will be performed to assess the validity of these assumptions and the possible effects of biological and heating process construction on groundwater extraction and treatment.

Institutional controls will be implemented to prevent exposure to contaminated soil and groundwater for each of the alternatives. These controls are implementable pursuant to regulations. DTSC and EPA will negotiate the controls with the landowners.

Availability of vendors should not limit implementation of any of the remedial alternatives, although the experience of the operations and maintenance personnel will affect implementation effectiveness. The anaerobic process and necessary components are not proprietary. A benefit of the in situ processes is that they do not require excavation and ex-situ treatment or disposal. Therefore, availability of hazardous waste treatment and disposal capacity will not limit implementation of either in situ alternative with the exception of soil cuttings. A large quantity of spent GAC and used treatment plant and well components will be generated given the long implementation duration of the groundwater pump-and-treat system for all alternatives. The quantity of spent GAC generated is significantly reduced with implementation of the in situ heating because of the lower operating timeframe of the groundwater pump and treat. The spent GAC is currently transported to an offsite treatment facility for regeneration and reuse. EPA will continue to evaluate alternatives to GAC treatment.

2.10.2.5 Cost Estimates

This criterion evaluates the cost of implementing each remedial alternative. The cost of a remedial alternative encompasses all engineering, construction, operations and maintenance, and monitoring costs incurred over the life of the project.

Cost estimates are provided in both non-discounted and present value format (see Tables 18, 19, and 20). A 7 percent discount rate was used to calculate present value cost estimates. A 57-year time period was used for the Groundwater Alternative, a 52-year period was used for the In Situ Biological Treatment Alternative, and a 44-year period was used for the In Situ Heating Alternative. The analyses periods are based on predicted implementation periods for each respective remedial alternative.

2.10.3 Modifying Criteria

2.10.3.1 State Acceptance

This criterion reflects whether the State of California's environmental agencies agree with, oppose, or have no objection to or comment on the preferred alternative.

DTSC has reviewed the remedial investigation reports, feasibility study, and the proposed plan and concurs with in situ heating as the selected remedy for soil and groundwater remediation at the Frontier Fertilizer Site (see Appendix A).

2.10.3.2 Community Acceptance

This criterion evaluates whether community concerns are addressed by the remedy and if the community has a preference for a remedy.

The Proposed Plan has been presented to the community and discussed at a public meeting. The responsiveness summary portion of this ROD addresses the public's comments and concerns about the selected remedy. In general, the community is supportive of the in situ heating of the source area.

2.11 Principal Threat Waste

Source area soil is the principal threat waste that will be treated in situ by the selected remedy. The determination of a principal threat waste is based on the high soil concentrations of DBCP and EDB that qualify as mobile source materials under the definition of principal threats (A Guide to Principal Threat and Low Level Threat Wastes, EPA OSWER 9380,3-06FS).

2.12 Selected Remedy

The remedy that EPA has selected for Frontier Fertilizer consists of in situ heating of source soil and groundwater; operation of a groundwater pump-and-treat system; institutional controls; groundwater monitoring; access restrictions; and gravel, pavement, or wood chip cap. The decision to add treatment of nitrate using enhanced anaerobic biological treatment of the source area will be based on an evaluation planned for the design phase. This evaluation will include a comparison of nitrate levels in Site groundwater and City monitoring/drinking water wells in addition to discussions with the City of Davis to determine whether any changes are anticipated for the Site's nitrate discharge requirements.

The remedy selection is based on the RI and FS Reports, the administrative record for this Site, and an evaluation of comments submitted by interested parties during the public comment period.

This section presents the conceptual design for treatment of source soil by in situ heating, groundwater pump and treat, and possible secondary enhanced anaerobic biodegradation of nitrate. Design details will be evaluated and established during the remedial design phase of this project. These specifics include exact number and placement of electrodes and monitoring wells, selection of conduction or electrical resistive heating, operating temperature levels of heating and required vapor and/or condensate treatment, sampling frequency and number of air monitors, extraction well pumping rates, performance monitoring, and other related design components, including possible modification of groundwater extraction points and pumping rate. Also, during the design phase, a reevaluation of nitrate conditions will be completed to determine if the biological treatment will proceed. This will include a comparison of nitrate levels in Site groundwater and City monitoring/drinking water wells in addition to discussions with the City of Davis to determine whether any changes are anticipated for the Site's nitrate discharge requirements.

2.12.1 Summary of Rationale for Selected Remedy

The selected remedy provides the best balance with respect to the NCP evaluation criteria. Based on the information available at this time, EPA selected this alternative because it will reduce risk by treating the source area more effectively and quickly. Treating the source area soil and groundwater will reduce the time for groundwater pump and treat by eliminating the continuing source of contaminants to groundwater. The selected remedy is protective of human health and the environment, complies with state and federal regulations, is cost-effective, and satisfies the preference to permanently treat the contaminants in soil and groundwater.

2.12.2 Description of Selected Remedy

2.12.2.1 In Situ Heating of Source Area Soil and Groundwater

The selected remedy will use in situ heating to treat source area soil and groundwater down to 60-90 feet bgs (Media A and B). Removing the pesticides in the soil source area will eliminate the continuing source of groundwater contamination. The total source area soil targeted for cleanup is approximately 89,000 cubic yards (see Figure 1). The source volume estimate is based on soil samples collected as part of the remedial investigations. Some uncertainty exists in the source volume estimate due to the distribution and number of samples obtained. As the majority of soil samples were collected from between 0 to 30 feet bgs, the volume estimate for the deeper media has a higher degree of uncertainty.

Implementation of the in situ thermal process will require heat energy to be applied to the saturated and unsaturated contaminated soils (Media A and B) in order to heat and maintain the desired elevated temperature. Electrical power will heat the media using commercially available heating methods and equipment. Heating regimes incorporating electrical resistance or direct thermal conduction are proven technologies to heat the subsurface and remediate recalcitrant VOCs, such as those found at the Site, in various soil types.

Electrical resistive heating passes electrical current through the subsurface while the resistance presented by the soil raises the temperature. Conduction heating uses heated well casings to conduct heat through the subsurface. To implement either technology process option, electrodes are installed into the unsaturated and saturated source zones. Heating vertical limits are set by the depth to which electrodes can be installed, groundwater flow rate, and the size of the power control unit. These technology process options use electrodes installed into the ground along with vapor controls.

Laboratory treatability testing and published data indicate that heating Site pesticides transforms them to non-hazardous chemicals at temperatures below and above the boiling point of water. The duration of the implementation period and the additional risks and cost associated with higher temperatures will be evaluated to determine the optimum condition. Achieving and maintaining higher temperatures in the treatment zone requires higher energy input, resulting in higher costs, given that cooler groundwater is continuously moving through the saturated zones in Media B. The higher temperatures volatilize more contaminants in a shorter time period, but also require additional vapor controls to prevent any increased risks to the workers and nearby community.

EPA will establish performance standards for the in situ thermal treatment during remedial design. In order to evaluate the performance of the in situ thermal treatment technology, a sampling program will be established as part of the implementation of this technology.

Vapor controls include an impermeable layer of plastic over the source area, soil vapor collection and treatment, and air monitoring. The soil vapor collection system will be designed to manage the contaminants removed from the subsurface and meet federal and state air emission regulations. The complexity of the vapor control system is temperature dependent. The soil vapor collection system may include wells co-located with the heating elements to capture vapors from the heating process. The vapor treatment system will be specified during final system design but is likely to include separate vapor and condensate treatment systems. Residues from the vapor treatment system will be collected and stored on site until it is transported for treatment and disposal. Management and disposal of any waste will be handled and disposed of in accordance with state and federal hazardous waste management regulations.

An air monitoring plan will be developed in the remedial design process. A combination of modeling and real time data from ambient air monitoring stations will be utilized to prevent exposure to off-site residences. Modeling will be used to estimate vapor emissions from the heating process to determine the size of the vapor collection system. The monitoring program will include redundant safe-guards, for example, pressure, temperature and flow sensors to monitor process streams; remote monitoring capability; and alarm system and auto shutdown to notify responsible personnel.

The final design of the in situ heating system may require additional bench tests and/or pilot studies to identify the appropriate temperature range and other system specifics. The design phase is expected to take approximately 1 year, and design reports, as with all other project reports, will be prepared and circulated to the FFSOG and State agencies for review and comment. Once the heating and vapor collection system is installed, it is anticipated to be less than a year before a significant reduction in contaminant mass is achieved.

2.12.2.2 Groundwater Pump and Treat

The remedy includes continued operation of a groundwater pump-and-treat system. The current system includes collection of groundwater downgradient of the source zone with extraction wells and treatment with GAC treatment. Other treatment methods could be used if the data indicated that a more effective treatment could be obtained for an equivalent or lesser cost. Spent GAC is sent offsite for regeneration. Groundwater treatment with GAC is the presumptive ex-situ treatment for groundwater contaminated with VOCs, such as those that are found at this Site (EPA, 1996b).

The selected remedy includes any modifications or enhancements to the extraction and/or treatment system that would increase its effectiveness and/or decrease costs or time of operation. The system will be evaluated and modified, if necessary, to assure capture and containment of COCs so that the health of workers and residents is protected. Decisions to expand the groundwater extraction and treatment system will be based on groundwater monitoring data and, if possible, groundwater models. These future modifications/enhancements include as appropriate (but are not limited to) the following:

- Discontinuation of pumping at individual wells where cleanup goals have been attained and maintained
- Installation of additional extraction wells to facilitate or accelerate cleanup of the contaminant plume
- Replacement of the GAC system in part or in whole if a more effective or efficient method of treatment is confirmed
- Modifications to the groundwater monitoring program
- Additional monitoring wells as needed to define the nature and extent of groundwater contamination.

During the design phase, a monitoring plan will be developed to estimate the effectiveness of the heat treatment and of the groundwater extraction system. The monitoring plan may indicate that additional wells will be needed. If the heat treatment does not achieve an expected outcome within the five-year review period, then an alternate treatment process will be developed.

Currently, treated groundwater is discharged to the City of Davis sewer treatment plant (Permit 15-04). Alternate discharge options may be required if treated groundwater volume or chemical characteristics, such as nitrate concentrations, exceed the City of Davis sanitary sewer collection or treatment system capacity.

The pump-and-treat system will be needed for a significant time period after the heating is completed to treat the remaining groundwater to drinking water standards. Groundwater COC levels are expected to reduce sharply after the heating portion is finished.

2.12.2.3 Performance Monitoring

Performance monitoring will be used to optimize operations and maintenance of the groundwater pump-and-treat system, track mass removal from the in situ heating and groundwater extraction and treatment, verify containment of the COCs in groundwater zones, and demonstrate successful operation of the treatment plant. Remedy performance monitoring data will be documented in periodic groundwater monitoring reports.

After shutdown of the heating system, the results of the remedial action will be reported in an effectiveness monitoring report that will include temperature-reporting data, mass removal rates, operating conditions and analytical data from confirmatory samples. Reduction in COC concentrations will be confirmed with chemical analysis of confirmatory samples.

Monitoring will include water-level measurements as well as the collection and analysis of samples from wells located within and outside the plume areas. Currently 91 wells are monitored at least annually; 57 are monitored every 3 months. Treatment system influent and treated effluent will continue to be sampled as part of EPA's waste discharge permit with the City of Davis. A summary of the anticipated performance monitoring for the selected alternative is presented in Table 21.

Table 21
Performance Monitoring

Type of Monitoring Data	Monitoring Location	Purpose/Use of Data
Water levels	Monitoring wells throughout and around the COC plumes	• Prepare potentiometric surface maps and hydrographs. • Determine horizontal and vertical hydraulic gradients. • Confirm capture zones (containment of plumes).
COC concentrations in the S1, S2, A1 aquifer zones	Monitoring wells throughout and around the COC plumes	• Delineate areal and vertical extent of contamination. • Confirm reduction in COC concentrations.
COC concentrations in extracted groundwater	Extraction wells and treatment system influent	• Estimate cumulative mass of COCs removed from aquifer zones.
General water quality parameters as well as COC and nitrate concentrations in treatment plant effluent	Treatment plant discharge sampling points	• Assess performance of treatment system. • Demonstrate compliance with discharge requirements.
Flow rates	Extraction wells and treatment plant	• Confirm that extraction and treatment systems are operating to specifications.
Other operational parameters	Treatment plant and individual extraction well production	• Use as needed to assess proper operation or failure of pumps and filters.

Groundwater monitoring is anticipated to be performed using 90 existing wells and any additional wells added during design and remedial action. The actual number of monitoring wells to be sampled and the locations and specifications (depths, screened intervals, and well construction materials) for new monitoring wells will be determined during remedial design and documented in the Operation and Monitoring Plan (OMP). This plan will also provide details on sampling procedures, target analytes, analytical methods, field and laboratory quality assurance/quality control, and reporting requirements. Groundwater monitoring will continue until the shutdown criteria presented in Section 2.8, Remedial Action Objectives, are met.

2.12.2.4 Secondary Enhanced Anaerobic Biological Treatment of Nitrate

In situ heating does not treat nitrate; therefore, in situ anaerobic degradation may be included as a secondary process based on further analysis completed during the design phase. The decision to add treatment of nitrate using enhanced anaerobic biological treatment will be based on an evaluation planned for the design phase. This evaluation will include a comparison of nitrate levels in Site groundwater and City monitoring/drinking water wells in addition to discussions with the City of Davis to determine whether any changes are anticipated for the Site's nitrate discharge requirements. Nitrate is currently treated by the City of Davis wastewater treatment plant. The City of Davis has indicated that nitrate discharge requirements may become more stringent in the future, and there may be a discharge limit level established that will require treatment in situ or an additional treatment process at the treatment plant. It is estimated that biological treatment of nitrate will take approximately 5 years. The biological treatment will most likely take place after the thermal treatment has finished.

