RECORD OF DECISION

PEMACO MAYWOOD SUPERFUND SITE
MAYWOOD, CALIFORNIA

U.S. Environmental Protection Agency

Region 9

San Francisco, California

EPA ID: CAD980737092

JANUARY 13, 2005

RECORD OF DECISION

PEMACO SITE

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LIST OF ACRONYMS

ALs	Action Levels, California
ARARs	Applicable or Relevant and Appropriate Requirements
ASTs	aboveground storage tanks
Bgs	below ground surface
BTEX	benzene, toluene, ethyl benzene and xylenes
CalEPA	State of California Environmental Protection Agency
CCR	California Code of Regulations
CFR	Code of Federal Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
cis-1,2-DCE	cis-1,2-dichloroethene
COCs	chemicals of concern
CPT	cone penetration testing
CSM	Conceptual Site Model
CT	central tendency
DAF	Dilution Attenuation Factor
DCE	dichloroethene
DHS	California Department of Health Services
DNAPLs	Dense Non-Aqueous Phase Liquids
DO	dissolved oxygen
DTSC	Department of Toxic Substances Control, State of California

LIST OF ACRONYMS (CONTINUED)

EISB	Enhanced *In-Situ* Bioremediation
ELCR	excess lifetime cancer risk
EPA	Environmental Protection Agency
EPCs	exposure point concentrations
ERH	Electrical Resistance Heating
ESI	Expanded Site Investigation
FASP	Field Analytical Screening Program
FS	Feasibility Study
Ft	foot or feet
FTO	Flameless Thermal Oxidation
GAC	Granular Activated Carbon
HAST	Health Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
HRC®	hydrogen release compound
HRS	Hazard Ranking System
HVDPE	High-Vacuum Dual-Phase Extraction
IRIS	Integrated Risk Information System
ISCO	*In-Situ* Chemical Oxidation
ISCR	*In-Situ* Chemical Reduction
LAJR	Los Angeles Junction Railway
LARWQCB	Los Angeles Regional Water Quality Control Board
MCLs	Maximum Contaminant Levels
mg/kg	milligram per kilogram
MIP	membrane interface probe
MNA	Monitored Natural Attenuation
MRP	Maywood Riverfront Park
NAPLs	Non-Aqueous Phase Liquids
NCP	National Oil and Hazardous Substances Pollution Contingency Plan

LIST OF ACRONYMS (CONTINUED)

NHVOC	non-halogenated volatile organic compound
NPL	National Priority List
O&M	operation and maintenance
OEHHA	Office of Environmental Health Hazard Assessment
ORP	oxidation reduction potential
P&T	pump and treat
PAHs	polyaromatic hydrocarbons
PCE	tetrachloroethene
PHGs	Public Health Goals
ppb	parts per billion
PRGs	Preliminary Remediation Goals
PRP	potential responsible party
PUMA	Padres Unidos de Maywood (United Maywood Parents)
QA/QC	Quality Assurance/Quality Control
RAOs	Remedial Action Objectives
RD	Remedial Design
RfD	reference dose
RI	Remedial Investigation
RME	reasonable maximum exposure
ROD	Record of Decision
ROI	radius of influence
SARA	Superfund Amendments and Reauthorization Act
SCAQMD	South Coast Air Quality Management District
Scfm	standard cubic ft per minute
SSLs	Soil Screening Levels
SSRGs	site-specific remediation goals
START	Superfund Technical Assessment and Response Team
SVE	soil vapor extraction
SVOCs	semi-volatile organic compounds
SWRCB	State Water Resources Control Board

LIST OF ACRONYMS (CONTINUED)

TAT	turn-around time
TBC	to be considered
TCA	trichloroethane
TCE	trichloroethene
TMV	Toxicity, Mobility, or Volume
TOSC	Technical Outreach Services for Communities
UCL	upper confidence limit
µg/kg	microgram per kilogram
µg/L	microgram per Liter
USTs	underground storage tanks
UTL	upper tolerance limit
UV Ox	Ultraviolet Oxidation
VC	vinyl chloride
VE	vapor extraction
VOCs	volatile organic compounds

PART I DECLARATION

1.0 Site Name and Location

Pemaco Maywood
5050 Slauson Boulevard
Maywood, Los Angeles County, California
CERCLIS Identification # CAD980737092

2.0 Statement of Basis and Purpose

This Record of Decision (ROD) presents the selected remedial actions for the Pemaco Maywood (Pemaco) Superfund Site in Maywood, California. This document was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 USC Section 9601 et. seq., and to the extent practicable the National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR Section 300 et. seq., (NCP). The United States Environmental Protection Agency (EPA) issues this ROD pursuant to Section 104 of CERCLA and has selected the remedial action in accordance with Section 121 of CERCLA. This is considered a final site ROD. This decision is based on the administrative record for this site.

The State of California concurs with the selected remedy as documented by correspondence from the Department of Toxic Substances Control (DTSC) dated April 16, 2004.

3.0 Assessment of Site

Actual or threatened release of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

4.0 Description of Selected Remedy

The remedial investigation (RI) discovered that the Pemaco site has 56 chemicals with concentrations greater than preliminary remediation goals (PRGs) or federal and/or state regulatory limits in soil and/or groundwater. The chemicals of concern (COCs) consist of the following groups:

- Volatile organic compounds (VOCs) which include tetrachloroethene (PCE), trichloroethene (TCE), dichloroethene (DCE), vinyl chloride, and 1,4-dioxane;
- Metals;
- Non-halogenated volatile organic compounds (NHVOCs); and
- Semi-volatile organic compounds (SVOCs) which include polyaromatic hydrocarbons (PAHs).

This remedial action addresses the extent of COCs in each environmental media as they are currently defined through the Remedial Investigation/Feasibility Study (RI/FS) activities. Contaminated media include surface and near-surface soils, vadose zone soils, soil vapor and groundwater. The remedial action at the Pemaco Superfund site also aggressively addresses the principal threat waste by treating the hazardous substances present in the source areas, which will significantly reduce the mobility and/or volume of hazardous substances in the groundwater and soil media.

This action represents the final remedial action to treat and remove contaminants from soil and groundwater. Because the subsurface environment and contamination levels found at Pemaco were highly variable, EPA divided the site into three subsurface zones and evaluated assembled remediation alternatives by zone to develop an appropriate cleanup proposal for each individual zone. The zones identified at the Pemaco site are described as the following:

1. Surface and near surface soil remediation zone (0-3 feet (ft) below ground surface (bgs)); "N"
2. Upper vadose zone soil and perched groundwater (3-35 ft bgs); "SP"
3. Lower vadose zone soil and Exposition Zone groundwater (35-100 ft bgs): "SG".

The overall selected remedy for the entire site is composed of the selected remedial alternatives for each zone and is summarized below.

Surface and Near-Surface Soil Remediation Zone

Alternative N2 - Soil Cover/Revegetation

The end-use of the Pemaco Superfund site is a recreational public park. This remedial action would involve placement of a 1-foot layer, or approximately 4,550 cubic yards, of clean soil on the site with a non-woven geotextile layer between the soil cover and the native site soils. Implementation would take one to two months.

The direct capital cost estimate is $358,000 with a present worth value of $773,000. Implementation of this portion of the overall remedy will be coordinated with the City of Maywood as part of the City's design of the recreational park that includes the Pemaco property and the surrounding adjacent properties.

The City of Maywood's Remedial Action Plan for the Maywood Riverfront Park (June 2003) summarizes excavation activities and removal of approximately 6 "hot spots" on affected park properties (2 locations on the Pemaco property). These activities will be conducted by the City. The grading plan in that document shows all areas where remedial excavation will occur (Figure 5 of the City's document). Excavation of these 6 "hot spot" areas will occur during the park construction in 2005. EPA will conduct some oversite during these removal activities that will occur as a result of park development.

Upper Vadose Soils and the Perched Groundwater

Alternative SP-2a - High-Vacuum Dual-Phase Extraction (HVDPE) / Ultraviolet Oxidation (UV Ox) / Flameless Thermal Oxidation (FTO) / Granular Activated Carbon (GAC)

Approximately 32 extraction wells will be installed into the upper vadose zone soil layer (approximately 80,000 to 95,000 cubic yards of soil affected) and perched groundwater zone to remove contamination in both the liquid and gas phase. The perched groundwater plume has migrated approximately 250 ft to the south and 200 ft southwest of the Pemaco property. Approximately 1.4 million gallons of contaminated groundwater are estimated to be removed from the perched groundwater zone. Soil vapor contaminated with VOCs will be pumped to the surface and treated onsite using an FTO unit.

It is estimated that, after one year, concentrations of VOCs in the vapor will have decreased enough to switch to a GAC vapor treatment system for the remainder of the remedial action. Contaminated

groundwater will be pumped to the surface and treated onsite using a combination of liquid phase GAC and UV Ox.

The remedy for the upper vadose soils and the perched groundwater will achieve remediation levels that comply with ARARs and are protective of human health and the environment.

It is estimated that the treatment system will operate for 5 years and require an additional 5 years of monitoring. The estimated direct capital cost for this treatment zone is $1,407,000 with a present worth value of $4,838,000.

Lower Vadose Soils and Exposition Groundwater

Alternative SG5a – Electrical Resistance Heating (ERH) with Vapor Extraction (VE), Vacuum-Enhanced Groundwater Extraction, Groundwater Pump and Treat (Groundwater P&T), Monitored Natural Attenuation (MNA), UV Ox, FTO, and GAC

Treatment in this zone targets the highest concentrations of contaminated soil found at the site as well as the entire groundwater dissolved phase plume. The dissolved phase Exposition Zone groundwater plume extends southwest of the Pemaco property and lies beneath a two-block residential housing area. To address the principal threat soil and groundwater at the site, an in-situ thermal treatment process will be installed, hereafter referred to as Electrical Resistance Heating or ERH. The treatment system will consist of approximately 95 electrodes and 18 vapor extraction wells which will be installed within the 10,000 parts per billion (ppb) TCE groundwater contour. The electrodes and extraction wells will be installed to a depth of 100 ft bgs. Contaminated vapor will be extracted with a 1,500 standard cubic ft per minute (scfm) blower and treated onsite using a FTO unit. Groundwater will be treated onsite with a GAC/UV Ox unit.

Approximately 15.6 million gallons of VOC-contaminated groundwater and 14,000 cubic yards of VOC-contaminated soil have been identified in this zone. The vacuum-enhanced groundwater extraction network will address VOCs between the 10,000 ppb and 1,000 ppb groundwater TCE contours. This network will consist of approximately 12 vacuum enhanced groundwater extraction wells installed into the Exposition 'A' Zone (65 to 75 ft bgs) and the Exposition 'B' Zone (80 to 100 ft bgs). Fifteen extraction wells will be installed to address the contamination between the 1,000 and 10 ppb groundwater contours. The treated groundwater could be disposed by reinjection back into the aquifer, discharged to the sanitary sewer, or discharged to the LA River. EPA will comply with discharge requirements that are appropriate based on the option that is chosen during the design phase of the project.

Groundwater sampling in late 2003 indicated that groundwater from one well installed in the Exposition 'D' Zone (MW-24-140) contained low levels of VOCs (primarily TCE). The State of California (DTSC) requested that EPA place a groundwater extraction well at this location. Therefore, for the remedial action, the EPA will install an extraction well into the 'D' Zone (approximately 120-140 ft bgs) to extract groundwater from this location.

MNA will be used outside the 10 ppb groundwater TCE contour to demonstrate that the plume is being reduced. Onsite, FTO will be used to treat the VOC vapors extracted from the well network with a changeover to GAC when the vinyl chloride and 1,4-dioxane concentrations in the extracted vapor have decreased to acceptable levels. EPA estimates that the changeover should occur within one year. Groundwater will be treated with the GAC/UV Ox treatment system.

This remedy will also allow flexibility for in-situ oxidation and in-situ bioremediation of portions of the plume in conjunction with and/or after the ERH system has been installed. This component will only be used if the Agency determines that the addition of an in-situ treatment polishing step is needed to augment treatment of the 10,000 to 1,000 ppb groundwater contour. ERH will operate for approximately one year for treatment on the greater than 10,000 ppb contour source area. Vacuum-enhanced

groundwater extraction treatment is expected to continue for approximately 4 additional years. Groundwater monitoring is required for an additional 5 years for a total of 10 years. The remedy for the lower vadose soils and the Exposition groundwater will achieve remediation levels that comply with ARARs and are protective of human health and the environment.

The estimated capital cost for implementing the treatment system for this zone is $4,175,000 with a present worth value of $8,733,000.

Since the Pemaco site is located in a residential area, in this Record of Decision EPA is prohibiting the residential use of the Pemaco property through zoning and the use of an existing deed restriction. If after implementation of the remedy, hazardous waste will remain at the property at levels which are not suitable for unrestricted use of the land additional institutional controls may be required in the form of a State of California Land Use Covenant with the City of Maywood.

In response to comments received during the public comment period, EPA will conduct the following activities during remedy implementation:

- Vapor effluent monitoring of the FTO unit with dioxin and furans included in the list of analytes;
- Indoor air sampling and additional vapor monitoring on Walker Avenue and 59th Street;
- A heat exchanger and a vapor phase carbon adsorption unit will be installed to the post-exhaust side of the FTO unit;
- Development of a community involvement plan that will outline the lines of communication to disseminate final design, operations, and monitoring data to the community.

The total present worth value of the overall selected remedy for the Pemaco Superfund Site is $13,570,000.

5.0 Statutory Determinations

The selected remedy satisfies the statutory requirements of CERCLA. The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy uses permanent solutions, an innovative technology (electrical resistive heating to depths of 100 ft in the source area), and alternative treatment (or resource recovery) technologies to the maximum extent practical and satisfies the statutory preference for remedies that employ treatment that reduces the toxicity, mobility, or volume of hazardous substances, pollutants or contaminants as a principal element.

If this remedy results in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, California law requires an environmental restriction be placed on the property pursuant to 22 CCR 67391.1. Further, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment. Additional five year reviews will be conducted after the initial review if appropriate.

6.0 ROD Data Certification Checklist

The following information is included in the Decision Summary section of this ROD. Additional information can be referenced in the Administrative Record file for Pemaco.

- COCs and their respective concentrations, p. 22-35
- Baseline risk from COCs, p. 37-55
- Cleanup levels established for COCs, p. 11-15
- Description of Principal Threat Wastes, p. 116
- Current and anticipated future land use assumptions and current and potential future beneficial uses of groundwater, p. 35-37
- Potential land and groundwater use that will be available to the site as a result of the selected remedies, p. 35-37
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rates, and the number of years over which the remedy cost estimates are projected, p. 122-129
- Key factors that led to selecting the remedy, p. 131-133

7.0 Authorizing Signature

Elizabeth J. Adams, Chief
Site Cleanup Branch
U.S. Environmental Protection Agency, Region 9

Date

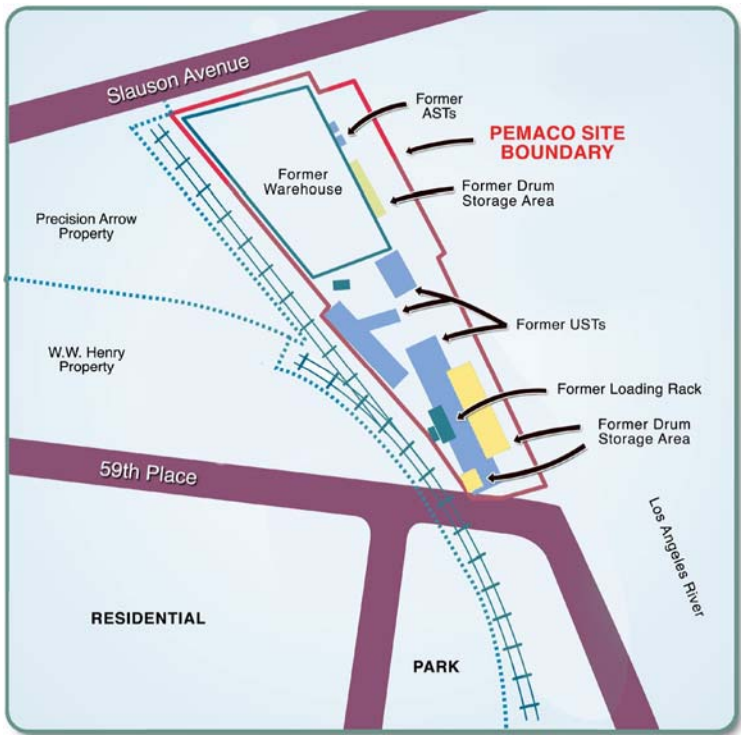
PART II DECISION SUMMARY

1.0 Site Name, Location, and Description

The Pemaco Superfund Site (Pemaco) is a 1.4-acre site located at 5050 Slauson Avenue in the City of Maywood, California (CERCLIS Identification Number CAD980737092). Maywood is an urban area located in eastern Los Angeles County. The site is adjacent to a residential neighborhood, a residential park and light industry immediately to the south, a heavy industrial area immediately to the north, an abandoned industrial property to the west and it is bordered by the concrete lined Los Angeles River to the east (see Figures 1-1 and 1-2). The EPA is the lead agency.

Figure 1-1. Site Location Map

Figure 1-2. Site Layout



The former Pemaco site was used as a chemical blending facility and chemical distributor from the late 1940s until June 1991. Historically, the Pemaco facility consisted of a 22,000-square-foot warehouse in the northern portion of the property and 31 underground storage tanks (USTs) and at least six aboveground storage tanks (ASTs) in the south part of the site. Large quantities of chemicals were stored in the ASTs and USTs, which ranged in size from 500 to 20,000 gallons, and in 55-gallon drums stored sporadically around the site.

Several chemicals have been identified as COCs for the Pemaco site. The types of chemicals discovered and the media type are summarized in Table 1-1. Chemicals of concern consist of TCE, PCE, benzene, toluene, hexane, ethyl benzene, methylene chloride, and vinyl chloride, as well as floating free product at multiple locations within the saturated zones. Specific analytes for each media will be presented in Section 5.0.

Table 1-1. Types of Chemicals of Concern Per Media

Media or Zone	Number of COCs Present	Types of COCs	Depth (ft bgs)	Extent
Ambient Air	11	VOCs	Breathing Zone	Onsite and offsite
Soil Vapor	12	VOCs	5 to 15	Onsite and offsite
Surface and Near Surface Soil	11	SVOCs and Metals	6 inches to 2.5	Onsite and adjacent industrial properties
Upper Vadose Zone	21	NHVOCs, VOCS, SVOCs and Metals	2.5 to 35	Onsite

Table 1-1. Types of Chemicals of Concern Per Media

Media or Zone	Number of COCs Present	Types of COCs	Depth (ft bgs)	Extent
Lower Vadose Zone	11	VOCs and Metals	35 to 65	Onsite
Perched Groundwater	28	NHVOCs, VOCs, SVOCs and Metals	25 to 35	Mixed VOC plume to 200 ft southwest of site
Exposition Groundwater Zone	20	NHVOCs, VOCs and Metals	65 to 110	VOC plume (mainly TCE) extends 1,100 ft southwest of site

VOC = volatile organic compounds NHVOC = non-halogenated volatile organic compounds

2.0 Site History and Enforcement Activities

2.1 Site History

Pemaco, Inc. formerly operated a custom chemical blending and distribution facility at 5050 E. Slauson Blvd. in Maywood, California, from the late 1940s until 1991 (E&E, 1998). A wide variety of chemicals were used onsite including chlorinated and aromatic solvents, flammable liquids, oils, and specialty chemicals. Marie B. Richardson was the owner of Pemaco, Inc. until 1984, at which time Lux International purchased the property(owner Lawerence Sze). Lux International operated the chemical blending facility until 1991 when they went out of business. No other use of the property is documented since 1991. Historically, the Pemaco facility consisted of a 22,000-square-foot warehouse in the northern portion of the property, and 31 USTs and at least 6 ASTs in the southern part of the property (Figure 1-2). Large quantities of chemicals were stored in the ASTs and USTs, which ranged in size from 500 to 20,000 gallons, as well as 55-gallon drums sporadically stored around the site. Most of the chemicals brought to the site were delivered via railcar from a rail spur that branched out from the Los Angeles Junction Railway (LAJR) property west of the site.

The first environmental investigation at Pemaco was performed by the site owner in 1990. Sixteen soil borings (B-1 through B-16) were drilled from 30 ft to 40 ft bgs and sampled every 5 ft. Each soil sample was analyzed for benzene, toluene, ethyl benzene and xylenes (BTEX) and NHVOCs and two samples from each boring were analyzed for VOCs as determined by field screening. Contaminants were detected in every boring. Toluene and paraldehyde were the most prevalent but benzene, PCE, DCE, and TCE were the only chemicals exceeding regulatory levels. Each boring was converted to a shallow monitoring well (B-1 through B-16), however, no indication of any groundwater sampling was reported.

Operations ceased at Pemaco during 1991. Between 1991 and 1994, approximately 400 55-gallon drums and three ASTs were removed from the site by order of the Los Angeles District Attorney's office. A substantial fire in 1993 destroyed much of the main warehouse building. In 1994, EPA Region IX Emergency Response conducted a removal assessment at Pemaco at the request of Los Angeles County. As a part of this assessment, EPA removed six 55-gallon drums, installed fencing, and secured UST fill pipes with locking well caps.

In June of 1995, EPA completed a preliminary assessment and site investigation at Pemaco. Pemaco was then entered into CERCLIS in 1995 under the I.D. number CAD980737092.

From February through May of 1997, EPA's Superfund Technical Assessment and Response Team (START) completed an Expanded Site Investigation (ESI), which included collection of additional soil samples, installation of monitoring wells, sampling of new and existing wells, and an evaluation of Hazard Ranking System (HRS) factors. The final listing on the National Priority List (NPL) occurred on January 19, 1999.

EPA completed additional removal activities at Pemaco between August 1997 and March 1998 under the direction of Region IX's Emergency Removal Office (E&E, 1998a, 1998b). Work included excavation and removal of USTs, air monitoring, building demolition, surface soil sampling for VOCs, soil vapor monitoring, subsurface soil sampling, groundwater sampling, remedial pilot tests, design and installation of a soil vapor extraction (SVE) system, and operation of the SVE system. The SVE system operated between March 1998 and March 1999 (E&E, 1999). By the end of August 1998, the SVE system had operated for 3,230 hours (134.6 days), and removed and treated approximately 90,000 pounds of hydrocarbons and solvents from vadose zone soils at the site. The SVE system was turned off on March 3, 1999 because the system had achieved its goals and because of community concern regarding the possibility of dioxin releases from the thermal oxidation unit.

Between January 2001 and March 2002, the EPA initiated the RI/FS for the site. The draft RI report was reviewed by the Agency in October 2002. Based on comments received from the State of California DTSC, the EPA installed additional deeper groundwater sampling wells during the summer of 2003. EPA also conducted additional rounds of indoor air sampling in the neighborhood surrounding the site during March and May 2003.

Based on the EPA's analysis of the previous indoor air sampling results and EPA consideration of a possible change to the TCE toxicity value, another round of air sampling was conducted during August 2003. The additional sampling effort was conducted to determine if the vapor intrusion pathway was causing a potential health risk via indoor air. The August 2003 sampling event was conducted to assess the need for an emergency removal action. The purpose of the action was to gain data so that the Agency could make a determination of whether or not soil vapor migration had caused migration of contaminants into the homes near the site at levels that would pose an unacceptable risk. Sampling activities included the EPA offering homeowners across the street from Pemaco a 24-hour relocation while the EPA conducted the August 2003 indoor air sampling. EPA sampled approximately 28 homes during this sampling effort. The EPA subsequently analyzed the data received from this sampling round and previous sampling efforts and determined that a separate remedy for the homes was not necessary. However, EPA determined that implementation of the remedy for the Pemaco Superfund site would ensure that detectable levels of chemicals found in the soil vapor would decrease and prevent a possible future vapor intrusion problem for the residential neighborhood.

2.2 Enforcement Activities

EPA conducted a Potential Responsible Party (PRP) search for the Pemaco Superfund site and the final report was completed during 2004. The search did not identify any transporter or generator PRPs for the Pemaco Superfund Site. The Department of Justice filed a civil action for Section 107 cost recovery and relief against Pemaco, Inc. and Mr. Lawrence Sze in 2000. EPA received $50,000 as a settlement with Mr. Sze, and the suit against Pemaco, Inc. was dismissed. The City of Maywood acquired the property from the Trust for Public Land (Trust) on December 30, 2002. EPA signed a prospective purchaser agreement with the Trust prior to the acquisition. The City of Maywood plans to construct a public recreational park on the former Pemaco site and five other surrounding properties.

Remedial investigations have shown that there is a co-mingled groundwater plume existing between Pemaco and the W.W. Henry property which is adjacent to the site at 5989 District Boulevard. W.W. Henry operated as a manufacturer of batteries, cosmetics, and adhesive products at this location. The site stored chemicals in USTs and aboveground mixing tanks. The chemicals reportedly used on site included: PCE, 1,1,1-trichloroethane (1,1,1-TCA), toluene, hexane, naptha, methanol, mineral spirits,

acetone, and isopropyl alcohol. The Pemaco RI detected PCE, toluene, and hexane that could be attributed to the W.W. Henry property in soils and groundwater. Although cleanup activities at the WW Henry property have been conducted via enforcement orders issued by the Los Angeles Regional Water Control Board, EPA issued a General Notice letter to W.W. Henry in January 2004 for this co-mingled area.

3.0 Community Participation

Since the 1998 removal actions, a community relations program has been ongoing at the Pemaco Superfund site and the requirements for public participation under CERCLA Section 113(k)(2)(B)(i)-(v) have been met. In 1998, EPA mailed fact sheets to community members and held a public meeting to discuss the removal activities conducted at the site. In 2000 and 2001, EPA mailed fact sheets and held community meetings to discuss the upcoming investigation activities, toxicity of chemicals found at the site, groundwater flow beneath the site and the preliminary findings of the RI. EPA requested feedback from residents attending the 2001 meeting. Many residents requested that the EPA cleanup the site as soon as possible because the residents wanted the Maywood Riverfront Park to be constructed without impediment from the Superfund site.

The RI/FS and Proposed Plan for the Pemaco Superfund site were released to the public on April 4, 2004. These documents were made available to the public in the administrative record through the EPA offices in San Francisco, CA and at an information repository maintained at the Maywood Cesar Chavez Public Library. EPA provided electronic copies of the administrative record and RI/FS to a community group in the City of Maywood, and a copy was placed at the Maywood Activity Center. The Proposed Plan was produced in both English and Spanish.

EPA published a notice in two newspapers serving the Maywood City area. The notices were placed in *The Press* (a division of the Wave Newspaper Group) on April 1, 2004 and *La Opinion* (a Spanish language newspaper) on April 2, 2004. In addition, on April 1, 2004 and April 2, 2004 2,500 flyers were given to students at the local schools to take home to their parents. Flyers were also made available at the library, city offices, and Municipal Drinking Water offices. The Maywood City Newsletter, which is published by the City of Maywood, also contained a copy of the public notice in English and Spanish. The newsletter is delivered to all mail addresses in the City of Maywood.

The April 1, 2004 public notice summarized EPA's proposed remedy for the site and invited citizens to attend a public hearing on April 17, 2004 at the Maywood Community Center. During the first week of the public comment period, EPA received a request from a community group in Maywood, Padres Unidos de Maywood (United Maywood Parents) known as PUMA to extend the public comment period an additional 60 days. EPA agreed to extend the public comment period 30 days and told the community group it would make a decision regarding the additional 30 days after the community meeting on April 17, 2004. The project manager and community involvement coordinator spoke at three high schools on April 16th and gave out flyers inviting students and parents to attend the April 17, 2004 public hearing.

A presentation of the proposed cleanup was made at the April 17 public meeting. Representatives from the community, EPA, Congresswoman Roybal-Allard's office, and contractors attended the public meeting. EPA staff answered questions about the investigation conducted at the site, the remedial alternatives evaluated during the FS process, and EPA's proposed alternative. Residents at the meeting requested that EPA extend the public comment period an additional 60 days. After the April 17th public hearing, EPA extended the public comment period to July 6, 2004, and published notices on April 29, 2004 in *The Press* and *La Opinion* to announce the extension of the public comment period an additional 63 days. The public notice also announced a second public hearing for the project which was held on May 22, 2004. EPA also purchased a second mailing list and sent out a second summary proposed plan fact sheet to all the addresses in the City of Maywood. This second fact sheet was four pages in English and Spanish. It invited residents to attend the second public hearing, announced the extension of the public comment period to July 6, 2004, and provided a summary of EPA's proposed plan. In addition,

EPA officials and contractors met with the community group PUMA at its regular weekly meeting on May 13th to answer questions about the proposed remedy.

The second public hearing was held on May 22, 2004 at the Maywood Activity Center. EPA staff invited a headquarters expert specializing in electrical resistive heating to attend the meeting as well as a contractor representing FTO to provide discussion and examples on use of these technologies at other sites across the country. In addition, EPA regional staff presented the proposed remedy again and held a second public comment session on the remedy. A response to the comments received from both public hearings and the public comment period is included in the responsiveness summary, which is a part of this ROD (see Part III).

EPA also facilitated a meeting between the community group PUMA and the Technical Outreach Services for Communities (TOSC). During the public comment period, EPA also responded to several e-mail questions and requests for additional information from the PUMA group members or community activists. In addition, EPA personnel participated in a round table discussion on a radio show entitled "Nuestra Voz en el Medio Ambiente" (Our Voice in the Environment) on June 10, 2004. EPA also continued community outreach activities by meeting with PUMA representatives during September, October and November 2004.

4.0 Scope and Role of Response Action

The Pemaco site had numerous sources of contamination (USTs, ASTs, drums, and sumps) that caused contaminant releases to soil and in turn, created multiple overlapping groundwater plumes at various depths.

This ROD addresses the entire extent of contaminated media underlying the Pemaco site, which consists of soils, soil vapor, and groundwater. This action aggressively addresses the highest contaminant levels found in soils and groundwater, which are a principal threat at this site. These source areas pose a principal threat because of risks posed from continued migration of contaminants into the groundwater and soil vapor. The purpose of this response action is to prevent any further migration of contaminants into the groundwater, prevent possible future exposure to the public of soil vapor containing contaminants from the site, prevent possible exposure to the public of contaminated soil, prevent further migration of contaminants onto adjacent properties, and to prevent contamination of underlying drinking water aquifers. The response actions will be performed to meet the final site treatment levels listed in Table 8-1. These levels are based on Applicable or Relevant and Appropriate Requirements (ARARs) and health protection criteria for groundwater.

The RI determined that the media zones beneath the site were very distinct and needed to be separated by depth to be properly addressed. The site was not divided into Operable Units, mainly due to the contiguous nature of the overlapping soil and groundwater plumes. To facilitate remediation decisions, an approach was developed that identified compatible combinations of media zones and treatment technologies for groundwater and soil. The following three remediation zones were identified in the RI/FS:

- Surface and Near-Surface Soil Remediation zone (0-3 ft bgs);
- Upper Vadose Soil and Perched Groundwater Remediation zone (3-35 ft bgs); and
- Lower Vadose Soil and Exposition Groundwater Remediation zone (35-100 ft bgs).

Contamination within the surface/near surface soil remediation zone and the upper vadose zone soil and perched groundwater remediation zone was found to be relatively homogenous with generally linear-type variances in concentrations. However, contamination within the lower vadose zone soil and Exposition groundwater remediation zone depicted wide-range, logarithmic variances in concentrations (*i.e.,* 10,000 ppb contour; 1,000 ppb contour; 100 ppb contour; and 10 ppb contour of the composite groundwater plumes). These plume contours were used to define suitable remediation technologies that were

appropriate for implementation within a zone based upon the volume of contaminant concentrations and the effectiveness of a technology in remediating each zone. Treatment alternatives were assembled for each zone and each suite of alternatives within a zone was compared against the nine criteria to come up with the best alternative for that treatment zone.

The selected remedy addresses the documented potential threats from the site to groundwater and soil. Surface water has not been identified as being of concern. Treatment of the contaminated groundwater will significantly reduce further horizontal and vertical migration of contaminants and prevent the possibility of contaminants migrating into regional drinking water aquifers. Treatment of the contaminated soil will prevent further migration of contaminated soil vapor, prevent future indoor air migration of these contaminants, prevent further contamination of the groundwater, and reduce toxicity and mobility of contaminants.

5.0 Site Characteristics

5.1 Conceptual Site Model

The conceptual site model (CSM) for the Pemaco Superfund site was developed in the early stages of the RI and has subsequently been updated (see Figure 5-1) as new information was developed. The conceptual site model was based on the following exposure pathways:

1. Ingestion and direct contact with surface and subsurface soil;
2. Inhalation of airborne contaminants in outdoor air originating from soil;
3. Ingestion, dermal contact, and inhalation of groundwater contaminants; and
4. Inhalation of indoor air contaminants originating from soil and groundwater contamination.

The receptors include future park users, excavation workers, and future onsite and offsite residents. The park user scenario represents the most likely future land use because the property is slated for development into the Maywood Riverfront Park. The excavation worker scenario was evaluated to determine if exposure to contaminants in subsurface soil would raise human health concerns (especially during redevelopment activities).

The planned future land use for the Pemaco property is as a park. Residential use of the property is being prohibited through zoning and by institutional controls in this document. While actual domestic use of untreated groundwater from the Exposition groundwater zones is unlikely because of the availability of a municipal water supply in the community and due to restrictions on development of private groundwater wells by the LARWQCB, EPA evaluated a residential scenario which included the use of groundwater to provide a conservative evaluation of all possible risks to human health.

Additional elements of the conceptual site model which include site use information, geologic and hydrologic information, contaminant source and release information, contaminant distribution, transport, and fate parameters are discussed below.

5.1.1 Current Site Description and Surrounding Use Information

The former Pemaco site is located in a mixed use industrial and residential area. All structures were removed from the site during the removal activities. The 1.4-acre site is currently a dirt lot with a small temporary storage trailer for EPA contractors. There is a remnant concrete pad that is orientated north-south and runs along the site's eastern border. The nearest residence is approximately 130 ft west-southwest of Pemaco's front gate located on the corner of District Blvd. and 59th Place. The residential neighborhood consists primarily of single-story homes of low- to moderate-income families and apartments on neighboring lots. Heliotrope Elementary School is approximately 0.3 miles west of Pemaco, and there are heavy industrial areas north of Pemaco, and north of Slauson Avenue. The lot

directly south of the Pemaco site is comprised of an abandoned industrial site (former Lubricating Oil Services) and a small residential park.

Immediately west of the Pemaco site is a 50-foot-wide railroad right-of-way that was used by Pemaco to load and receive products. There are two industrial properties on the west side of the tracks, one of which, the W.W. Henry property, has had several reported releases.

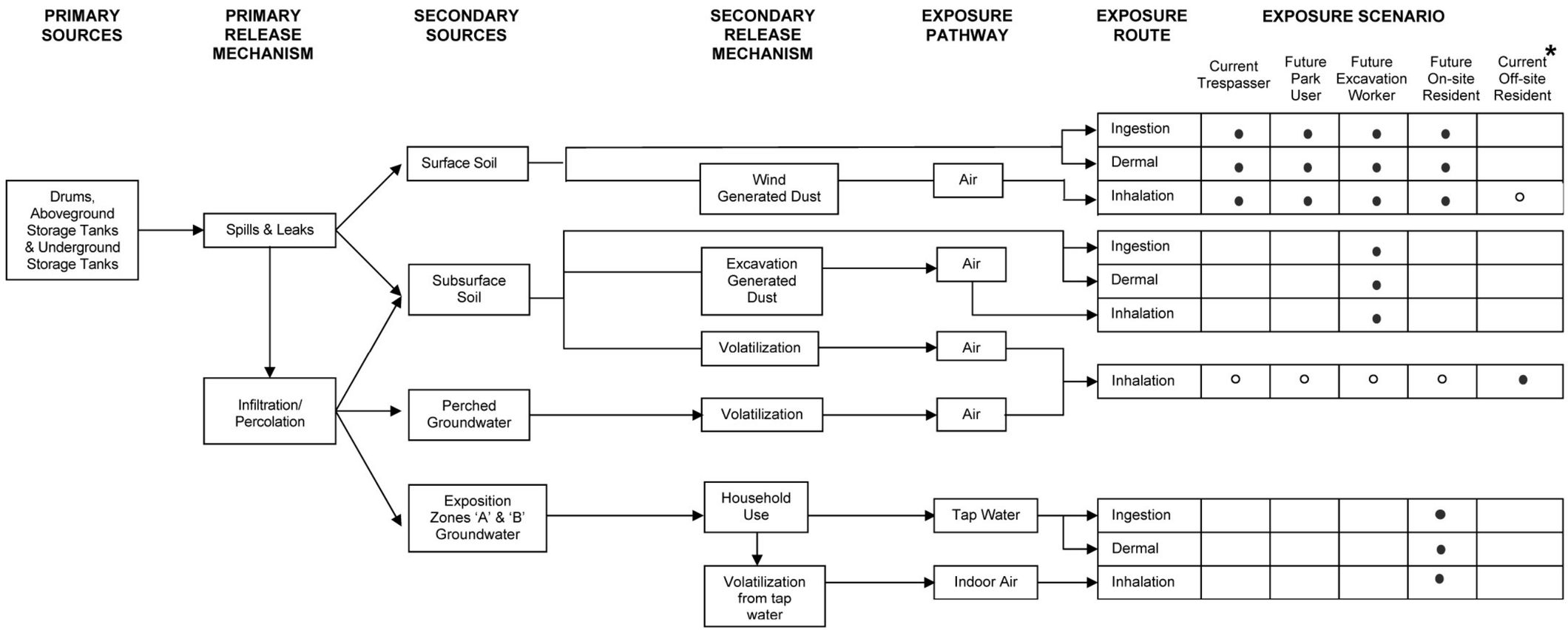
5.1.2 Drinking Water Wells

The groundwater beneath the Pemaco Superfund site is considered a future potential drinking water source by the State of California. Thirteen water purveyors supply drinking water to approximately 339,000 people by drawing groundwater from 78 wells within 4 miles of the site. The nearest down-gradient well from the site is located 0.3 miles to the south of Pemaco. There is also another down-gradient well located 0.75 miles southwest of the site.

The shallowest saturated zone within the Lakewood Formation is known as the Exposition Aquifer and is typically present between 65 ft bgs and 200 ft bgs, however in the site area the Exposition is comprised of several thin saturated zones separated by aquitards and is not currently used for drinking water. The local production wells are screened in aquifers located in the deeper San Pedro Formation (~350 to 1,500 ft bgs).

Figure 5-2 illustrates a simplified schematic of the deep aquifer system and local production wells.

Figure 5-1. Human Health Conceptual Site Model for Pemaco



Notes

● Completed pathway evaluated quantitatively

o Completed pathway not evaluated quantitatively

* Current off-site resident evaluated for exposures to chemicals found during indoor air sampling; however these chemicals may not be related to the Pemaco site.

5.2 Subsurface Conditions

5.2.1 Surface and Near Surface Soils

Surficial soils at Pemaco are typically silty sands and clayey sands that are non-native engineered fill placed for previous grading purposes to support former roads, former building pads and the removal activities in 1997. This fill typically extends two to three ft bgs and locally up to 6 ft. Granitic gravel covers the surface that underlies the adjacent railway west of Pemaco. This gravel base is generally 2 to 3 ft thick.

5.2.2 Upper Vadose Zone Soils

The upper vadose zone is comprised of silty sand with local clay and silt lenses and is typically located between 2 to 30 ft bgs. There is a laterally continuous clay interval that ranges from 1 to 10 ft thick and is found between 30 to 40 ft bgs. The perching clay, where it is thick, has local saturated silty sand intervals within it. The bottom of the upper vadose zone is placed at the base of this "perching clay."

5.2.3 Lower Vadose Zone Soils

Lower vadose zone soils are comprised of interbedded clayey silts, silty clays, silty sands and sands from 35 to 65 ft bgs. There is an unsaturated sand interval that is typically encountered between 40 and 50 ft bgs. This lower vadose zone sand varies from 1 to 14 ft thick and is predominately fine to medium grained sands and gravelly sands. The lower vadose zone sand appears to be continuous throughout the area as it was encountered in every boring completed in the site vicinity except in the area adjacent to MW-12 (Alamo and 60th Street) where is appears to pinch out locally. The thickest sequences are found along District Blvd, and in the area underlying 60th Street between Walker Avenue and District Boulevard. The interval between 50 and 65 ft bgs is generally fine grained (silts/clays) with thin local silty sand lenses.

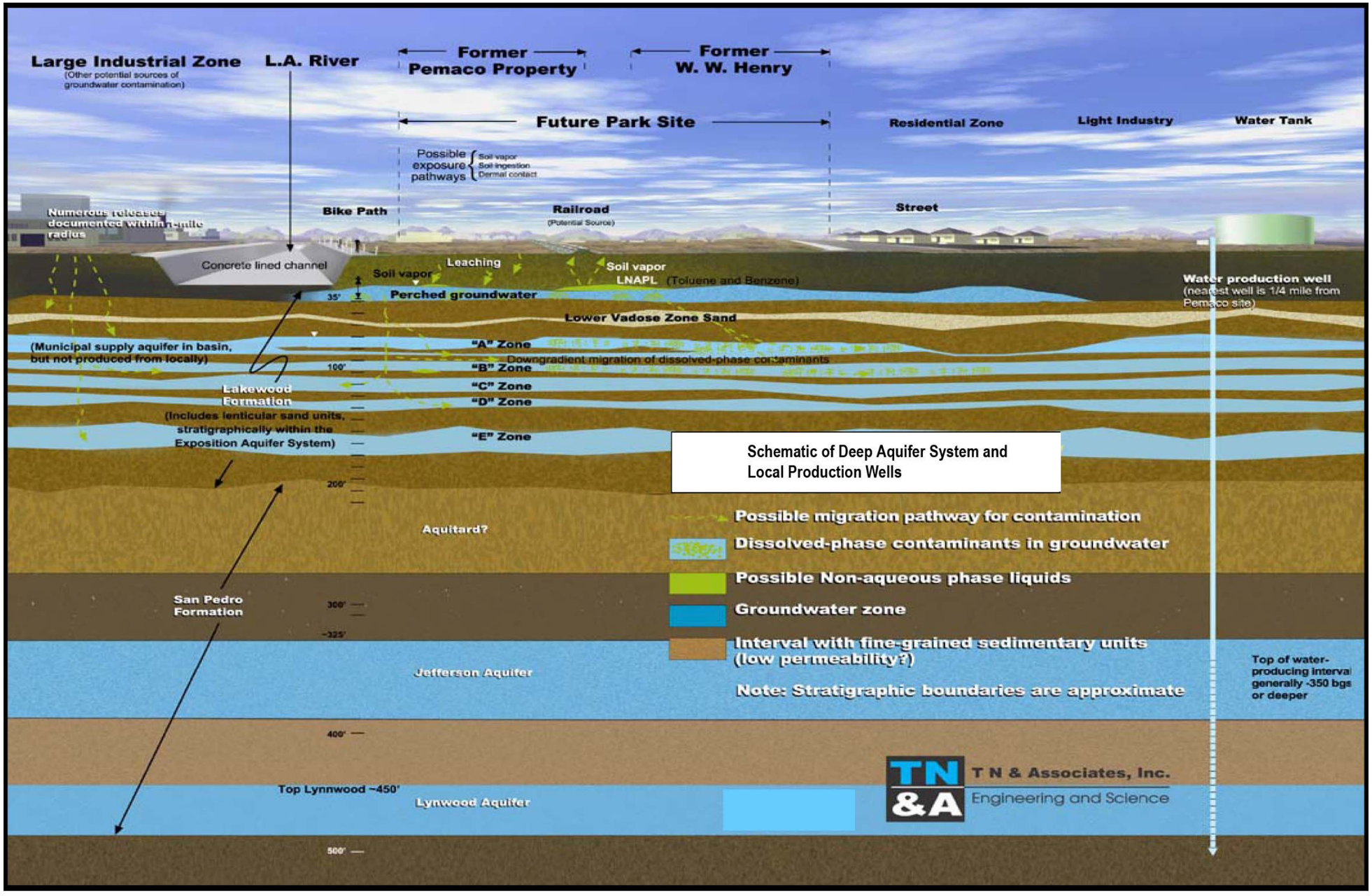
5.3 Hydrogelogy

5.3.1 Perched Groundwater

Groundwater in the perched zone occurs in lenses of poorly graded sand, silty sand, and sandy silt, which lie on top of the perching clay and are locally overlain by finer-grained units. These saturated lenses are located at different depths ranging from 20 and 40 ft bgs and 5 inches to 5 ft thick. The geometry of the perched zone is controlled by the highly irregular and undulating top surface of the underlying, laterally extensive perching clay. Measurements of depths to groundwater in the perched zone in the Pemaco site vicinity ranged from 18.48 ft bgs (B-31, April 2001) to 39.31 ft bgs (B-17, May 2001) since measurements began in September 2000. Groundwater fluctuations of greater than 5 ft have been observed since groundwater monitoring began.

The complex hydrogeology of the perched zone causes highly variable groundwater gradients. The overall general component of apparent groundwater flow in the perched zone is towards the southwest, but there are many localized areas that indicate that the apparent groundwater flow is in multiple directions. Due to the irregular nature of the perched groundwater zone, no numerical gradient was calculated in the RI/FS Reports.

Figure 5-2. Schematic of Deep Aquifer System and Local Production Wells



5.3.2 Exposition Zones 'A' through 'E'

The Exposition groundwater zones include five distinct saturated zones that are separated by silt/clay intervals. These five units have been informally named from top to bottom, the Exposition 'A' through 'E' zones.

- The 'A' zone is found between 65 and 75 ft bgs. It is comprised of fine silty and poorly graded sands locally interbedded with well-graded sands. The thickness of this zone is highly variable ranging from 3" to 10 ft thick. This interval can be characterized as a series of semi-continuous saturated sand lenses. Groundwater fluctuations of up to seven ft have been observed in the 'A' zone since measurements began in May 2001. Gradients ranged from 0.0043 to 0.011 ft per foot (ft/ft) from May 2001 to April 2002. Apparent groundwater flow directions have been consistently towards the southwest and south-southwest.

- The 'B' zone is typically found between 80 and 90 ft bgs. It is comprised of fine silty sands, poorly graded sands and poorly graded sands with silt ranging from 1.5 to 10 ft thick. The 'B' zone is more uniform and laterally continuous than the 'A' zone. Groundwater fluctuations of more then four ft have been observed in the 'B' zone since measurements began in May 2001. Gradients ranged from 0.0063 to 0.0092 ft/ft from May 2001 to April 2002. Apparent groundwater flow directions have been consistently towards the southwest.

The remaining three zones, 'C', 'D', and 'E' are typically found from 95 to 110 ft bgs, 125 to 145 ft bgs, and 160 to 175 ft bgs, respectively.

- The 'C' zone is comprised of saturated fine silty sands, poorly graded sands and poorly graded sands with silt ranging from 2 to 6 ft thick. It appears to be continuous throughout the site vicinity within the 95 to 110 ft depth interval. The gradient was approximately 0.013 ft/ft and is to the south-southeast in the site vicinity.

- The 'D' zone is comprised of interbedded fine silty sands, poorly graded sands and poorly graded sands with silt, well-graded sands and gravelly sands, and local well-graded sandy gravel intervals. Total thickness ranges from 6 to 15 ft. This zone is the thickest and highest-yielding of all the Exposition lithosomes encountered in the site vicinity and is found throughout the site area. The gradient in this zone was approximately 0.0013 towards the southwest.

- Only one well installed during the RI activities (MW-10-170) has penetrated the 'E' zone. This zone is comprised of alternating saturated intervals of 1 foot-thick fine silty sands and well-graded sands and is approximately 10 ft thick at the MW-10 location.

5.3.3 Hydraulic Parameters

A series of groundwater slug, pumping, and recovery tests were performed on the Exposition A and B Zones at the Pemaco site between December 12 and 24, 2001 to determine the permeability of the aquifer or the flow of groundwater through the A and B acquifers. As a result of the testing the following hydraulic conductivities (permeabilities) were calculated:

	• **Hydraulic conductivity**
• **'A' Zone**	• **8.3 E-04 to 2.3 E-03 ft/min**
• **'B' Zone**	• **1.3 E-03 to 7.1 E-02 ft/min**

In addition, the sustainable pumping rate from the 'B' zone was determined to be about 1 gallon per minute (gpm) and about 0.5 gpm from the 'A' zone. Calculated linear groundwater velocities averaged 0.47 ft per day (171 ft per year) in the 'B' Zone using the aquifer pump test data and average measured groundwater gradients.

5.4 Description of Contaminant Source and Release Information

A description of historical sampling and waste discovery for the Pemaco Superfund site is discussed in Section 2.0 of this ROD. EPA began collecting RI data for the Pemaco site in 2001. Data was collected by using a Geoprobe®, hollow stem auger (HSA) rig, mud rotary rig and reverse air percussion rig to install wells and collect soil data. All groundwater monitoring wells installed were placed on the quarterly groundwater monitoring program, and have been sampled frequently since the implementation of the wells.

Extensive sampling of soil, soil vapor, indoor and outdoor air and groundwater on the Pemaco property and surrounding area occurred during the RI/FS process and continue to date. Over 2,000 environmental samples have been collected and analyzed by various analytical methods to determine the extent of contamination in the various media.

Table 5-1 Estimation of Contaminated Soil Volumes

Soil Zones	COCs Above PRGs	Area of Contaminated Soil (ft^2)	Thickness of Contaminated Soils (ft)	Volume of Soil in Contaminated Area (cubic yard)	Average Concentration (mg/kg)
Surface Soil	Metals	1,875	1.0	69	48,334.86
Surface Soil	SVOCs	21,250	1.0	787	21.71
Surface Soil*	Metals SVOCs	22,500	1.0	833	NA
Near Surface Soil	Metals	1,250	2.0	93	48,930.48
Near Surface Soil	SVOCs	18,125	2.0	1,343	15.61
Near Surface Soil*	Metals SVOCs	18,750	2.0	1,389	NA
Combined Surface and Near Surface*	Metals SVOCs	31,875	3.0	2,222 [9] 3,541 [10]	NA
Upper Vadose Zone	Total VOCs	122,299	32.0	144,947	7.07
Upper Vadose Zone**	Total VOCs	69,611 (onsite only)	32.0	82,502	7.07
Lower Vadose Zone	Total VOCs	13,840	30.0	15,378	32.79
Lower Vadose Zone**	Total VOCs	12,716 (onsite only)	30.0	14,129	32.79

Notes:
1. *ft: foot*
2. *ft^2: square foot (unit of area)*
3. *mg/kg: milligram/kilogram (unit of concentration)*
4. *Areas for surface and near surface soils derived from adding the area of total grids (25 ft x 25 ft) which exceeded EPA Region IX PRG for Residential Soil.*

5. *Areas for upper and lower vadose zone soils derived from soil "plumes" based on the sum of all detected VOCs detected between 25 and 35 ft bgs and 54 and 56 ft bgs.*
6. *Surface and near surface soil thicknesses determined as 1.0 ft (zero to 1 ft bgs) and 2.0 ft (1 to 3 ft bgs), respectively. For alternative design (i.e. excavation), thickness was assumed to be 3 ft for near surface soil contaminated grids even if surface soil within that grid was below PRGs.*
7. *Upper and lower vadose zone soil thicknesses derived by assuming contamination existed throughout the entire zone thickness, 32 ft and 25 ft, respectively. (Upper vadose zone soils extend from 3-35 ft bgs; lower vadose zone soils extend from 35-65 ft bgs.)*
8. *Average concentrations determined using data collected in August 2003 with a cone penetration testing (CPT) rig equipped with a membrane interface probe (MIP). Real-time and discrete sampling data collected with the MIP indicates much higher soil/soil vapor concentrations than those reported from discrete soil samples collected during RI well installation activities. In addition, groundwater concentrations are indicative of non-aqueous phase liquid (NAPL) and/or free product; therefore, mass concentrations in soil are assumed to be much higher. This is supported by the MIP results as well as the results of a HVDPE pilot study, which removed approximately 81 pounds of VOCs in one day.*
9. Actual Volume of Contaminated soil
10. Actual Volume of Contaminated soil plus clean overburden

* *When calculating total area for surface soils and near-surface soils, grids contaminated with both metals and SVOCs were only counted once. Likewise, when calculating the combined surface and near-surface soil area, if grids were contaminated in both 'zones', the grid was only counted once; if the near-surface soil was contaminated and the surface soil within the same grid was clean, the area was still included in the total area.*

** *These vadose zone totals include only contaminated soils within the Pemaco boundary.*

Table 5-2 Estimation of Contamination in Groundwater

Groundwater Plume Zone	COC	Surface Area of Plume (ft^2)	Volume of Groundwater in Plume Area (L)	Volume of Groundwater in Plume Area (gallons)	Average Concentration (µg/L)
Perched Zone	PCE	79,379	2,491,026	658,059	120
	TCE	139,790	4,386,808	1,158,872	52
	VC	52,483	1,646,991	435,089	24
Composite Perched Zone	VOCs	168,180	5,277,741	1,394,232	469
Composite Perched Zone	VOCs (onsite only)	60,842	1,909,308	504,386	469
'A' Zone	TCE >10,000	9,941	511,346	135,083	27,409
'A' Zone	TCE >1,000	56,924	2,928,061	773,512	15,540
'A' Zone	TCE >1	352,616	18,137,883	4,791,522	1,864
'B' Zone	TCE >10,000	5,581	305,991	80,834	21,000
'B' Zone	TCE >1,000	67,847	3,719,871	982,686	12,765
'B' Zone	TCE >1	771,004	42,272,100	11,167,107	2,561
Composite 'A' and 'B' Zone	TCE >10,000	10,708	1,141,793	301,630	16,656
Composite 'A' and 'B' Zone	TCE >1,000	69,381	7,398,089	1,954,368	13,454
Composite 'A' and 'B' Zone	TCE >5	552,419	58,904,335	15,560,879	4,558

Notes:

1. *ft^2 : foot square (unit of area)*
2. *L: liters (unit of volume)*
3. *µg/L: microgram/liter (unit of concentration)*

4. *PCE: Tetrachloroethene; TCE - Trichloroethene; VC - Vinyl Chloride*
5. *TCE selected to represent maximum contamination within the 'A' and 'B' zones as TCE is the most concentrated and widely dispersed VOC within these zones. Average concentrations include all VOCs.*
6. *Areas derived from groundwater plumes using AutoCAD.*
7. *Plume thickness = average thickness for each groundwater zone (2.58, 3.2, and 3.73 ft for perched, 'A' zone and 'B' zone, respectively). Average porosity values used for each zone as follows: perched (0.4298), 'A' zone (0.568) and 'B' zone (0.5194). For the 'A' and 'B' Zone Overlay, the 'A' and 'B' Zone combined thickness was determined by adding the 'A' and 'B' Zone thicknesses; an average porosity value of the 'A' and 'B' Zones was used.*
8. *Average concentrations for individual plumes determined using concentrations of the stated VOC for all wells (January 2002 data). Average concentrations for composite plumes determined using a select number of wells representative of the composite plume.*

It was clear from past removal activities that solvents in the USTs, ASTs, sumps, and drums had spilled or were released into the subsurface. During removal activities, an abundant volume of subsurface soil (i.e., upper vadose zone soil) surrounding the tank farm was remediated by the former SVE system. However, subsurface soils (i.e., lower vadose zone soil) present beneath the former tank farm/SVE remediation area are still a primary source of contamination for the site as well as other areas on the property. Tables 5-1 and 5-2 provide estimates of the volumes of contaminated soil (post removal action) and groundwater. Clean fill was placed over much of the site during previous removal actions in 1997-1998 when the former warehouse foundation and USTs were removed from the central portion of the site.

5.4.1 COCs in Surface and Near-Surface Soil

Seventy-five surface (0.5 ft bgs) and 75 near-surface (2.5 ft bgs) soil samples were collected on and immediately adjacent to the Pemaco property. Samples were analyzed for SVOCs and metals. Analytical results indicated widespread concentrations of SVOCs and limited concentrations of metals exceeding EPA Region IX Preliminary Remediation Goals (PRGs) in both soil zones. Table 5-3a provides a summary of contaminants that exceed EPA Region IX PRGs for surface and near-surface soils.

Table 5-3a Chemicals Exceeding EPA Region IX Residential Soil PRGs in Surface and Near Surface Soil (0 to 2.5 ft bgs)

Chemical	EPA PRG (unit indicated below)	Maximum Concentration in Surface Soil	Maximum Concentration in Near Surface Soil
SVOCs (µg/kg)			
Benzo (a) anthracene	620	22,000 (GP-SS-14)	950 (GP-SS-31)
Benzo (a) pyrene	62	33,000 (GP-SS-14)	1,100 (GP-SS-31)
Benzo (b) fluoranthene	620	38,000 (GP-SS-14)	1,000 (GP-SS-11, GP-SS-31)
Benzo (k) fluoranthene	6,200/380*	28,000 (GP-SS-14)	760 (GP-SS-11)
Chrysene	62,000/3,800*	24,000 (GP-SS-14)	--
Dibenzo (a,h) anthracene	62	5,300 (GP-SS-14)	130 (GP-SS-31)
Indeno (1,2,3-cd) pyrene	620	19,000 (GP-SS-14)	670 (GP-SS-30)
Metals (mg/kg)			
Arsenic	22/0.39*	--	40.4 (GP-SS-45)
Iron	23,000	73,200 (GP-SS-75)	71,500 (GP-SS-61)
Lead	150	952 (GP-SS-87)	--
Manganese	1,800	1,940 (GP-SS-51)	--

Notes:

1. *µg/kg: microgram per kilogram.*
2. *mg/kg: milligram per kilogram.*
3. *-- data not available*
4. *Maximum concentration followed in parentheses by the sample location.*
5. *EPA Region IX PRGs are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data for each environmental media; in this case, residential soil. PRGs should be viewed as Agency guidelines for screening site conditions, not legally enforceable standards.*

* *State of California modified PRG.*

PAHs were the most prevalent SVOCs detected above Region IX PRGs for residential soil among both surface and near surface samples with concentrations ranging from 62 µg/kg to 38,000 µg/kg. For metals, the mean iron concentrations in California soils is approximately 37,000 mg/kg according to published technical literature. The mean iron concentrations for Pemaco in both surface and near surface soils are below the mean California number. EPA determined that the range of iron concentrations in Pemaco soils is within naturally-occurring background levels.

Arsenic, iron, lead, and manganese are the only metals detected at concentrations exceeding PRGs in surface and near-surface soils. The other metals concentrations exceeding PRGs (arsenic, lead, and manganese) were detected in very limited numbers (five of 150 samples) and at sporadic aerial distributions. It is unlikely that the elevated metal concentrations are a result of any significant contaminant source related to Pemaco.

5.4.2 COCs in Upper and Lower Vadose Zone Soils

A total of 616 samples were collected from vadose zone soils between 2.5 and 70 ft bgs.

