APPENDIX A – TECHNICAL IMPRACTICABILITY EVALUATION

FINAL FEASIBILITY STUDY
CASMALIA RESOURCES SUPERFUND SITE
CASMALIA, CALIFORNIA

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LIST OF ACRONYMS

°	Degrees
µg	Microgram
µg/L	Micrograms per liter
µm	Micrometers
ARAR	Applicable or relevant and appropriate requirement
bgs	Below ground surface
btoc	Below top of casing
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm/s	Centimeters per second
COC	Chemical of concern
CPT	Cone penetrometer test
CSC	Casmalia Resources Site Steering Committee
CSM	Conceptual Site Model
cy	Cubic yard
DCB	Dichlorobenzene
DCE	Dichloroethene
DNAPL	Dense non-aqueous phase liquid
EE/CA	Engineering Evaluation/Cost Analysis
EPA	Environmental Protection Agency
FS	Feasibility Study
g/cm^3	Grams per cubic centimeter
GAC	Granular activated carbon
gpm	Gallons per minute
HSCER	Hydrogeologic Site Characterization and Evaluation Report
HSIR	Hydrogeologic Site Investigation Report
HSU	Hydrostratigraphic Unit
L	Liters
LNAPL	Light non-aqueous phase liquid
m	Meters
m/day	Meters per day
MACTEC	MACTEC Engineering and Consulting, Inc.
MCL	Maximum Contaminant Level
mg/L	Milligrams per liter
MIBK	Methyl isobutyl ketone
msl	Mean sea level
NAPL	Non-aqueous phase liquid
NCP	National Contingency Plan
O&M	Operations and maintenance
P/S	Pesticide/Solvent
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PCT	Perimeter Control Trench
PHGs	Public Health Goals
ppb	Parts per billion
PRG	Preliminary Remediation Goal
PSCT	Perimeter Source Control Trench
RCF	Runoff Containment Facility

RCRA	Resource Conservation and Recovery Act
RGMEW	Routine Groundwater Monitoring Element of Work
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RO	Reverse osmosis
RWQCB	Regional Water Quality Control Board
SOW	Statement of Work
SVOC	Semivolatile organic compound
TBC	To be considered
TCA	Trichloroethane
TCE	Trichloroethene
TDS	Total dissolved solids
TI	Technical impracticability
TIE	Technical Impracticability Evaluation
TMB	Trimethylbenzene
TPH	Total petroleum hydrocarbon
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
VOC	Volatile organic compound
VSEP	Vibrating Shear Enhanced Processing

Executive Summary

Presented here in Appendix A as part of the Final Feasibility Study (FS) report to the United States Environmental Protection Agency (USEPA) is this Technical Impracticability Evaluation (TIE). As requested by the USEPA, this Executive Summary of the TIE was prepared to provide an overall summary of the contents of Appendix A.

Introduction

The restoration of contaminated groundwater, especially for a designated drinking water aquifer, is one of the objectives of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Superfund program. The National Contingency Plan (NCP), which provides the regulatory framework for the CERCLA program, states that USEPA "expects to return usable ground waters to their beneficial uses wherever practicable, within a time frame that is reasonable given the particular circumstances of the site." Generally, restoration cleanup levels are established by applicable or relevant and appropriate requirements (ARARs), such as the use of federal or state standards for drinking water quality.

Experience has shown, however, that restoration to drinking water quality may not always be achievable due to the limitations of available remediation technologies and the inherent limitations of the subsurface physical characteristics and contaminant properties. USEPA, therefore, must evaluate whether groundwater restoration at Superfund sites is attainable from an engineering perspective. As discussed in USEPA's 1993 *Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration* (TI Guidance), there are a number of factors that can inhibit groundwater restoration, which include hydrogeologic and contaminant-related factors, such as the presence of dense non-aqueous phase liquids (DNAPLs). This is particularly relevant to the Casmalia Resources Superfund Site (site), where non-aqueous phase liquids (NAPLs) exist at the site as the result of the disposal of billions of pounds of liquid wastes within capped landfills.

As provided for by USEPA guidance, groundwater ARARs may be waived or modified in cases where compliance with the requirements is technically impracticable from an engineering perspective. Where groundwater ARARs are waived at a Superfund site due to technical impracticability, the USEPA's general expectations are to prevent further migration of the contaminated groundwater plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction measures as appropriate.

Components of the TI Evaluation

This TIE has been prepared in strict accordance with the TI Guidance. The TIE contains six primary components, which include:

- Identifying specific ARARs or media cleanup standards for which TI determinations are sought;
- Evaluating the spatial area over which the TI decision may apply;
- Developing a conceptual model that describes the geology, hydrogeology, groundwater contaminant sources, transport, and fate;

- Evaluating the restoration potential of the site, including data and analyses that support any assertion that attainment of ARARs or media cleanup standards is technically impracticable from an engineering perspective;
- Estimating the cost of the existing or proposed remedy options, including construction, operation, and maintenance costs; and
- Any additional information or analyses that the USEPA deems necessary for the TIE, based on comments provided on this TIE.

The TI Guidance identifies primary factors that may inhibit groundwater restoration:

- Hydrogeologic limitations such as complex sedimentary deposits, aquifers of very low permeability, fractured bedrock aquifers, and other factors that make in situ treatment of contaminated groundwater extremely difficult; and
- Contaminant-related factors that may limit the success of an extraction or in situ treatment process (such as DNAPLs, types of chemical releases, volumes, and duration of release).

At this site, there are combinations of many of these factors that preclude groundwater restoration to drinking water standards, including the following:

- There are NAPLs *in* fractured bedrock.
- There are mixed wastes in groundwater (hydrocarbons, solvents, polychlorinated biphenyls [PCBs], metals, etc.,) that are not treatable by a single technology.
- Many of the contaminants are relatively immobile and sorption within the aquifer matrix appears to be the primary environmental fate-governing mechanism.
- The geology is complex; the overburden geology has extremely low permeability and the basement rock is highly fractured.
- There are ongoing sources of contaminants that are encapsulated within capped landfills (e.g., pesticides and solvents within the capped Pesticide/Solvent [P/S] Landfill).

Spatial Extent of the TI Determination

For the FS evaluation presented in the FS report, the groundwater Study Area at the site (FS Area 5) has been divided into three areas, which are referred to as Area 5 North, Area 5 West, and Area 5 South. These three groundwater areas are shown on Figure A-1 and are illustrated on the block diagram on Figure A-5a.

As described within this TIE, a TI determination is sought for Area 5 North. This groundwater area includes the most highly contaminated parts of the site, including the Capped Landfills, the PCB Landfill, the Burial Trench Area, and the Central Drainage Area. Light non-aqueous phase liquids (LNAPLs) and DNAPLs are found within this area. A TI determination is sought for both the Upper Hydrostratigraphic Unit (Upper HSU) and Lower Hydrostratigraphic Unit (Lower HSU) within this area for both organics and inorganics. This proposed “TI zone” is fully within the current boundaries of the site. The base of the TI zone is proposed to be defined as 200 feet above mean sea level, which will fully encompass any known DNAPL impacts to groundwater within Area 5 North.

The following areas are not included in the proposed TI zone:

- Area 5 South – This area includes the former Liquid Treatment Area and the former Ponds and Pads subarea, and is located immediately south (and downgradient) of Area 5 North, described above.
- Area 5 West – This area includes the RCRA Canyon and the West Canyon Spray Area, and is located west of Area 5 North and Area 5 South.

The Area 5 South and Area 5 West groundwater areas are evaluated within the FS where remediation alternatives are proposed that should meet required remediation ARARs.

Conceptual Site Model

The TIE discusses in detail a Conceptual Site Model (CSM) for groundwater at the site. Three-dimensional diagrams illustrating the CSM are included as Figures A-5a and A-5b of the TIE. We have briefly summarized that model in the paragraphs that follow.

The fundamental components of the CSM are briefly summarized below:

- Two HSUs have been defined for the site. The distinction between the Upper and Lower HSUs is atypical, as the units are not separated by an aquitard or aquiclude, but rather are defined by the degree of weathering of the fractured claystone. The Upper HSU has moderate to low hydraulic conductivity (~10^{-5} centimeters per second [cm/s]) while the Lower HSU has low hydraulic conductivity (~10^{-6} cm/s). Groundwater does not migrate quickly or easily through these geologic materials; for perspective, this range of hydraulic conductivities of these native soils is the same as those required for low-permeability Resource Conservation and Recovery Act (RCRA)-equivalent landfill caps.
- Site-wide groundwater flow and contaminant migration at the site is controlled by a series of east-west oriented clay barriers and extraction trenches constructed within the Upper HSU that are anchored within the Lower HSU and pumped using sump-wells. One extraction trench (referred to as the Perimeter Source Control Trench [PSCT]) is installed just south of the primary landfill and direct-disposal areas (roughly midway across the site), and a series of three different extraction trenches located along the southern property line (referred to as Perimeter Control Trenches A, B, and C) form a barrier to offsite groundwater migration.
- Groundwater on and near the site is not currently used as a drinking water resource. Groundwater in the vicinity of the site ranges from brackish to highly brackish (i.e., brackish conditions are generally defined as total dissolved solids (TDS) greater than 1,000 up to ~10,000 milligrams per liter [mg/L]). TDS concentrations in groundwater for all onsite and offsite wells are typically significantly greater than 1,000 mg/L and sometimes approach 20,000 mg/L. Groundwater flow beneath the site generally follows topography; groundwater flows south offsite, then west via Shuman Creek towards the Pacific Ocean. Shallow groundwater within the Shuman and Casmalia Creek watersheds is not used for drinking water because of poor yield and naturally high TDS levels. Offsite impacts are low due to both natural hydrogeologic conditions (such as fine-grained soils) as well as the long-term operation of both source and site perimeter hydraulic containment features.
- Organic and inorganic contaminants are found in groundwater throughout the site. The highest concentrations (including separate-phase product solvents and hydrocarbons) are found in Area 5 North, where significant amounts of waste materials are contained. These impacts are found within the Upper HSU and Lower HSU, including fractured bedrock. Organic and inorganic contaminants are also found at high concentrations

south of this area within Area 5 South. Although the former waste ponds and pads were largely excavated in this subarea, high concentrations of organic compounds (e.g., dissolved solvents) and inorganic compounds (e.g., metals) are present in groundwater, which might be due to either incomplete excavation of source soils or due to sorbed contaminants within the fractured claystone matrix that act as residual sources to groundwater impacts.

Technical Impracticability Evaluation Process

The TIE presents the extent of contamination and the geological considerations within the proposed TI zone. It also presents restoration alternatives that were developed to describe what actions would be necessary to restore groundwater to drinking water standards, and to understand the time frame to achieve those standards as well as the technical feasibility and costs of such actions. With that as a basis, the TIE evaluated the technical considerations and challenges of restoring groundwater in these areas to meet ARARs (Maximum Contaminant Levels [MCLs]). The restoration alternatives included detailed analyses of several different criteria (consistent with the criteria used in developing FSs under CERCLA) and concluded that aggressive mass removal in soil and groundwater would not be technically feasible, would not be acceptable to the local community, and would not significantly reduce the time frame to reach cleanup standards, regardless of cost.

Technical Impracticability Evaluation Conclusions

We have briefly summarized the primary justifications for a TI determination for Area 5 North in the bullets that follow.

- There are large quantities of liquid and solid hazardous wastes that were disposed of into landfills, ponds, evaporation pads, burial trenches, and injection wells at the site between 1979 and 1986. Much of that waste remains onsite and it would not be safe or practical to consider removal. The previous disposal practices have resulted in releases of LNAPLs and DNAPLs into the hydrogeologically complex environment of the site where low permeability and fractured overburden and bedrock exist. NAPL data, site hydrology, and fractures were evaluated and summarized in the Remedial Investigation (RI) process and is discussed again in the TIE and provides us sufficient information to evaluate site conditions.
- The primary source of DNAPL product at the site is likely the P/S Landfill, where solid wastes and containerized liquid wastes are encapsulated beneath an engineered cap. Over time, the drums may decay and leaks may occur, which would provide an ongoing source of DNAPL product to the base of the unlined landfill. These leaks would migrate to the base of the landfill where they could continue to migrate into fractures within the Lower HSU. The only way to ensure that no ongoing sources of DNAPL remain in this part of the site is to remove the entire contents of P/S Landfill. The TIE includes a detailed analysis of this restoration alternative, which determined that although the excavation and offsite disposal of the capped landfills is not impossible from an engineering perspective, the increased risks to human health and the environment from such a large-scale removal action would far outweigh the potential benefits to water quality at the site. Although remediation costs are not a primary factor in a TI determination, the estimated costs for complete restoration of the capped landfills area (including landfill removal) is in the tens of billions of dollars.

- Although hydraulic containment features (such as the PSCT) are currently in place to limit horizontal migration of contaminants within the Upper HSU, the presence of contaminants in deep fractured bedrock in the Lower HSU demonstrates that there are pathways of aqueous-phase chlorinated solvent contamination and DNAPL contamination between the P/S Landfill and potentially other source areas to the deeper bedrock (Lower HSU) aquifer.
- The RI has identified chlorinated solvent contamination in the Central Drainage Area that is located several hundred feet from the P/S Landfill, and demonstrated widespread Upper and Lower HSU contamination in this area. Similarly, there are groundwater impacts from the Burial Trench Area that extend well south of the PSCT into the former Ponds and Pads subarea.
- The overburden aquifer is a low-permeability, weathered claystone formation. LNAPLs and DNAPLs have been identified at several wells/piezometers within the Upper HSU, and it is likely that NAPLs may exist at other locations within the Upper HSU based on current groundwater chemistry data. DNAPL may be pooled in dead-end fractures or remain as residual in the fractures where diffusive losses to the porous matrix may dissipate DNAPL over time. These characteristics limit the hydraulic accessibility of DNAPL and, coupled with the low permeability of the Upper HSU, make removal of DNAPL and restoration of groundwater to background levels within 1,000 years impossible.
- There are currently no available technologies that are known to be effective in restoring DNAPL zones in complex heterogeneous geologic environments to drinking water quality. Findings established in the scientific community suggest that over 99 percent of the DNAPL would likely have to be removed to achieve a meaningful decrease in groundwater concentrations. Geochemical modeling of diffusion from the fractured claystone, provided in this TIE, shows that, even if all DNAPL could be removed immediately, the slow diffusion of constituents out of the fractured clays would keep groundwater concentrations above MCLs for over 1,000 years. Research has shown that even at the few DNAPL sites that have achieved closure following full-scale remediation (none of which involved DNAPLs in fractured bedrock like those observed at this site), groundwater concentrations could not be reduced to MCLs.
- This area also contains many other organics and inorganics (e.g., metals such as arsenic, nickel, cadmium, and selenium) that are significantly higher than their respective MCLs in both the Upper and Lower HSU. Groundwater is also elevated in TDS concentrations. No in situ technology is capable of treating the mixture of chemicals found in this area. Similar to the mechanism by which dissolved chemicals originating from a release of DNAPL diffuse into fractured media, high-concentration metals would also be expected to diffuse into fractured media. Upon decreasing the concentrations of metals in groundwater (e.g., via groundwater extraction) reverse matrix diffusion would commence, and would result in slowly decreasing groundwater concentrations. Geochemical modeling provided in this TIE demonstrates that even if groundwater extraction were capable of capturing all dissolved chemicals in groundwater, back diffusion of inorganic materials from the weathered bedrock formation would preclude groundwater restoration for hundreds of years.
- The most suitable remedial approach for Area 5 North is to prevent further migration of the contaminated groundwater plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction measures as appropriate.

1.0 Introduction

As part of the Final Feasibility Study (FS), this appendix has been prepared to evaluate proposing a technical impracticability (TI) waiver zone for groundwater restoration as provided in Section 2.9.2.2(K) of the Casmalia Resources Superfund Site (site) Consent Decree. This section of the Consent Decree provides the following performance standard:

> *Perform an analysis, substantiated by data and other evaluation information, consistent with 300.430(f)(ii)(C) of the NCP and the Guidance for Evaluating the Technical Impracticability for Groundwater Restoration, EPA Directive 9234.2-25, of the technical impracticability of restoring the groundwater in the Zone 1 area.*

The restoration of contaminated groundwater, especially for a designated drinking water aquifer, is one of the objectives of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Superfund program. The National Contingency Plan (NCP), which provides the regulatory framework for the CERCLA program, states that the United States Environmental Protection Agency (USEPA) "expects to return usable ground waters to their beneficial uses wherever practicable, within a time frame that is reasonable given the particular circumstances of the site" [NCP section 300.430(a)(l)(iii)(F)]. Generally, restoration cleanup levels are established by applicable or relevant and appropriate requirements (ARARs), such as the use of federal or state standards for drinking water quality (USEPA, 1993).

Experience has shown, however, that restoration to drinking water quality may not always be achievable due to the limitations of available remediation technologies and the inherent limitations of the subsurface physical characteristics and contaminant properties. USEPA therefore must evaluate whether groundwater restoration at Superfund sites is attainable from an engineering perspective. As discussed in USEPA's 1993 *Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration* (TI Guidance), there are a number of factors that can inhibit groundwater restoration, which include hydrogeologic and contaminant-related factors, such as the presence of dense non-aqueous phase liquids (DNAPLs). This is particularly relevant to the site, where the light non-aqueous phase liquids (LNAPLs) and DNAPLs present are primarily from the disposal of billions of pounds of liquid wastes within capped landfills. The factors that affect groundwater restoration, and their specific relevance to the site, are presented in Table A-1 and in Section 1.1 of this appendix.

As provided for by USEPA guidance, groundwater ARARs may be waived or modified in cases where compliance with the requirements is technically impracticable from an engineering perspective. Where groundwater ARARs are waived at a Superfund site due to technical impracticability, the USEPA's general expectations are to prevent further migration of the contaminated groundwater plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction measures as appropriate [NCP section 300.430(a)(l)(iii)(F)].

As stated in the Remedial Investigation/Feasibility Study (RI/FS) Work Plan, the preliminary response action objectives for the site include restoring groundwater quality to applicable standards, where technically practicable. As discussed in the performance standards for the RI/FS (see RI/FS Work Plan; Casmalia Resources Site Steering Committee [CSC], 2004), the practicability of restoring groundwater quality to applicable media standards will be evaluated per the NCP. Because the USEPA recognized that restoring groundwater under the site posed some specific challenges, the Consent Decree (and attached Statement of Work [SOW]) with

the CSC requires the CSC to conduct a preliminary TI Evaluation (TIE) as part of the Remedial Investigation (RI) process, and to complete the TIE as part of the subsequent FS process.

Per the TI Guidance (USEPA, 1993), groundwater restoration can be technically impracticable based on: (1) geologic and hydrogeologic constraints; (2) chemical-specific conditions (such as the presence of DNAPLs); and/or (3) treatment technology limitations. As provided for in the TI Guidance, decisions regarding the technical practicability of groundwater restoration must be based on a thorough characterization of the physical and chemical aspects of the site. All reasonable efforts must be made to identify the location of source areas through historical information searches and site characterization efforts. The TI Guidance notes "the presence of known remediation constraints, such as DNAPL, fractured bedrock, or other site conditions, are by themselves not sufficient to make a TI determination. Adequate site characterization data must be presented to demonstrate not only that the constraint exists, but that the effect of the constraint or contaminant distribution and recovery potential poses a critical limitation to the effectiveness of available technologies."

This appendix to the FS Report presents a TIE for the site. This appendix first presents a discussion of the factors affecting groundwater restoration (Section 1.1) and then provides an evaluation of the six components of a complete TIE, which include:

- Component 1 – Identifying specific ARARs or media cleanup standards for which TI determinations are sought (Section 2);
- Component 2 – Evaluating the spatial area over which the TI decision may apply (Section 3);
- Component 3 – Developing a conceptual model that describes the geology, hydrogeology, groundwater contaminant sources, transport, and fate (Section 4);
- Component 4 – Evaluating the restoration potential of the site, including data and analyses that support any assertion that attainment of ARARs or media cleanup standards is technically impracticable from an engineering perspective (Section 5);
- Component 5 – Estimating the cost of the existing or proposed remedy options, including construction, operation, and maintenance costs (Section 6); and
- Component 6 – Any additional information or analyses that the USEPA deems necessary for the TIE based on comments provided on this TIE.

As noted above, the SOW for the Consent Decree between USEPA and the CSC (USEPA, 1997) requires the CSC to complete the TIE in two steps: 1) the first step, presented in the RI Report (CSC, 2011), includes an evaluation of whether we have gathered the data needed to provide an evaluation of the first three of the six components and 2) the second step, presented in this appendix, also includes the technical engineering and cost evaluations associated with the TIE (i.e., the last three of the six components), along with any pertinent updates to the preliminary TIE that was included in the RI Report.

1.1 Factors Affecting Groundwater Restoration

There are many site conditions that are considered unfavorable for implementing a groundwater restoration remedy that would return groundwater to its beneficial uses within a time frame that is reasonable, as required by the NCP §300.430(a)(1)(iii)(C). As described in the TI Guidance, certain site characteristics may limit the effectiveness of subsurface remediation. Table A-1 describes these factors and provides a generalized remediation difficulty scale. Site-specific information (along with references to specific sections of this TIE that more thoroughly describe

these characteristics) are also provided in Table A-1 to provide perspective on how these factors might affect groundwater restoration at the site.

As shown in Figure 1 of USEPA's TI Guidance (OSWER Directive 9234.2-25, September 1993), there are many characteristics that affect groundwater restoration, including, but not limited to:

- Site Use (e.g., volumes, durations, types of chemical releases);
- Chemical Properties (e.g., decay potential, volatility, retardation potential);
- Contaminant Distribution (e.g., phase, volume of impacted media, depth);
- Geology (e.g., stratigraphic complexity, grain size, heterogeneity); and
- Hydraulics/Flow (e.g., conductivity, temporal variations, vertical flow).

Table A-1 describes how many of these factors, when reviewed individually and applied to the site conditions, tend to fall along the "increasing difficulty" end of the remediation difficulty scale as defined by USEPA in the TI Guidance. In some cases, limitations on remedial effectiveness based on individual factors like the ones described above could be addressed by selecting more aggressive treatment technologies. For example, solvent DNAPLs are generally considered more difficult to remediate than dissolved-phase solvents in groundwater. If all other conditions were generally favorable for groundwater restoration potential (e.g., it was a small release in a shallow homogenous sandy aquifer overlying competent unfractured bedrock), then an aggressive treatment technology could be selected to address the presence of recalcitrant DNAPLs that could possibly be effective within a reasonable time frame. However, at the site, there are combinations of many factors that are unfavorable for groundwater restoration. For example:

- There are LNAPLs and DNAPLs *in* fractured bedrock.
- There are mixed wastes in groundwater (hydrocarbons, solvents, polychlorinated biphenyls [PCBs], metals, etc.) that are not treatable by a single technology.
- Many of the contaminants are relatively immobile and sorption within the aquifer matrix appears to be the primary environmental fate-governing mechanism.
- The geology is complex; the overburden geology has low permeability and the basement rock is fractured.
- There are ongoing sources of contaminants that are encapsulated within capped landfills (Figure A-1) (e.g., pesticides and solvents within the capped Pesticide/Solvent [P/S] Landfill).

In addition to the regulatory framework that dictates the evaluation of factors related to TI (as described in Section 2.0), the data collected during the RI have demonstrated a set of conditions that, when evaluated individually or combined with each other, are consistent with the types of conditions that may ultimately require a TI waiver for the site. The six components of a TIE are evaluated below.

2.0 Potential Site-Specific Applicable or Relevant and Appropriate Requirements

The NCP requires that response actions at CERCLA sites meet ARARs unless there are reasons for invoking a waiver. ARARs consist of federal and state environmental requirements that may affect implementation of remedial alternatives. CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986, and implemented by the NCP, requires identification of all potential ARARs that must be addressed by the USEPA or parties undertaking the response action. Determination of ARARs is site-specific and depends on the chemical contaminants, site/location characteristics, and response actions being investigated for site cleanup. As discussed in the TI Guidance, the USEPA may determine that groundwater restoration is technically impracticable when groundwater cannot be restored with available remediation technologies within a reasonable time frame. In a case where groundwater may be used for drinking water, "restoration" refers to federal or state standards for drinking water quality or risk-based levels for compounds where no ARARs exist.