2.12.2.5 Institutional Controls

Institutional controls are non-engineering mechanisms to implement land-use restrictions that will be used to prevent exposure of future landowner(s) and/or user(s) of the property to hazardous substances and to maintain the integrity of the remedial action until remediation is complete and remediation goals have been achieved. Land-use restrictions are necessary to assure the protectiveness of, and prevent damage to or interference with, the remedial action. Monitoring and inspections will be conducted to assure that the land-use restrictions are being followed. To implement these objectives, EPA anticipates that restrictive covenants will be executed and recorded on all of the properties affected by the Frontier Fertilizer Site COCs and respective remediation. The restrictive covenants shall run with the land and be enforceable under California law against all future property owners and tenants. Land Use Covenants will be formalized pursuant to California Code of Regulations 67391.1 after the in situ heating is completed. The Land Use Covenant will include the following, at a minimum:

- Placement of warning signs or other posted information shall be allowed and, and once posted, no removal or interference with such signs or information shall be permitted.
- Placement of Site access controls, such as gates or fencing, shall be allowed and shall not be damaged or circumvented.
- The Site shall not be used in any manner that may interfere with the components of the remedy, as constructed pursuant to this ROD.

- EPA and DTSC must approve any construction planned in any areas that may impact the remedy components.
- No interference with or alterations to the grading, vegetation, surface water, and drainage controls shall be made without the prior written approval of EPA and DTSC.
- Remedy components shall not be disturbed, removed, or modified without the prior written approval of EPA and DTSC.
- Descriptions of contaminated groundwater and respective restrictions incorporated into the property deeds to minimize risk until groundwater reaches cleanup levels (that is, MCLs). Groundwater restrictions may include prohibiting any groundwater extraction.
- Specific building requirements may be included for the source area if groundwater and/or soil levels remain above concentrations that pose a risk via the vapor intrusion pathway. Concentrations of COCs in groundwater are expected to significantly decrease after the heating treatment of the source area is completed.
- Descriptions of any remaining soil above cleanup objectives are incorporated into the property deeds to minimize risk.
- Restrictions prohibiting residential use, daycare, hospitals, or schools for students under the age of 21.
- Prohibit the alteration, disturbance, or removal of groundwater extraction and monitoring wells and associated piping and equipment (for example, treatment system) without prior review and written approval from EPA and DTSC.
- Groundwater supply or monitoring wells shall not be constructed without the prior written approval of EPA and DTSC, and there shall be no extraction of or injection into groundwater on the Site.
- Owners of property affected by Site COCs and respective remedies shall disclose all institutional controls to all tenants on the property.
- All interferences or penetrations (including, but not limited to, utility trench excavations, excavations for fence posts, excavations for planting trees or large bushes, foundation excavations, and foundation piles) will be prohibited without prior approval from EPA and DTSC.
- No new construction shall occur on property affected by Site COCs without the prior written approval of EPA and DTSC.

    a) new construction shall be supported by subsurface explorations and analytical laboratory data to characterize the construction area for the possible existence of waste materials

b) if contaminants are discovered in the construction area, the contamination shall be remediated or buildings and structures must be appropriately designed to protect occupants.

c) Appropriate worker and public health and safety precautions, including but not limited to dust control, safety plans, and other forms of worker protection, must be taken prior to approval of construction.

- Pesticides or herbicides shall not be applied to the Site without the prior written approval of EPA and DTSC.

2.12.2.6 Cap to Protect Ecological Receptors

To protect ecological receptors from the contamination in the surface soil, the selected remedy includes a cap of wood chips, pavement, or gravel for the area not included in the heating remedy. Pavement could also be used to prevent exposure to surface soils. The cap will provide a barrier to the soil until the proposed development occurs. If the proposed development does not occur, the surface soil can be resampled to assess the current risk.

2.12.2.7 Five-Year Reviews

EPA will complete a statutory review at least every 5 years, following construction completion, to ensure that the remedy is both effective and protective of human health and the environment. The 5-year report will document the following: (1) whether the remedy is expected to remain protective, (2) the reductions in contaminants attributable to the remedy, (3) changes to the treatment system that could make it more effective or efficient, and (4) recommended specific actions to correct any deficiencies. If necessary, the 5-year report will include descriptions of follow-on actions needed to achieve, or to continue to ensure, protectiveness along with a timetable for these actions.

2.12.2.8 Operations and Monitoring Plan

An OMP that will be developed during the remedial design phase will establish the exact number and location of additional monitoring wells for the long-term groundwater pump-and-treat system. The plan will also outline sampling and analysis methods, sampling frequency for each well, and major decisions to be made during monitoring (for example, adding or removing wells, or changing sampling frequency or analytical parameters). The criteria for assessing the effectiveness of the remedial actions, for identifying when to shut off the in situ heating, for fine-tuning the long-term groundwater pump-and-treat system, and for determining the specifics of enhanced biological treatment will be developed during the remedial design phase and will be incorporated into the OMP.

RAOs for groundwater include reducing levels of chemicals in groundwater (and the source area soils) so that the groundwater could ultimately be used for domestic purposes. As part of the selected remedy, EPA will operate the groundwater pump-and-treat system to meet these RAOs. EPA will evaluate groundwater monitoring and system performance data to (1) optimize the performance of the hot spot wells in reducing COC contaminant mass in the central portion of the plumes and to determine when they may be shut down, and (2) optimize and verify the performance of the extraction wells in containing COCs within their present boundaries and determine when they may be shut down.

The selected remedy may change from that discussed in this ROD due to new information, design considerations, or construction technologies. Any changes are not anticipated to be substantially different than those discussed above, and any changes to the selected remedy will be documented in the Administrative Record in accordance with the requirements of the NCP.

2.12.3 Detailed Cost for the Selected Remedy

Detailed Cost for the Selected Remedy is included in Appendix B.

2.12.4 Expected Outcome from Selected Remedy

The selected remedy is expected to reduce the risk to human health from exposure to contaminated soil and groundwater. The in situ heating is expected to significantly reduce the pesticide COC concentrations in the source area, which will eliminate or at least substantially reduce the current continuing source of contaminants to the air and groundwater.

Another expected outcome of the selected remedy is that groundwater will not present a future unacceptable health hazard to human health through direct exposure (ingestion or inhalation) and the aquifer zones will be restored for future beneficial uses. Groundwater is expected to be restored to federal drinking water standards in approximately 44 years.

Institutional controls, such as a restrictive land use covenant, will prevent unacceptable health hazards to humans who work at the Site before remediation is complete. Institutional controls can prevent direct exposure (ingestion, dermal contact) to contaminated materials in the subsurface. For example, specific building requirements, such as ventilation systems, may also be included in the restrictive covenant.

The surface cap will eliminate the unacceptable risk to ecological receptors due to contact with contaminated surface soil.

2.13 Statutory Determinations

Under CERCLA 121 and the NCP 300.430 (f)(5)(ii), EPA must select remedies that are protective of human health and the environment, comply with ARARs, are cost-effective, and utilize permanent solutions and alternative treatment technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that, as their principal element, permanently and significantly reduce the volume, toxicity, or mobility of hazardous waste. The following sections discuss how the selected remedy meets these statutory requirements and preferences. Complete discussions can be found in the FS Report (CH2M HILL, 2006a).

There are no short-term threats associated with the selected remedy that cannot be readily controlled. In addition, no adverse cross-media impacts are expected from the remedy.

2.13.1 Protection of Human Health and the Environment

The selected remedy will be protective of human health by reducing potential for direct and indirect (vapor intrusion) contact to COCs in soil and groundwater. Reduction of the COC concentrations in groundwater to MCLs by source removal and groundwater pump and treat will return the groundwater to beneficial use. Although groundwater is not currently used for potable purposes, contaminated groundwater is a potential future threat to human health if it is used for domestic purposes. Institutional controls will be implemented to prevent exposure to contaminated soil and groundwater, although the in situ heating of the source area may permit reduced restrictions.

2.13.2 Compliance with ARARs

The selected remedy will comply with the substantial provisions of all ARARs. Section 121 (e) of CERCLA, U.S.C. 9621 (e), states that no federal, state, or local permit is required for remedial actions conducted entirely onsite. Therefore, actions conducted entirely onsite must meet only the substantive, not the administrative, requirements of the ARARs. Any action conducted offsite is subject to the full requirements of federal, state, and local regulations. The chemical-, location-, and action-specific ARARs for the selected remedy are listed in Appendix D and discussed below.

2.13.2.1 Chemical-Specific ARARs

Chemical-specific ARARs are health- or risk-based concentration limits, numerical values, or methodologies for various environmental media (for example, groundwater, surface water, air, and soil) that are established for a specific chemical that may be present in a specific media at the Site, or that may be discharged to the Site during remedial activities. These ARARs set limits on concentrations of specific hazardous substances, pollutants, and contaminants in the environment. Examples of this type of ARAR include state and federal drinking water standards. The selected remedial action can be implemented to comply with chemical-specific ARARs.

Chemical-specific ARARs have been identified for groundwater and soil. Groundwater is a medium of concern. Although shallow groundwater is not a potential source of drinking water, it contributes to the underlying aquifer, which is designated for beneficial use. In order to comply with the chemical-specific ARARs, the selected remedy is designed to be protective of beneficial uses and was evaluated for cleanup to MCLs and background. Where background or non-zero maximum contaminant limit goals (MCLGs) are not achievable, EPA has selected the more stringent of the state and federal MCLs as the potential ARAR. MCLs are relevant and appropriate to groundwater cleanups because the groundwater at the Site is a potential source of drinking water, and CERCLA expects to return usable waters to their beneficial uses whenever practicable, 40 CFR §§ 300.430(a)(i1)(iii)(F) and 300.430(e)(2)(i). At a minimum, water dedicated for use as domestic or municipal supply shall not contain concentrations of chemical constituents in excess of MCLs as stated in the Fourth Edition of the Water Quality Control Plan for the San Joaquin River and Sacramento River Basins, September 15, 1998 (Basin Plan). The primary COCs detected at the Site do not occur naturally and are not ubiquitous. Therefore, to achieve background levels, the concentrations of these chemicals will need to be below analytical detection limits.

As discussed in Section 2.12.2.3, the Resource Conservation and Recovery Act (RCRA) groundwater protection standards are identified as relevant and appropriate standards. Section 66264.94 (c) of Title 22 of these requirements specifies that, for corrective actions, concentrations limits greater than background levels can be established only by demonstrating the following conditions:

- It is technologically or economically infeasible to achieve the background value for that constituent
- The constituent will not pose a substantial present or potential hazard to human health or the environment as long as the concentration limit greater than background level is not exceeded

Critical issues for evaluating the technological feasibility of attaining background levels in groundwater in the aquifer are as follows:

- The background level or chemical concentration that must be achieved
- The area that must be restored, by medium (for example, soil or groundwater)
- The volume of material that must be treated or removed
- The availability of demonstrated technologies that can actually achieve background levels

Based on the estimated times for cleanup to MCLs, the timeframes for cleanup to background would be significant and technologically infeasible at this time given Site conditions, COCs, and current technology.

Cleanup levels for contaminated soil at the Site were established based on vadose zone modeling completed as part of the RI. These cleanup levels will result in achieving cleanup of groundwater to at least drinking water standards, or MCLs.

Safe Drinking Water Act. The Safe Drinking Water Act (SDWA) establishes national primary drinking water standards, MCLs, to protect the quality of water in public water systems. MCLs are enforceable standards and represent the maximum concentrations of contaminants permissible in water delivered to the public. MCLs are generally relevant and appropriate when determining acceptable exposure limits for waters that are current or potential sources of drinking water (40 CFR 300.430(e)(2)(i)(B)). Additionally, the SDWA sets MCLGs, which are non-enforceable health-based goals that are established at levels at which no known or anticipated adverse effects on human health occur. The NCP provides that MCLGs that are set at levels above zero are also generally relevant and appropriate for remedial actions for ground or surface waters that are current or potential sources of drinking water. However, where the MCLG for a contaminant has been set at zero, the MCL is generally the level to be attained by a remedial action addressing ground or surface water that is an actual or potential source of drinking water. The five primary COCs at the Site have MCLGs set at zero, and thus, the MCLs are relevant and appropriate.

California drinking water standards, under the SDWA, establish primary MCLs for contaminants that cannot be exceeded in public water systems. The California drinking water MCLs are, in some cases, more stringent than the federal MCLs and, in other cases, less stringent than the federal standards. The more stringent of the state and federal MCLs was chosen as the potential ARAR.

Pursuant to the Basin Plan discussed below, municipal or domestic drinking water supply is a designated beneficial use of the groundwater subject to remedial action at the Site. Therefore, the state and federal MCLs are relevant and appropriate water quality objectives for groundwater at this Site.

State Water Resources Control Board (SWRCB) Resolution 68-16 (Antidegradation Policy). This resolution requires the continued maintenance of high-quality water of the State. Water quality may not be allowed to be degraded below what is necessary to protect the “beneficial uses” of the water source. Beneficial uses of waters on and in the vicinity of the Site are identified in the Basin Plan.

Resolution 68-16 includes reference to activities that discharge to groundwater, such as groundwater treatment and reinjection. Activities that discharge to high quality waters (unaffected surface or groundwater) require the use of “best practicable treatment or control” of the discharge to avoid pollution or nuisance and maintain high quality. Best practicable treatment would take into account technical and economic feasibility. Resolution 68-16 applies to the addition of carbon substrate for enhanced biological degradation, and if groundwater treatment and reinjection is considered as an alternate groundwater disposal option. These actions must take into account the protection of beneficial uses and the maintenance of high-quality waters in the area.

RWQCB’s Basin Plan. The State of California established water quality objectives for the protection of groundwater and surface water under the Porter-Cologne Water Quality Control Act. These water quality objectives are established by the RWQCB for each basin and are based on the beneficial use(s) of the waters. The Basin Plan, dated September 1, 1998, establishes beneficial uses for groundwater and surface water, and water quality objectives designed to protect those beneficial uses. The Basin Plan includes implementation plans and other control measures designed to ensure compliance with regional and statewide plans and policies, and provides comprehensive water quality planning.

Three elements of the Basin Plan have been identified as potential ARARs by the RWQCB:

- Policy for Investigation and Cleanup of Contaminated Sites
- Policy for Application of Water Quality Objectives
- Wastewater Re-use Policy

The Basin Plan establishes narrative and numeric minimum standards for chemical constituents in groundwater in Chapter III-3.00. The Basin Plan states in part:

> "At a minimum, groundwater designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the MCLs."