Five primary areas of contamination have been identified in the upper vadose zone (between 2.5 and 35 ft bgs). These are:

- Below the north-central part of Pemaco site and extending approximately 80 ft offsite (to the west) between 25 and 35 ft bgs, primarily comprised of chlorinated VOCs;
- A small area below the central part of the Pemaco site around 15 ft bgs, primarily comprised of toluene, ethylbenzene, and xylenes;
- A small area below and adjacent to the central-west part of the Pemaco site (below the rail tracks) around 5 ft bgs, primarily comprised of SVOCs;
- Below the south part of Pemaco site and extending approximately 200 ft offsite (to the west/southwest) between 25 and 35 ft bgs, primarily comprised of chlorinated VOCs; and
- An offsite area resulting from releases at the adjacent former W.W. Henry-owned property, consisting primarily of benzene, toluene, and hexane.

Two areas of contamination have been identified in the lower vadose zone (between 35 and 70 ft bgs). One area is located below the south part of the Pemaco site and offsite to the south/southwest and is comprised of chlorinated VOCs. The other area is related to the W.W. Henry free product plume and was detected along 59th Place adjacent to the W.W. Henry property. The extent of this contamination is the subject of investigations for the W.W. Henry property which is being managed by the LARWQCB.

EPA Region IX PRGs are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data for each environmental media; in this case subsurface soil. The PRGs were used to screen subsurface soil as a threat to groundwater. DAF 20 PRGs were used when the contaminated soil is determined to not be directly adjacent to a drinking water source and dilution of the contaminant is occurring before it reaches the drinking water source.

DAF 20 PRGs were compared to concentrations found in the upper vadose zone soils (depth of 2.5 to 35 feet bgs) and lower vadose zone soils(depth of 35 - 65 feet). DAF 1 PRGs assume that the contaminated soil is directly adjacent to a drinking water source and no dilution of the contaminant is occurring along the pathway between the source soil and drinking water source. DAF 1 PRGs were compared to concentrations found at depths greater than 50 feet bgs. Tables 5-3b through 5-3d provide a summary of contaminants that exceed EPA Region IX PRGs in subsurface soils.

Table 5-3b Chemicals Exceeding EPA Region IX DAF 20 PRGs in Upper Vadose Soil (2.5 to 35 ft bgs)

Chemical	Region IX PRG (unit indicated below)	Maximum Concentration Found in Upper Vadose Zone Soil	Location
VOCs (µg/kg)			
1,1-Dichloroethene	60	400	WWH-2, 25-25.5'
Acetone	16,000	19,000	MW-16, 25-25.5'
Benzene	30	4,100	MW-06, 25-25.5'
cis-1,2-Dichloroethene	400	3,300	MW-18, 25-25.5'
Ethylbenzene	13,000	61,000	GP-VS-10, 16-16.5'
Methylene Chloride	20	530	MW-06, 25.5-26'
Tetrachloroethene	60	2,000	GP-VS-06, 29-29.5'
Toluene	12,000	98,000	GP-VS-10, 16-16.5'
Trichloroethene	60	3,300	GP-VS-18, 32-32.5'
Vinyl Chloride	10	280	MW-15, 25-25.5'
Xylenes (total)	210,000	430,000	GP-VS-10, 16-16.5'
SVOCs (µg/kg)			
Benzo (a) anthracene	2,000	32,000	GP-VS-09, 5-5.5'
Benzo (a) pyrene	8,000	27,000	GP-VS-09, 5-5.5'
Benzo (b) fluoranthene	5,000	40,000	GP-VS-09, 5-5.5'
Carbazole	600	1,900	GP-VS-09, 5-5.5'
Dibenzo (a,h) anthracene	2,000	5,200	GP-VS-09, 5-5.5'
Indeno (1,2,3-cd) pyrene	14,000	15,000	GP-VS-09, 5-5.5'
Isophorone	500	630	GP-VS-09, 34.5-35'
NHVOCs (µg/kg)			
Acetone	16,000	22,000	RW-01, 25-25.5'
Metals (mg/kg)			
Arsenic	29	29.2	MW-13, 34.5-35'
Chromium (total)	38	48.4	MW-13, 34.5-35'

Notes:

1. *µg/kg: microgram per kilogram.*
2. *mg/kg: milligram per kilogram.*
3. *EPA Region IX PRGs are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data for each environmental media; in this case, subsurface soil. PRGs should be viewed as Agency guideline for screening site conditions, not legally enforceable standards. PRGs are used to screen subsurface soil as a threat to groundwater. DAF 20 PRGs are used when the contaminated soil is not directly adjacent to a drinking water source and dilution of the contaminant is occurring before it reaches the drinking water source.*

Table 5-3c Chemicals Exceeding EPA Region IX DAF 20 PRGs in Lower Vadose Soil (35 - 65 ft bgs)

Chemical	EPA PRG (unit indicated below)	Maximum Concentration in Lower Vadose Soil Zone	Location
VOCs (µg/kg)			
Benzene	30	520	MW-06, 54.5-55'
1,2-Dichloroethane	20	400	MW-17, 55-55.5'
cis-1,2-Dichloroethene	400	730	RW-01, 55-55.5'
Methylene chloride	20	450	MW-18, 55-55.5'
Trichloroethene	60	2,100	MW-17, 45-45.5'
Vinyl Chloride	10	22	GP-VS-32, 39.5-40'
Metals (mg/kg)			
Chromium (total)	38	39.3	MW-19, 65-65.5'

Notes:

1. *µg/kg: microgram per kilogram*
2. *mg/kg: milligram per kilogram*
3. *EPA Region IX PRGs are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data for each environmental media; in this case, subsurface soil. PRGs should be viewed as Agency guidelines for screening site conditions, not legally enforceable standards. PRGs are used to screen subsurface soil as a threat to groundwater. DAF 20 PRGs are used when the contaminated soil is not directly adjacent to a drinking water source and dilution of the contaminant is occurring before it reaches the drinking water source.*

Table 5-3d Chemicals Exceeding EPA Region IX DAF 1 PRGs in Lower Vadose Soil (> 50 ft bgs)

Chemical	EPA PRG (unit indicated below)	Maximum Concentration Found in Lower Vadose Zone Soils > 50 ft bgs	Location
VOCs (µg/kg)			
Benzene	2.0	520	MW-06, 54.5-55'
1,2-Dichloroethane	1.0	400	MW-17, 55-55.5'
cis-1,2-Dichloroethene	20	730	RW-01, 55-55.5'
Methylene chloride	1.0	450	MW-18, 55-55.5'
Trichloroethene	0.7	1,400	MW-17, 55-55.5'
Metals (mg/kg)			
Antimony	0.3	1.5	MW-11, 64.5-65'
Arsenic	1.0	24.58	MW-14, 55-55.5'
Barium	82	337	MW-18, 55-55.5'
Cadmium	0.4	0.52	MW-05, 59.5-60'
Chromium (total)	2.0	39.3	MW-19, 65-65.5'
Nickel	7.0	35.3	MW-11, 64.5-65'

Notes:

1. *µg/kg: microgram per kilogram*
2. *mg/kg: milligram per kilogram*
3. *EPA Region IX PRGs are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data for each environmental media; in this case, subsurface soil. PRGs should be viewed as Agency guidelines, not legally enforceable standards. PRGs are used to screen subsurface soil as a threat to groundwater. DAF 1 PRGs assume that the contaminated soil is directly adjacent to a drinking water source and no dilution of the contaminant is occurring along the pathway between the source soil and the drinking water source.*

5.4.3 COCs in Groundwater

A total of 42 groundwater monitoring wells have been installed in the perched groundwater zone and 36 wells in the various Exposition groundwater zones. Five sampling and monitoring events have been conducted using this well network. These sampling and monitoring events have completely delineated the extent of the groundwater contamination or contaminant "plumes", originating from the Pemaco property. Plumes have been identified in the perched groundwater zone (25 to 35 ft bgs) and in the upper Exposition groundwater zones, which exist as individual semi-confined/confined sand zones typically found between 65 and 100 ft bgs.

Tables 5-3e and 5-3f provide a summary of contaminants that exceed California MCLs and/or EPA Region IX PRGs for drinking water in the perched groundwater zone and the Exposition groundwater zones, respectively.

Table 5-3e Chemicals Exceeding Primary MCLs and/or EPA Region IX PRGs for Drinking Water in Perched Groundwater Zone

Chemical	Primary MCL (µg/L)	EPA Region IX PRG (µg/L)	Maximum Concentration in Perched Groundwater (µg/L)	Location
VOCs				
1,1-Dichloroethane	5.0	810/0.2**	410	B-01
1,1-Dichloroethene	6.0	340	2,000	B-01
1,2-Dibromo-3-chloropropane	0.2	0.048/ 0.0016**	2	B-38
1,2-Dichloroethane	0.5	0.12	18	B-27
1,1,2-Trichloroethane	5.0	0.2	9	SV-04
Acetone	--	5500	1,500	B-22
Benzene	1.0	0.34	1,600	B-30
Chloroform	80 (THM)	0.17/0.53	41	B-23
Chloroethane	--	4.6	50	B-21
cis-1,2-Dichloroethene	6.0	61	780	B-21
Dibromochloromethane	80 (THM)	0.13	2.4	B-17
Ethylbenzene	300	1300	1200	B-08
Methyl tert-butyl Ether	13	13/6.2**	30	B-04
Tetrachloroethene	5.0	0.1	1,100	B-01
Toluene	150	720	2,000	B-13
trans-1,2-Dichloroethene	10	120	59	B-21
Trichloroethene	5.0	1.4	680	B-22
Vinyl Chloride	0.5	0.02	240	B-08, B-21
NHVOCs				
Acetonitrile (Co-elute w/ MIBK)	--	100	223	B-13
Methyl isobutyl ketone (MIBK)	--	2000	223	B-13
SVOCs				
1,4-Dioxane	3.0*	6.1	920	B-01
bis(2-Ethylhexyl)phthalate	4	4.8	11	B-10
Naphthalene	--	6.2	25	B-04
Metals				
Aluminum	1,000	36,000	52,700	B-10
Arsenic	10	0.045/.0071**	676	B-10
Chromium (total)	50	--	72	B-10
Iron	--	11,000	37,700	B-10
Lead	15*	--	11	B-25
Manganese	--	880	4,130	B-20

Table 5-3e Chemicals Exceeding Primary MCLs and/or EPA Region IX PRGs for Drinking Water in Perched Groundwater Zone

Chemical	Primary MCL (µg/L)	EPA Region IX PRG (µg/L)	Maximum Concentration in Perched Groundwater (µg/L)	Location
Selenium	50	180	279	B-25
Thallium	2.0	2.4	55.5	B-10

Notes:

1. *µg/L: microgram per liter.*
2. *-- data not available*
3. *EPA Region IX PRGs are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data for each environmental media; in this case, groundwater. PRGs should be viewed as Agency guidelines, not legally enforceable standards.*
4. *State of California MCLs are legally enforceable drinking water standards. These MCL levels are primarily risk-based levels similar to PRGs where it is assumed that a person will drink water with the specified chemical concentrations.*

** *California modified PRG.*

Table 5-3f Chemicals Exceeding Primary MCLs and/or EPA Region IX PRGs for Drinking Water in Exposition Groundwater Zones

Chemical	Primary MCL (µg/L)	EPA Region IX PRG (µg/L)	Maximum Concentration in Exposition Groundwater (µg/L)	Location
VOCs				
1,1-Dichloroethene	6.0	340	30	MW-17-85
1,2-Dibromo-3-chloropropane	0.2	0.048/0.0016*	5	MW-12-70, MW-12-90
1,2-Dichloroethane	0.5	0.12	0.4	MW-13-85
Acetone	--	5500	20,000	MW-09-85
Benzene	1.0	0.34	1,600	MW-06-85
Chloroform	80 (THM)	.17/0.53*	36	MW-05-85
cis-1,2-Dichloroethene	6.0	61	14,000	MW-17-85
Dibromochloromethane	80 (THM)	0.13	16	MW-03-85
Methylene Chloride	5.0	4.3	6	MW-10-175
Methyl tert-butyl Ether	13	13/6.2*	30	B-04
Tetrachloroethene	5.0	0.1	8.1	MW-03-85
trans-1,2-Dichloroethene	10	120	53	MW-17-70
Trichloroethene	5.0	1.4	22,000	MW-17-70
Vinyl Chloride	0.5	0.02	780	MW-18-85
NHVOCs				
Acetone (different analytical	--	5500	8,620	MW-17-85

Table 5-3f Chemicals Exceeding Primary MCLs and/or EPA Region IX PRGs for Drinking Water in Exposition Groundwater Zones

Chemical	Primary MCL (µg/L)	EPA Region IX PRG (µg/L)	Maximum Concentration in Exposition Groundwater (µg/L)	Location
method)				
Metals				
Aluminum	1,000	36,000	4,020	MW-02-95
Arsenic	10	0.045/.0071*	52.7	MW-10-110
Manganese	--	880	1,410	MW-09-85
Thallium	2.0	2.4	7.4	MW-03-85
Anions				
Sulfide	--	110+	9,500	MW-09-85

Notes:

1. *µg/L: microgram per liter*
2. *-- data not available*
3. *EPA Region IX PRGs are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data for each environmental media; in this case, groundwater. PRGs should be viewed as Agency guidelines, not legally enforceable standards.*
4. *State of California MCLs are legally enforceable drinking water standards. These MCL levels are risk-based levels similar to PRGs where it is assumed that a person will drink water with the specified chemical concentrations.*

* *California modified PRG*

\+ *110 µg/L is the PRG for hydrogen sulfide.*

5.4.3.1 COCs in Perched Groundwater

PCE, TCE and vinyl chloride are the most prevalent compounds in the perched groundwater zone. "Hot spot" areas of these plumes have had groundwater concentrations exceeding 1,000 µg/L. The dissolved-phase portions of these perched plumes extend offsite and have migrated beneath adjacent properties extending up to 250 ft to the south and up to 200 ft southwest of the Pemaco property. The southwest extent of the plume has migrated beneath one adjacent residential lot. Contaminant plumes originating from the Pemaco property have also co-mingled with other chlorinated and non-chlorinated contaminant plumes that have resulted from historical industrial uses of neighboring properties (see Figure 5.3).

5.4.3.2 COCs in Exposition Groundwater Zones

The Exposition groundwater zones include five distinct saturated sand zones located between 65 to 175 ft bgs. These zones are separated by fine-grained (silt/clay) intervals and vary in thickness. The most extensive groundwater contaminant plumes in the Pemaco area are found in the upper Exposition groundwater zones ('A' and 'B' zones) and are primarily comprised of TCE and its daughter products (see Figure 5-4). The largest plume is approximately 1,300 ft long and 750 ft wide and is within the 'B' zone. The dissolved-phase portion of this plume extends towards the southwest of the Pemaco property and underlies a two-block area that is used for residential housing. The "hot spot' area of this plume (principal threat) is directly below the southernmost portion of the Pemaco property and contains TCE concentrations exceeding 20,000 µg/L (see Figure 5-4). These high concentrations fall off quickly to levels below 100 µg/L approximately 300 ft away from the site, and fall below 10 µg/L approximately

500 ft away from the site. It should be noted that while the lateral extent of this plume is somewhat large, the vertical extent is limited to the saturated thickness of the 'B' Zone sand, which ranges from 1.5 to 10 ft thick and is typically found between 80 and 90 ft bgs. The principal threat or hot spot area probably occurred from a release from the former loading dock, former drum storage area or one of the former USTs located in this south portion of the site.

Figure 5-3 Extent of Groundwater Plume in Perched Zone

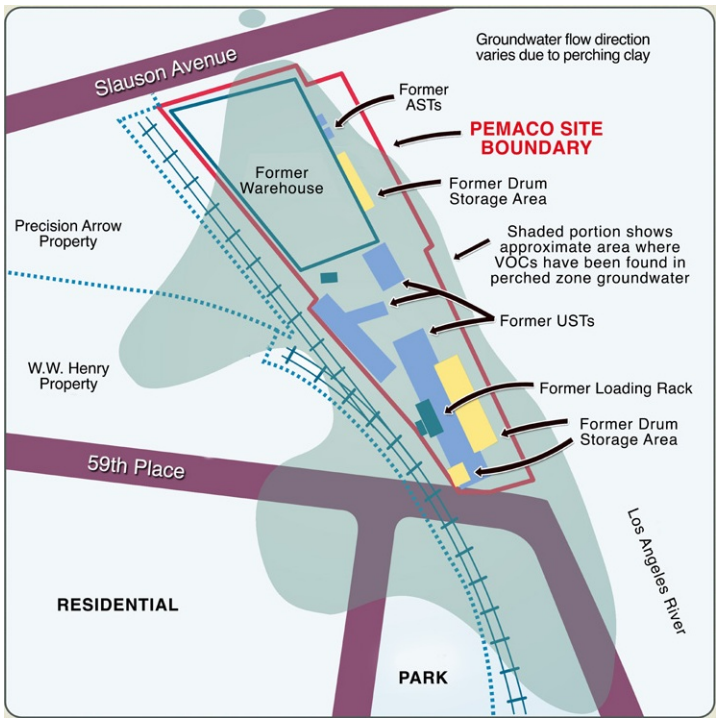
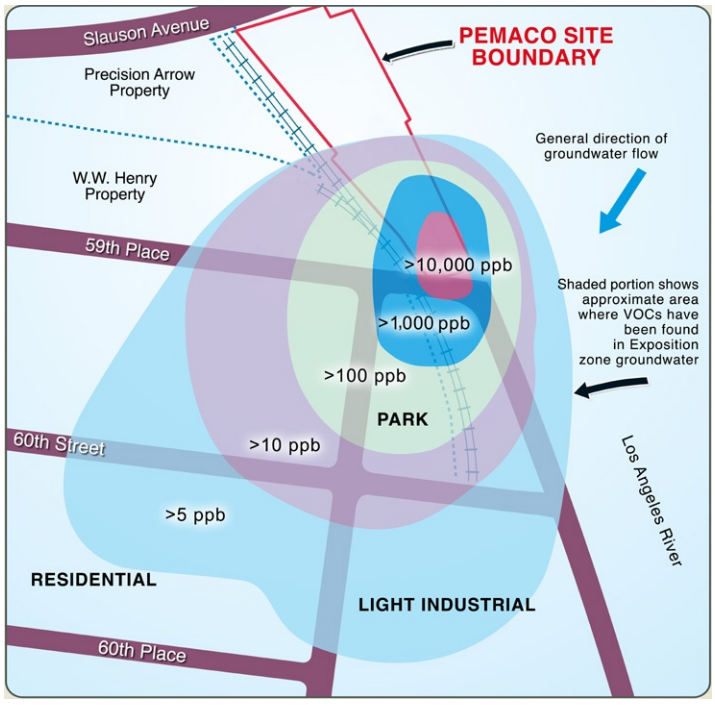


Figure 5-4 Extent of Groundwater Plume in Exposition 'A' and 'B' Zones



Metal concentrations in samples from the some of the Exposition 'B' Zone wells exceeded the selected ARARs (MCLs or PRGs) for aluminum; arsenic; hexavalent chromium, manganese and thallium. The hexavalent chromium concentrations appear to coincide with chlorinated VOC plume "hot spot" and could possibly be associated with a release. However, all of the detected hexavalent chromium concentrations are very low (<1 ug/L) and could also constitute background levels. The spatial

distribution and limited occurrences of elevated arsenic, aluminum, manganese and thallium concentrations indicate that these are likely high natural background levels.

There were originally six wells installed in the Exposition 'C', 'D' and 'E' Zones during the RI activities (2 in the 'C', 3 in the 'D', and 1 in the 'E'). Most of these wells were installed as down-gradient "sentry" wells. The only VOCs that have been consistently detected at concentrations at or exceeding detection levels are TCE and benzene in one of the 'C' Zone wells. These concentrations are detected at trace levels and may represent the dissolved-phase fringes of the TCE plume from the Pemaco site and the benzene plume from the W.W. Henry property. The trace benzene detections may also have been a result of the ambient sampling conditions (the well is in a high traffic area). Metal concentrations in samples from the Exposition 'C', 'D' and 'E' Zones exceeded the remediation levels for arsenic and for hexavalent chromium. These arsenic and hexavalent chromium concentrations are likely background levels and not from a Pemaco release as indicated by their spatial distributions.

During the data review stages of the RI activities, data gaps were identified regarding vertical concentration distributions and gradient directions in the lower Exposition 'C' and 'D' Zones in the immediate Pemaco site vicinity. In July and August of 2003, additional groundwater monitoring wells were installed in the Exposition 'C' and 'D' Zones in the immediate site vicinity adjacent to the postulated TCE release areas. Screening data collected from these wells in August 2003 and definitive data collected in October 2003 indicated that the only elevated TCE concentrations detected in these new deep wells were from the 'D' Zone well located directly adjacent to the postulated source area. These concentrations were detected at 38 and 120µg/L. No elevated TCE concentrations were detected in any of the surrounding wells which are located approximately 150 ft down and cross gradient to the postulated source area. EPA has agreed to turn monitoring well MW-24 into an extraction well at this location where TCE was detected above cleanup numbers. Estimated mass removal for this well location will be calculated during the design phase of the project, but the amount removed will be negligible compared to groundwater extraction that will be occurring in the shallower zones. Since the downgradient "C" and "D" zone wells are clean it is postulated that the vertical migration of TCE has only occurred in the vicinity of MW-24, and there are no longer any data gaps for the deeper zone.

5.5 Soil Vapor Sampling and Indoor Air Sampling

The first soil vapor sampling round was conducted during February 2001. During this initial round 66 on and off site locations were sampled. A second round of soil vapor and indoor/outdoor air samples were collected during July 2001. This sampling event was performed as a split-sampling event to determine whether contamination from the property next door to the site, W.W. Henry, was migrating into the neighborhood. Indoor air samples were collected from five residences on 59th Place, and two outside locations. The July/August sampling rounds showed elevated levels of acetone in the soil vapor as well as ambient/indoor air samples. Although the levels were below preliminary remediation goals for acetone in ambient air, the levels were above background levels found in ambient air for the Southern California area.

EPA followed up the sampling round with a March 2002 sampling that was implemented to determine whether or not lateral migration of soil vapors from contaminated perched groundwater was occurring or whether migration was occurring from a vadose zone soil source. Indoor air samples were collected from 12 residential locations and outdoor samples were collected from ten locations throughout the local area. Soil vapor was collected from 14 separate locations at 5 ft bgs and 15 ft bgs. At this time, EPA determined that soil vapors were migrating but the concentrations present in the indoor air samples were not above any health based standard and were mainly attributable to ambient air sources (vehicles and industrial activities).

An additional indoor/outdoor air and soil vapor sampling event was conducted in August 2003. EPA sampled approximately 28 homes during this sampling effort. Soil vapor samples were collected from 25 properties and several ambient air samples were also collected throughout the neighborhood. The results

were very similar to previous sampling events where VOCs were found ubiquitously throughout the neighborhood. EPA subsequently analyzed the data received from this sampling round and previous sampling rounds and determined that a separate remedy for the homes was not necessary. However, EPA has determined that implementation of the remedy for the Pemaco Superfund site would ensure that detectable levels of chemicals found in the soil vapor would decrease and prevent a possible future vapor intrusion problem for the residential neighborhood.

Tables 5-3g and 5-3h provide a summary of contaminants that exceed EPA Region IX PRGs for indoor/outdoor ambient air and soil vapor, respectively.

Table 5-3g. Chemicals Exceeding EPA Region IX PRGs for Ambient Air – Indoor/Outdoor Air

Chemical	EPA PRG (µg/m3)	Maximum Concentration in Indoor/Outdoor Air	Location
Benzene	0.23	16	SUMMA 5119 (indoor)
Chloroform	3.1/0.35*	8.8	SUMMA 5114 (indoor)
Chloromethane	1.1	6.19	5100 59th Place (indoor)
1,2-Dichloroethane	0.074	6.5	SUMMA 1 (outdoor)
1,3-Dichlorobenzene	3.3	6.01	5000/5130A 59th Place (indoor)
1,4-Dichlorobenzene	0.31	541.1	SUMMA 5119 (indoor)
Dichlorodifluoromethane	210	939.6	SUMMA 5000 (indoor)
Hexachlorobutadiene	0.086	8.4	SUMMA 5014 (indoor)
Methyl tert butyl ether	19/3.7*	72.1	SUMMA 5119 (indoor)
Tetrachloroethene	0.67	24.4	SUMMA 7 (outdoor)
1,2,4-Trimethylbenzene	6.2	21.1	SUMMA 7 (outdoor)

Notes:

1. *µg/m3: microgram per cubic meter*
2. *Maximum ambient air concentrations obtained from July 2001 and March 2002 sampling events*
3. *EPA Region IX PRGs are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data for each environmental media; in this case, ambient air. PRGs should be viewed as Agency guideline for screening site conditions, not legally enforceable standards.*
4. *1,4-Dichlorobenzene and Dichlorodifluoromethane are both present in commonly used household products and are not likely attributable to Pemaco.*

* *State of California modified PRG*

Table 5-3h. Chemicals Exceeding EPA Region IX PRGs for Ambient Air (x100) in Soil Vapor, 5 ft bgs and 15 ft bgs

Chemical	EPA PRG x100 (µg/m3)	Maximum Concentration 5 ft bgs Feb 2001 (FASP Lab)	Maximum Concentration 5 ft bgs Jul 2001 & Mar 2002	Maximum Concentration 15 ft bgs Jul 2001 & Mar 2002
Benzene	23	--	92.7 (SV2002-4-5)	204.5 (SV2002-5-15)
Bromodichloromethane	11	--	--	107.2 (SV2002-5112-15)
Chloroform	8.4	1,000 (GP-SV-SO20, GP-SV-09)	73.3 (LFSG 19)	146.5 (SV2002-5112-15)
Chloromethane	310/35*	--	--	169.3 (SV2002-5002-15)
Dibromochloromethane	8.0	--	--	12.8 (SV2002-5112-15)
cis-1,2-Dichloroethene	3,700	26,000 (GP-SV-05)	--	--
1,1-Dichloroethane	52,000/120 *	8,000 (GP-SV-04)	202.4 (SV2002-5002-5)	388.6 (SV2002-5002-15)
1,1-Dichloroethene	21,000.0	36,000 (GP-SV-SO11)	1,070.6 (SV2002-5002-5)	2,379.19 (SV2002-5002-15)
1,1,2,2-Tetrachloroethane	3.3	--	6.9 (SV2002-5100-5)	8.3 (SV2002-5021-15)
Tetrachloroethene	67	140,000 (GP-SV-09)	4,205.1 (SV2002-5-5)	1,288.7 (SV2002-5-15)
Trichloroethene	1.7	11,000 (GP-SV-05)	2,416.4 (SV2002-5-5)	10,739.5 (SV2002-4-15D)

Notes:

1. *µg/m3: microgram per cubic meter*
2. *-- data not available*
3. *Maximum soil vapor concentrations obtained from February 2001, July 2001, and March 2002 sampling events. Because the laboratory used during the February 2001 event was a field lab (Field Analytical Screening Program - FASP), which typically have higher method detection limits than fixed laboratories (as used during the July 2001 and March 2002 events), a separate column was included for soil vapor collected during the February 2001 sampling event.*
4. *Maximum concentration followed in parentheses by the sample location.*
5. *No soil vapor PRGs are available. EPA Region IX Ambient Air PRGs were multiplied by an attenuation factor of 100 to allow for screening of soil vapor data and to evaluate whether further investigation of ambient air is warranted. PRGs are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data for each environmental media; in this case, ambient air (multiplied by 100). PRGs should be viewed as Agency guidelines, not legally enforceable standards.*

* *State of California modified PRG*

6.0 Potential Future Site and Resource Uses

The City of Maywood currently owns the Pemaco property. The City has rezoned the property from industrial to recreational use. The City plans to build a 7.3-acre public recreational park, termed the Maywood Riverfront Park (MRP), on six properties surrounding and including the Pemaco Superfund site. The MRP is part of a larger Los Angeles River Greenway program and the Los Angeles River Master Plan. The plan for the park includes a playground area, soccer fields, basketball courts, native

plant landscaping, picnic areas, restrooms, and possibly a swimming pool. Construction on the park began in 2003 and stopped until the City was able to acquire the last property to be incorporated into the MRP. Construction on the park will resume again in the next few months. If after implementation of the remedy, hazardous waste remains on the site at levels which are not suitable for unrestricted use of the land, additional institutional controls may be required in the form of a State of California Land Use Covenant with the City of Maywood.

The perched groundwater under Pemaco is characterized as having poor quality and very low transmissivity. The Exposition groundwater Zone is not currently used as a drinking water source, so there are no other current or potential beneficial uses associated with groundwater under Pemaco. However, the Exposition groundwater zone is designated by the LARWQCB as being a potential drinking water source. Thus, EPA used as a basis for its reasonable exposure assumptions in its risk assessment (see Appendix 6 of the RI, and Section 7.0 below) the possibility that the groundwater under Pemaco may be a source of drinking water.

6.1 Institutional Controls for the Pemaco Superfund Site

Institutional controls are non-engineering mechanisms used to implement land-use restrictions that will be used to prevent exposure of humans (land-owners and/or other users of the property) to hazardous materials, hazardous wastes or constituents, or hazardous substances remaining on the property; to ensure the integrity of the remedial action; and to allow the CERCLA lead agency and DTSC and its authorized agents, employees and contractors access to the property to maintain and ensure the effectiveness of the remedial action, as necessary. If hazardous materials, hazardous wastes or constituents, or hazardous substances will remain at the property at levels which are not suitable for unrestricted use of the land, land use restrictions will be required and will be implemented through a land use covenant/Environmental Restriction pursuant to California Civil Code section 1471 and 22 CCR section 67391.1. It shall be entered into by the owner(s) with DTSC and recorded in the County records. The land-use covenant will carry restrictions such as are necessary to ensure the protectiveness of and prevent damage to or interference with the remedial action. Additionally, monitoring, inspections, and reporting will be conducted to ensure compliance with the land-use restrictions. The Covenant shall run with the land and bind all successive owners and occupants.

As one layer of institutional control for the Site, EPA has worked with the City of Maywood and the Trust for Public Land over the past 5 years to determine the final zoning use for the Pemaco Superfund Site. In addition, EPA and the City of Maywood signed an Agreement and Covenant Not to Sue on December 7, 2001. This document was generated to settle any potential liability issues that could occur from the City of Maywood acquiring the Pemaco Superfund Site. A benefit stated in the agreement is the property would be redeveloped as a public park. The document also states the "City will impose covenants, conditions and restrictions that run with the Property to preserve and protect the remedial action implemented by EPA for the Site, the form and substance of which covenants, conditions and restrictions shall be subject to review and approval by EPA". A deed restriction was also signed concurrent with the Covenant Not to Sue. The deed restriction contains a restriction on use of groundwater at the Site. It prohibits the extraction of groundwater for use as a drinking water or other domestic purposes. Allowable uses are limited to: (i) groundwater monitoring and remediation, (ii) dewatering or dust control during Park development activities (treated groundwater), and/or (iii) irrigation of the Park (treated groundwater).

The Superfund Site is currently owned by the City of Maywood, and the local government has agreed to prohibit residential use of the property. The City of Maywood has already changed the zoning of the area from industrial to recreational use. The Trust for Public Land entered into a covenant dated December 30, 2002 restricting certain uses of the property that is recorded in the Los Angeles County records. Although these layers of institutional control are already in place, if after cleanup there is contamination left in place, California law may require an additional layer of institutional control pursuant to Title 22

California Code of Regulations section 67391.1. If such additional institutional control layer is required, this Record of Decision requires compliance with the regulation and includes a requirement for an implementation and enforcement plan for the institutional control to ensure the effectiveness of the remedy. The Implementation and Enforcement Plan details will be set forth during the remedial design phase. DTSC's costs associated with the administration of the State Land Use Covenant are response costs under CERCLA and DTSC may require responsible parties, facility owners, or operators or project proponents involved in land use covenants to pay such costs.

The Institutional Controls objectives to be achieved through land-use restrictions at the Site pursuant to California Civil Code section 1471, California Health and Safety Code sections 25222.1,25233, 25234, 25355.5, California Code of Regulations, title 22, section 67391.1 include:

- Prohibit sensitive uses such as residential, hospital, school, child care facility, and hospice;
- Other than remediation performed by the regulatory agencies as approved under this ROD, prohibit groundwater extraction and/or usage without prior review and written approval of DTSC;
- Other than remediation performed by the regulatory agencies as approved under this ROD, prohibit the alteration, disturbance, or removal of groundwater extraction/monitoring wells and any associated piping and equipment without the review and written approval of DTSC;
- Other than remediation performed by the regulatory agencies as approved under this ROD, such as the clean fill imported as part of the remedial action, prohibit any alteration, disturbance, or excavation of soil and caps without a DTSC approved excavation workplan;
- Any contaminated soils brought to the surface by grading, excavation, trenching or backfilling shall be managed in accordance with all applicable provisions of state and federal law;
- Other than remediation performed by the regulatory agencies as approved under this ROD, the Owner shall provide the Department written notice at least fourteen (14) days prior to any building, filling, grading or excavating at the Property.

More detailed specifics of the Implementation and Enforcement Plan for Institutional Controls shall be addressed at the Remedial Design phase. The Remedial Design package shall include an Institutional Controls remedial design section to more specifically describe the required implementation and enforcement actions including, but not limited to:

- Requirements for a five-year review;
- Frequency and requirements for periodic monitoring or visual inspections;
- Identification of responsibilities for the City and DTSC for implementation, monitoring, inspections, reporting, and enforcement of the Institutional Controls;
- Reporting results of monitoring and inspections;
- Notification procedures to DTSC or other regulatory agencies; and
- Recording requirements for the Covenant.
- An agreement to pay DTSC for all costs associated with the administration of such controls.

The City as owner shall be responsible for implementing, monitoring, inspecting, reporting, and enforcing the Institutional Controls as approved by DTSC in the Remedial Design Package. Should any of the Institutional Controls fail or be compromised, the City shall ensure appropriate actions are taken to reestablish the protectiveness of the institutional control.

7.0 Summary of Site Risks

7.1 Summary of Human Health Risk Assessment

This summary of health risks includes sections on the identification of COCs, the exposure assessment, toxicity assessment, and risk characterization.

7.1.1 Identification of Chemicals of Concern

The COCs driving the need for remedial action (risk drivers) are based on the data collected during the RI, FS, and data gap assessments as discussed in Section 5.0. The concentrations of COCs found to pose potential threats to human health in the soil and groundwater at Pemaco are presented in Tables 7-1a through 7-1c. The tables also identify the exposure point concentrations (EPCs) for soil and groundwater, ranges of concentrations detected for each COC, the detection frequency (*i.e.,* the number of times the chemical was detected in the samples collected at Pemaco), and how the EPC was derived.

7.1.2 Exposure Assessment

Exposure refers to the potential contact of an individual (receptor) with a chemical. Exposure assessment is the determination or estimation of the magnitude, frequency, duration, and route of potential exposure. This section briefly summarizes the potentially exposed populations, the exposure pathways evaluated, and the exposure quantification from the baseline risk assessment performed for the Pemaco Superfund site. A complete discussion of all scenarios and exposure pathways is presented in Appendix 6 of the RI report (TN&A, 2003).

The Pemaco property and six nearby properties are to be redeveloped into the Maywood Riverfront Park. The plan for the park includes a playground area, soccer fields, basketball courts, native plant landscaping, picnic areas, restrooms, and a parking area. The current plan does not specify a swimming pool, but it is a future possibility. The property was zoned industrial, but it is currently zoned for recreational use. Since the Pemaco site is located in a residential area, a future on-site residential exposure scenario was evaluated to determine if significant health risks would be expected in the event current land usage plans changed for the property. The site is currently fenced and access is limited.

Five exposure scenarios were evaluated in the baseline risk assessment:

- The current trespasser scenario evaluated exposure to surface soils by the ingestion, dermal, and inhalation pathways.
- The future park user scenario evaluates exposure to surface soil by the ingestion, dermal, and inhalation pathways.
- The future excavation worker scenario evaluates exposure to surface and subsurface soils (to 15 ft bgs) by the ingestion, dermal and inhalation pathways.
- Although this remedy prohibits residential use of the property, the future onsite residential scenario evaluates exposure to surface soils and to groundwater within the Exposition ‘A’ and ‘B’ zones by the ingestion, dermal, and inhalation pathways. Vapor intrusion by volatile chemicals detected in onsite shallow soil gas was also evaluated for the future onsite residential scenario.
- The current offsite residential scenario evaluates risks posed by potential inhalation exposure to chemicals volatilizing from the onsite subsurface soil and perched groundwater or volatilizing from perched groundwater plumes that are migrating offsite. There are currently no water supply wells in the Exposition ‘A’ and ‘B’ groundwater zones; therefore, exposure to groundwater in these zones was not evaluated.

Based on the extensive database available for the Pemaco site, fate and transport modeling were not required. The onsite risks to human health were evaluated, therefore, on the basis of the measured concentrations of chemicals in the surface soil, subsurface soil, soil gas, and groundwater in the perched zone and Exposition 'A' and 'B' Zones. Offsite risks were evaluated on the basis of measured concentrations of chemicals in indoor and outdoor air samples and soil gas samples collected on the Pemaco site and nearby residential locations.

Two general types of exposure scenarios were evaluated in order to provide information on the range of risks potentially experienced by the population potentially affected by Pemaco-related contamination. A "reasonable maximum exposure" (RME) receptor was designed to represent people who may have high exposures to COCs. A "central tendency" (CT) receptor was designed to represent people who may have more typical exposures to COCs. The results of these two cases provide a realistic range of general exposures to COCs and, consequently, a range of human health risks associated with those general exposures. The RME and CT exposure scenarios were developed in accordance with Part A, Human Health Evaluation Manual, of the Risk Assessment Guidance for Superfund (U.S. EPA, 1989).

RME and CT exposure parameters were developed for all five exposure scenarios.

Current Trespassers: The trespasser scenario was developed using exposure parameters representative of the frequency and duration of trespassers per consultation with the City of Maywood, local police, and church groups.

Future Park Users: For the future park user scenario, outdoor athletic activities are likely to be the most intensive use of the park. Playing soccer was selected as an activity representative of the RME conditions. Because the Pemaco site is adjacent to a residential community, residential exposure duration parameters were applied. It was also assumed that the park would be accessible to small children.

Trespassers and park users are expected to have contact only with the surface soil.

Future Excavation Workers: An excavation worker scenario was evaluated for potential risks due to exposure to subsurface soils up to a depth of 15 ft. Although an excavation worker may only spend a few days or weeks on the Pemaco site, exposure over a career was evaluated. This reflects the potential that an excavation worker in a metropolitan area such as Los Angeles may frequently excavate on properties that are being redeveloped after previous industrial uses.

Future On-site Residents: Potential future onsite residents were assumed to have contact with the surface soil and to use groundwater from the Exposition groundwater zones for all domestic needs. Default residential parameters were used.

Current Off-site Residents: The current offsite resident exposure scenario was developed to assess inhalation exposure to chemicals volatilized from subsurface soils and perched groundwater plumes. Residential inhalation exposure parameters were used to evaluate data from indoor and outdoor air samples. This exposure pathway was also evaluated using the Johnson and Ettinger model to predict potential exposures due to vapor intrusion by volatile chemicals found in shallow soil gas samples.

Table 7-1a. Exposure Point Concentration Summary - Surface Soils

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	Chemical of Concern	Concentration Detected			Units	Frequency of Detection	Exposure Point Concentration	
		Minimum	Maximum	Arithmetic Mean			Value (mg/kg)	Statistical Measure[1]
Riverfront Park	Arsenic	1.1 J	19.8	4.51	mg/kg	73/75	6.2	95% UCL-NP
	Benzo(a)anthracene	0.040 J	22 J	0.49	mg/kg	38/75	1.34	95% UCL-NP
	Benzo(a)pyrene	0.040 J	33 J	0.66	mg/kg	40/75	1.92	95% UCL-NP
	Benzo(b)fluoranthene	0.055 J	38 J	0.77	mg/kg	39/75	3.00	95% UCL-NP
	Benzo(k)fluoranthene	0.038 J	28 J	0.58	mg/kg	38/75	2.83	95% UCL-NP
	bis(2-Ethylhexyl)phthalate	0.048 J	6.8	0.39	mg/kg	29/75	1.46	95% UCL-NP
	Chrysene	0.0.39 J	24 J	0.54	mg/kg	42/75	1.48	95% UCL-NP
	Dibenzo(a,h)anthracene	0.040 J	5.3 J	0.26	mg/kg	13/75	2.91	95% UCL-NP
	Indeno(1,2,3-cd)pyrene	0.042 J	19 J	0.46	mg/kg	36/75	1.21	95% UCL-NP
	Lead	1.6	952	45.94	mg/kg	75/75	114.00	95% UCL-NP
	Manganese	162	1,940	385.23	mg/kg	75/75	489.00	95% UCL-NP

Notes:

1) 95% Upper confidence limit (UCL) derived by nonparametric (NP) statistical techniques (Gilbert, 1987).

2) Supporting documentation may be referenced in the Final Technical Memorandum: Baseline Risk Assessment, Pemaco Superfund Site, Maywood, CA (TN&A, August 2003).

mg/kg = milligram per kilogram

J = Analytical Qualifier, Estimated Value

Max = Maximum Concentration

The table above presents the chemicals of concern (COCs) detected in surface soil above screening levels and their respective exposure point concentration (i.e., the concentration that will be used to estimate the exposure and risk in surface soil). The table includes the range of concentrations detected for each COC, as well the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the Site), the exposure point concentration (EPC) and how the EPC was derived. The 95% UCL on the arithmetic mean was used as the EPC for all COCs in surface soil detected above screening levels.

Table 7-1b. Exposure Point Concentration Summary – Surface and Subsurface Soil

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil
Exposure Medium: Surface and Subsurface Soil

Exposure Point	Chemical of Concern	Concentration Detected			Units	Frequency of Detection	Exposure Point Concentration	
		Minimum	Maximum	Arithmetic Mean			Value (mg/kg)	Statistical Measure[1]
Riverfront Park	Arsenic	0.79 J	40.40	3.94	mg/kg	222/233	5.22	95% UCL-NP
	Benzo(a)anthracene	0.039 J	33 J	0.45	mg/kg	88/233	0.95	95% UCL-NP
	Benzo(a)pyrene	0.040 J	33 J	0.49	mg/kg	90/233	0.85	95% UCL-NP
	Benzo(b)fluoranthene	0.039 J	40	0.59	mg/kg	96/233	0.95	95% UCL-NP
	Benzo(k)fluoranthene	0.038 J	29 J	0.47	mg/kg	87/233	0.78	95% UCL-NP
	bis(2-Ethylhexyl)phthalate	0.038 J	47	0.58	mg/kg	97/233	0.92	95% UCL-NP
	Chrysene	0.039 J	33 J	0.48	mg/kg	96/233	0.85	95% UCL-NP
	Copper	6.4	346 J	24.09	mg/kg	230/233	26.9	95% UCL-NP
	Cyanide	0.06 J	1.10	0.05	mg/kg	14/174	0.08	95% UCL-NP
	Dibenzo(a,h)anthracene	0.043 J	5.3 J	0.25	mg/kg	22/233	0.68	95% UCL-NP
	Ethylbenzene	0.001 J	2.4 J	0.053	mg/kg	26/86	2.4	Max
	Indeno(1,2,3-cd)pyrene	0.038 J	19 J	0.36	mg/kg	81/233	0.61	95% UCL-NP
	Lead	1.6	952	21.71	mg/kg	232/233	35.5	95% UCL-NP
	Manganese	149	1,940	348	mg/kg	232/232	370	95% UCL-NP
	Trichloroethene	0.002 J	2.35	0.053	mg/kg	9/86	1.51	95% UCL-NP

Notes:

1) 95% Upper confidence limit (UCL) derived by nonparametric (NP) statistical techniques (Gilbert, 1987).

2) Supporting documentation may be referenced in the Final Technical Memorandum: Baseline Risk Assessment, Pemaco Superfund Site, Maywood, CA (TN&A, August 2003).

mg/kg = milligram per kilogram

J = Analytical Qualifier, Estimated Value

Max = Maximum Concentration

The table above presents the chemicals of concern (COCs) detected in surface and subsurface soil above screening levels and their respective exposure point concentration (i.e., the concentration that will be used to estimate the exposure and risk in surface and subsurface soil). The table includes the range of concentrations detected for each COC, as well the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the Site), the exposure point concentration (EPC) and how the EPC was derived. The 95% UCL on the arithmetic mean was used as the EPC for all COCs in surface and subsurface soil detected above screening levels with exception to ethylbenzene. The maximum concentration was used as the default EPC for ethylbenzene.

Table 7-1c. Exposure Point Concentration Summary – Groundwater

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical of Concern	Concentration Detected			Units	Frequency of Detection	Exposure Point Concentration	
		Minimum	Maximum	Arithmetic Mean			Value (mg/kg)	Statistical Measure[1]
Exposition	1,1-Dichloroethane	0.3 J	2	9.09	mg/L	7/102	2	Max
A & B	1,2,4-Trimethylbenzene	0.28 J	1.4 J	6.3	mg/L	3/25	1.4	Max
Tap Water	Acetone	9 J	20,000 J	1,038	mg/L	26/101	7,963	95% UCL-NP
	Aluminum	5.8 J	4020 J	4020	mg/L	11/22	4020	Max
	Arsenic	4.6 J	52.7	13	mg/L	10/22	50.53	95% UCL-NP
	Benzene	0.4 J	1,600 J	26.22	mg/L	15/101	200	95% UCL-NP
	bis(2-Ethylhexyl)phthalate	1 J	2 J	4.4	mg/L	4/21	2	Max
	Bromomethane	0.5 J	2 J	8.85	mg/L	7/104	2	Max
	Chloroform	0.5 J	36 J	6.43	mg/L	12/102	34.08	95% UCL-NP
	cis-1,2-Dichloroethene	0.4 J	14,000	234	mg/L	57/101	2,464	95% UCL-NP
	Ethylbenzene	0.25 J	3.5	9.1	mg/L	7/101	3.5	Max
	Hexane	1.2 J	311	35.6	mg/L	8/18	311	Max
	Iron	21.8 J	5,010	421.5	mg/L	13/22	2,073	95% UCL-LN
	Manganese	5.1 J	1,410	370	mg/L	22/22	1,350	95% UCL-LN
	Selenium	5.2	23.5	4.7	mg/L	6/21	14	95% UCL-NP
	Tetrachloroethene	0.1 J	9	5.86	mg/L	18/102	8.07	95% UCL-NP
	trans-1,2-Dichloroethene	1.6 J	53	7.69	mg/L	16/12	23.28	95% UCL-NP
	Trichloroethene	1	27,000	1,947	mg/L	64/101	4,136	95% UCL-NP
	Vinyl Chloride	0.7 J	780	17.13	mg/L	18/101	200	95% UCL-NP

Notes:

1) 95% Upper confidence limit (UCL) derived by nonparametric (NP) statistical techniques (Gilbert, 1987).

2) Supporting documentation may be referenced in the Final Technical Memorandum: Baseline Risk Assessment, Pemaco Superfund Site, Maywood, CA (TN&A, August 2003).

3) Maximum concentrations determined from detected concentrations only. As a conservative measure, arithmetic mean concentrations determined from detects, non-detects (half-detection limit), and diluted non-detects (half-detection limit).

µg/L = microgram per liter

J = Analytical Qualifier, Estimated Value

Max = Maximum Concentration

The table above presents the chemicals of concern (COCs) detected in groundwater above screening levels and their respective exposure point concentration (i.e., the concentration that will be used to estimate the exposure and risk in groundwater). The table includes the range of concentrations detected for each COC, as well the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the Site), the exposure point concentration (EPC) and how the EPC was derived. The 95% UCL on the arithmetic mean was used as the EPC for the majority of COCs in groundwater detected above screening levels. The maximum concentration was used as the default EPC for all other COCs in groundwater.

7.1.3 Toxicity Assessment

Tables 5.3a through 5.3h show the COCs that are the major risk contributors for Pemaco. The COCs evaluated were selected using the following criteria:

- Those chemicals detected in greater than 5 percent of the samples analyzed and detected at a maximum concentration that exceeded one-tenth of the EPA Region IX PRGs were retained as COCs.
- The concentrations of inorganic chemicals in the soil were also screened against the 95 percent upper tolerance limit (95% UTL) of the background data for California soils (Bradford, et al., 1996).
- The exposure point concentration evaluated was either the maximum detected concentration or the 95 percent upper confidence limit (95% UCL) calculated based on the statistical distribution of the sample concentration values.

Toxicity values (cancer slope factors and references doses) were selected from several sources. Preference was given to values available on EPA's Integrated Risk Information System (IRIS) accessible at http://www.epa.gov/IRIS (EPA, 2002). If no toxicity values were available on IRIS the Health Effects Assessment Summary Tables (HEAST) was searched (EPA, 1997). If information was not available from these two sources, values used by EPA Region IX to develop the PRG values were used to assess risks at the Pemaco site (EPA, 2000). Consistent with a long-standing agreement between Region 9 and the California Environmental Protection Agency (Cal/EPA), where toxicity values were available for the same COC from both agencies, Cal/EPA values were used to evaluate risks at the Pemaco site whenever they were more than 4-fold more conservative than the corresponding EPA values (Cal/EPA, 1996).

Based on data from the above sources, COCs were classified as human carcinogens, probable human carcinogens, possible human carcinogens, and noncarcinogenic as presented with respect to oral/dermal and inhalation pathways. Tables 7-2a and 7-2b provide the carcinogenic oral/dermal and inhalation slope factors, respectively. In addition to their classification as human carcinogens, COCs with toxicity data indicating their potential for adverse noncarcinogenic health effects were recognized. Tables 7-3a and 7-3b provide the noncarcinogenic oral/dermal and inhalation slope factors, respectively.

Table 7-2a. Cancer Toxicity Data Summary – Oral/Dermal

Chemical of Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal[1]	Dermal Cancer Slope Factor		Weight of Evidence / Cancer Guideline Description[2]	Source(s)	Date[3]
	Value	Units		Value	Units			
1,1,2-Trichloroethane	5.7E-02	$(mg/kg\text{-}day)^{-1}$	1	5.7E-02	$(mg/kg\text{-}day)^{-1}$	C	IRIS	04/16/03
1,1-Dichloroethane	5.7E-03	$(mg/kg\text{-}day)^{-1}$	1	5.7E-03	$(mg/kg\text{-}day)^{-1}$	NA	EPA Region 9	10/01/02
1,1-Dichloroethene	NA	NA	NA	NA	NA	C	IRIS	08/26/02
1,2-Dichloroethane	9.1E-02	$(mg/kg\text{-}day)^{-1}$	1	9.1E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	04/17/03
1,2,4-Trimethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	NA	NA	NA	NA	NA	D	IRIS	08/26/02
Aluminum	NA	NA	NA	NA	$(mg/kg\text{-}day)^{-1}$	B2	NA	NA
Arsenic	1.5E+00	$(mg/kg\text{-}day)^{-1}$	1	1.5E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	08/26/02
Benzene	5.5E-02	$(mg/kg\text{-}day)^{-1}$	1	5.5E-02	$(mg/kg\text{-}day)^{-1}$	A	IRIS	08/26/02
Benzo(a)anthracene	7.3E-01	$(mg/kg\text{-}day)^{-1}$	1	7.3E-01	$(mg/kg\text{-}day)^{-1}$	B2	EPA Region 9	10/01/02
Benzo(a)pyrene	7.3E+00	$(mg/kg\text{-}day)^{-1}$	1	7.3E+00	$(mg/kg\text{-}day)^{-1}$	B2	EPA Region 9	10/01/02
Benzo(b)fluoranthene	7.3E-01	$(mg/kg\text{-}day)^{-1}$	1	7.3E-01	$(mg/kg\text{-}day)^{-1}$	B2	EPA Region 9	10/01/02
Benzo(k)fluoranthene	1.2E+00	$(mg/kg\text{-}day)^{-1}$	1	1.2E+00	$(mg/kg\text{-}day)^{-1}$	B2	EPA Region 9	10/01/02

Table 7-2a. Cancer Toxicity Data Summary – Oral/Dermal

Chemical of Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal[1]	Dermal Cancer Slope Factor		Weight of Evidence / Cancer Guideline Description[2]	Source(s)	Date[3]
	Value	Units		Value	Units			
bis(2-Ethylhexyl)phthalate	1.4E-02	$(mg/kg\text{-}day)^{-1}$	1	1.4E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	04/16/03
Bromomethane	NA	NA	NA	NA	NA	D	IRIS	04/16/03
Chloroform	3.1E-02	$(mg/kg\text{-}day)^{-1}$	1	3.1E-02	$(mg/kg\text{-}day)^{-1}$	B2	EPA Region 9	10/01/02
Chloromethane	1.3E-02	(mg/kg-day)-1	1	1.3E-02	(mg/kg-day)-1	D	EPA Region 9	10/01/02
Chrysene	1.2E-01	$(mg/kg\text{-}day)^{-1}$	1	1.2E-01	$(mg/kg\text{-}day)^{-1}$	B2	EPA Region 9	10/01/02
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	D	IRIS	08/26/02
Copper	NA	NA	NA	NA	NA	NA	NA	NA
Cyanide	NA	NA	NA	NA	NA	D	IRIS	04/17/03
Dibenzo(a,h)anthracene	7.3E+00	$(mg/kg\text{-}day)^{-1}$	1	7.3E+00	$(mg/kg\text{-}day)^{-1}$	B2	EPA Region 9	10/01/02
Dibromochloromethane	8.4E-02	$(mg/kg\text{-}day)^{-1}$	1	8.4E-02	$(mg/kg\text{-}day)^{-1}$	C	IRIS	04/15/03
Dichlorodifluoromethane	NA	NA	NA	NA	NA	NA	IRIS/Region 9	10/01/02
Ethylbenzene	3.85E-03	$(mg/kg\text{-}day)^{-1}$	1	3.85E-03	$(mg/kg\text{-}day)^{-1}$	NA	EPA Region 9	09/26/02
Hexane	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	7.3E-01	$(mg/kg\text{-}day)^{-1}$	1	7.3E-01	$(mg/kg\text{-}day)^{-1}$	B2	EPA Region 9	10/01/02
Iron	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	B2	IRIS	08/26/02
Manganese	NA	NA	NA	NA	NA	D	IRIS	08/26/02
Methyl tert-Butyl Ether	1.8E-03	(mg/kg-day)-1	1	1.8E-03	(mg/kg-day)-1	NA	EPA Region 9	10/01/02
Selenium	NA	NA	NA	NA	NA	D	IRIS	04/16/03
Tetrachloroethene	5.2E-02	$(mg/kg\text{-}day)^{-1}$	1	5.2E-02	$(mg/kg\text{-}day)^{-1}$	NA	EPA Region 9	10/01/02
trans-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA	IRIS	08/26/02
Trichloroethene	4.0E-01	$(mg/kg\text{-}day)^{-1}$	1	4.0E-01	$(mg/kg\text{-}day)^{-1}$	NA	EPA Region 9	10/01/02
Vinyl Chloride	1.5E+00	$(mg/kg\text{-}day)^{-1}$	1	1.5E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	04/16/02
Vinyl Chloride (Adult)	7.5E-01	$(mg/kg\text{-}day)^{-1}$	1	7.5E-01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	04/16/02

Notes:
Dermal Reference Dose (RfD) = Oral RfD/Oral to Dermal Adjustment Factor
EPA Group:

- *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 noncarcinogenicity*

3. *For IRIS values, the date IRIS was searched is given. For EPA Region 9 values, the date of publication is given.*
4. *Supporting documentation may be referenced in the Final Technical Memorandum: Baseline Risk Assessment, Pemaco Superfund Site, Maywood, CA (TN&A, August 2003).*

ND = No Data
NA = Not Applicable
IRIS = Integrated Risk Information System
RfD = Reference Dose
This table provides carcinogenic risk information which is relevant to the chemicals of concern in both soil and groundwater. At this time, slope factors are not available for the dermal route of exposure. Thus, the dermal slope factors used in the assessment were extrapolated from oral values. An adjustment factor was applied, and was dependent on how well the chemical is absorbed via the oral route (see 'oral absorption efficiency for dermal' above).

Table 7-2b. Cancer Toxicity Data Summary – Inhalation

Chemical of Concern	Unit Risk		Inhalation Cancer Slope Factor		Weight of Evidence / Cancer Guideline Description[1]	Source(s)	Date[2]
	Value	Units	Value	Units			
1,1,2-Trichloroethane	1.60E-02	$(mg/m^3)^{-1}$	5.60E-02	$(mg/kg\text{-}day)^{-1}$	C	IRIS	04/16/03
1,1-Dichloroethane	1.60E-03	$(mg/m^3)^{-1}$	5.70E-03	$(mg/kg\text{-}day)^{-1}$	NA	EPA Region 9	10/01/02
1,1-Dichloroethene	NA	NA	NA	NA	C	IRIS	08/26/02
1,2-Dichloroethane	2.60E-02	$(mg/m^3)^{-1}$	9.10E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	04/17/03
1,2,4-Trimethylbenzene	NA	NA	NA	NA	NA	NA	NA
Acetone	NA	NA	NA	NA	D	IRIS	08/26/02
Aluminum	NA	NA	NA	NA	B2	EPA Region 9	NA
Arsenic	4.30E+00	$(mg/m^3)^{-1}$	1.50E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	08/26/02
Benzene	8.30E-03	$(mg/m^3)^{-1}$	2.90E-02	$(mg/kg\text{-}day)^{-1}$	A	IRIS	08/26/02
Benzo(a)anthracene	NA	NA	7.30E-01	$(mg/kg\text{-}day)^{-1}$	B2	EPA Region 9	10/01/02
Benzo(a)pyrene	NA	NA	7.30E+00	$(mg/kg\text{-}day)^{-1}$	B2	EPA Region 9	10/01/02
Benzo(b)fluoranthene	NA	NA	7.30E-01	$(mg/kg\text{-}day)^{-1}$	B2	EPA Region 9	10/01/02
Benzo(k)fluoranthene	NA	NA	3.90E-01	$(mg/kg\text{-}day)^{-1}$	B2	EPA Region 9	10/01/02
bis(2-Ethylhexyl)phthalate	NA	NA	1.40E-02	$(mg/kg\text{-}day)^{-1}$	B2	EPA Region 9	10/01/02
Bromomethane	NA	NA	NA	NA	D	IRIS	04/16/03
Chloroform	5.4E-03	$(mg/m^3)^{-1}$	1.90E-02	$(mg/kg\text{-}day)^{-1}$	B2	EPA Region 9	10/01/02
Chloromethane	NA	NA	6.30E-03	(mg/kg-day)-1	D	EPA Region 9	10/01/02
Chrysene	NA	NA	3.90E-02	$(mg/kg\text{-}day)^{-1}$	B2	EPA Region 9	10/01/02
cis-1,2-Dichloroethene	NA	NA	NA	NA	D	IRIS	08/26/02
Copper	NA	NA	NA	NA	NA	NA	NA
Cyanide	NA	NA	NA	NA	D	IRIS	04/17/03
Dibenzo(a,h)anthracene	NA	NA	7.30E+00	$(mg/kg\text{-}day)^{-1}$	B2	EPA Region 9	10/01/02
Dibromochloromethane	NA	NA	8.40E-02	$(mg/kg\text{-}day)^{-1}$	C	EPA Region 9	10/01/02
Dichlorodifluoromethane	NA	NA	NA	NA	NA	EPA Region 9	10/01/02
Ethylbenzene	NA	NA	3.85E-03	$(mg/kg\text{-}day)^{-1}$	NA	EPA Region 9	10/01/02
Hexane	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	7.30E-01	$(mg/kg\text{-}day)^{-1}$	B2	EPA Region 9	10/01/02
Iron	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	B2	IRIS	08/26/02
Manganese	NA	NA	NA	NA	D	IRIS	08/26/02
Methyl tert-Butyl Ether	NA	NA	1.80E-03	(mg/kg-day)-1	NA	EPA Region 9	10/01/02
Selenium	NA	NA	NA	NA	D	IRIS	04/16/03
Tetrachloroethene	NA	NA	1.00E-02	$(mg/kg\text{-}day)^{-1}$	NA	EPA Region 9	10/01/02
trans-1,2-Dichloroethene	NA	NA	NA	NA	NA	IRIS	08/26/02
Trichloroethene	1.10E-01	$(mg/m^3)^{-1}$	4.00E-01	$(mg/kg\text{-}day)^{-1}$	NA	EPA Region 9	10/01/02
Vinyl Chloride	8.80E-03	$(mg/m^3)^{-1}$	3.10E-02	$(mg/kg\text{-}day)^{-1}$	A	IRIS	04/16/03
Vinyl Chloride (Adult)	4.40E-03	$(mg/m^3)^{-1}$	1.60E-02	$(mg/kg\text{-}day)^{-1}$	A	IRIS	04/16/03

Notes:

Dermal Reference Dose (RfD) = Oral RfD/Oral to Dermal Adjustment Factor

EPA Group:

- *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 noncarcinogenicity*

5. For IRIS values, the date IRIS was searched is given. For EPA Region 9 values, the date of publication is given.

6. Supporting documentation may be referenced in the Final Technical Memorandum: Baseline Risk Assessment, Pemaco Superfund Site, Maywood, CA (TN&A, August 2003).