Hydrogeologic limitations, such as complex sedimentary deposits, low permeability aquifers, types of fractured bedrock, and contaminant-related factors, such as the presence of non-aqueous phase liquids (NAPLs), are among the factors that can inhibit groundwater restoration. DNAPL is present at most sites where the USEPA has determined that groundwater restoration is technically impracticable (USEPA, 1993). The site includes many of the elements supporting TI, including the presence of large quantities of drummed wastes within capped landfills, wastes that were directly disposed of into the subsurface (e.g., in the Burial Trench Area), and DNAPLs associated with these sources that have migrated into deep fractured bedrock.

ARARs are promulgated, enforceable federal and more stringent state environmental or public health requirements. There are two categories of requirements: "applicable" and "relevant and appropriate." A requirement may be either applicable or relevant and appropriate, but not both. These categories are defined below:

- Applicable Requirements – The NCP defines applicable requirements as "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site."
- Relevant and Appropriate Requirements – The NCP defines relevant and appropriate requirements as "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not 'applicable' to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at CERCLA site, address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well suited to a particular site."
- To Be Considered – TBC guidelines are non-promulgated criteria, advisories, and guidance issued by the federal or state governments. Along with ARARs, TBCs may be used to develop the interim action limits necessary to protect human health and the environment.

ARARs and TBCs are divided into three categories: chemical-specific, location-specific, and action-specific. These categories are briefly described for site groundwater in the paragraphs that follow.

2.1 Potential Chemical-Specific ARARs

Chemical-specific ARARs are usually health-based or risk-based numerical values or methodologies that establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. In general, chemical-specific requirements are set for a single chemical or a closely related group of chemicals. These requirements do not consider mixtures of chemicals. Potential chemical-specific ARARs for groundwater at the site include:

- State and federal Maximum Contaminant Levels (MCLs), which are chemical-specific ARARs that govern the quality of drinking water provided by a public water supply. MCLs may be used as relevant and appropriate requirements in establishing groundwater remediation goals for private wells and surface water remediation goals at the site;
- Preliminary Remediation Goals (PRGs), which may be used for general risk screening purposes or to set initial cleanup goals; and
- Public Health Goals (PHGs), which are chemical-specific water quality goals based on current health risk assessment methods.

As described below in this TIE, restoration of groundwater quality to drinking water standards may be technically impracticable at the site. The compounds and their respective potential ARARs for which a technical impracticability waiver may be requested are presented in Table A-2. The compounds include all chlorinated solvents released at the site and related compounds, such as daughter compounds, as well as other co-located compounds dissolved in groundwater such as petroleum hydrocarbons, pesticides, herbicides, and heavy metals. At Casmalia, chlorinated compounds are the most widespread. These and other co-located compounds are generally recalcitrant and may limit the ability to restore groundwater at the site. There are multiple chemicals of concern that commingle with the chlorinated solvents at the site, and there is little perceived benefit to attempting to remediate the co-located compounds (i.e., not seeking to apply an ARAR waiver) while applying an ARAR waiver to chlorinated compounds. Therefore, a TI waiver would apply to all dissolved contaminants found at the site within the TI zone. The maximum reported groundwater concentrations for each of the compounds exceeding MCLs are listed in Table A-3 for reference.

2.2 Potential Location-Specific ARARs

Location-specific ARARs are restrictions placed on the concentrations of hazardous substances, or the conduct of activities solely because they are in specific areas. The general types of potential location-specific ARARs that may be applied to the site are summarized on Table A-4 and briefly described below:

- Location standards for construction of any new treatment, storage, or disposal facilities based on seismic considerations;

- Air quality standards for storage of volatile organic compounds (VOCs) onsite; and
- Water quality criteria based on the Central Coast Regional Water Quality Control Board (RWQCB) Basin Plan (RWQCB, 1994).

No waiver of location-specific ARARs would likely be sought for the site if a TI waiver is implemented. It is assumed that any remedial activities at the site will be designed to meet location-specific ARARs.

2.3 Potential Action-Specific ARARs

Action-specific ARARs are usually technology-based or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are generally focused on actions taken to remediate, handle, treat, transport, or dispose of hazardous wastes. These action-specific requirements do not in themselves determine the remedial alternative; rather, they indicate how a selected alternative must be implemented. The general types of potential action-specific ARARs that may be applied to the site are summarized on Table A-5 and are briefly described below:

- Air quality. Ambient air quality standards may be applied to actions that could result in air emissions of specific VOCs. Air Quality Management District Regulations and a number of Resource Conservation and Recovery Act (RCRA) regulations govern emissions from process vents, equipment, tanks, and containers. These requirements may be considered depending on the response actions selected;
- Water quality. The potential for offsite migration of chemicals will be monitored at the property boundary. Water quality goals must be met based on beneficial uses that have been established by RWQCB; and
- Hazardous waste management. Various California state regulations establish standards for identification, treatment, storage, and disposal of hazardous waste, in addition to establishing standards for closure, post closure, and groundwater monitoring.

No waiver of action-specific ARARs would likely be sought for the site if a TI waiver is implemented. It is assumed that any remedial activities at the site will be designed to meet action-specific ARARs.

3.0 Spatial Extent of TI Decisions

As described in the TI Guidance, where the USEPA determines that groundwater restoration is technically impracticable, the area over which the decision applies (the "TI zone") may include a portion of, or all portions of the contaminated groundwater that do not meet the required cleanup levels. However, delineation of a TI zone based on the location of a particular mapped concentration contour interval (e.g., the MCL for a particular VOC) should generally be avoided because the location of mapped contours is often highly interpretive and their position may change over time.

The FS evaluation for the site is conducted by combining the individual study areas at the site into five FS Areas (FS Areas 1 to 5) and doing separate evaluations for each FS Area. Areas 1 through 4 include surface water and vadose zone source areas and encompass the entire footprint of the site (Figure A-2). Area 5 (site-wide groundwater) is divided into 3 subareas (Area 5 North, Area 5 South, and Area 5 West) (Figure A-3).

A TI zone for Area 5 North is recommended. The potential TI zone encompasses the Upper Hydrostratigraphic Unit (HSU) and the Lower HSU within the entire footprint of Area 5 North. The base of the TI zone is proposed to be defined as 200 feet above mean sea level (msl). This elevation is 100 feet below the deepest monitoring well in the P/S Landfill and Central Drainage Area, where DNAPLs are present (the deepest well, RP-94D, is screened between approximately 319 and 300 feet msl). Although the depth of all DNAPLs is uncertain in this area, the deepest observed DNAPLs was found at RGPZ-7D, which is screened between approximately 328 and 315 feet msl. The proposed base of the TI zone at 200 feet msl will fully encompass any known DNAPL impacts to groundwater within Area 5 North. The contaminants for which a TI waiver would potentially apply include organics and inorganics. The spatial extent of this potential TI zone area is shown in Figures A-4 and A-5a. This area is currently impacted by contamination emanating from the site.

The following areas are not included in the area for which a TI determination is sought:

- Area 5 South – This area includes the former Liquid Treatment Area and the former Ponds and Pads subarea.
- Area 5 West – This area includes the RCRA Canyon and the West Canyon Spray Area.

The Area 5 South and Area 5 West groundwater areas are evaluated within the FS where remediation alternatives are proposed that should meet required remediation ARARs.

The basis for proposing this TI zone is described in more detail in Section 4, but is generally due to the following conditions at the site. Area 5 North includes the following contaminant sources: primarily wastes within capped landfills, wastes that were directly disposed of into the subsurface (e.g., in the Burial Trench Area), and DNAPLs associated with these sources that have migrated into deep fractured bedrock. Very high concentrations of metals and dissolved-phase organic compounds occur throughout the area within the Upper HSU. DNAPLs and elevated levels of organic compounds occur within the Lower HSU. Free DNAPLs occur in the P/S Landfill within the Upper HSU and the Central Drainage Area within the Lower HSU. Free DNAPL is present in the Lower HSU but the extent is uncertain. The proposed base of the TI zone at 200 feet msl will fully encompass any known DNAPL impacts to groundwater within Area 5 North, as discussed above. Free LNAPL occurs within the P/S Landfill and Central

Drainage Area. Residual NAPL occurs in other areas, such as the Burial Trench Area. Groundwater is also elevated in total dissolved solids (TDS) concentrations.

4.0 Conceptual Site Model

This section presents a detailed summary of information related to the site's physical characteristics, nature and extent of groundwater contamination (including the presence of NAPLs), and the fate and transport of contamination as it relates to the practicability of groundwater restoration at the site. These items are presented in the form of a Conceptual Site Model (CSM). Development of a CSM for the site is a dynamic process: it has been developed over time following numerous investigations, and has been presented in many forms in existing documents for the site. This TIE provides a summary and interpretation of the existing site data so that this document can be reviewed and evaluated independently from the primary source documents (the RI and FS), however, the foundations of the CSM can also be found in the following sections of the RI Report (CSC, 2011):

- Section 4 of the RI Report presents a detailed discussion of the site-specific geology and hydrogeology;
- Section 5 of the RI Report describes the nature and extent of contamination in the various environmental media; and
- Section 6 of the RI Report summarizes contaminant fate and transport at the site.

The CSM, as summarized below, includes the most important geologic and hydrogeologic conditions at the site to support the TIE. This section includes general summaries of the following:

- Regional and Site Geologic and Hydrogeologic Setting – This section references other specific sections and appendices of the RI Report wherein detailed discussions of regional and local geologic and hydrogeologic conditions may be found. Information presented in these other sections and appendices include descriptions of geologic formations, topography, drainage features, and regional groundwater resources and quality, as well as descriptions of hydrostratigraphic units, the degree of fracturing in the subsurface, groundwater movement and hydraulic properties, solute transport, groundwater elevations, flow divides, vertical gradients, annual fluctuations in response to recharge, and liquid control features operating at the site. (Section 4.1);
- Contaminant Distribution in Groundwater – The discussion in this section will identify primary site groundwater contaminant source areas, present the lateral and vertical extent of aqueous phase contamination, and describe the location and extent of NAPL contamination. (Sections 4.2 and 4.3); and
- Contaminant Fate and Transport – This discussion identifies major groundwater contaminant transport pathways at the site, summarize relevant flow model findings, and provide information on the potential for natural attenuation or degradation of groundwater contaminants (Section 4.4).

The CSM was developed based on the results of historical investigations and refined over time as new data were gathered as part of the Routine Groundwater Monitoring Element of Work (RGMEW), RI/FS Work Plan scoping activities, and performing the RI activities. The CSM presents the current understanding of the physical and chemical conditions at the site. The CSM is graphically illustrated as block diagrams in Figures A-5a and A-5b and is summarized in the following text. Figures A-5a and A-5b show site features, locations of groundwater and DNAPL contamination, the three groundwater areas, the conceptualized geology of the site, and

the limits of the proposed TI zone. Figure A-5b shows a more detailed view of the onsite (Zone 1) area.

The CSM summarized below describes the range of physical and chemical conditions at the site that are important with respect to characterizing the site's physical characteristics, nature and extent of contamination, and fate and transport of contamination.

The subsections below are summaries of more detailed descriptions provided in the RI Report.

As noted above, the FS updates the CSM based on any additional data or analysis that updates or changes the understanding of the geology, hydrogeology, groundwater contaminant sources, transport, and fate.

4.1 Regional and Site Geologic and Hydrogeologic Setting

The site is located on the south flank of Casmalia Hills located in the southern extent of the Coast Range geomorphic province. The topography of the site is relatively steep, dominated by a northwest-southeast trending ridge (the North Ridge) along the northern boundary. The site ranges in elevation from 835 feet msl along the North Ridge and slopes to 375 feet msl at the southern boundary. During historical operations, natural drainages on the southern flank of the North Ridge were excavated to unweathered bedrock and landfill cells were created within the enlarged canyons. These include the current P/S Landfill, PCB Landfill, Metals Landfill, Caustics/Cyanide Landfill, and Acids Landfill.

Numerous liquid containment ponds and evaporation pads have existed in the lower elevations of the central and southern areas of the site, though most have been removed and capped. Five ponds currently occupy the southern site area within the footprint of former Ponds and Pads. These include the Runoff Containment Facility (RCF) Pond and Pond 13, the A-Series Pond and Pond A-5, and Pond 13.

South of the site border, prominent hills at the southwestern and southeastern corners define three drainages (A-, B-, and C-Drainages) through which surface water and groundwater naturally exit.

In general, the geology of the site is dominated by massive to faintly bedded Todos Santos Claystone bedrock. The upper 30 to 60 feet of the claystone (informally referred to as the Upper HSU) has been eroded, physically weathered and diagenetically altered, resulting in the formation of a weathered rind of claystone with (pseudo-)fracture porosity. The weathered claystone has significantly greater fracture porosity than the underlying unweathered claystone (informally referred to as the Lower HSU). At the site, the Todos Santos claystone is approximately 1,300 feet thick and underlain by the oil-rich Monterey Formation. Alluvium occurs atop the claystone and within present and former drainages. Site operations have removed the weathered claystone from some areas (i.e. beneath the landfill cells) and emplaced refuse and other fill material in others (i.e. the landfill cells).

Two hydrostratigraphic units have been defined for the site. The distinction between the Upper and Lower HSUs is atypical, as the units are not separated by an aquitard or aquiclude, but rather, are defined by the degree of weathering of the claystone. The Upper HSU has moderate to low hydraulic conductivity (~10^{-5} centimeters per second [cm/s]) while the Lower HSU has low hydraulic conductivity (~10^{-6} cm/s). Site-wide groundwater flow and contaminant migration at

the site is now controlled by a series of east-west oriented clay barriers and extraction trenches constructed within the Upper HSU and anchored within the Lower HSU and pumped sump-wells.

Details of the regional and site geologic and hydrogeologic setting are provided below.

4.1.1 Geologic Setting

Casmalia Resources investigated the regional and local geology through numerous site-specific field investigations. Casmalia Resources drilled several hundred borings, installed several hundred groundwater monitored wells and piezometers, and performed other site investigation work to assess the site's geology, hydrogeology, and nature and extent of contamination. The results of this work is documented in several reports, including the Hydrogeologic Site Characterization and Evaluation Report (HSCER; Woodward-Clyde Consultants, 1988a), Geologic Siting Criteria Assessment (Woodward-Clyde Consultants, 1988b), and Hydrogeologic Site Investigation Report (HSIR; Woodward-Clyde Consultants and Canonie Environmental, 1989).

4.1.2 Regional Geology

The site is located on a topographic (structural) ridge within the Santa Maria Basin. The Santa Maria Basin is a triangular-shaped synclinal basin, bounded on the south by the Santa Ynez Mountains and on the east and northeast by the San Rafael Mountains. The shape of the landforms in the area has been governed by accretion of the California landmass and Neogene tectonic activities associated with the San Andreas transform fault system. The base of the Santa Maria Basin is formed by the Upper Jurassic Franciscan Formation. Up to 27,000 feet of Tertiary-age marine and non-marine sediments are present in the Santa Maria Basin. Geologic formations present within the Santa Maria Basin, include the Knoxville, Lospe, Point Sal, Monterey, and Sisquoc. The surface expression of the regional geology is presented in Figure A-6 (portion of regional geologic map, based on United States Geological Survey Orcutt and Casmalia quadrangles; Dibblee, 1989). Detailed geologic conditions within the site and directly surrounding areas are presented in Figure A-7 (Site Geologic Map; Woodward Clyde Consultants, 1988a). The regional stratigraphy and structural relationships are depicted in Figures A-8 and A-9.

The Monterey and Sisquoc Formations comprise the upper 6,300 feet of sediments in the Santa Maria Basin. At the site, the upper Miocene Monterey Formation is present at approximately 1,300 feet below ground surface (bgs) (Section 4.2, Page 4-2, Woodward-Clyde Consultants, 1988a and 1988b). The Monterey Formation is approximately 5,000 feet thick and is composed of interbeds of porcelaneous shale, chert, limestone, diatomaceous shale, and diatomite. Oil and gas are locally produced from fractured sections of the Monterey Formation including areas lying to the east and north of the site.

Conformably overlying the Monterey Formation is the upper Miocene to middle Pliocene Sisquoc Formation. The Sisquoc is formally divided into two members: the lower Todos Santos Claystone Member, and the upper Tinaquaic Sandstone Member (Woodring and Bramlette, 1950). Onsite, the Todos Santos Claystone Member is present at the surface and extends down to approximately 1,300 feet. The Todos Santos Claystone Member comprises porcellaneous shale, platy shale, claystone, diatomite, and siltstone. The upper Tinaquaic Sandstone Member of the Sisquoc Formation is not present at the site.

4.1.3 Local Geology

The following sections summarize the identified surface and near-surface geologic units present at the site. Site surface geologic conditions are depicted on the site geologic map provided in Figure A-7. This map is taken directly from the HSCER (Figure 5-1-1; Woodward-Clyde Consultants, 1988a) and is based on site conditions in the mid- to late 1980s, before Casmalia Resources began pond closure remediation activities. Although Casmalia Resources removed a large volume of former pond subgrade material and placed these materials into the current landfills in the late 1980s, the overall interpretation of the surface geologic conditions depicted in Figure A-7 is applicable to current conditions.

4.1.3.1 Alluvium, Colluvium, and Fill

Typical of California hillside geology, the site's hillside has undergone weathering and erosion to provide colluvium and alluvium sediment that was deposited within the hillside canyons and valley floor. Much of the original colluvium and alluvium once present at the site has subsequently been redistributed during site development and operational activities. Colluvium is present as thin layers in undisturbed areas and has been documented on the hillsides surrounding the site, ranging in thickness from 5 to 10 feet with some deposits up to 20 feet thick. Discontinuous, localized deposits of alluvium have been reported at the site. Engineered fill is present throughout the site as dikes, berms, environmental barriers, and solid waste disposal units. Fill material was also placed in association with landfill capping activities, and as buttresses at the toe of some landfills. Fill was generally derived from excavation of onsite soils and consists of silty clay and pebble-to-cobble size fragments of claystone and silty claystone (McClelland Consultants, 1989).

4.1.3.2 Claystone

Sediment of the Todos Santos Claystone Member of the Sisquoc Formation was original deposited in a (Miocene to Late Pliocene) marine continental margin slope environment, as indicated by diatomaceous fossil types. At the site, the claystone has been informally divided into weathered and unweathered stratigraphic units. The differentiation between the two units is based on the presence or absence of weathering (i.e., difference in color, degree of fracturing and type of secondary mineralization).

Within the facility, the weathered claystone is exposed across 90 percent of the site and ranges in thickness from 15 to 65 feet. The thicker sections of weathered claystone occur in areas of topographic highs, particularly in the northern portions of the site and gradually thin to the south. The weathered claystone is yellowish-gray to pale olive to olive-gray, and ranges from massive to faintly bedded.

The weathered claystone is pervasively fractured. While much effort has been exhausted to define fracture and jointing patterns within the weathered claystone, inherently the weathered claystone is predominantly the result of physical and diagenetic alteration of the surface exposure of the Todos Santos Claystone. As such, observed fracture patterns are surficial in nature (that is, to the depth of fresh unweathered claystone). Observed "structural trends" within the weathered claystone show wide variation; due to the processes that formed fractures within this unit, structural features within the unweathered claystone overprint the structural relationship developed due to regional tectonic influences.

The unweathered claystone is exposed in less than 10 percent of site outcrop and typically lies at depths of 15 to almost 100 feet bgs. The unweathered claystone is up to 1,300 feet thick and conformably overlies the Monterey Formation. The unweathered claystone is olive-black to gray olive-green (wet), and medium bluish-gray (dry) in color. Grain-size analysis determined that the majority (64 to 86.5 percent) of the claystone comprises very fine silts and clays with minor amounts of sand and silt; with pure smectite or illite/smectite being the dominant clay minerals. The unweathered claystone is significantly less fractured than the overlying weathered claystone.

4.1.4 Regional and Site Hydrogeologic Setting

The site is located in the Casmalia Hills, a topographic high separating two groundwater basins. The Santa Maria Valley groundwater basin occurs to the north and east, and the San Antonio Valley Creek groundwater basin lies to the south (Figure A-10). The site lies between these two basins but drains to the Pacific Ocean within the Shuman Creek watershed. Although this watershed is formally associated with the San Antonio hydrologic unit, the watershed is not within the boundaries of the San Antonio groundwater basin.

The southern boundary of the Santa Maria Valley groundwater basin lies approximately 2.5 miles north of the site. Consolidated non-water-bearing Tertiary rocks form the boundaries of the basin (Worts, 1951), which isolate the basin from the Casmalia Hills. Groundwater flow in the Santa Maria Valley basin follows the surface topography. At the southern boundary of the basin near the Casmalia Hills, groundwater flow is to the north away from the site, and then westward to the Pacific Ocean.

The northern boundary of the site is approximately 2.5 miles from San Antonio Valley Creek groundwater basin. This groundwater basin also has consolidated non-water-bearing Tertiary rocks that form its boundaries; the groundwater flow follows surface topography. At the northern boundary of the basin, groundwater flows southward away from the Casmalia Hills, then westward to the Pacific Ocean.

The Shuman Creek watershed drains the Casmalia Hills in the vicinity of the site and mostly is isolated by hill top ridges from the adjacent Santa Maria Valley and the San Antonio Valley Creek groundwater basins. The site is underlain by the Tertiary-age Todos Santos Member of the Sisquoc Formation. These Tertiary marine rocks are generally considered non-water-bearing compared to the unconsolidated sediments found within the nearby alluvial valleys and basins. However, minor amounts of water are contained in the upper weathered portion of the Todos Santos and within joints and fractures in the lower unweathered Todos Santos. However, as noted at the site during RGMEW events, well recovery following purging of wells screened within the unweathered Todos Santos claystone take several months or longer to occur, indicating that the unweathered claystone has a very low permeability. Groundwater flow beneath the site generally follows topography, flowing south offsite, then west via Shuman Creek towards the Pacific Ocean.

4.1.4.1 Water Classification

The Central Coast RWQCB has identified several beneficial uses for the surface waters (and therefore, associated groundwater) of the Shuman and Casmalia Creek watersheds in the San

Antonio hydrologic unit. The beneficial uses include agricultural, municipal, and recreational use, as well as supporting various fresh, warm water wildlife habitats (RWQCB, 1994).

4.1.4.2 Inventory of Water Wells within a 3-Mile Radius

The most current well inventory study was conducted in 2006 as part of the Remedial Investigation, and identified 38 water wells within a 3-mile radius of the site (Figure A-11). Based on well permits from 1926 to present, and contact with current property owners, the following data was derived for well status and usage. Agricultural and irrigation uses predominate (21 wells), followed by domestic (3 wells); the remaining 14 wells include two industrial wells, two test wells, and 10 wells of unknown use and status. A total of 34 owners were contacted during the 2006 well inventory, confirming 13 properties with no wells, 14 properties with wells, and combined 34 existing wells. No owner conformation regarding the existence of the remaining four wells has been received; however, permit records indicated that two of these wells were abandoned. The methodology and findings of the 2006 well inventory survey are detailed in Appendix N of the RI Report (CSC, 2011).

4.1.4.3 Potential for Site Impacts to Offsite Water Supplies

Groundwater contamination is predominantly located within the boundary of the site. Water quality in monitoring wells installed in nearby offsite areas (Upper HSU wells in the North Ridge, North Drainage, and the A-, B-, and C-Drainages) have only infrequently exceeded their respective MCLs/PRGs for organic and inorganic constituents. Offsite impacts are low due to both natural hydrogeologic conditions (such as fine grained soils) as well as the long-term operation of both source and site perimeter hydraulic containment features.

4.1.4.4 Groundwater Resources On and Near the Site

Groundwater on and near the site is not currently used as a drinking water resource. Groundwater in the vicinity of the site ranges from brackish to highly brackish (i.e., brackish conditions are generally defined as TDS >1,000 up to ~10,000 milligrams per liter [mg/L]). TDS concentrations in groundwater for all onsite and offsite wells, with the exception of water supply wells WS-1 through WS-4, are typically significantly greater than 1,000 mg/L and sometimes approach 20,000 mg/L. TDS concentrations for the water supply wells located along Casmalia Creek typically range between 1,100 and 1,500 mg/L and is considered slightly brackish, with the highest concentration at 3,700 mg/L. The lower TDS concentrations observed in the water supply wells located along Casmalia Creek are due to lower TDS surface water percolation into the creek alluvium.

TDS concentrations are naturally elevated in groundwater contained in the Upper HSU weathered claystone and Lower HSU unweathered claystone. Most monitoring wells are completed in weathered or unweathered claystone, as opposed to alluvium. TDS in offsite weathered and unweathered claystone is variable and often exceeds 5,000 mg/L and can exceed 10,000 mg/L. Where TDS is naturally elevated offsite, major ions (e.g., chloride, sulfate) exceed their secondary MCLs, while metals generally do not exceed their primary MCLs.