SWRCB Resolution 92-49. SWRCB Resolution 92-49, "Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Section 13304," Section III.G addresses the establishment of groundwater cleanup levels and states, in part, that dischargers are required to clean up and abate the effects of discharges in a manner that promotes attainment of background water quality or the best water quality that is reasonable if background levels cannot be restored. In approving any alternative cleanup level less stringent than background, Resolution 92-49 requires the Regional Board to apply Title 27 CCR Section 20400, and the cleanup level shall:

- Be consistent with maximum benefit to the people of the State
- Not unreasonably affect present and anticipated beneficial use of such water
- Not result in water quality less than that prescribed in the Water Quality Control Plans and Policies adopted by the SWRCB and RWQCBs

Title 23 California Code of Regulations Section 2907. This Water Board provision is the regulatory restatement of Resolution 92-49. It was promulgated in accordance with a State law requirement that any quasi-legislative pronouncement such as a Water Board Resolution be reduced to a "clear and concise summary of any regulatory provisions." This regulation represents the Water Board's own interpretation of Resolution 92-49, and as such, it is a valuable tool for understanding the Resolution. Pursuant to this regulation, the RWQCB must require the lowest achievable clean-up levels if restoration of background is not feasible. Moreover, the Regional Board must ensure that dischargers have the opportunity to select cost-effective methods for cleaning up contamination.

RCRA Hazardous Waste Determinations. The RCRA requirements for identification and listing of hazardous waste can be found in CCR Title 22, Division 4.5, Chapter 11. A waste is a RCRA hazardous waste if it is determined to be so under 22 CCR 66262.11, if it exhibits any of the characteristics of ignitability, corrosivity, reactivity, or toxicity identified in Title 22 66261.21, 66261.22(a)(1), 66261.22(a)(2), 66261.23, and 66261.24(a)(1), or if it is listed as a hazardous waste in Article 4 of Chapter 11.

Under the California RCRA program, that is, Chapter 6.5 of the California Health and Safety Code and CCR Title 22, wastes can be classified as non-RCRA, State-only, hazardous wastes if they do not meet RCRA waste criteria, but exceed the Soluble Threshold Limit Concentration (STLC) or the Total Threshold Limit Concentration (TTLC) values listed in 22 CCR 66261.24(a)(2). Additionally, wastes may be considered a State-only hazardous waste if they meet the criteria contained in 22 CCR 66261.101. The toxicity characteristic leaching procedure (TCLP), STLC, and TTLC limits are used to characterize waste during remediation activities and do not represent cleanup levels for soil or groundwater.

Any wastes that are generated during construction activities, groundwater and soil monitoring, or through operation of a treatment device, will require waste characterization to determine the appropriate classification of the waste. Some wastes generated at the Site (for example, extracted groundwater, soil cuttings) may be classified as toxicity characteristic waste as defined by contaminant concentrations that exceed the TCLP limits. If these wastes are characterized as hazardous, the management, treatment, and storage of these wastes must comply with RCRA hazardous waste regulations. Following characterization, federal or state hazardous wastes will be disposed of in accordance with California hazardous waste management requirements in 22 CCR 66262.10 through 66262.43.

2.13.2.2 Location-Specific ARARs

Location-specific ARARs are concerned with the area in which the Site is located. There are no location-specific ARARs that are anticipated to have a significant impact on the selected remedy. Previous surveys, ecological risk assessments, and water resource assessments did not reveal any historical, cultural, or archaeological resources, or wetlands that could be impacted by the remedial alternatives evaluated for the Site. Wildlife habitat will be affected by the proposed alternatives as is expected by the proposed future development of the Site. The Site is designated as Light Industrial/Business Park in the “Mace Ranch Plan Development, #4-88.”

2.13.2.3 Action-Specific ARARs

The federal and state action-specific ARARs generally set performance, design, or other similar action-specific controls or restrictions on certain activities related to the management of hazardous substances or the discharge of water and airborne pollutants. Action-specific ARARs of particular significance to the selected remedy are discussed in more detail below.

Hazardous Waste Management ARARs under RCRA

EPA has authorized California to implement its own hazardous waste and corrective action programs in lieu of implementing RCRA; therefore, the relevant provisions of the state statutes and regulations (California Hazardous Waste Control Act and Title 22, CCR, Sections 66264 et seq. and 66265 et seq.) are treated as the federal requirements in lieu of the federal statutes and regulations (RCRA, Subtitle C, and 40 CFR 264 and 265). California requirements that exceed the scope of federal requirements for these programs are treated as state requirements.

RCRA requirements are generally applicable under two scenarios: (1) sites where hazardous wastes were treated, stored, or disposed of after the effective date of RCRA; and (2) a CERCLA activity involving treatment, storage, or disposal of hazardous waste. These two scenarios are contingent upon the determination that a RCRA hazardous waste is present and on the identification of the period of waste management (EPA, 1988). For the purposes of this ARARs analysis, only the RCRA requirements that apply to wastes generated, stored, or disposed of during the CERCLA activity are considered applicable. Other RCRA requirements will be considered relevant and appropriate.

The substantive storage requirements of California regulations found in 22 CCR 66262.30 through 66262.34 are applicable to the storage of hazardous wastes generated and stored onsite, such as contaminated groundwater, soil cuttings, and treatment plant residuals. This includes requirements for waste accumulation, container storage, and secondary containment. Any offsite storage of hazardous wastes would be subject to administrative requirements as well.

Air ARARs

The selected remedy includes in situ heating for COC removal through vapor or steam from the aquifer; therefore, there is the potential for VOCs to be released into the air. Off-gas from the steam stripping operation that treats vapors from heat treatment will comply with the substantive air emissions requirements of the Yolo-Solano Air Quality Management District. Requirements that are considered to be potential federal ARARs include Rules 2.5, 2.11, 2.13, 2.19, and 3.13.

2.14 Cost Effectiveness

The selected remedy is cost effective because the remedy's cost is proportional to its overall effectiveness (see 40 CFR 300.430 (f) (l) (ii) (D)). This determination was made by evaluating the overall effectiveness of those alternatives that satisfied the threshold criteria (that is, that are protective of human health and the environment and comply with all federal or any more stringent state ARARs). Overall effectiveness was determined by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness). The overall effectiveness of each alternative was then compared to each alternative's costs to determine cost-effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence represents a reasonable value for the money to be spent.

The estimated present worth cost of the selected remedy is higher than all of the other alternatives. However, the selected remedy offers a much higher degree of protectiveness and overall effectiveness than any of the other alternatives because the in situ heating effectively treats the contaminated source area soil and groundwater.

2.15 Utilization of Permanent Solutions and Alternative Treatment Technologies (or Resource Recovery Technologies) to the Maximum Extent Practicable

EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and alternative treatment technologies can be used in a practicable manner at the Frontier Fertilizer Site. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA has determined that the selected remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a primary element, basis against offsite treatment and disposal, and state and community acceptance.

The selected remedy treats the COC contaminated soil, which constitutes the principal health threats at the Site. The selected remedy satisfies the criteria for long-term effectiveness by removing the COC contamination from the soil up to depths of approximately 90 feet bgs.

The groundwater treatment system currently removes COCs with GAC that is sent offsite for regeneration. Some public comments received indicated a preference for groundwater treatment methods that do not involve offsite shipment for regeneration. EPA will consider utilizing another treatment method if the on-going evaluation indicates another groundwater treatment system would offer greater effectiveness or reduced cost.

The selected remedy will permanently reduce the toxicity and volume of COC contaminants and will assist in restoration of the groundwater to its designated beneficial uses.

2.16 Preference for Treatment as a Principal Element

CERCLA Section 121 (b) identifies a statutory preference for alternatives that use treatment to reduce the toxicity, mobility, or volume of contamination. EPA has determined that in situ treatment of Site COCs complies with this requirement. Implementation of in situ heating destroys COCs that would otherwise be available to desorb into both groundwater or soil gas.

2.17 Five-Year Review Requirements

Section 121 (c) of CERCLA and the NCP (300.430 (f) (5) (iii) (C)) provide the statutory and legal basis for conducting the five-year review. Because this remedy will result in hazardous substances, pollutants, or contaminants remaining onsite at concentrations that will not allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of the remedial action to evaluate if the remedy is, or will continue to be protective of human health and the environment. If the five-year review indicates that treatment system modifications are required in order to be protective of human health or to provide more effective treatment, then a proposal will be developed to refine the treatment and monitoring system.

2.18 Documentation of Significant Changes

The Proposed Plan, released for public comment in June 2006, identified In Situ Heating and Groundwater Pump and Treat as the preferred alternative for remediation of the soil and groundwater at the Frontier Fertilizer Site. There are no significant changes to the selected remedy; however, the following bullets represent changes resulting from comments:

- The biological treatment of nitrate will be considered secondary and will be based on additional evaluation during the design phase;

- The conceptual design discussed in the ROD includes treatment to depths of approximately 90 feet bgs. The actual depth of treatment will be dependent upon the ability to heat the more saturated materials found between approximately 60 to 90 feet bgs. The information determining the effectiveness of heating to these depths will emerge in the design development phase;

- The ARARs Table (Appendix D) has been amended to include Rule #2.13, Yolo-Solano Air Pollution Control District.

- The size of the Pine Tree Properties Site has been corrected in the ROD. The Proposed Plan referred to the triangular parcel as 8-acres instead of 11.43-acres.

PART 3 RESPONSIVENESS SUMMARY

The Proposed Plan, released for public comment in June 2006, identified In Situ Heating and Groundwater Pump and Treat as the preferred alternative for remediation of the soil and groundwater at the Frontier Fertilizer Site. There are no significant changes to the selected remedy.

3.1 Introduction

The purpose of this Responsiveness Summary is to document EPA's responses to the questions and comments raised during the public comment period for the Frontier Fertilizer Superfund Site. On June 7, 2006, the Proposed Plan was mailed to the Frontier Fertilizer mailing list, which includes 1,050 local residents. The notice summarized the EPA's proposed remedy for the Site, and invited citizens to attend a June 22, 2006 public meeting where EPA presented the Proposed Plan and recorded public comments. The meeting and availability of the Proposed Plan were also included in a June 7, 2006 notice in *The Davis Enterprise*, a newspaper serving the Davis area.

A 30-day comment period on the proposed remedy was held from June 12 to July 12, 2006. This was extended two weeks to July 26, 2006 at the request of the TAG (i.e., the FFSOG). The two-week extension was announced in *The Davis Enterprise* on July 13, 2006. Flyers also were mailed to the full mailing list.

During the public comment period, EPA met with the FFSOG, DTSC, RWQCB, CH2M HILL, and a representative from the City of Davis Natural Resources Commission on July 5 and July 17 to discuss the FFSOG's comments on the Feasibility Study and Proposed Plan.

This responsiveness summary addresses the verbal comments received during the June 22 public comment meeting and the written comments submitted to the agency via e-mail and mail during the time frame of June 12, 2006 to July 26, 2006. All original comments received from individuals, groups, and agencies regarding the Proposed Plan are presented in the Administrative Record. A copy of the transcript of the June 22 public comment meeting is also in the Administrative Record. EPA considered all of the comments summarized in this document before selecting a final remedial alternative to address contamination at the Site.

3.2 Stakeholder Issues and EPA Responses

A summary of the verbal and written comments received during the public comment period, as well as EPA's responses are provided below. There were many common elements to the questions and comments submitted to the EPA by various stakeholders about the selected remedy presented in the Proposed Plan. The comments and responses have been organized into the following common elements:

3.2.1 Thermal Treatment 3-2
3.2.2 Biological Treatment 3-7

3.2.3 Nitrate/Nitrite 3-10
3.2.4 Carbon Tetrachloride 3-11
3.2.5 Contaminant Containment and Remediation 3-11
3.2.6 Models 3-13
3.2.7 Development in the Area 3-14
3.2.8 Operations and Maintenance/Funding 3-16
3.2.9 Human Health Risks 3-17
3.2.10 Cleanup Timeframes 3-18
3.2.11 Other 3-18
3.2.12 Community Acceptance Criteria 3-19

3.2.1 Thermal Treatment

Comment #1: A commenter requests information on the effectiveness of in situ thermal treatment technology at Superfund sites in conditions of complex hydrology.

Response: EPA provided the following websites to the commenter that provide examples of thermal treatment's effectiveness at other sites:

- EPA CLU site with thermal destruction as well as other remedial tech info. http://clu-in.org/techfocus/default.focus/sec/Thermal%5FEnhancements/cat/Overview/
- http://www.cesiweb.com/
- http://www.thermalrs.com/
- http://www.terratherm.com/

Comment #2: What happens to the fertilizer after the heat breaks it up? Does it stay in the area?

Response: The Site is contaminated with pesticides and fertilizers. The in situ heating technologies will breakdown the primary COCs, pesticides, and CCl_4, into non-toxic compounds. The fertilizers, including nitrate, are not the primary COCs and are not expected to be changed with heat treatment. However, the remedy includes possible enhancement of existing anaerobic biological conditions to treat the nitrate and residual pesticides. The biological reaction that treats the nitrate is called denitrification, and it results in the conversion of nitrate and nitrite to di-nitrogen gas.

The decision to add treatment of nitrate using enhanced anaerobic biological treatment of the source area will be based on an evaluation planned for the design phase. This evaluation will include a comparison of nitrate levels in Site groundwater and City monitoring/drinking water wells in addition to discussions with the City of Davis to determine whether any changes are anticipated for the Site's nitrate discharge requirements.

Comment #3: The FFSOG suggested that thermal treatment should be considered by itself without the use of biological treatment.

Response: In situ heating is the primary treatment component of the selected remedy. Biological treatment is a secondary treatment that will be implemented based on the following factors which will be evaluated during the design phase:

a) A comparison of nitrate levels in Site groundwater to City monitoring/drinking water wells to determine the ambient level of nitrate and the Site's contribution

b) Discussions with the City of Davis regarding whether any changes are anticipated for the Site's nitrate discharge requirements

Comment #4: DTSC recommends that EPA include technical experts' experience with low and high temperature for in situ thermal treatment.