ND = No Data *NA = Not Applicable*

IRIS = Integrated Risk Information System *RfD = Reference Dose*

This table provides carcinogenic risk information which is relevant to the chemicals of concern via the inhalation route.

Table 7-3a. Non-Cancer Toxicity Data Summary – Oral/Dermal

Chemical of Concern	Chronic/ Subchronic	Oral RfD		Primary Target Organ(s)	RfD:Target Organ(s)	
		Value	Units		Source(s)	Date(s)
1,1,2-Trichloroethane	Chronic	4.0E-03	mg/kg-day	Clin Chemistry	IRIS	04/16/03
1,1-Dichloroethane	Chronic	1.0E-01	mg/kg-day	None	HEAST	7/97
1,1-Dichloroethene	Chronic	5.0E-02	mg/kg-day	Liver	IRIS	08/26/02
1,2-Dichloroethane	Chronic	3.0E-02	mg/kg-day	NA	EPA Region 9	10/01/02
1,2,4-Trimethylbenzene	Chronic	5.0E-02	mg/kg-day	NA	EPA Region 9	10/01/02
Acetone	Chronic	1.0E-01	mg/kg-day	Liver/Kidney	IRIS	08/26/02
Aluminum	Chronic	1.0E+00	mg/kg-day	NA	EPA Region 9	10/01/02
Arsenic	Chronic	3.0E-04	mg/kg-day	Skin	IRIS	08/26/02
Benzene	Chronic	3.0E-03	mg/kg-day	NA	EPA Region 9	10/01/02
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	Chronic	2.0E-02	mg/kg-day	Liver	IRIS	08/26/02
Bromomethane	Chronic	1.4E-03	mg/kg-day	Stomach	IRIS	04/16/03
Chloroform	Chronic	1.0E-02	mg/kg-day	Liver	IRIS	08/26/02
Chloromethane	NA	NA	NA	NA	EPA Region 9	10/01/02
Chrysene	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	Chronic	1.0E-02	mg/kg-day	NA	HEAST	7/97
Copper	Chronic	4.0E-02	mg/kg-day	Gastro-Intestinal	HEAST	7/97
Cyanide	Chronic	2.0E-02	mg/kg-day	Thyroid	IRIS	4/17/03
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Dibromochloromethane	Chronic	2.0E-02	mg/kg-day	Liver	IRIS	04/16/03
Dichlorodifluoromethane	Chronic	2.0E-01	mg/kg-day	Growth	IRIS	11/13/02
Ethylbenzene	Chronic	1.0E-01	mg/kg-day	Liver/Kidney	IRIS	04/16/03
Hexane	Chronic	6.0E-02	mg/kg-day	Nervous system/ Testes	HEAST	7/97
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
Iron	Chronic	3.0E-01	mg/kg-day	NA	EPA Region 9	10/01/02
Lead (4)	NA	NA	NA	NA	NA	NA
Manganese	Chronic	4.66E-02	mg/kg-day	Clin Chemistry	IRIS	08/26/02
Methyl tert-Butyl Ether	Chronic	8.60E-01	mg/kg-day	NA	EPA Region 9	10/01/02
Selenium	Chronic	5.0E-03	mg/kg-day	Liver	IRIS	04/16/03
Tetrachloroethene	Chronic	1.0E-02	mg/kg-day	Liver	IRIS	08/26/02
trans-1,2-Dichloroethene	Chronic	2.0E-02	mg/kg-day	Clin Chemistry	IRIS	08/26/02
Trichloroethene	Chronic	3.0E-04	mg/kg-day	NA	EPA Region 9	10/01/02
Vinyl Chloride	Chronic	3.0E-03	mg/kg-day	Liver	IRIS	08/26/02

Notes:

1. *Source: EPA 2001. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.*
2. *Dermal RfD = Oral RfD x Oral absorption efficiency for dermal*
3. *For IRIS values, the date IRIS was searched is given.*
   For EPA Region 9 values, the publication date is given.
   For HEAST values, the publication date is given.
4. *Lead toxicity was evaluated using either the IEUBK or Adult lead model.*

ND = No Data
NA = Not Applicable
IRIS = Integrated Risk Information System
RfD = Reference Dose
HEAST= Health Effects Assessment Summary Tables

This table provides carcinogenic risk information relevant to the chemicals of concern in both soil and groundwater.

Table 7-3b. Non-Cancer Toxicity Data Summary – Inhalation

Chemical of Concern	Chronic / Subchronic	Inhalation RfC		Primary Target Organ(s)	RfC : Target Organ(s)	
		Value	Units		Source(s)	Date(s)
1,1,2-Trichloroethane	Chronic	NA	NA	NA	EPA Region 9	10/01/02
1,1-Dichloroethane	Chronic	4.9E-01	mg/m^3	None	HEAST	7/97
1,1-Dichloroethene	Chronic	2.0E-01	mg/m^3	Liver	IRIS	08/26/02
1,2-Dichloroethane	Chronic	4.9E-03	mg/m^4	NA	EPA Region 9	10/01/02
1,2,4-Trimethylbenzene	Chronic	NA	NA	NA	EPA Region 9	10/01/02
Acetone	Chronic	NA	NA	NA	EPA Region 9	10/01/02
Aluminum	Chronic	NA	NA	NA	EPA Region 9	10/01/02
Arsenic	NA	NA	NA	NA	NA	NA
Benzene	Chronic	6.0E-03	mg/m^3	NA	U.S.EPA Region 9	10/01/02
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	Chronic	NA	NA	NA	EPA Region 9	10/01/02
Bromomethane	Chronic	5.0E-03	mg/m^3	Nasal epithelium	IRIS	04/15/03
Chloroform	Chronic	3.0E-03	mg/m^3	NA	EPA Region 9	10/01/02
Chloromethane	Chronic	3.0E-01	mg/m^3	Cerebellum	EPA Region 9	10/01/02
Chrysene	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	Chronic	NA	NA	NA	EPA Region 9	10/01/02
Copper	NA	NA	NA	NA	NA	NA
Cyanide	Chronic	3.0E-03	mg/m^3	Nervous system	IRIS	04/17/03
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Dibromochloromethane	Chronic	NA	NA	NA	EPA Region 9	10/01/02
Dichlorodifluoromethane	NA	NA	NA	NA	EPA Region 9	10/01/02
Ethylbenzene	Chronic	1.0E+00	mg/m^3	Developmental	1000	04/15/03
Hexane	Chronic	2.0E-01	mg/m^3	Nervous system	IRIS	04/16/03
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA
Lead (3)	NA	NA	NA	NA	IRIS	08/26/02
Manganese	Chronic	5.0E-05	mg/m^3	Nervous system	IRIS	08/26/02
Methyl tert-Butyl Ether	Chronic	3.0E+00	mg/m^3	Kidney	EPA Region 9	10/01/02
Selenium	NA	NA	NA	NA	NA	NA
Tetrachloroethene	Chronic	NA	NA	NA	EPA Region 9	10/01/02
trans-1,2-Dichloroethene	Chronic	NA	NA	NA	EPA Region 9	10/01/02
Trichloroethene	Chronic	3.5E-02	mg/m3	NA	EPA Region 9	10/01/02
Vinyl Chloride	Chronic	1.0E-01	mg/m^3	Liver	IRIS	08/26/02

Notes:

1. *RfDs were derived from inhalation RfCs (mg/m^3) by multiplying by a conversion factor of 20 m^3/day per 70 kg.*
2. *For IRIS values, the date IRIS was searched is given.*
   For EPA Region 9 values, the publication date is given.
   For HEAST values, the publication date is givem
3. *Lead toxicity was evaluated using either the IEUBK or Adult lead model.*

ND = No Data
NA = Not Applicable
IRIS = Integrated Risk Information System
RfD = Reference Dose
HEAST= Health Effects Assessment Summary Tables

This table provides carcinogenic risk information which is relevant to the chemicals of concern in both soil and groundwater.

7.1.4 Risk Characterization Assessment

This section presents the results of the evaluation of the potential risks to human health associated with exposure to contaminated soil, soil vapor and groundwater at the Pemaco Superfund Site.

A risk assessment was performed at the Pemaco site to identify and estimate potential health risks to people potentially exposed to chemicals under the current conditions at the site and under future uses of the property if contamination at the Site is not remediated. The risk assessment addressed the following exposure scenarios: (1) risks to current trespassers at the site, (2) risks for a future park user, (3) risks for a future excavation worker at the site, (4) risks for a future hypothetical on-site resident, and (5) risks for current off-site residents. These risk scenarios were chosen based on current, proposed, and possible future uses of the property.

The risk assessment concluded that potential health risks from site-related contamination are low at present, mainly because access to the site is currently restricted. However, if the Pemaco contamination is not remediated, there is the potential for much greater health risks in the future.

Two types of potential health risks were addressed in the assessment, the risk of developing cancer and the risk of developing non-cancer health effects. Potential cancer risks were estimated for those chemicals that have the ability to increase the risk of developing cancer if there is repeated exposure to environmental levels of these chemicals which are too high for periods of time which are too long. Non-cancer risks were estimated for chemicals which have the ability to cause other types of health effects under similar conditions.

Consistent with the Agency's risk assessment guidelines in Risk Assessment Guidance for Superfund (U.S. EPA, 1989), the Pemaco risk assessment was based on "reasonable maximum exposure" (RME) conditions in order to estimate risks for those people experiencing the highest reasonably possible exposure to contamination from the Site. For example, under RME conditions exposure to site-related contamination was assumed to occur 250 days per year (future park user) to 350 days per year (resident), both over a 30 year period. Risks for people who are exposed less often and/or for shorter periods of time were shown to be correspondingly lower.

The significance of potential cancer risks is determined by EPA according to a range of acceptable cancer risks between one-in-one-million (1E-6) and 100-in-one-million (1E-4), as presented in the National Contingency Plan. Under the Superfund program, the Agency's goal is to control overall site-related cancer risks to within this target risk range.

The significance of potential non-cancer hazards are determined by comparison to a Hazard Index (HI) of one (1.0). The hazard index is the ratio of estimated exposure for site-related contaminants to their non-cancer reference doses; reference doses represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect. HI values equal to or less than 1.0 indicate that no adverse health effects are expected. HI values greater than 1.0 indicate an increased risk of adverse health effects; the greater the HI, the more likely that health effects will be experienced, especially by more sensitive members of the exposed population.

The total estimated carcinogenic risk and non-cancer hazards for each of the five receptor scenarios calculated as part of the Pemaco risk assessment are tabulated below for both RME and CT parameters. The specific chemical risk drivers associated with each media are discussed in the paragraphs that follow and are summarized in Table 7-4.

Table 7-4. Summary of Risk for Each Receptor

Receptor	Media	Total Carcinogenic Risk		Total Noncarcinogenic Hazard Quotient	
		RME[1]	CT[2]	RME	CT
Current Onsite					
Trespasser	Surface soil	4.5E-6	4.3E-7	0.012	0.0022
Future Onsite					
Park User	Surface soil	7.9E-5	1.9E-5	0.31	0.12
Excavation Worker	Surface and subsurface soil	6.9E-6	8.5E-7	0.12	0.025
Resident	Surface soil, groundwater, and vapor intrusion	**1.6E-1**	**4.5E-2**	**1,800**	**750**
Current Offsite					
Resident	Indoor/Outdoor air	9.2E-5	2.3E-5	**11**	**7.1**
	Outdoor air background	3.7E-5	NA	**4.4**	NA
	Modeled vapor intrusion	1.6E-5	3.1E-6	0.01	0.0055

NOTES
[1] *Reasonable maximum exposure parameters*
[2] *Central tendency exposure parameters*

Risks for Current Trespassers: Under current land-use conditions, when the only use of the site is by occasional trespassers, the estimated cancer risk using RME parameters falls at the lower end of the EPA target risk range of 1E-6 to 1E-4. Estimated cancer risk for trespassers are primarily due to potential exposure to the polyaromatic hydrocarbons (PAHs), benzo(a)pyrene and dibenzo(a,h)anthracene by the ingestion and dermal exposure routes. Using CT parameters, the carcinogenic risk for the Trespasser was below the target range. The total non-cancer HI was well below the target level of 1.0, thus indicating that non-cancer adverse effects to human health would be unlikely.

Risks for Future Park Users: The estimated cancer risks using the future park user scenario with either the RME or CT parameters fall in the middle of the EPA target risk range (see above table). Estimated cancer risks for future park users are primarily due to potential exposure to the PAHs, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene by the ingestion and dermal exposure routes. The total non-cancer HI was well below the target level of 1.0, thus indicating that non-cancer adverse effects to human health would be unlikely.

Risks for Future Excavation Workers: The estimated cancer risk using the future excavation worker scenario with RME parameters falls in the lower end of the EPA target risk range and falls below the target range using CT parameters (see above table). Estimated cancer risks for future excavation workers are primarily due to potential exposure to arsenic, and the PAHs benzo(a)pyrene, and dibenzo(a,h)anthracene by the ingestion exposure route. The total non-cancer HI was well below the target level of 1.0, thus indicating that non-cancer adverse effects to human health would be unlikely.

Risks for Future On-site Residents: Estimated cancer risks using the future onsite resident exposure scenario, with either RME or CT parameters, fall ***well above*** the upper end of the EPA target risk range (see above table). The estimated carcinogenic risks were primarily due exposure to contaminants in the Exposition groundwater zones. Potential cancer risks for future on-site residents were greatest for inhalation exposure, but also exceeded the upper end of the EPA target risk range due to ingestion and dermal exposure. These estimated cancer risks are primarily due to potential exposure to arsenic,

benzene, chloroform, ethylbenzene, tetrachloroethylene (PCE), trichloroethylene (TCE), and vinyl chloride. The total non-cancer HI also ***greatly exceeded*** the target level of 1.0, thus indicating that non-cancer adverse effects to human health are likely. The elevated non-cancer HI was primarily due to potential exposure to acetone, arsenic, benzene, chloroform, cis-1,2-dichloroethene, hexane, trichloroethylene (TCE), and vinyl chloride.

Most or all of the cancer and non-cancer risks to future on-site residents are due to site-related groundwater contamination, which is present as a result of past activities at Pemaco. Thus these risk assessment findings support the need for remedial action at the site.

Risks for Current Off-site Residents: Estimated cancer risks for off-site residents, based on measured indoor and outdoor air concentrations, using the current offsite resident exposure scenario fall within the target risk range using either RME or CT exposure parameters (see Table 7-4). These estimated cancer risks are primarily due to potential exposure to chloroform, benzene, methyl tert-butyl ether, and tetrachloroethene. The total non-cancer HI also exceeded the target level of 1.0 with either RME or CT parameters, thus indicating that non-cancer adverse effects to human health would be possible. The elevated non-cancer HI was primarily due to potential exposure to chloroform, 1,2,4-trimethylbenzene, and benzene. Risk estimates, based on background air sample data, also resulted in carcinogenic estimates within the EPA target risk range and the non-cancer HI also exceeded the target level of 1.0 using RME parameters. Thus, the site-related risks may lie within the level of background risk, but more background data is needed to establish an adequate statistical basis for comparison.

Many of the major contributors to cancer and non-cancer risks for current off-sire residents are chemicals for which there are other likely sources in the Maywood area (e.g., motor vehicles, local industrial facilities). This conclusion is supported by risk estimates, based on background air data collected by both EPA and the South Coast Air Quality Management District (SCAQMD), which also resulted in cancer estimates within the target risk range and a non-cancer HI which was greater than the screening level of 1.0. In order to focus only on potential risks due to site-related contamination, estimates of cancer risk were developed based on modeling of vapor intrusion (movement of site-related soil gas contamination into houses in the adjacent neighborhood). Modeling of indoor air exposures from measured soil gas concentrations in the neighborhood gave estimates of cancer risk within the target range, and the non-cancer HI estimate was well below the 1.0 screening level (see Table 7.4). The greatest potential cancer risk from vapor intrusion was due to exposure to trichloroethene.

Risk-based values, or remediation goal options, were developed during the Pemaco risk assessment for all risk drivers summarized by receptor above. These goals are calculated by rearranging the equations used to calculate each COCs HI or incremental cancer risk so that the equations can be used to solve for a concentration that will result in target hazard indexes of 1.0 or target cancer risk of 10-6. Remediation goal options for each risk driver are provided in Table 7-5.

7.1.5 Risk Drivers

The Pemaco-related contaminants which contribute the most to potential cancer and non-cancer health risks, the “risk drivers”, are listed here by environmental media. Risk drivers are those Pemaco-related contaminants which contributed a cancer risk greater than 1E-6 or a HI greater than 1.0 to one or more of the exposure scenarios evaluated in the risk assessment.

With regard to outdoor and indoor air, there were a number of compounds which were measured during sampling that potentially contributed cancer risks greater than 1E-6 and/or non-cancer HIs greater than 1.0 but were <u>not</u> identified as Pemaco-related contamination. This distinction was made by the Agency on the basis of comparison to background air data from both EPA and SCAQMD and the results of vapor intrusion modeling conducted for the risk assessment.

On-site Surface Soil – risks to current trespassers, future on-site park users, future on-site residents:

- Arsenic,
- Benzo(a)anthracene,
- Benzo(a)pyrene,
- Benzo(b)fluoranthene,
- Benzo(k)fluoranthene,
- Dibenzo(a,h)anthracene
- Indeno(1,2,3-cd)pyrene

On-site Surface and Sub-surface Soil – risks to future on-site excavation workers:

- Arsenic,
- Benzo(a)pyrene,
- Dibenzo(a,h)anthracene

Groundwater – risks to future on-site residents:

- Acetone,
- Arsenic,
- Benzene,
- Chloroform,
- cis-1,2-dichloroethene,
- Ethylbenzene,
- Hexane,
- Tetrachloroethylene (PCE),
- Trichloroethylene (TCE), and
- Vinyl chloride.

Soil Vapor – risks to current off-site residents:

- Trichloroethylene (TCE)

7.1.6 Uncertainty Analysis

Uncertainties are inherent in quantitative estimates of human health risk because such assessments link (1) measured amounts of individual contaminants at a site (*i.e.,* field data) with (2) exposure parameters that are assumptions or defaults, and (3) toxicity values that are most likely to have been modeled from experimental data in animals. Uncertainties associated with the accuracy and representativeness of the field measurements, the validity of the exposure assumptions and defaults, and/or the appropriateness of the dose-response model ensure that point estimates of risk will have boundaries. They will have an upper and a lower range in which the "true" extent of site-specific carcinogenic risk or systemic hazard will be equally likely to fall.

Itemizing the nature and extent of major components of the overall uncertainty may be useful to remedial decision-making since overly conservative assumptions and overestimates of risk may mean costly remediation activity where none is warranted. At the same time, insufficiently conservative assumptions and underestimates of risk may cause a potentially hazardous site to be left unremediated. This could have adverse human health implications. In general terms, many of the factors built into the exposure assessment are likely to result in an overestimation of risk because the assumptions underlying the data processing steps and exposure assessments are conservative. By contrast, an absence of toxicity information for some COCs will result in those contaminants being excluded from the risk/hazard analysis, for example, through a lack of RfDs or slope factors for some COCs. This could lead to an underestimate of risk.

Uncertainties are associated with each phase of the risk assessment, and, therefore, may be conveniently discussed within the four broad categories of risk assessment activity, namely, data gathering and evaluation, exposure assessment, toxicity assessment, and risk characterization. The analysis of all the uncertainties provides a semi-quantitative assessment of the uncertainty bounding the quantitative risk estimates. Thus, in this discussion, the magnitude of the effect of an uncertainty on the risk characterization is categorized as small, moderate, or large. Uncertainties categorized as small should not affect the risk estimates by more than one order of magnitude, uncertainties categorized as moderate may affect the risk estimates by between one and two orders of magnitude, and uncertainties categorized as large may affect the risk estimate by more than two orders of magnitude. Specific uncertainties in each of the four broad risk assessment categories are discussed in the Risk Assessment (Appendix 6 of the RI) in Section 7.0.

The most significant uncertainty identified in the Pemaco Risk Assessment was the uncertainty associated with TCE Toxicity Values. The toxicity values for TCE were withdrawn from IRIS and there are currently no cancer slope factors or reference doses that have undergone a complete EPA review. An EPA external review draft of *Trichloroethylene Health Risk Assessment: Synthesis and Characterization* was used as a source of quantitative toxicity information in this risk assessment (EPA, 2001c). The toxicity factors from the external review draft indicate that TCE may be more toxic than previously estimated and use of these factors, has resulted in much higher cancer and noncancer risk estimates than would have been derived using the toxicity factors from the National Center for Environmental Assessment that were used prior to release of the TCE external review draft. Both the risk and hazard values using the older toxicity factors or the more recent factors from the 2001 external review draft were calculated for the Pemaco Superfund site. All indicate that the possibility of adverse human health effects are possible if the contaminated groundwater from the Exposition 'A' & 'B' groundwater zones were to be used as a source of household water.

7.2 Summary of Ecological Risk Assessment

Due to the urban location of Pemaco, no risks to ecological receptors is anticipated, therefore an ecological risk assessment was not performed. This is further justified by the conservative risk scenarios completed for the human health risks in the way that it is unlikely that any ecological risks (if present) would exceed the risks identified by the human health risk assessment.

7.3 Risk Assessment Conclusion

Although the Pemaco site is currently zoned for recreational use, the only current use is by people who trespass on the site, and EPA contractors conducting investigation work. Current offsite risks posed by potential inhalation exposure to volatile chemicals in the neighborhood adjacent to the Pemaco site were also evaluated. Future exposure scenarios evaluated during the risk assessment included future park users, future excavation workers and future onsite residents. Institutional controls implemented by this ROD will prohibit residential development of the site in the future.

Trespassers and park users are expected to have contact only with the surface soil. In contrast, an excavation worker scenario was evaluated for potential risks due to exposure to subsurface soils up to a depth of 15 ft. Potential future onsite residents were assumed to have contact with the surface soil and to use groundwater from the Exposition groundwater zones for all domestic needs. The current offsite resident exposure scenario was developed to assess inhalation exposure to chemicals volatilized from subsurface soils and perched groundwater plumes.

Table 7-5. Chemical Risk Drivers for Each Receptor by Media

Receptor	Receptor Age	Scenario Timeframe	Type of Risk/ Hazard	Reasonable Maximum Exposure Cancer Risks and Noncancer Hazards Per Receptor by Media(1)											
Trespassers	Adolescent	Current	Cancer Risk	Total Risk	Exposure Medium	Exposure Route Contribution to Risk	Percent by Route	Chemicals Contributing Significantly to Risk (2)	Percent by Chemical	Exposure Point Concentration	RME Exposure Route Total	Remediation Goal Option (3)	Industrial Region 9 PRG		Units
				4.5E-06	Surface soil	Ingestion	43.9	Benzo(a)pyrene	29.2	1.9E+00	1.3E-06	1.5E+00	6.2E-02	ca	mg/kg
						Dermal	56.1	Dibenzo(a,h)anthracene	44.3	2.9E+00	2.0E-06	1.5E+00	6.2E-02	ca	mg/kg
						Inhalation	0.003								
			Non-cancer Hazard	Total Hazard Index	Expousre Medium	Exposure Route Contribution to HI	Percent by Pathway	Chemicals Contributing Significantly to HI (2)	Percent by Chemical	Exposure Point Concentration	RME Exposure Route Total	Remediation Goal Option (3)	Industrial Region 9 PRG		Units
				1.0E-02	Surface soil	Ingestion	81.1	The total HQ did not exceed 1.0							
						Dermal	18.6								
						Inhalation	0.3								
Park User	Adult/Child	Future	Cancer Risk	Total Risk	Exposure Medium	Exposure Route Contribution to Risk	Percent by Route	Chemicals Contributing Significantly to Risk (2)	Percent by Chemical	Exposure Point Concentration	RME Exposure Route Total	Remediation Goal Option (3)	Industrial Region 9 PRG		Units
				7.9E-05	Surface soil	Ingestion	73.8	Arsenic	14.4	6.2E+00	1.1E-05	5.4E-01	3.9E-01	ca*	mg/kg
						Dermal	26.2	Benzo(a)anthracene	2.0	1.3E+00	1.5E-06	8.7E-01	6.2E-01	ca	mg/kg
						Inhalation	0.01	Benzo(a)pyrene	28.0	1.9E+00	2.2E-05	8.7E-02	6.2E-02	ca	mg/kg
								Benzo(b)fluoranthene	4.4	3.0E+00	3.5E-06	8.7E-01	6.2E-01	ca	mg/kg
								Benzo(k)fluoranthene	6.8	2.8E+00	5.4E-06	5.3E-01	6.2E+00	ca	mg/kg
								Dibenzo(a,h)anthracene	42.4	2.9E+00	3.4E-05	8.7E-02	6.2E-02	ca	mg/kg
								Indeno(1,2,3-cd)pyrene	1.8	1.2E+00	1.4E-06	8.7E-01	6.2E-01	ca	mg/kg
			Non-cancer Hazard	Total Hazard Index	Expousre Medium	Exposure Route Contribution to HI	Percent by Pathway	Chemicals Contributing Significantly to HI (2)	Percent by Chemical	Exposure Point Concentration	RME Exposure Route Total	Remediation Goal Option (3)	Industrial Region 9 PRG		Units
				3.1E-01	Surface soil	Ingestion	93.3	The total HQ did not exceed 1.0							
						Dermal	5.2								
						Inhalation	1.4								
Excavation Worker	Adult	Future	Cancer Risk	Total Risk	Exposure Medium	Exposure Route Contribution to Risk	Percent by Route	Chemicals Contributing Significantly to Risk (2)	Percent by Chemical	Exposure Point Concentration	RME Exposure Route Total	Remediation Goal Option (3)	Industrial Region 9 PRG		Units
				6.9E-06	Surface and	Ingestion	88.1	Arsenic	32.6	5.2E+00	2.2E-06	2.3E+00	1.6E+00	ca	mg/kg
					subsurface soil	Dermal	11.1	Benzo(a)pyrene	28.7	8.5E-01	2.0E-06	4.3E-01	2.1E-01	ca	mg/kg
						Inhalation	0.8	Dibenzo(a,h)anthracene	23.0	6.8E-01	1.6E-06	4.3E-01	2.1E-01	ca	mg/kg
			Non-cancer Hazard	Total Hazard Index	Expousre Medium	Exposure Route Contribution to HI	Percent by Pathway	Chemicals Contributing Significantly to HI (2)	Percent by Chemical	Exposure Point Concentration	RME Exposure Route Total	Remediation Goal Option (3)	Industrial Region 9 PRG		Units
				1.2E-01	Surface and	Ingestion	50.5	The total HQ did not exceed 1.0							
					subsurface soil	Dermal	0.7								
						Inhalation	48.8								

Table 7-5. Chemical Risk Drivers for Each Receptor by Media

Receptor	Receptor Age	Scenario Timeframe	Type of Risk/ Hazard	Reasonable Maximum Exposure Cancer Risks and Noncancer Hazards Per Receptor by Media(1)											
Resident (onsite)	Adult/Child	Future	Cancer Risk	Total Risk	Exposure Medium	Exposure Route Contribution to Risk	Percent by Route	Chemicals Contributing Significantly to Risk (2)	Percent by Chemical	Exposure Point Concentration	RME Exposure Route Total	Remediation Goal Option (3)	Residential Region 9 PRG		Units
				1.1E-04	Surface soil	Ingestion	73.8	Arsenic	14.4	6.2E+00	1.6E-05	3.9E-01	3.9E-01	ca*	mg/kg
						Dermal	26.1	Benzo(a)anthracene	2.0	1.3E+00	2.2E-06	6.2E-01	6.2E-01	ca	mg/kg
						Inhalation	0.01	Benzo(a)pyrene	28.0	1.9E+00	3.1E-05	6.2E-02	6.2E-02	ca	mg/kg
								Benzo(b)fluoranthene	4.4	3.0E+00	4.8E-06	6.2E-01	6.2E-01	ca	mg/kg
								Benzo(k)fluoranthene	6.8	2.8E+00	7.5E-06	3.8E-01	6.2E+00	ca	mg/kg
								Dibenzo(a,h)anthracene	42.4	2.9E+00	4.7E-05	6.2E-02	6.2E-02	ca	mg/kg
								Indeno(1,2,3-cd)pyrene	1.8	1.2E+00	2.0E-06	6.2E-01	6.2E-01	ca	mg/kg
				1.6E-01	Groundwater	Ingestion	21.9	1,1-Dichloroethane	0.001	2.0E+00	1.1E-06	1.9E+00	2.0E+00	Cal/ca	mg/L
						Dermal	2.8	Arsenic	0.8	5.1E+01	1.3E-03	3.8E-02	4.5E-02	ca	mg/L
						Inhalation	75.4	Benzene	0.4	2.0E+02	6.5E-04	3.1E-01	3.4E-01	ca*	mg/L
								bis(2-Ethylhexyl)phthalate	0.001	2.0E+00	1.1E-06	1.8E+00	4.8E+00	ca	mg/L
								Chloroform	0.04	3.4E+01	6.8E-05	5.0E-01	5.3E-01	Cal/ca	mg/L
								Ethylbenzene	0.001	3.5E+00	1.4E-06	2.6E+00	2.9E+00	ca	mg/L
								Tetrachloroethene	0.01	8.1E+00	1.7E-05	4.8E-01	6.6E-01	ca	mg/L
								Trichloroethene	95.1	4.1E+03	1.6E-01	2.6E-02	2.8E-02	ca	mg/L
								Vinyl Chloride	3.6	2.0E+02	6.0E-03	3.3E-02	2.0E-02	ca	mg/L
			Non-cancer Hazard	Total Hazard Index	Exposure Medium	Exposure Route Contribution to HI	Percent by Route	Chemicals Contributing Significantly to HI (2)	Percent by Chemical	Exposure Point Concentration	RME Exposure Route Total	Remediation Goal Option (3)	Residential Region 9 PRG		Units
				4.4E-01	Surface soil	Ingestion	91.8	The total HQ did not exceed 1.0							
						Dermal	5.2								
						Inhalation	3.1								
				1.8E+03	Groundwater	Ingestion	75.5	Acetone	1.8	8.0E+03	3.3E+01	2.4E+02	6.1E+02	nc	mg/L
						Dermal	8.5	Arsenic	0.9	5.1E+01	1.6E+01	3.1E+00	4.5E-02	ca	mg/L
						Inhalation	15.8	Benzene	2.4	2.0E+02	4.5E+01	4.5E+00	3.4E-01	ca*	mg/L
								Chloroform	0.7	3.4E+01	1.3E+01	2.6E+00	5.3E-01	Cal/ca	mg/L
								cis-1,2-Dichloroethene	5.7	2.5E+03	1.0E+02	2.4E+01	6.1E+01	nc	mg/L
								Hexane	0.1	3.1E+02	2.2E+00	1.4E+02	3.5E+02	nc	mg/L
								Manganese	0.2	1.4E+03	3.1E+00	4.4E+02	8.8E+02	nc	mg/L
								Trichloroethene	87.6	4.1E+03	1.6E+03	2.6E+00	2.8E-02	ca	mg/L
								Vinyl Chloride	0.5	2.0E+02	8.9E+00	2.3E+01	2.0E-02	ca	mg/L
			Cancer Risk	Total Risk	Exposure Medium	Exposure Route Contribution to Risk	Percent by Route	Chemicals Contributing Significantly to Risk (2)	Percent by Chemical	Exposure Point Concentration	RME Exposure Route Total	Remediation Goal Option (3)	Region 9 PRG		Units
				9.9E-06	Vapor	Inhalation	100.0	Benzene	0.1	--	9.5E-06	--	2.3E-01	ca	mg/m^3
					Intrusion			Tetrachloroethene	4.1	--	4.1E-07	--	6.7E-01	ca	mg/m^3
								Trichloroethene	95.7	--	1.0E-08	--	1.7E-02	ca	mg/m^3
			Non-cancer Hazard	Total Hazard Index	Expousre Medium	Exposure Route Contribution to HI	Percent by Pathway	Chemicals Contributing Significantly to HI (2)	Percent by Chemical	Exposure Point Concentration	RME Exposure Route Total	Remediation Goal Option (3)	Region 9 PRG		Units
				--	Vapor	Inhalation	100.0	The total HQ did not exceed 1.0							
					Intrusion										

Table 7-5. Chemical Risk Drivers for Each Receptor by Media

Receptor	Receptor Age	Scenario Timeframe	Type of Risk/ Hazard	Reasonable Maximum Exposure Cancer Risks and Noncancer Hazards Per Receptor by Media(1)											
Resident (offsite)	Adult/Child	Current	Cancer Risk	Total Risk	Exposure Medium	Exposure Route Contribution to Risk	Percent by Route	Chemicals Contributing Significantly to Risk (2)	Percent by Chemical	Exposure Point Concentration	RME Exposure Route Total	Remediation Goal Option (3)	Region 9 PRG		Units
				9.2E-05	Indoor/Outdoor Air	Inhalation	100.0	Benzene	29.3	See Note 4.			2.3E-01	ca	mg/m^3
								Chloroform	25.2				3.5E-01	ca	mg/m^3
								Chloromethane	3.8						
								Methyl tert butyl ether	4.8				3.7E+00	ca	mg/m^3
								Tetrachloroethene	36.8				6.7E-01	ca	mg/m^3
			Non-cancer Hazard	Total Hazard Index	Exposure Medium	Exposure Route Contribution to HI	Percent by Pathway	Chemicals Contributing Significantly to HI (2)	Percent by Chemical	Exposure Point Concentration	RME Exposure Route Total	Remediation Goal Option (3)	Region 9 PRG		Units
				1.1E+01	Indoor/Outdoor Air	Inhalation	100.0	Benzene	19.1	See Note 4.			2.3E-01	ca	mg/m^3
								Chloroform	49.7				3.5E-01	ca	mg/m^3
								Dichlorodifluoromethane	0.4				6.2E+00	ca	mg/m^3
								Methyl tert butyl ether	0.1				2.3E-01	ca	mg/m^3
								Tetrachloroethene	0.7				3.5E-01	ca	mg/m^3
								1,2,4-Trimethylbenzene	29.7				6.2E+00	ca	mg/m^3

Notes:
(1) Reasonable maximum exposure receptor scenario selected to be conservative.
(2) Chemicals with total risk exceeding 1.0E-6 or total Hazard Index exceeding 1.0.
(3) Remediation Goal Option calculated for an Excess Lifetime Cancer Risk of 1.0E-6 or for a Hazard Index of 1.0.
(4) Residential air sampling for current offsite residents will continue. Total risk and total hazard index values estimated from previous air sampling events.

(5) Vapor intrusion modeling for current offsite resident scenario and future onsite resident scenario both result in cancer risks within range of USEPA target range and noncancer hazards well below the threshold level of 1.0.

The only scenario which exceeded the generally accepted EPA screening levels for both carcinogenic health risks (between 10-6 and 10-4) and for non-carcinogenic health risks (HQ <1.0) was the future onsite resident exposure scenario. The estimated carcinogenic risks for future onsite residents were primarily due to inhalation exposure to contaminants (primarily arsenic, benzene, chloroform, TCE, and vinyl chloride) in Exposition Zone groundwater. The elevated noncarcinogenic hazard index was primarily due to potential exposure to acetone, arsenic, benzene, chloroform, cis-1,2-dichloroethene, manganese, TCE, and vinyl chloride in Exposition Zone groundwater.

The current offsite resident exposure scenario exceeded the total noncarcinogenic hazard index indicating that noncarcinogenic adverse effects to human health would be possible (primarily due to potential exposure to chloroform, 1,2,4-trimethylbenzene, and benzene). However, risk estimates based on background air sample data, also resulted in carcinogenic estimates which exceeded the noncarcinogenic risk target level. Thus, the site-related risks may lie within the level of background risk, but more background data is needed to establish an adequate statistical basis for comparison.

The response action selected in this ROD is necessary to protect public health or welfare or the environment from actual or threatened releases of pollutants or contaminants from the Pemaco site which may present an imminent and substantial endangerment to public health or welfare.

8.0 Remedial Action Objectives (RAOs)

The Remedial Action Objectives (RAOs) for Pemaco are to protect human health and the environment from threats caused by exposure to contaminated soil, soil vapor, indoor air, and groundwater and to restore groundwater to potential beneficial use as a drinking water source. The selected remedy meets these RAOs through treatment of soil and groundwater contaminated with VOCs, NHVOCs, SVOCs and metals. The RAOs also serve to facilitate the five-year determination of protectiveness of human health and the environment.

The EPA has identified the following RAOs for the Pemaco Superfund site:

8.1 Soil RAOs

- Prevent human exposure (by direct contact) to contaminated soils having COCs in excess of soil ARARs and standards that are protective of human health and the environment.
- Prevent migration of COCs from soil to groundwater at levels that would exceed drinking water standards.

8.2 Groundwater RAOs

- Restore the groundwater quality in perched groundwater zone, and Exposition Zones to drinking water standards (MCLs).
- Prevent vertical migration of COCs from the perched groundwater and deeper Exposition Zones at rates that would cause groundwater to exceed drinking water standards.
- Prevent further offsite migration of contaminated groundwater beneath additional adjacent properties.
- Prevent migration of contaminated groundwater to local production wells.

8.3 Indoor Air RAOs

- Remediate COCs in soil and groundwater to drinking water standards and other health based action levels to eliminate potential exposures to indoor air contaminants created by site contamination.
- Prevent further migration of soil vapor in excess of ARARs and standards that are protective of human health and the environment.

These RAOs for the Pemaco Superfund site were developed by EPA based on the following:

- Reasonable anticipated land use scenarios summarized in the human health risk assessment that include recreational land use, as the property is currently incorporated into redevelopment plans to be made into the Maywood Riverfront Park.
- The human health risk assessment identified the appropriate exposure pathways, routes, and receptors as well as COCs which required that a remedial action be performed at the site to protect human health and the environment.

8.4 Remediation Levels for the Pemaco Superfund Site

Soil Remediation Levels

The health-based remediation levels for soil were developed based on the assumptions that soil contaminants could leach into the groundwater and that the groundwater would be used for potable and domestic purposes. The health-based remediation levels for soil were then estimated using the health-based cleanup standards for groundwater; MCLs, preliminary remediation goals (PRGs), dilution attenuation factors (DAF) and site-specific hydrogeologic conditions. Since the remedy for surface soils consists of a soil cover layer, EPA chose not to set contaminant specific remediation levels for the surface soils. However the agency did set contaminant specific remediation levels for lower and upper vadose zone soils. These contaminant specific remediation levels were set for the chemicals that drive the risk at the site (see Section 7.1.5). The final remediation levels for the chemicals detected in soils will prevent contaminant concentration in groundwater from exceeding MCLs.

Groundwater Remediation Levels

Although this remedy prohibits future residential use of the former Pemaco property, health-based remediation levels for groundwater were also derived for chemicals that did not have an MCL based on the groundwater ingestion and inhalation pathways under a reasonable maximum exposure residential use scenario. Thus, the final groundwater remediation levels for chemicals in the groundwater were the more stringent of the federal or California maximum contaminant levels (MCLs). For chemicals that did not have a designated MCL, EPA followed the following procedures to determine a groundwater remediation level:

- EPA compared the maximum concentration of a COC found at the site to the health-based PRGs. If the maximum concentration fell within EPA's acceptable cancer risk range then the agency decided not to set a chemical specific remediation level.
- If the maximum concentration of a COC found at the site was higher than the health-based PRGs and was outside of EPA's acceptable cancer risk range, then the agency set chemical specific remediation levels for those chemicals at PRGs.
- By setting remediation levels for the majority of the COCs at MCLs, PRGs, health-based standards, or effluent limits, it is anticipated that the concentrations of the remaining COCs, i.e. those for which no cleanup levels were selected, will be reduced.

- EPA evaluated the California Regional Water Quality Control Board Los Angeles Region, Order No. R4-2002-0107, Waste Discharge Requirements for Discharges of Treated Groundwater from Investigation and/or Cleanup of Volatile Organic Compounds in Contaminated-sites to Surface Waters in Coastal Watersheds of Los Angeles and Ventura Counties for applicability to groundwater remediation levels. If the Waste Discharge Requirement was lower than the remediation level, EPA set a secondary remediation level for the groundwater effluent from the treatment system. The Waste Discharge Requirement only applies when the contaminant is treated and discharged from the site. The primary remediation level applies as a monitoring and remediation level for the groundwater aquifer.

Table 8-1. Site–Specific Remediation Levels (SSRLs)

Zone	Chemical of Concern	Site-Specific Remediation Levels[1] (IN BOLD)				
		ARARs[2]	10^{-6} Cancer Risk			
		Primary MCLs	Region IX PRGs *(type of PRG)*	Park User Exposure[3]	Excavation Worker Exposure[4]	Remediation Levels[5]
COCs only found in Upper Vadose Zone	***VOCs (µg/kg)***		*DAF 20 SSL*			
	1,1-Dichloroethene	--	60 µg/kg	--	722 µg/kg ca	**60 µg/kg**
	Acetone	--	16,000 µg/kg	--	--	**16,000 µg/kg**
	Ethylbenzene	--	13,000 µg/kg	--	--	**13,000 µg/kg**
	Tetrachloroethene	--	60 µg/kg	--	11,300 µg/kg ca	**60 µg/kg**
	Toluene	--	12,000 µg/kg	--	--	**12,000 µg/kg**
	Xylenes (total)	--	210,000 µg/kg	--	--	**210,000 µg/kg**
	SVOCs (µg/kg)		*DAF 20 SSL*			
	Benzo (a) anthracene	--	2000 µg/kg	--	2,610 µg/kg ca	**2,000 µg/kg**
	Benzo (a) pyrene	--	8,000 µg/kg	--	261 µg/kg ca	**261 µg/kg**
	Benzo (b) fluoranthene	--	5,000 µg/kg	--	2,610 µg/kg ca	**2,610 µg/kg**
	Carbazole	--	600 µg/kg	--	--	**600 µg/kg**
	Dibenzo (a,h) anthracene	--	2,000 µg/kg	--	762 µg/kg ca	**762 µg/kg**
	Indeno (1,2,3-cd) pyrene	--	14,000 µg/kg	--	2,610 µg/kg ca	**2,610 µg/kg**
	Isophorone	--	500 µg/kg	--	--	**500 µg/kg**
COCs found in both Upper and Lower Vadose Zone Soils	***VOCs (µg/kg) DAF 20***		*DAF 20 SSL*			
	Benzene	--	30 µg/kg	--	--	30 µg/kg
	1,2-Dichloroethane	--	20 µg/kg	--	--	20 µg/kg
	cis-1,2-Dichloroethene	--	400 µg/kg	--	--	400 µg/kg
	Methylene chloride	--	20 µg/kg	--	--	20 µg/kg
	Trichloroethene	--	60 µg/kg	--	--	60 µg/kg
	Vinyl Chloride	--	10 µg/kg	--	--	10 µg/kg
	Metals (mg/kg) DAF 20		*DAF 20 SSL*			
	Chromium (total)	--	38 mg/kg	--	--	38 mg/kg
COCs found only in Perched Ground-water Zone	***VOCs (µg/L)***		*Tap Water*			
	1,1-Dichloroethane	5 µg/L	810/**0.2 µg/L***	--	--	**5 ug/L**
	1,1,2-Trichloroethane	5 µg/L	**0.2 µg/L**	--	--	**5 µg/L 0.60 ug/l[(7)]**
	Chloroethane	--	**4.6 µg/L**	--		**100 ug/l[(6)]**
	Ethylbenzene	300 µg/L	1300 µg/L	--		**300 µg/L**
	Toluene	**150 µg/L**	720 µg/L	--		**150 ug/L**
	NHVOCs (µg/L)		*Tap Water*			
	Acetonitrile (Coelute w/ MIBK)	--	100 µg/L	--	--	**100 µg/L**
	Methyl isobutyl ketone (MIBK)	--	2000 µg/L	--	--	**2000 µg/L**
	SVOCs (µg/L)		*Tap Water*			
	1,4-Dioxane	**3.0 µg/L****	6.1 µg/L	--	--	**3.0 µg/L****
	bis(2-Ethylhexyl)phthalate	**4 µg/L**	4.8 µg/L	--	--	**4 µg/L**
	Naphthalene***	--	6.2 µg/L	--	--	**6.2 µg/L**
	Metals (µg/L)		*Tap Water*			
	Chromium (total)	**50 µg/L**	--	--	--	**50 µg/L**
	Iron	--	**11,000 µg/L**	--	--	**11,000 µg/L**
	Lead	**15 µg/L****	--	--	--	**15 µg/L** **5 ug/l [(7)]**
	Selenium	**50 µg/L**	180 µg/L	--	--	**50 µg/L**

Table 8-1. Site–Specific Remediation Levels (SSRLs)

Zone	Chemical of Concern	Site-Specific Remediation Levels[1] (IN BOLD)				
		ARARs[2]	10^{-6} Cancer Risk			
		Primary MCLs	Region IX PRGs *(type of PRG)*	Park User Exposure[3]	Excavation Worker Exposure[4]	Remediation Levels[5]
COCs found in both Perched and Exposition Groundwater Zones or in Exposition Groundwater zone only	***VOCs (µg/L)***		*Tap Water*			
	Acetone	--	5500 µg/L	--	--	**5500 µg/L** **700 ug/L**[(7)]
	1,1-Dichloroethene	**6 µg/L**	340 µg/L	--	--	**6 µg/L**
	1,2-Dibromo-3-chloropropane	0.2 µg/L	0.048/0.**0016 µg/L***	--	--	**0.2 µg/L**
	1,2-Dichloroethane	0.5 µg/L	**0.12 µg/L**	--	--	**0.5 µg/L** **0.38 ug/L**[(7)]
	Benzene	1 µg/L	0.34 µg/L	--	--	**1 µg/L**
	Chloroform	80 ug/L (THM)	.17/0.53 µg/L*	--	--	**80 ug/L**
	cis-1,2-Dichloroethene	**6 µg/L**	61 µg/L	--	--	**6 µg/L**
	Dibromochloromethane	80 ug/L (THM)	**0.13 µg/L**	--	--	**80 ug/L**
	Methylene Chloride	5 µg/L	**4.3 µg/L**	--	--	**5 µg/L** **4.7 ug/L**[(7)]
	Methyl tert butyl ether	13 µg/L	**6.2 µg/L**	--		**13 µg/L** **5 ug/L**[(7)]
	Tetrachloroethene	5 µg/L	**0.1 µg/L**	--	--	**5 µg/L** **0.8 ug/L**[(7)]
	trans-1,2-Dichloroethene	**10 µg/L**	120 µg/L	--	--	**10 µg/L**
	Trichloroethene	5 µg/L	1.4 µg/L	--	--	**5 µg/L** **2.7 ug/L**[(7)]
	Vinyl Chloride	0.5 µg/L	**0.02 µg/L**	--	--	**0.5 µg/L**
	Metals (µg/L)		*Tap Water*			
	Aluminum	**1000 µg/L**	36,000 µg/L	--	--	**1000 µg/L**
	Arsenic	10 µg/L	0.045 µg/L/.0071	--	--	**10 µg/L**
	Manganese	--	**880 µg/L**	--	--	**880 µg/L**
	Thallium	**2 µg/L**	2.4 µg/L	--	--	**2 µg/L**
	Anions (µg/L)		*Tap Water*			
	Sulfide	--	**110 µg/L**[#]	--	--	**110 µg/L** **1 ug/L**[(7)]

NOTES:

1. *Concentrations in bold represent SSRLs (most conservative of numbers 2 through 5).*
2. *ARARs are discussed in Section 13.0 of this document. Primary Maximum Contaminant Levels (MCLs) are based on the most conservative of the federal EPA and California Department of Health Services MCLs for drinking water. For groundwater COCs with no available MCLs, EPA Region IX Preliminary Remediation Goals (PRGs) were used. Subsurface soils were screened against Region IX PRGs Soil Screening Levels (SSLs) with Dilution Attenuation Factors (DAF). DAF 20 PRGs are used when the contaminated soil is not directly adjacent to a drinking water source and dilution of the contaminant is occurring before it reaches the drinking water source. DAF 1 PRGs assume that the contaminated soil is directly adjacent to a drinking water source and no dilution of the contaminant is occurring along the pathway between the source soil and the drinking water source.*
3. *Park user exposure scenario calculated at 10-6 cancer risk (from Maywood Riverfront Park, or MRP, Risk Assessment). Remediation levels are risk-based values developed during the Pemaco Baseline Risk Assessment. These levels are calculated by rearranging the equations used to calculate each COC's hazard quotient or incremental cancer risk so that the equations can be used to solve for a concentration that will result in target hazard indexes of 1.0 or a target cancer risk of 1E-06. Remediation goal options differ for each risk driver. Due to the numerous receptor scenarios, the most conservative goal was listed when COCs overlapped from one receptor to another.*
4. *Excavation worker exposure scenario calculated at 10-6 cancer risk (from MRP Risk Assessment).*
5. *DTSC recommended clean up levels based on background or ambient levels in Los Angeles for arsenic are 10-12 mg/kg and for benzo(a)pyrene are 900 µg/kg.*
6. *California Regional Water Quality Control Board Los Angeles Region Waste Discharge Requirements for Los Angeles and Ventura Counties.*
7. *California Regional Water Quality Control Board Los Angeles Region Waste Discharge Requirements for Los Angeles and Ventura Counties. The discharge limit applys when water is extracted from the aquifer, treated and discharged. The MCL or Federal Action Level applies for waters left in the groundwater aquifer.*

µg/kg: microgram per kilogram.
mg/kg: milligram per kilogram.
µg/L: microgram per liter.

Table 8-1. Site–Specific Remediation Levels (SSRLs)

Zone	Chemical of Concern	Site-Specific Remediation Levels[1] (IN BOLD)				
		ARARs[2]	10^{-6} Cancer Risk			
		Primary MCLs	Region IX PRGs *(type of PRG)*	Park User Exposure[3]	Excavation Worker Exposure[4]	Remediation Levels[5]

ca: carcinogenic
nc: noncarcinogenic
* *State of California modified PRG.*
** *California Department of Health Action Level, no available MCL*
\+ *The value of lead is The EPA remediation goal for residential exposure.*
++ *The lead value was derived using The Adult lead Model for non-residential exposure using parameters for a Mexican American Population.*
# *110 µg/L is the Region IX Tap Water PRG for hydrogen sulfide.*

9.0 Description of Alternatives

The remedial action for Pemaco addresses removal of contaminants from soil and groundwater. Since the subsurface geologic and hydrogeologic environments and contamination levels found at Pemaco are highly irregular and variable, EPA divided the site into three subsurface zones or "remediation zones" and assembled remedial alternatives by zone to develop an appropriate cleanup strategy for each individual zone. The remediation zones identified at the Pemaco site are:

a) Surface and near surface soil remediation zone (0-3 ft bgs) – "N"
b) Upper vadose zone soil and perched groundwater (3-35 ft bgs) – "SP"
c) Lower vadose zone soil and Exposition groundwater (35-100+ ft bgs) – "SG"

Based on RAOs, the quantity and composition of media to be remediated, key assumptions, technical project meetings, and the screening of remediation technologies for each media (i.e., surface/near-surface soil, upper vadose soil, perched groundwater, lower vadose soil, Exposition groundwater, ex-situ groundwater, and ex-situ vapor), EPA assembled a range of remedial alternatives for the site including five for the Surface and Near-Surface Soil Remediation Zone (0 to 3 ft bgs), eleven for the Upper Vadose Soil and Perched Groundwater Remediation Zone (3 to 35 ft bgs) , and ten for the Lower Vadose Soil and Exposition Groundwater Remediation Zone (35 to 100 ft bgs).

The remedial alternatives were then screened based on effectiveness, implementability, and estimated cost to determine the most promising and efficient remedial actions and provide a more manageable number of alternatives for detailed evaluation and comparative analysis (see Section 10). Remedial alternatives that EPA retained during the remedial alterative screening consist of the following:

Surface and Near-Surface (N) Soil Remediation Zone Alternatives

- N1 – No Action
- N2 – Soil Cover/Revegetation
- N3 – Excavation and Offsite Disposal

Upper Vadose Soil (S) and Perched (P) Groundwater Remediation Zone Alternatives

- SP1 No Action
- SP2a High Vacuum Dual Phase Extraction(HVDPE)/Ultraviolet Oxidation(UV Ox)/Flameless Thermal Oxidation(FTO) /Granular Activated Carbon (GAC)
- SP2b High Vacuum Dual Phase Extraction(HVDPE)/Ultraviolet Oxidation (UV Ox)/Granular Activated Carbon(GAC)
- SP3 *In-Situ* Chemical Oxidation (ISCO)
- SP4 Enhanced *In-Situ* Bioremediation (EISB)

- SP5 MNA

Lower Vadose Soil (S) and Exposition Groundwater (G) Remediation Zone Alternatives

- SG1 No Action
- SG2 ISCO/In-Situ Chemical Reduction (ISCR)/Groundwater Pump & Treat (P&T)/MNA/UV Ox
- SG3 EISB/Groundwater P&T/MNA/UV Ox
- SG4a Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/MNA/UV Ox/ FTO/GAC
- SG4b Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/MNA/UV Ox/GAC
- SG5a Electrical Resistive Heating (ERH) with VE/Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/ MNA/UV Ox/ FTO/GAC
- SG5b ERH with VE/Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/ MNA/UV Ox/GAC

Sections 9.1 through 9.3 below provide a detailed description of alternatives and remedy components for each remediation zone including:

- Treatment technologies and materials they will address,
- Containment components of the remedy and materials they will address,
- Institutional controls (if applicable),
- Operations and maintenance activities required to maintain integrity of the remedy, and
- Monitoring requirements.

Following the description of remediation alternatives, the common elements, distinguishing features, and expected outcomes for the remedial alternatives within each remediation zone are summarized.

9.1 Surface and Near-Surface Soil Remediation Zone Alternatives

The surface and near-surface soil remediation zone poses risks of human exposure to current trespassers, future park users, and future excavation workers by direct contact (ingestion and/or dermal contact) with soils containing COCs. This ROD does prohibit future residential development of the Pemaco Site. Five remediation alternatives were identified to reduce these risks as well as the potential risks associated with the migration of COCs in surface and near-surface soils to the perched groundwater, although the COCs in this zone are characteristically non-mobile and are not expected to migrate.

9.1.1 Alternative N1 – No Action

As required by the NCP, a "no action" alternative must be included as a remedial alternative to provide a baseline for evaluation of the remedial process options.

The No Action alternative does not involve any proactive treatment, removal, or monitoring of the contaminated media. In surface and near-surface soils soil, COCs consisting of metals and SVOCs exist at concentrations above cleanup levels. Under the no action alternative, pathways for human exposure via inhalation, ingestion, or dermal contact, and pathways for migration via wind and surface water runoff will persist. The No Action alternative for the surface and near/surface remediation zone would not be protective of human health as residents may be exposed to COCs.

9.1.2 Alternative N2 – Soil Cover/Revegetation

Soil Cover/Revegetation *Surface and Near-Surface Soil Remediation Zone*	
Alternative Description	
Soil cover involves emplacement of a layer of soil, typically one-foot or greater in thickness, and establishing vegetative growth to stabilize the soil in place. The soil cover does not treat or destroy the COCs but acts as a barrier or containment and eliminates the pathways to human exposure. Long-term monitoring and maintenance of the soil cover and vegetative growth is essential to prevent erosion and exposure of the underlying contaminants. The addition of a non-woven geotextile layer below the soil cover would enhance this alternative and act as an indicator of excessive erosion. Unlike an impermeable cap, a soil cover allows for percolation of precipitation and irrigation water into the subsurface. Percolation of water through surface soils poses a minor concern since the metal and SVOC COCs are not very mobile in the environment and tend to adhere tightly to their soil matrix. The completed soil cover could serve as a recreational area following revegetation.	
Site Characteristics	
Area To Be Graded and Covered:	
Area of Pemaco site:	65,000 ft^2
Area of adjacent railway:	22,500 ft^2
Preparation of Subgrade:	
Concrete area to be removed or broken in place:	13,000 ft^2
Thickness:	6 in
Volume:	240 yd^3
Vegetated area to be disposed/composted:	51,952 ft^2
Thickness:	3 in (assumed)
Volume to be hauled/disposed:	480 yd^3
Fence length adjoining railway to be removed:	540 ft
Volume (rough estimate) to be hauled/disposed:	60 yd^3
Cover Soil:	
Volume, 1-foot (1.4 x actual volume to account for compaction):	4,550 yd^3
Topsoil volume, 4 in:	1,080 yd^3
Surface Restoration:	
Vegetative cover to be established as needed:	87,500 ft^2

Conceptual Design Components and Assumptions	
Component	**Assumptions**
Preparation of Subgrade: Includes clearing existing vegetation and fixtures such as concrete pads, walls, fencing, rail lines, etc. with the intent of creating a suitable surface for the application of cover soils. Semi-impermeable surfaces, such as concrete pads, promote uneven drainage patterns, ponding or subsurface erosion, which can lead to slips and cracks in the cover. Therefore, the concrete pads should be removed or broken-up in place and compacted into the subgrade so that drainage is promoted.	• Concrete will be broken-up and left in place, *i.e.,* no hauling. • Monitoring well relocation will take place under Maywood Riverfront Park Project • Removal of fencing except north, east, and south site boundary.
Disposal: Vegetation can be composted or disposed of at a RCRA Subtitle D landfill.	• All vegetation will be hauled to a composting facility. • All concrete will be broken-up and remain in place. • Fencing will be hauled to a recycler.
Earthwork: To strip vegetation, prepare ground surface to receive cover soil, achieve desired control of run-on/runoff, and to accommodate future use.	• City of Maywood provides grading plan. • Cuts made into 'clean' soil will be used as fill at other areas within the Site. • Adequate compaction is assumed following rough grading.