4.1.5 Site Hydrogeologic Physical Characteristics

Surface and subsurface site physical hydrogeologic characteristics influence groundwater flow. In addition to natural physical features, physical features constructed as part of historical waste

disposal and response activities by Casmalia Resources and more recent response activities performed by the CSC also influence groundwater flow. The hydrogeologic characteristics of both the natural and constructed conditions are evaluated below within the geological framework presented above.

Casmalia Resources and the CSC investigated the site hydrogeologic conditions through numerous site-specific field investigations. Casmalia Resources drilled several hundred borings, installed several hundred groundwater monitored wells and piezometers, and performed other site investigation work to assess the site's geology, hydrogeology, and nature and extent of contamination. The results of this work by Casmalia Resources are presented in many previous reports, including the Hydrogeologic Assessment Report (Canonie Environmental 1987), HSCER and HSIR. This historical work was supplemented with additional site-specific work performed as part of the RGMEW and RI. The CSC is currently performing semiannual, monthly, and continuous monitoring of selected wells as part of the RGMEW.

Figure A-12 illustrates the location of all current site wells and piezometers. The wells and piezometers shown on Figure A-12 include those still in existence installed by Casmalia Resources in the 1970s and 1980s, those installed by the CSC from 1998 through 2008 as part of the RGMEW, and those installed by the CSC from 2004 through 2007 as part of the RI. Many of the groundwater monitoring wells, piezometers, and other borings and casings installed by Casmalia Resources in the 1970s and 1980s no longer exist and are not shown on Figure A-12.

4.1.5.1 Site Hydrostratigraphic Units

The Todos Santos Member of the Sisquoc Formation is laterally and vertically extensive across the site. The near-surface portion of the unit is extensively weathered and has a distinctly different hydrologic and chemical character (primarily from the differing types of materials found within fractures) as compared to the deeper unweathered unit.

Based on the degree of weathering, two hydrostratigraphic units (HSUs), an Upper and Lower HSU have been informally defined for the site. The Upper HSU consists of the weathered and transition zone claystone; the Lower HSU consists of the unweathered claystone. For a more detailed description of the Site Stratigraphic Characteristics, refer to Section 5.2 of the HSCER.

Overlying the weathered claystone is discontinuous surficial clayey soils, colluvium, alluvium, and fill. These materials are hydrogeologically distinct from the claystone and are not included in the Upper HSU as these surficial fill materials are discontinuous across the site.

4.1.5.1.1 Upper Hydrostratigraphic Unit

The Upper HSU consists of the weathered and highly fractured claystone, as described in above. The thin, approximately 2- to 5-foot transition zone between the weathered and unweathered claystone is included in the Upper HSU. The Upper HSU is found beneath 90 percent of the site and ranges in thickness from approximately 30 to 60 feet. The Upper HSU is generally thicker in the higher topographic areas, although the unit is mostly to completely unsaturated in some of the topographically higher areas of the site. The Upper HSU is poorly transmissive and has a geometric mean hydraulic conductivity of 6.8×10^{-5} cm/s, according to the HSIR. As presented in the RI Report, the geometric mean horizontal hydraulic conductivity for the Upper HSU is 1.05×10^{-5} cm/s, based on all field testing (packer, slug, and pump tests).

4.1.5.1.2 Lower Hydrostratigraphic Unit

The Lower HSU consists of the unweathered claystone at the site. The top of the unit generally follows the surface topography. The unit is estimated to be approximately 900 to 1,300 feet thick and is underlain by Monterey shale. The Lower HSU has a much lower fracture density compared to that of the Upper HSU. Although groundwater flow occurs through fractures, most groundwater in this unit is in the matrix porosity. The Lower HSU is expected to approximate a porous medium on a large scale (hundreds of feet or more). This unit is less transmissive than the Upper HSU, with a geometric mean hydraulic conductivity of 1.3 x 10^{-6} cm/s (Section 4.2.2, Page 4-7 of the HSIR; Woodward-Clyde Consultants and Canonie Environmental, 1989). As presented in the RI Report, the geometric mean horizontal hydraulic conductivity for the Lower HSU is 1.03 x 10^{-6} cm/s, based on all field testing (packer, slug, and pump tests).

It is also important to understand the fractured nature of the hydrostratigraphic units at the site. Previous geologic investigations have concluded the following:

- The weathered claystone is more pervasively fractured than the unweathered claystone.
- The fractures in the weathered claystone display highly variable dip within boreholes, with the dip generally less than 30 degrees (°).
- Within the unweathered claystone, there is a wide range of fracture orientation and no discernible predominant orientation of fractures.
- Some common fracture orientations occur in both the weathered and unweathered claystone, typically northeast- to east-northeast striking high angle to near vertical fractures.
- The density and degree of fracturing within the unweathered claystone varies between both distant and adjacent sampling locations.
- Fractures within the unweathered claystone are observed to display primarily relatively steep dips (predominantly between 50° and 90°) with a significant population of fractures also displaying less steep dips (predominantly between 0° and 20°). Fractures dips between these two populations also occur (between 20° and 50°).
- Fracture dip directions within the unweathered claystone are also variable, but predominant dip-directions occur to the northwest, northeast, and southeast for the more steeply dipping fractures (greater than 20°) and occur to the northeast and east for the less steeply dipping fractures(less than 20°). The dip direction of the more steeply dipping fractures is variable and not uniformly consistent with the regional strike indicating that the steeper fractures observed at the site are secondary features.
- Bedding plane dip directions within the unweathered claystone are generally observed at less than 20°, which is consistent with surface observations.
- Fractures in the unweathered claystone are observed to decrease with depth in some boreholes while they are present throughout the depth of other boreholes. Therefore, the depth to which DNAPL migration occurs within these fractures is not known. At depth, it is likely that fractures ultimately lead to dead ends.
- The continuity between fractures in the unweathered claystone may limit the extent of potential fluid pathways on a site-wide scale while the continuity on a local scale appears to be sufficient to transmit groundwater and DNAPL.
- Clay constitutes the dominant mineral type of fracture infilling at depths 40 feet below the weathered/unweathered claystone contact.

This interconnectivity of fractures within the unweathered claystone is important because, as described below, DNAPL may be pooled in dead-end fractures or remains as residual in the fractures where diffusive losses to the porous matrix may dissipate DNAPL over time. These fracture characteristics, coupled with the low permeability of the Upper HSU, limit the hydraulic accessibility of DNAPLs, which is one of the important justifications for creating a TI zone for portions of the site.

4.2 Dissolved-Phase Contaminant Distribution

The groundwater chemistry data collected both during the RGMEW and RI monitoring programs was used to assess groundwater contamination at the site and to evaluate areas of the site that have the potential to contain NAPL (see Section 5 and Appendix M of the RI Report for a complete summary of the available data). Groundwater contamination is predominantly located within the boundary of the site with significantly less contamination in offsite areas.

4.2.1 Organic Compounds

VOCs are used to summarize the extent of organic compounds. VOCs are generally more mobile in groundwater relative to the other classes of organic compounds (semivolatile organic compounds [SVOCs], herbicides, pesticides, PCBs, and dioxins/furans) and the extent of the other classes of organic compounds are generally contained within the extent of VOCs. Therefore, to illustrate the extent of contamination, Figures A-13 through A-15 present maps of Total VOC iso-concentration contours with time-concentration graphs of select VOCs posted next to wells for the Upper HSU and Lower HSU. Additional figures in Appendix G of the RI Report post organic chemistry data next to individual wells for these VOCs, other VOCs, and other organic compounds (SVOCs, pesticides, PCBs, herbicides, and dioxins/furans) for wells in the Upper HSU and Lower HSU.

Area 5 North is north of the Perimeter Source Control Trench (PSCT) in the area of the primary source areas and contains the majority of the dissolved-phase VOC contamination and all of the known NAPL contamination. As further described below, free-phase LNAPL occurs within the P/S Landfill and in the Central Drainage Area and free-phase DNAPL occurs within the P/S Landfill. The areas with the highest concentrations of VOCs are located within the P/S Landfill, the Central Drainage, the Burial Trench Area, and near the toe of the Metals, Caustic/Cyanide, and Acids Landfills (Figure A-13). The concentrations for VOC compounds in the Upper HSU north of the PSCT ranged from below laboratory reporting levels to in excess of 1,000,000 parts per billion (ppb). VOC impacts within the Upper HSU also extend into both Area 5 South and Area 5 West in areas south of the PSCT. Concentrations of VOCs within these southern areas are generally lower than those observed in Area 5 North (generally in the 10 to 100 ppb range, as shown on Figure A-14), but are present at concentrations in excess of 20,000 ppb downgradient of the former Burial Trench Area.

In the Lower HSU, the majority of the samples collected did not contain VOC concentrations in excess of MCLs/PRGs. However, low concentrations of VOCs occur within the Lower HSU at the following areas: The Central Drainage Area, the Burial Trench Area, the southern edge of the Acids Landfill, along the PSCT, along the North Ridge, and northeast of the Caustic/Cyanide Landfill (Figure A-15). The elevated concentrations in the Burial Trench Area and along the North Ridge are in areas with strong downward hydraulic gradients. The elevated concentrations along the PSCT are laterally downgradient of the higher dissolved-phase

concentrations in the Burial Trench Area (RIPZ-16) and DNAPL present in the Central Drainage Area (RGPZ-7C/D).

In offsite areas, VOC concentrations in Upper HSU wells in the North Ridge, North Drainage, and the A-, B-, and C-Drainages have only infrequently exceeded their respective MCLs/PRGs.

4.2.2 Metals

Dissolved concentrations of arsenic and other metals are elevated throughout the site. Arsenic is used to summarize the overall extent of elevated metals because it is the most broadly elevated metal within the Upper HSU, it exceeds primary MCLs where elevated, and the extent of the other elevated metals is generally contained within the extent of elevated arsenic. Figures A-16a and A-16b present arsenic iso-concentration contours for the Upper HSU and Figure A-17 presents arsenic iso-concentration contours for the Lower HSU. Similar iso-concentration contours are provided in Figures A-18a through A-23 for nickel, cadmium, and selenium because they also are broadly elevated within the Upper HSU and exceed primary MCLs where elevated.

The general distribution of elevated metals is similar to the distribution of elevated VOCs in the Upper HSU. The higher concentrations of metals in the Upper HSU are generally located within the Central Drainage Area, similar to the higher concentrations of VOCs north of the PSCT (Area 5 North). Elevated levels also occur south of the PSCT (Area 5 South) and in RCRA Canyon (Area 5 West). Metals concentrations in the Lower HSU are generally lower than in the Upper HSU. The elevated metals concentrations in the Lower HSU do not appear to coincide spatially with the elevated VOC concentrations in the Lower HSU to the degree that the distributions of elevated metals and elevated VOCs coincide for the Upper HSU.

The relationship of metals in groundwater to metals in soil differs in Area 5 South and Area 5 West. As shown in Figures A-23a through A-23d, metals concentrations in soil are in general several orders of magnitude higher in the RCRA Canyon Area within the Area 5 West boundary compared to metals concentrations in soil within the Area 5 South boundary. However, as shown in Figures A-16a through A-23, metals concentrations in groundwater are similar beneath these two areas. In addition, most areas of the former Ponds and Pads within the Area 5 South boundary have already undergone remediation, including excavation of waste material and placement within site landfills, whereas the RCRA Canyon Area is largely unremediated. Due to the high concentrations of metals in surface/shallow soils, infiltration of precipitation/surface water through the upper layers of soil is believed to be one of the mechanisms for transport of contaminants to Area 5 West groundwater, but is not a major contributor to migration of contaminants to Area 5 South groundwater. The source of groundwater contamination in Area 5 South is from historical operation of the former Ponds and Pads. Since most of this waste was previously remediated, the source to groundwater in Area 5 South is currently the two ponds that did not undergo complete closure (Ponds A and B), residual material left in place post-closure of the other ponds, and in the aquifer material itself due to sorption onto or diffusion into the fractured claystone matrix.

4.2.3 Evaluation of Areas Potentially Containing NAPL

Concentrations of known site NAPL chemicals of concern (COCs) were compared with each chemical's aqueous solubility to determine if dissolved chemical concentrations greater than 1 percent and 10 percent of their solubility concentration are present in site groundwater.

Dissolved concentrations greater than 1 percent or 10 percent of NAPL compounds solubilities are often an indicator of NAPL presence (USEPA, 2004b). The solubilities used in this analysis were compiled from the Risk Assessment Information System (www.risk.lsd.ornl.gov) (United States Department of Energy [USDOE], 2006). Figures A-24, A-25, and A-26 show the areas where dissolved chemical concentrations are greater than 1 and 10 percent aqueous solubility and also where free-phase NAPL has been measured for LNAPL in the Upper HSU, DNAPL in the Upper HSU, and DNAPL in the Lower HSU, respectively.

As described by USEPA (1992), for DNAPLs comprising a mixture of chemicals, the "effective solubility" should be calculated for comparison to groundwater concentrations. The effective solubility is the theoretical aqueous solubility of an organic constituent in groundwater that is in chemical equilibrium with a mixed DNAPL (a DNAPL containing several organic chemicals). The effective solubility of a particular organic chemical can be estimated by multiplying its mole fraction in the DNAPL mixture (obtained via analysis of the DNAPL sample or estimated from waste characterization data) by its pure-phase solubility. For example, if a laboratory analysis indicates that the mole fraction of trichloroethene (TCE) in DNAPL is 10 percent, then the effective solubility would be 110 mg/L [pure-phase solubility of TCE, multiplied by the mole fraction of TCE (1,100 mg/L)*(0.10) = 110 mg/L].

The use of this approach at the site is problematic because of the large number of chemicals detected in site DNAPL (the Gallery Well DNAPL contained over 40 different VOCs). Using this approach, the calculated effective solubilities of any individual constituent are significantly lower than the pure-phase aqueous solubilities. For example, the mole fraction of TCE in the Gallery Well DNAPL was approximately 3 percent, which results in an effective solubility of 31 mg/L [(1,100 mg/L)*(0.03) = 31 mg/L]. As discussed below, it is likely not appropriate to employ the 1 percent rule of thumb for inferring the presence of a DNAPL phase based on this calculated effective solubility. Numerous wells at the site are documented as containing concentrations of constituents greater than 1 percent of these calculated effective solubilities do not contain DNAPLs. Feenstra and Cherry (1996) noted that use of a 1 percent rule of thumb in any assessment of the spatial distribution of DNAPL zones must be performed cautiously, particularly in the downgradient direction, as the dissolved plume emitted by the DNAPL could migrate a substantial distance from the source zone. It has found that the 1 percent rule of thumb is generally consistent when comparing dissolved-phase chemical concentrations with pure-phase aqueous solubilities, rather than effective solubilities (i.e., DNAPL observations in wells are generally found in locations where the dissolved chemistry exhibits concentrations greater than 1 percent of the pure-phase solubilities).

A comparison of COC concentrations to aqueous solubilities has been performed for the following chemicals: 1,1-dichloroethane, 1,1,1-trichloroethane (1,1,1-TCA), 1,2-dichlorobenzene (1,2-DCB), 1,2,4-trimethylbenzene (1,2,4-TMB), benzene, carbon tetrachloride, chloroform, ethylbenzene, Freon 113, methylene chloride, methyl ethyl ketone, methyl isobutyl ketone (MIBK), n-nitrosopyrrolidine, tetrachloroethene (PCE), toluene, TCE, vinyl chloride, and xylenes (see Table A-6). These chemicals were chosen because they were detected at the highest concentrations in the speciation analysis of the NAPL collected from Gallery Well, GW-P(W), SUMP 9B-PB, RGPZ-7C, and RGPZ-7D. The site wells and piezometers that are known to contain NAPL or are potentially impacted by NAPL (based on dissolved chemical concentrations) are listed in Table A-6 and shown on Figures A-24, A-25, and A-26.

For the fall 2004 and spring 2005 RI sampling events, ethylbenzene, toluene, and xylenes were detected in the groundwater samples at concentrations greater than 1 percent and 10 percent of

their aqueous solubilities (see Table A-6). The dissolved concentrations greater than 1 percent and 10 percent of the aqueous solubility for the Upper HSU are primarily located in the Central Drainage Area between the Gallery Well and PSCT-1 (see Figure A-24). However, dissolved concentrations of LNAPL greater than 1 percent and 10 percent of the aqueous solubility for these two sampling events have not been detected in PSCT-1 or in any sampling locations south of the PSCT. In the Burial Trench Area, RIMW-7 had dissolved concentrations of xylenes greater than 1 percent of the aqueous solubility. Lower HSU piezometer RGPZ-6D had dissolved concentrations of xylenes greater than 1 percent of the aqueous solubility.

For the chlorinated VOCs, 1,1,1-TCA, 1,2-DCB, 1,2,4-TMB, Freon 113, methylene chloride, MIBK, PCE, and TCE were detected at dissolved concentrations greater than 1 percent of the aqueous solubility, and 1,2-DCB, 1,2,4-TMB, and PCE were detected at dissolved concentrations greater than 10 percent of the aqueous solubility (see Table A-6). Dissolved concentrations greater than 1 percent of the aqueous solubility in the Upper HSU were primarily located in the Central Drainage Area (see Figure A-25). One well at the toe of the Metals Landfill (WP-8S) and one at the toe of the Caustic/Cyanide Landfill (RG-9B) had detections of Freon 113 greater than 1 percent of the aqueous solubility, although concentrations of other COCs including PCE, TCE, cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride were much lower in these wells. Wells RIMW-7 and RIMW-8, which are located downgradient of the burial trenches, had detections of Freon 113, PCE, and TCE greater than 1 percent solubility (see Figure A-25). RIMW-8 had dissolved concentrations of Freon 113 greater than 10 percent of the aqueous solubility.

4.3 NAPL Observations

LNAPL and DNAPL have been directly measured and/or observed in the Central Drainage Area. Descriptions of the distributions of LNAPL and DNAPL are summarized in Section 4.2. Figures A-24, A-25, and A-26 show the areas where dissolved chemical concentrations are greater than 1 and 10 percent aqueous solubility and also where free-phase NAPL has been measured for LNAPL in the Upper HSU, DNAPL in the Upper HSU, and DNAPL in the Lower HSU, respectively.

All of the known free-phase NAPL contamination that has been measured in monitoring wells, piezometers, or extraction wells is located north of the PSCT, although evidence of residual NAPL contamination has been observed during various investigations in other areas. Currently, LNAPL is present as a separate (free) phase in 12 Upper HSU wells and piezometers in an area from RIPZ-14 at the top of the P/S Landfill to just north of PSCT-1. In the Upper HSU, DNAPL is present as measurable amounts in P/S Landfill Piezometers RIPZ-13 and RIPZ-27, and the Gallery Well. In the Lower HSU, DNAPL is present at measurable amounts in piezometers RGPZ-7C and RGPZ-7D between the P/S Landfill and PSCT-1. Historically, small amounts (less than 0.2 foot) of LNAPL have been measured in RG-3B (in the former Pad 9A area), but LNAPL is no longer observed in this well.
To date, neither LNAPL nor DNAPL have been measured in any other site wells or piezometers. NAPL has not been detected in the recently installed RI wells and piezometers in the Burial Trench Area (although observations during drilling may suggest NAPL in this area), or in other site wells and piezometers near and downgradient of the other site landfills. The Upper HSU locations in the Central Drainage Area where LNAPL and DNAPL have been observed or inferred generally coincide with an historical site drainage that ran the length of the P/S Landfill and continued into the area that is now the RCF Pond.

LNAPL and DNAPL depths and thicknesses are routinely measured in these wells and piezometers. The source of DNAPL to the Lower HSU piezometers is uncertain. The two potential source areas are (1) what could be as much as approximately 100,000 gallons of free-phase DNAPL in the P/S Landfill (located 500 feet to the north of the Lower HSU piezometers) and (2) an unknown (current or former) body of free-phase DNAPL in the former Pad 9A/B area located between the P/S Landfill and the two Lower HSU piezometers.

Some uncertainty regarding the distribution of DNAPLs in the subsurface will always remain, because it is not possible to collect data from every potential geologic fracture. However, other than the above-listed locations, to date, neither LNAPL nor DNAPL has been measured as a free phase in any other site wells or piezometers outside the boundary of the P/S Landfill and Central Drainage Area. Free-phase NAPL has not been detected in the recently installed RI wells and piezometers in the Burial Trench Area (although observations during drilling may suggest some NAPL in this area), or in other site wells and piezometers near and downgradient of the other site landfills. Groundwater samples from some monitoring wells in the Central Drainage Area that do contain free-phase NAPL also have relatively high concentrations of dissolved LNAPL and DNAPL constituents. Relatively high concentrations may indicate the presence of LNAPL or DNAPL near these wells, and in such cases the aqueous groundwater chemistry was reviewed as evidence of NAPL presence (see Section 4.2). Also reviewed were the RI drilling investigation data with respect to NAPL observations in core samples. All of these lines of evidence were evaluated to delineate the likely lateral and vertical extent of NAPL. Table A-7 summarizes this information with respect to potential NAPL locations at the site. Figures A-24, A-25, and A-26 show the locations of known or inferred NAPLs in the Upper and Lower HSU. Based on these data, discrete site areas potentially impacted by NAPL have been identified, as discussed below.

4.3.1 P/S Landfill and Central Drainage Area

The Upper HSU locations in the Central Drainage Area where LNAPL and DNAPL have been observed or inferred generally coincide with a historical site drainage that ran along the length of the P/S Landfill and continued into the area that is now the RCF Pond (see Figures A-24 and A-25). A brief discussion of potential NAPL sources follows, and is based on information contained in Sections 2.2.3 through 2.2.5 of the RI Report (see Tables A-8 through A-12, and Figure A-27 of this appendix).

The potential source(s) of NAPLs in the Central Drainage Area include:

- The P/S Landfill, where billions of pounds of pesticides and solvents were disposed of from 1979 through 1989. Waste disposal in the P/S Landfill began at the toe of an existing canyon (or surface drainage), and waste placement continued to the north. The landfill is unlined and the landfill operators excavated Upper HSU and alluvial deposits to the approximate contact with the Lower HSU claystone to create landfill volume. As shown on Figures A-28 through A-30, a former surface-water drainage feature ran the entire length of the P/S Landfill.
- Former ponds and pads in the NAPL area downgradient of the P/S Landfill. These include Pond R and Pads 9A and 9B, which were all designated as “Landfill Runoff/Leachate Control” units. Pond R held liquids from 1977 through 1987 and Pads 9A and 9B contained liquids from 1985 through 1987. Note that Pond 7 (which held waste liquids from 1979 through 1984) was converted into Pads 9A and 9B in 1985. Neither Pond R nor Pads 9A and 9B were completely closed during pond closure

activities and these three units were recommended for landfill closure (presumably a capping remedy as recommended for the site landfills).

- Former ponds (Ponds 6 and 19) just west of the NAPL area, which held site runoff and other liquids from about 1980 through 1987. These ponds are considered possible NAPL sources because (1) they were designated to receive landfill runoff or leachate, (2) they are located along former site drainages where NAPL may more easily migrate, and (3) they were not completely closed during pond closure activities. Notations made during closure of Pond 6 indicated that the western third of the pond was possibly impacted by leachate from the P/S Landfill. Pond 19 was recommended for closure, with the exception of the south dike and adjacent fill materials. The western third of Pond 6 and the southern portion of Pond 19 were recommended for closure as landfills.

4.3.1.1 P/S Landfill and Central Drainage Area LNAPL

LNAPL is currently detected in the following Upper HSU wells and piezometers within the P/S Landfill and Central Drainage Area (Figure A-24):

P/S Landfill (from north to south)

- RIPZ-14 located on top of the landfill, 700 feet north of the Gallery Well;
- RIPZ-39, located on Bench 2 Road, 300 feet north of the Gallery Well;
- RIPZ-13 located on Bench 1 Road, 150 feet north of the Gallery Well; and
- Gallery Well, and adjacent piezometers GW-PZ-W, GWPZ-E1, GW-PZ-E2, GW-PZ-E3, RIPZ-23, RIPZ-24, RIPZ-27, and RIPZ-38 (these wells are all located at the toe of the P/S Landfill).

Central Drainage Area

- Sump 9B piezometers Sump 9B-PB, Sump 9B-PC, Sump 9B-CW, RIMW-3, RIPZ-25, and RIPZ-31 (all located in the former Pad 9B area); and
- RGPZ-5B and RIPZ-8 (located on the former Pond R bench).