Response: Technical staff from EPA, DTSC, and EPA's outside contractors will be part of the design team. EPA strongly supports technical assistance throughout the Superfund process. Assistance by EPA's Office of Research and Development and Region 9's Technical Support Group has been provided through the alternatives' development and selection. During the design phase, EPA also will solicit input from EPA headquarters' staff with in situ heating expertise in addition to ongoing support from EPA Region 9's Technical Support Staff. Region 9 Air Division Staff are also expected to provide input on the vapor treatment and air monitoring plan. In addition, DTSC has a technical support group with expertise in in situ heating.

Comment #5: FFSOG requests that EPA analyze heating elements to depths in excess of 60 feet.

Response: The ROD states that EPA will attempt to treat below 60 feet. The conceptual design discussed in the ROD includes treatment to depths of 90 feet bgs. As discussed in the FS (CH2M HILL, 2006a), the greatest concentration of contaminant mass is located at approximately 20 to 40 feet bgs; however, COC concentrations have been detected to approximately 90 feet bgs. The actual depth of treatment will be dependent upon the ability to heat the more saturated materials found between 60 and 90 feet bgs.

Comment #6: DTSC recommends that the ROD specify an iterative course of action which may include bench and pilot scale studies designed to demonstrate and optimize a final remedial alternative for in situ thermal treatment that is capable of meeting State and federal cleanup objectives safely and in a reasonable timeframe.

Response: The need for additional bench-scale studies and possible pilot studies will be evaluated during the design phase. Additional bench-scale studies at higher temperatures may be warranted to evaluate all possible high temperature by-products.

Comment #7: DTSC states that the temperatures necessary to volatize water would not be expected to be sufficient to remove EDB, TCP, DBCP, and any other compounds with lower vapor pressures.

Response: In situ heating can degrade Site COCs by hydrolysis. Volatilization, on the other hand, transfers contaminants from the aqueous to the vapor phase. Hydrolysis reactions chemically transform the Site's COCs at lower temperatures within the aqueous phase. The target temperature and the treatment by-products for the in situ heating will be determined during the design phase. The bench-scale test report includes references to published data on hydrolysis and COCs.

Comment #8: DTSC requests that the ROD identify the possible thermal breakdown products resulting from low/high temperature thermal off-gas vapor control systems and include air emission standards or identify the appropriate permitting authority for any offsite response actions.

Response: During the bench-scale test completed in October 2005, the following methods were used to detect COCs and by-products: VOCs (524.2/SOP354 aqueous phase, TO-15 vapor phase, 8260B/SOP305 solid phase); 8015B/SOP380 TPH Purgable; 8015B/SOP380 TPH Extractable; and Anions 300.0/SOP530. Additional bench-scale studies may be planned to evaluate higher temperatures and breakdown products. Based on data gathered from other sites, heating has been conducted safely and air emissions successfully controlled. EPA will consult with the following technical experts during the preparation of the vapor treatment design and air monitoring plan: Air Pollution Control District, DTSC, RWQCB, Region 9 Technical Support (Toxicologist, Engineer), and Region 9 Air Division Staff.

Any vapor control systems will be operated onsite and thus subject to meeting the substantive requirements of air emissions standards. The vapor treatment system will be designed to ensure that there are no unacceptable risks to the community. EPA's Region 9 Site toxicologist will be involved in the preparation of the air monitoring plan.

Comment #9: DTSC requests the ROD define, through figures/cross sections, the lateral and vertical dimensional boundaries of the heating zone to capture the source area mass with inclusion of physical features.

Response: Figure 2 has been included in the ROD. The source zone boundary (that is, Media A and B) to be heated is depicted in the figure.

Comment #10: DTSC requests the ROD describe whether protection of the existing groundwater pump-and-treat system subsurface equipment is necessary during the application of an in situ thermal process.

Response: The following subsurface equipment is part of the current groundwater pump-and-treat system: extraction wells, and treated and untreated groundwater conveyance plumbing. These systems are expected to be operable up to temperatures around 140 degrees Fahrenheit.

Comment #11: DTSC found no evidence for hydrolysis reactions of the halogenated compounds with water at 90° and 115° in the treatability study. EPA should consider defining and initiating studies to more fully evaluate the effect due to hydrolysis for a low temperature thermal remediation concept before implementing a design. For any bench-scale study, consider use of stainless steel pressure vessels, uniform method of heating, and vacuum extraction of the headspace directly above the saturated zone to capture any vapors produced. Include tests for hydrolysis reactions and thermal breakdown byproducts (for example, aldehydes, alcohols, ketones, etc.). Consider adding alkali to raise the hydroxide (OH) ion in some tests. From results, define effects of hydrolysis/vaporization at various temperatures/conditions. Select a representative in situ thermal system.

Response: During the design phase, EPA will evaluate whether further bench-scale studies are warranted. Additional bench-scale studies may be planned to evaluate higher temperatures and breakdown products. However, we believe the treatability study provided substantial evidence supportive of hydrolysis at the temperatures considered, including: first-order decay kinetics, an increase in rates with temperature consistent with the Arrhenius equation, and increases in aqueous chloride and bromide concentrations.

Comment #12: DTSC comments that there is not sufficient OH^- ion available in water to cause the hydrolysis reaction to proceed. At pH of 7, there are 10^{-7} moles/liter of OH^- ion. The pH would need to be much higher to catalyze a hydrolysis reaction of halogenated pesticides present.

Response: Further tests will be completed during the design phase to further confirm the expected reactions. While hydrolysis consumes hydroxyl ions and lowers pH, dehydrohalogenation does not, and both types of reactions may be occurring at elevated temperatures. In hydrolysis, hydroxyl ions are substituted for halogens on the hVOCs, which increases the proportion of hydrogen ions in solution relative to hydroxyl ions and lowers the pH. In dehydrohalogenation, a hydrogen ion and a halogen ion are released to the solution as a double bond is formed between carbon atoms; this causes an increase in the concentration of hydrogen ions in solution, and also lowers the pH. Figure 4-2 (CH2M HILL, 2006c) shows the pH dropped from about 8 initially to as low as 6.3, with the drop in pH increasing with temperature. This is consistent with the greater degree of hVOC reduction observed at higher temperatures. Thus, both dehydrohalogenation and hydrolysis lower pH. Ultimately, the end result, destruction of COCs by heating, is more relevant than the exact mechanism by which this occurs.

Comment #13: DTSC states that the Bench-Scale Treatability Studies Final Report (June 2006) used a form of the rate equation for the uni-molecular decomposition reaction, which would hold true if the concentration of the halogenated compound or the concentration of OH^- ion did not participate in the reaction. Half-lives can only be used in a uni-molecular decomposition reaction rate equation.

Response: Strictly speaking, it is true that half-lives are only used in uni-molecular decomposition reaction rate equations. However, reactions that may in fact not be true first-order reactions can often be approximated as such. In the case of hydrolysis (2 reactants) and dehydrohalogenation (1 reactant) transformation rates are commonly reported as first-order in the literature. The decay curves in this study were closely approximated by first-order kinetics. Refer to Figures 4-4 to 4-7 (CH2M HILL, 2006c) for comparison of decay data to first-order kinetics.

Comment #14: FFSOG requests that EPA conduct more data collection and analysis to identify mechanisms that may be resulting in observed decreases in COC concentrations under high temperatures, identify all possible byproducts, and determine the need for using higher temperatures.

Response: During the design phase, EPA will evaluate whether further bench-scale studies are warranted. Additional bench-scale studies may be planned to evaluate higher temperatures and possible by-products.

Comment #15: DTSC suggests that a possible explanation for the decrease in contaminants during the bench-scale testing is diffusion through seals or septa of the glass flasks during the experiment. During heating in the closed container, the pressure of the gas in the headspace would have increased due to the ideal gas law. At 90°, the total pressure in the headspace would increase to about 1.24 atmospheres. At 115°, the pressure would be about 1.32 atmospheres.

Response: Comment acknowledged. Vessel components and test temperatures were chosen based on chemical and temperature compatibility and were tested before use. Components such as stainless steel would be warranted for higher temperatures and pressures. Volatilization could not explain the corresponding increases in bromide and chloride, and decreases in pH.

Comment #16: DTSC states that the driving force is the difference in partial pressures of the compounds in the headspace and in the ambient air. Water's ambient partial pressure is determined by the relative humidity in the laboratory. The halogenated compounds would have zero partial pressure in the laboratory (ambient) and would therefore have a much greater driving force for diffusion out of the flask than would water.

Response: See above comment response.

Comment #17: DTSC states that the halogenated compounds and water at 90° and 115° are ranked, from largest to smallest vapor pressure: DCP > water > EBD > TCP > DBCP.

Response: Comment acknowledged.

Comment #18: DTSC states that vapors may need to be condensed, which may require liquid phase secondary treatment. This is not identified in the Proposed Plan, but the ROD should discuss this likely occurrence.

Response: EPA agrees. Section 2.12 of the ROD includes provision for condensate treatment, if required.

Comment #19: DTSC requests that the ROD have estimates of the amount of water vapor that may need to be removed during the thermal process.

Response: The amount of water vapor produced as part of the implementation of in situ heating is temperature dependent. Further studies, possibly bench and/or pilot scale, are planned as part of the design phase to determine the implementation temperature and any requirements for water vapor treatment.

Comment #20: DTSC states that as a Superfund lead site, the State provides a 10 percent match for the cost of construction of the remedy, bears 100 percent of long-term O&M costs, and provides long-term oversight until remedial action objectives are achieved. As a result, DTSC has a significant stake in and responsibility for ensuring the efficiency, effectiveness, and safety of the remedy and must, in accordance with federal statute, concur with the ROD before it can be issued by EPA. Towards that end, DTSC favors a remedy that approaches 100 percent removal of contaminant mass underlying the disposal area. DTSC requests heating elements to depths in excess of 60 feet be fully explored.

Response: The conceptual design discussed in the ROD includes treatment to depths of 90 feet bgs, however, the actual depth of treatment will be dependent upon the ability to heat the more saturated materials found between 60 and 90 feet bgs, which will be evaluated in the design phase and may include additional bench-scale or pilot-scale tests.

3.2.2 Biological Treatment

Comment #1: Commenter is a resident of Mace Ranch. Based on the material received in the mail and the *Davis Enterprise* article, commenter supports the plan. Commenter is most interested in the use of the biological treatment element of the plan. Commenter hopes this technique will provide less energy-intensive ways of toxic cleanup. Is there more information available on this technology and the Maywood project?

Response: EPA website address was provided to commenter with link to Maywood project (Pemaco Superfund Site). The enhanced biological treatment portion is less energy-intensive but is not as effective at treating the primary COCs as in situ heating. The biological treatment is a secondary treatment for nitrate and any residual pesticides that may remain after the heat treatment. The decision to pursue biological treatment of nitrate and residual pesticides will be based on the following factors evaluated during the design phase:

a) A comparison of nitrate levels in Site groundwater to City monitoring/drinking water wells to determine the ambient level of nitrate and the Site's contribution

b) Discussions with the City of Davis regarding whether any changes are anticipated for the Site's nitrate discharge requirements

Comment #2: DTSC suggests that the EPA eliminate the biological degradation component of the preferred remedy in the ROD until further information on nitrate characterization and a safe delivery system is fully explored. Commenter states that time appears available given the biological degradation system is likely to be used after the thermal option is implemented, which will allow time to definitively establish the extent of site releases vs. non-site releases.

Response: Please see the answer provided above. EPA is required to clean up the contaminated groundwater and soil in a safe and effective manner. Data from additional testing will be considered during remedial design phase.

Comment #3: FFSOG is concerned that the injection and application at land surface of beer fermentation waste may change hydraulic gradients and cause increased downward movement of contaminants. Commenter would like to see evidence that the substance will not move into the deeper levels of the groundwater system and degrade the groundwater. Additionally, FFSOG stated that the organic carbon not consumed by microbes may move downward in the aquifer.

Response: EPA, DTSC, and the RWQCB are all actively involved in restoring the groundwater and will not introduce an additive that will degrade the groundwater. The RWQCB was involved in the selection of possible carbon substrate, including beer fermentation process waste, for possible use at the Site. Upward groundwater gradients in the treatment area (that is, source zone) are maintained by the groundwater extraction system. The beer fermentation waste will be injected or applied in the source area where the data show an upward gradient. In response to the expressed concern, EPA may install additional wells in the area of proposed application to verify that there is an upward gradient in all areas of potential application.

Comment #4: Moreover, the EPA should provide scientific evidence that the beer waste procedure has been proven to effectively eliminate nitrates without contaminating the soil or water with other toxins.

Response: See above response.

Comment #5: FFSOG states that there seems to be little technical justification of application of beer waste at land surface. Downward movement of beer fermentation waste will be slow and creation of anaerobic conditions is dubious in the unsaturated zone; therefore, injection of beer fermentation waste into the slowly permeable deposits at the site may result in a much smaller effect than expected.

Response: Comment acknowledged. The effectiveness of the technology can be limited by the ability to introduce the additive to the subsurface. Currently, a field study is underway to evaluate substrate application methods.

Comment #6: Commenter requests further quantitative analysis of the effects of the highly heterogeneous subsurface geologic materials on the implementation and effectiveness of in situ biological treatment. The beer waste may not effectively reach and reduce nitrate concentrations due to the disperse nature of the nitrate distribution and highly heterogeneous subsurface geologic materials.

Response: Please see the above response. If design of secondary biological treatment proceeds, the results of the pilot test will be used to select an effective methodology for application.

Comment #7: FFSOG states that a review of the scientific documents on biological treatment and results from the biodegradation study provided little substantive evidence for the success of large-scale biological treatment for enhanced biological transformation of the primary contaminants. FFSOG states that this is consistent with a recently released DTSC study of bioremediation sites in California which stated that "…it was not clear (from the studies evaluated) that biodegradation was proceeding in a reliable, demonstrative manner that would be desired for a final remedy." Additionally FFSOG states, "The fact sheet stated that laboratory studies using different substances to stimulate microbial activity were inconclusive. Actually, the treatability study authors were conclusive in stating that "there was no clear evidence that biodegradation of target hVOCs was enhanced by the amended treatments relative to the unamended controls."