Soil Cover/Revegetation *Surface and Near-Surface Soil Remediation Zone*	
Cover Soil Application: Lifts should not be greater than 8 inches followed by compaction to 90% of maximum density. Must be capable of supporting vegetative growth such as a sandy loam.	• 1 foot of cover soil. • Finish grading - to smooth out surface and apply topsoil. • 4 inches of topsoil.
Surface Restoration: Broadcast seed or sod, install rooted plants, or prepare for landscaping in accordance with City of Maywood Riverfront Park plans.	• The City of Maywood will provide the Park landscaping plans, which will determine how the surface is landscaped and vegetation established. • Land surveys to define new cover elevations and extent.
Annual Operation and Maintenance:	• Budget for regular maintenance, irrigation, surveying and repair of cover surface and Five-Year Review Reports.
Duration Range for Soil Cover Construction:	Approximately 1 to 2 months
Conceptual Design Considerations	
Residential neighborhoods are located to the south of and adjacent to the Pemaco Site. The City of Maywood intends to accept available grants to convert the Pemaco Site and adjoining properties, including: the railway right-of-way, Precision Arrow, W.W. Henry, Catellus, and Lubrication and Oil Services, to a recreational area named the Maywood Riverfront Park.	

9.1.3 Alternative N3 – Excavation and Offsite Disposal

Excavation and Offsite Disposal *Surface and Near-Surface Soil Remediation Zone*	
Alternative Description	
Soil excavation and offsite disposal involves removal of the impacted surface and near-surface soils and disposal of the soil offsite at an approved landfill. By removing the impacted soil, pathways for human exposure and potential for migration of surface contaminants are eliminated; and a greater buffer zone is created between surface activities and vadose zone soils. Following soil removal, the site would be regraded and revegetated similar to the soil cover option above. Since the components of a soil cover and design assumptions are discussed above, this section will focus on the excavation, disposal characterization sampling, and disposal phases.	
Site Characteristics	
Contaminated Soil Areas:	25 by 25 ft grids identified in RI
Depths to be Excavated: Refer to the Excavation Volume Calculation Worksheet under the Supporting Documentation Tab.	1-ft depth excavated for 0.5 ft sample exceedance 3-ft depth excavated for 2.5 ft sample exceedance
Volume of soil to be excavated:	2,900 yd^3
Volume of soil to be hauled for disposal (after expansion x 1.3):	3,770 yd^3 (6,630 tons)
Volume of concrete to be excavated and disposed:	250 yd^3
Volume of backfill required:	3,770 yd^3
Conceptual Design Components and Assumptions	
Component	**Assumptions**
Excavation: Conventional backhoe loader or excavator would be used.	• Suggested cleanup criteria is Residential PRGs for SVOCs and Metals (except Iron, which gets cleaned up to background levels) • Assume dust suppression (sprinkler truck) will be required.
Stockpiling: Excavated soil would be covered and held in roll-offs or on plastic sheeting until analytical results are evaluated.	• Process train based on 400 yd^3 excavated per day

Excavation and Offsite Disposal *Surface and Near-Surface Soil Remediation Zone*	
	• 20 yd^3 per roll off or pile based on weight limit for hauling • 3 day staging requirement for analytical evaluation = 20 piles/day x 3 days = 60 pile requirement
Sampling Regimen: One composite sample per 20 c.y. analyzed for VOCs, SVOCs, and metals.	• Assume rapid (24 hours) analytical turnaround time (TAT) • Assume all analytical results come back "dirty" and soil must be disposed of offsite. If clean soil is identified, it could be used for backfill.
Disposal: Roll off bins would be manifested and hauled to closest approved treatment/disposal facility. The removal and transportation of contaminated materials involves the increased potential for human exposure and efforts to comply with RCRA regulations.	• Assume 20 trucks per day depart the site for approximately 9 days.
Backfill: Apply typical sandy backfill in 8-inch lifts, compact, continue to grade.	• Backfill required only to fill excavations. No additional cover soil intended.
Surface Restoration: Broadcast seed or sod, install rooted plants, or prepare for landscaping in accordance with City of Maywood Riverfront Park plans.	• The City of Maywood will provide the Park landscaping plans, which will determine how the surface is landscaped and vegetation established.
Additional Remedial Action Required:	• Excavation and offsite disposal implemented with other remedial process option that addresses vadose zone and groundwater contamination.
Duration Range for Excavation and Offsite Disposal:	• Approximately 1.5 months
Conceptual Design Considerations	
Residential neighborhoods are located to the south of and adjacent to the Pemaco Site. The City of Maywood intends to convert the Pemaco Site and adjoining properties including: the railway right-of-way, Precision Arrow, W.W. Henry, Catellus, and Lubrication and Oil Services, to a recreational area named the Maywood Riverfront Park.	

9.1.4 Common Elements and Distinguishing Features – Surface and Near-Surface Soil Zone Remedial Alternatives

Both surface and near-surface soil remedial alternatives eliminate pathways for human exposure to COCs present in this remediation zone, thereby complying with ARARs. Alternative N2 requires monitoring and maintenance of a soil and vegetative cover to remain effective. Deed restrictions would be necessary to assure that potential future property development (post-Maywood Riverfront Park) does not disturb the integrity of the soil cover. Alternative N3 is more permanent and does not require monitoring or institutional controls; however, soil excavation poses short-term impacts, requires handling of contaminated soil, offsite disposal, and is approximately twice the cost of Alternative N2.

9.1.5 Expected Outcomes of Each Alternative

Both Alternatives N2 and N3 are expected to eliminate the primary route of human and ecological exposure to COCs; and therefore, would be protective of human health and the environment. Both alternatives are amenable to the future construction of the Maywood Riverfront Park, which will include both grading and landscaping activities.

The selected alternative for surface and near-surface soil remediation zone (0-3 ft bgs) will eliminate/minimize the potential for exposure to any residual surface/subsurface non-VOC contamination. The outcome will be suitable for the proposed use of the property as a park.

9.2 Upper Vadose Soils and Perched Groundwater Remediation Zone Alternatives

The upper vadose soil and perched groundwater remediation zone poses risks of human exposure to future excavation workers, and future offsite residents by direct contact (inhalation, ingestion, and/or dermal contact) with soils, groundwater, and/or soil vapors containing COCs. Six remedial alternatives were identified to reduce these risks by addressing the following:

1. COCs in upper vadose soils;
2. Further lateral migration of COCs onto adjacent properties;
3. Vertical migration of COCs to deeper groundwater zones; and
4. Groundwater restoration

9.2.1 Alternative SP1 – No Action

As required by the NCP, a "No Action" alternative must be included as a remedial alternative to provide a baseline for evaluation of the remedial process options.

The No Action alternative does not involve any proactive treatment, removal, or monitoring of the contaminated media. In the upper vadose soil and perched groundwater remediation zone (3 to 35 ft bgs), VOCs exist at concentrations above the EPA Region IX PRGs and federal EPA and California Department of Health Services (DHS) MCLs, respectively. During site redevelopment, excavation workers may be exposed to COCs via ingestion, dermal contact, and inhalation of upper vadose soils. Residual VOC contamination in upper vadose soils can migrate to the surface in vapor form and create a pathway for human exposure to COCs via inhalation. In addition, residual VOC contamination may migrate downward and act as a continued source of deeper groundwater zones. No Action for the upper vadose soil and perched groundwater remediation zone would not be protective of human health as future excavation workers and residents may be exposed to COCs. In addition, groundwater quality would not be restored to ARARs and/or local background.

9.2.2 Alternative SP2a – HVDPE/UV Ox/FTO/GAC

High Vacuum Dual Phase Extraction(HVDPE)/Ultraviolet Oxidation (UV OX)/Flameless Thermal Oxidation(FTO) /Granular Activated Carbon(GAC)

Upper Vadose Soil and Perched Groundwater Remediation Zone

Alternative Description

HVDPE uses high vacuum to extract groundwater and soil vapor from the contaminated zones. Typical groundwater extraction wells screened through the contaminated soil and perched groundwater would be installed to remove contaminants in both the gas and liquid phase. Drawdown caused by groundwater extraction exposes additional well screen area from which soil vapor is extracted; thereby removing VOCs trapped in the soil pores. The contaminated groundwater and soil vapor are transported to separate above ground treatment systems where the contaminants are removed prior to discharge. This alternative uses UV Ox (possibly accessorized with GAC) for groundwater treatment and FTO and GAC for vapor treatment. Both UV Ox and FTO would completely destroy all COCs onsite with no residual wastes to manage.

Assuming cleanup criteria are met, the treated groundwater could be disposed by reinjection back into the aquifer, discharge to the sanitary sewer, or discharge to the LA River (depending on permit approval). Likewise, the treated soil vapor would discharge to the air above the site.

This alternative assumes that that initial high mass loading of VOCs extracted during the first year of operation would be more effectively and efficiently treated using FTO. Due to the 99.9% destruction effectiveness rate of FTO, the production of combustion by-products (*e.g.,* dioxin) above background concentrations is unlikely. After the first year, it is estimated that the mass loading will be significantly reduced and switching to a GAC vapor treatment system would be more cost effective. GAC absorbs COCs from the extracted vapor for later disposal at an offsite approved facility. GAC is not an effective method of treatment for low molecular weight VOCs, such as vinyl chloride, or COCs with low adsorptive capacity, such as 1,4-dioxane. However, it is estimated that a significant proportion of these two contaminants would be eliminated in the first year to allow for treatment via GAC. Further evaluation of the proportion of these COCs in the vapor stream would be necessary prior to implementing GAC vapor treatment.

Similar to vapor treatment, GAC may eventually be used as a stand-alone technology for treatment of extracted groundwater if low-adsorptive compounds are not present in the extracted groundwater at concentrations over MCLs. The need for supplementary GAC (to UV Ox) to treat groundwater will be determined during the Remedial Design (RD) phase of the project.

HVDPE allows for good control over contaminant mobility and a reduction in contaminant volume (onsite) for both soil and groundwater. HVDPE would effectively eliminate the potential for migration of COCs in this remediation zone and the pathways to human exposure to COCs in both upper vadose soils and the perched groundwater.

Site Characteristics	
Area of Source Control:	
Soil Area (based on exceedances of DAF 20 SSLs):	69,600 ft^2
Approximate Thickness:	32 ft (3 to 35 ft bgs) 37 ft (3 to 40 ft bgs including perching clay)
Volume:	82,500 yd^3 to 95,400 yd^3
Perched Groundwater Area:	168,000 ft^2
Approximate Thickness:	2 to 3 ft (top of perching clay 25 to 35 ft bgs)
Analytical Data:	
Maximum concentration of Primary COCs in Upper Vadose Zone soils:	Acetone (16,000 µg/kg) Benzene (4,100 µg/kg) DCE (400 µg/kg) Cis-1,2-Dichloroethene (cis-1,2-DCE) (3,300 µg/kg) Ethylbenzene (61,000 µg/kg) Methylene chloride (530 µg/kg) PCE (2,000 µg/kg) Toluene (98,000 µg/kg) TCE (3,300 µg/kg) Vinyl chloride (280 µg/kg)

High Vacuum Dual Phase Extraction(HVDPE)/Ultraviolet Oxidation (UV OX)/Flameless Thermal Oxidation(FTO) /Granular Activated Carbon(GAC) *Upper Vadose Soil and Perched Groundwater Remediation Zone*	
	PAHs (630 to 40,000 µg/kg)
Maximum concentration of Primary COCs in Perched Zone groundwater:	Benzene (1,600 µg/L) PCE (1,100 µg/L) TCE (680 µg/L), cis-1,2-DCE (780 µg/L) Vinyl chloride (240 µg/L) 1,4-dioxane (920 µg/L)
Hydrogeologic Data:	
Depth to Perched Zone groundwater:	20 to 30 ft bgs
Direction/gradient of groundwater flow in Perched Zone:	Inconsistent due to perching clay
HVDPE Pilot Test Data:	Vacuum radius of influence (ROI) of 54 ft at 68 scfm and 14 in of Hg GW extraction = 0.8 gpm
Potential Receptors: Residential neighborhoods are adjacent to the south of the site.	
Conceptual Design Components and Assumptions	
Component	**Assumptions**
HVDPE Well Networks: Thirty-two extraction wells will be installed to 35 ft bgs to provide coverage over the contaminated soil and perched groundwater area. Soil treatment area and treatment criteria will be based on EPA Region IX Soil DAF 20 SSLs. Perched groundwater treatment area and criteria based on MCLs.	• Design vacuum ROI of 50 ft • Design GW extraction rate of 0.8 gpm per well. • Drop-vacuum-tube method to be implemented. • All wells shall be 4" diameter, Schedule 80 PVC. • Screened from 5 to 35 ft bgs.
Groundwater Treatment System: A fenced and covered treatment compound would be mounted on a 20 ft by 30 ft concrete pad with containment foundation (to be shared with vapor treatment). Electrical service and remote monitoring communication system would be tied into local services with possible back-up power generation. The treatment process would be UV oxidation since it is the most effective commercially available treatment technology used to treat 1,4-dioxane to levels suitable for discharge. Concentrations of 1,4-dioxane cannot be effectively removed for discharge using air stripping or GAC. UV-OX is a destruction process that oxidizes organic contaminants by adding oxidizing agents such as ozone (O_3) or hydrogen peroxide (H_2O_2) to the contaminated groundwater. The contaminated solution is passed through a chamber where it is exposed to intense UV radiation and oxidized into harmless byproducts.	• Design flow and influent conc. are 25 gpm and 500 ppb total VOC. • Treatment criterion is to be based on SSRGs (Table 4-1). • Treatment system influent and effluent to be sampled daily during 7-day startup; quarterly after documented stabilization; semiannually after established trend or continued stabilization. Effluent sampling frequency would be determined by discharge permit. • Long-term O&M plan to be implemented for treatment system. • Influent trench and pipe = 1,200 ft • Effluent trench and pipe = 500 ft
Soil Vapor Treatment System: The selected soil vapor treatment process, FTO for the first year followed by GAC for the remaining years, would be housed in the treatment compound alongside the groundwater treatment system. Treatment criteria will be determined in accordance with the South Coast Air Quality Management District (SCAQMD) discharge permit. Target destruction efficiency would average 99% with concentrations of combustion by-products (e.g., dioxin) below background concentrations during FTO operation and low (approved) concentrations of vinyl chloride and 1,4-dioxane emissions during GAC operation.	• Total design system flow of 1,000 scfm based on 50% of wells on-line per extraction event. • Estimated initial influent vapor concentration of approximately 5.0 ppmv • Treatment system influent and effluent to be sampled daily during 7-day startup; weekly after documented stabilization or trend; quarterly or in accordance with discharge permit thereafter. • Additional monitoring via PID will be performed to supplement sampling

High Vacuum Dual Phase Extraction(HVDPE)/Ultraviolet Oxidation (UV OX)/Flameless Thermal Oxidation(FTO) /Granular Activated Carbon(GAC) *Upper Vadose Soil and Perched Groundwater Remediation Zone*	
	data and to schedule timing for switching on-line wells. • Assumptions are based on HVDPE pilot test.
Monitoring/Reporting Frequency: Reporting will be performed to maintain discharge permits, document contaminant removal rates, flows, cleanup forecasts, and groundwater gradient maps, in appropriate frequency to data collection.	• Semiannual groundwater sampling events are recommended. • Initial monthly monitoring of the GAC effluent will be performed to demonstrate acceptable concentrations of vinyl chloride and 1,4-dioxane. • Annual monitoring may be recommended after demonstration of reduction in plume volume and mobility. • Quality Assurance/Quality Control (QA/QC) Program Plan will be instituted for all sampling and treatment. • Long term O&M plan required.
Estimated Project Duration: 5 years + minimum of 5 years monitoring.	• Approximately 10 years.
Conceptual Design Considerations	
Enhancements: Hydraulic or pneumatic fracturing could be used as an enhancement for removal of contaminant from source area. Targeted "fracing" zone would be the perching clay 28 to 35 ft bgs.	

9.2.3 Alternative SP2b – HVDPE/UV Ox/GAC

High Vacuum Dual Phase Extraction(HVDPE)/Ultraviolet Oxidation (UV OX) /Granular Activated Carbon(GAC) *Upper Vadose Soil and Perched Groundwater Remediation Zone*	
Alternative Description	
The treatment process is the same as described in Alternative SP2a with the exception of vapor treatment, which would employ only GAC. GAC absorbs COCs from the extracted vapor for later disposal at an offsite approved facility. GAC is not an effective method of treatment for low molecular weight VOCs, such as vinyl chloride, or COCs with low adsorptive capacity, such as 1,4-dioxane. Further evaluation of the proportion of low molecular weight VOCs in the vapor stream would be necessary prior to implementing GAC vapor treatment. Assuming cleanup criteria are met, the treated soil vapor would discharge to the air above the site.	
Site Characteristics	
The Site Characteristics are the same as Alternative SP2a.	
Conceptual Design Components and Assumptions	
Component	**Assumptions**
HVDPE Well Networks: See Alternative SP2a for the HVDPE well network.	• Same as Alternative SP2a.
Groundwater Treatment System: See Alternative SP2a for the Groundwater treatment system.	• Same as Alternative SP2a.
Soil Vapor Treatment System: The selected soil vapor treatment process, GAC, would be housed in the treatment compound alongside the groundwater treatment system. Treatment criteria will be determined in accordance with the SCAQMD discharge permit. Target destruction efficiency would average 99% with low (approved) concentrations of vinyl chloride and 1,4 dioxane	• Same as Alternative SP2a without FTO.

High Vacuum Dual Phase Extraction(HVDPE)/Ultraviolet Oxidation (UV OX) /Granular Activated Carbon(GAC) *Upper Vadose Soil and Perched Groundwater Remediation Zone*	
emissions during GAC operation.	
Monitoring/Reporting Frequency: Reporting would be the same as Alternative SP2a without the FTO system.	• Same as Alternative SP2a with the addition of: • Additional reporting of effluent monitoring data for vinyl chloride and 1,4-dioxane would be performed in accordance with the SCAQMD permit.
Estimated Project Duration: Same as Alternative SP2a	• Approximately 10 years.
Conceptual Design Considerations	
Same as Alternative SP2a	

9.2.4 Alternative SP3 – ISCO

***In Situ* Chemical Oxidation (ISCO)** *Upper Vadose Soil and Perched Groundwater Remediation Zone*	
Alternative Description	
ISCO involves injecting the selected oxidizing agent into the subsurface and collecting and analyzing groundwater samples to monitor the degradation process. The contaminant concentrations (*i.e.,* chlorinated ethenes), general chemistry parameters pertinent to the process (*i.e.,* total organic carbon, peroxide, chloride, sulfate, manganese, and ferrous iron) and environmental indicators (*i.e.,* pH, specific conductivity, oxidation-reduction potential, and turbidity) are documented prior to and following the injection events. Long-term monitoring includes additional parameters such as natural attenuation indicators (*i.e.,* dissolved gases and selected anions). ISCO is not recommended for *in-situ* treatment of soil since the mechanics of substrate delivery are unproven and groundwater is required to assist with dispersion. For this reason, ISCO would only provide a partial treatment solution to the upper vadose soil and perched groundwater remediation zone. Pathways to human exposure in upper vadose soils and the potential for migration of COCs would not be addressed.	
Site Characteristics	
Area of Source control:	
Soil Area (based on exceedances of the DAF 20 SSLs):	69,600 ft^2
Approximate Thickness:	32 ft (3 to 35 ft bgs) 37 ft (3 to 40 ft bgs including perching clay)
Volume:	82,500 yd^3 to 95,400 yd^3
Perched Groundwater Area:	168,000 ft^2
Approximate Thickness:	2 to 3 ft (top of perching clay 25 to 35 ft bgs)
Analytical Data:	
Maximum concentration of COCs in upper vadose zone soils:	Acetone (16,000 µg/kg) Benzene (4,100 µg/kg) DCE (400 µg/kg) Cis-1,2-DCE (3,300 µg/kg) Ethylbenzene (61,000 µg/kg) Methylene chloride (530 µg/kg) PCE (2,000 µg/kg) Toluene (98,000 µg/kg) TCE (3,300 µg/kg) Vinyl chloride (280 µg/kg) PAHs (630 to 40,000 µg/kg)
Maximum concentration of COCs in perched zone groundwater: TOC (5 to 30 mg/L) and pH (6.5 to 7.5) assumed from 'A' Zone	Benzene (1,600 µg/L) PCE (1,100 µg/L) TCE (680 µg/L), cis-1,2-DCE (780 µg/L)

***In Situ* Chemical Oxidation (ISCO)** *Upper Vadose Soil and Perched Groundwater Remediation Zone*	
	Vinyl chloride (240 µg/L) 1,4-dioxane (920 µg/L)
Hydrogeologic Data:	
Depth to perched zone groundwater:	20 to 30 ft bgs.
Direction and gradient of groundwater flow in perched zone:	Inconsistent due to perching clay
Miscellaneous: Residential neighborhoods are situated to the south of the site.	
Conceptual Design Components and Assumptions	
Component	**Assumptions**
Bench Test: Collection of one sample per zone (total of 2 samples) to determine the actual volume of the oxidizing agent required per injection location for contaminant oxidation and complete degradation.	• Fenton's reagent or permanganate solution to be applied due to high contamination levels and complexity of site hydrogeology. • Bench test will determine volume of reagent needed.
Pilot Test: An ISCO pilot test would confirm project feasibility and design parameters prior to full-scale implementation. Baseline sampling (one-time event) prior to injection activity and one sampling event following each injection activity (a total of three sampling events) is expected over the 3-month pilot study period. Parameters to be monitored include: COCs (chlorinated ethenes), field parameters (pH, specific conductivity, oxygen reduction potential (ORP), and turbidity), and general chemistry parameters (total organic carbon, peroxide, chloride, sulfate, manganese, and ferrous iron).	• Treatment area: approx. 3,000 ft^2, thickness would be the entire perched zone. • Assume 15-foot ROI per injection point, and 3 injection locations. • Assume the oxidant and dose rate will be determined by the bench test. Since Fenton's reagent is the most aggressive, assume for the purposes of the conceptual design that a Fenton's reagent dose rate of 1,600 gallons per location will be applied. • Approximately 4,800 gallons of material required. • Duration for injection & process monitoring: 3 months.
Full-Scale Application: Injection points to be placed to deliver reagents to the perched groundwater zone. Treatment criterion is to be based on SSRGs (Table 4-1).	• Assume 15-foot ROI per injection point, and 100 injection locations. • 3 injection events (1 month period between events). • Each event to be completed in 50 days. • Assume Fenton's reagent dose rate of 1,600 gallons per location (dose adjusted for volume as determined by the pilot study). • Approximately 480,000 gallons of material required. • Duration for injection & process monitoring: 6-9 months.
Monitoring Well Network: Required to track performance of ISCO and assure compliance with treatment criteria. Wells situated mostly within plume and western perimeter since the hydraulic gradient is inconsistent.	• Perched Zone: 8 wells, 2-inch diameter, Schedule 40 PVC, screened 20 to 35 ft bgs. Some injection wells would be converted for use as monitoring wells.
Estimated Project Duration (pilot + full-scale): 1 year + minimum of 5 years monitoring.	• Approximately 6 years.
Conceptual Design Considerations	

***In Situ* Chemical Oxidation (ISCO)** *Upper Vadose Soil and Perched Groundwater Remediation Zone*
ISCO does not address vadose zone soil contamination. Consider combining with HVDPE for treatment of vadose zone soil. Hydraulic or pneumatic fracturing could be used as an enhancement to improve dispersion of oxidizing agents. Efficient use of technology should include "fracing" in the perching clay.

9.2.5 Alternative SP4 – EISB

Enhanced *In-situ* Bioremediation (EISB) *Upper Vadose Soil and Perched Groundwater Remediation Zone*	
Alternative Description	
EISB involves injecting the selected organic substrate (electron donor) and collecting and analyzing groundwater samples to monitor the bioremediation process. The contaminant concentrations and general chemistry parameters (selected anions, degradation by-products, and environmental indicators) are documented prior to and following the injection activity. EISB is a method used to degrade chlorinated ethenes using microbiological processes naturally occurring in the substrate environment. The intrinsic microbiological processes are promoted by subsurface injection of organic substrate. Reductive dechlorination is one of the primary attenuation mechanisms by which chlorinated solvent groundwater plumes can be remediated. This process is a subsequent degradation of PCE to TCE, TCE to cis-1.2-DCE, cis-1,2-DCE to vinyl chloride, and finally vinyl chloride to ethene. In this manner, the COCs such as TCE can be degraded into harmless compounds such as ethene over time. Hydrogen Release Compound (HRC®) one of the available organic substrates is well documented for accelerating *in-situ* bioremediation rates of chlorinated ethenes via anaerobic reductive dechlorination processes. Reductive dechlorination is not effective for treating compounds (*e.g.,* benzene, toluene) that biodegrade under aerobic conditions; these compounds would have to be addressed aerobically before or after reductive dechlorination. EISB is not recommended for in-situ treatment of soil since the mechanics of substrate delivery are unproven and groundwater is required to assist with dispersion. For this reason, EISB would only provide a partial treatment solution to the upper vadose soil and perched groundwater remediation zone. Pathways to human exposure in upper vadose soils and the potential for migration of COCs would not be addressed.	
Site Characteristics	
Area of Source control:	
Soil Area (based on exceedances of the DAF 20 SSLs):	69,600 ft^2
Approximate Thickness:	32 ft (3 to 35 ft bgs) 37 ft (3 to 40 ft bgs including perching clay)
Volume:	82,500 yd^3 to 95,400 yd^3
Perched Groundwater Area:	168,000 ft^2
Approximate Thickness:	2 to 3 ft (top of perching clay 25 to 35 ft bgs)
Analytical Data:	
Maximum concentration of COCs in upper vadose zone soils:	Acetone (16,000 µg/kg) Benzene (4,100 µg/kg) DCE (400 µg/kg) Cis-1,2-DCE (3,300 µg/kg) Ethylbenzene (61,000 µg/kg) Methylene chloride (530 µg/kg) PCE (2,000 µg/kg) Toluene (98,000 µg/kg) TCE (3,300 µg/kg) Vinyl chloride (280 µg/kg) PAHs (630 to 40,000 µg/kg)
Maximum concentration of COCs in perched zone groundwater:	Benzene (1,600 µg/L) PCE (1,100 µg/L) TCE (680 µg/L),

Enhanced *In-situ* Bioremediation (EISB) *Upper Vadose Soil and Perched Groundwater Remediation Zone*	
	cis-1,2-DCE (780 µg/L) Vinyl chloride (240 µg/L) 1,4-dioxane (920 µg/L)
Average levels of major environmental indicators (oxygen, nitrate, and sulfate) in the perched zone:	0.8 mg/L, 4.1 mg/L, and 157 mg/L, respectively (assumed from 'A ' Zone)
Hydrogeologic Data:	
Depth to perched zone groundwater:	20 to 30 ft bgs.
Direction/gradient of groundwater flow in perched zone:	Inconsistent due to perching clay
Miscellaneous: Residential neighborhoods are situated to the south of the site.	
Conceptual Design Components and Assumptions	
Component	**Assumptions**
Analytical and Hydrogeologic Data: Potential sulfate reduction demand <490 µg/L. General anaerobic groundwater geochemistry with oxygen <2.2 mg/L, nitrate <40 mg/L, and oxidation-reduction potential between –116 mV and 225 mV.	• Suitable geochemistry for use.
Pilot Test: An EISB pilot test would refine design parameters prior to full-scale implementation. Baseline sampling (one-time event) prior to injection activity and an estimated 3 sampling events following injection activity is expected over the 6-month pilot study period. Parameters to be monitored for long-term treatment monitoring include: COCs (chlorinated ethenes), field parameters (dissolved oxygen (DO), ORP, pH, and temperature), biodegradation parameters (nitrate, sulfate, sulfide, chloride, ferrous iron, and alkalinity), substrate fermentation products (total organic carbon and metabolic acids), and biodegradation end products (carbon dioxide, methane, ethane, and ethene).	• Test area: 900 s.f. x 50 ft thick • Assume 9 injection points with minimum of 0.625-inch inner diameter. • Assume 10-foot ROI per injection point, 10-foot saturated thickness. • HRC® dose rate of 8.0 lbs per vertical ft (80 lbs per point). • Duration for injection and process monitoring: 6 months.
Full-Scale Application: Injection points to be placed to deliver reagents to the perched groundwater zone. Treatment criterion is to be based on SSRGs (Table 4-1).	• Assume 200 injection points with minimum of 0.625-inch inner diameter. • Ten direct push borings per day (5 week completion). • Assume 10 to 15-foot ROI per injection point; varying thicknesses. • HRC® dose rate in the range of 18 to 20 lbs per vertical foot (assume 280 lbs per point). Possibly in two applications. • Duration for injection and process monitoring: 6 months.
Monitoring Well Network: Required to track performance of EISB and assure compliance with treatment criteria. Wells situated mostly within perched zone plume since the hydraulic gradient is inconsistent.	• Perched Zone: 8 wells, 2-inch diameter, Schedule 40 PVC, screened 20 to 35 ft bgs.
Monitoring/Reporting Frequency: Reporting will be performed in compliance with permits and to document contaminant removal rates, flows, cleanup forecasts, and groundwater gradient maps, in appropriate frequency to data collection.	• Baseline sampling (one-time event) prior to injection activity. • Semiannual sampling events following injection activity. • Parameters to be monitored identical to pilot study (see above). • QA/QC Program Plan for the sampling plan.
Estimated Project Duration (pilot + full-scale): 1 year + minimum of 5 years monitoring.	• Approximately 6 years.
Conceptual Design Considerations	
Monitoring program can be reevaluated after 5 years for potential of sampling location or frequency reduction. Delivery locations may need to be adjusted to take into account site features such as underground utilities and other site structures.	

Enhanced *In-situ* Bioremediation (EISB) *Upper Vadose Soil and Perched Groundwater Remediation Zone*
Due to specific physical characteristics of HRC® material, pressure required for delivery to the subsurface ranges from 200 psig to 1,500 psig, for which Rupe ORC/HRC 9-1500 and the Geoprobe GS-2000 pumps are recommended by Regenesis – the HRC® material producer. Design is for a one-time application of HRC®; the need for re-application will primarily depend on site-specific biodegradation performance. If required, re-application will be applied over the reduced area and dose amount compared to the initial application. Hydraulic or pneumatic fracturing could be used as an enhancement to improve dispersion of HRC®. Efficient use of technology should include "fracing" in the perching clay.

9.2.6 Alternative SP5 – MNA

Monitored Natural Attenuation(MNA) *Upper Vadose Soil and Perched Groundwater Remediation Zone*	
Alternative Description	
MNA consists only of collecting and analyzing groundwater samples and hydraulic data to document and/or model the persistence of contaminant concentrations or their natural attenuation. Natural attenuation differs from 'No Action' because it requires that supporting documentation, including groundwater monitoring results and modeling predictions, be supplied to demonstrate that contaminant concentrations can be reduced to cleanup levels in a reasonable timeframe. Chlorinated and BTEX compounds (site COCs) are amenable to natural attenuation in groundwater provided that characteristic environmental conditions and intrinsic microbiological processes are present. The natural attenuation processes include biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biological stabilization, transformation, or destruction of contaminants, *i.e.,* chlorinated solvents. MNA is not practical in the unsaturated zone and is best when combined with a source control option since it does not actively affect mobility, toxicity, or volume. MNA would not eliminate the potential for migration of COCs in this remediation zone nor the pathways to human exposure to COCs without the addition of a more aggressive remedial alternative.	
Site Characteristics	
Area of Source control:	
Soil Area (based on exceedances of the DAF 20 SSLs):	69,600 ft^2
Approximate Thickness:	32 ft (3 to 35 ft bgs) 37 ft (3 to 40 ft bgs including perching clay)
Volume:	82,500 yd^3 to 95,400 yd^3
Perched Groundwater Area:	168,000 ft^2
Approximate Thickness:	2 to 3 ft (top of perching clay 25 to 35 ft bgs)
Analytical Data:	
Maximum concentration of COCs in Upper Vadose Zone soils:	Acetone (16,000 µg/kg) Benzene (4,100 µg/kg) DCE (400 µg/kg) Cis-1,2-DCE (3,300 µg/kg) Ethylbenzene (61,000 µg/kg) Methylene chloride (530 µg/kg) PCE (2,000 µg/kg) Toluene (98,000 µg/kg) TCE (3,300 µg/kg) Vinyl chloride (280 µg/kg) PAHs (630 to 40,000 µg/kg)
Maximum concentration of COCs in Perched Zone groundwater:	Benzene (1,600 µg/L) PCE (1,100 µg/L) TCE (680 µg/L), cis-1,2-DCE (780 µg/L) Vinyl chloride (240 µg/L) 1,4-dioxane (920 µg/L)
Average levels of major environmental indicators (oxygen, nitrate, and	1.1 mg/L, 2.4 mg/L, and 131 mg/L,

Monitored Natural Attenuation(MNA) *Upper Vadose Soil and Perched Groundwater Remediation Zone*	
sulfate) in the perched zone:	respectively
TOC range and pH range are:	3.2 to 100 mg/L and 5.6 to 10.7; respectively
Hydrogeologic Data:	
Depth to perched zone groundwater:	20 to 30 ft bgs.
Direction and gradient of groundwater flow in perched zone:	Inconsistent due to perching clay
Miscellaneous: Residential neighborhoods are situated to the south of the site.	
Conceptual Design Components and Assumptions	
Component	**Assumptions**
General: MNA is only practical as a containment option when combined with a source control option.	• Removal of free product and source areas must be performed.
Monitoring Well Network: To be established to assess potential migration of contaminants and reduction in concentrations. Wells would be situated mostly within the plume and western perimeter of the perched zone since the hydraulic gradient is inconsistent.	• Perched Zone: 8 wells, 2-inch diameter, Schedule 40 PVC, screened 20 to 35 ft bgs
Monitoring/Reporting Frequency: Reporting will be performed to document contaminant removal rates, cleanup forecasts, and groundwater gradient maps, in appropriate frequency to data collection. Parameters to be monitored include: COCs (chlorinated ethenes), field parameters (DO, ORP, pH, and temperature), biodegradation parameters (nitrate, sulfate, sulfide, chloride, ferrous iron, and alkalinity), substrate fermentation products (total organic carbon and metabolic acids), and biodegradation end products (carbon dioxide, methane, ethane, and ethene).	• Semiannual sampling events are recommended. • QA/QC Program Plan will be provided for the Sampling Plan.
Estimated Project Duration:	• Approximately 50 years.
Conceptual Design Considerations	
MNA does not address vadose zone soil contamination and requires combining with a source control alternative for soil. Monitoring program can be reevaluated after 5 years for potential of sampling location or frequency reduction.	

9.2.7 Common Elements and Distinguishing Features – Upper Vadose Soil and Perched Groundwater Zone Remedial Alternatives

Alternatives SP2a and SP2b both use HVDPE as the primary remedial action and UV Ox for *ex-situ* (above ground) treatment of extracted groundwater. The only distinguishing feature between these two alternatives is the *ex-situ* treatment of extracted soil vapor and secondary vapor emissions from the UV Ox treatment system. Alternative SP2a would use an FTO unit for the first year of operation (to handle initial high mass loading) followed by GAC; Alternative SP2b would use GAC for the entire operation of the HVDPE system.

Alternatives SP3 and SP4 are both in-situ (below ground) remedial alternatives, which would primarily treat perched groundwater. Alternative SP3 would involve dispensing chemical oxidants to the subsurface to destroy COCs in groundwater, while Alternative SP4 uses a hydrogen-release compound to expedite natural degradation processes (*i.e.,* dechlorination).

Alternative SP5 is a passive remedial alternative which simply documents the continued migration or natural attenuation of COCs at the site over time.

9.2.8 Expected Outcomes of Each Alternative

Alternatives SP2a and SP2b are both expected to remove existing VOC contamination to levels that prevent impact to the groundwater, and the indoor and outdoor air quality above ground. However, Alternative SP2a, which uses an FTO system, is expected to be more effective at treating *ex-situ* vapors and meeting air emission standards during operation of the HVDPE system.

Alternatives SP3 and SP4 are expected to reduce COCs in groundwater where the physical delivery of oxidants/substrates is successful. COCs present in low-permeability (fine-grained) upper vadose soils and other areas where oxidant/substrate delivery is unsuccessful would remain in place.

Alternative SP5 may reduce COCs through natural degradation/natural attenuation process, but not likely for 50+ years.

9.3 Lower Vadose Soil and Exposition Groundwater Remediation Zone Alternatives

The Lower Vadose Soil and Exposition Groundwater Remediation Zone poses risks of human exposure to future onsite residents by direct contact (inhalation, ingestion, and/or dermal contact) with groundwater containing COCs. Five remedial alternatives were identified to reduce these risks by addressing the following:

1. Continued migration of COCs from the source area (highly contaminated lower vadose soils) to Exposition groundwater zones;
2. Further migration of COCs to adjacent properties;
3. Potential migration to local production wells; and
4. Groundwater restoration

The five remedial alternatives assembled for the lower vadose zone soil and Exposition groundwater remediation zone address both source reduction and containment. This was necessary due to the large discrepancy between the source area (69,400 ft^2) and the entire dissolved-phase plume area (550,000 ft^2). As the original sources (*e.g.,* drums, USTs) are no longer present on the site, "source areas" as referenced in this document are actually secondary sources or areas of heavily contaminated media (namely lower vadose zone soils) that have free product or high concentrations of residual contamination. The source area within this remediation zone was delineated during RI activities and is represented as the area within the 1,000 µg/L TCE contour of the Exposition 'A' and 'B' composite plume illustrated in Figure 5-4.

9.3.1 Alternative SG1 – No Action

As required by the NCP, a "No Action" alternative must be included as a remedial alternative to provide a baseline for evaluation of the remedial process options.

The No Action alternative does not involve any proactive treatment, removal, or monitoring of the contaminated media. In the lower vadose soil and Exposition groundwater remediation zone (35 to 100 ft bgs), VOCs exist at concentrations above the EPA Region IX PRGs and federal EPA and California DHS MCLs, respectively. If not addressed, lower vadose soils will continue to act a source for the Exposition groundwater zones. A pathway for human exposure may eventually exist if groundwater contamination spreads towards domestic production wells; the shallowest well is located approximately 4,000 ft downgradient of the site and is screened beginning at 350 ft bgs. Therefore, No Action for the lower vadose soil and Exposition groundwater remediation zone would not be protective of human health as

residents may be exposed to COCs. In addition, groundwater quality would not be restored to ARARs and/or local background.

9.3.2 Alternative SG2 – ISCO/ISCR/Groundwater P&T/MNA/UV Ox

***In Situ* Chemical Oxidation (ISCO)/*In Situ* Chemical Reduction(ISCR)/Groundwater Pump & Treat (P&T)/Monitored Natural Attenuation (MNA)/Ultraviolet Oxidation (UV Ox)** *Lower Vadose Soil and Exposition Groundwater Remediation Zone*	
Alternative Description	
Under this alternative, ISCO and ISCR would be used in combination, series, or individually (based on treatability study results) to treat higher concentrations of contaminants within the 1,000 ppb composite groundwater plume contour. Groundwater P&T would be used between the 1,000 and 10 ppb composite groundwater plume contour to provide hydraulic control and to facilitate dispersion of oxidizing/reducing agents similar to a recirculation cell. MNA would be used outside the 10 ppb composite plume to demonstrate plume reduction. Extracted groundwater would be treated via UV oxidation, possibly accessorized with GAC. The need for supplementary GAC to treat groundwater will be determined during the RD phase of the project and may eventually be used as a stand-alone technology for treatment of extracted groundwater if low-adsorptive compounds, such as vinyl chloride, are not present in the extracted groundwater at concentrations over MCLs. ISCO and ISCR involve injecting select oxidizing/reducing agents into the subsurface and collecting/analyzing groundwater samples to monitor the degradation process. The contaminant concentrations (i.e., chlorinated ethenes), general chemistry parameters pertinent to the process (i.e., total organic carbon, peroxide, chloride, sulfate, manganese, and ferrous iron) and environmental indicators (i.e., pH, specific conductivity, oxidation-reduction potential, and turbidity) are documented prior to and following the injection events. Long-term monitoring includes additional parameters such as natural attenuation indicators (i.e., dissolved gases and selected anions). ISCO and ISCR are not recommended for *in-situ* treatment of unsaturated soil since the mechanics of substrate delivery are unproven and groundwater is required to assist with dispersion. To determine the effectiveness of either ISCO or ISCR, the optimal spacing between injection points, and the amount of oxidizing/reducing agent needed, a treatability study would be performed prior to full-scale application. ISCO and ISCR have identical delivery methods (via well), and similar costs. The treatability study results would be used to determine whether both technologies or just one would be applied.	
Site Characteristics	
Area of Source Control:	
‘A’ and ‘B’ Exposition groundwater zones:	69,400 ft^2 (within the 1,000 ppb contour)
Analytical Data:	
Maximum concentration of Primary COCs in ‘A’ Zone:	TCE (27,000 µg/L), cis-1,2-DCE (2,600 µg/L) and vinyl chloride (100 µg/L)
Maximum concentration of Primary COCs in ‘B’ Zone:	TCE (21,000 µg/L), cis-1,2-DCE (14,000 µg/L) and vinyl chloride (780 µg/L)
Average level of total organic carbon in ‘A’ Zone:	4.9 mg/L
Average level of total organic carbon in ‘B’ Zone:	56 mg/L
Range of pH levels in Exposition groundwater zones:	6.5 to 7.5
Hydrogeologic Data:	
Depth to groundwater in Exposition Groundwater:	67 ft bgs
Saturated soil thickness:	Approximately 50 ft
Direction and gradient of groundwater flow in ‘A’ Zone:	0.011 ft/foot, southwest
Direction and gradient of groundwater flow in ‘B’ Zone:	0.009 ft/foot, west-southwest
Hydraulic conductivity (average for ‘A’ Zone):	1.46E-03 ft/min
Hydraulic conductivity (average for ‘B’ Zone):	3.27E-02 ft/min
Conceptual Design Components and Assumptions	
Component	**Assumptions**

***In Situ* Chemical Oxidation (ISCO)/*In Situ* Chemical Reduction(ISCR)/Groundwater Pump & Treat (P&T)/Monitored Natural Attenuation (MNA)/Ultraviolet Oxidation (UV Ox)** *Lower Vadose Soil and Exposition Groundwater Remediation Zone*	
Bench Test: Collection of one sample per zone (total of 3 samples) to determine the actual volume of the oxidizing/reducing agent required per injection location for contaminant oxidation/reduction and complete degradation.	• For ISCO: Fenton's reagent or a permanganate solution would be applied because of the high contamination levels and complexity of site hydrogeology. • For ISCR: a proprietary zero-valent iron solution would be used • Bench test to determine reagent volume.
Pilot Test: An ISCO and ISCR pilot test would confirm project feasibility and design parameters prior to full-scale implementation. Baseline sampling (one-time event) prior to injection activity, one sampling event following each injection event, and one follow-up sampling event after several weeks. Parameters to be monitored include: COCs (chlorinated ethenes), field parameters (pH, specific conductivity, ORP, and turbidity), and general chemistry parameters (total organic carbon, peroxide, chloride, sulfate, manganese, and ferrous iron). Enhancement of both applications would be observed by first fracturing the formation at one of the injection locations (per pilot test). (Note that complications can arise below the water table where fracing borehole cannot stay open long enough for injection tools to re-enter boring.)	• Treatment area: approx. 3,000 ft^2; 50 ft thick. • Assume 15-foot ROI per injection point, and 3 injection locations per pilot test, and one injection event. • Install three monitoring wells, in addition to existing. • For ISCO: Assume the oxidant and dose rate will be determined by the bench test. Since Fenton's reagent is the most aggressive, assume for the purposes of the conceptual 3,200 gallons (based on Fenton's dose rate) per location will be applied. • Approximately 9,600 gallons of material required. Duration for injection and process monitoring: 3 months. • For ISCR: Estimated solution dose rate (based on FEROX^{sm}) of 13,000 lbs per injection location, to be adjusted according to the bench test, for a total of 39,000 lbs. • Duration for injection and process monitoring: 6 months

***In Situ* Chemical Oxidation (ISCO)/*In Situ* Chemical Reduction(ISCR)/Groundwater Pump & Treat (P&T)/Monitored Natural Attenuation (MNA)/Ultraviolet Oxidation (UV Ox)** *Lower Vadose Soil and Exposition Groundwater Remediation Zone*	
Full-Scale Application: It is assumed that permanent injection wells would be placed within the 1,000 ppb groundwater composite TCE plume contour. Reagents will be delivered throughout the Exposition 'A' and 'B' zones. The pilot study results would be used to select the most applicable oxidizing/reducing agent to inject. Since the delivery mechanisms are the same the conceptual design and cost estimate are not significantly affected by leaving the selection of reagents open until the pilot study data is reviewed. Well network design is based on pump test data (average width of capture of 45 ft along downgradient axis; average width of capture of 69 ft along cross-gradient axis). <u>Between the 1,000 and 10 ppb contour:</u> Fifteen (15) P&T wells will be installed in three networks: wells screened in the 'A' Zone, wells screened in the 'B' Zone, and wells screened continuously through the 'A' and 'B' Zones. System flow of 44 gpm (2.0 gpm x [3] 'A' and [3] 'B' wells; 4.0 gpm x [9] 'A' and 'B' wells. To prevent the potential for cross contamination between the different Exposition Zones, the wells screened continuously through the 'A' and 'B' Zones are located outside the 100 ppb plume contour line. <u>Outside the 10 ppb contour</u> MNA would be used outside the 10 ppb composite plume to demonstrate plume reduction and/or point of compliance.	• Assume 98 injection locations – 2 in PVC wells. • Assume 2 injection events (1 month period between events). • Each event to be completed in 50 days. • Assume 15-foot ROI per injection point. • Reagent dose rate adjusted for volume/weight as determined by the pilot study. • Duration for injection and process monitoring: 6-9 months. • P&T wells to be situated predominantly on the downgradient edge of the source area and along public right-of-ways. • All P&T piping systems would be placed in a trench network. • All P&T wells shall be 6-inch diameter, Schedule 80 PVC. A 0.5 hp submersible pump will be installed in each well. • 'A' Zone: 3 wells, Schedule 80 PVC, screened 65 to 75 ft bgs. • 'B' Zone: 3 wells, Schedule 80 PVC, screened 80 to 100 ft bgs. • 'A' and 'B' Zone: 9 wells Schedule 80 PVC, screened 65 to 100 ft bgs.
Groundwater Treatment System: UV oxidation was selected based on ability to meet treatment discharge requirements. A fenced and covered treatment compound would be mounted on a 20 ft by 30 ft concrete pad with containment foundation (to be shared with vapor treatment). Handling and storage of hydrogen peroxide requires special safety precautions. Electrical service and remote monitoring communication system would be tied into local services with possible back-up power generation. High turbidity, oil and grease, or metal ions would cause interference with UV treatment. It is assumed that typical pretreatment (filtration) for turbidity would be performed.	• Design flow and influent conc. are 50 gpm and 5.0 ppm total VOC • Treatment criterion is to be based on SSRGs (Table 4-1). • Treatment system influent and effluent to be sampled daily during 7-day startup; quarterly after documented stabilization; semiannually after established trend or continued stabilization. Effluent sampling frequency would be determined by discharge permit. • Long-term O&M plan to be implemented for treatment system. • Influent trench and pipe = 1,200 ft Effluent trench and pipe = 500 ft
Monitoring Well Network: Required for MNA and to track performance of ISCO/ISCR and assure compliance with treatment criteria. Wells within each network (Exposition 'A' and 'B' Zones) will be situated to characterize conditions upgradient and downgradient of the injection locations; and upgradient, downgradient, within the plume, and lateral extent of the plume.	• 'A' Zone: 10 wells, 2-inch diameter, Schedule 40 PVC, screened 65 to 75 ft bgs. • 'B' Zone: 10 wells, 2-inch diameter, Schedule 40 PVC, screened 80 to 100 ft bgs. • 'C' Zone: 5 existing wells shall be used as needed.

***In Situ* Chemical Oxidation (ISCO)/*In Situ* Chemical Reduction(ISCR)/Groundwater Pump & Treat (P&T)/Monitored Natural Attenuation (MNA)/Ultraviolet Oxidation (UV Ox)** *Lower Vadose Soil and Exposition Groundwater Remediation Zone*	
Monitoring/Reporting Frequency: Reporting will be performed in compliance with permits and to document contaminant removal rates, flows, cleanup forecasts, and groundwater gradient maps, in appropriate frequency to data collection. Parameters to be analyzed for oxidation/reduction process monitoring are same as pilot study (see above).	• Baseline sampling (one-time event) prior to injection activity. • Semiannual sampling events following the completion of the injection process. • A limited amount of additional sampling after each injection event would be performed for ISCO. • Reporting upon completion of each sampling event. • O&M not anticipated.
Estimated Project Duration (pilot + full-scale): 1 year ISCO/ISCR and P&T + minimum of 5 years monitoring and P&T.	• Approximately 6 years.
Conceptual Design Considerations	
Monitoring program can be reevaluated after 5 years for potential of sampling location or frequency reduction. Delivery locations may need to be adjusted to take into account site features such as underground utilities and other site structures. Upon supplementing groundwater and hydrologic data for the 'C' Zone, a determination for either continued monitoring or monitoring and treatment will be made. Potential additional injections of oxidizing agents (Fenton's or permanganate) or reducing agents (zero valent iron solution) can be considered; the need for re-application will primarily depend on site-specific degradation performance. If required, re-application will be applied over the reduced area and dose amount compared to the initial application. Fracturing the formation prior to an injection event may enhance treatment, as determined by the pilot study.	

9.3.3 Alternative SG3 – EISB/Groundwater P&T/MNA/UV Ox

Enhanced In Situ Bioremediation (EISB)/Groundwater Pump & Treat (P&T)/MNA/UV Ox *Lower Vadose Soil and Exposition Groundwater Remediation Zone*
Alternative Description
Under this alternative, EISB would be used, based on treatability study results, to treat higher concentrations of contaminants within the 1,000 ppb composite plume contour. P&T would be used between the 1,000 and 10 ppb composite plume contour to provide hydraulic control and to facilitate dispersion of organic substrate, similar to a recirculation cell. MNA would be used outside the 10 ppb composite plume to demonstrate plume reduction and/or point of compliance. Extracted groundwater would be treated via UV oxidation, possibly accessorized with GAC. The need for supplementary GAC to treat groundwater will be determined during the RD phase of the project and may eventually be used as a stand-alone technology for treatment of extracted groundwater if low-adsorptive compounds, such as vinyl chloride, are not present in the extracted groundwater at concentrations over MCLs. EISB is a method used to degrade chlorinated ethenes using microbiological processes naturally occurring in the substrate environment. The intrinsic microbiological processes are promoted by subsurface injection of organic substrate. Groundwater samples are collected and analyzed prior to and following the injection activity to document the bioremediation process. Reductive dechlorination is one of the primary attenuation mechanisms by which chlorinated solvent groundwater plumes can be remediated. This process is a subsequent degradation of PCE to TCE, TCE to cis-1.2-DCE, cis-1,2-DCE to vinyl chloride, and finally vinyl chloride to ethene. In this manner, the COCs such as TCE can be degraded into harmless compounds such as ethene over time. HRC® one of the available organic substrates is well documented for accelerating *in-situ* bioremediation rates of chlorinated ethenes via anaerobic reductive dechlorination processes. Reductive dechlorination is not effective for treating compounds (e.g., benzene, toluene) that biodegrade under aerobic conditions; these compounds would have to address aerobically before or after reductive dechlorination. EISB is not recommended for *in-situ* treatment of soil since the mechanics of substrate delivery are unproven and groundwater is required to assist with dispersion. For this reason, EISB would only provide a partial treatment solution to the Lower Vadose Soil and Exposition Groundwater Remediation Zone.

Enhanced In Situ Bioremediation (EISB)/Groundwater Pump & Treat (P&T)/MNA/UV Ox *Lower Vadose Soil and Exposition Groundwater Remediation Zone*	
Site Characteristics	
Area of Source control:	
'A' and 'B' Exposition groundwater zones:	69,400 ft^2 (within 1,000 ppb contour)
Analytical Data:	
Maximum concentration of Primary COCs in 'A' Zone:	TCE (27,000 µg/L), cis-1,2-DCE (2,600 µg/L) and vinyl chloride (100 µg/L)
Maximum concentration of Primary COCs in 'B' Zone:	TCE (21,000 µg/L), cis-1,2-DCE (14,000 µg/L) and vinyl chloride (780 µg/L)
Average levels of major environmental indicators (oxygen, nitrate, and sulfate) in the 'A' Zone:	0.8 mg/L, 4.1 mg/L, and 157 mg/L, respectively
Average levels of major environmental indicators (oxygen, nitrate, and sulfate) in the 'B' Zone:	0.5 mg/L, 0.2 mg/L, and 210 mg/L, respectively
Hydrogeologic Data:	
Depth to groundwater in Exposition Groundwater:	67 ft bgs
Saturated Soil Thickness:	50 ft
Direction and gradient of groundwater flow in 'A' Zone:	0.011 ft/foot, southwest
Direction and gradient of groundwater flow in 'B' Zone:	0.009 ft/foot, west-southwest
Hydraulic conductivity (average for 'A' Zone):	1.46E-03 ft/min
Hydraulic conductivity (average for 'B' Zone):	3.27E-02 ft/min
Receptors:	
Most shallow well used for domestic production:	Located approx. 4,000 ft southwest of site; screen interval begins at 350 ft bgs.
Closest well used for domestic production:	Located approx. 2,600 ft southwest of site; screen interval begins at 610 ft bgs.
Residential neighborhoods:	Located to the south and downgradient

Conceptual Design Components and Assumptions	
Component	**Assumptions**
Analytical and Hydrogeologic Data: Potential sulfate reduction demand <490 µg/L. General anaerobic groundwater geochemistry with oxygen <2.2 mg/L, nitrate <40 mg/L, and oxidation-reduction potential between –116 mV and 225 mV.	• Estimated groundwater velocity: up to 0.5 ft/day
Pilot Test: An EISB pilot test would refine design parameters prior to full-scale implementation. Baseline sampling (one-time event) prior to injection activity and an estimated 4 sampling events following injection activity is expected over the 6-month pilot study period. Parameters to be monitored for long-term treatment monitoring include: COCs (chlorinated ethenes), field parameters (DO, ORP, pH, and temperature), biodegradation parameters (nitrate, sulfate, sulfide, chloride, ferrous iron, and alkalinity), substrate fermentation products (total organic carbon and metabolic acids), and biodegradation end products (carbon dioxide, methane, ethane, and ethene).	• Test area: 900 s.f. x 50 ft thick • Assume 9 injection wells, 2-in. diameter, schedule 40 PVC. • Assume 15-foot ROI per injection point. • HRC® dose rate of 8.0 lbs per vertical ft (400 lbs per point). • Duration for injection and process monitoring: 6 months.
Full-Scale Application: Injection points to be placed within 1,000 µg/L TCE contour to deliver substrate to Exposition 'A' and 'B' Zones. Duration for injection and process monitoring: 6 to 9 months. Well network design is based on pump test data (average width of capture of 45 ft along downgradient axis; average width of capture of 69 ft along cross-gradient axis). <u>Between the 1,000 and 10 ppb contour:</u> Fifteen (15) P&T wells will be installed in three networks: wells screened in the 'A' Zone, wells screened in the 'B' Zone, and wells screened continuously through the 'A' and 'B' Zones. System flow of 44 gpm (2.0 gpm x [3] 'A' and [3] 'B' wells; 4.0 gpm x [9] 'A' and 'B' wells. To prevent the potential for	• Assume 98 injection wells, same design as pilot. • Assume 15-foot ROI per injection point. • HRC® dose rate in the range of 18 to 20 lbs per vertical foot or approximately 910 lbs per point. Possibly in two applications. • Total HRC® requirement is approximately 89,180 lbs. • P&T wells to be situated predominantly on the downgradient edge of the source

Enhanced In Situ Bioremediation (EISB)/Groundwater Pump & Treat (P&T)/MNA/UV Ox *Lower Vadose Soil and Exposition Groundwater Remediation Zone*	
cross contamination between the different Exposition Zones, the wells screened continuously through the 'A' and 'B' Zones are located outside the 100 ppb plume contour line. Outside the 10 ppb contour MNA would be used outside the 10 ppb composite plume to demonstrate plume reduction and/or point of compliance.	area and along public right-of-ways. • All P&T piping systems would be placed in a trench network. • All P&T wells shall be 6-inch diameter, Schedule 80 PVC. A 0.5 hp submersible pump will be installed in each well. • 'A' Zone: 3 wells, Schedule 80 PVC, screened 65 to 75 ft bgs. • 'B' Zone: 3 wells, Schedule 80 PVC, screened 80 to 100 ft bgs. • 'A' and 'B' Zone: 9 wells Schedule 80 PVC, screened 65 to 100 ft bgs.
Conceptual Design Components and Assumptions	
Component	**Assumptions**
Monitoring Well Network: Required to track performance of EISB and assure compliance with treatment criteria. Wells within each network (Exposition 'A', and 'B' Zones) will be situated to characterize conditions upgradient and downgradient of the injection locations; and upgradient, downgradient, within the plume, and lateral extent of the plume.	• 'A' Zone: 10 wells, 2-inch diameter, Schedule 40 PVC, screened 65 to 75 ft bgs. • 'B' Zone: 10 wells, 2-inch diameter, Schedule 40 PVC, screened 80 to 100 ft bgs. • 'C' Zone: 5 existing wells shall be used as needed.
Monitoring/Reporting Frequency: Reporting will be performed in compliance with permits and to document contaminant removal rates, flows, cleanup forecasts, and groundwater gradient maps, in appropriate frequency to data collection. QA/QC Program Plan to be included for the sampling plan.	• Baseline sampling (one-time event) prior to injection activity. • Semiannual sampling events following injection activity. • Parameters to be monitored identical to pilot study (see above).
Estimated Project Duration (pilot + full-scale): 1 year EISB and P&T + minimum of 5 years monitoring and P&T.	• Approximately 6 years.
Conceptual Design Considerations	
Monitoring program can be reevaluated after 5 years for potential of sampling location or frequency reduction. Delivery locations may need to be adjusted to take into account site features such as underground utilities and other site structures. Due to specific physical characteristics of HRC® material, pressure required for delivery to the subsurface ranges from 200 psig to 1,500 psig, for which Rupe ORC/HRC 9-1500 and the Geoprobe GS-2000 pumps are recommended by Regenesis – the HRC® material producer. • Design is for a one-time application of HRC®; the need for re-application will primarily depend on site-specific biodegradation performance. If required, re-application will be applied over the reduced area and dose amount compared to the initial application. • Fracturing the formation prior to an injection event may enhance treatment, as determined by the pilot study.	

9.3.4 Alternative SG4a – Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/MNA/UV Ox/FTO and GAC

Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/MNA/UV Ox/FTO and GAC
Lower Vadose Soil and Exposition Groundwater Remediation Zone

Alternative Description

Under this alternative, vacuum-enhanced groundwater extraction would be performed on all wells within the 1,000 ppb composite plume contour source area to treat dissolved phase contaminants and free product. Between the 1,000 ppb and 10 ppb composite plume contour, typical P&T wells would be used to achieve hydraulic control of the dissolved contaminant plume. MNA would be used outside the 10 ppb composite plume to demonstrate plume reduction and/or point of compliance. The contaminated groundwater and soil vapor would be transported to separate above ground treatment systems where the contaminants would be removed prior to discharge. UV Ox, possibly accessorized with GAC, would be used for groundwater treatment and FTO and GAC would be used for vapor treatment. Both UV Ox and FTO would completely destroy all COCs onsite with no residual wastes to manage. After one year of remediation, the vapor treatment system would be switched to GAC - a more cost effective option for lower contaminant loading. The treated groundwater could be disposed by reinjection back into the aquifer, discharged to the sanitary sewer, or discharged to the LA River depending on permit approval. The treated soil vapor would discharge to the atmosphere.