4.3.1.1.1 LNAPL in the P/S Landfill

The LNAPL zone in the P/S Landfill extends from the top of the landfill at RIPZ-14 southward to the Gallery Well. The extent of the LNAPL zone does not imply that the LNAPL is contiguous throughout this area; LNAPL is probably located in discrete zones as influenced by available flow paths and soil properties. Several of the piezometers along the clay barrier (Figure A-31) and north of the clay barrier within the landfill interior (Figure A-32) are constructed with the top of the screen below LNAPL and therefore, some of the LNAPL thickness shown in the cross sections in Figures A-31 and A-32 may not represent actual thicknesses. LNAPL in these wells may be trapped in the blank casing above the screen. The top of LNAPL in the piezometers along the clay barrier is approximately 10 feet or more below the top of the barrier (Figure A-31).

The Gallery Well was the only well in the P/S Landfill prior to 1999 to assess liquid levels, including LNAPL. The Gallery Well is screened at the bottom 20 feet of the well. The current action level implemented in 2000 (63 feet below top of casing [btoc]) maintains the pumping liquid level at approximately the mid-point of the screen. The liquid level prior to 2000 (30 feet btoc) was above the screen. Although the current liquid level is maintained within the screened interval, the extraction pump is near the bottom of the Gallery Well so LNAPL may not be effectively recovered at the Gallery Well.

Along the clay barrier, piezometers GW-PZ-W and GWPZ-E1 were installed in 1999 to assess whether the liquid levels were below the top of the clay barrier (25 feet west and east of the Gallery Well). Piezometers GW-PZ-E2 and GW-PZ-E3 were subsequently installed in 2003 to further assess LNAPL thicknesses and the liquid levels in relation to the clay barrier (50 and 75 feet east of the Gallery Well). Further details on LNAPL and DNAPL thickness, elevations, hydrographs, and recovery rates are provided in Attachment A-3. In 2001, the maximum LNAPL thickness in these piezometers was approximately 9 feet in GW-PZ-E3 (Figure A3-1). Piezometers RIPZ-23 and RIPZ-24 were installed next to GW-PZ-W and GW-PZ-E1 in 2004 because the screen elevations for GW-PZ-W and GW-PZ-E1 were below the LNAPL. Piezometers RIPZ-27 and RIPZ-38 were installed in 2007 to follow-up from the Phase 2 seismic refraction survey in the P/S Landfill to delineate the bottom of the landfill where pooled DNAPL potentially exists. The LNAPL thicknesses have fluctuated over time in these piezometers along the clay barrier (Figure A3-1, Table A3-1). Current maximum thicknesses are 21.12 feet in RIPZ-27 and 29.78 feet in RIPZ-38 according to December 28, 2011, liquid level measurements (Table A3-1). It should be noted that, due to a variety of hydrodynamic processes, the amount of LNAPL measured in a well may not always be indicative of the amount of LNAPL in the subsurface or the amount that could be recoverable.

North of the clay barrier, piezometer RIPZ-14 was installed in 2006 to assess liquid levels at the top of the P/S Landfill and RIPZ-13 in 2007 to follow up from the Phase 2 seismic refraction survey in the P/S Landfill to delineate the bottom of the landfill where pooled DNAPL potentially exists. The LNAPL thickness in RIPZ-14 was several tenths of a foot from when the piezometer was installed through 2009; the LNAPL thickness increased to several feet starting in 2010, and is currently approximately 5 feet (Figure A3-1, Table A3-1). However, RIPZ-14 is screened significantly below the water table, so this may not represent the true LNAPL thickness (the objective of this piezometer was not to assess LNAPL). The LNAPL thickness in RIPZ-13 was initially 6.31 feet after installation and is currently 8.96 feet according to December, 28, 2011 liquid level measurements (Figure A3-1; Table A3-1).

4.3.1.1.2 LNAPL in the Central Drainage Area

Based on the LNAPL elevation monitoring, dissolved chemistry analyses, and sample observations, the LNAPL zone in the Central Drainage Area likely extends from the Gallery Well to a location near RG-3B, approximately 200 feet north of PSCT-1. LNAPL was not observed in wells, piezometers, or deep soil borings drilled downgradient of RG-3B during the 2000, 2004, or 2006 drilling programs, and has not been observed during subsequent water level measurements. The extent of the LNAPL zone does not imply that the LNAPL is contiguous throughout this area; LNAPL is probably located in discrete zones as influenced by available flow paths and soil properties. The lateral extent of the LNAPL zone may be 300 to 400 feet wide from near piezometer RIPZ-8 to near RGPZ-5B, and possibly narrows to the south.

In the Sump 9B area, the early piezometers and wells were screened below the water table and potential LNAPL. Piezometers SUMP-9B-PA, -9B-PB, and -9B-PC were installed in 1999 to assess the hydraulic effect of liquids extraction from Sump 9B. The liquid levels in these piezometers were above the top of the screens in this area. RGPZ-5B was installed between Sump 9B and the Gallery Well in 2000 and is screened below the water table. Piezometer SUMP-9B-CW was installed in 2001 as a “companion well” next to Sump 9B. SUMP-9B-CW was screened at the bottom of the Upper HSU to assess for the potential presence of pooled DNAPL in the Sump 9B area, since the bottom of Sump 9B is above the HSU contact. The liquid level is above the screen in SUMP-9B-CW. RG-3B was installed in 1998 to generally

assess the liquid level in the Central Drainage Area. The liquid levels were above the screen in RG-3B.

Recent wells installed as part of the RI were intentionally screened above the water table to assess the potential presence and thickness of LNAPL. These included RIPZ-8, RIPZ-25, RIPZ-26, and RIPZ-31. As of December 2011, the thickness of LNAPL in the Central Drainage Area wells ranges from 0.01 feet (9B-PZ-C, Sump 9B (CW), and RIPZ-25) to 12.68 feet (RGPZ-5B) (Figure A3-1; Table A3-1).

4.3.1.2 P/S Landfill and Central Drainage Area DNAPL

DNAPL is currently detected in the following P/S Landfill and Central Drainage Area wells (Figures A-25 and A-26):

P/S Landfill (from north to south)
- RIPZ-13 located on Bench 1 Road, 150 feet north of the Gallery Well;
- RIPZ-27 located on Gallery Well Road, 10 feet north of the Gallery Well; and
- Gallery Well (Upper HSU).

Central Drainage Area
- RGPZ-7C (Lower HSU); and
- RGPZ-7D (Lower HSU).

Figures A3-2, A3-3, and A3-4 provide DNAPL hydrographs for RIPZ-13 in the P/S Landfill and RGPZ-7C and RGPZ-7D in the Lower HSU. These hydrographs are further referenced below.

4.3.1.2.1 DNAPL in the P/S Landfill

There is a potentially large volume of free-phase DNAPL in the P/S Landfill based on (1) past and current DNAPL extraction rates at the Gallery Well and (2) volumetric estimates from thicknesses of DNAPL measured in the Gallery Well and piezometers within the landfill. This volume is estimated to potentially be as much as approximately 100,000 gallons.

USEPA's original liquids extraction effort from the Gallery Well was continued when the CSC began site work in 1996. The long-term average DNAPL recovery rate measured since 2003 was approximately 6.25 gallons per day, or 2,300 gallons per year and the recent DNAPL recovery rate during 2009 through 2011 was approximately 1,900 gallons per year, based on the tank fill gauging data (Figure A3-5).

The initial DNAPL thickness in the Gallery Well at the time the CSC began site work in 1996 is not known. The first known measured DNAPL thickness was 9.2 feet, prior to performing a DNAPL recovery test in 1997. The DNAPL thickness was approximately 7 to 8 feet during normal operations in 1998 and 1999 (Figure A3-6). Beginning in November 1999 the pump intake was lowered to near the well bottom, and subsequently the DNAPL thickness has been less than 2 to 4 feet.
The following four piezometers were installed in the P/S Landfill in August 2007 to follow up from the Phase 2 seismic refraction survey to delineate the bottom of the P/S Landfill where pooled DNAPL might potentially exist:

- RIPZ-27 located on Gallery Well Road, 8 feet north of the Gallery Well;
- RIPZ-38 located on Gallery Well Road, 50 feet west of the Gallery Well;

- RIPZ-13 located on Bench 1 Road, 150 feet north of the Gallery Well; and
- RIPZ-39 located on Bench 2 Road, 300 feet north of the Gallery Well.

Since installation, DNAPL has accumulated in RIPZ-13 and RIPZ-27, but not RIPZ-38 and RIPZ-39 (Figure A3-6). DNAPL entered RIPZ-27 and RIPZ-13 slowly after installation. DNAPL thickness in RIPZ-27 reached a maximum of approximately 6 feet in 2009 and since then has steadily declined to the current thickness of 1 foot. In RIPZ-13, DNAPL thicknesses slowly increased to the current steady-state thickness of approximately 14 feet. A DNAPL recovery test was performed at RIPZ-13 in 2009 to determine the rate and amount of DNAPL recharge in the immediate vicinity of the well (Figure A3-3). Approximately 42 gallons of DNAPL were pumped from the well during the eight pumping tests. Discussions are continuing with USEPA about any appropriate next steps to develop more information to test whether the DNAPL present in RIPZ-13 originated from a discreet release of a relatively small volume of DNAPL from drums pierced during cone penetrometer test (CPT) or piezometer installation activities, or is instead a larger in situ pool of DNAPL at the base of the P/S Landfill.

4.3.1.2.2 DNAPL in the Central Drainage Area

In the Lower HSU, the following drilling and monitoring well data indicate DNAPL in the Central Drainage Area:

- RGPZ-7C and RGPZ-7D – DNAPL observed in Lower HSU fractures during drilling/coring for piezometer installation in 2000 and DNAPL measured during routine groundwater monitoring from 2003 through 2011;
- RGPZ-6C and RGPZ-6D – DNAPL observed in Lower HSU fractures during drilling/coring for piezometer installation in 2000 and high dissolved-phase concentration of VOCs in groundwater measured during the two RI groundwater monitoring events in 2004 and 2005; and
- RISB-02 – DNAPL in Lower HSU fractures during drilling/coring, accumulated DNAPL measured in the bottom of the borehole, and free-phase DNAPL “blobs” actively entering the borehole liquid column during down-hole video logging in 2006.

These four piezometers, boring RISB-02, and the fracture intervals within the five borings where DNAPL was observed during drilling/coring are shown in Figure A-33. The DNAPL observed in the Lower HSU fractures was sometimes noted as a “chemical sheen,” “product sheen,” or as an actual NAPL. At RISB-02, DNAPL was observed to actively enter the borehole water column from Lower HSU fractures during downhole video logging and accumulate at the bottom of the 253-foot deep boring to a thickness of approximately 15 feet.

The horizontal DNAPL extent in the Lower HSU fractures likely encompasses the southern portion of the P/S Landfill to the north and the Central Drainage Area to the south (Figure A-26).

4.3.2 Burial Trench Area

Neither LNAPL nor DNAPL have been directly measured in the Burial Trench Area, but NAPL may be present based on observations made during drilling and groundwater sampling, and the dissolved chemistry analyses. At RIMW-7, LNAPL was inferred during drilling and DNAPL could be present based on the dissolved-phase chemistry analysis. Only one DNAPL compound (Freon 113) was noted as a possible DNAPL indicator in the Upper HSU at RIMW-8. Because only one compound exceeded 10 percent of its solubility at that location, the likelihood of DNAPL there is low (one would expect more chemicals indicating DNAPL). Piezometers

RIPZ-15 and RIPZ-16 were installed downgradient (south) of the Burial Trench Area and were constructed (screened) to intercept potential DNAPL present at the base of the Upper HSU and upper portions of the Lower HSU. To date, no free-phase LNAPL or DNAPL has been observed in Piezometers RIPZ-15 and RIPZ-16.

The former burial trenches themselves are the most likely source of any potential NAPLs in this area. Seven trenches (approximately 15 feet deep) were sequentially excavated into the subsurface and wastes were placed in the trenches from 1974 to 1979 before the landfills were constructed. Waste disposal in that area also included disposal into 11 injection wells (approximately 30 to 40 feet deep) that operated from 1978 to 1982 (records indicate that one well was reportedly never placed into service). The trenches reportedly received between 6,000 and 80,000 pounds of waste and approximately 1.3 million pounds of waste were disposed via injection wells.

Pond 23 (located over the former burial trenches) was constructed in 1984 to provide runoff control in the area and held liquids until 1987. Although the pond was designated as an alternate alkaline pond (or designated to receive bulk liquid wastes), it is not clear that the pond was used for those purposes. Based on the waste disposal history, it appears that the most significant sources of potential NAPLs in the Burial Trench Area are the trenches and wells themselves.

4.3.3 Other Site Areas

NAPLs have not been detected in any site wells or piezometers outside the boundary of the P/S Landfill beyond those noted in the Central Drainage Area. Also, the results of the ultraviolet induced fluorescence/Membrane Interface Probe work completed across the site (targeted at former ponds where NAPL constituents may have been disposed of, and along the former site drainages) indicated only one potential NAPL location at the southern perimeter of the site (sample RISBON-59), but a subsequent focused study of that area later determined that no NAPLs were present.

Although Figure A-25 indicates potential DNAPL (based on dissolved concentrations) at the toe of the Metals and Caustics/Cyanides Landfills, these locations are not considered to contain potential NAPL. Only one chemical (Freon 113) exceeded 1 percent solubility in both of these locations and dissolved concentrations of other NAPL-indicator VOCs were much lower.

4.4 Aqueous-Phase Contaminant Fate and Transport

This section includes an evaluation of the following potential migration pathways for aqueous phase contamination in groundwater:

- Potential migration toward the North Drainage Area;
- Potential migration from the Landfills and Burial Trench Area;
- Potential migration across or beneath the PSCT;
- Potential migration across or beneath the Perimeter Control Trenches (PCTs); and
- Potential migration within the Lower HSU.

The primary physical processes that result in the movement of dissolved-phase chemicals in groundwater are advection and dispersion. Advection is the movement of chemicals with the bulk movement of groundwater. Advection is generally the primary transport mechanism at site

with moderate to high groundwater flow rates. Mechanical dispersion is the mixing of COCs with groundwater moving along the groundwater flow path. Dispersion will cause some chemical molecules to travel faster and some to travel slower than the average groundwater flow velocity. Dispersion will have the effect of spreading out (lowering) chemical concentrations as they adjectively move with groundwater.

Only highly "mobile" and "persistent" chemicals will move at the same or similar rate as groundwater flow. Most chemicals will move slower than groundwater due to natural attenuation mechanisms that include the following:

- Biodegradation (organics). Biodegradation is the process where microbes degrade and destroy organic chemicals by transforming them into other byproducts. This will reduce the concentration of the organic chemicals along the groundwater flow path. Organics may degrade aerobically or anaerobically. Metals are not subject to biodegradation.
- Sorption (organics and inorganics). Sorption is the process where organic and inorganic chemicals transfer from being dissolved in groundwater to the solid phase of the aquifer matrix. Sorption generally involves three primary mechanisms: adsorption onto the surface of the solid phase, precipitation onto the solid phase, and absorption (i.e., diffusion into the solid phase).
- Dilution (organics and inorganics). Dilution is the process where recharge from another source (e.g., rainfall infiltration) dilutes the organic and inorganic chemical concentrations. Dilution also results from dispersion (mechanical mixing).

Hydraulic containment and chemical mass removal from groundwater also occurs via the onsite groundwater extraction and treatment facilities. This includes the current liquids extraction at the Gallery Well, Sump 9B, PSCT, and three PCTs as summarized in the Performance of Existing Interim Response Actions sections below (Sections 5.1.2 and 5.2.2). Hydraulic containment will act to change the direction of groundwater and contaminant flow paths.

The migration and persistence of dissolved-phase chemicals based on their movement with groundwater movement, natural attenuation mechanisms, and hydraulic containment at the site are summarized below. The following figures display groundwater flow particle tracking simulated using the site groundwater flow model, overlying the total VOC groundwater concentration contours:

- *Figure A-34, VOC – Groundwater Particle Flow Map, Upper HSU, 2004 (Dry)*
- *Figure A-35,VOC – Groundwater Particle Flow Map, Upper HSU, 2001 (Wet)*
- *Figure A-36, VOC – Groundwater Particle Flow Map, Lower HSU, 2004 (Dry) – Between PCB Landfill and PSCT-4*
- *Figure A-37, VOC – Groundwater Particle Flow Map, Lower HSU, 2004 (Dry) – Near RGPZ-6 and RGPZ-7*

Figures A-34 and A-35 are a projection of the groundwater flow paths determined from the site groundwater flow model within the Upper HSU for the Dry (2004) and Wet (2001) model simulations, respectively. The release point for these tracking particles was along the North Ridge. Additional particle tracks were provided for "reverse particle tracking" from PSCT-4 and the three PCTs to more fully show groundwater flow paths and capture by the extraction facilities. The modeling indicates that groundwater (and contaminant) flow within the Upper HSU is downhill to the south and converges towards the Central Drainage Area.

Figures A-36 and A-37 are a projection of the groundwater flow paths determined from the site groundwater flow model within the Lower HSU for the Dry (2004) model simulation. The release point for these tracking particles was north of (and deeper than) the PSCT, to reflect contamination within the Lower HSU in this area. This includes the VOCs detected north of PSCT-4 at RIPZ-16 and also the VOC and DNAPL detected north of PSCT-1 at piezometers RGPZ-7C and RGPZ-7D. The modeling indicates that groundwater (and contaminant) flow within the Lower HSU is south underneath the PSCT and continues southward toward the south part of the site.

A full description of the site groundwater flow model (i.e., MODFLOW model) is provided in the RI Report. Modifications to the site groundwater flow model that were made to enable modeling remedial alternatives presented in the FS are discussed in Appendix D-1 of the FS.

The particle tracks represent the direction of groundwater flow and where dissolved-phase COCs will potentially migrate. However, the actual rate and distance that COCs will migrate along these groundwater flow paths will be influenced by the natural attenuation mechanisms and active hydraulic containment. Based on the particle track modeling conducted using the site groundwater flow model, the time it would take a groundwater particle shown in Figures A-36 or A-37 to travel from its position north of the PSCT to the southern property line is on the order of a hundred thousand years.

4.4.1 Potential Migration toward the North Drainage Area

The potential for aqueous-phase contaminant migration into the North Drainage Area was evaluated using the interpreted Upper HSU water level data, the RGMEW chemistry data, and the site groundwater flow modeling results. The interpreted water table contour maps created from site-wide monitoring results consistently indicate a groundwater divide approximately coincident with the ridgeline along the northern site boundary. The presence of the groundwater divide (that generally coincides directly with the topographic divide on the North Ridge) indicates that groundwater and potential aqueous-phase contaminants occurring along the southern side of the groundwater divide will flow to the south in a direction away from the North Drainage Area. Groundwater monitoring data collected during RGMEW from wells completed along the groundwater divide and in the North Drainage indicate that aqueous-phase contaminants are not migrating into the North Drainage. Groundwater modeling results (Figures A-34 and A-35) also indicate flow paths from just south of the North Ridge groundwater divide are to the south, and do not indicate flow from Zone 1 to the North Drainage.

4.4.2 Potential Migration from the Landfills and Burial Trench Area

The interpreted water table contour maps created from site-wide monitoring results consistently indicate that groundwater flows in a southerly direction from the landfills toward the PSCT. Groundwater flow south of the PSCT occurs towards the A-Series Pond and RCF Ponds.
Monitoring results indicate that groundwater downgradient of the P/S Landfill has been impacted by organic compounds, primarily from the P/S Landfill, extending from the Gallery Well down to the vicinity of PSCT-1. The distribution of contamination appears to follow the groundwater gradient from the source areas towards the PSCT indicating migration of aqueous-phase contaminants. Chemistry data indicate that additional sources between the P/S Landfill and the PSCT may also have contributed aqueous-phase contaminants to groundwater, particularly in the area of Sump 9B and RG-3B. Sump 9B is within the area of the former Pad 9B, while Well RG-3B and the Road Sump are within the area of the former Pad 9A.

Chemical sampling results suggest that the Heavy Metals, Caustics/Cyanides, and Acids Landfills may be source areas for aqueous-phase contaminants resulting in aqueous-phase migration downgradient from the toes of the landfills. The groundwater flow paths interpreted from the water level data suggest that aqueous-phase migration of contaminants from the vicinity of these three landfill areas is occurring toward the PSCT.

Chemical sampling results from SW-17, which is on the downgradient side of the Burial Trench Area, suggest that this area is a source for aqueous-phase contaminant migration. Contaminants, presumably from the Burial Trench Area, appear to migrate southward to the PSCT, approximately 100 feet downgradient. The chemicals detected at SW-17 appear to be among the main contaminants detected along the PSCT, including those from PSCT-1.

There is a potential for NAPL presence (both LNAPL and DNAPL) in and around the Burial Trench Area. This is a likely area for NAPL occurrence because of the significant quantities of containerized liquids (including solvents) that were deposited in the burial trenches and other various products that were injected into the injection wells. This is supported by the high VOC concentrations in groundwater from SW-17, (where cis-1,2-DCE significantly exceeds 1 percent of its solubility). In addition, downward gradients (up to about 0.5 foot/foot) are present at the northern part of this area. The downward vertical gradient increases to the north (in area of PCB Landfill) and lessens toward the south (in area of PSCT-4). The potential therefore exists for contaminant migration into the Lower HSU from potential Burial Trench sources.

4.4.3 Potential Migration Across or Beneath the PSCT

The PSCT extraction system was designed and is operated to prevent the potential migration of aqueous-phase contamination across or beneath this liquid control feature. Water-level data collected to date support the interpretation that the PSCT captures groundwater approaching from the upgradient side and captures groundwater within the vicinity of the downgradient side of the PSCT. Groundwater modeling results (Appendix F of the RI Report) indicate the PSCT effectively captures groundwater in the Upper HSU with limited underflow beneath the PSCT through the Lower HSU.

A projection of the groundwater flow paths determined from the site groundwater flow model within the Upper HSU for the Dry (2004) and Wet (2001) simulations indicate the PSCT is effective in capturing liquids moving southward across the site within the Upper HSU (Figures A-34 and A-35, respectively). The 2004 (dry) model simulated particle tracks pass through the trench in the PSCT-1 area indicating some uncertainty during drier conditions when a recharge mound from precipitation may not be present to the south of PSCT-1. The bypass of the trench may be an artifact of the model.

Organic compounds have been detected in some areas south of the PSCT. On the basis of the specific compounds detected and their concentrations relative to the wells within and upgradient of the PSCT, these compounds appear to potentially be related either to previously existing ponds and pads or to contaminants that were present in these areas prior to construction of the PSCT. On the basis of the evaluation of the water levels from within the PSCT and nearby piezometers and wells, the wells immediately south (within approximately 75 feet) of the PSCT are likely within the capture zones of the PSCT extraction wells. In addition, the measured gradient between Well Pair RG-2B and -4B (respectively located approximately 30 and 100 feet downslope of PSCT-4), typically shows a southward horizontal gradient at this location.

4.4.4 Potential Migration Across or Beneath the PCTs

Concentrations of organic compounds in the area between the PSCT and the PCTs appear to potentially be related to contaminants present prior to construction of the PSCT. Closer to the PCTs, organic compound detections are generally sporadic and at relatively low concentrations (<10 micrograms per liter [µg/L]). Higher concentrations have been detected on occasion (e.g., Well RP-100A in October 1998); however, such concentrations have not been confirmed by subsequent results.

Groundwater flow at the southeastern perimeter of the site is directed into the A-Drainage due to the presence of a prominent hill south of the Zone 1 boundary. Groundwater recharge through this hill causes a reversal of the flow gradient immediately south of the site boundary. This topographically induced groundwater barrier is complemented by the presence of the PCT-A, which extends eastward across the head of the A-Drainage.

Water levels in all three PCT-A extraction wells are generally maintained between 10 to 30 feet lower than the prevailing water levels immediately downgradient of the PCT. These data appear to demonstrate the reversal in groundwater gradients by the operation of PCT-A, and the effective prevention of groundwater movement from the site into the A-Drainage.

Groundwater flow at the south-central perimeter of the site is directed into the B-Drainage due to presence of two prominent hills, which define the B-Drainage. The PCT-B perimeter trench contains an extraction well (RAP-1B), which is directly south of Pond 13 in the B-Drainage. Groundwater elevation in RAP-1B was approximately 9 feet lower than the stage elevation of Pond 13, and 4 feet lower than the groundwater elevation in Well B-5. The lower water level in PCT-B suggests that the facility is effective in preventing offsite groundwater flow. Groundwater flow in the vicinity of PCT-B is further impeded by the reversal in groundwater gradients that occur immediately south of the site. The two prominent hills on either side of the B-Drainage just south of the southern site border result in corresponding increases in groundwater elevation on either side of the B-Drainage. The net result is that groundwater gradients are oriented northward toward the Zone 1 site boundary, or are directed into the B-Drainage. Thus, the head of the B-Drainage serves as a groundwater divide, preventing groundwater from flowing past PCT-B. The eastern and western edges of PCT-B terminate within the adjoining hills.