Response: Biological treatment was not selected as a primary treatment of brominated primary COCs.

Comment #8: FFSOG commented that the treatability report stated "it is unknown if additional time would have lowered reducing conditions sufficiently to degrade all the hVOCs." Therefore, FFSOG states that there is no scientific basis for EPA's estimate that 10 years will be required for biological treatment.

Response: The 10-year estimate refers to biological treatment of the pesticides, the primary COCs. This alternative was not selected. The selected remedy includes biological treatment of nitrate as a possible secondary component. The decision to add treatment of nitrate using enhanced anaerobic biological treatment of the source area will be based on an evaluation planned for the design phase. This evaluation will include a comparison of nitrate levels in Site groundwater and City monitoring/drinking water wells in addition to discussions with the City of Davis to determine whether any changes are anticipated for the Site's nitrate discharge requirements. The 10-year timeframe is an estimate for cleanup of only 50 percent of the Site COCs using biological treatment only. This remedy was not selected due to the greater proven effectiveness of in situ heating.

Comment #9: A nearby resident states that the use of beer fermentation waste may generate unpleasant odors.

Response: Based on the on-going field studies, odors from the beer fermentation waste are only detected by field crews when they obtain water from the monitoring wells during sampling procedures.

Comment #10: FFSOG requests that the EPA analyze the effects of the thermal treatment on the soil microbial population and its ability to denitrify.

Response: The effects of in situ heating on the soil microbial population are temperature dependent. Published literature indicates that rates of anaerobic degradation of organic material increase at elevated temperatures.

Comment #11: FFSOG requests the EPA add flexibility into the thermal treatment, pump-and-treat system, common components, and in situ biological treatment alternatives so as to eliminate the biological treatment if possible.

Response: The ROD refers to the biological treatment as a secondary treatment. Treatment of the primary COCs is the highest priority.

3.2.3 Nitrate/Nitrite

Comment #1: The commenter asked if the water has been tested from the pump-and-treat system for nitrates and nitrites?

Response: Samples of treatment system influent and effluent have been analyzed for nitrate and nitrite. Frontier Fertilizer treatment system effluent was sampled to evaluate anion concentrations between January & August 2005. Nitrate ranged from 32 to 36 mg/L and nitrite was not detected above RL of 0.5 mg/L in any of the samples.

Comment #2: DTSC suggests that if nitrate is carried forward to the ROD, a remediation goal should be defined.

Response: In Section 2.13 of the ROD the following criteria are provided that will be used during design to evaluate whether to proceed with secondary biological treatment of nitrate:

a) A comparison of nitrate levels in Site groundwater to City monitoring/drinking water wells to determine the ambient level of nitrate and the Site's contribution

b) Discussions with the City of Davis regarding whether any changes are anticipated for the Site's nitrate discharge requirements

Comment #3: The FFSOG and other commenter's requested that cleanup levels for nitrates should be established prior to designing a treatment.

Response: Please see above response.

Comment #4: Commenter states that EPA guidelines have not been followed for nitrates.

Response: EPA followed guidance for conducting remedial investigations and feasibility studies at the Frontier Fertilizer Superfund Site. A nitrate technical memorandum was issued in 2006 because nitrate analyses were completed after the remedial investigation and risk assessment reports were completed. Nitrate is not considered a primary COC for the Site. Currently, nitrate in the extracted groundwater is treated at the City of Davis wastewater treatment plant.

Comment #5: Commenter requests a feasibility study be performed to generate and compare alternative approaches to removing nitrates from extracted groundwater.

Response: Further evaluation of nitrate treatment is planned for the design phase.

Comment #6: FFSOG and another commenter request that sufficient analysis of the alternative to continue to treat nitrates via the city's wastewater treatment plant.

Response: Further discussions with the City of Davis are planned during the design phase to determine whether any changes are anticipated for the Site's nitrate discharge requirements.

Comment #7: FFSOG requests that in situ biological treatment for nitrates should be considered a secondary alternative to the current method of treatment, which is at the City of Davis wastewater treatment plant.

Response: Please see the answer above.

Comment #8: A nearby resident requests the EPA focus on the cleanup of the pesticides (EDB, DCP, and DBCP) over the cleanup of nitrates.

Response: In situ heating of the primary COCs is top priority for the Site.

3.2.4 Carbon Tetrachloride

Comment #1: Commenter suggests that it is better to wait until the EPA has carbon tetrachloride data before establishing cleanup standards.

Response: A footnote has been added to Table 17, Remedial Action Objectives. CCl_4-contaminated soil was not detected in the Site investigations probably due to the compound's physical properties. EPA's contractors developed a soil cleanup goal for CCl_4 that will be used if it is detected in future soil sampling.

Comment #2: Commenter states that the vadose-zone modeling, constructed in the 1999 RI, which was used to establish cleanup goals for carbon tetrachloride is not applicable to all possibly yet-to-be-found carbon tetrachloride locations at the Frontier Fertilizer Site that might require remediation.

Response: See above response.

Comment #3: Commenter states the cleanup level for carbon tetrachloride in soil in the Final Feasibility Study is not consistent with EPA's RAO of "reducing levels of chemicals in groundwater (and chemical sources to groundwater) so that the groundwater could ultimately be used for domestic purposes." Commenter states that the soil concentration proposed as a cleanup level is not demonstrated to be consistent with protection of the underlying groundwater as required by the above objective.

Response: The CCl_4 soil cleanup value is based on the results of vadose zone modeling documented in the "Supplemental Remedial Investigation Report, 1999." The cleanup value was developed to ensure that the CCl_4 levels in groundwater do not exceed MCLs.

3.2.5 Contaminant Containment and Remediation

Comment #1: A commenter asked whether the contaminant plumes reduced in size over time?

Response: The concentration of contaminants in the groundwater has declined in most monitored locations including, at the leading edge of the contaminant plume in the S-1 and S-2 groundwater zones. These decreases at the leading edge confirm that the contaminant plume has reduced in size in the S-1 and S-2 zones. At two locations in the A-1 zone, DCP concentrations have increased.

Comment #2: The FFSOG comments that the pump-and-treat system is not fully containing the contamination within the target area discussed in EPA documents (for example, Frontier Fertilizer Model Update and Extraction Wellfield Plan, July 3, 2003). Specifically, data for hydraulic gradients show downward groundwater movement where there is significant contamination. The FFSOG requests assurance that containment will be achieved as soon as possible and sufficient description of how this will occur.

Response: EPA will evaluate the groundwater containment system effectiveness during the design process and throughout the remediation process to determine if modifications to the existing system are necessary. The key threshold for determining if the vertical gradients actually result in significant COC transport is if concentrations are observed increasing in the A-1 zone and exceeding action levels. Recent evaluations indicate that COC concentrations detected in the A-1 zone are declining in all wells, with the exception of three (OW-14C, OW-11C, and X-7C), where concentrations have increased above drinking water standards.

Comment #3: FFSOG would prefer the COCs be destroyed onsite and not exported somewhere else.

Response: The selected remedy of heat treatment destroys contaminants in place, as does the secondary treatment with in situ biodegradation. The treatment of extracted groundwater with GAC adsorption does not treat these captured contaminants on-site. GAC is the presumptive remedy for treatment of the Site COCs. As part of the on-going management and optimization of the groundwater pump-and-treat system, EPA will continue to evaluate alternative groundwater treatment methods. Section 2.12.2 of the ROD states that other treatment methods [to GAC] could be used if data indicated greater effectiveness or reduced cost.

Comment #4: FFSOG would like the EPA to consider UV oxidation for destruction of the contaminants via the pump-and-treat system instead of, or in addition to, the activated carbon.

Response: Please see above response.

Comment #5: A nearby resident requests that modifications be made to the pump-and-treat system, including additional extraction wells and increased water discharge rates from the treatment plant, to fully contain the groundwater plume and prevent further spreading.

Response: Section 2.12.2 of the ROD includes a description of an operations and maintenance plan that will provide criteria for continuing to assess the progress of the groundwater pump-and-treat system and provision for any additional extraction wells needed to meet the RAOs.

Comment #6: DTSC requests that the ROD be flexible enough to allow for construction adjustments to the existing groundwater remediation system.

Response: Please see above response.

Comment #7: FFSOG requests that due to low hydraulic conductivity of the S-1 and S-2 materials, there should be consideration of achieving capture by pumping from the A-1 aquifer. The strong downward gradients at the site due to regional agricultural and municipal pumping make capture difficult by limited pumping in the S-1 and S-2.

Response: Extraction from the A-1 aquifer zone may be included as part of future modifications to the groundwater pump-and-treat system. Section 2.12.2 of the ROD includes a description of an operations and maintenance plan that will provide criteria for continuing to assess the progress of the groundwater pump-and-treat system and provision for any additional extraction wells needed to meet the RAOs. It is possible that extraction from the A-1 will increase downward transport of COCs.

Comment #8: FFSOG would like to see an alternative that lays out the future use of the pump-and-treat system that guarantees it will ensure capture for decades into the future, even under changing hydrologic conditions. FFSOG requests that there be inclusion of how the pump-and-treat system will be upgraded to achieve and maintain containment. FFSOG requests that effects on the pump-and-treat system from changes in regional water supply and pumping be examined.

Response: The selected remedy includes operation and modifications, as needed, of the groundwater pump-and-treat system. Improvements and modifications will continue through remedial design and remedial action. It is expected that groundwater concentrations will continue to decrease after the in situ heating removes the continuing source to groundwater. Section 2.12.2 of the ROD includes a description of an operations and maintenance plan that will provide criteria for continuing to assess the progress of the groundwater pump-and-treat system throughout changing hydrologic conditions.

Comment #9: FFSOG requests the establishment of performance criteria using a realistic physical model of the soil-groundwater system that predicts the concentrations (with an error margin) that should be measured after a pre-established period of operation of the remedy. Inability to meet the established criteria (concentration levels) should trigger a re-evaluation and development of an alternative plan for site cleanup.

Response: Performance criteria will be developed and included in the operations and maintenance plan prepared during the remedial design (see Section 2.12.2 of the ROD).

3.2.6 Models

Comment #1: FFSOG states the SourceDK program that was used to make remedial timeframe estimate is an unrealistic model that is not physically based.

Response: The SourceDK computer model was used in the draft and final Feasibility Studies for cost estimating purposes only. It is a model developed by the Air Force Center of Environmental Excellence to estimate remediation timeframes when comparing different remedial actions. It is a basic screening-level model that produces order-of-magnitude results; therefore, timeframe estimates should be used for comparison purposes only. The SourceDK model uses measured chemical concentrations in soil and groundwater (that is, takes into account site-specific physical and chemical characteristics, to predict rate of decay).

Comment #2: FFSOG requests that an improved groundwater flow model and a solute transport model be used (via multiple simulations using variable hydraulic conductivity distributions) to evaluate and predict groundwater contaminant capture, guide upgrades to the pump-and-treat system, effectively analyze the effects of different alternatives, estimate time for contaminant removal, and be used to estimate the possible error in capture contamination predictions.

Response: EPA plans further evaluation to determine whether improvements can be made to the Site's current groundwater model, developed in 2003, or whether a different groundwater model can be utilized.

Comment #3: FFSOG recommends the current model be improved as follows: (1) The model should be calibrated to current pumping conditions, (2) The bottom boundary that reflects regional pumping conditions should be reevaluated, (3) more work needs to be done in the S-2 to quantify the distribution of the hydraulic conductivity where most of the capture is taking place, and (4) future estimates for water level changes due to changing development of climactic conditions should be used to evaluate the future of the pump-and-treat system to contain the contamination. Future scenario predictions can probably be accomplished with ongoing regional modeling efforts currently occurring in Yolo County.

Response: EPA plans further activities to evaluate whether improvements can be made to the Site's groundwater model. In July 2003, EPA developed a five-layer complex groundwater model to aid in understanding the Site's subsurface. EPA and DTSC groundwater hydrologists do not believe that the current model adequately represents the Site's conditions; however, EPA is committed to evaluate the model for future use as a tool to measure the effectiveness of the groundwater pump-and-treat system.

3.2.7 Development in the Area

Comment #1: Commenter is concerned that the construction of Target next to the Frontier Fertilizer site might impede groundwater and soil cleanup as well as EPA's preferred alternative.

Response: EPA's cleanup and investigation activities take priority to any proposed development for the parcels surrounding the Site. This has been documented in the April 18, 2003 "Notice of Restrictive Covenants for the Mace Ranch Light Industrial/Business Park Regarding the Frontier Fertilizer Superfund Site."

Comment #2: Commenter states that he lives in Davis and works near the Frontier Fertilizer EPA Superfund site. Commenter is not at all sure how to technically evaluate the various options which EPA has proposed for addressing the final site cleanup solution. The commenter's values and goals for the effort are that the priority be implemented whichever solution can be done effectively and done well, and that EPA is not being "pushed around" by neighbors planning to sell their house soon or the City or even commercial developers in what commenter fears could be a short-sighted effort to develop the site and just "forget all about it." Of course this is a problem not of our making. Commenter continues that those in the neighborhood must live with the problem if it is not fixed right (or sell homes and move but commenter plans to stay a long time). Commenter states that residents bear the largest burden of risk (other than perhaps those doing the cleanup)! Commenter's focus is on having it done right. Being beholden to others by a brand new development will be of no help.

Commenter goes on to say that he/she trusts EPA to know the best way to carry out a cleanup and to choose the most effective one. The commenter wants EPA to not choose lesser approaches in spite of other interests. The goal of effective cleanup is more important than competing and reasonable but lesser goals such as speed, the desire to make the site look better, or even the hope of using the land for another economic purpose. Commenter thinks this goal is best for those neighboring the Frontier Fertilizer site and in the long-run for ALL Davis residents.

Incidentally, commenter is not against the proposed Target development, but is concerned if such a development will close monitoring wells or impede the progress of the important work EPA is doing to protect residents from harm.