This alternative assumes that initial high mass loading of VOCs extracted during the first year of operation would be more effectively and efficiently treated using FTO. Due to the 99.9% destruction effectiveness rate of FTO, the production of combustion by-products (e.g., dioxin) above background concentrations is unlikely. After the first year, it is estimated that the mass loading will be significantly reduced and switching to a GAC vapor treatment system would be more cost effective.

GAC absorbs COCs from the extracted vapor for later disposal at an offsite approved facility. GAC is not an effective method of treatment for low molecular weight VOCs, such as vinyl chloride, or COCs with low adsorptive capacity, such as 1,4-dioxane. However, it is estimated that a significant proportion of these two contaminants would be eliminated in the first year to allow for treatment via GAC. Further evaluation of the proportion of low molecular weight VOCs in the vapor stream would be necessary prior to implementing GAC vapor treatment.

Similar to vapor treatment, GAC may eventually be used as a stand-alone technology for treatment of extracted groundwater if low-adsorptive compounds are not present in the extracted groundwater at concentrations over MCLs. The need for supplementary GAC (to UV Ox) to treat groundwater will be determined during the RD phase of the project.

In the area of highest contamination (within 1,000 ppb contour), drawdown caused by groundwater extraction will expose well screen area from which soil vapor can be extracted, via surface blowers. As the soil vapor is extracted (under vacuum), it removes VOC contaminants trapped in the soil pores. Groundwater extraction coupled with high-vacuum vapor extraction allow for good control over contaminant mobility and a reduction in contaminant volume (onsite) through extraction of liquid phase and gas phase contaminants. Enhanced P&T with vapor extraction would effectively eliminate the potential for migration of COCs in this remediation zone and the pathways to human exposure for COCs in Exposition groundwater.

Site Characteristics	
Area of Source Control:	
‘A’ and ‘B’ Exposition groundwater zones:	69,400 ft^2 (within the 1,000 ppb contour)
Analytical Data:	
Maximum concentration of Primary COCs in ‘A’ Zone:	TCE (27,000 µg/L), cis-1,2-DCE (2,600 µg/L) and vinyl chloride (100 µg/L)
Maximum concentration of Primary COCs in ‘B’ Zone:	TCE (21,000 µg/L), cis-1,2-DCE (14,000 µg/L) and vinyl chloride (780 µg/L)
Hydrogeologic Data:	
Depth to groundwater in Exposition Groundwater:	67 ft bgs
Direction and gradient of groundwater flow in ‘A’ Zone:	0.011 ft/foot, southwest
Direction and gradient of groundwater flow in ‘B’ Zone:	0.009 ft/foot, west-southwest
Hydraulic conductivity (average for ‘A’ Zone):	1.46E-03 ft/min
Hydraulic conductivity (average for ‘B’ Zone):	3.27E-02 ft/min
Pump Test Data:	Average width of capture of 45 ft along downgradient axis; average width of capture of 69 ft along cross-gradient axis
Groundwater Extraction flow rate:	2 gpm for ‘A’ and ‘B’ Zones.

Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/MNA/UV Ox/FTO and GAC *Lower Vadose Soil and Exposition Groundwater Remediation Zone*	
HVDPE Pilot Test Data:	Vacuum ROI of 54 ft at 68 scfm and 14 in of Hg
Boundary Conditions:	No documented recharge from LA River
Potential Receptors:	
Most shallow well used for domestic production:	Located approx. 4,000 ft southwest of site; screen interval begins at 350 ft bgs
Closest well used for domestic production:	Located approx. 2,600 ft southwest of site; screen interval begins at 610 ft bgs
Residential neighborhoods:	Located to the south and downgradient. All homes on municipal water.

Conceptual Design Components and Assumptions	
Component	**Assumptions**

Vacuum-Enhanced and Groundwater Pumping Well Networks: Well network design is based on pump test data (average width of capture of 45 ft along downgradient axis; average width of capture of 69 ft along cross-gradient axis).
Within 1,000 ppb plume contour: Twenty (20) vacuum- enhanced groundwater extraction wells will be installed within the 1,000 ppb contour in two networks: 'A' Zone wells and 'B' Zone wells. System flow of 40 gpm (2.0 gpm x [20] 'A' and 'B' wells). Wells are typical P&T wells to which a vacuum is applied.
Between the 1,000 and 10 ppb contour: Fifteen (15) P&T wells will be installed in three networks: wells screened in the 'A' Zone, wells screened in the 'B' Zone, and wells screened continuously through the 'A' and 'B' Zones. System flow of 44 gpm (2.0 gpm x [3] 'A' and [3] 'B' wells; 4.0 gpm x [9] 'A' and 'B' wells. To prevent the potential for cross contamination between the different Exposition Zones, the wells screened continuously through the 'A' and 'B' Zones are located outside the 100 ppb plume contour line.
Outside the 10 ppb contour
MNA would be used outside the 10 ppb composite plume to demonstrate plume reduction and/or point of compliance.
	• Wells to be situated predominantly in the source area and along public right-of-ways
	• All piping systems would be placed in a trench network.
	• Assume a blower requirement of 1,500-scfm.
	• Groundwater extraction rate is estimated to be 2 gpm for 'A' and 'B' Zones for a total flow of 84 gpm.
	• All wells shall be 6-inch diameter, Schedule 80 PVC. A 0.5 hp submersible pump will be installed in each well.
	  • 'A' Zone: 13 wells, Schedule 80 PVC, screened 65 to 75 ft bgs.
	  • 'B' Zone: 13 wells, Schedule 80 PVC, screened 80 to 100 ft bgs.
	  • 'A' and 'B' Zone: 9 wells Schedule 80 PVC, screened 65 to 100 ft bgs. Wells to be situated predominantly in the source area and along public right-of-ways.
	Assumptions are based on HVDPE pilot test.

Groundwater Treatment System: UV oxidation was selected based on ability to meet treatment discharge requirements. A fenced and covered treatment compound would be mounted on a 20 ft by 30 ft concrete pad with containment foundation (to be shared with vapor treatment). Handling and storage of hydrogen peroxide requires special safety precautions. Electrical service and remote monitoring communication system would be tied into local services with possible back-up power generation. High turbidity, oil and grease, or metal ions would cause interference with UV treatment. It is assumed that typical pretreatment (filtration) for turbidity would be performed.	• Design flow and influent conc. are 150 gpm and 6.0 ppm total VOC (includes factor of safety increase). • Treatment criterion is to be based on SSRGs (Table 4-1). • Treatment system influent and effluent to be sampled daily during 7-day startup; quarterly after documented stabilization; semiannually after established trend or continued stabilization. Effluent sampling frequency would be determined by discharge permit. • Long-term O&M plan to be implemented for treatment system. • Influent trench and pipe = 1,200 ft Effluent trench and pipe = 500 ft

Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/MNA/UV Ox/FTO and GAC *Lower Vadose Soil and Exposition Groundwater Remediation Zone*	
Soil Vapor Treatment System: The selected soil vapor treatment process, FTO for the first year followed by GAC for the remaining years, would be housed in the treatment compound alongside the groundwater treatment system. Treatment criteria will be determined in accordance with the SCAQMD discharge permit. Target destruction efficiency would average 99% with concentrations of combustion by-products (e.g., dioxin) below background concentrations during FTO operation and low (approved) concentrations of vinyl chloride and 1,4-dioxane emissions during GAC operation.	• Total design system flow of 1,500 scfm. • Estimated average first year influent vapor concentration of 315 ppm • Treatment system influent and effluent to be sampled daily during 7-day startup; weekly after documented stabilization or trend; quarterly or in accordance with discharge permit thereafter. • Additional monitoring via PID will be performed to supplement sampling data and to schedule timing for switching on-line wells.
Monitoring/Reporting Frequency: Reporting will be performed to document contaminant removal rates, flows, cleanup forecasts, and groundwater gradient maps, in appropriate frequency to data collection.	• Semiannual groundwater sampling events are recommended. • Annual monitoring may be recommended after demonstration of reduction in plume volume and mobility. • QA/QC Program Plan will be instituted for all sampling and treatment. • Long term O&M plan required.
Estimated Project Duration: 15 years + a minimum of 5 years of groundwater monitoring.	• Approximately 20 years.
Conceptual Design Considerations	
This process option would be most cost effective if implemented through the perched zone also. Enhancements: Hydraulic or pneumatic fracturing could be used as an enhancement for removal of contaminant from source area. Targeted "fracing" zones to be performed only in impermeable lithosomes including 50–65 ft bgs (above the Exposition 'A' Zone) and 74–80 ft bgs (between the 'A' and 'B' groundwater zones). Efficient use of technology should include "fracing" in the perching clay (28–40 ft bgs)	

9.3.5 Alternative SG4b – Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/ MNA/UV Ox/GAC

Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/MNA/UV Ox/GAC *Lower Vadose Soil and Exposition Groundwater Remediation Zone*	
Alternative Description	
The treatment process and conceptual design is the same as described in Alternative SG4a with the exception of vapor treatment, which would employ only GAC. GAC absorbs COCs from the extracted vapor for later disposal at an offsite approved facility. GAC is not an effective method of treatment for low molecular weight VOCs, such as vinyl chloride, or COCs with low adsorptive capacity, such as 1,4-dioxane. Further evaluation of the proportion of low molecular weight VOCs in the vapor stream would be necessary prior to implementing GAC vapor treatment. Assuming cleanup criteria are met, the treated soil vapor would discharge to the air above the site.	
Site Characteristics	
The site characteristics are the same as Alternative SG4a.	
Conceptual Design Components and Assumptions	
Component	**Assumptions**
Vacuum Enhanced and Groundwater Pumping Well Networks: See Alternative SG4a for the Vacuum-Enhanced and Groundwater Pumping Well System.	• Same as Alternative SG4a.
Groundwater Treatment System: See Alternative SG4a for the Groundwater Treatment System.	• Same as Alternative SG4a.

Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/MNA/UV Ox/GAC *Lower Vadose Soil and Exposition Groundwater Remediation Zone*	
Soil Vapor Treatment System: The selected soil vapor treatment process, GAC, would be housed in the treatment compound alongside the groundwater treatment system. Treatment criteria will be determined in accordance with the SCAQMD discharge permit. Target destruction efficiency would average 99% with low (approved) concentrations of vinyl chloride and 1,4 dioxane emissions during GAC operation.	• Same as Alternative SG4a without FTO.
Monitoring/Reporting Frequency: Reporting would be the same as Alternative SG4a without the FTO system.	• Same as Alternative SG4a with the addition of: Additional reporting of effluent monitoring data for vinyl chloride and 1,4-dioxane would be performed in accordance with the SCAQMD permit.
Estimated Project Duration: Same as Alternative SG4a	• Approximately 20 years.
Conceptual Design Considerations	
Same as Alternative SG4a.	

9.3.6 Alternative SG5a – ERH with VE/Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/ MNA/UV Ox/FTO and GAC

ERH with VE/Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/ MNA/UV Ox/FTO and GAC *Lower Vadose Soil and Exposition Groundwater Remediation Zone*
Alternative Description
Under this alternative, ERH with VE would be used to treat soil and groundwater within the 10,000 ppb composite plume. Vacuum-enhanced groundwater extraction would be used between the 10,000 ppb and 1,000 ppb composite plume contour. Groundwater P&T would be used between 1,000 ppb and 10 ppb composite plume contour to achieve hydraulic control of the dissolved contaminant plume. MNA would be used outside the 10 ppb composite plume to demonstrate plume reduction and/or point of compliance. The contaminated groundwater and soil vapor would be transported to separate above ground treatment systems where the contaminants are removed prior to discharge. UV Ox, possibly accessorized with GAC, would be used for groundwater treatment and FTO and GAC for vapor treatment. Both UV Ox and FTO would completely destroy all COCs onsite with no residual wastes to manage. After one year of remediation, the vapor treatment system would be switched to GAC - a more cost effective option for lower contaminant loading. The treated groundwater could be disposed by reinjection back into the aquifer, discharged to the sanitary sewer, or discharged to the LA River depending on permit approval. The treated soil vapor would discharge to the atmosphere. ERH uses an array comprised of six to nine electrodes that are inserted into the ground to the depth of the contamination. The electrodes heat the soil and groundwater to approximately 100 degrees Celsius via resistive current. Contaminants are volatized and removed from the subsurface from the resulting *in-situ* steam stripping. Volatilized contaminants are collected at the surface via VE. ERH with VE would effectively eliminate the potential for migration and pathways to human exposure of COCs in this remediation zone. Vacuum-enhanced groundwater extraction would be performed on all wells between the 10,000 and 1,000 ppb composite plume contour. Drawdown caused by groundwater extraction exposes well screen area from which soil vapor can be extracted, via surface blowers. As the soil vapor is extracted (under vacuum), it removes VOC contaminants trapped in the soil pores. Vacuum-enhanced groundwater extraction will allow for good control over contaminant mobility and a reduction in contaminant volume (onsite) through extraction of liquid phase and gas phase contaminants. This alternative assumes that initial high mass loading of VOCs extracted during ERH operation would quickly overload a carbon treatment system. Therefore, FTO would be used for vapor treatment for the duration (approx. 1 year) that ERH was operated. Due to the 99.9% destruction effectiveness rate of FTO, the production of combustion by-products (e.g., dioxin) above background concentrations is unlikely. After the first year, ERH would be completed and it is estimated that the mass loading will be significantly reduced and switching to a GAC vapor treatment system would be more cost effective. Similar to vapor treatment, GAC may eventually be used as a stand-alone technology for treatment of extracted groundwater if low-adsorptive compounds are not present in the extracted groundwater at concentrations over MCLs. The need for supplementary GAC to treat groundwater will be determined during the RD phase of the project.

ERH with VE/Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/ MNA/UV Ox/FTO and GAC *Lower Vadose Soil and Exposition Groundwater Remediation Zone*	
Site Characteristics	
Area of Source control:	
‘A’ and ‘B’ Exposition groundwater zones:	69,400 ft^2 (within 1,000 ppb contour)
	10,700 ft^2 (within 10,000 ppb contour)
Analytical Data:	
Maximum concentration of Primary COCs in ‘A’ Zone:	TCE (27,000 µg/L), cis-1,2-DCE (2,600 µg/L) and vinyl chloride (100 µg/L)
Maximum concentration of Primary COCs in ‘B’ Zone:	TCE (21,000 µg/L), cis-1,2-DCE (14,000 µg/L) and vinyl chloride (780 µg/L)
Hydrogeologic Data:	
Depth to groundwater in Exposition Groundwater:	67 ft bgs
Saturated Soil Thickness:	50 ft
Direction of groundwater flow in ‘A’ Zone:	Southwest
Direction of groundwater flow in ‘B’ Zone:	West-southwest
Hydraulic conductivity (average for ‘A’ Zone):	1.46E-03 ft/min
Hydraulic conductivity (average for ‘B’ Zone):	3.27E-02 ft/min
HVDPE Pilot Test Data:	Vacuum ROI of 54 ft at 68 scfm and 14 in of Hg
Receptors:	
Most shallow well used for domestic production:	Located approx. 4,000 ft southwest of site; screen interval begins at 350 ft bgs.
Closest well used for domestic production:	Located approx. 2,600 ft southwest of site; screen interval begins at 610 ft bgs.
Residential neighborhoods:	Located to the south and downgradient
Conceptual Design Components and Assumptions	
Component	**Assumptions**
Treatment Criteria: Same for pilot study and full-scale treatment via ERH. Air treatment criteria to be determined in accordance with South Coast Air Quality Management District discharge permit. Target discharge <25 ppmv at an average total destruction efficiency of 99%. For water, target discharge <5 µg/L for max daily flow of 77,000 gpd of condensed water vapor (approximately 54 gpm).	• Soil vapor and groundwater treatment system influent and effluent to be sampled daily during startup period; weekly after documented stabilization or trend; quarterly or in accordance with discharge permit thereafter. • Additional air monitoring via PID would be performed to supplement sampling data.
Pilot Test: Pilot test with six electrodes is recommended to confirm site characteristics (i.e. soil resistivity, electrode diameter, moisture requirements, and ROIs (for heating and vapor extraction). Surface recovery of soil vapor will be achieved using 3 SVE wells screened from approx. 10-50 ft bgs, designed and operated at full scale using a 250-scfm blower. Surface recovery of water (from moisture stripping) will amount to approximately 1,400 gpd. Treatment process using UV oxidation would provide the most effective contaminant removal/destruction.	• Pilot study area approx. 2,000 s.f. x 50 ft thick. • Typical HSA drill rig used for drilling 6 electrode borings and three 2-inch VE wells • Assumes one fenced compound for electrical equipment and separate compound for soil vapor and water treatment. • ERH evaluation soil sampling assumes 3 borings to 100 ft bgs with 1 soil sample collected at each major lithosome (30 total samples for VOCs analysis). • Pilot study evaluation reporting will make recommendation for suitability of ERH at the site. • Duration of test and reporting: 6 months.

ERH with VE/Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/ MNA/UV Ox/FTO and GAC *Lower Vadose Soil and Exposition Groundwater Remediation Zone*	
Full Scale ERH within 10,000 ppb contour: Approximately ninety-six electrodes would be used to treat the source area to a depth of 100 ft bgs. Eight power delivery stations would be positioned at the surface around the perimeter of the 10,000 ppb contour. The surface within the 10,000 ppb plume contour would be fenced off and screened. Eighteen vapor extraction wells will be evenly spaced among the electrodes to extract the vaporized groundwater and contaminant load. Total blower requirement will be approximately 1,000 scfm (not including vacuum-enhanced groundwater extraction wells outside the 10,000 ppb contour).	• Array size, electrode diameter, and installation components are assumed to be the same as pilot scale. • Power supply equipment and connection organized by vendor. • Assume one 1,000-scfm blower with above ground placement of piping within the 10,000 ppb plume contour. • ERH evaluation soil sampling assumes 30 borings to 100 ft bgs with 1 soil sample collected at each major lithosome (300 total samples for VOC analysis).

Vacuum-Enhanced and Groundwater Pumping Well Networks: Well network design is based on pump test data (average width of capture of 45 ft along downgradient axis; average width of capture of 69 ft along cross-gradient axis).
<u>Between 10,000 and 1,000 ppb contours</u>: Twelve (12) vacuum-enhanced groundwater extraction wells will be installed between 10,000 and 1,000 ppb contours in two networks: 'A' Zone wells and 'B' Zone wells. System flow of 40 gpm (2.0 gpm x [20] 'A' and 'B' wells). Wells are typical P&T wells to which a vacuum is applied.
<u>Between the 1,000 and 10 ppb contour:</u> Fifteen (15) P&T wells will be installed in three networks: wells screened in the 'A' Zone, wells screened in the 'B' Zone, and wells screened continuously through the 'A' and 'B' Zones. System flow of 44 gpm (2.0 gpm x [3] 'A' and [3] 'B' wells; 4.0 gpm x [9] 'A' and 'B' wells. To prevent the potential for cross contamination between the different Exposition Zones, the wells screened continuously through the 'A' and 'B' Zones are located outside the 100 ppb plume contour line.
<u>Outside the 10 ppb contour:</u>
MNA would be used outside the 10 ppb composite plume to demonstrate plume reduction and/or point of compliance.
	• Wells to be situated predominantly in the source area and along public right-of-ways.
	• All piping systems outside the 10,000 ppb plume contour shall be placed in a trench network.
	• Assume one 1,000-scfm blower.
	• Groundwater extraction rate is estimated to be 2 gpm for 'A' and 'B' Zones for a total flow of 84 gpm.
	• All wells shall be 6-inch diameter, Schedule 80 PVC. A 0.5 hp submersible pump will be installed in each well.
	  • 'A' Zone: 9 wells, Schedule 80 PVC, screened 65 to 75 ft bgs.
	  • 'B' Zone: 9 wells, Schedule 80 PVC, screened 80 to 100 ft bgs.
	  • 'A' and 'B' Zone: 9 wells Schedule 80 PVC, screened 65 to 100 ft bgs.
	  • 'C' Zone: 5 existing wells shall be used as needed.
	• Assumptions are based on HVDPE pilot test.

Groundwater Treatment System: UV oxidation was selected based on ability to meet treatment discharge requirements. A fenced and covered treatment compound would be mounted on a 20 ft by 30 ft concrete pad with containment foundation (to be shared with vapor treatment). Handling and storage of hydrogen peroxide requires special safety precautions. Electrical service and remote monitoring communication system would be tied into local services with possible back-up power generation. High turbidity, oil and grease, or metal ions would cause interference with UV treatment. It is assumed that typical pretreatment (filtration) for turbidity would be performed.	• Design flow and influent conc. are 100 gpm and 6.2 ppm total VOC • Treatment criterion is to be based on SSRGs (Table 4-1). • Treatment system influent and effluent to be sampled daily during 7-day startup; quarterly after documented stabilization; semiannually after established trend or continued stabilization. Effluent sampling frequency would be determined by discharge permit. • Long-term O&M plan to be implemented for treatment system. • Influent trench and pipe = 1,200 ft Effluent trench and pipe = 500 ft

ERH with VE/Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/ MNA/UV Ox/FTO and GAC *Lower Vadose Soil and Exposition Groundwater Remediation Zone*	
Soil Vapor Treatment System: The selected soil vapor treatment process, FTO for the first year followed by GAC for the remaining years, would be housed in the treatment compound alongside the groundwater treatment system. Treatment criteria will be determined in accordance with the SCAQMD discharge permit. Target destruction efficiency would average 99% with concentrations of combustion by-products (e.g., dioxin) below background concentrations during FTO operation and low (approved) concentrations of vinyl chloride and 1,4 dioxane emissions during GAC operation.	• Total design system flow of 2,000 scfm. • Estimated average first year influent vapor concentration of 315 ppm • Treatment system influent and effluent to be sampled daily during 7-day startup; weekly after documented stabilization or trend; quarterly or in accordance with discharge permit thereafter. • Additional monitoring via PID will be performed to supplement sampling data and to schedule timing for switching on-line wells. • Additional monitoring via PID will be performed to supplement sampling data and to schedule timing for switching on-line wells.
Monitoring Well Network: To be established to assess potential migration of contaminants and reduction in concentrations. Wells within each network (Exposition 'A' and 'B') will be situated to characterize conditions upgradient, downgradient, within plume, and lateral extent of plume.	• A' Zone: 10 wells, 2-inch diameter, Schedule 40 PVC, screened 65 to 75 ft bgs. • 'B' Zone: 10 wells, 2-inch diameter, Schedule 40 PVC, screened 80 to 100 ft bgs. • 'C' Zone: 5 existing wells shall be used as needed.
Monitoring/Reporting Frequency: Reporting will be performed in compliance with permits and to document contaminant removal rates, flows, cleanup forecasts, and groundwater gradient maps, in appropriate frequency to data collection.	• Semi-annual groundwater monitoring is recommended based on maximum average velocity of 0.5 ft/day. • Annual monitoring may be recommended after demonstration of treatment.
Estimated Project Duration: ERH will require approximately 1 year for treatment of the >10,000 ppb plume contour source area. Vacuum-enhanced groundwater extraction and P&T is expected to continue for approximately 4 additional years. Groundwater monitoring is required for an additional 5 years for a total of 10 years.	• Approximately 10 years.
Conceptual Design Considerations	
Additional requirement of park area (approximately 12,000 ft^2) for power system delivery layout.	

9.3.7 Alternative SG5b – ERH with VE/Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/MNA/UV Ox/ GAC

ERH with VE/Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/MNA/UV Ox/GAC *Lower Vadose Soil and Exposition Groundwater Remediation Zone*
Description
The treatment process and conceptual design is the same as described in Alternative SG5a with the exception of vapor treatment, which would employ only GAC. GAC absorbs COCs from the extracted vapor for later disposal at an offsite approved facility. GAC is not an effective method of treatment for low molecular weight VOCs, such as vinyl chloride, or COCs with low adsorptive capacity, such as 1,4-dioxane. Further evaluation of the proportion of low molecular weight VOCs in the vapor stream would be necessary prior to implementing GAC vapor treatment. Assuming cleanup criteria are met, the treated soil vapor would discharge to the air above the site.
Site Characteristics
The Site Characteristics are the same as Alternative SG5a .

ERH with VE/Vacuum-Enhanced Groundwater Extraction/Groundwater P&T/MNA/UV Ox/GAC *Lower Vadose Soil and Exposition Groundwater Remediation Zone*	
Conceptual Design Components and Assumptions	
Component	**Assumptions**
Treatment Criteria: See Alternative SG4a for the Treatment Criteria.	• Same as Alternative SG5a.
Pilot Test: See Alternative SG4a for the Pilot Test design.	• Same as Alternative SG5a.
Full Scale ERH within 10,000 ppb contour: See Alternative SG5a for the ERH conceptual design.	• Same as Alternative SG5a.
Vacuum-Enhanced and Groundwater Pumping Well Networks: See Alternative SG5a for the vacuum-enhanced and groundwater pumping well conceptual design.	• Same as Alternative SG5a.
Groundwater Treatment System: See Alternative SG5a for the groundwater treatment system conceptual design.	• Same as Alternative SG5a.
Soil Vapor Treatment System: The selected soil vapor treatment process, GAC, would be housed in the treatment compound alongside the groundwater treatment system. Treatment criteria will be determined in accordance with the SCAQMD discharge permit. Target destruction efficiency would average 99% with low (approved) concentrations of vinyl chloride and 1,4 dioxane emissions during GAC operation.	• Same as Alternative SG5a without FTO.
Monitoring Well Network: See Alternative SG5a for the monitoring well network conceptual design.	• Same as Alternative SG5a.
Monitoring/Reporting Frequency: See Alternative SG5a for the monitoring/reporting conceptual design.	• Same as Alternative SG5a.
Estimated Project Duration: Same as Alternative SG5a.	• Approximately 10 years.
Conceptual Design Considerations	
Additional requirement of park area (approximately 12,000 ft^2) for power system delivery layout.	

9.3.8 Common Elements and Distinguishing Features – Lower Vadose Soil and Exposition Groundwater Zone Remedial Alternatives

All of the remedial alternatives for this remediation zone include the use of groundwater P&T between the 10,000 and 1,000 µg/L TCE contours, MNA outside the 10 µg/L contour, and UV Ox for *ex-situ* treatment of extracted groundwater. Based on comments received from the State of California during the Proposed Plan Public Comment Period, these alternatives will also include an additional groundwater extraction well to be installed within the Exposition 'D' Zone (approximately 120-140 ft bgs) in the vicinity of monitoring well MW-24. Elevated levels of TCE detected in groundwater from this well during sampling will be addressed with this extraction well.

Alternatives SG5a and SG5b both use ERH with VE within the 10,000 µg/L contour of the TCE composite Exposition 'A' and 'B' groundwater plume and vacuum-enhanced groundwater extraction between the 1,000 and 10,000 µg/L contours as the primary remedial actions. The only distinguishing feature between these two alternatives is the *ex-situ* treatment of extracted soil vapor and secondary vapor emissions from the UV Ox treatment system. Alternative SG5a would use an FTO unit for the first year of operation (to handle initial high mass loading) followed by GAC. Alternative SG5b would use GAC for the entire operation of the ERH and groundwater extraction systems.

Alternatives SG4a and SG4b both use vacuum-enhanced groundwater extraction within the 1,000 µg/L contour of the TCE composite Exposition 'A' and 'B' groundwater plume as the primary remedial action.

Again, the only distinguishing feature between these two alternatives is the *ex-situ* treatment of extracted soil vapor and secondary vapor emissions from the UV Ox treatment system. Alternative SG4a would use an FTO unit for the first year of operation (to handle initial high mass loading) followed by GAC; Alternative SG4b would use GAC for the entire operation of the vacuum-enhanced groundwater extraction system.

Alternatives SG2 and SG3 both use *in-situ* remedial alternatives within the 1,000 µg/L contour of the TCE composite Exposition 'A' and 'B' groundwater plume as the primary remedial action. Although these alternatives address groundwater within the source area of this remediation zone, they do not address lower vadose zone soil such as Alternatives SG4a, SG4b, SG5a and SG5b discussed above. The distinguishing feature between these alternatives is the treatment compound selected for application. Alternative SG2 would involve dispensing chemical oxidants, likely Fenton's reagent, to the subsurface to oxidize COCs in groundwater, while Alternative SG3 would dispense a hydrogen-release compound to expedite natural degradation processes (*i.e.,* reductive dechlorination).

9.3.9 Expected Outcomes of Each Alternative

Alternatives SG4a, SG4b, SG5a and SG5b are expected to reduce contaminant concentrations in lower vadose soil and Exposition groundwater within the source area and limit migration of COCs to viable aquifers – the primary route of human exposure. However, Alternatives SG4a and SG4b, which utilize vacuum enhanced extraction, are not expected to effectively reduce VOC contamination within low-permeability (fine-grained) lithosomes. Contaminant concentrations in groundwater would likely rebound as leaching occurs from these soils. On the contrary, Alternatives SG5a and SG5b, which utilize ERH with vapor extraction, are expected to remove existing VOC contamination in lower vadose soil to levels that prevent impact to the groundwater.

Alternatives SG2 and SG3 rely on saturated conditions for proper dispersion of oxidants and/or substrates to reduce contaminant concentrations. Similar to Alternatives SG4a and SG4b, COCs trapped in low-permeability soils may continue to act as a source of contamination for the Exposition groundwater zones and, potentially, deeper viable aquifers.

10.0 Comparative Analysis of Alternatives

In accordance with the NCP, the remedial alternatives developed for each of the three remediation zones defined at the Pemaco site were evaluated by comparison to each other to identify relative advantages and disadvantages. The comparative analysis conducted by EPA was based on the nine criteria specified in Section 121(b) of CERCLA. For an alternative to be an acceptable remedy it must, at a minimum, satisfy the statutory requirements of two threshold criteria: 1) Overall Protection of Human Health and the Environment, and 2) Compliance with Applicable or Relevant and Appropriate Requirements.

The nine CERCLA evaluation criteria are:

1. Overall protection of human health and the environment – addresses whether each alternative provides adequate protection of human health and the environment and describes how health risks are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls;

2. Compliance with ARARs – Section 121(d) of CERCLA and NCP §300.430(f)(l)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate federal and state requirements, standards, criteria, and limitations which are collectively referred to as ARARS unless such ARARS are waived under Section 121(d)(4);

3. Long-term effectiveness and permanence – the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met (includes consideration of residual risk that will remain onsite and the adequacy and reliability of controls);

4. Reduction of toxicity, mobility, or volume – the anticipated performance of the remedy to permanently or significantly reduce the toxicity, mobility, and volume of contamination;
5. Short-term effectiveness – addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved;
6. Implementability – addresses the technical and administrative feasibility of a remedy from design through construction and operation (availability of services and materials, administrative feasibility, coordination with other government entities, etc.);
7. Cost – capital, annual O&M and total present worth cost estimates for the remedial alternatives and indirect costs of each alternative in comparison to other equally protected alternatives;
8. State acceptance; and
9. Community acceptance.

The first two criteria are threshold criteria that must be met by each alternative. The next five criteria are the primary balancing criteria upon which the comparison is mostly based (criterion descriptions provided above). The final two criteria are referred to as modifying criteria (based on public comment received during the Proposed Plan Public Comment Period) to evaluate state and community acceptance.

A comparative analysis for each alternative relative to the nine evaluation criteria listed above is summarized in Sections 10.1 through 10.3. For each remediation zone, a "No Action" alternative was included in the comparisons as required in the NCP but was shown to be unacceptable *(i.e.,* did not satisfy the two threshold criteria), and therefore, was not included in the comparative analysis discussion below. In addition to the discussion in the following sections, the comparative analysis of remedial alternatives for the surface and near-surface soil remediation zone, the upper vadose soil and perched groundwater remediation zone, and the lower vadose soil and Exposition groundwater remediation zone are summarized in Tables 10-1, 10-2, and 10-3, respectively.

Table 10-1. Comparative Analysis of Remedial Alternatives – Surface and Near-Surface Soil Remediation Zone

Criterion	Selected Remedy - N2 - Soil Cover/Revegetation	N3 - Excavation and Offsite Disposal
Overall Protection of Human Health and the Environment	The soil cover does not treat or destroy the COCs but acts as containment and eliminates the pathways to human exposure. Through monitoring and maintenance of the soil cover, and associated vegetative cover, environmental and ecological exposure pathways are eliminated. The soil cover allows for percolation of precipitation and irrigation water into the subsurface. Over the long term, the organic COCs (SVOCs) would slowly naturally attenuate. The metals COCs would persist. Migration of the COCs to groundwater as a result of percolation poses a minor concern since the COCs are not mobile in the environment and tend to adhere tightly to their soil matrix. The completed soil and vegetative cover is consistent with the planned future use as a	Soil excavation and offsite disposal would eliminate the pathways to human and ecological exposure, and the potential for migration of the COCs to groundwater. The contaminated soil would have to be transferred to an environmentally secure and permitted landfill for treatment and/or disposal. The removed soil would be replaced by clean backfill and vegetative cover and no additional monitoring for COCs would be required.

Table 10-1. Comparative Analysis of Remedial Alternatives – Surface and Near-Surface Soil Remediation Zone

Criterion	Selected Remedy - N2 - Soil Cover/Revegetation	N3 - Excavation and Offsite Disposal
	recreational area.	
Compliance With ARARs	The soil cover would eliminate exposure pathways, thereby complying with health based ARARs. Monitoring and maintenance of the vegetative cover would be performed to assure exposure pathways remain closed and compliance with health-based ARARs is maintained.	Soil excavation and offsite disposal would comply with ARARs by meeting contaminant limits, health based guidance, and eliminating exposure pathways. No monitoring of the backfilled area would be required since all surface and near-surface COCs would be removed. Disposal of the contaminated soil would be manifested in accordance with waste management and landfill regulations.
Long-Term Effectiveness And Permanence	Once the soil cover is in place all risks related to surface and near-surface soil would be eliminated. Requires reliance on continued maintenance of soil cover. The reliance will be reduced once vegetation is allowed to grow and sustain the soil cover. Deed restrictions or institutional controls are necessary to assure that potential future development does not disturb the integrity of the soil cover. Erosional processes associated with future planned use as a recreational area would be counteracted by regular maintenance. Ecological receptors that burrow to depths greater than one-foot in the areas of contamination could contact contaminants and would have to be controlled via the maintenance plan.	Soil excavation and offsite disposal would eliminate all risks related to surface and near-surface soil. No monitoring of the backfilled area would be required since all surface and near-surface COCs would be removed. All risk to ecological receptors would be eliminated. No deed restrictions or institutional controls required to reduce risk with respect to future soil contact. Erosional concerns would be eliminated.
Reduction of Toxicity, Mobility or Volume (TMV) through Treatment	No reduction in TMV of metals; however, they are not considered mobile in the environment, particularly after placement of a soil cover. Natural attenuation of SVOCs would take many years, eventually reducing TMV. The SVOCs are not considered very mobile, particularly after placement of a soil cover. Soil cover does not address statutory preference for remedies that employ treatment as a principal element.	Relative to the contaminated site, TMV would be reduced. Relative to the disposal site, toxicity and volume would remain the same until treated. Mobility would remain the same until treated at the offsite disposal facility. Any disposal would be performed at an environmentally secure and permitted landfill for treatment and/or disposal. Soil excavation and offsite disposal meets the statutory preference for remedies since it is directed at the contaminants posing the principal threat.
Short-term Effectiveness	Although a soil cover would not treat the COCs it would eliminate the risk of exposure; thus demonstrating good short term effectiveness. Potential short-term impacts to remedial construction workers, the community, or the environment would be from dust emissions. These impacts would be minimal since the contaminated soil would be left in place. Dust emissions would be mitigated through	Soil excavation and offsite disposal would eliminate all risk once the soil is removed from the site. Soil excavation and hauling could potentially generate significant quantities of dust that could pose short-term impacts to remedial construction workers, the community, or the environment. These impacts would be mitigated through engineering controls (dust suppression), air monitoring, and

Table 10-1. Comparative Analysis of Remedial Alternatives – Surface and Near-Surface Soil Remediation Zone

Criterion	Selected Remedy - N2 - Soil Cover/Revegetation	N3 - Excavation and Offsite Disposal
	engineering controls (dust suppression), air monitoring, and personal protective equipment.	personal protective equipment. Additional engineering controls would be required to mitigate traffic, noise, and dust from the trucks hauling soil off site.
Implementability	No technical constraints. May require regulatory waivers for leaving soil in place that exceeds PRGs and SSRGs. Action would require administration and enforcement of institutional controls to prevent future residential development. Action would require administration of long-term soil cover monitoring and maintenance program. The engineering services and materials would be readily available for constructing a soil cover.	No technical constraints. Action will require administration of an excavation and endpoint sampling plan. Action will require administrative documentation of waste profiling, classification, and disposal. The engineering services and materials would be readily available for excavation and offsite disposal.
Estimated Cost[1]		
Direct Capital Cost	$358,000	$1,310,000
Annual O&M Cost	$25,000	No O&M would be required.
O&M Present Worth	$415,000 (30 yr term at 4.25% interest)	No O&M would be required.
Total Present Worth	$773,000	$1,310,000

NOTES:

1. *Cost estimates and present worth values are rounded to three significant figures. Cost estimates are considered order-of-magnitude with an expected accuracy of plus 50 to minus 30 percent.*

10.1 Surface and Near-Surface Soil Remediation Zone

10.1.1 Overall Protection of Human Health and the Environment

All of the Surface and Near-Surface Soil Remediation Zone alternatives, except for Alternative N1 (No Action), would reduce current baseline risks and would provide some level of protection to human health and the environment.

Alternative N3 (Excavation and Offsite Disposal) would provide the highest degree of protection to human health and the environment from COCs in surface and near-surface soils because COCs would be physically removed from the site and disposed in a secure landfill with long-term maintenance. This alternative would eliminate potential pathways to human and ecological exposure at the Site and the potential for migration of COCs to groundwater through percolation.

Although Alternative N2 (Soil Cover/Revegetation) would not physically remove COCs, the 1-foot soil cover would reduce the likelihood of direct contact with these soils. Because this is the primary route of human and ecological exposure to COCs, this alternative would be protective of human health and the environment. Migration of COCs to groundwater as a result of percolation is considered a minor concern since the COCs (PAHs, metals) are characteristically non-mobile as demonstrated by the duration they have remained in place at the Site. Additionally, the percolation of water through these soils would create favorable conditions for natural bioattenuation of the organic COCs over time. Through maintenance of a vegetative cover and quarterly inspections for erosion, this alternative would prevent future direct exposure. The addition of a non-woven geotextile layer below the soil cover would enhance this option by

acting as an indicator of excessive erosion and providing an additional layer to ensure the effectiveness of the soil cover.

10.1.2 Compliance with the ARARs

The screening of the ability of alternatives to comply with ARARs included a review of ARARs and TBCs as discussed in Section 13.2.

Alternative N3 (Excavation and Offsite Disposal) would meet ARARs through physical removal of surface and near surface soils from the Site and transportation of the affected soils to a certified landfill. Alternative N2 (Soil Cover/Revegetation) would meet ARARs through the elimination of potential exposure pathways. Alternative N1 (No Action) would not meet ARARs.

10.1.3 Long-Term Effectiveness and Permanence

Alternative N3 (Excavation and Offsite Disposal) would afford the highest degree of long-term effectiveness and permanence because surface and near surface soils would be physically removed from the site. The soil would be placed in a secured and managed landfill facility with long-term controls in effect. This would effectively eliminate risks from direct contact in this remediation zone.

Alternative N2 (Soil Cover/Revegetation) is considered adequate and reliable in eliminating exposure risks and preventing migration of COCs (via erosion). This alternative would require indefinite surface inspections and implementation of corrective actions (*e.g.,* maintenance and/or repair of surfaces in order to address erosion and surface wear) to remain effective. This ROD has included the above corrective actions as an institutional control for the site in order to maintain the integrity of the soil cover.

10.1.4 Reduction of Toxicity, Mobility, and Volume (TMV) through Treatment

By physically transferring all contaminated soil offsite to a secure landfill, Alternative N3 (Excavation and Offsite Disposal) would reduce the TMV of surface and near-surface soils at the Site, but the toxicity and volume of the contaminated soils would remain until treated. Secure lined landfills with leachate collection systems, by design, reduce mobility. RCRA hazardous materials are subject to pre-placement treatment to meet land disposal restrictions, which, if required, would reduce toxicity.

Although Alternative N2 (Soil Cover/Revegetation) would not reduce the toxicity or volume of COCs within this remediation zone, this alternative would provide significant reductions in contaminant mobility at the Site. The lack of reduction in toxicity and volume would be compensated for by the elimination of potential exposure routes.

10.1.5 Short-Term Effectiveness

Alternative N2 (Soil Cover/Revegetation) is anticipated to have the greatest short-term effectiveness for quickly achieving RAOs (one to two months for construction of soil cover) with minimal impact to remedial construction workers, the community, and the environment. Potential short-term risks consist of dust emissions, which could be mitigated through engineering controls (dust suppression), air monitoring, and PPE.

Table 10-2. Comparative Analysis of Remedial Alternatives – Upper Vadose Soil and Perched Groundwater Remediation Zone

Criterion	SP2a – Selected Remedy - HVDPE/UV Ox/FTO/GAC	SP2b – HVDPE/UV Ox/GAC	SP3 – *In-Situ* Chemical Oxidation	SP4 – Enhanced *In-Situ* Bioremediation	SP5 – Monitored Natural Attenuation
Overall Protection of Human Health and the Environment	HVDPE in the upper vadose/perched groundwater zone would effectively eliminate potential exposure to contaminated soils (via inhalation, ingestion, or dermal contact to future construction workers) and contaminated groundwater (via migration of COCs in groundwater to domestic production wells) through a reduction in COCs over time. A fenced and covered treatment compound would eliminate public access to the treatment system. Extracted groundwater would require *ex-situ* treatment via UV oxidation. A properly designed UV oxidation treatment system is protective of human health and the environment for the removal of all VOC COCs. Extracted soil vapor would require *ex-situ* treatment via FTO for the first year of operation followed by GAC. FTO is the most effective thermal treatment technology available and is capable of handling the initial high mass loading expected from the HVDPE. Assumes that prior to implementing GAC, low molecular weight VOCs (vinyl chloride) and/or COCs with low adsorptive capacity (1,4-dioxane), which cannot be effectively treated by GAC, will be significantly reduced during the first year. Properly designed FTO and GAC treatment systems are protective of human health and the environment for the destruction of most organic contaminants. Treatment compound must be adequately secured, maintained, and monitored to prevent leaks and creation of exposure pathways. All treatment systems require routine monitoring and maintenance to assure effective capture of contaminants in accordance with discharge permits. All used carbon eventually needs to be disposed in landfills, or regenerated.	HVDPE in the upper vadose/ perched groundwater zone would effectively eliminate potential exposure to contaminated soils (via inhalation, ingestion, or dermal contact to future construction workers) and contaminated groundwater (via migration of COCs in groundwater to domestic production wells) through a reduction in COCs over time. A fenced and covered treatment compound would eliminate public access to the treatment system. Extracted groundwater would require *ex-situ* treatment via UV oxidation. A properly designed UV oxidation treatment system is protective of human health and the environment for the removal of all VOC COCs. Extracted soil vapor would be treated at the surface via GAC. A properly designed GAC treatment system is protective of human health and the environment for the removal of most organic contaminants from the effluent stream. Close monitoring of GAC system influent and effluent, especially with respect to low molecular weight VOCs (vinyl chloride) and/or COCs with low adsorptive capacity (1,4-dioxane) is required to ensure the system is protective of human health and the environment. Treatment compound must be adequately secured, maintained, and monitored to prevent leaks and creation of exposure pathways. Both treatment systems require routine monitoring and maintenance to assure effective capture of contaminants in accordance with discharge permits. All used carbon eventually needs to be disposed in landfills.	• The *ISCO* alternative would reduce contaminant toxicity in groundwater, reducing the potential exposure pathway of COCs in groundwater via migration to domestic production wells. • ISCO would only provide a partial treatment solution to the upper vadose zone soil and perched groundwater zone, because ISCO is not recommended for *in-situ* treatment of soil (difficulty in dispersing oxidants). As such, potential pathways for exposure via inhalation, ingestion, or dermal contact to future construction workers are not eliminated.	The EISB alternative would reduce contaminant toxicity in groundwater, reducing the potential exposure pathway of COCs in groundwater via migration to domestic production wells. EISB is not recommended for *in-situ* treatment of soil since the mechanics of substrate delivery are unproven and groundwater is required to assist with dispersion. EISB would provide only a partial treatment solution to the upper vadose zone soil and perched groundwater zone. As such, the potential pathways for exposure via inhalation, ingestion, or dermal contact to future construction workers are not eliminated.	MNA may result in reduced contamination; however, remediation of this zone through attenuation and degradation processes would be expected to take 50+ years. In conjunction with an effective source treatment alternative, MNA is protective of human health and the environment by restoring groundwater quality along plume fringes towards that of drinking water standards over time.

Table 10-2. Comparative Analysis of Remedial Alternatives – Upper Vadose Soil and Perched Groundwater Remediation Zone

Criterion	SP2a – Selected Remedy - HVDPE/UV Ox/FTO/GAC	SP2b – HVDPE/UV Ox/GAC	SP3 – *In-Situ* Chemical Oxidation	SP4 – Enhanced *In-Situ* Bioremediation	SP5 – Monitored Natural Attenuation
Compliance With ARARs	Directly addresses groundwater and soil contamination, and hence, is expected to achieve remedial objectives and would be compliant with ARARs. Monitoring of remediation area required to assure compliance with ARARs. The treatment processes would have to comply with water discharge and air emission standards. *Ex-situ* treatment of groundwater via UV Oxidation would comply with all ARARs and discharge requirements. *Ex-situ* treatment of vapor via FTO and GAC is capable of meeting all ARARs and discharge requirements. Engineering controls would be established to manage any residuals associated with the FTO and GAC treatment systems in accordance with requirements for treatment, storage, and disposal of solid wastes/used carbon. A discharge gas scrubber would most likely be required to reduce acid gas emissions from the FTO.	Directly addresses groundwater and soil contamination, and hence, is expected to achieve remedial objectives and would be generally compliant with ARARs. Monitoring of remediation area required to assure compliance with ARARs. The treatment processes would have to comply with water discharge and air emission standards. *Ex-situ* treatment of groundwater via UV Oxidation would comply with all ARARs and discharge requirements. *Ex-situ* treatment of vapor via GAC capacity would likely result in non-compliance with ARARs (i.e., discharge requirements) due to the presence of low molecular weight VOCs such as vinyl chloride or COCs with low adsorptive capacity such as 1,4 dioxane. These compounds have been detected at elevated concentrations within this zone. Consequently they must be monitored carefully; or if in high enough concentrations, a treatment alternative other than GAC should be used in order to be protective of the environment. Engineering controls would be established to meet associated requirements for treatment, storage, and disposal of used carbon.	Reduction of COCs would eliminate groundwater exposure pathways, thereby complying with groundwater ARARs. Will not achieve subsurface soil ARARs. Monitoring of remediation area required to assure compliance with chemical-based ARARs.	Degradation of chlorinated VOCs would eliminate groundwater exposure pathways, thereby complying with groundwater ARARs. Will not achieve subsurface soil ARARs. Monitoring of bioremediation area required to assure compliance with ARARs and TBCs.	MNA would not actively address upper vadose soil zone/perched groundwater zone, although natural attenuation may eventually result in general compliance with groundwater ARARs (although this could take many years). Would not address subsurface soil remedial objectives. Subsurface soil ARARs would not be met because subsurface soil contaminants would not be mitigated.

Table 10-2. Comparative Analysis of Remedial Alternatives – Upper Vadose Soil and Perched Groundwater Remediation Zone

Criterion	SP2a – Selected Remedy - HVDPE/UV Ox/FTO/GAC	SP2b – HVDPE/UV Ox/GAC	SP3 – *In-Situ* Chemical Oxidation	SP4 – Enhanced *In-Situ* Bioremediation	SP5 – Monitored Natural Attenuation
Long-Term Effectiveness And Permanence	Long-term effectiveness (for meeting RAOs) would be achieved because HVDPE proactively removes and treats COCs. Removal of contaminants within the perched groundwater zone and upper vadose zone from the Site would be permanent. HVDPE process consists of generally conventional and well- proven technologies and is expected to be highly reliable when adequately operated and maintained. UV oxidation is a well proven and effective method of treatment over time when adequately operated and maintained. The effectiveness of UV oxidation is dependent on the aqueous stream being able to transmit UV light; i.e., low turbidity and metal ions <10 mg/L. Pretreatment of the influent (via GAC) can minimize cleaning and maintenance of the UV reactor and ensure an effective method of treatment over time. FTO is a highly effective treatment process for the destruction of all VOCs. Contaminants are permanently destroyed onsite through FTO. Carbon adsorption is a well-proven and effective method of treatment over time when adequately operated and maintained; however, permanent destruction of the COCs would take place at an offsite approved facility. Assumes that prior to implementing GAC, low molecular weight VOCs (vinyl chloride) and/or COCs with low adsorptive capacity (1,4-dioxane), which cannot be effectively treated by GAC, will be significantly reduced during the first year. Routine monitoring of the treatment process would be performed to assure effectiveness over time.	Long-term effectiveness (for meeting RAOs) would be achieved because HVDPE proactively removes and treats COCs. Removal of contaminants within the perched groundwater zone and upper vadose zone from the Site would be permanent. HVDPE process consists of generally conventional and well- proven technologies and is expected to be highly reliable when adequately operated and maintained. UV oxidation is a well proven and effective method of treatment over time when adequately operated and maintained. The effectiveness of UV oxidation is dependent on the aqueous stream being able to transmit UV light; i.e., low turbidity and metal ions <10 mg/L. Pretreatment of the influent (via GAC) can minimize cleaning and maintenance of the UV reactor and ensure an effective method of treatment over time. Carbon adsorption is a well proven and effective method of treatment over time when adequately operated and maintained. COCs are adsorbed by the carbon; however, permanent destruction of the COCs would take place at an offsite approved facility. Carbon adsorption is not as effective on low molecular weight VOCs such as vinyl chloride or COCs with low adsorptive capacity such as 1,4 dioxane. Routine monitoring of the treatment process would be performed to assure effectiveness over time.	*ISCO* would permanently remove COCs and expedite natural attenuation of remaining site contaminants. Monitoring of the remediation area required to assure long-term effectiveness over time. Long-term effectiveness dependent on success of each injection event (3 injection events proposed with a 1 month period between events). Pilot test recommended to confirm site characteristics. Chemical oxidation is a well-developed, increasingly used process that has proven effective for the destruction of many of the VOCs present in the perched groundwater.	EISB would expedite natural attenuation of chlorinated VOCs. Not effective for treating compounds (e.g., benzene, toluene) that biodegrade under aerobic conditions; would have to address these compounds aerobically before or after reductive dechlorination. Monitoring of the remediation area required to assure effectiveness over time. Design is for one-time application of HRC®; the need for reapplication will depend on actual site-specific biodegradation performance. Pilot test recommended to confirm site characteristics.	Effectiveness of natural attenuation in restoring subsurface soil and groundwater quality to RAOs in a reasonable timeframe without a pro-active technology is not likely. Long-term effectiveness and permanence of other alternatives, however, may be documented by MNA.

Table 10-2. Comparative Analysis of Remedial Alternatives – Upper Vadose Soil and Perched Groundwater Remediation Zone

Criterion	SP2a – Selected Remedy - HVDPE/UV Ox/FTO/GAC	SP2b – HVDPE/UV Ox/GAC	SP3 – *In-Situ* Chemical Oxidation	SP4 – Enhanced *In-Situ* Bioremediation	SP5 – Monitored Natural Attenuation
Reduction of Toxicity, Mobility or Volume (TMV) through Treatment	HVDPE allows for good control over contaminant mobility and a reduction in contaminant volume for both soil and groundwater. UV oxidation required during treatment process, because it is effective in treatment of 1,4-dioxane. Estimated volume of soil exceeding ARARs is approximately 80,000 to 95,000 cubic yards; estimated volume of groundwater exceeding ARARs is approximately 1.4 million gallons. Extracted water and vapor would require treatment via *ex-situ* treatment alternatives UV Ox, FTO, and GAC. UV oxidation is a very effective treatment method for reducing the TMV of almost all organic contaminants. All COCs would be completely destroyed onsite with no residual wastes to manage. FTO locally destroys contaminants resulting in a permanent reduction in TMV of COCs. The generation of acid gasses in the effluent stream of the FTO can be controlled through the operation of a scrubber. The mobility and volume of COCs are greatly reduced as they become adsorbed to the GAC. Toxicity is not reduced onsite but is typically performed at the disposal facility via thermal oxidation. Carbon that has exceeded its useful lifespan would be transported for offsite regeneration or landfilling. Some degradation products, such as vinyl chloride and smaller molecules (e.g., 1,4 dioxane) are not adsorbed well. Consequently they must be monitored carefully to be sure the TMV of these contaminants are being addressed.	HVDPE allows for good control over contaminant mobility and a reduction in contaminant volume for both soil and groundwater. UV oxidation required during treatment process, because it is effective in treatment of 1,4-dioxane. Estimated volume of soil exceeding ARARs is approximately 80,000 to 95,000 cubic yards; estimated volume of groundwater exceeding ARARs is approximately 1.4 million gallons. Extracted water and vapor would require treatment via *ex-situ* treatment alternatives UV Ox and GAC. UV oxidation is a very effective treatment method for reducing the TMV of almost all organic contaminants. All COCs would be completely destroyed onsite with no residual wastes to manage. The mobility and volume of COCs are greatly reduced as they become adsorbed to the GAC. Toxicity is not reduced onsite but is typically performed at the disposal facility via thermal oxidation. Carbon that has exceeded its useful lifespan would be transported for offsite regeneration or landfilling. Some degradation products, such as vinyl chloride and smaller molecules (e.g., 1,4 dioxane) are not adsorbed well. Consequently they must be monitored carefully to be sure the TMV of these contaminants are being addressed.	Fenton's reagent (most aggressive oxidant available) is expected to reduce toxicity of contaminants in groundwater. The mobility and volume of contamination will also be reduced by this alternative. The TMV of upper vadose zone soils would not be reduced by *ISCO* because there is no conventional method available to adequately distribute the oxidation reagent though the soil. Estimated treatment area is 168,000 square ft; approximate thickness would include entire perched groundwater zone (2 to 3 ft). Because of physical limitations of delivery of electron donors in the heterogeneous subsurface, there will likely be areas of contamination that remain.	HRC® has proven to reduce toxicity of chlorinated VOCs into harmless compounds over time. The mobility and volume of chlorinated VOCs will also be reduced by this alternative. Not effective for treating compounds (e.g., benzene, toluene) that biodegrade under aerobic conditions; would have to address these compounds aerobically before or after reductive dechlorination. The TMV of upper vadose zone soils would not be reduced by *in-situ* bioremediation. Estimated treatment area is 168,000 square ft; approximate thickness would include perched groundwater zone (2 to 3 ft). Because of physical limitations of delivery of substrates in the heterogeneous subsurface, there will likely be areas of contamination that remain. Incomplete dechlorination may result in proliferation of daughter products (e.g., vinyl chloride, DCE).	MNA is a not an *active* treatment alternative and is therefore not considered effective in reduction of TMV. MNA may result in reduced TMV in both media of this remediation zone through attenuation and degradation processes, but not within a reasonable timeframe. Purge water from semiannual monitoring events would be produced that would require treatment prior to disposal. Estimated volume of soil exceeding TBCs is approximately 80,000 to 95,000 cubic yards; estimated volume of groundwater exceeding ARARs is approximately 1.4 million gallons.

Table 10-2. Comparative Analysis of Remedial Alternatives – Upper Vadose Soil and Perched Groundwater Remediation Zone

Criterion	SP2a – Selected Remedy - HVDPE/UV Ox/FTO/GAC	SP2b – HVDPE/UV Ox/GAC	SP3 – *In-Situ* Chemical Oxidation	SP4 – Enhanced *In-Situ* Bioremediation	SP5 – Monitored Natural Attenuation
Short-term Effectiveness	Air emissions from vapor treatment would comply with air emission standards. Risks to workers performing remedial and monitoring activities can be controlled and mitigated with proper health and safety measures (e.g. air monitoring, personal protective equipment). Estimated project duration is 5 years + 5 additional years of monitoring; RAOs will likely be met. The UV oxidation requires that caustic oxidants be stored at the treatment facility. Risks to workers from oxidant storage and handling and from monitoring activities can be controlled and mitigated with proper health and safety measures; e.g., air monitoring and personal protective equipment. Due to the high effectives of FTO, the production of combustion by-products (e.g. dioxin) above background concentrations is unlikely. Evaluation of the air emissions may be required to demonstrate no significant impact to the community from combustion by-products. Transportation of used carbon to an offsite facility for regeneration or disposal would require hazardous waste manifesting and increase local traffic. Risks to workers performing monitoring activities of both treatment systems can be controlled and mitigated with proper health and safety measures; e.g., air monitoring and personal protective equipment.	Air emissions from vapor treatment would comply with air emission standards. Risks to workers performing remedial and monitoring activities can be controlled and mitigated with proper health and safety measures (e.g. air monitoring, personal protective equipment). Estimated project duration is 5 years + 5 additional years of monitoring; RAOs will likely be met. The UV oxidation requires that caustic oxidants be stored at the treatment facility. Risks to workers from oxidant storage and handling and from monitoring activities can be controlled and mitigated with proper health and safety measures; e.g., air monitoring and personal protective equipment. Transportation of used carbon to an offsite facility for regeneration or disposal would require hazardous waste manifesting and increase local traffic. Risks to workers performing monitoring activities of both treatment systems can be controlled and mitigated with proper health and safety measures; e.g., air monitoring and personal protective equipment.	Nature of alternative does not require *ex-situ* engineering controls or treatment options. Risks to workers performing remedial and monitoring activities can be controlled and mitigated with proper health and safety measures (e.g. air monitoring, PPE). Estimated project duration is 1 year plus a minimum of 5 years of monitoring; RAOs may not be met in all subsurface areas (delivery of electron donors).	Nature of alternative does not require *ex-situ* engineering controls or treatment options. Risks to workers performing remedial and monitoring activities can be controlled and mitigated with proper health and safety measures (e.g. air monitoring, PPE). Estimated project duration is 1 year plus a minimum of 5 years of monitoring; RAOs may not be met (delivery of oxidants).	No additional risks beyond those posed by current conditions. Risks to workers performing monitoring activities are relatively minimal and can be controlled and mitigated with proper health and safety measures (e.g. PPE). Estimated project duration is 50+ years, RAOs will likely not be met.