Water levels in PCT-C and adjacent observation wells indicate that, under normal operations, a significant capture zone exists south of PCT-C and gradients are oriented northward from the nearby offsite (Zone 2) wells. At the southeastern end of the clay barrier, groundwater is impeded by a reversal in the groundwater gradient due to the hill between the B- and C-Drainages. Groundwater flow past the western end of the clay barrier is prevented by groundwater extraction from the PCT-C trench. Thus, PCT-C appears to be effectively preventing offsite migration of groundwater in this vicinity.

The water level data, the ground surface topography, and the inward groundwater gradients along the southern perimeter of the site suggest that there is a low probability that aqueous-phase contaminants are migrating across or beneath the PCTs. A projection of the groundwater flow paths determined from the site groundwater flow model within the Upper HSU for the Dry (2004) and Wet (2001) simulations indicate the PCTs are effective in capturing liquids moving southward across the site within the Upper HSU (Figures A-34 and A-35, respectively).

4.4.5 Potential Migration within the Lower HSU

As summarized above, the majority of the samples collected from the Lower HSU did not contain VOC and metals concentrations in excess of MCLs/PRGs. However, low concentrations of VOCs occur within the Lower HSU at the following areas: the Central Drainage Area; the Burial Trench Area; the southern edge of the Acids Landfill; along the PSCT; along the North Ridge; and northeast of the Caustic/Cyanide Landfill (Figure A-15).

Overall, the potential for aqueous-phase contaminant migration in Lower HSU is considered to be low due to a relatively large (order of magnitude) difference in estimated hydraulic conductivity between the Upper and Lower HSUs. The hydraulic conductivity contrast should preferentially direct groundwater flow from the less transmissive material (Lower HSU) toward the Upper HSU during horizontal groundwater flow conditions. However, dissolved-phase contaminant movement does occur where higher groundwater gradients occur. For example, the elevated concentrations of dissolved-phase VOCs in the Burial Trench Area and along the North Ridge are in areas where there are strong downward hydraulic gradients, which are sufficient to move dissolved-phase contaminants downward from source areas through interconnected fractures in the Lower HSU. Dissolved-phase contaminants along the PSCT are likely from horizontal movement of dissolved-phase contaminants towards the south from higher concentrations in the Burial Trench Area (RIPZ-16) and the DNAPL present in the Central Drainage Area (RGPZ-7C/D).

A projection of the groundwater flow paths determined from the site groundwater flow model within the Lower HSU for the Dry (2004) simulations indicates that groundwater (and contaminant) flow within the Lower HSU is south and that flow beneath the bottom of the PSCT may occur (Figures A-36 and A-37). Although groundwater flow may occur beneath the bottom of the PSCT, natural attenuation mechanisms will act to limit the actual downgradient transport of dissolved-phase contaminants.

4.5 Potential NAPL Mobility/Migration

NAPL is transported in groundwater by capillary forces and buoyancy effects associated with density differences between the NAPL and groundwater. LNAPL is less dense than water and tends to float on top of groundwater, while DNAPL is denser than water and tends to migrate downward through groundwater under gravity.

Movement of LNAPL in the subsurface is controlled by several processes. LNAPL will move downward through the unsaturated zone where a fraction of the LNAPL will be retained by capillary forces as residual globules in soil pores. If sufficient LNAPL occurs, it will continue to move downward under the force of gravity until it reaches a physical barrier (e.g., low permeability strata) or is affected by buoyancy forces near the water table. Once the capillary fringe is reached, the LNAPL may move laterally as a continuous, free-phase layer along the upper boundary of the water-saturated zone the water table. The principal migration direction will be in the direction of maximum decrease in water table elevation. The LNAPL mass may hydrostatically depress the capillary fringe and water table if a large enough mass of LNAPL is present. Infiltrating precipitation and passing groundwater in contact with residual or mobile LNAPL will dissolved soluble components and form an aqueous-phase contaminant plume.

Free phase DNAPL has the potential to laterally migrate along the HSU contact in the P/S Landfill area. DNAPL also has the potential to migrate downward into and through the

underlying fractured bedrock (i.e., Lower HSU) under certain conditions. Potential DNAPL penetration into the Lower HSU requires displacement of the water-saturated porous matrix or fractures. The driving force for DNAPL movement is the additional pressure buildup due to its higher density relative to water. Pore-scale capillary forces that retain water within pores or fractures counteract the additional pressure generated by the DNAPL pool. DNAPL is able to displace water only when the DNAPL pool height generates sufficient pressure to overcome the capillary pressures. Densities of the DNAPLs found within the P/S Landfill and within the Lower HSU in the Central Drainage area are relatively low (i.e., between 1 and 1.1 grams per cubic centimeter [g/cm^3]). The interfacial tension (i.e., the surface tension between two liquids) between the DNAPL and groundwater is also relatively low (i.e., less than 10 dynes per centimeter). While the relatively low densities reduce the potential for DNAPL migration, the low interfacial tension produces the opposite effect, increasing the migration potential.

The subsections below summarize the following:

- Potential NAPL migration mechanisms within the P/S Landfill and Central Drainage Area which are the primary areas with free-phase NAPL contamination; and
- Potential for migration in the Burial Trench Area, even though free-phase NAPL contamination has not been identified in this area.

4.5.1 Mobility/Migration of NAPLs between the P/S Landfill and PSCT-1

The primary potential sources of free-phase NAPLs within the eastern portion of the site are the P/S Landfill and the former ponds and pads located south of the P/S Landfill but within the Central Drainage Area. The P/S Landfill may be a continuing source of both LNAPLs and DNAPLs. Note that presently LNAPL and DNAPL are both being recovered by liquid extraction conducted in the Gallery Well.

The flow of NAPL through the vadose zone is controlled by the chemical and physical differences and the interactions between the NAPL and the soil gas, soil moisture, soil matrix, and gravity (Cohen and Mercer, 1993), and the pressure (head) in the NAPL. Some NAPL is trapped in the available pore space in the unsaturated zone, coating the soil matrix or as ganglia (suspended droplets trapped in the pore space). Because of the minute variations in pore size distributions, soil texture, soil structure, and mineralogy typical of most subsurfaces, the ultimate distribution of residual NAPL is not uniform or readily predictable. The NAPL ganglia can act as a source of dissolved-phase contamination when recharging water flowing through the contaminated pore space comes into contact with the NAPL.

The Gallery Well and associated clay barrier contain and collect DNAPL that migrates laterally along the contact with the Lower HSU under the P/S Landfill, as the containment feature is “keyed” approximately 5 feet into the underlying bedrock contact. The LNAPLs that exist in the P/S Landfill and Central Drainage Area are intercepted by a number of different physical containment features, including:

- The Gallery Well/clay barrier at the toe of the P/S Landfill;
- Sump 9B (to a limited extent); and
- The PSCT (collected by extraction well PSCT-1).

In addition to the potential lateral migration along the HSU contact in this area, DNAPLs could migrate downward into the underlying fractured bedrock (i.e., Lower HSU) under certain

conditions. Potential DNAPL penetration into the Lower HSU requires displacement of the water-saturated porous matrix or fractures. The driving force for DNAPL movement is the additional pressure buildup due to its higher density relative to water. Pore-scale capillary forces that retain water within pores or fractures counteract the additional pressure generated by the DNAPL pool. DNAPL is able to displace water only when the DNAPL pool height generates sufficient pressure to overcome the capillary pressures.

The densities of the DNAPLs found in this area are relatively low (the Gallery Well DNAPL density has been measured at approximately 1.08 g/cm^3, and piezometer RGPZ-7C DNAPL density is only 1.02 g/cm^3). The low densities of these DNAPLs are due to the mixture of chemicals within them, which include many organic chemicals with individual densities less than water. The interfacial tension (i.e., the surface tension between two liquids) between the DNAPL and groundwater is also relatively low, apparently due to the presence of alcohols and/or inorganic surfactants that are present in the DNAPL. While the relatively low densities reduce the potential for DNAPL migration, the low interfacial tension produces the opposite effect, greatly increasing the migration potential.

Previous site conditions have resulted in downward DNAPL migration based on reasonable assumptions for DNAPL properties (densities and interfacial tensions), DNAPL pooled heights, and fracture apertures. The observation of DNAPLs in piezometers RGPZ-7C and RGPZ-7D suggest that vertical migration of DNAPLs through the limited but potentially interconnected fracture network in the Lower HSU has already occurred within the Central Drainage Area.

Subsurface conditions and DNAPL presence within the P/S Landfill and in the Upper and Lower HSUs between the P/S Landfill and PSCT are illustrated on Figures A-25 and A-26. The presence of DNAPL in the Lower HSU (at RGPZ-7C and RGPZ-7D) could be attributable to a number of past conditions at the site and associated factors including, but not limited to, those listed below:

- Prior to the CSC's tenure at the site, when liquid extraction from the Gallery Well was limited and the action level in the well was significantly higher, the DNAPL pool height behind the clay barrier was reported to be as high as 9 feet, which exceeds the required thickness to effect DNAPL entry into underlying fractures.
- DNAPL reported in RGPZ-7C and RGPZ-7D may have originated from sources in the area other than the P/S Landfill, including Pads 9A and 9B or Pond R. The DNAPL may have migrated through a limited fracture network below these historical sources to the depths of the piezometers.
- The DNAPL noted in the Lower HSU may have entered the Lower HSU and migrated prior to the construction of the containment features of the P/S Landfill.

Although groundwater and NAPL observation data from this area are abundant, there are many geologic and hydraulic uncertainties regarding NAPL migration pathways that will always remain. However, based on the data collected to date, the potential for continued and significant DNAPL migration deep into the Lower HSU continues due to potential large volume (approximately 100,000 gallons) of free-phase DNAPL pooled in the P/S Landfill. Although the current extraction systems operating in the P/S Landfill limit the build-up of liquids behind the clay barrier, the hydraulic effect will not inhibit the downward driving force of DNAPL north of the Gallery Well in the vicinity of RIPZ-13. Extraction at the PSCT creates localized upward gradients, but these upward gradients do not extend northward into the Central Drainage Area consistently enough to prevent downward DNAPL migration.

The vertical extent of free-phase DNAPL in the Lower HSU is not known with certainty. Once DNAPL has entered a fracture or fracture network, progressively smaller aperture fractures will be invaded if the pooled DNAPL source is allowed to extend itself vertically while remaining a continuous, interconnected phase. The DNAPL driving head is not only a function of the pool height in the overlying Upper HSU (or P/S Landfill) but also the height of DNAPL accumulated in the fractures beneath this pool. The potentially mobile DNAPL volume in the P/S Landfill provides an ongoing source to allow the DNAPL to extend itself into fractures at depth, where those fractures are interconnected.

The localized horizontal extent of free-phase DNAPL in the Lower HSU is uncertain in the area of the P/S Landfill and Central Drainage Area, although the horizontal extent of free-phase DNAPL is not believed to extend offsite. Of the 408 boreholes that explored the Lower HSU, fracture interconnectivity between boreholes is difficult to demonstrate. The degree of interconnectivity of the fracture network is considered to decrease on a site-wide scale. On a localized scale, sufficient fracture interconnectivity has allowed DNAPL movement within the Lower HSU in the Central Drainage Area as evidenced by (1) free-phase DNAPL observed in Lower HSU fractures while drilling borehole RISB-2 and (2) measurable DNAPL accumulation in piezometers RGPZ-7C/D. The potential source of this DNAPL is from known free-phase DNAPL from the P/S Landfill and/or potential former free-phase DNAPL from the former Pad 9A/B area. Both of these areas are north of RISB-2 and RGPZ-7C/D.

Diffusion of contaminant mass from DNAPL contained within claystone fractures into pore water of the claystone matrix between fractures affects the persistence of DNAPL in the fractures. This diffusion causes a redistribution of contaminant mass from fractures to the claystone matrix that can slow the advance of DNAPL migration. If the DNAPL source is controlled, this diffusion can ultimately cause DNAPL migration to cease and DNAPL to disappear from fractures by dissolution and diffusion into the porous matrix.

It may be possible to remove free-phase DNAPL from the P/S Landfill by primary pumping methods. However, removal of free-phase DNAPL will leave behind residual phase DNAPL that is trapped by capillary forces as residual globules in the soil pores below the water table. Removal of residual DNAPL is much more energy intensive than removal of free-phase DNAPL because of these capillary forces holding residual DNAPL in place.

Removal of free-phase DNAPL from Lower HSU fractures is likely not feasible because it is not possible to sufficiently characterize the site to identify all potential fractures that may contain DNAPL. Meeting this objective would require literally hundreds of deep borings and even then, the extent of mobile DNAPL in fractures would likely not be known. In addition, removing DNAPL from select fractures that are found to contain mobile DNAPL would not be effective because of the very small storage capacity within fractures that would contain DNAPL. Any DNAPL removed from fractures would be replaced until the DNAPL source is removed. The most feasible method of controlling free-phase DNAPL migration in the Lower HSU is to remove the mobile DNAPL source. This would result in the mobile DNAPL in the fractures to stop being replenished, which would cause the DNAPL to stop advancing, and ultimately disappearing through matrix diffusion.

4.5.2 Mobility/Migration of NAPLs between the Burial Trench Area and PSCT-4

Three new RI monitoring wells (RIMW-6, RIMW-7, and RIMW-8) were installed within the Burial Trench Area to evaluate groundwater chemistry and to identify NAPL presence in that area. Although observations made during the drilling of well RIMW-7 indicated the potential presence of LNAPL, none of the newly installed RI monitoring wells in this area has contained measurable amounts of NAPLs. It should be noted, however, that these wells were intentionally installed outside of the former burial cells, and it has been assumed that NAPLs could be present within any of these former waste disposal features. The absence of NAPLs in the new wells is therefore not definitive evidence that NAPLs do not exist within the study area; rather, it indicates that the NAPLs that may be present are not found outside their original trench locations.

Piezometers RIPZ-15 and RIPZ-16 were installed within and downgradient (south) of the burial trenches in the Lower HSU. To date, no free-phase DNAPL has been observed in either piezometer, although higher concentrations are present in RIPZ-16, the piezometer between the Burial Trench Area and PSCT-4.

There are some potentially significant differences between the potential mobility of NAPLs observed within the Central Drainage Area and those NAPLs present within the Burial Trench Area. These potential differences include:

- The volume of wastes within the presumed sources can affect lateral and vertical migration of the NAPLs (e.g., increased DNAPL pool heights can increase the potential for downward migration within fractures), and the magnitude of the NAPL sources is likely significantly greater in the Central Drainage Area compared with the Burial Trench Area. Available data indicate that the primary source of the NAPLs in the Central Drainage Area is the P/S Landfill, which contains billions of pounds of waste pesticides and solvents. The quantity of wastes within the Burial Trench Area is not as great as that of the P/S Landfill.
- NAPL migration in the Central Drainage Area is likely influenced by the geologic properties of an alluvial canyon. This includes the presence of high hydraulic conductivity alluvium and weathered claystone. The former drainage channel could also act as a geologic depression where DNAPLs could accumulate and migrate down slope. In contrast, the Burial Trench Area was carved out of a ridge of bedrock. No obvious preferential flow paths or low points are known to exist in this area.
- Similar to the Central Drainage Area where the DNAPL is extracted using the existing well network, liquids are also removed from an extraction point within the PSCT located immediately downgradient from the Burial Trench Area. To date, NAPLs have not been observed within PSCT-4, which is the closest extraction well to the Burial Trench Area. The data collected to date indicate that the NAPLs (if present) beneath the Burial Trench Area have not migrated significantly since they were originally emplaced.

5.0 Evaluation of Restoration Potential

This section evaluates potential for restoration of site groundwater to MCLs. As noted in Section 3, site groundwater has been separated into three areas for the FS and one of these areas (Area 5 North) is evaluated in this TIE. For Area 5 North groundwater, this section provides a general description of the proposed source control measures, summarizes previous evaluations regarding effectiveness of existing source control measures, and provides an analysis on the potential to restore groundwater at the site to drinking water standards.

5.1 Restoration Potential for Area 5 North

5.1.1 Source Control Measures – Area 5 North

As described in Section 4 of this appendix, there are large quantities of wastes that were disposed into landfills, ponds, evaporation pads, burial trenches, and injection wells at the site between the late 1970s and late 1980s. Much of that waste remains onsite and it would not be safe or practical to consider removal. The previous disposal practices resulted in releases of LNAPLs and DNAPLs into a hydrogeologically complex environment where low permeability and fractured overburden and bedrock exist. NAPL data, site hydrology, and fractures were evaluated in the RI process and there is sufficient information to fully evaluate site conditions. Specific DNAPL sources at the site are discussed in Section 4.3 of this appendix. Some uncertainty regarding the distribution of DNAPLs in the subsurface will always remain, because it is impossible to collect data from every potential geologic fracture. However, other than the above-listed locations, to date, neither LNAPL nor DNAPL has been measured as a free phase in any other site wells or piezometers outside the boundary of the P/S Landfill and Central Drainage Area. Although the removal of all wastes from the landfills and remaining wastes from the burial trenches, ponds, and evaporation pads is not likely either safe or practical, for the purposes of this TIE it is assumed that this waste could be removed from the site, to the extent possible, to allow for a robust evaluation of restoration potential of groundwater at the site. In addition to the volume of DNAPL estimated to be present as a free phase beneath the P/S Landfill (estimated to be as much as approximately 100,000 gallons), there is some volume of DNAPL contained in drums within the P/S Landfill. LNAPL is also present within the P/S Landfill. The LNAPL and DNAPL present in the P/S Landfill and within the Central Drainage Area would need to be removed in order to achieve complete groundwater restoration.

5.1.2 Performance of Existing Interim Response Actions – Area 5 North

The following interim response actions have already been implemented at the site within Area 5 North:

- A PSCT that bisects the site downgradient of the landfills for intercepting contaminated groundwater from the landfills;
- A clay barrier that intercepts NAPLs migrating horizontally from the P/S Landfill and the Gallery Well that extracts contaminated liquids, including NAPLs, from the toe of the P/S Landfill;

- A subgrade sump (Sump 9B) that extracts contaminated liquids, including NAPLs, downgradient of the P/S Landfill; and
- RCRA caps constructed over the P/S, Metals, Caustic/Cyanide, and Acids Landfills to mitigate the potential for downward migration of chemicals that could contribute to further groundwater contamination.

To the extent described below in Section 5.1.4.1.2, some of these interim response actions will be carried forward as part of the hypothetical restoration alternative. The performance of the interim response actions is discussed below, and includes analysis of landfill cap performance, clay barrier investigation results, hydraulic containment provided by the extraction trenches, and groundwater VOC trends over time. The following sections discuss the hydraulic effectiveness of the landfill caps, the P/S Landfill clay barrier/Gallery Well, Sump 9B, and the PSCT, based on the local water-level elevation data. A detailed analysis of the hydraulic effectiveness of these liquid control features was presented in the Technical Memorandum (ICF Kaiser, 1998). Performance of these containment features through various water quality sampling programs is also summarized at the end of this section.

5.1.2.1 Capped Landfills

Onsite landfills include the four landfills capped between 1999 and 2002 (P/S, Metals, Caustic/Cyanide, and Acids Landfills) and a fifth landfill that currently has an interim soil cover (PCB Landfill). The former RCRA Landfill no longer exists. The P/S Landfill and Engineering Evaluation/Cost Analysis (EE/CA) Area (Metals, Caustic/Cyanide, and Acids Landfills) cap systems include (bottom to top): low permeability subgrade layer, 60 mil high density polyethylene geomembrane barrier layer, Geocomposite drainage layer, and a 2-foot thick vegetative soil layer. The P/S Landfill low permeability subgrade layer consists of a 2-foot thick compacted low permeability soil layer (processed and compacted claystone) and the EE/CA Area cap subgrade layer consists of a geosynthetic clay liner. An access road and drainage system is constructed on top of the cap. As further described below, these caps have been effective at reducing rainfall recharge, lowering liquid levels within and in the immediate vicinity of the landfills, and reducing liquids extraction rates from the P/S Landfill.

These RCRA-equivalent caps or covers have been constructed over the P/S, Metals, Caustic/Cyanide, and Acids Landfill cells across an approximate 40 acre contiguous area (construction occurred between 1998 and 2002) to prevent rainfall and surface water from infiltrating through the waste into the underlying HSUs. The impermeable cap has eliminated most rainfall infiltration, which has reduced the magnitude of the downward gradients at the landfills and led to an upward vertical gradient at the toe of at least two of the landfills (Metals and Caustic/Cyanide). Rainwater falling onto the capped landfills now flows as overland surface flow to the small collection (retaining) basin at the toes of the landfill cells that was constructed in 2003. Prior to landfill capping, rainfall infiltrated into the subsurface landfill waste materials or ran off as surface water that was diverted and collected within the RCF. Since capping was completed in 2002 and subsequently beginning with the 2008/09 winter, the stormwater in the retaining basin is now routed offsite to the constructed wetland within the B-Drainage area.

Groundwater elevations in wells within and immediately surrounding the capped landfill area historically responded to rainfall prior to capping. Since 2002 when the landfill capping was completed, the groundwater elevations in the wells within and immediately surrounding the capped landfill area (1) permanently decreased from approximately 10 up to 25 feet and (2) stopped responding seasonally to rainfall. The reduction in groundwater elevations from

capping the P/S, Metals, Caustic/Cyanide, and Acids Landfills has reduced the volume of liquids migrating from these landfills relative to historical conditions before these landfills were capped. Except for the Gallery Well extraction well, no monitoring wells or piezometers existed in the P/S Landfill to document the changes in liquid levels before the cap was constructed in 1999. Instead of using liquid levels, the change in liquids extraction rate from the Gallery Well can be used to assess the effectiveness of the cap in eliminating recharge to the landfill. The Gallery Well extraction rate fluctuated seasonally in response to recharge before 2002. Since 2002, the annual Gallery Well extraction rate has decrease by greater than 50 percent and it no longer fluctuates significantly in response to rainfall because of the cap. Based on these observations, the landfill caps appear to be effective in reducing surface water infiltration through these landfill wastes.

5.1.2.2 P/S Landfill Clay Barrier/Gallery Well

A clay barrier located at the toe of the P/S landfill was constructed in 1981-82 is approximately 200-feet long, 13-feet thick and up to 50 feet deep extending a minimum of 4-feet into the underlying claystone (Harding ESE, 2001). The clay barrier was constructed from local borrow of a very dark gray to black, hard adobe-type clay containing small rootlets and small pale brown claystone fragments. A partially constructed buttress embankment to protect the toe area of the P/S Landfill was built over the clay barrier, and extends approximately 30 feet above the clay barrier. RI activities were conducted to confirm the position and alignment of the barrier, determine the hydraulic conductivity of the clay barrier material, and define the elevation of the top of the P/S Landfill clay barrier. The measured hydraulic conductivity of three samples collected during a 2004 investigation from the P/S Landfill clay barrier range from 2.57×10^{-8} to 4.3×10^{-8} cm/s, which is consistent with an engineered compacted fill of low permeability.

A collection gallery and associated extraction point (the Gallery Well) was installed adjacent to the upgradient face of the clay barrier to facilitate removal of contaminated liquids. The Gallery Well consists of an approximately 5- to 6-foot-diameter gravel-filled pit adjacent to the upgradient (north) side of the clay barrier with a casing in the center of the pit to allow pumping of contaminated liquids and groundwater. The Gallery Well extends to a depth of approximately 75 feet below the top of the buttress embankment. Liquid extraction from the Gallery Well maintains the liquid levels along the Gallery Well bench below the upper limit of the clay barrier. The current liquids extraction action levels are as low as the Gallery Well can practically be pumped (63 feet btoc). Fluids extracted by the Gallery Well are currently transported to a permitted, offsite disposal facility. Based on fluid levels measured within piezometers near the toe of the P/S Landfill, the Gallery Well is effective at intercepting fluids as they approach the clay barrier.