Response: If the Target development proceeds, Target will be responsible for replacing and/or modifying nine monitoring wells/piezometers. These wells/piezometers are essential to our groundwater monitoring program and any modification/replacement must proceed with limited interference to EPA's sampling program. It is EPA's intention that cleanup activities take priority to any proposed development. EPA and DTSC have outlined restrictions in Section 2.12.2.5 of the ROD to ensure that the cleanup proceeds without interference.

Comment #3: Commenter has been following the remedial action plan the EPA has in place since the time I bought my house in 1999. Commenter understood at that time the project in place and the plan to remediate the problem and has been satisfied with the progress of the project thus far, and would like to thank the EPA for their persistence and care in addressing the groundwater and soil contamination at the site.

Commenter's only concern now is the proposed building of a Target store not far from the contaminated site and the construction that will accompany that construction (if it is approved). It's a very large building proposed (137,000 square feet), and roads and other infrastructure have already been installed in anticipation of more building.

Commenter would urge the EPA to investigate and thoroughly examine with the City of Davis any impact this project will have on the groundwater and soil contamination cleanup and the monitoring wells currently in place. Commenter's concern is that the construction will undo the work done so far and allow the contamination to again spread and do further damage to the groundwater system. Thank you for your continued care and diligence on cleaning up this site, and for the opportunity to comment on the project.

Response: Please see response to above question.

Comment #4: Commenter wants to know if EPA looked into whether this "Target" development is on the same contiguous parcel as the Frontier Fertilizer. Commenter is concerned that Target will capitalize on redeveloping the nearby property after EPA has spent money cleaning it up. If it is, have you thrown a remediation lien on the property?

Seems like there is something wrong if the proposed Target development is on the same parcel and the developer is thinking he is going to capitalize on redeveloping the property after you've spent 18M cleaning it up!

Response: In preliminary discussions with Target, EPA has stated that one of the parcels that Target is considering developing would be subject to a windfall lien. Established as a provision of the recently amended Superfund regulations, parcels may be subject to a lien "in an amount not to exceed the increase in the fair market value of the property attributable to the response action at the time of a sale or other disposition of the property" (42 U.S.C. 9607 (r) (4)). This parcel, located on the western side of the proposed development may be subject to a lien because there is CCl_4 contamination above drinking water standards that will be cleaned up by the remedial action.

3.2.8 Operations and Maintenance/Funding

Comment #1: Who will monitor the cleanup construction to make sure the remediation equipment is functional and effective over time?

Response: EPA and DTSC have the responsibility to ensure that the cleanup is effective over the long-term. Section 2.12.2 of the ROD includes performance monitoring and the description of the operations and maintenance plan that will be prepared during the remedial design.

Comment #2: Commenter is happy that EPA has decided on a plan and will try to clean up this site once and for all. Will funding for the plan be guaranteed so that the plan can be completely implemented? What happens if a few years into the project, the funding dries up? Are there contingencies in the plan for such an occurrence?

Response: In 1993, EPA established that the Site owners and operators, or potentially responsible parties, were not financially viable and since that time the investigations and removal actions have been funded from the Superfund budget. The remedial action also will be funded from the Superfund budget with 10 percent cost sharing from DTSC. Since the expiration of the Superfund Trust Fund, the Superfund budget primarily consists of Congressionally appropriated funds as part of the overall EPA budget. Therefore, funding cannot be guaranteed for the life of the project. However, EPA does give priority funding for ongoing projects. As this is not a private party-funded cleanup, the Superfund statute requires the State to take over funding when the project reaches the operations and maintenance phase.

Comment #3: Will funding be a problem in choosing the best remedy for the site and the surrounding people?

Response: The protection of human health and the environment was EPA's primary consideration during the selection of the remedy.

Comment #4: DTSC requests the ROD include capital and operation and maintenance costs and the assumptions leading to these values.

Response: Capital and operations and maintenance costs are included in Tables 18, 19, and 20. Operations and maintenance estimates are based on the past 11 years of groundwater pump-and-treat system operation predicted over the remediation period.

Comment #5: DTSC has requested that a gravel cap is used rather than wood chip to protect ecological receptors.

Response: EPA acknowledges this comment. The decision whether to use pavement, wood chip, or gravel will be determined, with input from DTSC, during design phase.

3.2.9 Human Health Risks

Comment #1: Commenter wonders what would happen if anyone was harmed by either contact with the soil or vapors at the Frontier Fertilizer site? Would the city be sued?

Response: Since listing the Frontier Fertilizer Site on the National Priorities List in 1994, EPA's involvement at the Site has focused on ensuring that there are no unacceptable health risks. The risk assessment, completed in 1999, evaluated the potential risk to public health from chemicals detected in the soil and groundwater. The baseline risk assessment indicates that soil contamination levels pose an unacceptable risk if people are in contact with the soil or vapors overlying the hot spot. The risk assessment (Bechtel, 1999) is available in the information repositories for review. The Site will remain secured and public access prohibited until the source area cleanup is completed. Institutional controls, included in Section 2.12.2.5 of the ROD, also limit potential exposure to contaminants. EPA has no information about whether the City of Davis could be subject to any lawsuit.

Comment #2: Commenter requests that the EPA set up a continuous monitoring system to detect system failures that could lead to a release of contaminants into the air. In addition to this, the commenter requests that a rapid notification system be set up to warn nearby residents of releases in time for residents to avoid exposures.

Response: The in situ heating system will not be operated until the vapor capture system is demonstrated to be effective at preventing any unacceptable risk from possible air emissions. To ensure that the system is protective, a combination of modeling and ambient air monitoring (Section 2.12.2 of the ROD) will be proposed in an air monitoring plan.

Comment #3: Commenter would like the EPA to demonstrate the protection of human health, in terms of vapor capture, for the thermal treatment. The EPA should reassure the community with examples of similar sites within similar communities where thermal treatment has been effective and safe. It should demonstrate that the safety plan proposed for Davis has been designed based on methods proven to be safe in similar conditions elsewhere.

Response: See above response.

Comment #4: Commenter asks whether the contaminant plumes in Figure 2 of the remedial newsletter sent are accurately represented? It seems like the plumes have shrunk compared to previous figures. Is that the case? Commenter really hopes so.

Response: Yes, the plumes depicted in Figure 2 are accurately represented. The relative size of the groundwater plumes has not changed significantly although the concentrations have decreased in all but 5 of the 115 wells. Samples are collected from many of the wells every 3 months to ensure that EPA has up-to-date information regarding the groundwater concentrations.

3.2.10 Cleanup Timeframes

Comment #1: Commenter requests that the EPA implement the chosen remedy in a timely manner.

Response: EPA agrees. Our goal is to implement the remedy in a timely, effective, and safe manner. By reducing the concentration of source area soil and groundwater, the continuing threat to groundwater will be reduced.

Comment #2: Commenter requests that the analysis of the pump-and-treat system should include reasonable timeframe estimates for site cleanup.

Response: Once source removal is complete, time estimates for operation of the pump-and-treat system can be developed with greater certainty. Preliminary estimates were presented in the FS (CH2M HILL, 2006a) for comparison purposes only. Section 2.12.2 of the ROD includes discussion of performance monitoring and the operations and maintenance plan for the groundwater pump-and-treat system. Performance monitoring will be used to optimize operation of the groundwater pump-and-treat system. The operations and maintenance plan, planned for remedial design, will include the sampling methods and criteria for assessing the effectiveness of the remedial action and the shutoff plan for the pump-and-treat system.

3.2.11 Other

Comment #1: Commenter asks who owns the Frontier Fertilizer land?

Response: A review of county property records indicates that the 11.43-acre Site is owned by Pine Tree Properties (Assessor's Parcel Number 071-412-031). An adjacent 7-acre parcel which is part of a 10.98 acre parcel, Assessor's Parcel Number 071-411-07, is known as the "Remainder Parcel." The Remainder Parcel is owned by RAMCO.

Comment #2: Commenter pointed out a typing mistake in the proposed plan (micrograms/liter vs. milligrams/liter).

Response: A correction flyer was mailed on July 12, 2006.

Comment #3: FFSOG requests that there be regular meetings between the FFSOG, EPA, and other interested stakeholders during the design and remedial action phases. These meetings should be frequent enough to inform the public on site progress. FFSOG requests the meetings be an opportunity for technical dialogue and presentation of technical information that is understandable to the lay person.

Response: EPA anticipates that community involvement, including technical meetings with the FFSOG and community meetings, will continue until the groundwater pump-and-treat system is turned off. Following the completion of the ROD, EPA plans to revise the Community Relations Plan. The FFSOG will be invited to participate in the document revision, along with other community members, to provide input on the community relations activities for the design and remedial action phases.

Comment #4: FFSOG requests that the EPA obtain a mutually agreeable third party technical review to address specific technical issues such as thermal treatment design, vapor capture, air monitoring, biological treatment, modeling, and pump-and-treat system design.

Response: EPA agrees that technical assistance should be used throughout the Superfund process. EPA, DTSC, and EPA's outside contractors will be part of the design team. Assistance by EPA's Office of Research and Development and Region 9's Technical Support Group has been provided through the alternatives' development and selection. During the design phase, EPA also will solicit input from headquarters' staff with in situ heating expertise in addition to ongoing support from EPA Region 9's Technical Support Staff. EPA Region 9 Air Division Staff are also expected to provide input on the vapor treatment and air monitoring plan. In addition, DTSC has a technical support group with expertise in in situ heating.

Comment #5: Commenter has reviewed the EPA Proposed Plan (June 2006) and the Feasibility Study (FS) for the Frontier Fertilizer Superfund site in Davis, California.

Commenter resides 2 blocks from the Frontier Fertilizer Superfund Site and works in an office building adjacent to the Superfund site. Commenter states that the Proposed Plan has attained a balance of information gathered and the selection of a reasonable preferred alternative. Since the discovery of hazardous waste released at the site over 23 years ago and the failure of the state agencies to take action, EPA assumed responsibility to remediate the site and has made a diligent effort to investigate and resolve the problem. Commenter believes EPA should continue its efforts and not delay the preparation of the Record of Decision for certification.

Response: Comment acknowledged.

3.2.12 FFSOG Community Acceptance Criteria

These criteria were e-mailed to EPA on June 13, 2006 by the FFSOG. They were discussed at meetings with the FFSOG on June 15 and July 5, 2006.

Acceptance Criterion #1: Remedial actions should pose no health threat to the community or environment. The primary concern is for those living in neighborhoods near the site. Remedial actions should be designed to either mitigate or avoid impacts through release of constituents of concern (COCs) to the air, water or soil.

Response: EPA would not go forward with the cleanup plan if the selected remedy presented an unacceptable risk to community. As a safety precaution, an air monitoring network will be established before the heat treatment is started.

Acceptance Criterion #2: Remediation Implementation. Proposed remedial solutions should be based on defensible science that can meet a standard of peer review. Adaptation and implementation of treatment and/or removal strategies and methodologies should be based on understandable and scientifically valid data and analysis. Sufficient evaluation using the best available analytical tools should demonstrate feasibility and implementability and quantify uncertainty.

Response: EPA and DTSC technical staff have been involved with the remedy selection to ensure the use of the best available data and analysis methods.

Acceptance Criterion #3: Future site decisions during the Proposed Plan and ROD processes and beyond should be based on continued and evolving understanding of the Site based on accurate data collection and use of physically-based analytical tools.

Response: Accurate data collection and use of physically-based analytical tools are some of the elements EPA considers to make site decisions.

Acceptance Criterion #4: Site Characterization. Final remedies should be based on complete characterization of the extent of contaminated soil and groundwater. The western extent of contaminated groundwater in the A-1 zone is currently unknown. Necessary characterization should be included in future budgets. Additional characterization is also necessary for nitrate.

Response: The remedial investigation was completed in 2003; however, further investigations can proceed based on changing or new data. EPA agrees that an additional well should be installed west of monitoring well OW-14C if concentrations continue above detection limits. EPA also agrees to continue with nitrate monitoring.

Acceptance Criterion #5: Remediation Implementation Timing. Cleanup should proceed in a timely manner. A time schedule should be established and adhered to and progress reported to the community regularly.

Response: EPA agrees. On-going communication with the community is part of the Superfund process. This includes community meetings, Fact Sheets, and meetings with smaller groups, including the FFSOG.

Acceptance Criterion #6: Cleanup Criteria. Groundwater and soils should be cleaned up to the strictest state standards. The cleanup levels should support multiple and unrestricted land uses.

Response: EPA policy states that EPA should cleanup Superfund sites to the reasonably anticipated future use of the property. The Frontier Fertilizer Site is in an area zoned for light industrial/business park in the “Mace Ranch Plan Development, #4-88.”

Acceptance Criterion #7: Contaminant Containment. Continued migration of contaminated groundwater beyond the influence of the current pump-and-treat system should be halted as soon as possible. Future operation, maintenance, and upgrades of the pump-and-treat system should include sufficient flexibility and robustness for contaminant capture and hydraulic containment until contaminant levels reach acceptable and applicable criteria.

Response: The remedy selected in the ROD has the flexibility for EPA to continue to monitor and modify/expand the groundwater pump-and-treat system as needed to capture contaminants and meet RAOs.

Acceptance Criterion #8: Priority. Cleanup should be given priority over any site-related or adjacent construction, development, and other non-remedial activities.

Response: EPA agrees.

Acceptance Criterion #9: Public Involvement. The public should be involved in cleanup decisions pre- and post-ROD. EPA should commit to keeping the public informed through timely and understandable communication, dialogue, and obtaining feedback on a regular basis until the site is closed.

Response: EPA agrees. Community relations activities are planned throughout the cleanup process.

Acceptance Criterion #10: Contingency Plan. Given the remedial uncertainties and lack of knowledge of future hydrologic conditions, a contingency cleanup plan should be completed and subject to public review.

Response: Groundwater monitoring will determine if additional expansion of the system is required to meet RAOs. In situ heating is a proven technology to clean up the source area soil and groundwater. EPA will develop confirmation sampling criteria and review data to evaluate the project’s effectiveness. The five-year review also is a formal review of the Site’s progress toward RAOs and provides an opportunity to adjust the remediation process.