Table 10-2. Comparative Analysis of Remedial Alternatives – Upper Vadose Soil and Perched Groundwater Remediation Zone

Criterion	SP2a – Selected Remedy - HVDPE/UV Ox/FTO/GAC	SP2b – HVDPE/UV Ox/GAC	SP3 – *In-Situ* Chemical Oxidation	SP4 – Enhanced *In-Situ* Bioremediation	SP5 – Monitored Natural Attenuation
Implementability	HVDPE process consists of generally conventional, well proven, and implementable technologies and is expected to be highly reliable when adequately operated and maintained. Personnel, equipment, and materials generally available for implementation/operation of HVDPE. Groundwater monitoring would indicate effectiveness of HVDPE as well as the status of the contaminant plume. System modifications may be added if warranted based on performance/monitoring data. Administrative requirements, such as discharge permits for treated vapor and groundwater are all feasible. Disruption of portion of Maywood Riverfront Park (MRP) for approximate 2-month period during implementation. UV oxidation is an established technology with sufficient vendors and no unusual technical problems anticipated. Consideration should be given to the turbidity and hardness of the aqueous stream, which can interfere with the oxidation process. This alternative is administratively feasible since state and local agency permits are routinely issued. The system can be modified or improved based on treatment results; e.g., prefiltration to combat fouling of the quartz sleeves, which transmit UV light FTO is a relatively new technology with few vendors; however, use of the technology is well documented and no unusual technical problems would be expected. The technology is anticipated to be administratively feasible since similar systems have been operating in the area since 1998 and the system does not have measurable emissions of dioxin – a by-product of combustion. No modifications are anticipated. Carbon treatment is a mature and very reliable technology with many vendors. No unusual technical problems are anticipated. The UV, FTO, and GAC systems require occupation of a small area of the MRP until the cleanup objectives are reached. Operation and maintenance personnel, materials, and utilities are readily available or in place for ex situ treatment systems since they have been previously operated at the site.	HVDPE process consists of generally conventional, well proven, and implementable technologies and is expected to be highly reliable when adequately operated and maintained. Personnel, equipment, and materials generally available for implementation/operation of HVDPE. Groundwater monitoring would indicate effectiveness of extraction and treatment as well as the status of the contaminant plume. System modifications may be added if warranted based on performance/monitoring data. Administrative requirements, such as discharge permits for treated vapor and groundwater are all feasible. Disruption of portion of MRP for approximate 2-month period during implementation. UV oxidation is an established technology with sufficient vendors and no unusual technical problems anticipated. Consideration should be given to the turbidity and hardness of the aqueous stream, which can interfere with the oxidation process. This alternative is administratively feasible since state and local agency permits are routinely issued. The system can be modified or improved based on treatment results; e.g., prefiltration to combat fouling of the quartz sleeves, which transmit UV light. Carbon treatment is a mature and very reliable technology with many vendors. No unusual technical problems are anticipated. Operation and maintenance personnel, materials, and utilities are readily available. This alternative is administratively feasible since state and local agency permits are routinely issued. The system can be modified or improved based on treatment results. The UV and GAC systems require occupation of a small area of the MRP until the cleanup objectives are reached. Operation and maintenance personnel, materials, and utilities are readily available or in place for ex situ treatment systems since they have been previously operated at the site.	Modifications to the system may be warranted based on system performance/monitoring data (e.g., additional injection events). Groundwater monitoring would provide indication of effectiveness of groundwater treatment and status of contaminant plume. Personnel, equipment, and materials generally available for implementation/operation of *ISCO*. Pilot test needed to establish suitability of method and to obtain additional design information. Administratively feasible; injection permits required from appropriate state and local agencies. Disruption of portion of MRP for approximate 2-month period.	Modifications to the system may be warranted based on system performance/monitoring data (e.g., additional injection events). Groundwater monitoring would provide indication of effectiveness of groundwater treatment and status of contaminant plume. Personnel, equipment, and materials generally available for implementation/operation of *in-situ* bioremediation. Pilot test needed to establish suitability of method and to obtain additional design information. Administratively feasible; injection permits required from appropriate state and local agencies. Disruption of portion of MRP for approximate 2-month period.	Technically feasible. Modifications, such as additional monitoring wells, can be easily implemented with a minimal amount of disturbance to the MRP. Groundwater monitoring would provide indication of status of contaminant plume. Personnel, equipment, and materials generally available for implementation/operation of MNA. Administratively feasible.

Table 10-2. Comparative Analysis of Remedial Alternatives – Upper Vadose Soil and Perched Groundwater Remediation Zone

Criterion	SP2a – Selected Remedy - HVDPE/UV Ox/FTO/GAC	SP2b – HVDPE/UV Ox/GAC	SP3 – *In-Situ* Chemical Oxidation	SP4 – Enhanced *In-Situ* Bioremediation	SP5 – Monitored Natural Attenuation
Estimated Cost[1]					
Direct Capital Cost	$1,410,000	$906,000	$1,850,000	$1,010,000	$131,000
Annual O&M Cost	$1,100,000	$595,000	$133,000	$140,000	$112,000
O&M Present Worth	$3,430,000 (5 yr term at 4.25% interest for O&M; 5 yr. term at 5.0% for additional monitoring)	$2,700,000 (5 yr term at 4.25% interest for O&M; 5 yr. term at 5.0% for additional monitoring)	$691,000 (6 yr term at 4.25% interest)	$726,000 (6 yr term at 4.25% interest)	$2,300,000 (50 yr term at 4.25% interest)
Total Present Worth	$4,840,000	$3,610,000	$2,540,000	$1,740,000	$2,430,000

Table 10-3. Comparative Analysis of Remedial Alternatives – Lower Vadose Soil and Exposition Groundwater Remediation Zone

Criterion	SG2 – ISCO/ISCR/P&T/MNA/UV Oxidation	SG3 – EISB/P&T/MNA/UV Oxidation	SG4a – Vacuum-Enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/FTO/GAC	SG4b – Vacuum-Enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/GAC	Selected Remedy - SG5a – ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/UV Oxidation/FTO/GAC	SG5b – ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/UV Oxidation/ GAC
Overall Protection of Human Health and the Environment	This alternative would reduce contaminant concentrations within the source area (>1,000 ppb composite TCE groundwater plume) through ISCO or ISCR. Selection of ISCO or ISCR would depend on bench and pilot study results. P&T between the 10 and 1,000 ppb composite TCE groundwater plume would reduce contaminant volume and limit migration of contaminants to viable aquifers - the primary route for exposure. MNA would be used outside the 10 ppb composite TCE groundwater plume to demonstrate plume reduction and/or point of compliance. Extracted groundwater would require *ex-situ* treatment via UV oxidation. A properly designed UV oxidation treatment system is protective of human health and the environment for the removal of all VOC COCs. The treatment compound must be adequately secured, maintained, and monitored to prevent leaks and creation of exposure pathways. The treatment system would require routine monitoring and maintenance to assure effective capture of contaminants in accordance with discharge permits. COCs are effectively destroyed onsite.	This alternative would reduce contaminant concentrations within the source area (>1,000 ppb composite TCE groundwater plume) through EISB. Selection of an appropriate electron donor substrate would depend on bench and pilot study results. P&T between the 10 and 1,000 ppb composite TCE groundwater plume would reduce contaminant volume and limit migration of contaminants to viable aquifers - the primary route for exposure. MNA would be used outside the 10 ppb composite TCE groundwater plume to demonstrate plume reduction and/or point of compliance. Extracted groundwater would require *ex-situ* treatment via UV oxidation. A properly designed UV oxidation treatment system is protective of human health and the environment for the removal of all VOC COCs. The treatment compound must be adequately secured, maintained, and monitored to prevent leaks and creation of exposure pathways. The treatment system would require routine monitoring and maintenance to assure effective capture of contaminants in accordance with discharge permits. COCs are effectively destroyed onsite.	This alternative would reduce contaminant concentrations within the source area (>1,000 ppb composite TCE groundwater plume) through vacuum enhanced groundwater extraction – an effective and well-proven technology for physically removing contamination. P&T between the 10 and 1,000 ppb composite TCE groundwater plume would reduce contaminant volume and limit migration of contaminants to viable aquifers - the primary route for exposure. MNA would be used outside the 10 ppb composite TCE groundwater plume to demonstrate plume reduction and/or point of compliance. Extracted groundwater would be treated via UV oxidation. A properly designed UV oxidation treatment system is protective of human health and the environment for the removal of all VOC COCs. Extracted soil vapor would be treated via FTO for the first year followed by GAC for the remaining 14 years. A properly designed FTO treatment system is protective of human health and the environment through COC destruction. FTO is 99.9% effective (i.e., no products of incomplete combustion). Evaluation of the vapor stream after one year will indicate whether the contaminant mass loading has been reduced to the extent that GAC is protective of human health and the environment. A properly designed GAC treatment system is protective of human health and the environment for the removal of *most* organic contaminants from the effluent stream (i.e., low molecular weight VOCs such as vinyl chloride and COCs with low adsorptive capacity such as 1,4-dioxane would not be absorbed by the GAC). Treatment compounds and systems must be adequately secured, maintained, and monitored to assure effective capture of contaminants and the elimination of potential additional exposure pathways.	This alternative would reduce contaminant concentrations within the source area (>1,000 ppb composite TCE groundwater plume) through vacuum enhanced groundwater extraction – an effective and well-proven technology for physically removing contamination. P&T between the 10 and 1,000 ppb composite TCE groundwater plume would reduce contaminant volume and limit migration of contaminants to viable aquifers - the primary route for exposure. MNA would be used outside the 10 ppb composite TCE groundwater plume to demonstrate plume reduction and/or point of compliance. Extracted groundwater would be treated via UV oxidation. A properly designed UV oxidation treatment system is protective of human health and the environment for the removal of all VOC COCs. Extracted soil vapor would be treated via GAC. A properly designed GAC treatment system is protective of human health and the environment for the removal of *most* organic contaminants from the effluent stream (i.e., low molecular weight VOCs such as vinyl chloride and COCs with low adsorptive capacity such as 1,4-dioxane would not be absorbed by the GAC).) Evaluation of the vapor stream will indicate whether GAC will provide adequate protection of human health and the environment. Treatment compounds and systems must be adequately secured, maintained, and monitored to assure effective capture of contaminants and the elimination of potential additional exposure pathways. COCs are effectively destroyed onsite using UV oxidation. All used carbon eventually needs to be disposed in a landfill or regenerated.	This alternative would destroy contaminants within 10,000 ppb TCE composite groundwater plume using ERH with VE. Vacuum enhanced groundwater extraction between the 1,000 and 10,000 ppb composite TCE groundwater plume would reduce contaminant volume and limit migration of contaminants. P&T between the 10 and 1,000 ppb composite TCE groundwater plume would reduce contaminant volume and limit migration of contaminants to viable aquifers - the primary route for exposure. MNA would be used outside the 10 ppb composite TCE groundwater plume to demonstrate plume reduction and/or point of compliance. Extracted groundwater would be treated via UV oxidation. A properly designed UV oxidation treatment system is protective of human health and the environment for the removal of all VOC COCs. Extracted soil vapor would be treated via FTO for the first year followed by GAC for the remaining 14 years. A properly designed FTO treatment system is protective of human health and the environment through COC destruction. FTO is 99.9% effective (i.e., no products of incomplete combustion). Evaluation of the vapor stream after one year will indicate whether the contaminant mass loading has been reduced to the extent that GAC is protective of human health and the environment. A properly designed GAC treatment system is protective of human health and the environment for the removal of *most* organic contaminants from the effluent stream (i.e., low molecular weight VOCs such as vinyl chloride and COCs with low adsorptive capacity such as 1,4-dioxane would not be absorbed by the GAC). Treatment compounds and systems must be adequately secured, maintained, and monitored to assure effective capture of	This alternative would destroy contaminants within 10,000 ppb TCE composite groundwater plume using ERH with VE. Vacuum enhanced groundwater extraction between the 1,000 and 10,000 ppb composite TCE groundwater plume would reduce contaminant volume and limit migration of contaminants. P&T between the 10 and 1,000 ppb composite TCE groundwater plume would reduce contaminant volume and limit migration of contaminants to viable aquifers - the primary route for exposure. MNA would be used outside the 10 ppb composite TCE groundwater plume to demonstrate plume reduction and/or point of compliance Extracted groundwater would require *ex-situ* treatment via UV oxidation. A properly designed UV oxidation treatment system is protective of human health and the environment for the removal of all VOC COCs. Extracted soil vapor would be treated via GAC. A properly designed GAC treatment system is protective of human health and the environment for the removal of *most* organic contaminants from the effluent stream (i.e., low molecular weight VOCs such as vinyl chloride and COCs with low adsorptive capacity such as 1,4-dioxane would not be absorbed by the GAC). Evaluation of the vapor stream will indicate whether GAC will provide adequate protection of human health and the environment. Treatment compounds and systems must be adequately secured, maintained, and monitored to assure effective capture of contaminants and the elimination of potential additional exposure pathways. COCs are effectively destroyed onsite using UV oxidation. All used carbon eventually needs to be disposed in a landfill or regenerated.

Table 10-3. Comparative Analysis of Remedial Alternatives – Lower Vadose Soil and Exposition Groundwater Remediation Zone

Criterion	SG2 – ISCO/ISCR/P&T/MNA/UV Oxidation	SG3 – EISB/P&T/MNA/UV Oxidation	SG4a – Vacuum-Enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/FTO/GAC	SG4b – Vacuum-Enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/GAC	Selected Remedy - SG5a – ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/UV Oxidation/FTO/GAC	SG5b – ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/UV Oxidation/ GAC
			COCs in are effectively destroyed onsite using UV oxidation and FTO. All used carbon eventually needs to be disposed in a landfill or regenerated.		contaminants and the elimination of potential additional exposure pathways. COCs in are effectively destroyed onsite using UV oxidation and FTO. All used carbon eventually needs to be disposed in a landfill or regenerated.	
Compliance With ARARs	Since ISCO/ISCR depends on saturated conditions for dispersion, reduction of COCs in unsaturated soil may be insufficient to comply with ARARs. Reduction of COCs in groundwater would eliminate exposure pathways, thereby complying with ARARs. Monitoring will be used to document compliance with chemical-based ARARs. Effluent groundwater would meet discharge criteria. UV oxidation effectively treats all COCs including 1,4-dioxane.	Since EISB depends on saturated conditions for dispersion, reduction of COCs in unsaturated soil may be insufficient to comply with ARARs. Reduction of COCs in groundwater would eliminate exposure pathways, thereby complying with ARARs. Monitoring will be used to document compliance with chemical-based ARARs. Effluent groundwater would meet discharge criteria. UV oxidation effectively treats all COCs including 1,4-dioxane.	Physically treats soil and groundwater contamination to eliminate exposure pathways, thereby complying with ARARs. Monitoring will be used to document compliance with chemical-based ARARs. Effluent groundwater would meet discharge criteria. UV oxidation effectively treats all COCs including 1,4-dioxane. Vapor discharge from FTO treatment is expected to exceed air emission standards. (After 1 year of FTO) Vapor discharge from GAC treatment is expected to meet air emission standards.	Physically treats soil and groundwater contamination to eliminate exposure pathways, thereby complying with ARARs. Monitoring will be used to document compliance with chemical-based ARARs. Effluent groundwater would meet discharge criteria. UV oxidation effectively treats all COCs including 1,4-dioxane. Vapor discharge from GAC treatment may not meet air emission standards for vinyl chloride and/or 1,4-dioxane. Careful monitoring will be required to assure compliance with ARARs.	Physically treats soil and groundwater contamination to eliminate exposure pathways, thereby complying with ARARs. Monitoring will be used to document compliance with chemical-based ARARs. Effluent groundwater would meet discharge criteria. UV oxidation effectively treats all COCs including 1,4-dioxane. Vapor discharge from FTO treatment is expected to exceed air emission standards. (After 1 year of FTO) Vapor discharge from GAC treatment is expected to meet air emission standards.	Physically treats soil and groundwater contamination to eliminate exposure pathways, thereby complying with ARARs. Monitoring will be used to document compliance with chemical-based ARARs. Effluent groundwater would meet discharge criteria. UV oxidation effectively treats all COCs including 1,4-dioxane. Vapor discharge from GAC treatment may not meet air emission standards for vinyl chloride and/or 1,4-dioxane. Careful monitoring will be required to assure compliance with ARARs.
Long-Term Effectiveness And Permanence	ISCO and ISCR are well developed, increasingly used processes which have proven effective for the destruction of many of the VOCs present in Site groundwater. A pilot test would better demonstrate the effectiveness of ISCO and/or ISCR to destroy COCs. Long-term effectiveness within the source area (>1,000 ppb composite TCE groundwater plume) is dependent on dispersion of oxidants and/or reductants. Effective dispersion cannot occur in unsaturated soil and can be difficult in low-permeability lithosomes. P&T between the 10 and 1,000 ppb-contours would provide hydraulic control and facilitate dispersion of oxidizing/reducing agents. MNA would be used to document effectiveness over time.	EISB is a well-developed increasingly used process, which has proven effective for the destruction of many of the VOCs present in the groundwater. The effectiveness of this alternative would be established by first performing a pilot test; however, EISB is expected to expedite destruction of the COCs. EISB is not effective for treating compounds that biodegrade aerobically; e.g., benzene. Long-term effectiveness within the source area (>1,000 ppb composite TCE groundwater plume) is dependent on dispersion of oxidants and/or reductants. Effective dispersion cannot occur in unsaturated soil and can be difficult in low-permeability lithosomes. P&T between the 10 and 1,000 ppb-contours would provide hydraulic control and facilitate dispersion of substrates. MNA would be used to document effectiveness over time.	Long-term effectiveness (for meeting RAOs) would be achieved through active groundwater and vapor extraction and treatment. Enhanced P&T (with vacuum extraction) consists of generally conventional and well- proven technologies and is expected to be highly reliable when adequately operated and maintained. Long term monitoring of the treatment zone would be required to assure effectiveness over time. Recovery of contaminants from the low-permeability lithosomes is a very slow process that may extend the period of monitoring or treatment. UV Oxidation (for groundwater) and FTO (for vapor) are proven technologies for permanently destroying all Site COCs without additional disposal requirements. GAC adsorbs contaminants and eventually requires disposal or regeneration.	Long-term effectiveness (for meeting RAOs) would be achieved through active groundwater and vapor extraction and treatment. Enhanced P&T (with vacuum extraction) consists of generally conventional and well- proven technologies and is expected to be highly reliable when adequately operated and maintained. Long term monitoring of the treatment zone would be required to assure effectiveness over time. Recovery of contaminants from the low-permeability lithosomes is a very slow process that may extend the period of monitoring or treatment. GAC may not effectively remove some COCs and eventually requires disposal or regeneration.	Although this process is not in widespread use, it has proven to be very effective in several full-scale demonstration projects. Long-term effectiveness would be achieved through active groundwater and vapor extraction and treatment. Monitoring of the remediation area is required to assure effectiveness over time. Removal of contaminants within the groundwater zone and upper vadose zone from the Site would be permanent. ERH technology has proven effective in removing contaminants from low-permeability lithosomes. UV Oxidation (for groundwater) and FTO (for vapor) are proven technologies for permanently destroying all Site COCs without additional disposal requirements. GAC adsorbs contaminants and eventually requires disposal or regeneration.	Although this process is not in widespread use, it has proven to be very effective in several full-scale demonstration projects. Long-term effectiveness would be achieved through active groundwater and vapor extraction and treatment. Monitoring of the remediation area is required to assure effectiveness over time. Removal of contaminants within the groundwater zone and upper vadose zone from the Site would be permanent. ERH technology has proven effective in removing contaminants from low-permeability lithosomes. GAC may not effectively remove some COCs and eventually requires disposal or regeneration.

Table 10-3. Comparative Analysis of Remedial Alternatives – Lower Vadose Soil and Exposition Groundwater Remediation Zone

Criterion	SG2 – ISCO/ISCR/P&T/MNA/UV Oxidation	SG3 – EISB/P&T/MNA/UV Oxidation	SG4a – Vacuum-Enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/FTO/GAC	SG4b – Vacuum-Enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/GAC	Selected Remedy - SG5a – ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/UV Oxidation/FTO/GAC	SG5b – ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/UV Oxidation/ GAC
Reduction of Toxicity,Mobility or Volume (TMV) through Treatment	Oxidation/reduction reactions would reduce the toxicity and volume of COCs in groundwater. ISCO/ISCR would not affect the mobility of the COCs. Due to the physical limitations of delivering the reagents into low-permeability lithosomes, there will likely be areas of contamination that remain.	HRC® (an organic substrate) has been demonstrated to reduce toxicity and volume of chlorinated VOCs into harmless compounds. EISB would not affect the mobility of the COCs. Not effective for treating compounds (e.g., benzene, toluene) that biodegrade under aerobic conditions; would have to address these compounds aerobically before or after reductive dechlorination. For TCE, intermediate/daughter products of reductive dechlorination may be more mobile and/or toxic (e.g. vinyl chloride). Due to the physical limitations of delivering the organic substrates into low-permeability lithosomes, there will likely be areas of contamination that remain.	Vacuum enhanced groundwater extraction allows for good control over contaminant mobility and a reduction in contaminant volume in groundwater. Toxicity would be completely reduced via the UV Oxidation and FTO *ex situ* treatment systems. After one year of operation, when the estimated lower contaminant loading would be more efficiently treated using GAC, GAC would replace the FTO and there would be slightly less reduction in toxicity, since GAC does not destroy the contaminants but adsorbs them for offsite disposal. Toxicity reduction of the extracted water and air would be in accordance with the discharge permits.	Vacuum enhanced groundwater extraction allows for good control over contaminant mobility and a reduction in contaminant volume in groundwater Toxicity of extracted groundwater would be completely reduced via UV oxidation. Toxicity reduction of extracted vapor would be less since GAC does not destroy the contaminants but adsorbs them for offsite disposal Toxicity reduction of the extracted water and air would be in accordance with the discharge permits.	ERH allows for control over contaminant mobility since contaminants are collected by the VE system. ERH demonstration projects show that it is very effective in reducing contaminant volume. Toxicity would be completely reduced via the UV Oxidation and FTO *ex situ* treatment systems. After one year of operation, when the estimated lower contaminant loading would be more efficiently treated using GAC, GAC would replace the FTO and there would be slightly less reduction in toxicity, since GAC does not destroy the contaminants but adsorbs them for offsite disposal. Toxicity reduction of the extracted water and air would be in accordance with the discharge permits.	ERH allows for control over contaminant mobility since contaminants are collected by the VE system. ERH demonstration projects show that it is very effective in reducing contaminant volume. Toxicity of extracted groundwater would be completely reduced via UV oxidation. Toxicity reduction of extracted vapor would be less since GAC does not destroy the contaminants but adsorbs them for offsite disposal Toxicity reduction of the extracted water and air would be in accordance with the discharge permits.
Short-term Effectiveness	Nature of alternative does not require *ex-situ* engineering controls or treatment options. Risks to workers performing remedial and monitoring activities can be controlled and mitigated with proper health and safety measures (e.g. air monitoring, personal protective equipment). Estimated project duration is 1 year plus a minimum of 5 years of monitoring. RAOs may not be met in all subsurface areas due to difficulty associated with delivery of reagents in low-permeability lithosomes.	Nature of alternative does not require *ex-situ* engineering controls or treatment options. Risks to workers performing remedial and monitoring activities can be controlled and mitigated with proper health and safety measures (e.g. air monitoring, personal protective equipment). Estimated project duration is 1 year plus a minimum of 5 years of monitoring. RAOs may not be met in all subsurface areas due to difficulty associated with delivery of reducing agents in low-permeability lithosomes.	Air emissions and water discharges from treatment processes would be designed to comply with emission/discharge standards. Risks to workers performing remedial and monitoring activities can be controlled and mitigated with proper health and safety measures (e.g. air monitoring, personal protective equipment). 15 years + a minimum of 5 years of groundwater monitoring RAOs will likely be met.	Air emissions and water discharges from treatment processes would be designed to comply with emission/discharge standards. Evaluation of initial mass loading would be performed to assure a GAC system would not be overloaded. Risks to workers performing remedial and monitoring activities can be controlled and mitigated with proper health and safety measures (e.g. air monitoring, PPE). 15 years + a minimum of 5 years of groundwater monitoring RAOs will likely be met.	Air emissions and water discharges from treatment processes would be designed to comply with emission/discharge standards. Risks to workers performing remedial and monitoring activities can be controlled and mitigated with proper health and safety measures (e.g. air monitoring, personal protective equipment). ERH will require approximately 1 year for treatment of the >10,000 ppb plume contour source area. Vacuum-enhanced groundwater extraction and P&T is expected to continue for approximately 4 additional years. Groundwater monitoring is required for an additional 5 years for a total of 10 years. RAOs will likely be met.	Air emissions and water discharges from treatment processes would be designed to comply with emission/discharge standards. Evaluation of initial mass loading would be performed to assure a GAC system would not be overloaded. Risks to workers performing remedial and monitoring activities can be controlled and mitigated with proper health and safety measures (e.g. air monitoring, personal protective equipment). ERH will require approximately 1 year for treatment of the >10,000 ppb plume contour source area. Vacuum-enhanced groundwater extraction and P&T is expected to continue for approximately 4 additional years. Groundwater monitoring is required for an additional 5 years for a total of 10 years. RAOs will likely be met.

Table 10-3. Comparative Analysis of Remedial Alternatives – Lower Vadose Soil and Exposition Groundwater Remediation Zone

Criterion	SG2 – ISCO/ISCR/P&T/MNA/UV Oxidation	SG3 – EISB/P&T/MNA/UV Oxidation	SG4a – Vacuum-Enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/FTO/GAC	SG4b – Vacuum-Enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/GAC	Selected Remedy - SG5a – ERH with VE/vacuum-Enhanced Groundwater Extraction/P&T/UV Oxidation/FTO/GAC	SG5b – ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/UV Oxidation/ GAC
Implementability	Pilot test needed to establish suitability of reagents and to obtain additional design information. Modifications (e.g., additional injection events and locations) to the system may be adopted following pilot study results and/or performance/monitoring data. Groundwater monitoring would provide indication of effectiveness of groundwater treatment and status of contaminant plume. Personnel, equipment, and materials generally available for implementation/operation of *ISCO*. Administratively feasible; injection permits required from appropriate state and local agencies. Disruption of portion of MRP for approximate 2-month period.	Pilot test needed to establish suitability of substrate and to obtain additional design information. Modifications (e.g., additional injection events and locations) to the system may be adopted following pilot study results and/or performance/monitoring data. Groundwater monitoring would provide indication of effectiveness of groundwater treatment and status of contaminant plume. Personnel, equipment, and materials generally available for implementation/operation of *in-situ* bioremediation. Administratively feasible; injection permits required from appropriate state and local agencies. Disruption of portion of MRP for approximate 2-month period.	Vacuum-enhanced groundwater extraction and P&T consist of conventional and well-proven technologies and are expected to be highly reliable under adequate O&M. Modifications to the system may be added if warranted based on system performance and/or monitoring data. MNA would provide indication of effectiveness of groundwater extraction, treatment, and status of contaminant plume. Obtaining the required discharge permit for treated groundwater and vapor is administratively feasible. Proposed switch to GAC after 1 year would cause minor short-term disruption for potential long-term benefit of reduced maintenance. Personnel, equipment, and materials generally available for implementation of all phases of alternative. Disruption of portion of MRP for approximate 2-month period.	Vacuum enhanced groundwater extraction and P&T consist of conventional and well-proven technologies and are expected to be highly reliable when adequately operated and maintained. Modifications to the system may be added if warranted based on system performance and/or monitoring data. MNA would provide indication of effectiveness of groundwater extraction, treatment, and status of contaminant plume. Obtaining the required discharge permit for treated groundwater and vapor is administratively feasible. Personnel, equipment, and materials generally available for implementation of all phases of alternative. Disruption of portion of MRP for approximate 2-month period.	Considered innovative technology for the depths of intended treatment; however there are no barriers to implementation. Modifications to the system may be added if warranted based on pilot test. Groundwater and soil vapor monitoring would provide indication of effectiveness of treatment system and status of contaminant plume. Administratively feasible; injection permits for ERH electrodes and discharge permits for treated groundwater and vapor emissions required from appropriate state and local agencies. Proposed switch to GAC after 1 year would cause minor short-term disruption for potential long-term benefit of reduced maintenance. Personnel, equipment, and materials generally available for implementation and/or operation of enhanced P&T. Disruption of portion of MRP for approximate 1-year period.	Considered innovative technology for the depths of intended treatment; however there are no barriers to implementation. Modifications to the system may be added if warranted based on pilot test. Groundwater and soil vapor monitoring would provide indication of effectiveness of treatment system and status of contaminant plume. Administratively feasible; injection permits for ERH electrodes and discharge permits for treated groundwater and vapor emissions required from appropriate state and local agencies. Personnel, equipment, and materials generally available for implementation and/or operation of enhanced P&T. Disruption of portion of MRP for approximate 1-year period.
Estimated Cost[1]						
Direct Capital Cost	$3,160,000	$2,620,000	$3,020,000	$2,070,000	$4,180,000	$4,200,000
Average Annual O&M Cost	$433,000	$433,000	$676,000	$718,000	$521,000	$614,000
O&M Present Worth	$2,250,000 (5 yr. Term at 4.25%)	$2,250,000 (5 yr. Term at 4.25%)	$3,110,000 (5 yr. Term at 4.25% for treatment system O&M; 5 yr. Term at 5.0% for MNA)	$3,300,000 (5 yr. Term at 4.25% for treatment system O&M; 5 yr. Term at 5.0% for MNA)	$4,560,000 (5 yr. Term at 4.25% for treatment system O&M; 5 yr. Term at 5.0% for MNA)	$4,560,000 (5 yr. Term at 4.25% for treatment system O&M; 5 yr. Term at 5.0% for MNA)
Total Present Worth	$5,410,000	$4,870,000	$6,130,000	$5,360,000	$8,740,000	$8,760,000

Alternative N3 (Excavation and Offsite Disposal) offers less short-term effectiveness than Alternative N2, because it would require the excavation, handling, and mixing of contaminated soil. Excavation and soil movement operations have the potential to generate significant amounts of dust that could be a threat to construction workers, the community, and the environment. In addition, the increase in traffic associated with hauling contaminated soil offsite and importing clean fill would significantly impact the surrounding communities. Traffic concerns could be lessened during the project through traffic routing (e.g., keeping all traffic to and from the Site restricted to Slauson Blvd. would eliminate neighborhood truck traffic). The dust and noise pollution could be mitigated with proper planning and suitable health and safety measures, such as engineering controls (dust suppression), air monitoring, and personal protective equipment, but not to the degree typical of a soil cover alternative.

10.1.6 Implementability

Alternative N2 (Soil Cover/Revegetation) would be the simplest alternative to implement from an administrative and technical viewpoint. Alternative N2 would require administrative efforts to modify land deeds in order to prevent future development of the property and to allow for indefinite monitoring and maintenance programs. Engineering services and materials would be readily available for constructing a soil cover.

Alternative N3 (Excavation and Offsite Disposal) would require significant administrative efforts for the profiling, manifesting, and disposing of contaminated soil. In addition, this alternative presents potential future liability associated with hauling COCs offsite. Technically, however, the operation would be simple to implement through use of the following planning measures: dust control, the staging of trucks, scheduling of traffic flow, and the weighing of vehicles. Several health and safety risks would need to be addressed as well with regard to truck traffic and the general hazards associated with excavation activities. The construction services and materials would be readily available for excavation and offsite disposal.

10.1.7 Estimated Cost

A summary of the estimated costs for each of the Surface and Near-Surface Soil Remediation Zone remedial alternatives is presented in Table 10-1. The cost estimates presented in Table 10-1 have been developed strictly for comparing the alternatives. The final costs of the treatment alternatives will depend on competitive bids, actual market conditions, actual site conditions, final project scope, and implementation schedules. Because of these factors and those unforeseen, project feasibility and requirements must be reviewed carefully to adequately address the decisions related to project funding.

The cost estimates are “order-of-magnitude” estimates having an intended accuracy range of +50% to –30%. They are not intended to limit the flexibility in the selection of the Remedial Design (RD) but to provide a consistent basis for evaluating cost in light of the other modifying criteria.

With exception to Alternative N1 (No Action), Alternative N2 (Soil Cover/Revegetation) is the least expensive alternative for remediation of surface and near-surface soils and presents the best value with a total present worth of approximately $773,000. Alternative N3 (Excavation and Offsite Disposal) is the most expensive option (approximately $1.3 million) as there are significantly more administrative and technical considerations. In addition, a major cost uncertainty associated with Alternative N3 is the actual transportation and disposal costs, which vary seasonally.

Also for consideration is the relatively high O&M costs (for 30 years of surface maintenance) associated with Alternative N2 (Soil Cover/Revegetation). In the event that O&M costs are reduced as a result of a shared budget with the Maywood Riverfront Park project, the actual project costs would be closer to the

capital costs (approximately $358,000). As an additional consideration, the capital costs of Alternative N2 are approximately one-quarter of the capital costs of Alternative N3 (approximately $1.3 million).

10.1.8 State Acceptance

The State of California concurs with the preferred alternative (Alternative N2) for this remediation zone.

10.1.9 Community Acceptance

During the public comment period for the Proposed Plan, no written comments were received with respect to the preferred alternative (Alternative N2) for this remediation zone. Questions and comments raised during the Public Meetings pertaining to surface and near-surface soils were only in relation to the safety of the future Maywood Riverfront Park and were addressed by EPA staff.

10.2 Upper Vadose Soil and Perched Groundwater Remediation Zone

10.2.1 Overall Protection of Human Health and the Environment

All of the alternatives, except for Alternative SP1 (No Action), would reduce current baseline risks and would provide some level of protection to human health and the environment.

Alternatives SP2a (HVDPE/UV Ox/FTO/GAC) and SP2b (HVDPE/UV Ox/GAC) would likely reduce COCs to remediation goals within both the soil column and the perched groundwater zone, thereby providing the highest levels of protection to human health and the environment. The removal of COCs in both media would eliminate pathways of human exposure and the potential for migration of COCs to deeper groundwater zones. Alternative SP2b (HVDPE/UV Ox/GAC) would require evaluation of the vapor stream, especially with respect to low molecular weight VOCs (e.g., vinyl chloride) and COCs with a low adsorptive capacity (e.g., 1,4-dioxane), to indicate whether GAC vapor treatment would provide adequate protection of human health and the environment.

Alternatives SP3 (*ISCO*) and SP4 (EISB) would provide adequate protection of human health and the environment through reduction of COCs in the perched groundwater zone; however, these alternatives do not address upper vadose soils and the risks associated with vapor phase migration of COCs to the surface. In addition, these alternatives would not be as protective as Alternatives SP2a and SP2b (HVDPE alternatives) in terms of COC reduction in perched groundwater because of the presence of "hot spots" or isolated pockets of elevated concentrations of COCs (>1,000 ppb) that may not be mitigated through *in-situ* treatment processes. The reduction of COCs in groundwater to remedial goals would depend not only on uniform oxidant and/or substrate delivery throughout the entire area of the perched groundwater plume, but also on large volumes of oxidant/substrate material being delivered to isolated contamination pockets. Where the process would be effective, COC concentrations would be reduced to achieve remediation goals. Where the process is not effective, COCs would continue to pose a risk to potential receptors. Impacted upper vadose soils, which would not be addressed under Alternatives SP3 and SP4, may act as a continual source of contamination to the perched groundwater and deeper saturated zones through leaching as well as provide a potential pathway for VOC migration to the surface.

Alternative SP5 (MNA) may reduce contamination in both media within this remediation zone through attenuation and degradation processes. As such, MNA would likely be protective of human health and the environment in some capacity, but not within a reasonable timeframe.

10.2.2 Compliance with the ARARs

The screening of the ability of alternatives to comply with ARARs included a review of ARARs as discussed in Section 13.2.

Alternatives SP2a (HVDPE/UV Ox/FTO/GAC) and SP2b (HVDPE/UV Ox/GAC) would meet ARARs/TBCs for both *in-situ* soil and groundwater as well as for extracted groundwater (through *ex-situ* groundwater treatment via UV Ox, possibly accessorized with GAC). However, only Alternative SP2a (HVDPE/UV Ox/FTO/GAC) would meet ARARs for extracted vapor (in terms of discharge criteria) since a FTO system would be used during the first year of HVDPE system operation. It is estimated that the largest amount of contamination, estimated to be 50 to 60% of the total mass, will be extracted during the first year. The COCs, such as 1,4-dioxane and vinyl chloride, which are prevalent in the perched zone, cannot be treated efficiently by GAC at high concentrations. It is estimated that the concentrations of these two contaminants will be significantly reduced after the first year, to the extent that GAC may be effectively used.

It is unlikely that the FTO vapor treatment system associated with Alternative SP2a (HVDPE/UV Ox/FTO/GAC) will emit products of incomplete combustion, such as dioxins or furans, above background levels due to the system's high destruction efficiency. The FTO would be regularly monitored to document compliance with emissions standards.

Alternatives SP3 (*ISCO*) and SP4 (EISB) would *not* achieve soil ARARs, but perched groundwater ARARs would likely be met.

Alternatives SP5 (MNA) and SP1 (No Action) would not achieve ARARs.

10.2.3 Long-Term Effectiveness and Permanence

Alternatives SP2a (HVDPE/UV Ox/FTO/GAC) and SP2b (HVDPE/UV Ox/GAC) would likely provide the highest degree of long-term effectiveness and permanence because these alternatives use treatment technologies that would reduce COC concentrations within perched groundwater and upper vadose soils to remediation goals. UV Oxidation (possibly accessorized with GAC) and FTO would effectively destroy COCs in extracted groundwater and vapor onsite; whereas permanent destruction of COCs in vapor adsorbed to GAC would take place at an offsite facility. Removal of contaminants within perched groundwater and upper vadose soils at the Site would be permanent with no treatment residuals and no untreated residual risks. HVDPE consists of generally conventional and well-proven technologies and is expected to be highly reliable when adequately operated and maintained. Both alternatives would require monitoring of the remediation area to assure effectiveness over the duration of system operation.

Unlike Alternatives SP2a and SP2b, Alternatives SP3 (*ISCO*) and SP4 (EISB) would not physically remove COCs; rather, they would be destroyed or degraded within the media below ground surface. Alternatives SP3 and SP4 would address baseline risks associated with the perched groundwater plumes. Assuming the appropriate dispersion, distribution, and homogeneity of the treatment process, Alternatives SP3 and SP4 would reduce the majority of COCs in the perched groundwater zone over the entire plume area. Where the processes are effective, remediation goals for the perched groundwater would be achieved.

Alternatives SP3 and SP4 would be ineffective treating COCs in upper vadose soils since dispersion mechanisms for oxidants/substrates are uncertain in unsaturated conditions. Similarly, the treatment of impermeable soils in both unsaturated and saturated conditions is difficult and could result in untreated residual contamination, leading to a rebound of COCs after treatment. The effectiveness of these alternatives in unsaturated and/or impermeable conditions would be a function of the density of oxidant/substrate distribution points. Therefore, design of the treatment application may be tailored to *partially* mediate the ineffectiveness of Alternatives SP3 and SP4 in unsaturated and/or impermeable conditions.

There is an additional uncertainty associated with the dechlorination reaction predicted for the SP4 (EISB) Alternative. There are some instances where PCE and TCE may not complete the biologically mediated reductive dechlorination pathway to ethene (assumes application of HRC®), resulting in the

possible generation and accumulation of vinyl chloride, which is more toxic and more mobile than TCE and PCE. Several treatments (*i.e.,* substrate injections) and long-term management and monitoring would be required to eliminate any remaining source of risk. Also, some of the COCs at Pemaco are organic compounds that will only biodegrade anaerobically (*e.g.,* chlorinated ethenes), some that only degrade aerobically (*e.g.,* petroleum hydrocarbons), and some that are more or less recalcitrant to biodegradation (*e.g.,* 1,4-dioxane). Any EISB program designed for the site would need to address this and would likely be implemented in several phases.

Although long-term effectiveness and permanence of Alternatives SP2a, SP2b, SP3, and SP4 may be documented through MNA, Alternative SP5 (MNA) alone would require approximately 50+ years to achieve remediation goals within this remediation zone.

10.2.4 Reduction of Toxicity, Mobility, and Volume (TMV) through Treatment

Alternatives SP2a (HVDPE/UV Ox/FTO/GAC) and SP2b (HVDPE/UV Ox/GAC) use technologies that increase the rate of mass transfer and enhance the physical removal of COCs in both perched groundwater and upper vadose zone soils, effectively reducing the TMV of COCs within both media. The major difference in these alternatives with respect to TMV lies in the *ex-situ* vapor treatment process options (i.e., FTO and GAC versus GAC alone). FTO would permanently destroy COCs onsite, eliminating the TMV of vapor contaminants extracted from the subsurface, whereas GAC would only reduce the mobility and volume of COCs onsite. All used carbon would likely undergo treatment at the approved disposal facility where toxicity would be reduced.

Alternatives SP3 (*ISCO*) and SP4 (EISB) would not physically remove COCs from the subsurface like HVDPE, nor would they address upper vadose soils. But, through the introduction and uniform distribution of oxidants and substrates, these alternatives would reduce the toxicity and volume by inducing chemical reactions with COCs in perched groundwater. These alternatives would not affect the mobility of COCs but would transform the COCs into less toxic compounds, with the exceptions noted below. Alternative SP3 (*ISCO*) uses an aggressive technology that is typically faster and more predictable than Alternative SP4 (EISB), which relies on slower natural processes. While Alternative SP4 enhances these biological processes, they still work at relatively slow, unsustainable rates. Alternative SP4 could also result in the proliferation of PCE and TCE daughter products through incomplete dechlorination. One daughter product, vinyl chloride, is more toxic and more mobile than PCE and TCE. These treatment residuals would pose uncertain risks. In addition, the enhancement of anaerobic biodegradation of chlorinated ethenes is not effective for treating compounds that biodegrade under aerobic conditions (i.e., benzene, toluene).

Both Alternatives SP3 (*ISCO*) and SP4 (EISB) have inherent physical limitations of oxidant/substrate delivery in the heterogeneous subsurface, which would likely result in post-treatment residual contamination in isolated, less permeable areas. Nonetheless, both alternatives would be effective in reducing the toxicity and volume of contamination in perched groundwater. Because of its aggressive nature, Alternative SP3 (*ISCO*) would be especially effective in the known pockets of elevated contamination (>1,000 ppb) given a dense distribution of substrate delivery points in those areas.

Alternative SP5 (MNA) may result in reduced TMV in both perched groundwater and upper vadose zone soils through natural attenuation and degradation processes, but not within a reasonable timeframe.

10.2.5 Short-Term Effectiveness

Alternatives SP2a (HVDPE/UV Ox/FTO/GAC) and SP2b (HVDPE/UV Ox/GAC) are anticipated to have the greatest short-term effectiveness with respect to meeting remedial action objectives. RAOs for both upper vadose soil and perched groundwater would likely be met within 5 years under Alternatives SP2a and SP2b. These alternatives are the only remedial options for this remediation zone that address both

media within such a favorable timeframe.

Both Alternatives SP2a and SP2b, however, present potential risks to workers, the community, and the environment during construction and implementation (approximately 2 months for both alternatives). Alternatives SP2a and SP2b would involve installation of 32 extraction wells and construction of two aboveground treatment systems (groundwater and soil vapor). Alternative SP2a would involve the replacement of the FTO vapor treatment system with a GAC vapor treatment system after approximately 1 year of HVDPE operation. Risks associated with construction and implementation activities of these alternatives include: increased traffic and particulate emissions from vehicles. These risks can be mitigated with proper planning and suitable health and safety measures, such as traffic control, worker PPE, air monitoring, and restricted access to the aboveground treatment systems.

Alternatives SP3 (ISCO) and SP4 (EISB) are similar with respect to short-term effectiveness, although Alternative SP3 is expected to reach perched groundwater RAOs at a faster rate than Alternative SP4 because ISCO is more aggressive than EISB. Because Alternatives SP3 and SP4 rely on in-situ destruction and/or degradation remedial processes and have inherent uncertainties, these alternatives are expected to take longer to reach perched groundwater RAOs than Alternatives SP2a and SP2b (HVDPE alternatives), which involve physical removal of contaminants. Based on monitoring data and dependent on the effectiveness of the processes, it is anticipated that Alternatives SP3 and SP4 would take about 1 to 6 years to reach perched groundwater RAOs. Baseline risks to the community associated with contaminants in upper vadose soils would remain.

Both Alternatives SP3 (ISCO) and SP4 (EISB) would involve the installation of 8 monitoring wells and the coring of injection points (approximately 100 for Alternative SP3 and 200 for Alternative SP4). Alternative SP3 (ISCO) would involve three injection events to be implemented in an approximate 6- to 9-month period; Alternative SP4 (EISB) would likely involve two applications over a 6-month period. Because of the in-situ nature of the alternatives, no ex-situ engineering controls or treatment systems would be required. The only short-term community risks associated with these alternatives consists of occasional increased traffic related to drilling activities. Additional risks to workers, beyond those linked directly to drilling, consist of the use of strong oxidants associated with Alternative SP3. Workers can mitigate these risks with proper planning and suitable health and safety measures, such as traffic control, appropriate PPE, and special handling of oxidants.

Alternative SP5 (MNA) is projected to take approximately 2 months to implement/construct (monitoring well installation) and 50+ years of operations to achieve perched groundwater RAOs. Baseline risks to the community associated with contaminants in upper vadose soils would remain. Short-term physical risks associated with Alternative SP5 would arise from the installation of 8 monitoring wells. Short-term risks to the community and environment associated with drilling activities include increased traffic, particulate emissions, and potential worker exposure to upper vadose soils. These risks could be mitigated with proper planning and suitable health and safety measures, such as traffic control, dust suppression, air monitoring, and worker PPE.

10.2.6 Implementability

Alternative SP5 (MNA) would be the simplest alternative to implement and consists of a generally conventional, well proven, and implementable technology. Personnel, equipment, and materials are also readily available for implementation/operation.

Alternatives SP3 (ISCO) and SP4 (EISB) are considered similar with respect to implementability and would be the next easiest to implement after SP5. Both alternatives would require injection well permits from appropriate state and local agencies prior to implementation. Pilot tests, as described in Sections 3.4.2.4 and 3.4.2.5, would be needed to establish suitability of the methods and to obtain additional design information. The addition of injection points and/or injection events to the assembled alternatives could be warranted based on system performance and actual monitoring data. In addition, based on the

performance of initial applications, the distribution of oxidants and substrates for isolated pockets of elevated contamination would need to be evaluated. Both alternatives would require coordination with the City of Maywood park construction since injection wellheads would be situated within the park boundary. Personnel, equipment, and materials are generally available for implementation/operation for both alternatives. All of these considerations are considered easier to implement than Alternatives SP2a and SP2b (HVDPE alternatives) because no ex-situ treatment systems and piping networks are required.

Alternatives SP2a (HVDPE/UV Ox/FTO/GAC) and SP2b (HVDPE/UV Ox/GAC) are considered similar with respect to implementability and would be the least easy to implement. Alternative SP2b would have more operational requirements than Alternative SP2a during the first year of operation due to the close monitoring and frequent carbon replacement that would be required to ensure discharge criteria. On the other hand, Alternative SP2a would require the substitution of the FTO vapor treatment system with a GAC vapor treatment system once mass loading and the COCs, 1,4-dioxane and vinyl chloride, are significantly reduced. Both alternatives consist of generally conventional, well proven, and implementable technologies and are expected to be highly reliable when adequately operated and maintained. Personnel, equipment, and materials are readily available for implementation/operation. Coordination with the City of Maywood would be required for well installation activities, which would ideally be installed after final grading activities, but prior to landscaping, of the Maywood Riverfront Park. Modifications to the assembled alternative (e.g., additional extraction wells) over time could be expected and warranted based on system performance and monitoring data, which would be necessary as an indicator of HVDPE effectiveness and contaminant plume status.

10.2.7 Estimated Cost

A summary of the estimated costs for each of the Upper Vadose Soil and Perched Groundwater Remediation Zone remedial alternatives is presented in Table 10-2. A more detailed cost estimate for the selected remedy is provided in Section 12.3.

The cost estimates presented in Table 10-2 have been developed strictly for comparing the alternatives. The final costs of the treatment alternatives will depend on competitive bids, actual market conditions, actual site conditions, final project scope, and implementation schedules. Because of these factors and those unforeseen, project feasibility and requirements must be reviewed carefully to adequately address the decisions related to project funding.

The cost estimates are “order-of-magnitude” estimates having an intended accuracy range of +50% to –30%. They are not intended to limit the flexibility in the selection of the RD but to provide a basis for evaluating cost in light of the other modifying criteria.

Alternative SP4 (EISB) has the lowest total present worth cost at approximately $1.7 million. The uncertainty in the final cost of this alternative lies in the ability of the injected substrate to effect contaminants trapped in the impermeable clay layers. Additional treatments or increasing the density of treatment points would increase the costs proportionately but are still estimated to provide the lowest total present worth cost, with the exception of Alternative SP1 (No Action).

Alternative SP5 (MNA) has the second lowest total present worth cost at approximately $2.4 million. Alternative SP5 is relatively expensive considering that no proactive treatment of contaminants would take place. Since Alternative SP5 would take a long time (approximately 50 years) to achieve RAOs, it is not considered cost effective. In addition, under Alternative SP5, contaminants in the perched zone could continue migrating to the Exposition groundwater zones, thereby increasing the cost to cleanup the deeper zone.

Alternative SP3 (*ISCO*) has the third lowest total present worth cost at approximately $2.5 million. Like the EISB alternative, the uncertainty in the final cost of this alternative lies in the ability of the injected

substrate to effect contaminants trapped in the impermeable clay layers. Additional treatments or increasing the density of treatment points would increase the costs proportionately.

Alternatives SP2a (HVDPE/UV Ox/FTO/GAC) and SP2b (HVDPE/UV Ox/GAC) have the highest total present worth costs at approximately $4.8 million and $3.6 million, respectively. Alternatives SP2a and SP2b use the best suited technologies for this remediation zone because it works well in both saturated and unsaturated conditions, unlike Alternatives SP3 and SP4, which rely on saturated conditions to facilitate treatment. Both of these alternatives have the highest degree of reliability as evidenced by their long history of use for similar applications and are therefore considered cost effective, relative to other alternatives. The only limitation of HVDPE, similar to Alternatives SP3 and SP4, is its ability to affect contaminants trapped in the impermeable clay layers in a predictable timeframe.

10.2.8 State Acceptance

The State of California concurs with the preferred alternative (Alternative SP2a) for this remediation zone.

10.2.9 Community Acceptance

During the public comment period for the Proposed Plan, several written comments were received specific to the FTO vapor treatment system associated with Alternative SP2a. These comments may be referenced in the Responsiveness Summary of this document.

Questions and comments pertaining to the FTO technology that were raised during the first public hearing (April 17, 2004) were addressed by EPA staff. After the April 17th public hearing, EPA extended the public comment period, announced a second public hearing, and sent out a second summary Proposed Plan fact sheet to all the addresses in the City of Maywood. In addition, EPA officials and contractors met with the community group PUMA at its regular weekly meeting on May 13, 2004 to answer questions about the preferred alternatives, specifically the FTO vapor treatment system.

The second public hearing was held on May 22, 2004 at the Maywood Activity Center. EPA staff invited a contractor representing FTO to provide discussion and examples on the use of this technology at other sites across the country.

EPA also facilitated a meeting between the community group PUMA and the TOSC. During the public comment period, EPA also responded to a number of email questions and requests for additional information from the PUMA group members and other community activists. EPA staff also met with representatives from PUMA during September, October, and November 2004. In response to comments received, EPA has agreed to implement additional response actions to the remedy.

10.3 Lower Vadose Soil and Exposition Groundwater Remediation Zone

10.3.1 Overall Protection of Human Health and the Environment

All of the alternatives, except for Alternative SG1 (No Action), would reduce current baseline risks and would provide some level of protection to human health and the environment.

Alternatives SG5a (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/FTO/GAC) and SG5b (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/GAC) would reduce COCs to achieve remediation goals within both the lower vadose soil column and the Exposition groundwater zones, thereby providing the highest level of protection to human health and the environment. The physical removal of COCs would effectively eliminate all exposure pathways and the potential for migration of COCs to local production wells or regional aquifer systems. Alternatives SG5a and SG5b are

the only alternatives assembled for this remediation zone that would eliminate the Site's principal COCs or heavily contaminated media, namely lower vadose zone soils that contain NAPL or high concentrations of residual contamination.

It should be noted that Alternative SG5b (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/GAC) would require evaluation of the vapor stream, especially with respect to low molecular weight VOCs (vinyl chloride), to indicate whether GAC would provide adequate protection of human health and the environment. If approved for operation, the GAC vapor effluent would require close monitoring of vinyl chloride to assure protectiveness. Likewise, the FTO vapor effluent associated with Alternative SG5a (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/FTO/GAC) would require close monitoring for products of incomplete combustion such as dioxins and furans; although, it is unlikely that an FTO vapor treatment system will emit these chemicals above background levels due to the system's high destruction efficiency.

Alternatives SG2 (ISCO/ISCR/P&T/MNA/UV Oxidation) and SG3 (EISB/P&T/MNA/UV Oxidation) would reduce contaminant concentrations within the Exposition groundwater source area, thereby reducing the potential for COCs to migrate to local domestic production wells. Because this is the primary route of human exposure to COCs through the Exposition groundwater zones, these alternatives would provide adequate protection of human health. However, these alternatives would not be as protective as Alternatives SG5a and SG5b (ERH alternatives) because they would not address the contamination in lower vadose soils, one of the Site's principal threat wastes (source area). Although P&T would enhance the distribution of the added substrates, the mechanics of these *in-situ* technologies rely to a great extent on groundwater flow to assist in dispersion. If left untreated, impacted lower vadose soils could act as a continual source of contamination to the Exposition groundwater zones and deeper saturated zones that may be used for local domestic production wells. In addition, because of the elevated concentrations of COCs detected in these groundwater zones (> 20,000 ppb), COCs may not be reduced to the remediation goals. The reduction of COCs to remediation goals would depend on uniform oxidant/reducing agent/substrate delivery throughout the entire source area. Where the processes are effective, it is expected that remediation goals would be achieved. Where the processes are not effective, COCs would continue to pose a risk to potential receptors.

Alternatives SG4a (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/FTO/GAC) and SG4b (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/GAC) would provide adequate protection of human health and the environment through reduction of COCs in lower vadose soils and Exposition groundwater within the source area. These alternatives, however, are not as aggressive as the ERH alternatives. As Vacuum-enhanced groundwater extraction may remediate the more coarse-grained lower vadose zone soils, this technology would not likely remediate COCs within the less-permeable fine-grained lithosomes. Therefore, Alternatives SG4a (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/FTO/GAC) and SG4b (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/GAC) would not be considered as protective as the ERH alternatives. Nonetheless, the reduction of COCs and the hydraulic control over contaminant mobility provided through groundwater and vapor extraction would ultimately reduce potential pathways to human exposure and the potential for future migration.

10.3.2 Compliance with the ARARs

The screening of the ability of alternatives to comply with ARARs included a review of ARARs as discussed in Section 13.2. It should be noted that the attainment of ARARs in the source area does not necessarily signify that ARARs will be attained for the entire lower vadose soil and Exposition groundwater zone as a whole. However, if the source area is eliminated, it is expected that the diluted-phase soil and groundwater plumes will diminish over time.

Alternatives SG5a (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/FTO/GAC) and SG5b (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/GAC) would meet ARARs for

both *in-situ* soil and groundwater by physically removing contaminants from the subsurface for *ex-situ* treatment. These are the only alternatives assembled for this remediation zone expected to achieve remediation goals in the source area (>10,000 µg/L contour of the composite Exposition 'A' and 'B' Zone TCE plume).

However, only Alternative SG5a (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/FTO/GAC) would meet ARARs for extracted vapor (in terms of discharge criteria) because this alternative would treat *ex-situ* vapors with an FTO vapor treatment system for the duration of ERH operation (approximately 1 year), during which time, approximately 50% of contamination will be extracted. It is unlikely that the FTO vapor treatment system associated with this alternative will emit products of incomplete combustion, such as dioxins or furans, above background levels due to the system's highly effective removal efficiency. The FTO would be carefully monitored for the release of these chemicals.

Alternative SG5b (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/GAC), which uses GAC to treat extracted vapors, cannot efficiently treat some COCs present within this remediation zone, in particular vinyl chloride. This alternative would require evaluation of the vapor stream to indicate whether GAC would meet ARARs or other discharge criteria.

Alternatives SG4a (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/FTO/GAC) and SG4b (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/GAC) would likely meet groundwater ARARs through physical removal of groundwater from the subsurface. Because the extracted groundwater exposes lower vadose soils, COCs trapped in soil pores of coarser grained units would be removed as well. This would effectively reduce VOC contamination in these soils, which would likely meet soil remediation goals until concentrations rebound as leaching occurs from finer-grained units, where vacuum-enhanced groundwater extraction would not likely be effective.

Both vacuum-enhanced alternatives would meet ARARs, or discharge criteria, for extracted groundwater through *ex-situ* treatment via UV Ox (possible accessorized with GAC); however, similar to the ERH alternatives, only Alternative SG4a (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/FTO/GAC) would meet ARARs/TBCs for extracted vapor (in terms of discharge criteria) because this alternative would treat *ex-situ* vapors with an FTO vapor treatment for the first year of system operation, during which time approximately 50% of contamination will be extracted. It is unlikely that the FTO vapor treatment system associated with this alternative will emit products of incomplete combustion, such as dioxins or furans, above background levels due to the system's highly effective removal efficiency. The FTO would be carefully monitored during its operation for the release of these chemicals.

Alternative SG4b (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/GAC), which uses only GAC to treat extracted vapors, cannot efficiently treat some COCs present within this remediation zone, in particular vinyl chloride at elevated concentrations. This alternative would require evaluation of the vapor stream to indicate whether GAC would meet ARARs or other discharge criteria.

The remaining proactive alternatives, Alternatives SG2 (ISCO/ISCR/P&T/MNA/UV Oxidation) and SG3 (EISB/P&T/MNA/UV Oxidation) would likely achieve ARARs for Exposition groundwater quite rapidly, however, with incomplete remediation of soil, the concentrations of COCs in groundwater would likely rebound to some degree and exceed remediation goals in a short period of time. Soil remediation goals would probably not be met, because these alternatives are difficult to implement in the fine-grained, non-saturated soils.

Alternative SG1 (No Action) would not achieve ARARs.

10.3.3 Long-Term Effectiveness and Permanence

Alternatives SG5a (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/FTO/GAC) and SG5b (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/GAC) would be expected to provide the highest degree of long-term effectiveness and permanence because they use a technology (ERH) that would be expected to achieve remediation goals for all known COCs and the respective baseline risks within the Lower Vadose Soil and Exposition Groundwater Remediation Zone. Although some uncertainty is associated with the effectiveness of ERH at the depths proposed, it has been proven to be effective in several full-scale demonstration projects. It is anticipated that the removal of contaminants within this remediation zone would be permanent and would result in no treatment residuals and no untreated residual risks.

As for ex-situ treatment of extracted groundwater and vapor associated with Alternatives SG5a (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/FTO/GAC) and SG5b (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/GAC), UV Oxidation and FTO are proven technologies for permanently destroying all Site COCs without additional disposal requirements. GAC on the other hand requires disposal at an approved landfill/disposal facility. Furthermore, GAC may not effectively remove some COCs from the vapor stream. Both alternatives would require monitoring of the remediation area and *ex-situ* treatment systems to assure effectiveness over the duration of system operation.