5.1.2.3 Sump 9B

Sump 9B is a gravel-filled collection trench and associated extraction point installed approximately 200 feet downgradient (south) of the Gallery Well and upgradient of the PSCT. During closure of former Pad 9B, Sump 9B was constructed to address observed contamination below the groundwater table. Sump 9B consists of a circular sump, approximately 27 feet deep and 12 feet wide. Extending approximately 100 to 150 feet westward from Sump 9B is a shallow (estimated 8 to 12 feet deep) trench. The sump and trench are filled with gravel to approximately 6 feet below grade and covered with compacted fill material. An extraction point is installed at the deepest portion of the sump. Fluids removed from the sump currently are taken to a permitted, offsite disposal facility.

The flat topography near Sump 9B promotes infiltration of rainfall runoff and groundwater recharge with groundwater encountered at only a few feet below ground surface.

The increased groundwater recharge occurring in the Sump 9B vicinity counteracts the hydraulic impact of groundwater extraction at Sump 9B. The water table contour maps provided in the RI Report do not reveal the presence of a distinct capture zone associated with extraction at Sump 9B. The water levels shown in Sump 9B and the nearby piezometers are representative median values that take into account the daily fluctuation due to pumping. During current pumping conditions, the water level in Sump 9B is usually maintained between 20 and 27 feet btoc, with the action level set at 20 feet btoc. The impact of groundwater extraction at Sump 9B is observed as drawdown in each of the nearby five shallow piezometers, one monitoring well, the deeper "Companion Well," and inferred convergent flow toward the sump.

5.1.2.4 PSCT

The PSCT is a continuous collection trench that is approximately 2,650 feet long and nominally 3 feet wide (Brierly and Lyman, 1989). The PSCT was installed in 1990, on an approximate east to west alignment across most of the central portion of the site and is situated downgradient of the five inactive landfill areas and the Burial Trench Area. The PSCT extends to depths ranging from approximately 13 to 65 feet, depending upon the depth at which unweathered claystone bedrock was encountered during construction. The PSCT is designed to intercept subsurface liquids migrating from north to south across the site. The major components of the PSCT include a filter fabric placed against the native alluvial or fill soils, a permeable gravel backfill, random backfill above the gravel, a low permeability cap to minimize water infiltration, and four collection sumps and associated extraction points. The gravel backfill extends approximately 10 feet above the highest level of groundwater seepage observed during excavation.

The four collection sumps were constructed by excavating pits into unweathered claystone bedrock or Lower HSU. The sumps are filled with gravel with a screened casing to facilitate liquid removal. Liquids collected in the PSCT flow along the bottom of the trench toward the center of each sump, away from engineered flow divides that isolate the individual sumps. When liquid levels exceed the level of the flow divides, liquids flow along the base of the trench to the lowest point in the system, located at extraction point PSCT-1. Currently, liquids are extracted from the PSCT-1, PSCT-2, and PSCT-4 sumps in this barrier system. Action and operating water levels in these three sumps are currently below the Upper/Lower HSU Contact. PSCT-3 is also equipped with a dedicated extraction pump, although liquid levels in the sump never reach the required action level of 51 feet btoc. Liquids extracted from the PSCT are treated at the PSCT Granular Activated Carbon (GAC) Treatment System and discharged into Pond 18.

The RI Report describes the impact of groundwater extraction at PSCT-1, PSCT-2, and PSCT-4. Capture zones extend southward in the Upper HSU from the PSCT extraction wells, and convergent flow to the Trench and Sumps is inferred based on water levels in the Sumps and nearby monitoring wells/piezometers.

5.1.2.5 Containment Feature Effectiveness Based on Concentration Trends

As discussed above in Section 4.2.1, VOCs are used to summarize the extent of organic compounds. In Figures A-13 through A-15, time-concentration graphs of select VOCs are posted next to wells for the Upper HSU and Lower HSU to illustrate the change in dissolved concentrations over time. Additional figures in Appendix G of the RI Report post organic chemistry data next to individual wells for these VOCs, other VOCs, and other organic compounds (SVOCs, pesticides, PCBs, herbicides, and dioxins and furans) for wells in the Upper HSU and Lower HSU. As shown in Figures A-13 through A-15, concentrations of the selected VOCs have remained generally stable. VOC concentrations in the wells in Area 5 North for the Upper HSU have remained elevated at several orders of magnitude above MCLs despite extraction of NAPL from the Gallery Well and Sump 9B.

Several wells downgradient of the PSCT extraction feature were analyzed for VOC indicator parameters to assess whether contaminants are moving across or under this extraction feature. Conclusions from the April 2009 through March 2010 semiannual groundwater monitoring report (MACTEC Engineering and Consulting, Inc. [MACTEC], 2010) are described below.

As part of the semiannual groundwater monitoring events, 10 PSCT sampling locations downgradient of the primary source area, nine wells (RG-1B, RG-4B, RG-5B, RG-6B, RG-7B, RIMW-2, RIMW-5, SW-29, and WP-3S), and one piezometer (PZ-P18-5) are sampled to assess whether contaminants are moving under or across the PSCT. All of the wells are completed in the Upper HSU and most are adjacent to the PSCT. Well SW-29 and piezometer PZ-P18-5 are located 1,200 and 700 feet downgradient of the PSCT, respectively. Wells RG-2B, RG-4B and RIMW-5, are 40, 100 and 140 feet, respectively downgradient of the PSCT in the vicinity of PSCT-4; well RG-1B is immediately downgradient from PSCT-1; and well WP-3S is located approximately 80 feet downgradient of PSCT-3. Wells RG-5B, RG-6B, and RG-7B are approximately 150 to 350 feet downgradient of the PSCT. VOC concentrations observed in these wells are variable, however, the variability observed in VOC concentrations do not suggest that significant migration of liquids is occurring (MACTEC, 2010).

5.1.3 Remedial Time Frame Analysis – Area 5 North

The time-frame analysis discussed in the paragraphs below illustrates why it is technically impracticable to restore groundwater concentrations to the MCLs with currently available technology. The evaluation of remedial time frames is dependent on DNAPL fate and transport mechanisms. Section 4.5.1 above, and Sections 5.1.3.1 and 5.1.3.2 below summarize key concepts of DNAPL fate and transport. The time-frame analysis discussed in Sections 5.1.3.3 and 5.1.3.4 demonstrates that even if 100 percent of the mobile and residual DNAPL could be instantaneously removed from the fractured claystone at the site, desorption and diffusion of COCs from the fractured claystone would keep dissolved concentrations above MCLs for an indeterminate amount of time. In addition, as discussed in Section 5.1.3.4, instantaneous removal of “sources” of dissolved metals from the Upper HSU would also similarly keep dissolved concentrations of metals above MCLs for over 100 years. The concepts behind desorption and diffusion from fractured claystone and a time-frame analysis based on the parameters governing these mechanisms at the site are presented herein. This time-frame analysis, while discussing the movement of dissolved COCs in groundwater, is also applicable to soil standards protective of groundwater because the nature of movement of the constituents from the soil to groundwater is by diffusion rather than advection.

5.1.3.1 Diffusion of DNAPL into Fractured Media

Research first presented by Parker et al. (1994) and further developed in Parker et al. (1996 and 1997) added an important factor to the understanding of DNAPL behavior and movement in fractured media. Fractured clays have been shown to have a very strong effect on the subsurface behavior of DNAPL. This is because the mass of DNAPL in the small fractures (e.g., 10 to 100 micrometer [µm] width) may be much less than the constituent mass that the few feet of clay between fractures can store dissolved in the pore space and sorbed to the clay. This region between fractures is referred to as the clay matrix.

Parker's research addresses the influence of constituent diffusion from the fracture into the porous matrix by describing how matrix diffusion can cause the DNAPL in a fracture to eventually "disappear" into the matrix through dissolved constituent diffusion. This occurs because the mass of DNAPL in a fracture, which typically has an aperture width of 0.1 millimeter or less, is very small compared to the dissolved- and sorbed-phase storage capacity of the adjacent porous matrix. As the DNAPL dissolves into the water phase, the constituents diffuse into the matrix. The rate of diffusion is controlled by Fick's Law, which states that the mass flux due to diffusion is a function of the concentration gradient between the high concentration area and the low concentration area (Parker et al., 1994).

The basic steps that occur according to Parker's research are presented in Figure A-38. As the DNAPL enters the hydrogeologic system, it will move preferentially through the largest fractures because they have the lowest entry pressures (Figure A-38, Frame A). As soon as the DNAPL enters the hydrogeologic system, it begins to dissolve into the groundwater. The dissolved constituents will begin to diffuse from the groundwater in the fracture into the groundwater in the porous matrix in response to the concentration gradient, always from higher to lower concentration (Figure A-38, Frame B). As the DNAPL dissolves into the groundwater in the fracture and diffuses into the groundwater in the porous matrix, the mass of DNAPL in the fracture is reduced and the constituent mass in the groundwater in the matrix is increased. After a relatively short time, if there is no source of DNAPL feeding the fracture, sufficient mass will be lost from the DNAPL in the fracture that the DNAPL continuity is broken and the DNAPL becomes discontinuous and is left as isolated "blobs" or at residual saturation in the fracture (Figure A-38, Frame C). At this point, the DNAPL column is no longer continuous and the capillary pressure is reduced to that exerted by the length of the individual "blobs." After a period ranging from days to years, depending on site conditions and the volume of any DNAPL feeding the fracture (Parker et al., 1994 and 1997), the entire mass of DNAPL originally in the fracture can dissolve and diffuse into the groundwater in the porous matrix (Figure A-38, Frame D). With a connected source of additional DNAPL, even more mass will dissolve and diffuse into the porous matrix.

Whether or not diffusion into the porous matrix leads to complete disappearance of DNAPL from the fracture, the most important aspect of diffusion for this time-frame analysis is the very slow reverse-diffusion that would occur from the matrix back into the fracture if the DNAPL were removed and the fracture flushed with clean water, as might occur as part of some response action. At the point shown in Figure A-38, Frame D, the groundwater concentration in the fracture will be in equilibrium with the dissolved groundwater concentration immediately inside the porous matrix. If clean water begins to flow through the fracture, this water will be impacted by the dissolved constituents in the porous matrix, because the concentration gradient will be reversed and will drive the constituent from the matrix to the fracture. However, the rate of

diffusion back out of the porous matrix is slower than the rate going in because the concentration gradient will be much lower. The significance of this is discussed below.

5.1.3.2 Effects of Reverse Matrix Diffusion

Due to the very low permeability of the clay matrix, the constituent moves into it primarily through diffusion, not advection. Significant constituent mass, however, can diffuse in to the porous matrix within a short amount of time. At the site, the historically released COCs have had 30 years or more to diffuse into the clay-matrix blocks. In addition, in some areas the fractures likely contained high or saturated concentrations for some or all of this time, maintaining a high concentration gradient to drive the diffusion.

After dissolution and diffusion of all the DNAPL into the clay matrix, slow reverse-diffusion back out of the matrix would occur once clean water begins flushing through the fractures as a result of natural groundwater flow or through a remedial technology. Once the constituents have dissolved into the groundwater in the clay matrix, they diffuse back out slowly due to the relatively low concentration gradients between the water in the matrix and the clean water in the fractures. The diffusion rate might be high initially, but declines as the constituent diffuses back out into the mobile water of the fracture, creating a slowly decreasing "tail" in the constituent concentrations with time. Consequently, as Sections 5.1.3.3 and 5.1.3.4 will demonstrate, the water recovered from the fractured clay units will have low, but greater than MCL concentrations, for an indeterminate amount of time. As will be shown below, although the constituent may have diffused into the clay matrix for only 30 years, it may take many times this duration for it to diffuse back out.

Diffusion through the clay matrix is described by Fick's law, which states that the rate of mass flux is directly proportional to the concentration gradient, the matrix porosity and the diffusion coefficient of the constituent in water, and is decreased by the tortuosity of the matrix. From the current perspective of the development status of remediation technologies, diffusion-limited mass transfer is an unavoidable physical limitation to onsite remediation.

Using the analysis presented by Parker et al. (1996 and 1997), the time frame for constituents to diffuse out of the clay matrix and reach certain standards can be projected analytically. Depending on geologic conditions and constituent properties, this time is typically on the scale of decades to centuries. Again, the significance is that where DNAPL entered the fractured claystone and diffused into the clay matrix, groundwater is likely to have slowly decreasing constituent concentrations over long periods of time. The time frame for constituents to diffuse out of the fractured claystone at the site to a sufficient level to reach MCLs is demonstrated analytically below.

Similar to the mechanism by which dissolved chemicals originating from a release of DNAPL diffuse into fractured media, high concentration metals would also be expected to diffuse into fractured media. Upon decreasing the concentrations of metals in groundwater (e.g., via groundwater extraction) reverse matrix diffusion would commence, and would result in slowly decreasing groundwater concentrations.

5.1.3.3 Analytical Model Time Frame Demonstration

The processes of DNAPL diffusion into a fractured porous matrix and reverse matrix diffusion were described mathematically by Parker et al. (1994, 1996, and 1997) and have been

supported with physical data. This analytical time frame demonstration was applied to the site using site-specific properties and properties of the most predominant constituent at the site, TCE, and another commonly detected compound at the site, PCE.

For simplification, these analytical estimates were determined using a single DNAPL-filled fracture and an initial concentration in the clay-matrix block created by the mass of one DNAPL-filled fracture. This approach does not account for the fact than fractures were likely replenished with more DNAPL as it dissolved into the clay-matrix blocks, which would result in mass equivalent to multiple fracture volumes being dissolved into the clay-matrix blocks and groundwater concentrations at or near saturated levels. Considering that this analysis assumes only the contents of a single fracture, this analytical demonstration provides conservative time frame estimates for DNAPL disappearance and subsequent reverse matrix diffusion; these time frames would increase if the model had allowed additional constituent mass to dissolve into the matrix block.

Outside of chemical-specific properties, the most critical parameters used in the calculations were a fracture aperture of 33 µm, a fracture spacing of 2.58 meters (m), a porosity of 0.44, an apparent tortuosity of 0.03, and the mass fraction of organic carbon (used in sorption estimation) of 0.00472. These parameters are based on observations from the site (CSC, 2011; Golder Associates Ltd., 2007). Other parameter values are shown in the input parameter tables and on the calculation sheets provided in Attachment A-1. As shown in the calculations in Table A1-2, the time frame for the diffusive disappearance of DNAPL from the fractures into the porous matrix would be approximately 250 days for TCE and 26 years for PCE. After the DNAPL is removed from the fracture by diffusion into the porous matrix, subsequent reverse matrix diffusion can begin; this process would result in groundwater concentrations that exceed MCLs for thousands of years. The time frame for groundwater concentrations of TCE or PCE in the fractures to reach 0.005 mg/L (the MCL for TCE or PCE) would be around 4,650 years or 6,300 years, respectively, after all DNAPL is removed from the fractures and assuming the fractures are continually flushed with clean water (Table A1-4). Given the fact that the DNAPL is unlikely to completely diffuse from the fractures and the residual DNAPL cannot be completely removed by remediation, the groundwater concentrations at the site will remain above MCLs for an indeterminate length of time.

5.1.3.4 Numerical Model Time Frame Demonstration

The remediation time frames after complete removal of the DNAPL and dissolved metals sources were evaluated with the numerical model code FRACTRAN. FRACTRAN is a two-dimensional, finite-element, solute transport model code developed by the University of Waterloo (Sudicky and McLaren, 1997). The model simulates combined steady-state groundwater flow and transient solute transport in porous or discretely-fractured porous media. FRACTRAN has been verified to analytical solutions and has been peer-reviewed in technical journals (Sudicky, 1989; Sudicky and McLaren, 1992; Harrison, et al., 1992).

For this remedial time frame analysis, simplified conceptual vertical profile models were constructed with FRACTRAN for Area 5 North for DNAPL and for dissolved arsenic, cadmium, nickel, and selenium. The design and construction of the models are described in Attachment A-2 to this appendix.

5.1.3.5 Limitations of Partial DNAPL Removal

DNAPL has been found in deep fractured bedrock at the site. The total distribution of DNAPL within this fractured media will never be completely known, as fracture networks are highly variable. Even the most aggressive types of remedial technologies that could be applied to this site are unlikely to be successful at complete removal of all DNAPL from every fracture at the site. Presented below are published studies that demonstrate the limited benefits of partial mass removal at DNAPL sites. Mass removal of DNAPL and dissolved-phase constituents will have negligible environmental benefit for concentration-based response action objectives unless almost all of the DNAPL can be located and removed. This is due to DNAPLs having aqueous solubilities that are very low, but still well above MCLs. Therefore, even a small mass of DNAPL will take decades to dissolve, impacting large volumes of groundwater over long periods of time. In other words, whether there is one gallon of DNAPL or thousands of gallons of DNAPL, the downgradient concentrations are likely to be similar, and would still be above MCLs. Because it is not possible to accurately locate or remove all DNAPL at a site, regulatory-based concentration standards cannot be met, as shown by the following examples.

Sale and Applegate (1997) present a case study representative of the experience at any DNAPL site. Even under very favorable site conditions (a relatively homogeneous, high-permeability aquifer), and careful design of the recovery system, recovery of DNAPL rapidly declined after 95 percent of the mobile DNAPL was removed. Note that this includes only that portion considered mobile or recoverable, such as pooled DNAPL, and not total DNAPL. It does not include DNAPL remaining at residual saturation.

Although more aggressive remediation technologies have been developed and are being tested with various levels of success, even these remediation efforts will leave DNAPL behind. The following examples demonstrate the significance of this finding.

5.1.3.5.1 A Simple Example

Since the mid-1980s, the understanding has developed that removing significant percentages of DNAPL at a site has little or no effect on groundwater concentrations (Pankow and Cherry, 1996). A simple way to envision this problem is to imagine a one-liter water-filled beaker full of sand and DNAPL (TCE) at residual saturation levels, and the following mass-volume analysis summarized in the following table:

Beaker analogy to estimate volume of TCE required to exceed MCL concentrations

Assumptions	Quantity	Units
Beaker volume	1	L
Porosity	45	%
DNAPL density	1.464	g/cm^3
Residual saturation	20	%
Volume of TCE at residual saturation	9×10^{-2}	L
Mass of TCE at residual saturation	132,000,000	µg
MCL	5	µg/L
Solubility	1,280,000	µg/L
Mass of dissolved TCE in beaker at MCL	2.25	µg
Volume of TCE in beaker at MCL[(a)]	1.54×10^{-9}	L
Mass of TCE in beaker at solubility	576,000	µg
Volume of TCE in beaker at solubility[(b)]	3.9×10^{-4}	L
Any volume of TCE greater than (a) means MCL exceeded.		
Any volume greater than (b) has no effect on concentration in groundwater.		

This analogy indicates that at residual saturation (the point at which DNAPL is no longer mobile) 9×10^{-2} liter (L) of TCE would be present in the beaker, while the MCL would only allow 1.54×10^{-9} L to be present from a risk based evaluation. Additionally, due to the low solubility limit of TCE, the volume of residual TCE would have to be reduced from 9×10^{-2} L to 3.9×10^{-4} L before the concentration in the water would be affected. Therefore, until the volume of residual TCE (DNAPL) is reduced to a few tenths of a milliliter (about four drops), which would be equivalent to 99.6 percent removal of the residual DNAPL (even higher removal percentages are required if total DNAPL is considered), mass removal will have no effect at all on the concentrations in the beaker. The converse of this is that any mass of DNAPL in the beaker greater than the same nominal volume will also have no effect on concentrations because the dissolved concentrations are at the solubility limit.

The reason that DNAPL removal does not significantly reduce dissolved constituent concentrations in groundwater is that DNAPL compounds have aqueous solubilities that are very low, but greater than the associated MCLs by factors of 30,000 to over 1,000,000 for the COCs at the site. Therefore, even a small mass of DNAPL will dissolve slowly, impacting large volumes of groundwater over long periods of time. This is the fundamental reason that pump-and-treat technologies can only be viewed as containment measures at DNAPL sites, and have not been successful as remedial measures to meet required cleanup levels. This is also one of the reasons why more aggressive in situ treatment technologies fail to achieve concentrations levels as low as the MCLs. To reiterate the basic concept, whether there are a few gallons of DNAPL or thousands of gallons of DNAPL, the downgradient concentrations are likely to be similar, and would be above MCLs.

5.1.3.5.2 Experimental Example – Porous Media

The conceptual demonstration in the previous section was effectively illustrated in physical experiments performed by Imhoff et al. (1998). In these experiments, residual saturations of TCE were emplaced in three columns of porous media (glass beads, uniform sand, and a treated soil). Water was flushed through at a high flow rate initially to ensure that all mobile DNAPL was removed, leaving only a residual saturation. Initial TCE saturation in the 11

experiments ranged from 6.4 percent to 18.9 percent. Water was then flushed through at rates ranging from approximately 9 meters per day (m/day) in the glass bead medium to less than 1 m/day in the sand and soil experiments. Effluent samples were taken periodically, and the experiment continued until effluent concentrations dropped below the limit of detection, which was well below the MCL for TCE (0.005 mg/L).

In this experiment, effluent concentrations stayed at or near the solubility limit (1,000 mg/L) for the first 100 to 200 pore volumes in all experiments before showing any decrease. In the glass bead columns, concentrations reached the MCL after approximately 300 pore volumes. In the sand column, concentrations dropped below the MCL after approximately 500 pore volumes. In the column containing soil, concentrations had still not reached the MCL after 860 pore volumes. In all experiments it was thought that the effluent concentrations at later times were derived from desorption from the porous medium, and somewhat from the experimental equipment. In the soil experiment, it was thought that DNAPL had completely dissolved somewhere between 600 and 860 pore volumes, but desorption kept concentrations above the MCLs. This experiment demonstrated two points: 1) that increasing complexity of the geologic medium (glass beads to sand to soil) increases cleanup time, and 2) a large number of pore volumes are needed to dissolve even a small mass of DNAPL.

The Imhoff et al. (1998) results are strongly dependent on various factors including groundwater flow rates, uniformity of groundwater flow (due to heterogeneities), and the scale and geometry of the residual DNAPL zone. However, the results effectively illustrate that even if most DNAPL could be removed from the site using some innovative remediation technology, groundwater would have to be flushed through that zone at the scale of hundreds of pore volumes before groundwater concentrations would change significantly, and much more before they would approach MCLs. For any site, and particularly for sites with heterogeneous conditions and low permeability such as the subject site, this might require centuries of groundwater flushing.

Note that this is a separate issue from the clay-matrix diffusion presented in Sections 5.1.3.3 and 5.1.3.4. The foregoing time scale is only for removing small DNAPL saturations, even before the back-diffusion time frame presented in Sections 5.1.3.3 and 5.1.3.4 begins.

5.1.3.5.3 Experimental Example – Fractured Media

Detwiler et al. (2001) presented a physical demonstration similar to Imhoff et al. (1998) except they used a textured glass flow-through device to simulate a variable aperture fracture. The original purpose of this experiment was to evaluate the performance of a NAPL transport and dissolution algorithm, but they also presented sufficient data to allow the results to be used to evaluate the difficulties of mass removal. They placed a quantity of TCE (DNAPL) in the water-filled fracture and then photographically documented its dissolution over time. Over the course of flushing more than 600 fracture pore volumes, they were able to remove approximately 80 percent of the initial DNAPL volume emplaced, leaving 20 percent still trapped in the fracture.

5.1.3.5.4 Mathematical Analysis

Freeze and McWhorter (1997) presented a qualitative analysis of the limited benefits of partial mass removal (DNAPL recovery), as discussed in the previous section. Their conclusions were that very high levels of mass recovery, far in excess of what is currently technically practicable, would be required to meet regulatory or health-based concentration levels at a downgradient point of compliance. Sale (1998) has presented quantitative evidence supporting this concept.

Essentially, Sale took individual analytical solutions describing the dissolution of individual DNAPL pools under uniform, steady-state groundwater flow and superimposed the solutions to represent multiple DNAPL pools. Various pool configurations were then investigated. This analytical method was verified against other analytical solutions and with data from laboratory experiments.

The main principles that govern mass transport in a DNAPL zone were demonstrated by Sale's work. Sale (1998) showed that field-scale mass transfer of DNAPL (dissolution) is limited primarily by the advective-dispersive transport of contamination away from the DNAPL pool and not the internal rate of dissolution (at the pore scale) from DNAPL to groundwater. Also, mass transfer is limited by interference from groundwater contamination from upgradient DNAPL sources. The fact that mass transfer is limited by advective-dispersive transport away from the pool means that mass transfer is largely independent of the saturation of DNAPL pools. Another aspect is that dissolution of a DNAPL pool takes place primarily at the leading edge (with respect to the direction of groundwater flow). This is due to the leading edge of the DNAPL pool loading the groundwater with dissolved concentrations close to the solubility limit. Although high concentrations only occur a few centimeters above the pool, it effectively limits dissolution from the remainder of the pool. The same effect takes place with multiple pools where dissolution takes place primarily at the leading pools, limiting the dissolution of the other downgradient DNAPL pools. Therefore, the orientation and distribution of DNAPL pools in the source zone are strong factors in the field-scale mass transfer of contamination from the separate, nonaqueous phase to that dissolved in the aqueous phase.