Acceptance Criterion #11: Destruction of constituents of concern locally is preferable to export. The community prefers that toxic chemicals be degraded to non-toxic chemicals on or near the Site rather than exporting them elsewhere for treatment.

Response: EPA is currently treating groundwater using activated carbon. This is sent offsite for regeneration to Kentucky as there are no facilities closer. We will continue to evaluate other groundwater treatment methods as part of the management of the groundwater pump-and-treat system.

3.3 Technical and Legal Issues

3.3.1 Technical Issues

There are no significant technical changes to the selected remedy; however, the following minor changes represent changes resulting from comments:

- The biological treatment of nitrate will be considered secondary.
- The conceptual design discussed in the ROD includes treatment to depths of 90 feet bgs. The actual depth of treatment will be dependent upon the ability to heat the more saturated materials found between 60 and 90 feet bgs. The information determining the effectiveness of heating to these depths will be determined in the design development phase.
- The ARARs Table (Appendix D) has been amended to include Rule #2.13, Yolo-Solano Air Pollution Control District.
- The size of the Pine Tree Properties Site has been corrected in the ROD. The Proposed Plan referred to the triangular parcel as 8 acres instead of 11.43 acres.

3.3.2 Legal Issues

There are no significant legal issues.

PART 4 WORKS CITED

Bechtel. 1997. *Remedial Investigation, Frontier Fertilizer Superfund Site.* Prepared for U.S. Environmental Protection Agency, Region 9.

Bechtel. 1999a. *Baseline Risk Assessment Report, Frontier Fertilizer Superfund Site.* Final. Prepared for U.S. Environmental Protection Agency, Region 9.

Bechtel. 1999b. *Supplemental Remedial Investigation Report, Frontier Fertilizer Superfund Site.* Prepared for U.S. Environmental Agency, Region 9.

CH2M HILL. 2003. *Supplemental Remediation Investigation Report #2, Frontier Fertilizer Superfund Site.* Final. Prepared for U.S. Environmental Protection Agency, Region 9.

CH2M HILL. 2006a. *Feasibility Study, Frontier Fertilizer Superfund Site.* Final. Prepared for U.S. Environmental Protection Agency, Region 9. June.

CH2M HILL. 2006b. *Screening-Level Ecological Risk Assessment, Frontier Fertilizer Superfund Site.* Final. Prepared for U.S. Environmental Protection Agency, Region 9. June.

CH2M HILL. 2006c. *Bench-Scale Treatability Studies: ZVI, Biodegradation, and Thermal Treatment, Frontier Fertilizer Superfund Site.* Final. Prepared for U.S. Environmental Protection Agency, Region 9. June.

U.S. Environmental Protection Agency (EPA). 1988. *CERCLA Compliance with Other Laws Manual.* May.

U.S. Environmental Protection Agency (EPA). 1992. *Guidance for Data Usability in Risk Assessment (Part A).* Final.

APPENDIX A

California Department of Toxic Substances Control
Concurrence with the Selected Remedy

Department of Toxic Substances Control

Linda S. Adams
Secretary for
Environmental Protection

Maureen F. Gorsen, Director
8800 Cal Center Drive
Sacramento, California 95826-3200

Arnold Schwarzenegger
Governor

September 20, 2006

Ms. Kathleen Johnson
Environmental Protection Agency, Region IX
Federal Facilities and Private Sites
75 Hawthorne Street
San Francisco, California 94105

FRONTIER FERTILIZER SITE RECORD OF DECISION CONCURRENCE

Dear Ms. Johnson:

On behalf of the State of California, the Department of Toxic Substances Control (DTSC), in consultation with the Central Valley Regional Water Quality Control Board (RWQCB), hereby concurs with the United States Environmental Protection Agency's (U.S. EPA's) proposed remedy for the Frontier Fertilizer Site in Davis, Yolo County, California as presented in the draft Record of Decision (ROD). The remedy proposes to address 1) pesticide source area contamination by heating the soil and groundwater in-situ and recovering the generated soil vapor for treatment; 2) dissolved plume groundwater contamination through continued extraction and treatment with potential modifications to the system; and 3) risk to ecological receptors through placement of a temporary cap until future development of the site. DTSC agrees that any decision to add treatment of nitrate using enhanced anaerobic biological treatment be based on an evaluation planned during the remedial design phase. Pursuant to the draft ROD, land use covenants are an essential element of the remedy to prevent sensitive uses of impacted properties. These land use covenants must be negotiated with property owners, approved by DTSC and U.S. EPA, and recorded with Yolo County.

Thank you for the opportunity to review the draft ROD. If you have any questions regarding the foregoing, please contact Mr. Richard Hume at (916) 255-3690.

Sincerely,

James L. Tjosvold, P.E., Chief
Northern California-Central Cleanup Operations Branch

cc: See next page.

cc: Ms. Amy Terrell
Regional Water Quality Control Board
Central Valley Region
11020 Sun Center Drive, #200
Rancho Cordova, California 95670-6114

Mr. Richard Hume, Chief
National Priority List Unit
Northern California-Central Cleanup Operations Branch
Site Mitigation and Brownfields Reuse Program
Department of Toxic Substances Control
8800 Cal Center Drive
Sacramento, California 95826

APPENDIX B

Cost Estimate for the Selected Remedy

APPENDIX B COST ESTIMATE FOR THE SELECTED REMEDY

Table B-1

Selected Remedy Activities	Cost
CAPITAL COST Construction Activities Mobilization/demobilization	$196,000
Monitoring, sampling, testing, and analysis	$373,324
Site work	$88,000
Demolition and removal	$18,000
Onsite treatment	$4,565,000
Offsite treatment/disposal	$65,000
Contingency	$1,856,750
Total Construction Activity	$7,162,074
Project management	$106,000
Remedial design	$155,000
Construction management	$87,000
Total Professional/Technical Service	$348,000
Total Institutional Controls	$10,000
TOTAL CAPITAL COST	$7,520,074
Annual O&M Elements Monitoring, sampling, testing, and analysis	$298,000
Extraction, containment, or treatment systems	$230,700
Offsite treatment/disposal	$55,000
Contingency	$87,600
Total O&M Activity	$671,300
Project management	$89,000
Technical support	$18,000
Total Professional/Technical Service	$107,000
Institutional Controls (Reimbursed by property owners-DTSC cost estimate here?)	$0
TOTAL ANNUAL O&M ELEMENTS	$778,300
TOTAL O&M ELEMENTS	$34,245,200
TOTAL O&M ELEMENTS PW w/ 7% DF	$10,552,191

Table B-2 Summary of Cost	
Criteria	**Selected Alternative**
<u>PERIODIC COST ELEMENTS</u>	
Construction/O&M Activities	
Remedy failure or replacement	$420,000
Demobilization of onsite extraction, containment, or treatment systems	$1,250,000
Contingency	$511,000
Total Construction/O&M Activity	$2,181,000
Professional/Technical Services	
Five-year reviews	$245,000
Groundwater performance and optimization study	$0
Remedial action report	$210,000
Total Professional/Technical Service	$455,000
Institutional Controls (Reimbursed by property owners—DTSC cost estimate here?)	$0
TOTAL PERIODIC ELEMENTS	$2,636,000
TOTAL PERIODIC ELNTS PW w/ 7% DF	$340,898
<u>REMEDIAL ALTERNATIVE NON-DISCOUNTED COST</u>	$44,401,274
<u>REMEDIAL ALTERNATIVE PRESENT VALUE w/ 7% DF</u>	$18,413,163

APPENDIX C

Summary of Community Meetings and Fact Sheets

APPENDIX C SUMMARY OF COMMUNITY MEETINGS AND FACT SHEETS

Table C-1
Community Meetings

Date	Comments
01/14/93	DTSC Organized Site Update Meeting
08/18/98	State, EPA and FFSOG
03/17/99	State, EPA and FFSOG
04/26/99	State, EPA and FFSOG
05/03/99	State, EPA and FFSOG
05/05/99	State, EPA and FFSOG
09/20/99	State, EPA and FFSOG
06/12/00	State, EPA and FFSOG
08/02/00	EPA Site Update
09/28/00	State, EPA and FFSOG
03/08/01	State, EPA and FFSOG
06/28/01	EPA Site Update
08/09/01	State, EPA and FFSOG
06/04/03	EPA Site Update
05/26/04	State, EPA and FFSOG
05/23/05	State, EPA and FFSOG
06/15/06	State, EPA and FFSOG
06/22/06	The Proposed Plan was presented and verbal comments were recorded.
07/05/06	State, EPA and FFSOG
07/15/06	State, EPA and FFSOG

Table C-2
Fact Sheets

Date	Topic
January 1993	DTSC: Public Meeting to be Held
November 1993	DTSC: Frontier Fertilizer Site Groundwater Cleanup Started
April 1995	EPA Begins Activities at Frontier Fertilizer
September 1997	Update on Frontier Fertilizer Superfund Site
May 1998	Additional Groundwater Monitoring Wells to be Installed in Mace Ranch Park
October 1999	Extraction Wells and Additional Groundwater Monitoring Wells to be Installed in Mace Ranch Park
April 2000	Extraction Well to be Installed in Mace Ranch Park
July 2000	New Location Proposed for Extraction Well in Mace Ranch Park
June 2001	Next Phase of Field Activities to Expand the Groundwater Extraction and Treatment System at the Frontier Fertilizer Superfund Site
December 2002	EPA Completes Planned Characterization of Site Contamination
May 2003	Community Update: Construction Planned for Summer of 2003
August 2003	Update: Treatment System Expansion Work to begin August 25, 2003
June 2005	Update on Groundwater Extraction, Treatment and Monitoring Activities
June 2006	EPA Proposes Groundwater and Soil Remedies and Requests Public Comment
June 23, 2006	Correction to June 2006 Proposed Plan Table of Preliminary Cleanup Levels for Soil and Groundwater

APPENDIX D

ARARs for the Selected Remedy

APPENDIX D ARARS FOR THE SELECTED REMEDY

Table D-1
Chemical-specific ARARs

	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
1	Resource Conservation and Recovery Act (RCRA) Hazardous Waste Determination Title 22 CCR, Division 4.5, Chapter 11, 66261.21, 66261.22(a)(1), 66261.22(a)(2), 66261.23, and 66261.24(a)(1) or Article 4, Chapter 11, 22 CCR 66260.200	Potentially Applicable	A hazardous waste is considered a RCRA hazardous waste if it exhibits any of the characteristics of ignitability, corrosivity, reactivity, or toxicity, or if it is listed as a hazardous waste.	Wastes generated during construction, monitoring, or remediation at Frontier Fertilizer must be characterized and managed in accordance with RCRA requirements.
2	California Hazardous Waste Determination 22CCR 66261.24(a)(2), 22CCR66262.11	Potentially Applicable	Wastes can be classified as non-RCRA, state-only hazardous wastes if they exceed the Soluble Threshold Limit Concentration (STLC) or Total Threshold Limit Concentration (TTLC) values, but do not exceed the federal standards.	Wastes generated during construction, monitoring, or remediation at Frontier Fertilizer must be characterized and managed appropriately.
3	National Drinking Water Standards (MCLs) Federal Safe Drinking Water Act 42 U.S.C. 300g-1 40 CFR 141.61	Relevant and Appropriate	Establishes national primary drinking water standards and Maximum Contaminant Levels (MCL) to protect the quality of water in public water systems. MCLs represent the maximum concentrations of contaminants permissible in a water system delivered to the public. MCLs are generally relevant and appropriate when determining acceptable exposure limits for groundwater that is a current or potential source of drinking water.	National primary drinking water standards are health-based standards for public water systems (MCLs). The National Contingency Plan (NCP) defines MCLs as relevant and appropriate for groundwater determined to be a current or a potential source of drinking water in cases where MCL goals are not ARARs. Groundwater in the vicinity of Frontier Fertilizer has been designated for drinking water use.
4	California Safe Drinking Water Standards (MCLs) State MCLs found in 22 CCR §64435 and §64444.5	Relevant and Appropriate	Establishes primary MCLs for contaminants that cannot be exceeded in public water systems. In some cases, the California drinking water standards are more stringent than the federal MCLs.	Like federal MCLs, state MCLs are relevant and appropriate as cleanup goals for groundwater determined to be a current or a potential source of drinking water. Groundwater in the vicinity of Frontier Fertilizer has been designated for drinking water use.

Table D-1
Chemical-specific ARARs

	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
5	Regional Water Quality Control Board's Water Quality Control Plan (Basin Plan) Chapters 2 and 3	Potentially Applicable	The Water Quality Control Plan (also known as the Basin Plan) for the Sacramento and San Joaquin river basins, dated September 1, 1998, establishes beneficial uses for groundwater and surface water, water quality objectives designed to protect those beneficial uses, and implementation plans to achieve water quality objectives.	The narrative water quality objectives (WQOs) described in the Basin Plan may be considered for groundwater discharges. The substantive provisions of Chapters 2 and 3, narrative standards for groundwater and surface water standards, are potentially applicable.
7	Waste Discharge Requirements (WDRs), 23 CCR 2591 (a)	Potentially Applicable	A WDR establishes narrative and chemical-specific requirements for the discharge of treated wastewater to land (including an evaporation/percolation pond and irrigation fields) in the vicinity of Frontier Fertilizer.	Potentially applies to any remedial activity at Frontier Fertilizer that will potentially impact the nature or volume of wastewater discharged to land.
8	Concentration Limits, 22 CCR 66264.94 (b),(c)	Potentially Relevant and Appropriate	Provides basis for decisionmaking on alternate concentration limits for hazardous constituents.	Potentially applicable to the technical infeasibility of remediating to background levels.