Alternatives SG4a (Vacuum-Enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/FTO/GAC) and SG4b (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/GAC) consist of generally conventional and well-proven technologies and are expected to be highly reliable when properly operated and maintained. These alternatives would require a much longer period of time to reduce risks within this remediation zone than Alternatives SG5a and SG5b (about 15 years compared to about 5 years) because the technology (vacuum-enhanced groundwater extraction) that employ Alternatives SG4a and SG4b are less aggressive than those involved in Alternatives SG5a and SG5b (ERH alternatives). In addition, Alternatives SG4a and SG4b would only provide a partial solution to the reduction of COCs in lower vadose soils because this alternative is not effective for reducing contamination within the fine-grained (low-permeability) lithosomes. This is particularly significant within the Exposition 'B' Zone, where fine-grained units are more prevalent. The steep cone of depression that resulted during the 'B' Zone HVDPE pilot test confirms the limited exposure of contaminated media (fine-grained intervals) to soil vapor extraction. Impacted lower vadose soils not treated by vapor extraction may act as a continual source of contamination to the Exposition groundwater zones and deeper saturated zones through leaching. This alternative would require monitoring of the remediation area to assure effectiveness over the duration of system operation.

The ex-situ treatment technologies for extracted groundwater and vapor associated with Alternatives SG4a (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/FTO/GAC) and SG4b (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/GAC); namely, UV Oxidation and FTO, are proven technologies for permanently destroying all Site COCs without additional disposal requirements (although, UV Ox may require pretreatment of the influent via GAC to increase the effectiveness of UV oxidation, which is dependent on the aqueous stream being able to transmit UV light (i.e., low turbidity and metal ions <10 mg/L). Alternatively, vapor-phase GAC requires disposal at an approved landfill/disposal facility and may not effectively remove some COCs from the vapor stream. Both alternatives would require monitoring of the remediation area and *ex-situ* treatment systems to assure effectiveness over the duration of system operation.

Alternatives SG2 (ISCO/ISCR/P&T/MNA/UV Oxidation) and SG3 (EISB/P&T/MNA/UV Oxidation) would rely on in-situ chemical reactions and biological degradation remedial processes to address the COCs. These alternatives would not address in-situ reduction of COCs in lower vadose soils; however, they would involve the potential reduction of COCs and respective baseline risks associated with the

Exposition groundwater zones. With appropriate dispersion, distribution, and homogeneity of the treatment (oxidants/reducing agents/substrates), Alternatives SG2 and SG3 would reduce COCs within the Exposition groundwater source area. Where the processes would be effective, little or no residual contamination would remain. However, where the processes are ineffective, these alternatives could result in treatment residuals and/or untreated residual contamination, the magnitude of which poses uncertain risks to potential receptors. For example, with Alternative SG3 (EISB/P&T/MNA/UV Oxidation), PCE and TCE may not complete the reductive dechlorination pathway to ethene with the application of HRC®, resulting in the possible generation and accumulation of vinyl chloride, which is more toxic and more mobile than its parent products. Additionally, because of the elevated COC concentrations in these groundwater zones (> 20,000 ppb) and uncertainties associated with uniform substrate distribution and dispersion, residual contamination in these areas could be a remaining source of risk. The effectiveness of these alternatives in mitigating groundwater within the entire Exposition source area would be a function of the density of substrate distribution points and practicality.

For both in-situ alternatives, periodic monitoring of groundwater would be required to assess effectiveness and to guide process applications. Several treatments (i.e., substrate injections/additions) and long-term management and monitoring would be required for both of these alternatives.

It should also be noted that some of the COCs at Pemaco are compounds that generally biodegrade anaerobically (*e.g.,* chlorinated ethenes), some that only degrade aerobically (*e.g.,* petroleum hydrocarbons), and some that are more or less recalcitrant to biodegradation (*e.g.,* 1,4-dioxane). Any EISB program designed for the Site would need to address this and would likely be implemented in several phases.

10.3.4 Reduction of Toxicity, Mobility, and Volume (TMV) through Treatment

Alternatives SG5a (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/FTO/GAC) and SG5b (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/GAC) use technologies that physically remove and, through *ex-situ* treatment, destroy COCs so that remediation goals would be achieved in the lower vadose zone and the Exposition groundwater. ERH with VE is the only technology that could effectively reduce the TMV of all COCs within the entire source area of this remediation zone.

As previously discussed, UV Oxidation and FTO are proven technologies for permanently destroying all Site COCs. Thus the TMV of extracted groundwater and vapor, under Alternative SG5a (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/FTO/GAC), would also be reduced. For both ERH alternatives, GAC would reduce the volume and mobility of COCs in the vapor stream. Toxicity reduction via GAC would not occur unless the offsite disposal facility treated the carbon prior to disposal.

Alternatives SG4a (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/FTO/GAC) and SG4b (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/GAC) would reduce the TMV of COCs in Exposition groundwater and in the coarse-grained lower vadose soils through physical removal of COCs followed by aboveground treatment. These alternatives would not effectively address COCs trapped within low-permeability (fine-grained) lithosomes of the lower vadose zone such as the ERH alternatives. However, through hydraulic control, the mobility of free product and dissolved phase contaminants within these soils would be reduced. The TMV of extracted groundwater and vapors would be similar to those associated with Alternatives SG5a (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/FTO/GAC) and SG5b (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/GAC), as described above.

Alternatives SG2 (ISCO/ISCR/P&T/MNA/UV Oxidation) and SG3 (EISB/P&T/MNA/UV Oxidation) would not physically remove COCs from the subsurface in the source area like the ERH or vacuum-enhanced groundwater extraction alternatives, nor would they address lower vadose soils. But, through the introduction and uniform distribution of oxidants/reducing agents/substrates, these alternatives would

reduce the toxicity and volume of COCs in the Exposition groundwater zones. P&T between the 10 and 1,000 ppb-contours would provide hydraulic control and facilitate dispersion of the oxidizing/reducing agents or substrates. In addition to proper application procedures, P&T would also serve as an engineering control to prevent the possible "spreading" of COCs during injection events.

Alternative SG2 (ISCO/ISCR/P&T/MNA/UV Oxidation) uses more aggressive processes that are typically faster and more predictable than Alternative SG3 (EISB/P&T/MNA/UV Oxidation), which would rely on enhancing natural biological processes. While Alternative SG3 (EISB/P&T/MNA/UV Oxidation) enhances these natural processes, they still work at slow, unsustainable rates. Alternative SG3 could also result in the proliferation of PCE and TCE daughter products through incomplete sequential dechlorination (or "stalling" of the dechlorination process at DCE or vinyl chloride). One daughter product, vinyl chloride, is more toxic and more mobile than PCE and TCE. These treatment residuals would pose uncertain risks. In addition, the enhancement of anaerobic biodegradation of chlorinated ethenes is not effective for treating compounds that biodegrade under aerobic conditions (i.e., benzene, toluene). Both of these alternatives have inherent physical limitations of respective substrate delivery in the heterogeneous subsurface, which would likely result in areas with residual contamination after treatment. Because of the aggressive nature and lack of potentially more toxic and more mobile intermediates, Alternative SG2 would be especially effective within the principal source area or 1,000 ppb contour, a.k.a. area of principal threat wastes.

10.3.5 Short-Term Effectiveness

This screening criterion is two-fold. One aspect addresses the time until remedial action objectives are met and the other addresses the effects of the alternative during the construction and implementation phase of the alternative.

Alternatives SG5a (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/FTO/GAC) and SG5b (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/GAC) are anticipated to have the greatest short-term effectiveness with respect to meeting remedial action objectives. Lower vadose soil and Exposition groundwater RAOs would be met within approximately 5 years under this alternative. These alternatives necessitate the installation of 18 SVE wells and 96 electrodes (for ERH), the installation of 12 vacuum-enhanced groundwater extraction wells and 15 P&T wells, the construction of two aboveground treatment systems (groundwater and vapor), and installation of eight small power delivery stations. Potential risks to workers, the community, and the environment associated with construction (approximately 1 year) and implementation activities of these alternatives include: increased traffic, particulate emissions from vehicles, and high voltage hazards. All of these risks can be mitigated with proper planning and suitable health and safety measures, such as traffic control, worker PPE, air monitoring, and limited access to the aboveground treatment systems/power delivery stations.

Alternatives SG2 (ISCO/ISCR/P&T/MNA/UV Oxidation) and SG3 (EISB/P&T/MNA/UV Oxidation) are very similar with respect to short-term effectiveness, although Alternative SG2 (ISCO/ISCR/P&T/MNA/UV Oxidation) is expected to reach Exposition groundwater RAOs at a faster rate than Alternative SG3 (EISB/P&T/MNA/UV Oxidation) because ISCO and ISCR are more aggressive than EISB. Because all of these alternatives rely on in-situ destruction and/or degradation remedial processes, it would likely take longer to reach Exposition groundwater RAOs under these alternatives than Alternatives SG5a and SG5b (ERH alternatives), which involves physical removal of contaminants. Based on monitoring data and dependent on the effectiveness of the processes, it is anticipated that Alternatives SG2 and SG3 would take 1 to 6 years to reach Exposition groundwater RAOs. Baseline risks to the community associated with contaminants in lower vadose soils would remain.

Alternatives SG2 (ISCO/ISCR/P&T/MNA/UV Oxidation) and SG3 (EISB/P&T/MNA/UV Oxidation) each necessitate the installation of 15 P&T wells and 20 monitoring wells within the Exposition 'A' and 'B' Zones, the coring of 98 injection points, and the construction of an aboveground groundwater treatment system. Alternative SG2 would require 2 injection events, while Alternative SG3 would only

require 1 injection event (each injection event to be implemented in an approximate 2-month period). The only short-term community risks associated with these alternatives would consist of occasional traffic issues related to drilling activities. Additional risks to workers, beyond those associated directly to drilling consist of the use of strong oxidants associated with Alternative SG4. These risks can be mitigated with proper planning and suitable health and safety measures, such as traffic control, appropriate PPE, and special handling of oxidants by workers.

Alternatives SG4a (Vacuum-Enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/FTO/GAC) and SG4b (Vacuum-Enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/GAC) are projected to take approximately 2 months to implement/construct and 20 years to achieve Exposition groundwater RAOs. Baseline risks to the community associated with contaminants in lower vadose soils would remain. Short-term risks associated with this alternative are related to the installation of 15 P&T wells and 20 vacuum-enhanced groundwater extraction wells within the Exposition 'A' and 'B' Zones, the construction of two aboveground treatment systems (groundwater and vapor), and the installation of approximately 1,700 ft of trenching. Short-term risks to the community and environment associated with drilling, construction, and trenching activities include increased traffic, particulate emissions, and potential worker exposure to COCs during remedial and monitoring activities. These risks can be mitigated with proper planning and suitable health and safety measures, such as traffic control, dust suppression, air monitoring, and worker PPE.

10.3.6 Implementability

Alternatives SG2 (ISCO/ISCR/P&T/MNA/UV Oxidation) and SG3 (EISB/P&T/MNA/UV Oxidation) would be the simplest alternatives to implement. Both alternatives would require injection well permits or approvals from appropriate state and local agencies prior to implementation. Pilot tests, as described in Sections 3.4.3.2 and 3.4.3.3, would be needed to obtain required design information. The addition of injection points and/or injection events to the assembled alternatives could be warranted based on pilot test results and/or system performance and monitoring data. In addition, based on the performance of initial applications, the need for additional injection events would need to be evaluated. Both alternatives would require coordination with the City of Maywood park construction since injection wellheads would be situated within the park boundary. Personnel, equipment, and materials are generally available for implementation/operation for both alternatives.

Alternatives SG4a (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/FTO/GAC) and SG4b (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/GAC) would be relatively simple to implement, although these alternatives would have more operational requirements than Alternatives SG2 and SG3 because of the additional aboveground vapor treatment system. Overall, these alternatives consist of generally conventional, well proven, and implementable technologies and are expected to be highly reliable when adequately operated and maintained. Personnel, equipment, and materials are readily available for implementation/operation. Coordination with the City of Maywood would be required for well installation activities, which would ideally be installed after final grading activities, but prior to hardscaping and landscaping of the Maywood Riverfront Park. The aboveground treatment systems associated with Alternatives SG4a and SG4b would be coordinated with the City of Maywood and could be situated in the southeast corner of the park. Modifications to the assembled alternative could be warranted based on system performance/monitoring data (e.g., additional extraction wells). Groundwater monitoring would be necessary to assess remediation effectiveness and contaminant plume status. Discharge permits or disposal facility acceptance for treated groundwater would generally be required.

Alternatives SG5a (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/FTO/GAC) and SG5b (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/GAC) are the most complex alternatives to install/construct and, during implementation, to operate. Although ERH with VE is no longer considered an innovative technology, it is a relatively new technology that requires sophisticated

equipment and skilled technical personnel. As such, relatively few vendors offer ERH with VE and personnel, equipment, and materials have limited availability. A pilot test would be needed to establish suitability of the method at the site and to obtain additional design information, as described in Section 3.4.3.6. System modifications could be warranted based on performance and monitoring data. As stated in Section 10.3.5, a large portion of the Maywood Riverfront Park would be disrupted for approximately 1-year. The partial park closure would need to be coordinated in cooperation with the City of Maywood.

10.3.7 Estimated Cost

A summary of estimated costs for each of the lower vadose zone soils and Exposition groundwater remediation zone alternatives is presented in Table 10-3. A more detailed cost estimate for the preferred alternative is provided in Section 12.3.

The cost estimates summarized in Table 10-3 have been developed strictly for comparing the alternatives. The final costs of the treatment alternatives will depend on competitive bids, actual market conditions, actual site conditions, final project scope, and implementation schedules. Because of these factors and those unforeseen, project feasibility and requirements must be reviewed carefully to adequately address the decisions related to project funding.

The cost estimates are "order-of-magnitude" estimates having an intended accuracy range of +50% to –30%. They are not intended to limit the flexibility in the selection of the RD but to provide a basis for evaluating cost in light of the other modifying criteria.

Alternative SG3 (EISB/P&T/MNA/UV Oxidation) has the lowest total present worth cost (approximately $4.8 million) with the exception of Alternative SG1 (No Action).

The second least expensive alternatives are Alternative SG4b (Vacuum-Enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/GAC) and Alternative SG2 (ISCO/ISCR/P&T/MNA/UV Oxidation). They have similar total present worth costs of approximately $5.4 million. Alternative SG2 (ISCO/ISCR/P&T/MNA/UV Oxidation) uses a technology that is identical in application to Alternative SG3, but is more expensive mainly because of the cost of reagents. Therefore, Alternative SG2 is not considered to be as good a value as Alternative SG3.

Alternative SG4a (Vacuum-Enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/FTO/GAC) provides the fourth lowest total present worth cost at approximately $6.1 million. Comparatively, Alternative SG4a uses a technology that is identical in application to Alternative SG4b (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/GAC), but is more expensive due to the addition of an FTO vapor treatment system for use during the first year of system operation. As the majority of COCs will be extracted during the first year and some COCs within this remediation zone, in particular vinyl chloride, cannot be treated by GAC at elevated concentrations, the FTO treatment system associated with Alternative SG4a is considered to be a good value.

Alternatives SG5a (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/UV Ox/FTO/GAC) and SG5b (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/UV Ox/GAC) provide the most expensive alternatives with a total present worth of approximately $8.8 to 8.9 million, respectively. These alternatives are estimated to be the most effective and expeditious of all the alternatives. The cost effectiveness of this alternative may be considered good based on the estimated high effectiveness over a short period of time. However, they are significantly more expensive than the other alternatives - which are estimated to be less effective and take a longer period of time.

10.3.8 State Acceptance

The State of California DTSC raised concerns with respect to elevated concentrations of TCE detected in double-nested monitoring well MW-24, which is screened within the Exposition 'C' and 'D' Zones. The DTSC requested that EPA place an extraction well in the vicinity of this monitoring well as an addition to the preferred alternative for this remediation zone. In response, EPA will install a recovery well to approximately 140 ft bgs to extract and treat groundwater in this area.

With the exception of the above-mentioned issue which has been addressed by the EPA, the State of California concurs with the preferred alternative (Alternative SG5a) for this remediation zone.

10.3.9 Community Acceptance

During the public comment period for the Proposed Plan, written comments were received with respect to ERH and the FTO vapor treatment system associated with Alternative SG5a. These comments may be referenced in the Responsiveness Summary of this document.

Questions and comments pertaining to ERH and FTO technologies that were raised during the first public hearing (April 17, 2004) were addressed by EPA staff. After the April 17 public hearing, EPA extended the public comment period, announced a second public hearing, and sent out a second summary Proposed Plan fact sheet to all the addresses in the City of Maywood. In addition, EPA officials and contractors met with the community group PUMA at its regular weekly meeting on May 13 to answer questions about ERH and FTO.

The second public hearing was held on May 22, 2004 at the Maywood Activity Center. EPA staff invited a headquarters expert specializing in ERH to attend the meeting as well as a contractor representing FTO to provide discussion and examples on the use of these remedies at other sites across the country.

EPA also facilitated a meeting between the community group PUMA and the TOSC. During the public comment period, EPA also responded to a number of email questions and requests for additional information from the PUMA group members and other community activists. EPA believes it has addressed the community's concerns.

11.0 Principal Threat Waste

The NCP establishes EPA's expectation that treatment be used to address the principal threats posed by hazardous substances wherever practical. The principal threat concept applies to the characterization of "source materials" at Superfund sites. A source material is material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to the groundwater, surface water, or air, or act as a source for direct exposure. Principal threat wastes are essentially source materials that are highly mobile and cannot be reliably controlled in place, or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal threat wastes are those source materials that generally can be reliably contained and would present only a low risk in the event of exposure. The manner in which principal threats are addressed generally will determine whether the statutory preference for treatment as a principal element is satisfied.

At the Pemaco site, several original or primary sources of contamination were identified during previous environmental investigations at the site including: a drum storage area in the southern portion of the site, 31 USTs, at least 6 ASTs, and a loading dock in the southwest corner of the property (Figure 1-2). Due to leaks, spills, potential improper handling and infiltration/percolation of COCs, these primary sources have impacted localized soil and groundwater to such a degree that "secondary" sources of contamination were created. As the original sources are no longer present at the site (excavation of USTs, removal of drums, etc.), these highly toxic secondary sources of contamination present in vadose zone soils, perched

groundwater, and Exposition groundwater within the vicinity of the 10,000-µg/L contour (of the composite Exposition 'A' and 'B' groundwater TCE plume) are considered the present-day source materials.

Groundwater within this contour zone contains free product [both non-aqueous phase liquids (NAPLs) and dense non-aqueous phase liquids (DNAPLs) have been detected in groundwater] and/or high concentrations of residual contamination. In addition, subsurface soil within this zone contains high concentrations of chemicals, namely VOCs, that are (or potentially are) mobile because of volatilization and subsequent subsurface transport. These soil contaminants may act as a continuing source and subsequent threat to groundwater. As such, these heavily contaminated media are considered principal threat wastes.

To address these wastes, remedial alternatives for the two subsurface remediation zones capable of reducing and/or remediating the principal threat wastes through treatment were favored. For the Upper Vadose and Perched Groundwater Remediation Zone, Alternative SP2a and SP2b were favored because they involve the application of HVDPE, which would increase the rate of extraction of contaminated media between 3 and 35 ft bgs. The other, more passive alternatives developed for this remediation zone (Alternatives SP3 – ISCO and Alternative SP4 – EISB) do not involve contaminant extraction and do not address upper vadose zone soils. For the Lower Vadose and Exposition Groundwater Remediation Zone, which contains the majority of principal threat wastes at the site, Alternatives SG5a and SG5b were favored because they involve the application of ERH directly to soil and groundwater between 35 and 100 ft bgs within the 10,000-ppb contour of the composite Exposition 'A' and 'B' TCE plume. ERH with VE is the only technology capable of source mass reduction within Exposition groundwater, high-permeability lower vadose soils, and low-permeability lower vadose soils. The other alternatives for this remediation zone (Alternative SG2 – ISCO/ISCR, Alternative SG3 – EISB, and Alternatives SG4a and SG4b – Vacuum-Enhanced Groundwater Extraction) cannot effectively address COCs trapped within low-permeability soils, which if not treated, may act as a continual source of contamination to Exposition groundwater zones and deeper saturated zones through leaching.

12.0 Selected Remedy

The remedial action for Pemaco addresses removal of contaminants from soil and groundwater. Since the subsurface geologic and hydrogeologic environments and contamination levels found at Pemaco are highly irregular and variable, EPA divided the site into three subsurface zones or "remediation zones" and assembled remedial alternatives by zone to develop an appropriate cleanup strategy for each individual zone. The remediation zones identified at the Pemaco site are:

d) surface and near surface soil remediation zone (0-3 ft bgs) – "N"
e) upper vadose zone soil and perched groundwater (3-35 ft bgs) – "SP"
f) lower vadose zone soil and Exposition groundwater (35-100+ ft bgs) – "SG"

The selected remedy for the entire site is as follows:

- Surface and Near-Surface Soil: Soil Cover/Revegetation (*Alternative N2*).
- Upper Vadose Zone Soil and the Perched Groundwater: HVDPE with UV Oxidation for treatment of extracted groundwater, and, FTO and GAC for treatment of extracted vapors (*Alternative SP2a*).
- Lower Vadose Zone Soil and Exposition Groundwater: ERH with VE, Vacuum-Enhanced Groundwater Extraction, Groundwater P&T, and MNA. UV Oxidation for treatment of extracted groundwater, and FTO and GAC for treatment of extracted vapors (*Alternative SG5a*).

The EPA believes the selected remedy for Pemaco meets the threshold criteria and provides the best balance of tradeoffs among the alternatives considered. The EPA expects the selected remedy to satisfy the statutory requirements of CERCLA Section 121(b): 1) protection of human health and the environment: 2) compliance with ARARs; 3) cost effectiveness; 4) use of permanent solutions and alternative treatment technologies to the maximum extent practicable; and 5) use of treatment as a principle component.

12.1 Summary of the Rationale for the Selected Remedy

Numerous factors were considered in choosing the selected remedy for the Pemaco site. In some cases, different evaluation factors were more applicable to some of the three remediation zones than to others. The principal factors weighed in choosing the selected remedies for each zone are as follows:

Surface and Near-Surface Soil Remediation Zone

- Use of a soil cover will eliminate or minimize the potential for exposure to residual subsurface contamination for the proposed use of the site as a park. The selected alternative is protective of human health and the environment.

Upper Vadose Soils and the Perched Groundwater

- Data obtained from field treatability tests performed during the FS confirm that HVDPE can be used to effectively remove and treat VOCs simultaneously from both soil and groundwater in the upper vadose zone and perched groundwater zone.
- The vapor extraction component of the system will capture subsurface vapors and eliminate the potential for vapor migration to the surface, thereby eliminating the potential for exposure to COCs in indoor and outdoor air.
- The selected alternative is protective of human health and the environment and complies with ARARs for all COCs.

Lower Vadose Soils and Exposition Zone Groundwater

- Data obtained from field treatability tests performed during the FS confirm that HVDPE can be used to effectively remove and treat VOCs in the lower vadose zone soil and in the Exposition ‘A’ and ‘B’ groundwater zones.
- While a recently developed technology, ERH has been demonstrated at numerous sites throughout the country as an effective technology to remove VOCs from very low permeability lithosomes, such as those that separate the groundwater-containing sands in the lower vadose zone. It is essentially the only remedial technology, other than excavation, that has proven to be effective to remove VOCs, especially NAPL, from “tight” soil.
- In addition to being the most technically effective alternative for removing VOCs from this zone, ERH (combined with groundwater and vapor extraction) will require the least amount of time compared to other technologies to reach remedial goals.
- Removal of the plume “core/source” area should allow the downgradient portions of the plume to reach remedial goals within a reasonable timeframe through groundwater extraction and MNA.
- The selected alternative is protective of human health and the environment and complies with ARARs for all COCs.

12.2 Description of the Selected Remedy

Descriptions of the selected remedy, broken down by remediation zone, are contained in Sections 12.2.1 through 12.2.3, below.

12.2.1 Selected Alternative for Surface and Near-Surface Soil Remediation Zone

Soil Cover/Revegetation (Alternative N2)

The proposed future use of the Pemaco site is a recreational park. This alternative would place a 1-foot layer or approximately 4,550 cubic yards of clean soil on the site, with the addition of a non-woven geotextile layer between the soil cover and the native site soils. Implementation of this remedy will take one to two months. Implementation of this portion of the remedy will be conducted by the City of Maywood as part of the design and construction of the recreational park that includes the Pemaco property and the surrounding adjacent properties.

12.2.2 Selected Alternative for Upper Vadose Soils and the Perched Groundwater

Alternative SP2a – HVDPE, UV Ox, FTO, and GAC

Approximately 32 dual-phase extraction wells will be installed into the upper vadose zone soil (approximately 80,000 to 95,000 cubic yards of soil affected) and the perched groundwater zone to remove contamination in both the liquid and gas phase. The perched groundwater plume has migrated approximately 250 ft to the south and up 200 ft southwest of the Pemaco property. Approximately 1.4 million gallons of contaminated groundwater is present within the impacted perched groundwater zone.

Extracted contaminated vapor will be pumped to the surface and treated onsite using a FTO unit. It is estimated that after one year, concentrations of poorly adsorbing chemicals (e.g., vinyl chloride) in the vapor phase will have decreased enough to safely change over to a GAC system for treatment of extracted vapors for the remainder of the cleanup.

Groundwater will be treated with a UV Ox system, possibly supplemented with GAC adsorption. The need for supplementary GAC to treat groundwater will be determined during the RD phase of the project. Also, similar to vapor treatment, GAC may eventually be used as a stand-alone technology for treatment of extracted groundwater if low-adsorptive compounds such as vinyl chloride are not present in the extracted groundwater at concentrations over MCLs.

It is estimated that the treatment system will operate for 5 years and require an additional 5 years of monitoring.

12.2.3 Selected Alternative for Lower Vadose Soils and Exposition Groundwater

Alternative SG5a – ERH with VE, Vacuum-Enhanced Groundwater Extraction, Groundwater P&T, MNA, UV Ox, FTO, and GAC

Treatment in this zone targets the highest concentrations of contamination found on the site as well as the entire groundwater dissolved-phase plume.

For the "core" or source area of contamination, an ERH system consisting of approximately 95 electrodes and 18 vapor extraction/groundwater extraction wells will be installed within the mapped isoconcentration contour line which represents 10,000 ug/L of TCE in groundwater. This area corresponds to the highest concentrations of COCs in both soil and groundwater within this deepest remediation zone (35-100 ft bgs). The ERH and associated vapor and groundwater extraction systems will address the principal threat soil and groundwater at the site. The electrodes and monitoring wells will be installed to a depth of 100 ft bgs. The system will include a 1,500 scfm blower for vapor extraction.

The dissolved-phase Exposition zone groundwater plume extends southwest of the Pemaco property and lies beneath a two-block residential housing area. A vacuum-enhanced groundwater pump-and-treat network will address VOCs within the mapped isoconcentration contour line which represents 1,000 ug/L of TCE in groundwater. This treatment network will consist of approximately 12 vacuum enhanced groundwater extraction wells installed into the 'A' zone (65 to 75 ft bgs) and the 'B' zone (80 to 100 ft bgs). Sampling conducted during late 2003 indicated that one well (MW 24) installed on the Pemaco property in the 'C' and 'D' zones, contained low contaminant concentrations. The State of California requested that EPA place an extraction well in this location. In response to this request, EPA will install an extraction well into the 'D' zone (approximately 120-140 ft bgs) and treat extracted groundwater from this zone.

Additional groundwater extraction wells will be installed to address groundwater contamination in the area between the mapped isoconcentration contour lines for 1,000 and 10 ug/L of TCE. MNA will be used outside the 10 ug/L TCE contour to demonstrate plume reduction and/or point of compliance.

FTO will be used to address the vapors extracted from the treatment systems with a change over to GAC when the vinyl chloride concentrations in the effluent have decreased to safe levels. EPA estimates that this switch-out should occur within one year.

Groundwater will be treated with a UV Ox system, possibly supplemented with GAC. The need for supplementary GAC to treat groundwater will be determined during the RD phase of the project. Also, similar to vapor treatment, GAC may eventually be used as a stand-alone technology for treatment of extracted groundwater if low-absorptive compounds such as vinyl chloride are not present in the extracted groundwater at concentrations over MCLs. The treated groundwater could be disposed by reinjection back into the aquifer, discharged to the sanitary sewer, or discharged to the LA River. EPA will comply with discharge requirements that are appropriate based on the option that is chosen during the design phase of the project.

Implementation of the remedy for the Lower Vadose Soils and Exposition Groundwater will allow flexibility for possible future use of *in situ* oxidation and/or *in situ* bioremediation of portions of the source area of the plume, after the ERH system has been removed. This "life-cycle" remedial component will only be used if the Agency determines, after completion of the ERH operation, that the additional implementation of *in situ* treatment is needed to augment or provide a "polishing step" for treatment of groundwater after the principal threat area has been treated.

It is estimated that ERH will require approximately one year for treatment of the source area. Vacuum-enhanced groundwater extraction and treatment, with the possibility of supplementary *in situ* chemical oxidation or enhanced bioremediation, is expected to continue for approximately 4 additional years. Groundwater monitoring is required for an additional 5 years for a total of 10 years.

12.2.4 Institutional Controls for the Pemaco Site

The Pemaco Superfund site is currently zoned for recreational use. In order to protect the integrity of the remedial action, the remedy for the site prohibits future residential use of the property. The current deed for the Pemaco property contains a covenant that prohibits residential use of the property. Because

groundwater contains contaminants above drinking water standards, the current deed for the Pemaco property also contains a restriction on use of groundwater at the Site. It prohibits the extraction of groundwater for use as drinking water or other domestic purposes. Allowable uses are limited to: (i) groundwater monitoring and remediation, (ii) dewatering or dust control during Park development activities (treated groundwater), and/or (iii) irrigation of the Park (treated groundwater). If after implementation of the remedy, hazardous waste will remain at the property at levels which are not suitable for unrestricted use of the land, additional institutional controls may be required in the form of a State of California Land Use Covenant with the City of Maywood.

12.2.5 Additional Actions

Based on comments received during the public comment period, the following activities will be included as part of the remedy implementation:

- Conduct indoor air sampling and additional vapor monitoring on Walker Avenue and 59th Street during remedial operations
- Conduct thorough vapor monitoring of the FTO unit and include dioxin and furans on the list of analytes
- A heat exchanger and a vapor phase carbon adsorption unit will be installed to the post-exhaust side of the FTO unit;
- In addition, if the agency determines that it is necessary to augment treatment of the of the principal threat source area, an in situ oxidation and/or in situ bioremediation polishing step will be implemented.
-

12.3 Summary of the Estimated Remediation Costs

The estimated costs for the selected remedy are presented in two parts.

- The cost estimate for Alternative N2 – Surface and Near-Surface Soil Remediation Zone is in Table 12-1.
- The cost estimate for Alternative SP2a – Upper Vadose Soil and Perched Groundwater Remediation Zone is in Table 12-2.
- The cost estimate for Alternative SG5a – Lower Vadose Soil and Exposition Groundwater Remediation Zone is in Table 12-3.

These tables present the subtotal capital and O&M costs organized according to the main components of the selected remedies. The total costs on a yearly basis, annual present worth, and total present worth costs are shown on the second page of each table under the Present Worth Analysis.

Uncertainty in Cost Estimates

All assumptions used in calculating the cost estimates are listed in the table footnotes and as follows:

- Instead of assuming a 10% contingency for project management and support in the Capital Costs section, a practice suggested in the EPA Guide to Preparing Superfund Proposed Plans, RODs, and Other Remedy Selection Decision Documents, Chapter 6, Page 6-43 (EPA 540-R-98-031, July 1999), the actual labor breakdown was estimated for equipment installation. The equipment installation labor

categories include: 1) construction management, 2) mechanical assembly and installation, 3) engineering, design, and inspection, and 4) project management. These four labor categories are intended to provide a more accurate description and estimate of labor costs than a general 10% contingency.

- Several cost items identified in the tables have been revised since the completion of the FS and Proposed Plan in accordance with design updates, receipt of new bids, and/or per ROD Guidance (EPA, 540-R-98-031).

- Considerable savings in both capital costs and O&M would be realized if both upper vadose zone remedial actions and the lower vadose zone remedial actions were implemented simultaneously. Several cost items are identified in the Tables that are duplicated for both the upper and lower vadose zone areas, e.g., purchase of an FTO. If both cleanup actions are implemented together, then cost savings of 1/2 the values shown would be realized for each zone being treated. Additional savings of approximately 25% could be realized from installation labor if cleanup actions from both zones are implemented together. There are other unquantifiable savings that could also occur as a result of shared construction costs, such as optimization of field effort during trenching and laying pipe.

Table 12-1 - Detailed Cost Summary of Remedial Alternative N2
Soil Cover/Revegetation
Surface and Near-Surface Soil Remediation Zone

Treatment System Equipment and Installation

Item N	Description	Quantity	Unit	Unit Rate	Total Cost	Source
Equipment, Materials, and Subcontractors						
1	Geophysical Clearance	1	lump sum	$2,200.00	$2,200	Spectrum Geophysics
2	Concrete Demolition, leave in place	1,450	sq. yard	$11.00	$15,950	RS Means
3	Fence Demolition and Haul (445 linear feet)	1	lump sum	$2,144.00	$2,144	RS Means
4	Vegetative Stripping and Subgrade Preparation	481	cubic yard	$1.34	$645	RS Means
5	Dust Control, light	4	day	$755.00	$3,020	RS Means
6	Vegetative Haul plus 30% LA traffic markup	481	cubic yard	$3.74	$1,801	RS Means
7	Backfill - delivered (1-ft. depth)	4,550	cubic yard	$22.50	$102,375	TN&A - quote for similar work
8	Grading - spread from pile to finish grade	4,550	cubic yard	$4.33	$19,702	RS Means
9	Geotextile barrier - Incl. materials and installation	9,717	sq. yard	$2.13	$20,697	RS Means
10	Surveying 2 crew, estab. grade, slope & cover thickness	8	day	$2,000.00	$16,000	RS Means
11	Top Soil - deliver/spread (4-in. depth)	1,080	cubic yard	$22.50	$24,300	TN&A - quote for similar work
12	Temp. Subsurface Irrigation System - 1spr. hd./ 225 s.f.	388	per head	$38.00	$14,744	RS Means
13	Grass Cover- via hydroseeding	87,454	sq. feet	$0.07	$6,122	RS Means
14	Heavy Equipment Mob/Demob	4	each	$250.00	$1,000	TN&A - quote for similar work
15	Misc. Landscaping and Erosion Control	1	lump sum	$25,153.00	$25,153	RS Means
16	Handling Fees (3%)	1	lump sum	$7,675.56	$7,676	T N & Associates
17	Contingency (10%)	1	lump sum	$25,585.19	$25,585	RS Means
	Subtotal (Equipment, Materials, and Subs)				**$289,113**	
Labor						
18	Construction Management	250	hour	$85.00	$21,250	T N & Associates
19	Engineering, Design, and Inspection	300	hour	$100.00	$30,000	T N & Associates
20	Project Management	160	hour	$110.00	$17,600	T N & Associates
	Subtotal (Labor)				**$68,850**	
TOTAL TREATMENT SYSTEM EQUIPMENT, INSTALLATION, SUBS, AND LABOR:					**$357,963**	

Assumptions:

1. Refer to the conceptual design for Alternative N2 (Section 3.4.1.2) for additional design information and assumptions.

2. There will be no disposal costs for fencing since it can be sold to recycler or reused by the City of Maywood.

3. There will be no disposal costs for stripped vegetation, since it can be composted and reused by the City of Maywood.

4. Hydroseeding was selected over sod for an estimated savings of approximately $35,000.

5. A geotextile barrier was selected to separate cover soil from underlying contaminants.

Table 12-1 - Detailed Cost Summary of Remedial Alternative N2
Soil Cover/Revegetation
Surface and Near-Surface Soil Remediation Zone

Annual Operation and Maintenance

Item N	Description	Quantity	Unit	Unit Rate	Total Cost	Source
O&M - Utilities, Materials, and Subs						
1	Vegetative Cover Maintenance and Repair	1	lump sum	$3,148.00	$3,148	RS Means
2	Brush Clearing - medium density	4	each	$1,100.00	$4,400	RS Means
3	Handling Fees (3%)	1	lump sum	$226.44	$226	T N & Associates
4	Contingency (10%)	1	lump sum	$754.80	$755	RS Means
	Subtotal (Equipment, Materials, and Subs)				**$8,529**	
Labor						
5	Quarterly Inspection	80	hours	$85.00	$6,800	T N & Associates
6	Monitoring and Reporting	50	hours	$100.00	$5,000	T N & Associates
7	Management of O&M	40	hours	$110.00	$4,400	T N & Associates
	Subtotal (Labor)				**$16,200**	
TOTAL ANNUAL OPERATION AND MAINTENANCE					**$24,729**	

Present Worth of Annual Operation and Maintenance

	Cost	Interest Rate	Years	**Present Worth**	
Total Present Worth of Annual O&M	24,729	4.25%	30	**$414,957**	Calculated using uniform series present worth factor.

Assumptions:

1. *Establishment of native vegetative cover is included in installation. Long-term irrigation is not planned.*
2. *Assumes that 5% of the cover surface (approx. 4,400 s.f.) will require fill and replanting (annually) due to erosional forces. Backfill for the repair area at a three inch depth is assumed (40 c.y.).*
3. *Brush cutting is assumed to take place quarterly.*
4. *Quarterly inspections would be performed and reported in conjunction with well monitoring. A memo report identifying areas of wear or erosion would be issued.*
5. *A 30-year project term was assumed for comparison purposes. The interest rate of 4.25% is the reported Prime Rate (Nov. 2002). Backfill for the repair area at a three inch depth is assumed (40 c.y.).*

Table 12-2. Detailed Cost Summary for Remedial Alternative SP2a
High-Vacuum Dual-Phase Extraction / Ultraviolet Oxidation / Flameless Thermal Oxidation / Granular Activated Carbon
Upper Vadose Soil and Perched Groundwater Remediation Zone

Capital Costs

Item No.	Description	Quantity	Unit	Unit Rate	Cost	Notes
HVDPE Equipment, Materials, and Subcontractors						
1	Trmt. Compound - Concrete Contain., Steel Bldg., Fencing, Lights	1	lump sum	$58,568.00	$58,568	♦
2	Utility Connections (electric, gas, sewer)	1	lump sum	$29,220.00	$29,220	
3	Mobilization/Demobilization	2	each	$5,200.00	$10,400	
4	1500 ACFM High Vac. Extraction System	1	lump sum	$141,346.50	$141,347	♦♦
5	Well Installation, 4" dia.	32	each	$3,500.00	$112,000	
6	Piping Network, Manifold, Valves	1	lump sum	$34,861.80	$34,862	
7	Trenching and Backfill, 8" wide trench, 24" deep	4,500	linear feet	$2.18	$9,810	
8	Installation and Start-Up	50	hour	$65.00	$3,250	
9	Site Restoration	1	lump sum	$60,000.00	$60,000	♦
10	Confirmation Soil Borings and Analytical Services	1	lump sum	$34,574	$34,574	
Flameless Thermal Oxidizer (FTO) Equipment and Installation						
11	Alzeta QR 1500 ACFM	1	lump sum	$351,244	$351,244	♦♦
UV Ox. Equipment, Materials, & Subcontractors						
12	Bench Test/Mob./Installation/Start-Up/Demob.	1	lump sum	$23,463.30	$23,463	♦♦
13	Rayox Reactor System w/PreTrmt. Flow rated to 50 gpm.	1	lump sum	$156,422.00	$156,422	♦
14	Discharge Conveyance System	1	lump sum	$9,810.00	$9,810	
Vapor Phase GAC, Equipment, Materials, & Subcontractors						
15	Mobilization/Installation/Start-Up/Demob.	1	each	$14,749.20	$14,749	
16	3000 lb Vapor Phase GAC Vessels (full)	2	lump sum	$7,650.00	$15,300	♦
	Subtotal				$1,065,019	
17	Contingency Allowance (15%)	1	lump sum	$156,188.90	$156,189	
Subtotal (Equipment, Materials, and Subs)					**$1,221,207**	
Equipment Installation Labor						
18	Construction Management	930	hour	$85.00	$79,050	♦
19	Mechanical Assembly and Installation	360	hour	$85.00	$30,600	
20	Engineering, Design, and Inspection	400	hour	$100.00	$40,000	♦
21	Project Management	330	hour	$110.00	$36,300	
Subtotal (Installation Labor)					**$185,950**	
TOTAL CAPITAL COSTS AND INSTALLATION:					**$1,407,157**	

♦ *Indicates items that have been revised since the completion of the FS and Proposed Plan in accordance with design updates, receipt of new bids, and/or per ROD Guidance (EPA Doc. 540-R-98-031).*
Line Items 1 and 9 were increased in response to community concerns to provide a building that eliminates potential sound and visual nuisances at the property.
Line Items 4, 11, 12, 13, and 16 were increased to accommodate increased design knowledge and treatment capacity; design vapor flow was increased from 1000 ACFM to 1500 ACFM.
Line Items 18 and 20 were reduced to reflect a decrease in contingency as project knowledge is increased.
Line Items 18-21 are considered more accurate substitutions for the ROD Guidance Document's project mgmt. and support contingency of 10%.

♦♦ *Indicates items that are duplicated in the cost estimate for the lower vadose soil and exposition groundwater. If both alternatives are implemented together, then cost savings of 1/2 the values shown would be realized for each alternative. Additional savings of approximately 25% could be realized from Installation Labor if both alternatives are implemented together.*

Assumptions:

1. *This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost. It was based on the best available information regarding the anticipated scope of the remedial alternative. Major changes may occur and may be documented in the form of a memo in the Administrative Record file, an ESD, or a ROD amendment.*
2. *Refer to the Conceptual Design for Alternative SP2 for additional design information and assumptions.*
3. *Concentrations of 1,4 dioxane in perched groundwater would not adsorb efficiently to vapor phase carbon and is therfore best treated using UV oxidation.*
4. *This alternative assumes high VOC mass loading during the first year of operation would be most effectively and efficiently treated using FTO (for vapor) and UV oxidation (for groundwater). After approximately one year of remediation, the vapor treatment system could be switched to GAC - a more cost effective option for lower contaminant loading.*
5. *Confirmation soil sampling is included above, confirmation groundwater sampling is included under O&M.*
6. *The confirmation soil borings would be spaced one boring per 100' x 100' foot grid for 16 boring locations for the perched zone. Seven samples would be collected per boring at approximate five-foot intervals to a depth of 35 feet bgs (5' to 35' bgs).*

Table 12-2. Detailed Cost Summary for Remedial Alternative SP2a
High-Vacuum Dual-Phase Extraction / Ultraviolet Oxidation / Flameless Thermal Oxidation / Granular Activated Carbon
Upper Vadose Soil and Perched Groundwater Remediation Zone

Annual Operation and Maintenance Costs

Item No.	Description	Quantity	Unit	Unit Rate	Cost	Notes
Flameless Thermal Oxidizer (Annual Cost, 1 Year)						
1	Electrical Consumption	170,820	kWH	$0.18	$30,748	
2	Water Consumption	8,496	100 c.f.	$1.67	$14,187	♦
3	Gas Consumption	266,742	therm	$0.69	$184,052	♦
4	Sodium Hydroxide (25%)	38,544	gal	$1.10	$42,398	♦
5	Alzeta Service Plan/Start Up Testing/Mob/Demob.	1	lump sum	$31,068.00	$31,068	
6	Laboratory Analysis of Vapor Discharge	12	month	$6,587.00	$79,044	
7	Laboratory Analysis of Water Discharge	12	month	$500	$6,000	
	Subtotal				$387,497	
8	Contingency Allowance (15%)	1	lump sum	$58,124.62	$58,125	♦
Subtotal (FTO Annual O&M Costs, 1-Year)					**$445,622**	♦♦
Vapor Phase GAC System (Annual Costs, 4 Years)						
9	Replacement Carbon (average yearly, over 4 years)	24,000	lbs	1.15	$27,600	♦
10	Carbon Analytical Profiling	8	per vessel	350.00	$2,800	♦
11	Carbon Disposal (average yearly, over 4 years)	24,000	lbs	0.60	$14,400	♦
12	Laboratory Analysis of Vapor Discharge	12	month	1,867.14	$22,406	
	Subtotal				$67,206	
13	Contingency Allowance (15%)	1	lump sum	$10,080.85	$10,081	♦
Subtotal (GAC Annual O&M Costs, 4-Years)					**$77,287**	
HVDPE System (Annual Costs, 5 Years)						
14	Electrical Consumption	536,550	kWH	$0.18	$96,579	♦ ♦♦
15	Maintenance and Service (Average for 5 yrs.)	1	lump sum	$5,550.00	$5,550	
16	Mechanical, Pipe, Valves, Parts (Average for 5 yrs.)	1	lump sum	$6,972.36	$6,972	
UV Oxidation System (Annual Costs, 5 Years)						
17	Electrical Consumption	490,341	kWH	$0.18	$88,261	♦
18	Peroxide, Delivered as 35% Solution (in lbs)	18,797	lbs	$0.33	$6,146	♦
19	Maintenance, Parts, Lamp Replacement (Avg. for 5 year)	1	lump sum	$6,968.50	$6,969	♦
20	Laboratory Analysis of Water Discharge	12	month	$500.00	$6,000	
O&M Labor (Annual Costs, 5 Years)						
21	Weekly Inspection and Monitoring	1,240	hours	85.00	$105,400	
22	Data Processing and Reporting	840	hours	100.00	$84,000	
23	Management of O&M	480	hours	110.00	$52,800	
	Subtotal				$458,678	
24	Contingency Allowance (15%)	1	lump sum	$68,801.66	$68,802	♦
Subtotal (Annual O&M Costs, 5-Years)					**$527,479**	
Groundwater Monitoring (Annual Costs, 10 Years)						
25	(2) Semiannual GW Sampling Events, Incl. Some soil	85	each	$227.20	$19,312	
26	GW Monitoring, Data Tabulation,& Reporting Labor	320	hours	85.00	$27,200	
	Subtotal				$46,512	
27	Contingency Allowance (15%)	1	lump sum	$6,976.80	$6,977	♦
Subtotal (GW Monitoring Annual O&M Costs, 10-Years)					**$53,489**	

Table 12-2. Detailed Cost Summary for Remedial Alternative SP2a
High-Vacuum Dual-Phase Extraction / Ultraviolet Oxidation / Flameless Thermal Oxidation / Granular Activated Carbon
Upper Vadose Soil and Perched Groundwater Remediation Zone

Present Worth Analysis

Year	Capital Cost	FTO O&M, 1st Year	Carbon O&M Years 2-4	HVDPE Sys. O&M, Years 1-5	GW Monitor Years 1-10	Total Costs	Discount Factor (4.5%)	Present Worth
0	$1,407,157					$1,407,157	1.00	$1,407,157
1		$445,622		$527,479	$53,489	$1,026,590	0.96	$982,383
2			$77,287	$527,479	$53,489	$658,255	0.92	$602,784
3			$77,287	$527,479	$53,489	$658,255	0.88	$576,826
4			$77,287	$527,479	$53,489	$658,255	0.84	$551,987
5			$77,287	$527,479	$53,489	$658,255	0.80	$528,217
6					$53,489	$53,489	0.77	$41,074
7					$53,489	$53,489	0.73	$39,305
8					$53,489	$53,489	0.70	$37,613
9					$53,489	$53,489	0.67	$35,993
10					$53,489	$53,489	0.64	$34,443
Totals	$1,407,157	$445,622	$309,146	$2,637,397	$534,888	$5,334,210		$4,837,781
TOTAL PRESENT WORTH:								**$4,837,781**

♦ *Indicates items that have been revised since the completion of the FS and Proposed Plan in accordance with design updates, receipt of new bids, and/or per ROD Guidance (EPA Doc. 540-R-98-031).*
Line Items 2-4, 9-11, and 14-19, were increased to accommodate increased design knowledge and treatment capacity; design vapor flow was increased from 1000 ACFM to 1500 ACFM.
Line Items 8, 13, 24, and 27 are less than the 25% contingency allowance that the ROD Guidance document prescribes because DPE is a technology frequently applied to other Superfund Sites and good cost data was available for the preparation of this estimate.
Line Items # 21-23 and 26 are considered more accurate substitutions for the ROD Guidance Document's project mgmt. and support contingency of 15% for O&M.

♦♦ *Indicates items that are duplicated in the cost estimate for the lower vadose soil and exposition groundwater. If both alternatives are implemented together, then cost savings of 1/2 the values shown would be realized for each alternative. Additional cost savings of approximately 25% could be realized from O&M Labor if both alternatives are implemented together.*

Assumptions:

1. *The estimated 5-year HVDPE project duration was calculated based on anticipated contaminant extraction rates. An additonal 5 years of monitoring is typical.*
2. *Electrical rate for small business were provided by Southern California Edison (Los Angeles) and range from $.14 - $.21/kWH.*
3. *Semiannual groundwater sampling would be performed on 32 wells and the analysis would be for VOCs via EPA Methods 8260B.*
4. *Carbon useage is based on FS Table 3.4 of Appendix B (Groundwater Extraction Design Summary For The Upper Vadose and Perched Groundwater Zone).*
5. *Weekly inspections will be performed and reported in conjunction with the remediation system monitoring and compliance sampling.*
6. *Costs are based on 2004 dollars. The discount factor (4.5%) used in the present worth calculations is the reported Prime Rate (July 2004). Any effect that an increase in inflation may have on project costs over its duration was assumed to be cancelled by a similar anticipated rise in interest rates.*

Table 12-3. Detailed Cost Summary for Remedial Alternative SG5a
Electrical Resistance Heating with Vapor Extraction / Vacuum-Enhanced Groundwater Extraction / Groundwater Pump and Treat / Monitored Natural Attenuation / Ultraviolet Oxidation / Flameless Thermal Oxidation / Granular Activated Carbon
Lower Vadose Soil and Exposition Groundwater Remediation Zone

Capital Costs

Item No.	Description	Quantity	Unit	Unit Rate	Cost	Notes
Elec. Resistance Heating						
1	Control compound for PDS, security fencing, com.	1	lump sum	$53,758	$53,758	♦
2	Utility connection (High Volt Electric and water)	1	lump sum	$29,284	$29,284	
3	Mobilization/Demob.	2	each	$20,000.00	$40,000	
4	Preliminary Resistivity Testing & Design	1	lump sum	$16,573.00	$16,573	
5	Pilot Study - 12 electrode, install, monitor, report, trmt.	1	lump sum	$318,953.00	$318,953	
6	Full Scale Ops. - 78 elec., 26 borings, utils., controls	1	lump sum	$1,010,061.00	$1,010,061	♦
7	SVE Extraction System - 8 wells, 4 in., piping, trench.	1	lump sum	$143,362.32	$143,362	♦
8	Confirmation Soil Borings and Analytical Services	1	lump sum	$39,760	$39,760	♦
Flameless Thermal Oxidizer (FTO)						
9	Alzeta QR 1500 ACFM	1	lump sum	$351,244	$351,244	♦ ♦♦
Vacuum Enhanced GW Extract Equip.,Materials, and Subs						
10	Trmt. Compound - Concrete Contain., Steel Bldg., Fencing, Lights	1	lump sum	$58,568.00	$58,568	♦
11	Utility Connections (all systems - gas, elec., sewer)	1	lump sum	$29,220.00	$29,220	
12	Mobilization/Demobilization	4	each	$5,200.00	$20,800	
13	1500 ACFM High Vac. Extraction System	1	lump sum	$122,910.00	$122,910	♦ ♦♦
14	Well Installation, 6" dia.	36	each	$15,785.00	$568,260	♦
15	Piping Network, Manifold, Valves	1	lump sum	$43,807.00	$43,807	
16	Trenching and Backfill, 8" wide trench, 24" deep	3,324	linear feet	$2.18	$7,246	
17	Installation and Start-Up	100	hour	$65.00	$6,500	
18	High Temp Well Pump AP4, 316 SS Housing	12	each	$3,882.45	$46,589	♦
19	Regular Well Pump - AP4, FRP Housing	24	each	$2,391.68	$57,400	♦
20	Compressor, controls, nyl. Jacket tube, cable, fittings	1	lump sum	$67,036.61	$67,037	
21	Site Restoration and Well Destruction	1	lump sum	$75,000.00	$75,000	♦
22	Confirmation Soil Sampling after Treatment	1	lump sum	$34,574	$34,574	
UV Ox. Equipment, Materials, & Subcontractors						
22	Bench Test/Mob./Installation/Start-Up/Demob.	1	lump sum	$23,463.30	$23,463	
23	Rayox Reactor System w/PreTrmt. Flow rated to 60 gpm.	1	lump sum	$195,527.50	$195,528	♦
24	Discharge Conveyance System	1	lump sum	$9,810.00	$9,810	
Vapor Phase GAC (Installed Yr 2) Equipment, Materials, & Subcontractors						
24	Mobilization/Installation/Start-Up/Demob.	1	each	$23,463.30	$23,463	
25	8000 lb Vapor Phase GAC Vessels (full)	2	lump sum	$10,400.00	$20,800	♦
	Subtotal				$3,413,971	
26	Contingency Allowance (15%)	1	lump sum	$512,095.62	$512,096	
Subtotal (Equipment, Materials, and Subs)					**$3,926,066**	
Equipment Installation Labor						
27	Construction Management, Well Installation	1,250	hour	$85.00	$106,250	♦
28	Mechanical Assembly and Installation	400	hour	$85.00	$34,000	♦
29	Engineering, Design, and Inspection	650	hour	$100.00	$65,000	♦
30	Project Management	400	hour	$110.00	$44,000	♦
Subtotal (Installation Labor)					**$249,250**	
TOTAL CAPITAL COSTS AND INSTALLATION:					**$4,175,316**	

♦ *Indicates items that have been revised since the completion of the FS and Proposed Plan in accordance with design updates, receipt of new bids, and/or per ROD Guidance (EPA Doc. 540-R-98-031).*
Line Items 1, 10, and 21 were increased in response to community concerns, to provide a treatment building that eliminates potential sound and visual nuisances at the park property.
Line Items 6, 7, and 8 were decreased due to review of soil resistivity data and corresponding increase in electrode ROI to 13 ft.
Line Items 9, 13, 14, 18, 19, 23, and 25 were increased to accommodate increased design knowledge and treatment capacity; design vapor flow was increased from 1000 ACFM to 1500 ACFM.
Line Items # 27-30 are considered more accurate substitutions for the ROD Guidance Document's project mgmt. and support contingency of 10%.

♦♦ *Indicates items that are duplicated in the cost estimate for the upper vadose soil and perched groundwater. If both alternatives are implemented together, then cost savings of 1/2 the values shown would be realized for each alternative. Additional cost savings of approximately 25% could be realized from Installation Labor if both alternatives are implemented together.*

Assumptions:

1. *This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost. It was based on the best available information regarding the anticipated scope of the remedial alternative. Major changes may occur and may be documented in the form of a memorandum in the Administrative Record file, an ESD or a ROD amendment.*
2. *Refer to the Conceptual Design for Alternative SP5 for additional design information and assumptions.*
3. *The ERH pilot scale and full scale operations include all drilling, power modules, utility costs, O&M, data collection, and reporting. The 1-year ERH timeframe was provided by two vendors.*
4. *Anticipated initial concentrations of 1,4 dioxane and vinyl chloride in extracted groundwater and vapor would not adsorb efficiently to GAC, and would require treatment by other methods.*
5. *This alternative assumes high VOC mass loading during the first year of operation would be most effectively and efficiently treated using FTO (for vapor) and UV oxidation (for groundwater). After approximately one year of remediation, the vapor treatment system could be switched to GAC - a more cost effective option for lower contaminant loading.*
6. *The confirmation soil borings would be spaced one boring per 100' x 100' foot grid for 16 boring locations for the deep zone. Eight samples would be collected per boring at approximate five-foot intervals to a depth of 95 feet bgs (60' to 95' bgs).*

Table 12-3. Detailed Cost Summary for Remedial Alternative SG5a
Electrical Resistance Heating with Vapor Extraction / Vacuum-Enhanced Groundwater Extraction / Groundwater Pump and Treat / Monitored Natural Attenuation / Ultraviolet Oxidation / Flameless Thermal Oxidation / Granular Activated Carbon
Lower Vadose Soil and Exposition Groundwater Remediation Zone

Annual Operation and Maintenance Costs

Item No.	Description	Quantity	Unit	Unit Rate	Cost	Notes	
Flameless Thermal Oxidizer (Annual Cost, 1 Year)							
1	Electrical Consumption	346,896	kWH	$0.18	$62,441		
2	Water Consumption	24,312	100 c.f.	$1.67	$40,601		
3	Gas Consumption	304,848	therm	$0.69	$210,345		
4	Sodium Hydroxide (25%)	72,270	gal	$1.10	$79,497	♦	
5	Alzeta Service Plan/Start Up Testing/Mob/Demob	1	lump sum	$31,068.00	$31,068		
6	Laboratory Analysis of Vapor Discharge	12	month	$6,587.00	$79,044		
7	Laboratory Analysis of Water Discharge	12	month	$500	$6,000		
	Subtotal				$508,996		
8	Contingency Allowance (15%)	1	lump sum	$76,349.47	$76,349	♦	
Subtotal (FTO Annual O&M Costs, 1-Year)					**$585,346**	♦	♦♦
Vapor Phase GAC System (Annual Costs, 4 Years)							
9	Replacement Carbon (average yearly, over 4 years	104,000	lbs	1.15	$119,600	♦	
10	Carbon Analytical Profiling	35	per vessel	350.00	$12,133		
11	Carbon Disposal (average yearly, over 4 years)	104,000	lbs	0.60	$62,400	♦	
12	Laboratory Analysis of Vapor Discharge	12	month	1,867.14	$22,406		
	Subtotal				$216,539		
13	Contingency Allowance (15%)	1	lump sum	$32,480.85	$32,481	♦	
Subtotal (GAC Annual O&M Costs, 4-Years)					**$249,020**		
Vacuum Enhanced GW Extract (Annual Costs, 5 Years)							
14	Electrical Consumption	670,688	kWH	$0.18	$120,724	♦	♦♦
15	Maintenance and Service (Average for 5 yrs.)	1	lump sum	$7,400.00	$7,400	♦	
16	Mechanical, Pipe, Valves, Parts (Average for 5 yrs	1	lump sum	$6,720.00	$6,720	♦	
UV Oxidation System (Annual Costs, 5 Years)							
17	Electrical Consumption	686,477	kWH	$0.18	$123,566	♦	
18	Peroxide, Delivered as 35% Solution (in lbs)	56,390	lbs	$0.33	$18,439	♦	
19	Maintenance, Parts, Lamp Replacement (Avg. for	1	lump sum	$10,452.75	$10,453	♦	
20	Laboratory Analysis of Water Discharge	12	month	$500.00	$6,000		
O&M Labor (Annual Costs, 5 Years)							
21	Weekly Inspection and Monitoring	1,240	hours	85.00	$105,400		
22	Data Processing and Reporting	840	hours	100.00	$84,000		
23	Management of O&M	480	hours	110.00	$52,800		
	Subtotal				$535,502		
24	Contingency Allowance (15%)	1	lump sum	$80,325.28	$80,325	♦	
Subtotal (Annual O&M Costs, 5-Years)					**$615,827**		
Groundwater Monitoring (Annual Costs, 10 Years)							
25	(2) Semiannual GW Sampling Events, Incl. Some	93	each	$227.20	$21,021		
26	GW Monitoring, Data Tabulation,& Reporting Lal	320	hours	85.00	$27,200	♦	
	Subtotal				$48,221		
27	Contingency Allowance (15%)	1	lump sum	$7,233.08	$7,233	♦	
Subtotal (GW Monitoring Annual O&M Costs, 10-Years)					**$55,454**		

Table 12-3. Detailed Cost Summary for Remedial Alternative SG5a
Electrical Resistance Heating with Vapor Extraction / Vacuum-Enhanced Groundwater Extraction / Groundwater Pump and Treat / Monitored Natural Attenuation / Ultraviolet Oxidation / Flameless Thermal Oxidation / Granular Activated Carbon
Lower Vadose Soil and Exposition Groundwater Remediation Zone

Present Worth Analysis

Year	Capital Cost	FTO O&M, 1st Year	Carbon O&M Years 2-4	Vacuum Enhanced GW Extract O&M, Years 1-5	GW Monitor & MNA Years 1-10	Total Costs	Discount Factor (4.5%)	Present Worth
0	$4,175,316					$4,175,316	1.00	$4,175,316
1		$585,346		$615,827	$55,454	$1,256,627	0.96	$1,202,514
2			$249,020	$615,827	$55,454	$920,301	0.92	$842,747
3			$249,020	$615,827	$55,454	$920,301	0.88	$806,456
4			$249,020	$615,827	$55,454	$920,301	0.84	$771,729
5			$249,020	$615,827	$55,454	$920,301	0.80	$738,496
6					$55,454	$55,454	0.77	$42,583
7					$55,454	$55,454	0.73	$40,749
8					$55,454	$55,454	0.70	$38,994
9					$55,454	$55,454	0.67	$37,315
10					$55,454	$55,454	0.64	$35,708
Totals	$4,175,316	$585,346	$996,079	$3,079,136	$554,536	$9,390,414		$8,732,607
TOTAL PRESENT WORTH:								**$8,732,607**

♦ *Indicates items that have been revised since the completion of the FS and Proposed Plan in accordance with design updates, receipt of new bids, and/or per ROD Guidance (EPA Doc. 540-R-98-031).*

Line Items 4, 9, 11, 14, and 15-19 were increased to accommodate increased design knowledge and treatment capacity; design vapor flow was increased from 1000 ACFM to 1500 ACFM.