Sale (1998) demonstrated the effects of partial mass removal with various approaches. First, the effect of reducing the saturation of a DNAPL pool was explored. This would be the result of most remedial actions, e.g., where mobile DNAPL is drained to a recovery well or surfactant flooding is used to achieve a high reduction in saturation. As explained by Sale, the end result is usually reduction in saturation, but little or no decrease to the overall dimensions of the DNAPL pools. For this example, the effects of reducing the saturation in a pool of TCE 10 m wide by 10 m long and 0.30 m in height were explored. It was shown that decreasing an initial saturation of 0.8 to values of 0.4, 0.2, and 0.1 would in each step halve the time period over which dissolution occurred. However, groundwater concentrations downgradient of the source zone would change little initially, and would still remain orders of magnitude above MCLs for decades. The groundwater concentrations over time for this scenario are shown in Figure A-39.

In another demonstration, the effects of partial source-zone removal were examined. This would correspond to a situation where some subset of a DNAPL source zone was completely removed by excavation or some hypothetical in situ remediation method, but where other portions of the zone were left unaffected. Downgradient groundwater concentrations over time were determined for one case where a DNAPL source zone originally 40 m by 40 m was reduced to 20 m in length, and another case where the width was reduced to 20 m. It was found that halving the source zone width would also decrease the initial downgradient concentration by one half, but would have no effect on the overall longevity of the source. And again, concentrations would remain well above MCLs. For the case of halving the length of the source zone, the longevity of the zone was decreased, but groundwater concentrations showed only a slight decrease.

The research results presented in Sale (1998) quantitatively support the conclusion of Freeze and McWhorter (1997). Even if 95 percent or greater of DNAPL mass could be removed from a site, constituent concentrations in groundwater would decrease only slightly, if at all, and would

remain well above typical risk-based or regulatory limits for an indeterminate period of time. In fact, in many scenarios, over 99.9 percent (Cherry et al., 1996; Freeze and McWhorter, 1997) of DNAPL mass might have to be removed in order to achieve MCLs. Combining this understanding with the review of the development status of current DNAPL remedial technologies shows that remediation to MCLs is not technically practicable at the site.

5.1.3.6 DNAPL Removal Conclusions

As documented above, for mass removal to achieve MCLs, all DNAPL has to be removed from a groundwater system and residual constituents must desorb from the soil matrix and be removed. Presently, there are no documented sites with DNAPL below the water table where groundwater concentrations approaching regulatory or risk-based concentration goals have been achieved and maintained (USEPA, 2003; GeoSyntec Consultants, 2004; McGuire et al., 2006). A 2004 study by the USEPA reviewed DNAPL sites that had achieved closure, and found that these sites had groundwater cleanup goals much higher than MCLs and other restrictions on closure (USEPA, 2004a). This conclusion applies to both pilot test-scale sites and full-scale sites. A follow-up study completed by the USEPA in 2009 provided updates to the cases presented in 2004 and added five additional sites at which DNAPL source reduction technologies were applied. In that 2009 study, the USEPA identified only three sites where MCLs were achieved at DNAPL sites following aggressive remedial actions, but at each of those sites, the impacted aquifers were relatively coarse-grained deposits – none of them included DNAPLs in fractured bedrock (USEPA, 2009). To date, there are no known sites where DNAPLs in fractured bedrock have ever been successfully remediated to the point where groundwater has reached MCLs.

The preceding discussion has reviewed a simple analogy, two experiments, and a mathematical analysis that all demonstrate why DNAPL mass removal efforts at sites around the world are unable to substantially reduce dissolved groundwater concentrations. All available information indicates that no currently available technology can achieve MCLs for groundwater at the site.

5.1.4 Conceptual Restoration Alternative – Area 5 North

As discussed in Sections 5.1.3 and 5.1.5, no remedial technologies are available that are able to remediate Upper and Lower HSU groundwater to remedial goals within 1,000 years. However, as part of this TIE, we have considered a source removal and aggressive groundwater extraction and treatment program that would need to be implemented to even attempt to achieve restoration of groundwater to MCLs or any other water quality goals for the site. The aggressive groundwater extraction program described below, therefore, represents a hypothetical system that is not being proposed for use at the site, but has been developed to understand what would be necessary to more aggressively treat groundwater at the site, regardless of anticipated effectiveness. The scope of this source removal coupled with aggressive groundwater extraction and treatment program is discussed below in Section 5.1.4.1. Following discussion of the restoration alternative scope, the restoration alternative for Area 5 North is evaluated against the CERCLA nine criteria in Section 5.1.4.2.

5.1.4.1 Scope of Restoration Alternative

This section describes the probable scope of the above-mentioned aggressive groundwater extraction and treatment program that addresses the portions of Area 5 North that currently exceed groundwater remedial goals as well as the source areas to Area 5 North. Section

5.1.4.1.1 addresses removal of sources to Area 5 North groundwater, Section 5.1.4.1.2 describes the groundwater and NAPL extraction scheme for this area, and Section 5.1.4.1.3 details the treatment system that would be required for the extracted liquids. Please note that we have assumed groundwater extraction followed by above-ground treatment and discharge is the most viable alternative because in situ treatment technologies are not capable of treating all of the mixed wastes found in groundwater at the site to MCLs. The conceptual design of the restoration alternative for Area 5 North is shown in Figures A-40a through A-40d.

5.1.4.1.1 Source Removal

Wastes previously placed in the various site landfills are potential ongoing sources to groundwater because the wastes may eventually leak from their containment through the fractured claystone that underlies the landfills. In addition, wastes placed in burial trenches or injected into the subsurface may leach to groundwater. The P/S, Metals, Caustic/Cyanide, and Acids Landfills are currently managed with existing RCRA caps that were installed to prevent exposure to the wastes contained within the landfills and to minimize infiltration of surface water through the wastes. However, for full restoration of site groundwater, wastes that are sources to groundwater contamination must be removed or fully contained or they will continue to contribute mass to groundwater.

Estimated volumes of waste in the P/S, Metals, Caustic/Cyanide, Acids, and PCB Landfills were used to define the scope of source removal for the site restoration alternative. It is assumed that the daily soil cover used in these landfills has also been impacted due to leaking waste from drums or contact with contaminated solid wastes. Therefore, it is assumed that the entire volume in each landfill would be excavated and disposed of offsite. The following volumes of waste, daily soil cover, and pond closure soils were estimated to be present within each of these landfills as of January 1989 per the RI Report:

- P/S Landfill – 1,518,450 cubic yards (cy) (899,000 cy waste, 527,990 cy daily soil cover, and 91,460 cy pond closure soils);
- Metals Landfill – 599,090 cy (230,090 cy waste, 135,130 cy daily soil cover, and 233,870 cy pond closure soils);
- Caustic/Cyanide Landfill – 753,670 cy (273,940 cy waste, 160,880 cy daily soil cover, and 318,850 cy pond closure soils);
- Acids Landfill – 225,770 cy (35,930 cy waste, 51,270 cy daily soil cover, and 138,570 cy pond closure soils); and
- PCB Landfill – 390,400 cy (approximately 2.7:1 waste to soil daily cover, or approximately 284,890 cy waste and 105,510 cy daily soil cover).

In addition, impacted soil and applied waste would be removed from the Burial Trench Area and impacted soil would be removed from the Central Drainage Area. Approximately 4.76 acres of the Central Drainage Area would be excavated to 5 feet bgs to remove soil that exceeds risk-based criteria and the entire Burial Trench Area (approximately 5.51 acres) would be excavated to 40 feet bgs to remove waste that was injected through a series of wells and left in place, for a total of 394,000 cy.

For these areas, wastes and impacted soils would be excavated to remove the landfill material down to the Lower HSU interface. This would include the following activities:

- Perform site clearance/grubbing to prepare area for excavation;

- Build temporary tents with air scrubbing systems over excavation areas to mitigate vapor/particulate exposures to site workers and the community;
- Provide Level A personal protective equipment for construction workers;
- Manually excavate and remove waste containers/soil;
- Pack waste containers into overpacks with absorbent to contain free liquids;
- Transport by truck to U.S. Ecology in Beatty, Nevada (Class I Landfill) for offsite disposal; and
- Grade and install vegetative cover.

5.1.4.1.2 Extraction System

The current hydraulic containment systems in Area 5 North (e.g., the PSCT, Gallery Well, etc.) are designed to intercept contaminant plumes as they migrate away from source areas, and are proven to be effective for that purpose. Operation of Sump 9B, which only exhibits limited effectiveness, would not be continued under this alternative. A more aggressive extraction network would also focus on the following impacted areas:

- DNAPLs within and beneath the P/S Landfill (estimated to be as much as 100,000 gallons presently, excluding the long-term leakage from drummed wastes within the landfill);
- LNAPLs within the P/S Landfill;
- LNAPLs, DNAPLs, and dissolved VOCs within the Central Drainage Area in the Upper HSU (primarily between the P/S Landfill and PSCT-1);
- DNAPLs and dissolved VOCs within the Central Drainage Area in the Lower HSU;
- Dissolved VOCs within the Burial Trench Area in the Upper and Lower HSUs; and
- Dissolved metals above MCLs in the Upper HSU throughout Area 5 North (see Figures A-16a and b, A-18a and b, A-20a and b, and A-22a and b).

To address these areas, we have made the following assumptions regarding well performance and capture zone effectiveness:

- Upper HSU and Lower HSU wells will produce, on average, 1 gallon per minute (gpm) of total fluids discharge. Based on groundwater modeling, we estimate that the hydraulic influence of pumping at this rate would be approximately 100 feet. We estimate that the hydraulic influence of pumping in Lower HSU wells would vary significantly due to the fractured nature of the bedrock, but are likely to be much smaller than what is possible in the overlying Upper HSU.
- Upper HSU DNAPL wells will produce, on average, 1000 gallons per year of DNAPL discharge. Although the current DNAPL extraction rate averages about 1,900 gallons per year, we assume that the addition of several closely spaced DNAPL extraction wells would decrease the efficiency per well.
- Lower HSU DNAPL wells will produce, on average, 100 gallons per year of DNAPL discharge. We estimate that the hydraulic influence of pumping in Lower HSU wells would vary significantly due to the fractured nature of the bedrock, but are likely to be much smaller than what is possible in the overlying Upper HSU.

Based on the water budget estimated from the groundwater flow model for the entire site, 50 gpm was assumed for the total extraction rate from Area 5 North. Assuming all of the Upper and Lower HSU groundwater extraction wells pump at a rate of 1 gpm, the water budget allots

for 50 extraction wells across the TI zone. Based on the size of the areas within Area 5 North that display some form of contamination, a total of 40 Upper HSU wells are proposed for Area 5 North. These wells will be spaced throughout the contaminated areas of Area 5 North, concentrating on the areas of high contaminant concentrations. In addition to the 40 Upper HSU total fluids extraction wells proposed for Area 5 North, additional Lower HSU wells are proposed to target the elevated VOCs detected (Figure A-15). Due to the fractured bedrock nature of the Lower HSU the radius of influence for the Lower HSU wells is difficult to predict, thus complicating the design of the extraction network to cover the areas depicted in Figure A-15. For costing purposes, it is assumed that 10 Lower HSU extraction wells pumping at an extraction rate of 1 gpm will be suitable for VOC capture in the Lower HSU within Area 5 North.

The USEPA requested that additional extraction wells be placed to address areas of Lower HSU groundwater contaminated by VOCs near the Burial Trench Area and the Central Drainage Area. For costing purposes it is assumed that 4 Lower HSU extraction wells pumping at an extraction rate of 1 gpm will be suitable for VOC capture in the Lower HSU adjacent to the PSCT within Area 5 North. The number and spacing of these Lower HSU extraction wells would be determined during the remedial design phase. The total extraction rate using these assumptions for Area 5 North and the northern portion of Area 5 South is approximately 54 gpm.

In addition to the total fluids extraction wells discussed above, new DNAPL and LNAPL extraction wells are proposed for Area 5 North. The proposed Area 5 North DNAPL and LNAPL wells and assumed recovery rates are:

- Ten Upper HSU wells in the P/S Landfill assumed to extract 700 gallons per year of DNAPL and 1000 gallons per year of LNAPL, to target any pooled DNAPLs and LNAPLs upgradient of the Gallery Well;
- Five Upper HSU wells assumed to extract 300 gallons per year of DNAPL, focusing on the area between the P/S Landfill and PSCT-1 to target any pooled DNAPLs; and
- Five Lower HSU wells in the P/S Landfill assumed to recover 100 gallons per year of DNAPL.

For costing purposes the volume of co-extracted water sent to the treatment system from these wells was considered minimal.

5.1.4.1.3 Treatment System

A more aggressive extraction and treatment scheme would include groundwater/NAPL extraction as discussed above. Please note that we have assumed groundwater extraction followed by above-ground treatment and discharge is the most viable alternative because in situ treatment technologies are not capable of treating all of the mixed wastes found in groundwater at the site to MCLs. The treatment system would be sized to accommodate extracted groundwater from the area of the site within the TI zone (Area 5 North). For costing purposes, the total capacity of the treatment system is assumed to be 55 gpm, which is based on the water budget for the site provided by the site groundwater flow model. As discussed in Section 5.1.5, in situ technologies would not be able to reduce concentrations to below MCLs in Area 5 North for all contaminants.

The extracted streams from Area 5 North would include the following constituent classes that would need to be treated:

- NAPL (LNAPL and DNAPL);
- Total petroleum hydrocarbons (TPH);
- VOCs;
- SVOCs, including polycyclic aromatic hydrocarbons;
- Pesticides/herbicides;
- Dioxins;
- Cyanide;
- Metals; and
- Dissolved anions such as chloride and sulfate, which contribute to TDS.

The treatment scheme would include the following components to treat these constituents:

Process Component	**Purpose**
Equalization tank	Combine extracted streams into one inlet stream
Oil water separator	Remove LNAPLs and DNAPLs from the process
Filtration	Remove suspended solids
Acidification	Keep metals in solution so they don't precipitate in air stripping towers or PhotoCat
Stainless steel air stripping tray towers	Remove VOCs
PhotoCat (Ultraviolet + titanium dioxide)	Treat pesticides, SVOCs, dioxins, TPH, and cyanide
Alkalization/Neutralization	Re-neutralize stream
Reverse osmosis (RO)	Remove metals and dissolved anions
Vibratory Shear Enhanced Processing (VSEP) (a vibrating membrane filtration system)	Concentrate RO reject brine
GAC	Polishing step for any residual organics in treated water stream
Discharge to creek	Discharge of treated water

The non-aqueous streams resulting from this process would be further managed as follows:

- NAPLs recovered from the oil water separator would be containerized and sent offsite for incineration or other disposal.
- Filter media and solids removed via hydro-cyclonic filtration would be sent offsite for disposal as a hazardous waste.
- RO/VSEP membranes (when replaced) would be sent offsite for disposal as hazardous waste.
- GAC would be sent offsite for regeneration.
- The vapor stream generated from the air stripping towers would be treated by a thermal oxidizer equipped with a heat exchanger and followed by an acid scrubber prior to discharge to the air.
- The rejectate from the VSEP (approximately 2.8 gpm) would be transferred to a new evaporation pond for further concentration.
- At regular intervals, the dewatered pond residue would be scraped, containerized and sent offsite for disposal.

For costing purposes, it was assumed that the current long-term monitoring program would be continued, and would be supplemented by sampling of the extraction system, treatment system, and discharge.

5.1.4.2 Detailed Evaluation of Restoration Alternative

This section presents a detailed evaluation of the restoration alternative for Area 5 North against the CERCLA nine criteria. The CERCLA nine criteria are described below, followed by an evaluation of the restoration alternative described above against these nine criteria.

5.1.4.2.1 CERCLA Nine Criteria

Nine federal criteria have been developed to evaluate the extent to which remedial alternatives meet the statutory requirements of the NCP. The USEPA guidance describes these nine criteria under three primary categories: threshold criteria, primary balancing criteria, and modifying criteria (USEPA, 1988).

The following is a brief description of the nine criteria:

Threshold Criteria are the criteria that must be met for an alternative to be considered or selected:

- **Overall Protection of Human Health and the Environment** assesses whether each alternative provides adequate protection of human health and the environment. The overall assessment of protection draws on the analyses conducted for other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. The assessment describes how site risks posed through each pathway are eliminated, reduced or controlled through treatment, engineering, or institutional controls. The assessment also allows for consideration of whether an alternative poses any unacceptable short-term or cross-media impacts.
- **Compliance with ARARs** addresses fulfillment of all applicable or relevant and appropriate requirements of federal or state law (as defined in CERCLA Section 121). The analysis summarizes which requirements are applicable or relevant and appropriate to an alternative and describes how the alternative meets these requirements. Compliance was evaluated for the three types of ARARs: chemical-specific ARARs, location-specific ARARs, and action-specific ARARs. The analysis also assesses whether waivers would be appropriate. Under certain circumstances, some ARARs may be waived. Only ARARs that apply to onsite response actions may be waived; other statutory requirements, such as the requirement that remedies be protective of human health and the environment, cannot be waived. The specific waivers provided by CERCLA Section 121(d)(4) include:
    - Technical Impracticability - This waiver may be used where engineering feasibility and reliability of an alternative in achieving some of the ARARs are unfavorable. Cost is a factor, although not generally the major factor in the evaluation of technical impracticability.

Primary Balancing Criteria are used to assess the relative advantages and disadvantages of each alternative in terms of its performance. These include:

- **Long-Term Effectiveness** refers to the: (1) magnitude of residual risk, and (2) adequacy and reliability of controls. The residual risk of an alternative is related to the potential for persons or eco-receptors to be exposed to untreated waste, or treatment residuals, at the conclusion of remedial activities. Adequacy and reliability of controls addresses the uncertainties associated with long-term protection from residual contamination that may be left in place; the assessment of the potential need to replace technical components of the alternative, such as a cap, a slurry wall, or a treatment system; and the potential exposure pathways and risks posed should the response action need upgrading.
- **Reduction of Toxicity, Mobility, or Volume through Treatment** addresses the anticipated performance of the treatment technologies as measured by reduction in mass of contaminants. This criterion addresses the statutory preference for selecting response actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility, and volume of the contaminants.
- **Short-Term Effectiveness** addresses any adverse impacts on human health and the environment posed during the construction and implementation period until response action objectives are met. It primarily addresses human health risks during response actions like excavation, transportation of hazardous materials, air-quality impacts or noise impacts from treatment operations. It also addresses protection of workers from hazards during response actions, effects to eco-receptors, the effectiveness and reliability of protective measures to be taken, and any environmental impacts during remedial operation.
- **Implementability** addresses the technical and administrative feasibility of an alternative as well as the availability of required services and materials. Technical feasibility includes anticipated construction and operational difficulties and the reliability of the technology. Administrative feasibility includes coordination difficulties and difficulties in complying with agency requirements for permitting and obtaining construction rights-of-way. Administrative feasibility also includes consideration of property owner acceptance and conflicts between remedial alternatives and current land use. The third issue considered under implementability is the availability of services and materials for each alternative, including disposal services and storage capacity.
- **Costs** include budgetary capital, operations and maintenance (O&M) costs, and present worth costs. Capital costs consist of direct (construction) and indirect (non-construction and overhead) costs. Direct capital costs include equipment and installation costs. Indirect capital costs include engineering and design, permitting, startup and shakedown, and contingency costs. O&M costs include labor, materials, and energy costs once the remedy is constructed. A present worth analysis is used to evaluate costs that occur over the period of the response action by discounting future costs to a common base year. The present worth costs are estimated based on the number of years the remedy is operational. For an engineering control or an institutional control that can last indefinitely into the future, a 30-year time period is assumed. Cost estimates for the alternatives are developed to an accuracy of +50 percent to -30 percent.

Modifying Criteria are used to gauge agency and community acceptance at a later stage in the FS. Such input can be incorporated, at USEPA's discretion, into the final remedy. These include:

- **State Acceptance** describes acceptance of the alternative by the supporting local, state or federal agencies.
- **Community Acceptance** describes acceptance of the alternative by the community.

Of these nine criteria, the first seven are addressed in TIE. The two modifying criteria, State Acceptance and Community Acceptance, will be addressed later when that information is available. State Acceptance will be addressed once the State has reviewed and commented on the FS report and TIE, and will be incorporated into the Proposed Plan. Community Acceptance will be addressed after the USEPA has received public comments on the Proposed Plan. The Record of Decision will incorporate the final evaluation of these two criteria.

5.1.4.2.2 Evaluation against CERCLA Nine Criteria

Overall Protection of Human Health and the Environment

This alternative would not be protective of human health and the environment because of the low short-term effectiveness due to the high potential for risks to human health during construction. However, this alternative would supplement existing groundwater/NAPL extraction with additional groundwater and NAPL extraction throughout the contaminated areas of Area 5 North to reduce contaminant mass throughout the site. The existing extraction features would continue to be operated to contain the source indefinitely. Periodic DNAPL and LNAPL extraction is included to reduce the source contaminant mass. The time frame for aquifer restoration would be thousands of years. Institutional controls would control potential exposures to groundwater and soil contamination and landfill waste.

Compliance with ARARs

The restoration alternative would not comply with ARARs because Area 5 North groundwater would exceed MCLs for over 1000 years, and no TI waiver would be in place to waive chemical-specific ARARs. Other ARARs would be met, including requirements for a worker health and safety program, and for a restrictive covenant when waste is left in place beyond unrestricted use levels.

Long-Term Effectiveness and Permanence

Residual risk would be minimized under this alternative because landfill waste as well as soils that pose a threat to groundwater would be excavated and sent offsite for disposal. However, residual NAPL ganglia would remain, and contaminants that have dissolved into the fractured claystone matrix would cause groundwater to remain above MCLs for over 1,000 years. This alternative would effectively contain the source via periodic NAPL extraction and perimeter source control.

Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would provide treatment of extracted groundwater. In addition, extracted LNAPL/DNAPL would be separated from the extracted groundwater and this reduced volume would be sent offsite for further treatment/disposal. The volume of extracted groundwater that is impacted would be reduced by the RO and VSEP technologies, and would be further reduced by the use of evaporation to further concentrate the waste stream prior to disposal.

Short-Term Effectiveness

Removal of all wastes from the site landfills would not be safe for either the construction workers or the community and would take decades to complete. Handling of the numerous drums contained in the landfills, many of which are likely leaking, would be dangerous for the construction workers. This alternative has the potential to generate emissions of contaminants as dust and as VOCs. Excavation and aggressive groundwater/NAPL extraction would only remove the potential ongoing source of wastes to groundwater, but not the residual ganglia remaining in the claystone fractures that also act as sources to groundwater or the contaminants that have dissolved into the claystone matrix. Based on the time frame modeling results, groundwater would not reach MCLs for over 1,000 years following complete removal of sources, including any residual ganglia. In addition, the naturally high TDS in the area would still prohibit the water from being drinkable. Transport of over a billion pounds of waste through the community over the course of several decades would cause significant nuisance to the community.

Implementability

This alternative would not be implementable. For costing purposes, it was assumed that all the excavated waste would be transported to U.S. Ecology landfill in Beatty, Nevada; however, neither this landfill, nor any other landfill already constructed would have the capacity to manage all the waste currently contained within the landfills at the site. Due to the fractured nature of the Upper and Lower HSUs, it would be impossible to locate all mobile DNAPL within the claystone, let alone to completely remove it. In addition, even if all mobile DNAPL could be located and removed, residual DNAPL ganglia, as well as contaminants that have dissolved into the claystone matrix, would still remain at the site. Cleaning up site groundwater to MCLs via extraction wells would also be difficult due to the low hydraulic conductivity of site aquifer materials (~10^{-5} cm/s for the Upper HSU and ~10^{-6} cm/s for the Lower HSU). Groundwater does not migrate quickly or easily through these geologic materials; for perspective, this range of hydraulic conductivities of these native soils is the same as those required for low-permeability RCRA-equivalent landfill caps.