Table D-2
Location-specific ARARs

	Location	Requirement	ARAR Determination	Description	Comments
1	Critical habitat such as nesting habitat upon which endangered species or threatened species depend.	Substantive portions of the Endangered Species Act of 1973 (16 USC 1531-1538, 1539); 50 CFR Part 200, 50 CFR Part 402 Substantive portions of the California Endangered Species Act (CA Fish and Game Code, Division 3, Chapter 1.5) Substantive portions of the Native Plant Protection Act (CA Fish and Game Code, Division 2, Chapter 10)	Potentially Applicable	Requires action to conserve endangered species or threatened species, including consultation with the United States Department of the Interior, Fish and Wildlife Service.	No endangered or threatened species have been identified at Frontier Fertilizer. The Frontier Fertilizer Site may be a habitat for the burrowing owl, a species of concern in California. Remedial actions at Frontier Fertilizer must be sensitive to the regulations that protect wildlife and plant species of special status.
2	Within area where action may cause harm to migratory birds (that is, nesting habitats, foraging areas, etc.).	Migratory Bird Treaty Act (16 USC 703), 50 CFR 10.13	Potentially Applicable	Establishment of a federal prohibition, unless permitted by regulations, to "pursue, hunt, take, capture, kill…" any migratory bird or any part, nest, or egg of any such bird.	Many common migratory species have been identified at Frontier Fertilizer. Remedial actions at Frontier Fertilizer must be sensitive to the regulations that protect migratory birds.
3	Within area where action may cause harm to birds (that is, nesting habitats, foraging areas, etc.).	California Fish and Game Code, Div. 4, Part 2, Chapter 1, 3503.	Potentially Applicable	It is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, except as otherwise provided by this code or any regulation made pursuant thereto.	Many common avian species have been identified at Frontier Fertilizer. Remedial actions at Frontier Fertilizer must be sensitive to the regulations that protect birds, including the burrowing owl.
4	Within area where action may cause irreparable harm, loss, or destruction of significant artifacts	National Archaeological and Historical Preservation Act (16 USC Section 469); 36 CFR Part 65	Potentially Applicable	Alteration of terrain that threatens significant scientific, prehistoric, historic, or archaeological data may require actions to recover and preserve artifacts.	The selected remedy will not alter or destroy any known prehistoric or historic archaeological features at Frontier Fertilizer. Although Frontier Fertilizer is completely developed, it remains unpaved in many areas. However, because there is a possibility that buried historic or prehistoric remains could be discovered during construction, mitigation measures to protect the area would be required if such a discovery were uncovered.

Table D-3
Action-specific ARARs

	Location	Requirement	ARAR Determination	Description	Comments
1	RCRA hazardous waste treatment	22 CCR 66265.370 and 66265.377	Potentially Relevant and Appropriate	Establishes requirements for owners and operators of interim status facilities that thermally treat hazardous waste in devices other than those that use flame combustion.	Substantive provisions are relevant and appropriate for treatment by in situ electrical resistance heating.
2	Cleanup of releases to the environment	27 CCR Section 20400 and 23 CCR 2550.4	Potentially Applicable	Concentration lists must be established for groundwater, surface water, and the unsaturated zone. Must be based on background, equal to background, or for corrective actions, may be greater than background, not to exceed the lower of the applicable WQO or the concentration technologically or economically achievable. Specific factors must be considered in setting cleanup standards above background levels.	Applies in setting groundwater cleanup levels for all discharges of waste to land.
3	Land use covenants	22 CCR 67391.1(a)(b)(d)(g)(i) CA Civil Code Section 1471 (a)	Relevant and Appropriate	LUC Agreements are proprietary controls that run with the land, agreed to by property owners, to implement Institutional Controls at sites where there has been a release of hazardous substances, and where some wastes will remain in place. The LUC Agreements allow ongoing use of property as long as the cleanup remedy is not compromised by current or future development.	Substantive provisions are relevant and appropriate if contamination will remain onsite above levels suitable for unrestricted use.

Table D-3
Action-specific ARARs

	Location	Requirement	ARAR Determination	Description	Comments
4	Groundwater monitoring	22 CCR 66264.97(b)(1)(a)(b)(c)(d), (2), (4), (5), (6), (7) and (e)(1), (2), (3), (4), (5)	Relevant and Appropriate	Establishes general requirements for groundwater monitoring systems for hazardous waste facilities.	These regulations require general water quality monitoring of groundwater at Frontier Fertilizer. The intent of these requirements is currently being met under the existing groundwater monitoring program. Additional monitoring wells may be required during remedy implementation.
5	Control of air emissions	Yolo-Solano AQMD—Rule 2.5, Nuisance	Potentially Relevant and Appropriate	No discharge from any source, contaminants which cause injury, detriment, nuisance or annoyance.	Substantive provisions are relevant and appropriate to the selected remedy with a potential for air emissions.
6	Control of air emissions	Yolo-Solano AQMD—Rule 2.11, Particulate Matter	Potentially Applicable	Limits visible particulate emissions to the property line.	Applicable to the selected remedy if it results in the production of particulate matter.
7	Control of air emissions	Yolo-Solano AQMD—Rule 2.13, Organic Solvents	Potentially Relevant and Appropriate	Limits emissions of organic solvents pertaining to potential flame treatment of solvents.	Substantive provisions apply if the selected remedy results in the production of organic solvents.
8	Control of air emissions	Yolo-Solano AQMD—Rule 2.19 (a) Particulate Matter Process Emission Rate	Potentially Applicable	Provides PM_{10} emission rates (lbs/hr) based on process material weights.	Applicable to the selected remedy if it results if air emissions exceeding AQMD thresholds.
9	Control of air emissions	Yolo-Solano AQMD—Rule 3.4 New Source Review	Potentially Relevant and Appropriate	Establishes performance and monitoring standards for new air emission sources. New sources exceeding the primary pollutant thresholds are required to apply the best available control technology (BACT).	Substantive provisions are relevant and appropriate to the selected remedy if there is a potential to emit primary pollutants to the atmosphere that exceed AQMD thresholds.

Table D-3
Action-specific ARARs

	Location	Requirement	ARAR Determination	Description	Comments
10	Control of air emissions	Yolo-Solano AQMD—Rule 3.13, Toxics New Source Review (T-BACT for HAPs)	Potentially Applicable	Requires the best available control technology for toxics (T-BACT) at any constructed or reconstructed major source of hazardous air pollutants (HAPs).	Applicable to selected remedy if it results in emissions of HAPs (currently CCl_4 and 1,2 DBCP are listed as HAPs) in quantities greater than 10 tons per year of 1 HAP, or a combined total of 25 tons for multiple HAPs). Rule 3.13.110 contains criteria for exemptions from this process.
11	Hazardous waste treatment facility	22 CCR 66264.14	Relevant and Appropriate	Any proposed treatment facility is anticipated to maintain a fence in good repair that completely surrounds the active portion of the facility. A locked gate at the facility should restrict unauthorized personnel entrance.	Security prevents entry from unauthorized personnel.
12	Hazardous waste treatment facility	22 CCR 66264.15-16	Relevant and Appropriate	The hazardous waste facility standards require routine facility inspections conducted by trained hazardous waste facility personnel. Inspections are to be conducted at a frequency to detect malfunctions and deterioration, operator errors, and discharges that may be causing or leading to a hazardous waste release and a threat to human health or the environment.	Substantive provisions are relevant and appropriate to the groundwater treatment facilities for this Site.
13	Hazardous waste treatment facility	22 CCR Div 4.5, Chap. 14, Art. 3	Potentially Relevant and Appropriate	Facility design and operation to minimize potential fire, explosion, or unauthorized release of hazardous waste.	Substantive provisions are relevant and appropriate to the groundwater treatment facilities for this Site.

Table D-3
Action-specific ARARs

	Location	Requirement	ARAR Determination	Description	Comments
14	Hazardous waste treatment facility	22 CCR Div. 4.5, Chap. 14, Art. 6	Relevant and Appropriate	The requirements present the groundwater monitoring system objectives and standards to evaluate the effectiveness of the corrective action program (remedial activities). After completion of the remedial activities and closure of the facility, groundwater monitoring will continue for an additional 3 years to ensure attainment of the remedial action objectives.	Substantive provisions are relevant and appropriate to the groundwater treatment facilities for this Site.
15	Hazardous waste treatment facility	22 CCR Div. 4.5, Chap. 14, Art. 7	Relevant and Appropriate	The closure and post-closure requirements establish standards to minimize maintenance after facility closure to protect human health and the environment.	Substantive provisions of the closure and post-closure requirements are relevant and appropriate to the selected remedy. Clean closure of the treatment facility through equipment decontamination and removal of any hazardous waste is anticipated.
16	Hazardous waste container storage	22 CCR 66264.171, 172, 173, 174	Potentially Applicable	Containers of RCRA hazardous waste must: 1. Be maintained in good condition. 2. Be compatible with hazardous waste to be stored. 3. Be closed during storage except to add or remove waste. 4. Have adequate secondary containment when stored onsite.	These requirements are applicable to any hazardous wastes that are generated and stored temporarily in containers at Frontier Fertilizer prior to offsite disposal and may include wastes such as soil, debris, or treatment residuals (water, sludge, filters).
17	Hazardous waste container storage	22 CCR 66264.175 (a) and (b)	Potentially Applicable	Place containers on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide a containment system with a capacity of 10 percent of the volume of containers with liquids. Remove spilled or leaked waste in a timely manner to prevent overflow of containment system.	These requirements are applicable to hazardous wastes that are generated and stored temporarily in containers at Frontier Fertilizer prior to offsite disposal.

Table D-3
Action-specific ARARs

	Location	Requirement	ARAR Determination	Description	Comments
18	Hazardous waste container storage	22 CCR 66262.30 through 66262.33	Potentially Applicable	Prior to transportation, containers would be packaged, labeled, marked, and placarded in accordance with RCRA and Department of Transportation requirements.	These requirements are applicable to containers that are used to contain hazardous wastes that are sent offsite for disposal.
19	Shipping hazardous waste offsite	22 CCR 66262.11- 66262.23	Potentially Applicable	Prior to transportation, generator must determine whether waste is hazardous prior to shipping waste offsite. Once determination has been made, generator must obtain and use a manifest.	Applicable to actions that send hazardous waste (including treatment byproducts) offsite for treatment, storage, or disposal.
20	Hazardous waste accumulation	22 CCR 66262.34	Potentially Relevant and Appropriate	Accumulation of hazardous wastes onsite for longer than 90 days would be subject to the substantive RCRA requirements for storage facilities.	Substantive provisions are relevant and appropriate to hazardous waste that is stored temporarily onsite prior to offsite disposal.
21	Treatment	22 CCR 66264.601-603 and 22 CCR 66265.401	Relevant and Appropriate	These regulations include design, operation, maintenance, and closure requirements for miscellaneous treatment units and units that use chemical, physical, or biological treatment methods to treat hazardous waste.	Substantive provisions are relevant and appropriate.
22	Treatment	22 CCR 66264.192, 193, 194, and 196	Relevant and Appropriate	These regulations include requirements to ensure that tanks and ancillary equipment are adequately designed, operated, and maintained to ensure that the tank system will not fail.	Substantive portions of these requirements may be relevant and appropriate to tanks that are used during hazardous waste treatment.

Table D-3
Action-specific ARARs

	Location	Requirement	ARAR Determination	Description	Comments
23	Disposal	42 U.S.C. 6939 b (b)	Potentially Relevant and Appropriate	This policy established by EPA exempts water from LDRs, if two conditions are met: • Groundwater has been treated to reduce hazardous constituents prior to reinjection. • The CERCLA response action must be sufficient to protect human health and the environment.	Substantive provisions are relevant and appropriate to treated reinjected groundwater.
24	Discharge of waste to water including discharge to soil	State Water Resources Control Board Resolution 68-16 ("Antidegradation Policy")	Relevant and Appropriate	Requires that high-quality surface- and groundwaters be maintained to the maximum extent possible to protect all beneficial uses unless certain findings are made. Discharges to high quality waters must be treated using best practicable treatment or control, necessary to prevent pollution or nuisance and to maintain the highest water quality consistent with maximum benefit to the people of the state. Requires cleanup to background water quality or to lowest concentrations technically and economically feasible to achieve.	Substantive provisions are relevant and appropriate to remedial actions at Frontier Fertilizer that involve reinjection of treated groundwater must comply with substantive provisions to protect beneficial uses and the maintenance of high-quality waters in the area. If degradation is allowed, the discharge must meet best practical treatment or control, and result in the highest water quality possible consistent with the maximum benefit to the people of the state.
25	Surface and groundwater cleanup	State Water Resources Control Board Resolution 92-49, IIIg	Relevant and Appropriate	Requires that RWQCBs ensure that dischargers clean up and abate the effects of discharges in a manner that promotes the attainment of either background quality or water quality that is reasonable if background water quality cannot be restored.	Substantive provisions are relevant and appropriate to any discharges to groundwater must consider attainment of the highest water quality that is economically and technically achievable. Potentially relevant to cleanup of discharges that affect or may affect the waters of the state.

Table D-3
Action-specific ARARs

	Location	Requirement	ARAR Determination	Description	Comments
26	Underground Injection of treated groundwater	40 CFR 144.12, excluding the reporting requirements in 144.12 (b), 144.12 (c)(1), 146.12 (d) and 146.13 (a), (b), (d)	Relevant and Appropriate	Any injection wells utilized as part of the selected remedy will be Class V wells under the UIC program.	There are currently no specific technical requirements for injection into Class V wells. Substantive provisions of the UIC rules are relevant and appropriate only to the extent necessary to ensure that reinjection of treated groundwater will not cause the aquifer underlying the Frontier Fertilizer Site to violate primary drinking water regulations.
27	Water discharges	SWRCB Resolution 88-63	Potentially Relevant and Appropriate	Specifies that with certain exceptions all ground and surface waters have the beneficial use of municipal or domestic water supply. SWRCB Resolution 88-63 applies to all sites that may be affected by discharges of waste to groundwater or surface water. The resolution specifies that with certain exceptions all groundwater and surface waters have beneficial use of municipal or domestic water supply. Exceptions include: • TDS exceeds 3,000 mg/L or • Water source does not provide sufficient water to supply a single well capable of producing an average sustained yield of 200 gallons per day.	Substantive provisions are relevant and appropriate to determine beneficial uses for waters that may be affected by discharges of waste.