Line Items 8, 13, 24, and 27 are less than the 25% contingency allowance that the ROD Guidance document prescribes because increased knowledge and detailed bids have been reviewed for O&M since the FS and Proposed Plan.

Line Items # 21-23 and 26 are considered more accurate substitutions for the ROD Guidance Document's project mgmt. and support contingency of 15% for O&M.

♦♦ *Indicates items that are duplicated in the cost estimate for the lower vadose soil and exposition groundwater. If both alternatives are implemented together, then cost savings of 1/2 of the values shown would be realized for each alternative. Additional cost savings of approximately 25% could be realized from O&M Labor if both alternatives are implemented together.*

Assumptions:

1. The estimated 5-year vacuum enhanced groundwater extraction project duration was calculated based on anticipated contaminant extraction rates. An additional 5 years of monitoring is typical.

2. Electrical rate for small business were provided by Southern California Edison (Los Angeles) and range from $.14 - $.21/kWH.

3. Semiannual groundwater sampling would be performed on 36 wells and the analysis would be for VOCs via EPA Methods 8260B.

4. Weekly inspections will be performed and reported in conjunction with the remediation system monitoring and compliance sampling.

5. Costs are based on 2004 dollars. The discount factor (4.5%) used in the present worth calculations is the reported Prime Rate (July 2004). Any effect that an increase in inflation may have on project costs over its duration was assumed to be cancelled by a similar anticipated rise in interest rates.

- A remedial action start date of 2005 was assumed, which is identified as year 0 in the Present Worth Analysis. In the first year, all capital expenditures are assumed to be made. O& M costs are assumed to begin in 2006, which is identified as year 1. The actual start date for capital expenditures and O&M expenditures may be later and may overlap.
- The overall duration of the remedial action was assumed to be 10 years for both vadose zone and groundwater alternatives, comprised of 5 years of active remediation (HVDPE for Alternative SP2a and ERH combined with vacuum enhanced groundwater extraction for Alternative SG5a) and 5 years of groundwater monitoring.
- All costs (undiscounted) were estimated in 2004 dollars.
- The discount factor (4.5%) used in the present worth calculations is the reported Prime Rate (July 2004). Any effect that an increase in inflation may have on project costs over its duration was assumed to be cancelled by a similar anticipated rise in interest rates.

Major sources of uncertainty in the cost estimates include:

- The actual configuration of technologies and sequence of technologies used will be determined during RD. Final selection of some of these technologies will be based on the outcome of treatability studies to be performed during the RD.
- Whether the RD can be implemented in coordinated concert with grading activities by others associated with the Maywood Riverfront Park construction or whether remedial site work will have to be done separately.
- The actual mass of contaminants beneath the site and the degree to which the remedial methods actually mobilize and remove it under site-specific conditions.
- The actual ROI of the ERH electrodes and the vapor and groundwater extraction wells.
- The ability to install wells and electrodes at the desired locations or whether special designs must be created to avoid subsurface obstructions, utilities, or private property.
- The ability to treat the extracted contaminants simply with one process or whether multiple processes must be used for different recalcitrant compounds.
- Utility costs and the amount of water that may be discharged to sanitary sewer or storm drain.
- The extent, type, and duration of treatment system monitoring.
- The duration of remedial action.
- Site security requirements.
- Duration of groundwater monitoring at the site.

The cost summary tables are based on the best available information regarding the anticipated scope of the remedial action. Changes in the cost elements are likely to occur as a result of the new information and data collected during the RD phase. Major changes may be documented in the form of a memorandum to the Administrative Record file, an Explanation of Significant Differences or a ROD amendment. The projected cost is based on an order-of-magnitude engineering cost estimate that is expected to be within +50 or -30 percent of the actual project cost.

12.4 Expected Outcome of Selected Remedy

The selected alternative for surface and near-surface soil remediation zone (0-3 ft bgs) will eliminate or minimize the potential for exposure to residual surface and subsurface non-VOC contamination. The outcome will be suitable for the proposed use of the property as a public park.

The selected alternatives for both the Upper Vadose Soils and the Perched Groundwater (3-35 ft bgs) and Lower Vadose Soils and Exposition Groundwater (35-100 ft bgs) are expected to remove existing VOC contamination to levels that prevent impact to the groundwater, and the indoor and outdoor air quality above ground.

The contaminated groundwater under Pemaco is characterized as shallow groundwater of poor quality water (*e.g.,* due to high background levels of sulfate, chloride and total dissolved solids). Although the impacted groundwater zones are not currently used as a drinking water source, Pemaco is located within a groundwater basin (the Central Basin) that is designated by the Water Quality Control Plan for the Los Angeles Region (the Basin Plan) as having beneficial uses for drinking water, agricultural, industrial processes, and industrial services. There are no other potential beneficial uses associated with groundwater in the impacted zones underlying Pemaco. The potential for groundwater at Pemaco being used as a drinking water source, is the most conservative scenario used as a basis for the reasonable exposure assessment assumptions and risk characterization conclusions that prompted the remedial action objectives for Pemaco. This remedy also prohibits residential development of the former Pemaco property. Once implemented, the selected remedy for groundwater will protect the existing beneficial uses of the currently uncontaminated deeper aquifers and will remove VOC contamination above drinking water standards in the currently impacted groundwater zones.

13.0 Statutory Determinations

Under CERCLA §121 and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements (unless a statutory waiver is justified), are cost-effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduce the volume, toxicity, and mobility of hazardous wastes as a principal element and a bias against offsite disposal of untreated wastes.

13.1 Protection of Human Health and the Environment

13.1.1 Surface and Near-Surface Soil Remediation Zone

The selected remedy for the Surface and Near-Surface Soil Remediation Zone, Alternative N2 (Soil Cover/Revegetation), will protect human health and the environment by eliminating exposure pathways to COCs through the addition of a 1-foot soil cover followed by a vegetative cover. A non-woven geotextile layer below the soil cover will enhance this remedy by acting as an indicator of excessive erosion. Migration of COCs to groundwater as a result of percolation is considered a minor concern since the COCs (PAHs, metals) are characteristically non-mobile. Additionally, the percolation of water through these soils would create favorable conditions for natural bioattenuation of the organic COCs over time.

The cumulative excess carcinogenic risk from exposure to surface soils (future park user scenario) is estimated at 7.9E -05 with a non-carcinogenic HI of 3.1E -01. The estimated carcinogenic risks fall in the

middle of the EPA target risk range of 10E-04 to 10E-06. The total noncarcinogenic HI is well below the target level of 1.0, thus indicating that noncarcinogenic adverse effects to human health would be unlikely. The soil and vegetative cover will reduce the carcinogenic and noncarcinogenic risks to even lower levels by providing a barrier between potential receptors and COCs present within this remediation zone.

13.1.2 Upper Vadose Soil and Perched Groundwater Remediation Zone

The selected remedy for this remediation zone, Alternative SP2a (HVDPE/UV Ox/FTO/GAC), will protect human health and the environment by removing COCs within both the soil column and the perched groundwater zone. The reduction of COCs in both media would eliminate pathways of human exposure via volatilization to the surface (indoor/outdoor air quality) and via migration of COCs to deeper groundwater zones (potential migration to local production wells).

The cumulative excess carcinogenic risk from exposure to upper vadose soils (excavation worker scenario) is estimated at 6.9E -06 with a non-carcinogenic HI of 1.2E -01. The estimated carcinogenic risks falls in the lower end of the EPA target risk range of 10E-04 to 10E-06. The total noncarcinogenic HI is well below the target level of 1.0, thus indicating that noncarcinogenic adverse effects to human health would be unlikely. The removal of COCs via HVDPE will reduce the carcinogenic and noncarcinogenic risks to even lower levels.

Estimates of carcinogenic risk based on vapor intrusion modeling from maximum observed shallow soil gas concentrations also gave estimates of cancer risk within the EPA target range, as well as a noncancer hazard estimate well below the threshold level of 1.0.

13.1.3 Lower Vadose Soil and Exposition Groundwater Remediation Zone

The selected remedy for this remediation zone, Alternative SG5a (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/FTO/GAC), will protect human health and the environment by removing COCs within both the lower vadose soil column and the Exposition groundwater zones. The physical removal of COCs would effectively eliminate all exposure pathways and the potential for migration of COCs to local production wells and/or regional aquifer systems. Alternative SG5a is the only alternative assembled for this remediation zone capable of eliminating the site's principal threat wastes, namely lower vadose zone soils that contain NAPL or high concentrations of residual contamination, in addition to effectively treating the extracted vapor stream via FTO.

Although the impacted Exposition groundwater zones are not currently used as a drinking water source, Pemaco is located within a groundwater basin (the Central Basin) that is designated by the Water Quality Control Plan for the Los Angeles Region (the Basin Plan) as having beneficial uses for drinking water, agricultural, industrial processes, and industrial services. Once implemented, the selected remedy for groundwater will protect the existing beneficial uses of the currently uncontaminated deeper aquifers and will remove VOC contamination above drinking water standards in the currently impacted groundwater zones.

The cumulative excess carcinogenic risk from exposure to Exposition groundwater is estimated at 1.6E -01 with a non-carcinogenic HI of 1.8E +03. The total noncarcinogenic HI also greatly exceeded the target level of 1.0, thus indicating that noncarcinogenic adverse effects to human health would be possible. The removal of COCs in both lower vadose soils and Exposition groundwater via ERH with VE and

groundwater P&T will reduce contamination to meet the protective state and federal drinking water standards.

13.2 Compliance with Applicable or Relevant and Appropriate Requirements

Remedial actions selected under CERCLA must comply with ARARs under federal environmental laws, or where more stringent than the federal requirements, state environmental or facility siting laws. Where a state has been delegated authority to enforce a federal statute, such as RCRA, the delegated portions of the statute are considered to be a federal ARAR unless the state law is broader or more stringent than the federal law.

The ARARs are identified on a site-specific basis from information about site-specific chemicals, specific actions that are being considered, and specific site location features. There are three categories of ARARs: 1) chemical-specific requirements, 2) location-specific requirements, and 3) action specific requirements. Where there are no chemical-, location-, or action-specific ARARs, EPA may consider non-promulgated federal or state advisories and guidance as to-be-considered (TBC) criteria. Although consideration of a TBC criteria is not required, standards based on TBCs that have been selected and adopted in a ROD are legally enforceable as performance standards.

Chemical-specific ARARs are risk-based standards or methodologies that may be applied to site-specific conditions and result in the development of cleanup levels for the COCs at Pemaco.

Location-specific ARARs are restrictions placed on the chemical contaminant or the remedial activities based on a geographic or ecological feature. Examples of features include wetlands, floodplains, sensitive ecosystems and seismic areas.

Action-specific ARARs are usually technology- or activity-based requirements. They are triggered by the particular remedial activities selected to accomplish a remedy.

A summary of ARARs and adopted TBCs for the selected remedies are presented in Table 13-1.

13.3 Cost Effectiveness

In EPA's judgment, the selected remedies for the three remediation zones are cost-effective and present reasonable values. According to the NCP, a remedy is cost-effective if its costs are proportional to its overall effectiveness. The overall effectiveness of the selected remedies was demonstrated in the comparative analysis of the alternatives within each remediation zone. The selected remedies satisfy the threshold criteria (overall protectiveness and compliance with ARARs), while scoring high with respect to three of the five balancing criteria (long-term effectiveness; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness).

The overall effectiveness of the alternatives was then evaluated with respect to the respective cost estimates.

13.3.1 Surface and Near-Surface Soil Remediation Zone

Although the selected remedy for the Surface and Near-Surface Soil Remediation Zone, Alternative N2 (Soil Cover/Revegetation) does not involve the removal or treatment of surface and near-surface soils, the containment of COCs in this remediation zone provides a significant increase in the protection of human health and the environment.

The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence this alternative represents a reasonable value for the money to be spent.

13.3.2 Upper Vadose Soil and Perched Groundwater Remediation Zone

The selected remedy for this remediation zone, Alternative SP2a (HVDPE/UV Ox/FTO/GAC), has the highest total present worth cost of the remedial alternatives for this remediation zone. However, this remedy uses the best suited technologies for this remediation zone because it works well in both saturated and unsaturated conditions. The selected remedy provides effective and permanent solutions to both soil and groundwater in a relatively short time-frame and is therefore considered cost effective, relative to other alternatives.

13.3.3 Lower Vadose Soil and Exposition Groundwater Remediation Zone

The selected remedy for this remediation zone, Alternative SG5a (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/FTO/GAC), is estimated to be the most effective and expeditious of all the alternatives for this remediation zone. Although this remedy is significantly more expensive than the other alternatives, it is the only remedy capable of eliminating the Site's principal threat wastes by increasing the rate of extraction and source mass reduction in a relatively short time-frame.

In addition, the FTO system is the only *ex-situ* vapor treatment system capable of effectively treating the extracted vapor stream during operation of the ERH system. Therefore, this remedy is considered cost effective relative to other alternatives.

13.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The EPA believes that the selected remedy for each remediation zone represent that maximum extent to which permanent and alternative solutions can be used in a practical manner at Pemaco. The statutory preference for treatment as a principal element and bias against offsite treatment and disposal was also considered in addition to State and community acceptance.

An evaluation of the selected remedies with respect to the balancing and modifying criteria follows.

13.4.1 Surface and Near-Surface Soil Remediation Zone

Long-Term Effectiveness and Permanence: Onsite soil treatment alternatives, which were not retained during the screening process, were not considered capable of adequately and permanently treating both metal and PAH COCs. As such, containment and offsite disposal were considered the best options for this remediation zone.

The selected remedy, Alternative N2 (Soil Cover/Revegetation), includes the addition of a 1-ft layer of clean soil followed by a vegetative cover which will stabilize the soil and coincide with development of the site as the Maywood Riverfront Park. This remedy is considered adequate and reliable in eliminating exposure risks and preventing migration of COCs (via erosion). While Alternative N3 may afford a higher degree of long-term effectiveness and permanence at the Pemaco site, the excavated soil would require long-term management at an offsite disposal facility and would not be consistent with NCP §300.430(f)(l)(ii)(E), which has bias against offsite disposal.

Table 13-1. Summary of ARARs for Selected Remedies

Authority	Medium	Requirement	Status	Synopsis of Requirement	Action to be Taken to Attain Requirement
CHEMICAL-SPECIFIC CRITERIA					
Federal Regulatory Requirement s	Groundwater	Federal Primary Drinking Water Standards 40 Code of Federal Regulations (CFR) Part 141	Relevant and Appropriate	Federal primary MCLs under the Safe Drinking Water Act (SDWA) protect the public from contaminants that may be found in drinking water. The NCP defines MCLs as relevant and appropriate for groundwater that is a potential source of drinking water. Although neither the perched nor the Exposition groundwater is a viable aquifer, the San Pedro Aquifers, which are used for municipal and industrial purposes, may lie beneath the site. To prevent potential migration to possible lower aquifers, the selected remedy will use federal MCLs, unless State MCLs are more stringent, as cleanup levels for perched and exposition groundwater.	The selected remedy will comply with these regulations through source reduction, plume containment and monitored natural attenuation.
State Regulatory Requirement	Groundwater	California Primary Drinking Water Standards Health and Safety Code (H&S Code) §4010 *et seq.* 22 California Code of Regulations (CCR) §64431 and 64444	Relevant and Appropriate	California Primary MCLs protect public health from contaminants that may be found in drinking water sources.	The selected remedy will use State MCLs that are more stringent than federal MCLs as cleanup goals.
State Regulatory Requirement	Groundwater	Secondary Drinking Water Standards 22 CCR §64471	Relevant and Appropriate	Since there are no primary MCLs for aluminum, iron, manganese and MTBE, the secondary MCLs will be the cleanup level.	The selected remedy will comply with these regulations through source reduction, plume containment and MNA.

Table 13-1. Summary of ARARs for Selected Remedies

Authority	Medium	Requirement	Status	Synopsis of Requirement	Action to be Taken to Attain Requirement
State Regulatory Requirement	Soil and Groundwater	State Water Resources Control Board (SWRCB) Resolution No. 92-49 III.G Policy and Procedures for Investigation and Cleanup and Abatement of Discharges under Water Code Section 13304 (amended 4\21\94)	Relevant and Appropriate	To protect groundwater, the resolution requires cleanup to either background water quality or the best water quality that is reasonable if background water quality cannot be restored. Non-background cleanup levels must be consistent with maximum benefit to the public, present and anticipated future beneficial uses, and conform to water quality control plans and policies.	The selected remedy will comply with these regulations through source reduction, plume containment and remediation of the aquifer to beneficial use.
State Regulatory Requirement	Groundwater	Water Quality Control Plan - Los Angeles Region California Water Code § 13240 *et seq*	Relevant and Appropriate	Establishes beneficial uses of ground and surface waters, establishes water quality objectives, including narrative and numerical standards, establishes implementation plans to meet water quality objectives and protect beneficial uses, and incorporates statewide water quality control plans and policies. Only the WQOs for groundwater are ARARs. While the stratigraphic equivalent zones present below the site are thin and low-yielding (i.e. do not, at present, meet the strict definition of "aquifer," since that definition includes the "ability to yield commercially significant quantities of water"), the zone still falls within the potential drinking water beneficial use designation per the Water Quality Control Plan for Los Angeles Region.	The selected remedy will comply with these regulations through source reduction, plume containment and MNA.

Table 13-1. Summary of ARARs for Selected Remedies

Authority	Medium	Requirement	Status	Synopsis of Requirement	Action to be Taken to Attain Requirement
State Regulatory Requirement	Soil and Groundwater	DTSC Hazardous Waste Regulations Hazardous Waste Definition Standards 22 CCR Part 261	Applicable	Contaminated soil and groundwater, once extracted for treatment, must be managed as state & federal hazardous waste if such soil or groundwater contains levels of hazardous substances that meet or exceed state and federal hazardous waste toxicity criteria for specific hazardous wastes and/or contains one or more RCRA -listed hazardous wastes.	The determination of whether wastes generated during remedial activities are hazardous will be made at the time the wastes are generated. Contaminated media treated to specified cleanup levels will no longer need to be managed as a hazardous waste.
ACTION-SPECIFIC CRITERIA					
Federal Regulatory Requirement	Groundwater	NPDES Non-Point Source Discharge 40 CFR §122.26	Relevant and Appropriate	Non-point sources addressed by using best management practices for control of contaminants to stormwater runoff from construction activities on sites greater than one acre.	Construction activities associated with the selected remedy will be less than one acre; however, BMPs will be enacted to eliminate and/or reduce potential contaminant migration pathways to storm water runoff.
Federal and State Regulatory Requirement	Groundwater	NPDES Point Source Discharge 40 CFR 122-125	Applicable	The substantive provisions of an NPDES permit for discharges to a State body of water, i.e. waste discharge requirements, will apply if the treated water is discharged to the LA River.	The treated water that will be discharged to the LA River will comply with the waste discharge requirements.
State Regulatory Requirement	Groundwater	SWRCB Resolution 68-16 Statement of Policy with Respect to Maintaining High Quality of Waters in California Water Code § 13140	Applicable	Under the State's Antidegradation Policy as set forth in State Board Resolution No. 68-16, whenever the existing quality of water is better than that needed to protect present and potential beneficial uses, such existing quality will be maintained. Applies to the discharge of waste to waters, including re-injection into the aquifer.	Treated groundwater will not be discharged into the aquifer unless it meets this requirement.
State Regulatory Requirement	Soil	California Water Code §13140 - 13147, 13172, 13260, 13263, 132267, 13304 27 CCR Div.2, Subdiv.1, Chap.3, Subchap.2, Art.2	Applicable	Wastes classified as a threat to water quality (designated waste) may be discharged to a Class I hazardous waste or Class II designated waste management unit. Nonhazardous solid waste may be discharged to a Class I, II, or III waste management unit. Inert waste would not be required to be discharged into a SWRCB-classified waste management unit.	Waste streams not meeting cleanup criteria will be classified for disposal to appropriate permitted offsite waste management units. CERCLA waste (*e.g.*, contaminated soil, spent GAC) will be disposed at an offsite disposal facility.

Table 13-1. Summary of ARARs for Selected Remedies

Authority	Medium	Requirement	Status	Synopsis of Requirement	Action to be Taken to Attain Requirement
		(Porter-Cologne Water Quality Control Act)			
State Regulatory Requirement	Groundwater	SWRCB Resolution No. 88-63 Sources of Drinking Water	Applicable	This policy specifies that ground and surface waters of the state are either existing or potential sources of municipal and domestic supply except water supplies with: a. Total dissolved solids exceeding 3,000 milligrams per liter, or b. Natural or anthropogenic contamination (unrelated to a specific pollution incident) that cannot reasonably be treated for domestic use using either best management practices (BMPs) or best economically achievable treatment practices, or c. The water source does not provide a sustained yield of 200 gallons per day.	The perched zone is not capable of sustaining 200 gallons per day through a single well. The upper and deeper Exposition Zones could likely sustain 200 gallons per day. The perched zone is being cleaned up so it is not a continuing source of contamination to the upper and deeper Exposition Zones. The upper and deeper Exposition Zones are being cleaned up to MCLs.
Federal Regulatory Requirement	Soil and Groundwater	Hazardous Waste Regulations Hazardous Waste Determination by Generators 22 CCR §66262.11, 66264.13(a) & (b)	Applicable	A generator must determine if the waste is classified as a hazardous waste in accordance with the criteria provided in these requirements.	The determination of whether wastes generated during remedial activities, such as soil cuttings from well installation and treatment residues, are hazardous will be made when the wastes are generated.
Federal Regulatory Requirement	Soil and Groundwater	Hazardous Waste Regulations Accumulation Time 22 CCR § 66262.34	Applicable for any operation where hazardous waste is generated.	Onsite hazardous waste accumulation is allowed for up to 90 days as long as the waste is stored in containers or tanks, on drip pads, inside buildings, is labeled and dated, etc.	If wastes generated during remedial activities are hazardous, they will be managed to comply with these requirements.
Federal Regulatory Requirement	Soil and Groundwater	Hazardous Waste Regulations	Substantive provisions are relevant and	A treatment facility should maintain a fence in good repair which completely surrounds the active portion of the facility. A locked gate at the facility	Although this is not a hazardous waste facility, the selected remedy will comply with these regulations as specified.

Table 13-1. Summary of ARARs for Selected Remedies

Authority	Medium	Requirement	Status	Synopsis of Requirement	Action to be Taken to Attain Requirement
		Hazardous Waste Security 22 CCR §66264.14	appropriate if waste is determined to be RCRA hazardous waste.	should restrict unauthorized personnel entrance. The security standards to prevent entry from unauthorized personnel for the proposed remedial treatment alternatives should be applied.	
Federal Regulatory Requirement	Soil and Groundwater	Hazardous Waste Regulations Hazardous Waste Facility General Inspection Requirements and Personnel Training 22 CCR §66264.15 - 66264.16	Substantive provisions are relevant and appropriate if waste is determined to be RCRA hazardous waste.	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 which may be causing or leading to a hazardous waste release and a threat to human health or the environment.	Although this is not a hazardous waste facility, the selected remedy will incorporate an operation and maintenance program to be implemented by trained personnel.
Federal Regulatory Requirement	Soil and Groundwater	Hazardous Waste Regulations Preparedness and Prevention 22 CCR Div. 4.5, Chap. 14, Art. 3	Substantive provisions are relevant and appropriate if waste is determined to be RCRA hazardous waste.	Facility design and operation to minimize potential fire, explosion, or unauthorized release of hazardous waste.	Although this is not a hazardous waste facility, selected remedy will be properly designed, operated and maintained to comply with substantive requirements.
Federal Regulatory Requirement	Groundwater	Hazardous Waste Regulations Water Quality Monitoring and Response Systems for Permitted Systems 22 CCR Div 4.5, Chap. 14, Art.6	Relevant and Appropriate	There is a requirement for the groundwater monitoring system 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 five years to ensure attainment of the remedial action objectives.

Table 13-1. Summary of ARARs for Selected Remedies

Authority	Medium	Requirement	Status	Synopsis of Requirement	Action to be Taken to Attain Requirement
Federal Regulatory Requirement	Soil and Groundwater	Hazardous Waste Regulations Use and Management of Containers 22 CCR Div 4.5, Chapter 14, Art. 9	Substantive provisions are applicable if waste is determined to be RCRA hazardous waste.	Maintain container and dispose to a Class I hazardous waste disposal facility within 90 days. The 90-day storage limit prevents greater environmental hazard than already exists.	Waste contained onsite will be maintained in a container in good condition prior to offsite disposal to appropriate permitted offsite waste management units.
Federal Regulatory Requirement	Groundwater	Hazardous Waste Regulations Tank Systems 22 CCR Div. 4.5, Chapter 14, Art. 10	Substantive provisions are applicable if waste is determined to be RCRA hazardous waste.	Minimum design standards (i.e., shell strength, foundation, structural support, pressure controls, seismic considerations) for tank and ancillary equipment are established. The requirements for minimum shell thickness and pressure controls to prevent collapse or rupture prevents a greater environmental hazard than already exists.	If wastes are determined to be RCRA hazardous, the selected remedy will comply with these regulations as specified.
Federal Regulatory Requirement	Soil and Groundwater	Hazardous Waste Regulations Miscellaneous Units Requirements 22 CCR Div. 4.5, Chapter 14, Art. 16 22 CCR § 66264.601 - 66264.603	Substantive provisions are relevant and appropriate if waste is determined to be RCRA hazardous waste.	Minimum performance standards are established for miscellaneous equipment to protect health and the environment. "Miscellaneous units" are units that are not a container, tank, surface impoundment, pile, land treatment unit, landfill, incinerator, boiler and any industrial furnace other than industrial furnaces.	The Flameless Thermal Oxidizer unit is considered a miscellaneous unit. The selected remedy will comply with these regulations.
State Regulatory Requirement	Air	SCAQMD Rules and Regulations Regulation IV, Rule 402, Nuisance.	Applicable	A person shall not discharge from any source whatsoever such quantities of air contaminants or other material which cause injury, detriment, nuisance, or annoyance to any considerable number of persons or to the public or which endanger the comfort, repose, health, or safety of any such persons or the public or which cause to have a natural tendency to cause injury or damage to business or property.	The selected remedy will comply with these regulations as specified.
State Regulatory	Air	SCAQMD Rules and Regulations	Applicable	Emissions of fugitive dust shall not remain visible in the atmosphere beyond the property line of the	The selected remedy will comply with these regulations as specified.

Table 13-1. Summary of ARARs for Selected Remedies

Authority	Medium	Requirement	Status	Synopsis of Requirement	Action to be Taken to Attain Requirement
Requirement		Regulation IV, Rule 403, Fugitive Dust		emission source. Activities conducted in the South Coast Air Basin shall use best available control measures to minimize fugitive dust emissions and take necessary steps to prevent the track-out of bulk material onto public paved roadways as a result of their operations.	
State Regulatory Requirement	Air	SCAQMD Rules and Regulations Regulation IV, Rule 404, Particulate Matter – Concentration.	Applicable	Particulate matter in excess of the concentration standard conditions shall not be discharged from any source. Particulate matter in excess of 450 milligrams per cubic meter (0.196 grain per cubic foot) in discharged gas, calculated as dry gas at standard conditions, shall not be discharged to the atmosphere from any source.	The selected remedy will comply with these regulations as specified.
State Regulatory Requirement	Soil and Groundwater	*Land Use Covenant Regulation 22 CFR Section 67391.1 (a), (b), (c) (1), (d), (g), (i)	Relevant and Appropriate	If hazardous materials, hazardous wastes or constitutents, or hazardous substances will remain at the property after implementation of the remedy at levels which are not suitable for unrestricted use of the land, this requirement would be relevant and appropriate.	A response action decision document which includes limitations on land use or other institutional controls, requires that the limitations or controls are clearly set forth and defined in the response action decision document, and shall specify that the limitations or controls will be incorporated into an appropriate land use covenant as required by Section 67391.1 and shall include an implementation and enforcement plan.
State Regulatory Requirement	Soil and Groundwater	Environmental Covenant Requirements Civil Code Section 1471	Relevant and Appropriate	If hazardous materials, hazardous wastes or constitutents, or hazardous substances will remain at the property after implementation of the remedy at levels which are not suitable for unrestricted use of the land, this requirement would be relevant and appropriate.	Specifies manner by which environmental covenants are recorded and made applicable to successors to the land restricted by the covenant.
TO-BE-CONSIDERED CRITERIA that have been adopted as Performance Standards					
State Regulatory Requirement	Soil and Groundwater	California Well Standards California Department of Water Resources Bulletin 74-90	Performance Standard	Provides minimum specifications for monitoring wells, extraction wells, injection wells, and exploratory borings.	Design and construction specifications are considered for construction and destruction of wells and borings.

Table 13-1. Summary of ARARs for Selected Remedies

Authority	Medium	Requirement	Status	Synopsis of Requirement	Action to be Taken to Attain Requirement
State Regulatory Requirement	Soil and Groundwater	EPA Region IX Preliminary Remediation Goals (PRGs) for Soil, or Soil Screening Levels (SSLs)	Performance Standard	PRGs are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data. No MCLs are available for soils. PRGs for subsurface soils are termed SSLs and are used to screen subsurface soils as a threat to groundwater. A DAF of 20 and 1 are available. DAF 20 PRGs are used when the contaminated soil is not directly adjacent to a drinking water source and dilution of the contaminant is occurring before it reaches the source. DAF 1 PRGs assume that the contaminated soil is directly adjacent to a drinking water source and no dilution is occurring.	PRGs for tap water will be used as clean up levels where no MCLs are available. The selected remedy will use PRGs for Residential Soil as clean up goals for surface and near surface soils, DAF 20 SSLs for subsurface soils to 50 ft and DAF 1 SSLs for subsurface soils greater than 50 ft bgs.
State Regulatory Requirement	Soil and Groundwater	California Department of Health Action Levels (ALs)	Performance Standard	ALs are health-based advisory levels established by the California Department of Health Services for contaminants that lack primary MCLs. ALs are advisory levels and not enforceable standards. An AL is the level of a contaminant in drinking water that is considered not to pose a significant health risk to people ingesting that water on a daily basis. It is calculated using standard risk assessment methods for noncancer and cancer endpoints, and typical exposure assumptions, including a 2-liter per day ingestion rate, a 70-kilogram adult body weight, and a 70-year lifetime.	ALs will be used as clean up goals where no MCLs or PRGs are available (i.e., Lead and 1,4-Dioxane).

*The State of California does not agree with US EPA's position that only portions of 22 CCR Section 67391.1 are relevant and appropriate requirements. The State believes that 22 CCR Section 67391.1 in its entirety applies to these remediation activities. However, since the site is not a federal property, the application of subsection (e) is not appropriate. Further, since a land use covenant is feasible here, the infeasibility provisions in subsection (f) are also not appropriate. The State reserves its authority to bring actions against violators of state legal authority, even if the state legal authority is not listed as an applicable and or relevant and appropriate requirement in this Table 13.1.

Reduction of Toxicity, Mobility or Volume Though Treatment: Although the selected remedy, Alternative N2 (Soil Cover/Revegetation), would not reduce the toxicity or volume of COCs within this remediation zone, this alternative would provide significant reductions in contaminant mobility at the Site. The lack of reduction in toxicity and volume would be compensated for by the elimination of exposure routes to potential receptors. Furthermore, natural attenuation of PAHs would likely occur over the years, eventually reducing their toxicity and/or volume.

By comparison, Alternative N3 (Excavation and Offsite Disposal) would reduce the TMV of surface and near-surface soils at the Pemaco site, but the toxicity and volume of the contaminated soils would remain until treated at the selected offsite disposal facility. Again, this alternative would not be consistent with NCP §300.430(f)(l)(ii)(E), which has bias against offsite disposal.

Short-Term Effectiveness: The selected remedy, Alternative N2, would eliminate the risk of exposure to COCs with minimal impact to remedial construction workers, the community, and the environment, thus demonstrating good short-term effectiveness. By comparison, excavation and soil movement operations associated with Alternative N3 have the potential to generate significant amounts of dust that could be a threat to construction workers, the community, and the environment. These impacts would be minimal under Alternative N2 since the contaminated soil would be left in place.

Implementability: The selected remedy, Alternative N2 (Soil Cover/Revegetation), would be simple to implement from an administrative and technical viewpoint. Engineering services and materials would be readily available for constructing a soil cover, and the vegetative cover would complement landscaping plans associated with the future Maywood Riverfront Park. Modest administrative efforts would be required to modify land deeds in order to prevent future development of the property (post-Maywood Riverfront Park) and to allow for indefinite monitoring and maintenance programs.

On the other hand, Alternative N3 (Excavation and Offsite Disposal) would require significant administrative efforts for the profiling, manifesting, and disposing of contaminated soil. In addition, this alternative presents potential future liability associated with hauling COCs offsite.

Costs: The selected remedy is cost-effective.

State Acceptance: The State of California and the City of Maywood have accepted the selected remedy.

Community Acceptance: The community has accepted the selected remedy.

13.4.2 Upper Vadose Soil and Perched Groundwater Remediation Zone

Long-Term Effectiveness and Permanence: The selected remedy includes the use of HVDPE, which is a presumptive remedy for VOCs in soil and groundwater. By reducing COC concentrations within both perched groundwater and upper vadose soils, Alternative SP2a (HVDPE/UV Ox/FTO/GAC), would provide a high degree of long-term effectiveness and permanence for this remediation zone. UV Oxidation and FTO would effectively destroy COCs in extracted groundwater and vapor onsite; permanent destruction of COCs in vapor adsorbed to GAC would take place at an offsite facility.

By comparison, Alternatives SP3 (*ISCO*) and SP4 (EISB) would not physically remove COCs; rather, they would be destroyed or degraded *in-situ*. Where the processes are effective, remediation goals for the perched groundwater would be achieved. However, these alternatives would be ineffective for treating COCs in upper vadose soils since dispersion mechanisms for oxidants/substrates are uncertain in unsaturated conditions. Similarly, the treatment of impermeable soils in both unsaturated and saturated conditions is difficult and could result in untreated residual contamination, leading to a rebound of COCs after treatment or possible generation and accumulation of vinyl chloride (associated with EISB

dechlorination train). Alternative SP5 (MNA) alone would require approximately 50+ years to achieve remediation goals within this remediation zone.

Reduction of Toxicity, Mobility or Volume Though Treatment: The use of HVDPE associated with Alternative SP2a will increase the rate of mass transfer and enhance the physical removal of COCs in both perched groundwater and upper vadose zone soils, effectively reducing the TMV of COCs within both media. The use of UV Oxidation and FTO for *ex-situ* groundwater treatment and *ex-situ* vapor treatment, respectively, will permanently destroy COCs onsite, eliminating the TMV of contaminants extracted from the subsurface. GAC, which may be used to supplement these treatment technologies, will only reduce the mobility and volume of COCs onsite. All used carbon would likely undergo treatment at the approved disposal facility where toxicity would be reduced.

Through the introduction and uniform distribution of oxidants and/or substrates, the *in-situ* alternatives (Alternatives SP3 and SP4) would reduce the toxicity and volume of COCs in perched groundwater. However, these alternatives would not address upper vadose soils nor would they affect the mobility of COCs. Alternative SP5 (MNA) may result in reduced TMV in both perched groundwater and upper vadose zone soils through natural attenuation and degradation processes, but not within a reasonable timeframe.

Short-Term Effectiveness: The selected remedy, Alternatives SP2a (HVDPE/UV Ox/FTO/GAC), is expected to meet RAOs for both upper vadose soil and perched groundwater within 5 years. With exception to Alternative SP2b, this alternative is the only remedial option for this zone that addresses both media within such a favorable timeframe. Potential risks to workers, the community, and the environment during construction and implementation (approximately 2 months) can be mitigated with proper planning and suitable health and safety measures, such as traffic control, worker personal protective equipment, air monitoring, and restricted access to the aboveground treatment systems.

Because Alternatives SP3 and SP4 rely on *in-situ* destruction and/or degradation remedial processes and have inherent uncertainties, these alternatives are expected to take longer to reach perched groundwater RAOs than the HVDPE alternatives, which involve physical removal of contaminants. Alternative SP5 (MNA) is projected to 50+ years of operations to achieve perched groundwater RAOs.

Implementability: The selected remedy, Alternatives SP2a (HVDPE/UV Ox/FTO/GAC), consists of generally conventional, well proven, and implementable technologies and is expected to be highly reliable when adequately operated and maintained. Personnel, equipment, and materials are also readily available for implementation/operation.

Cost: The selected remedy is cost-effective.

State Acceptance: The State of California (DTSC and LARWQCB) and the City of Maywood have accepted the selected remedy.

Community Acceptance: Community concerns associated with the FTO unit have been addressed as described in Section 10.2.9 and Part III of this document.

13.4.3 Lower Vadose Soil and Exposition Groundwater Remediation Zone

Long-Term Effectiveness and Permanence: The selected remedy, Alternative SG5a, uses ERH technology with vapor extraction, which is the only technology expected to achieve remediation goals and reduce baseline risks within this remediation zone. It is anticipated that the removal of contaminants within this remediation zone will be permanent and will result in no treatment residuals and no untreated residual risks.

As for *ex-situ* treatment of extracted groundwater and vapor associated with the selected remedy, UV Oxidation and FTO are proven technologies for permanently destroying site COCs without additional disposal requirements. Both *ex-situ* treatment units will require effluent monitoring to assure effectiveness of the systems in meeting discharge criteria. The supplemental use of GAC for either *ex-situ* treatment system will require disposal at an approved landfill/disposal facility.

Reduction of Toxicity, Mobility or Volume Though Treatment: The selected remedy, Alternative SG5a (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/FTO/GAC), uses technologies that physically remove and, through *ex-situ* treatment, destroy COCs so that remediation goals would be achieved in both the lower vadose zone and the Exposition groundwater. ERH with VE is the only technology that could effectively reduce the TMV of all COCs within the entire source area of this remediation zone.

As previously discussed, UV Oxidation and FTO are proven technologies for permanently destroying all Site COCs. Thus the TMV of extracted groundwater and vapor, under Alternative SG5a (ERH with VE/Vacuum-Enhanced Groundwater Extraction/P&T/FTO/GAC), would also be reduced. GAC, which may be used to supplement these treatment technologies, will only reduce the mobility and volume of COCs onsite. All used carbon would likely undergo treatment at the approved disposal facility where toxicity would be reduced.

By comparison, the vacuum-enhanced alternatives (Alternatives SG4a and SG4b) would reduce the TMV of COCs in Exposition groundwater and in the coarse-grained lower vadose soils, but would not effectively address COCs trapped within low-permeability (fine-grained) lithosomes such as with the ERH alternatives. These impermeable soils could result in untreated residual contamination, leading to a rebound of COCs after treatment.

The *in-situ* alternatives (Alternatives SG2 and SG3) would not physically remove COCs from the subsurface in the source area like the ERH or vacuum-enhanced groundwater extraction alternatives, nor would they address lower vadose soils. These alternatives would, however, reduce the toxicity and volume of COCs in the Exposition groundwater zones where the processes are effective.

Short-Term Effectiveness: Under the selected remedy (Alternative SG5a), lower vadose soil and Exposition groundwater RAOs would be met within approximately 5 years. Furthermore, the majority of COCs would be removed during the first year of operation of the ERH system. Potential risks to workers, the community, and the environment associated with construction (approximately 1 year) and implementation of this alternative includes: increased traffic, particulate emissions from vehicles, and high voltage hazards. All of these risks can be mitigated with proper planning and suitable health and safety measures, such as traffic control, worker personal protective equipment, air monitoring, and limited access to the aboveground treatment systems/power delivery stations.

Because Alternatives SG2 (ISCO/ISCR/P&T/MNA/UV Oxidation) and SG3 (EISB/P&T/MNA/UV Oxidation) rely on *in-situ* destruction and/or degradation remedial processes, it would likely take longer to reach Exposition groundwater RAOs under these alternatives than the ERH alternatives, which involves physical removal of contaminants. Baseline risks to the community associated with contaminants in lower vadose soils would remain.

Alternatives SG4a (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/FTO/GAC) and SG4b (Vacuum-enhanced Groundwater Extraction/P&T/MNA/UV Oxidation/GAC) are projected to take approximately 2 months to implement/construct and 20 years to achieve Exposition groundwater RAOs. Similar to the *in-situ* alternatives, baseline risks to the community associated with contaminants in lower vadose soils would remain.

Implementability: While ERH is no longer considered an innovative technology, it is a relatively new technology that requires sophisticated equipment and skilled technical personnel. However, the selected remedy is technically feasible and implementable, and all material and equipment is commercially

available. A large portion of the Maywood Riverfront Park would be disrupted for approximately 1-year. The partial park closure would need to be coordinated in cooperation with the City of Maywood.

Cost: The selected remedy is cost-effective.

State Acceptance: The State of California (DTSC and LARWQCB) and the City of Maywood have accepted the selected remedy. Comments raised by the DTSC have been addressed as described in 10.3.8 and Part III of this document.

Community Acceptance: Community concerns associated with the FTO unit have been addressed as described in Section 10.3.9 and Part III of this document.

13.5 Preference for Treatment as a Principal Element

As discussed in Section 11.0, the free product and high concentrations of residual contamination present in vadose zone soils, perched groundwater, and Exposition groundwater have been defined as present-day source materials which pose a principal threat at Pemaco. As such, EPA's statutory preference for treatment of principal threats applies to this site (NCP §300.430(a)(l)(iii)(A)).

This selected remedies for the Upper Vadose Soil and Perched Groundwater Remediation Zone and the Lower Vadose Soil and Exposition Groundwater Remediation Zone satisfy the statutory preference for treatment as a principal element of the remedy (i.e., reduces toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment) (NCP §300.430(f)(5)(ii)(F)). Treatment is a major component of the selected remedies for soil and groundwater within these remediation zones through the application of HVDPE and ERH technologies, which increase the rate of extraction and source mass reduction.

13.6 Five-Year Review Requirements

Because these remedies may result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, and will take longer than five years to attain RAOs and cleanup levels, a statutory review will be conducted within five years of construction completion for Pemaco to ensure that the remedies are, or will be, protective of human health and the environment.

14.0 Documentation of Significant Changes

The Proposed Plan for Pemaco was released for public comment in April 4, 2004. The public comment period was officially open through July 6, 2004.

The Proposed Plan identified alternatives for the 3 different remediation zones as follows:

- Surface and Near-Surface Soil: Soil Cover/Revegetation (*Alternative N2*).
- Upper Vadose Zone Soil and the Perched Groundwater: HVDPE with UV Oxidation for treatment of extracted groundwater, and, FTO and GAC for treatment of extracted vapors (*Alternative SP2a*).
- Lower Vadose Zone Soil and Exposition Groundwater: ERH with VE, Vacuum-Enhanced Groundwater Extraction, Groundwater P&T, and MNA. UV Oxidation for treatment of extracted groundwater, and FTO and GAC for treatment of extracted vapors (*Alternative SG5a*).

The items listed below are additional tasks to be completed based upon comments received during the public comment period.

- Vapor effluent monitoring of the FTO unit with dioxin and furans included in the list of analytes;
- Indoor air sampling and additional vapor monitoring on Walker Avenue and 59th Street;
- A heat exchanger and a vapor phase carbon adsorption unit will be installed to the post-exhaust side of the FTO unit;
- Develop a community involvement plan that will outline the lines of communication to disseminate final design, operations, and monitoring data to the community.
- The State of California requested that EPA install an extraction well into the 'D' Zone at MW-24-140 (approximately 120-140 ft bgs).

EPA reviewed all written and verbal comments submitted during the public comment period. It was determined that the items above pose no significant changes to the remedy, as originally identified in the Proposed Plan. The technical enhancements identified above for several of the alternatives will be integrated, as necessary or appropriate, during the RD and O&M phases of the project.

PART III RESPONSIVENESS SUMMARY

1.0 Introduction

This document provides the EPA's responses to questions and comments received on the Proposed Plan for the Pemaco Superfund Site. On April 3, 2004, the Proposed Plan (in both Spanish and English) was delivered to persons on the Pemaco mailing list. The Public Comment Period for the Pemaco Superfund Site opened on April 4, 2004. The EPA announced the Proposed Plan in two newspapers serving the Maywood area. Announcements were placed in the *The Press* on April 1, 2004, and *La Opinion* (Spanish language newspaper) on April 2, 2004. In addition, 2,500 bilingual flyers were distributed at the local schools for students to take home to their parents. Flyers were also left at the library, city offices, and municipal drinking water offices. On April 16, 2004, the project manager and community involvement coordinator spoke at three high schools and gave out flyers inviting students and parents to attend the April 17, 2004, public hearing.

The April 1, 2004, public notice summarized the EPA's proposed remedy for the site, and invited citizens to attend the public hearing on April 17, 2004 at the Maywood Community Center. During the first week of the public comment period, the EPA received a request from a community group in Maywood, PUMA, to extend the public comment period an additional 60 days. The EPA agreed to extend the public comment period 30 days but told the community group it would make a decision regarding the additional 30 days after the community meeting on April 17, 2004.

After the public hearing on April 17, 2004, the EPA extended the public comment period to July 6, 2004 and subsequently published notices in *The Press* and *La Opinion* announcing the extension on April 29, 2004. The public notice also announced a second public hearing which was held on May 22, 2004. In addition, EPA officials and contractors met with PUMA at its regular weekly meeting on May 13, 2004, to answer questions about the proposed remedy. The EPA also facilitated a meeting between PUMA and the TOSC. TOSC representatives from the University of Oregon met with the community group and subsequently provided comments on the proposed remedy during the public comment period.

During the public comment period, the EPA also responded to several e-mail questions and requests for additional information from PUMA group members and community activists. At the April 17, 2004

public hearing, the community group also submitted approximately 40 written questions for EPA response. This responsiveness summary includes written comments submitted to the agency at the public hearings, as well as comments submitted via email and mail during this time frame. In addition, EPA personnel participated in a round-table discussion on a radio show entitled "Nuestra voz en el medio ambiente" (our voice in the environment) on June 10, 2004. This responsiveness summary also includes the EPA's responses to other comments or questions asked via e-mail and telephone during the public comment period.

Comments received from individuals or groups regarding the Proposed Plan are presented in Appendix 1. The specific documents that were issued to PUMA responding to the 40 questions submitted by Felipe Aguirre at the April 17, 2004, meeting and the questions and issued responses to LFR Levine Fricke (consultant for the W.W. Henry property) are given in Appendix 1.

2.0 Stakeholder Issues and EPA Responses

There were many common elements to the questions and comments submitted to the EPA by various stakeholders (*e.g.*, state agencies, community groups, PRPs) about the selected remedy presented in the Proposed Plan. The majority of questions and comments addressed the following issues:

- Questions regarding gradients and vertical contaminant distribution data gaps in the lower Exposition Zones 'C' and 'D'.
- General questions about the safety of the future Maywood Riverfront Park in terms of human health effects of the future park users.
- Questions concerning the general health of the community and the high incidences of health problems like cancer, asthma, and allergies and if they are related to Pemaco.
- Questions regarding the safety of the local drinking water and if Pemaco has caused contamination in local drinking water wells, specifically the Prospect Well operated by the Maywood Municipal Water Company No. 3, which is 4,100 ft southwest of Pemaco.
- Questions concerning the actions that will take place if the remediation equipment malfunctions or if there is a catastrophic event.
- Questions concerning the possibility of dioxins and furans being created and emitted to the atmosphere due to the operation of the FTO unit proposed in the selected remedy.
- Comments inferring that the EPA has not properly evaluated all the available treatment technologies for extracted vapors before making its decision to select the FTO unit for vapor abatement.
- Questions concerning the electrical resistive heating (ERH) technology and if it will mobilize existing contaminants releasing them directly to the atmosphere or cause them to migrate to drinking water wells on an accelerated rate.
- General concern for communication between the EPA and the community.

The EPA responses to these questions and concerns are provided below.

2.1 Gradient and Vertical Contaminant Distribution Data Gaps

The State of California DTSC issued comments concerning the RI data. The DTSC interpreted the RI data to indicate that there was a lack of data for the lower Exposition Zones 'C' and 'D' near the TCE source

area in the southern portion of the site. In response, the EPA installed several new deep groundwater monitoring wells in the site vicinity and has sampled each well multiple times. Results were issued in the RI as Appendix 13. The results of the deep groundwater sampling did not cause significant changes to the selected remedy. The DTSC is currently satisfied with the EPA's technical response that will include addition of groundwater extraction from the Exposition 'D' Zone.

2.2 Health Effects for Future Park Users

Several community members expressed concern about the safety of the proposed recreational park. The EPA has selected the remedies outlined in this ROD for the primary purpose of reducing potential adverse health effects to the future users of the Pemaco property and the surrounding community. The risk assessment completed for Pemaco used the future park user as one of the main risk scenarios. Very conservative values were used in regards to the exposure of future park users to the Pemaco COCs as they exist currently. The risk to the future park user if no remedial measures were undertaken (*i.e.,* the Pemaco property was opened to the public as it currently exists) was calculated to be within the EPA's acceptable risk levels. The selected remedy includes remedial actions that will further reduce existing or potential risks to the future park user. In other words, the EPA considers the Pemaco property to be acceptable for recreational users based on the RI data, and potential health risks at the site will be even further reduced after the selected remedies are implemented.

2.3 High Incidences of Health Problems in the Maywood Area

Several community members expressed concern that the cancer, asthma, and allergy rates may be higher than normal in their community. The EPA is working with other local and state agencies to provide the community with more information about environmental issues in their community beyond the Pemaco property issues. According to the data collected, the Pemaco property is not causing significant additional health risks to the current offsite residents. Significant health risks have been identified by state and local agencies as well as environmental groups that relate to the general air quality in the Los Angeles Basin area mainly caused by vehicle exhaust and currently operating industries. The EPA has informed the California Air Resources Board and the South Coast Air Quality Management District about the concerns of the Maywood community and is facilitating a relationship between the public agencies and the Maywood community so that air quality information that falls outside the scope of the Pemaco site activites can be properly distributed to the community.

2.4 Contamination in Drinking Water Wells

The community is concerned that the low levels of TCE detected in the Maywood Mutual Water Company No.3 "Prospect Well" is related to the Pemaco site. The RI activities performed at Pemaco have delineated the TCE plume related to Pemaco. This plume was found to extend approximately 1,060 ft towards the southwest from Pemaco before it terminates. The closest well to Pemaco is Maywood Mutual Water Company No.3 "District Well" which is on the corner of District Boulevard and Randolph Avenue, approximately 1,500 ft south of Pemaco. TCE has never been detected in the "District Well." The "Prospect Well" is approximately 4,100 ft southwest of Pemaco. The TCE concentrations in the Prospect Well are below California DHS MCLs and meet the standards; therefore, no corrective action has been implemented by the Maywood Mutual Water Company or the State of California Department of Health Services. The community is still concerned, however, that these levels are unsafe and that the TCE could be coming from Pemaco. It is unlikely that the TCE in the Prospect Well is originating from Pemaco because of the distance of the well from the site and the fact that several other potential sources of

contamination exist closer to the Prospect Well than Pemaco. In fact, the selected remedy chosen for the Pemaco site will reduce actual or potential impacts to groundwater drinking wells in the Maywood area.

2.5 Remediation Equipment Malfunctions and Catastrophic Events

Some of the community members are concerned that the proposed treatment systems will pose a health risk to the community if the equipment malfunctions or if there is a catastrophic event, such as an earthquake or flood. The remediation equipment proposed has inherent safety features in its design. Automatic sensors, equipped with their own power sources, will detect if there is a malfunction and shut the system down accordingly. The system is designed so that when it shuts down, no untreated fluids or vapors would be released to the environment. All piping to the treatment system will be located underground. The remediation system compound design will adhere to all appropriate Uniform Building Code requirements to mitigate potential structural failure from catastrophic events and the facility will be built with a secondary containment feature that will be able to hold the capacity of any liquids stored in the compound. Details of all these physical features will be finalized in the design phase.

2.6 Emissions of the Flameless Thermal Oxidation Unit

There has been much concern expressed over the potential for toxic emissions from the FTO unit to further degrade the air quality in the neighborhood surrounding Pemaco. Of particular concern is the emission of dioxins and furans from the incomplete combustion of chlorinated compounds. Because of the expected mass flow rate and vapor concentrations during the first year of remediation and also because of the physical properties of some of the COCs, the EPA has determined that thermal oxidation is the best option for treatment of the vapor during the first year of remediation. The FTO unit chosen for the selected remedy has been designed to achieve much higher destruction efficiency than the standard thermal oxidation units that have been the subject of concern over the last few years. The EPA believes that the operation of the FTO will not further degrade air quality in the site vicinity. To ensure that the EPA's assertions are correct, the EPA will conduct indoor air sampling and additional vapor monitoring on Walker Avenue and 59th Street during FTO operations. EPA will design the FTO unit so that a heat exchanger and a vapor-phase GAC adsorption unit will be installed to the post-exhaust side of the FTO unit. Thorough emission monitoring of the FTO unit will be performed and vapor samples will be tested for dioxins and furans along with other analytes.

2.7 Evaluation of Available Treatment Technologies for Extracted Vapors

As stated above, the EPA has selected an FTO unit as the vapor abatement technology for the first year of remediation because of the anticipated concentrations and the physical properties of some of the VOCs expected to be present in the extracted soil vapor. The FS presented all commercially available technologies for vapor treatment and screened out those technologies that were deemed less suitable or not feasible. It was the opinion of various community members and activist groups that some of the abatement technologies were not properly evaluated before they were screened out, and that certain vapor abatement technologies are available that were not evaluated. In response to these concerns, an additional memorandum was compiled by the EPA detailing the technical aspects of several alternative vapor abatement technologies. This memorandum outlined the specific technical evaluations of the other technologies and why they were judged not to be the most feasible technologies for the specific Pemaco situation. This memorandum was presented to the community members in a September 9, 2004 PUMA meeting and is presented in Appendix 1.

2.8 Potential for the ERH Technology to Mobilize Contaminants

Concerns from the community have been expressed that the vapors produced in the proposed ERH area will escape and pose a health risk to the community. Also, there is concern that the ERH technology may mobilize "free phase" contaminants into the dissolved phase at an expedited rate causing an increased threat of contaminating groundwater production wells. The selected remedy will utilize both vapor extraction wells and HVDPE wells in every zone that the ERH heating elements will affect from 35 to 100 ft bgs in both the unsaturated and saturated zones. These systems (SVE and HVDPE) will create a zone of low pressure in subsurface soil that will draw vapors out of the ERH treatment zone. Furthermore, HVDPE wells will be operating in the shallow soil zones above the ERH area and will act as an additional safeguard to prevent off-gassed vapors, released from the heated soil and groundwater, to reach the surface. Detailed stratigraphy mapping has been performed in the ERH area to support the remedial design (RD). All preferential pathways identified during this mapping will be addressed by the VE and HVDPE wells. The lateral and vertical spacing of the VE and HVDPE wells (both shallow and deep) will provide for ample coverage of the ERH area to trap all migrating vapor, free phase, and dissolved phase contaminants.

2.9 EPA and Community Communications

Several community members have been concerned about the communications and dissemination of information between the EPA and the community members. To promote communication, the EPA has participated in workshops, public meetings, school appearances, and radio station appearances and has purchased advertising space on radio stations and in newspapers as outlined in this ROD (Part II, Section 3.0) to communicate about the activities at Pemaco and to disseminate the information collected during the RI and FS activities. The EPA has integrated the community concerns into the selected remedy to select the most safe and feasible technology to remediate the Pemaco site.

The EPA wants the community to be informed. The EPA will continue to work with community members during the RD, construction, and operations and maintenance phases by implementing a communications plan to share all significant information concerning the selected remedy at Pemaco. Discussions concerning the format and frequency of the communications are currently underway between the EPA and PUMA.

3.0 Technical Issues

3.1 Technical Issues

The most apparent community concern with the selected remedy involves the selection of the FTO unit to treat the extracted vapors. This issue merits additional technical discussion because it is such a high priority subject. The COCs at Pemaco are very chemically diverse and include several compounds that do not readily adsorb to carbon (specifically, 1,4-dioxane, acetone, and vinyl chloride). Therefore, a chemical destruction technology such as thermal oxidation was judged to be necessary until the mass flow rate and concentrations of 1,4-dioxane, acetone, and vinyl chloride are sufficiently reduced to levels that will accommodate the low adsorption rates of carbon and still meet discharge limit requirements. Destruction technologies besides thermal oxidation do exist, however they cannot treat the combination of contaminants, as well as volumes and flow rates of the vapors that the Pemaco remediation system are expected to produce.

Please refer to Appendix 1 for more discussion of alternative treatment technologies considered for vapor. Also, if carbon is used to treat the vapors, the mass of contaminants that is expected to be removed from

the subsurface in the vapor phase during the first year of remediation would require several hundred tons of carbon to be shipped to and removed from the site every week. Because of the factors discussed above and further discussed in Appendix 1, FTO was judged to be the only feasible vapor treatment technology for the Pemaco site during the initial stages of remediation.