Costs

Cost estimates prepared for the restoration alternatives described in this TIE are presented in Tables A-13a and A-13b. Area 5 North cost estimates, including source removal, are presented in Table A-13a and the aboveground treatment system backup costs are presented in Table A-13b. As shown on Table A-13a, the cost of this alternative would be extremely high ($26.4 to 26.5 billion, depending on the default factor and O&M duration used). Costs are discussed further in Section 6.0.

5.1.5 Other Applicable Technologies – Area 5 North

Section 3.10.3 of the RI/FS Work Plan presented some preliminary groundwater remedial alternatives. These broad-brush alternatives have provided a basis for formulating the more detailed alternatives presented in Section 11 of the FS Report. In the RI/FS Work Plan, conceptual remedial options were formulated for the Northern Groundwater Area (i.e., the contaminated plume north of the PSCT), Southern Groundwater Area, and Offsite Groundwater Area.

As described in the RI/FS Work Plan and presented in the FS Report, groundwater remediation alternatives have been developed that include elements such as NAPL removal, source control and/or containment, passive groundwater treatment, and institutional controls. Also evaluated were in situ treatment alternatives (e.g., biosparging, in situ thermal desorption), and whether they are potentially effective in the technology-screening phase of the FS Report. In situ treatment alternatives may not be effective because technologies to treat the wide variety of chemicals onsite are limited, and because the low permeability of the weathered and unweathered fractured bedrock may limit the effectiveness of these types of in situ treatment technologies. In situ thermal desorption was carried forward to the screening of remedial alternatives section (Section 10 of the FS Report) as an example of a thermal treatment option, and then screened out based on the effectiveness and implementability challenges related to low permeability fractured claystone and the need for hundreds of closely spaced borings on top of the landfill waste. At the present time, remedial alternatives considered for the Upper HSU site groundwater include, but are not limited to, the following elements implemented alone or in combination:

- NAPL Removal – This scenario includes removal of NAPL from selected existing extraction points and from new extraction points identified during the FS process. The scope of source removal actions is based on the degree of risk reduction expected and any other potential benefits that would result from source removal. The option of NAPL removal includes offsite disposal for extracted NAPL. The NAPL Removal alternatives do not include removal of the drummed wastes within the capped P/S Landfill.
- Source Control – This option includes extraction of groundwater from the Gallery Well, and/or the PSCT to maintain hydraulic control of the dissolved-phase plume. The option includes onsite treatment of extracted liquids from the PSCT followed by onsite storage of the effluent.
- Physical Containment – This scenario includes extending the existing engineered cap from the base of the former landfills south to the PSCT, thereby reducing infiltration and groundwater flow through the contaminated water bearing zone within the Upper HSU.
- Monitored Natural Attenuation – This option includes continued groundwater quality monitoring to indicate stable or declining contaminant concentrations in the leading edge of the plume. This option may be considered as a source control and/or containment option if further assessment indicates that the plume has (or will) reach equilibrium.
- Perimeter Control – This includes continued extraction of groundwater from the RAP and PCT wells at the site perimeter. The option may include treatment of the extracted liquids, and the effluent will be routed to an onsite pond for evaporation.
- Perimeter Containment/Treatment – This option includes installing barrier walls and/or in situ passive treatment walls downgradient and in lieu of the three PCTs. The in situ passive treatment walls are designed to reduce organic and metal concentrations in the aqueous plume. The passive treatment walls could be combined with subsurface barriers to achieve a funnel and gate scenario.
- Institutional Controls – This includes instituting site access and deed restrictions to mitigate potential exposure to contaminants in site groundwater. Ongoing groundwater quality monitoring is also included in this option.

The remedial options discussed in the above paragraphs generally apply to the Upper HSU groundwater. Remedial options for the Lower HSU groundwater are very limited primarily because of the reduced permeability in this claystone, which makes it almost impossible to extract groundwater or DNAPL at these depths. A comprehensive screening of all potential alternative technologies (the same as that provided in Tables 9-3 and 9-4 of the FS Report for

groundwater and extracted groundwater, respectively), is provided as Tables A-14 and A-15 in this TIE appendix.

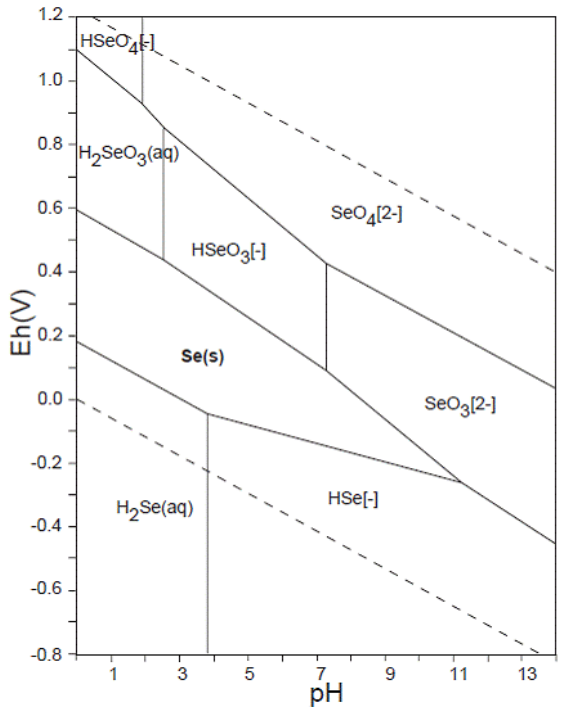
Removal of DNAPL from within the Lower HSU and hydraulic containment alternatives for DNAPL within the Lower HSU were eliminated in the Section 10 Screening Evaluation of the FS Report based on physical limitations imposed due to contaminant depth and because of the uncertainties associated with designing an effective remedy when the precise mechanism for the deeper DNAPL contamination is unknown. Hydraulic containment alternatives for dissolved-phase contaminants within the Lower HSU were retained for further detailed evaluation in Section 11 of the FS Report. Source removal from the Lower HSU would be infeasible not only based on depth considerations but also because the DNAPL migration pathway cannot be defined. As discussed in Section 5.1.3, if there is residual DNAPL in the pore spaces and fractures in the Upper and Lower HSU, these DNAPL zones (of unknown location) will continue to provide a source for ongoing aqueous-phase groundwater contamination. The locations of adsorbed DNAPL in the Central Drainage Area of the site (which cannot physically be removed) cannot reasonably be defined because of the complex geology of the fractured claystone matrix. The USEPA's Technology Innovation Program and the United Kingdom's Environmental Agency have both assembled information on efforts to identify and remediate DNAPLs in fractured rock sites, which can be reviewed on the USEPA's CLU-IN website: http://clu-in.org/fracrock/ and http://www.clu-in.org/conf/itrc/dnaplpa/ dnapl_handbook_final.pdf. Monitored natural attenuation and institutional controls for Lower HSU groundwater/NAPL were not evaluated in the FS; however, groundwater quality monitoring will be continued in the Lower HSU to assess future groundwater quality trends.

In situ technologies were eliminated in the screening of remedial alternatives phase of the FS (Section 10 of the FS Report) based on the depth and variety of chemicals present in groundwater, and because of the complex geologic and hydrogeologic site conditions. Not only would individual in situ technologies not be able to manage all of the contaminants in Area 5 North groundwater, but in situ technologies that may be applicable to one contaminant type may be incompatible with other contaminants. In addition, high TDS levels (greater than the California secondary MCL of 1,000 mg/L) in site groundwater would not be removed through in situ technologies. Therefore, even if other contaminants were removed from Area 5 North groundwater, it would still not be a suitable drinking water source due to high TDS levels.

Site groundwater contains various metals/metalloids and inorganics above federal or state MCLs (e.g., arsenic, selenium). Sorption and precipitation of metals are sensitive to pH and redox conditions, especially for those metals with multiple valence states. In situ treatment technologies that change the pH or redox conditions in the subsurface to treat some contaminants can result in increased potential hazard from other contaminants. For example, arsenic is more mobile, soluble, and toxic in its reduced form (As[III]), whereas selenium and chromium are more mobile, soluble, and toxic in their oxidized forms (Se[VI] or Se[IV] and Cr[VI]).

In aerobic aqueous systems, arsenic is predominantly present in an arsenate form (As[V]), which is an oxyanion. Under reducing conditions, arsenic is predominantly found as a form of arsenite (As[III]), which is more mobile, soluble, and toxic than arsenate. As shown in the Eh/pH diagram below, selenium is predominantly present as a selenate (Se[VI]) in aerobic aqueous systems and as selenite (Se[IV]) in mildly reducing (anoxic) environments. Most metal selenates and selenites are moderately soluble. Under strongly reducing conditions and strongly acidic conditions, selenium is reduced to the zero valent form (Se[0]). However if the

pH or the Eh change it will reoxidize and resolubilize. Selenium is right below sulfur on the periodic table and the behavior of selenium mimics that of sulfur forming soluble oxyanions. It is difficult to precipitate selenium just as it is difficult to precipitate sulfates.



The following bullets illustrate why in situ technologies would not be able to treat groundwater to MCLs within 100 years:

- Technologies that rely on or cause an increase in the groundwater redox potential (oxidizing conditions) such as aerobic natural attenuation, air sparging, and in situ chemical oxidation could result in mobilization of certain metals/inorganics such as selenium and chromium, in forms that are more hazardous than their reduced counterparts. In addition, natural attenuation is a slow process.
- On the other hand, in situ technologies that rely on or cause a decrease in the groundwater reduction-oxidation potential (reducing conditions) such as enhanced anaerobic bioremediation or in situ chemical reduction, could result in mobilization of certain metals/inorganics such as arsenic, in forms that are more hazardous than their reduced counterparts. In addition, natural attenuation is a slow process.
- Finally, TDS would still remain above its secondary MCLs.

6.0 Cost Estimates

Cost estimates are included as Component 5 of the TIE. As discussed above in Section 5.1.5, no remedial technologies are available that are able to remediate Upper and Lower HSU groundwater to remedial goals within 100 to 1000 years. In addition, aggressive groundwater treatment for Area 5 North is discussed in Section 10 of the FS Report and, based on that evaluation, was ruled out as a possible remedial alternative. However, as part of this TIE, we have considered an aggressive site-wide groundwater treatment program that would need to be implemented to even attempt to achieve restoration of groundwater to MCLs or any other water quality goals for the site. Recognized as part of this aggressive groundwater restoration alternative is the need to remove the waste remaining at the site (primarily in landfills within the boundaries of Area 5 North), which would continue to serve as a long-term source to groundwater contamination.

The scope of this aggressive groundwater treatment program is discussed above in Section 5.1.4.1, and the estimated costs are presented in Tables A-13a and A-13b. Table A-13a provides estimated costs for Areas 5 North, including source removal. Table A-13b presents the costs for the groundwater treatment system. Although the costs are provided separately for each area, estimated costs for the continued operation of current remedial measures are included in Tables E-5-1, E-6-1, and E-7-1. All of these cost estimates include a net present value for construction, operations, and maintenance costs over a 30-year period, as is required for an FS. They also include a net present value over a period of 100 years to maintain consistency with the FS. Discount rates of 3 and 7 percent were used for consistency with USEPA FS guidance and the FS.

The probable scope of the above-mentioned aggressive groundwater extraction and treatment program for the TI zone is described in Section 5.1.4.1.3. This system addresses all areas of the TI zone that currently exceed groundwater remedial goals.

As discussed above, this TIE demonstrates that no treatment program will be capable of achieving groundwater remedial goals in the TI zone within 100 to 1,000 years, even when coupled with source removal. The aggressive groundwater extraction and source removal program described above therefore represents a hypothetical system that is not being proposed for use at the site, but has been developed to understand what would be necessary to more aggressively treat groundwater at the site, regardless of anticipated effectiveness.

7.0 Conclusions

The purpose of this TIE is to evaluate the practicability of returning groundwater to its beneficial use, as established by ARARs, or by risk-based goals where no ARARs exist. This TIE completes and updates the preliminary TIE that was included in the RI Report. Based on the analysis conducted in this TIE, as summarized below, a TI waiver of selected groundwater ARARs is warranted for the site under NCP Section 300.430(f)(l)(ii)(C)(3) and the USEPA's TI Guidance for groundwater restoration. As required by the RI/FS Work Plan and the SOW of the Consent Decree, the TIE presented in the FS Report includes the following six components, which constitute a full TIE based on USEPA's TI Guidance.

- Component 1 – Identifying specific ARARs or media cleanup standards for which TI determinations are sought;
- Component 2 – Evaluating the spatial area over which the TI decision may apply;
- Component 3 – Developing a conceptual model that describes the geology, hydrogeology, groundwater contaminant sources, transport, and fate;
- Component 4 – Evaluating the restoration potential of the site, including data and analyses that support any assertion that attainment of ARARs or media cleanup standards is technically impracticable from an engineering perspective;
- Component 5 – Estimating the cost of the existing or proposed remedy options, including construction, operation, and maintenance costs; and
- Component 6 – Any additional information or analyses that the USEPA deems necessary for the TIE based on comments provided on this TIE.

The USEPA TI Guidance identifies three general categories of factors that may inhibit groundwater restoration:

- Hydrogeologic limitations such as complex sedimentary deposits, aquifers of very low permeability, fractured bedrock aquifers, and other factors that make in situ treatment of contaminated groundwater extremely difficult;
- Contaminant-related factors that may limit the success of an extraction or in situ treatment process (such as DNAPLs); and
- Remediation system design inadequacies. This factor is not considered by the USEPA to be sufficient justification for a determination of technical impracticability.

As summarized below, sufficient information exists to evaluate these limitations for Area 5 North at the site:

- There are large quantities of liquid and solid hazardous wastes that were disposed into landfills, ponds, evaporation pads, burial trenches, and injection wells at the site between the late 1970s and late 1980s. Much of that waste remains onsite in Area 5 North and it would not be safe or practical to consider removal. The previous disposal practices resulted in releases of LNAPLs and DNAPLs into a hydrogeologically complex environment where low permeability and fractured overburden and bedrock exist. NAPL data, site hydrology, and fractures were evaluated in the RI process and we have sufficient information to fully evaluate site conditions.

- The primary source of DNAPL product at the site is likely the P/S Landfill located in Area 5 North, where drummed wastes are encapsulated beneath an engineered cap. Over time, these drums may decay and leaks may occur, which would provide an ongoing source of DNAPL product to the base of the landfill. These leaks would migrate to the base of the landfill where they could continue to migrate into fractures within the Lower HSU. The only way to ensure that no ongoing sources of DNAPL remain in this part of the site is to remove the entire contents of P/S Landfill. Not only is this technically impracticable, the increased risks to human health and the environment from such a large-scale removal action would far outweigh the potential benefits to water quality at the site.
- Although hydraulic containment features (such as the PSCT) are currently in place to limit horizontal migration of contaminants within the Upper HSU, the presence of contaminants in deep fractured bedrock in the Lower HSU demonstrates that there may be pathways of aqueous phase chlorinated solvent contamination and DNAPL contamination between the P/S Landfill and potentially other source areas to the deeper bedrock (Lower HSU) aquifer.
- The RI has identified chlorinated solvent contamination in the Central Drainage Area that is located several hundred feet from the P/S Landfill, and demonstrated widespread Upper and Lower HSU contamination in this area. Similarly, there are groundwater impacts from the Burial Trench Area that extend well south of the PSCT into the former ponds and pads subarea.
- The RI has identified that the bedrock under the site is sedimentary in nature and is fractured. Once DNAPL reaches the bedrock, it will migrate downward until it cannot overcome the entry pressure of the fracture due either to the small aperture width or limitations in pool height. The DNAPL may also enter dead-end fractures and cause diffusion of aqueous contaminants into the rock matrix. Removal of DNAPL from fractured bedrock and restoration of groundwater to background concentrations in DNAPL zones within 1000 years is not possible due to limited natural or induced flushing within bedrock fractures, particularly dead-end fractures. Also, as discussed in the literature and guidance documents, back diffusion from the matrix could cause concentrations to persist above groundwater standards for over 1000 years. Current remedial technologies are not effective in restoring DNAPL zones in low permeability (weathered claystone) and fractured media (unweathered claystone), particularly in complex settings such as the site.
- The overburden aquifer is a low-permeability, weathered claystone formation. LNAPLs and DNAPLs have been identified at several wells/piezometers within the Upper HSU, and it is likely that NAPLs may exist at other locations within the Upper HSU based on current groundwater chemistry data. DNAPL may be pooled in dead-end fractures or remain as residual in the fractures where diffusive losses to the porous matrix may dissipate DNAPL over time. These characteristics limit the hydraulic accessibility of DNAPL and, coupled with the low permeability of the Upper HSU, make removal of DNAPL and restoration of groundwater to background levels within 1,000 years impossible.
- There are currently no available technologies that are known to be effective in restoring DNAPL zones in complex heterogeneous geologic environments to drinking water quality in a reasonable time frame.
- This area also contains many other organic and inorganic (e.g., metals such as arsenic, nickel, cadmium, and selenium) that are significantly higher than their respective MCLs in both the Upper and Lower HSU. Groundwater is also elevated in TDS concentrations. No in situ technology is capable of treating the mixture of chemicals found in this area.

Similar to the mechanism by which dissolved chemicals originating from a release of DNAPL diffuse into fractured media, high concentration metals would also be expected to diffuse into fractured media. Upon decreasing the concentrations of metals in groundwater (e.g., via groundwater extraction) reverse matrix diffusion would commence, and would result in slowly decreasing groundwater concentrations. Geochemical modeling demonstrates that even if groundwater extraction were capable of capturing all dissolved chemicals in groundwater, back diffusion from the weathered bedrock formation would preclude groundwater restoration for hundreds of years.

It is recommended that the TI zone should apply to groundwater within the Upper and Lower HSUs in Area 5 North, and should include both organic and inorganic compounds. This area is currently impacted by contamination emanating from sources at the site. As shown in Figures A-1 and A-5a, the potential lateral boundaries of a TI waiver zone extend to the northern and eastern site boundaries. The base of the TI zone is proposed to be defined as 200 feet msl, which will fully encompass any known DNAPL impacts to groundwater within Area 5 North.

The compounds and their respective list of ARARs for which a TI waiver will be considered are presented in Table A-2. The chlorinated organic compounds are the most widespread and recalcitrant compounds at the site and will dictate the ability to restore groundwater. However, the previous disposal operations at the site accepted a variety of mixed liquid wastes and, as such, groundwater beneath the site is commonly impacted by numerous contaminants. For example, waste solvents that were used as degreasers can produce groundwater impacted by both VOCs and petroleum hydrocarbons; because these were disposed of in a mixed pesticide/solvent landfill, liquids that have historically discharged from that landfill can contain pesticides, VOCs, and hydrocarbon constituents. In addition, concentrations of inorganic contaminants (e.g., arsenic and nickel) above drinking water standards are present throughout the site. The low yield potential and the high dissolved solids content also preclude the site from ever being developed as a drinking water source.

For Area 5 North, in addition to discussing the demonstrated inability to remove more than a fraction of the DNAPL at fractured bedrock sites such as the site, this evaluation presented the findings established in the scientific community that over 99 percent of the DNAPL would likely have to be removed to achieve a meaningful decrease in groundwater concentrations. Furthermore, the time-frame analysis of diffusion from the fractured claystone showed that even if all DNAPL could be removed immediately, the slow diffusion of constituents out of the fractured clays would keep groundwater concentrations above MCLs for over 1,000 years. Research has shown that even at the few DNAPL sites that have achieved closure following full scale remediation (none of which involved DNAPLs in fractured bedrock), groundwater concentrations could not be reduced to MCLs (USEPA, 2004a; USEPA, 2009). In addition, diffusion modeling demonstrates that even if all sources of metals were removed from the site, back diffusion effects would preclude restoration to the MCLs for well over 100 years. Therefore, current technologies are technically, logistically, and financially impracticable to implement, and will not be effective at this site.

To support the TIE, costs were estimated for a restoration potential alternative, which included source removal (as necessary) and an aggressive groundwater extraction and treatment program for the groundwater area included in this TIE. Groundwater extraction followed by aboveground treatment and discharge is considered the most viable alternative because no single in situ treatment technology is capable of treating the mixed wastes found in

groundwater. The cost estimates, coupled with the remedial time frame analysis, show that the aggressive groundwater treatment program would not be cost effective to implement at the site.

8.0 References

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TABLES

Table A-1
Factors Affecting Groundwater Restoration at the Site
Casmalia Resources Superfund Site
Casmalia, CA

	Contaminant Characteristics	Generalized Remediation Difficulty Scale Increasing Difficulty →		Casmalia Site Condition	Notes	Primary Section Describing Site Condition
Site Use	**Nature of Release**	Small Volume →	Large Volume	Large Volume	The site is a former Class 1 hazardous waste management facility. It accepted large quantities of liquid and solid wastes, much of which remains buried in capped (but unlined) landfills, within trenches, and surrounding injection wells. Disposal features include: • Six landfills, • 43 surface impoundments, • 15 evaporation pads, • Two non-hazardous waste spreading areas, • Six oil field waste spreading areas, • 11 shallow injection wells, • Seven disposal trenches, and • One drum burial unit.	RI Section 2.2 - Site History and Use
		Short Duration →	Long Duration	Long Duration	Localized environmental impacts to onsite soil and groundwater began once the site accepted wastes in 1972 and continue through today.	RI Section 2.2 - Site History and Use
		Slug Release →	Continual Release	Continual Release	Wastes in some areas (e.g., selected surface impoundments, evaporation pads, spreading areas) have been removed and no longer represent an ongoing continual release, but several disposal features (e.g., capped landfills, injection wells, burial trenches, and some former waste storage pads) remain significant sources of environmental impacts to soil and groundwater.	RI Section 2.2 - Site History and Use
Chemical Properties	**Biotic/Abiotic Decay Potential**	High →	Low	High to Low	Onsite groundwater impacts are characterized by mixed liquids waste disposal. Biotic or abiotic decay may be appropriate for some classes of chemicals, but are not effective on others (e.g., metals cannot be degraded).	RI Section 6.4.2.3.1 - Migration and Persistence of Groundwater COPCs and Appendix O – Monitored Natural Attenuation Evaluation
	Volatility	High →	Low	High to Low	VOCs are present in groundwater, but heavy hydrocarbons also exist that are less volatile. Synthetic organic compounds (PAHs, PCBs, Herbicides, Pesticides, Dioxin/ Furans and Others, excluding the VOCs), typically have less affinity for water (very low solubility) and a greater affinity to absorb to soil. Because of their higher molecular weight, these compounds tend to be viscous and less volatile than VOCs.	RI Section 6.4.2.3.1 - Migration and Persistence of Groundwater COPCs and RI Appendix O – Monitored Natural Attenuation Evaluation
	Contamimant Retardation (Sorption) Potential	Low →	High	High	VOCs, particularly HVOCs like TCE and PCE, are not expected to selectively concentrate on or be sorbed by soils. But SVOCs, pesticides, herbicides, dioxins/furans, and PCBs are expected to be readily adsorbed to subsurface soils because of their insoluble nature, and sorption appears to be the primary environmental fate-governing mechanism for these classes of chemicals. Back diffusion of metals and dissolved solids in low hydraulic conductivity materials also limits the ability to restore groundwater to drinking water conditions.	Sections 4.4, 5.1.3.2

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Contaminant Distribution	**Contaminant Phase**	Aqueous, Gaseous → Sorbed → LNAPL → DNAPL	DNAPL	LNAPL and/or DNAPL have both been detected in monitoring points in isolated locations north of the PSCT, including locations within the Central Drainage Area and the Capped Landfills Area. DNAPL is present in an area between the P/S Landfill and PSCT-1. Previous site conditions could have resulted in downward DNAPL migration based on reasonable assumptions for DNAPL properties (densities and interfacial tensions), DNAPL pooled heights, and fracture apertures. The observation of DNAPLs in piezometers RGPZ-7C and RGPZ-7D suggest that vertical migration of DNAPLs through the limited but potentially interconnected fracture network in the Lower HSU has already occurred within the Central Drainage Area.	Section 4.3 - NAPL Observations
	Volume of Contaminated Media	Small → Large	Large	Volume and mass of impacted media will be calculated in the FS, but impacts to groundwater are widespread. LNAPL is present as a separate phase in 16 Upper HSU wells and piezometers in an area from the Gallery Well at the toe of the P/S Landfill to just north of PSCT-1. DNAPL is present in P/S Landfill piezometer RIPZ-13, installed in August 2007, the Upper HSU Gallery Well, and in two Lower HSU piezometers between the P/S Landfill and PSCT-1. LNAPL and DNAPL depths and thicknesses are routinely measured in these wells and piezometers, and a summary of historical NAPL levels is presented in Attachment A-3. Dissolved metals are pervasive throughout the Northern, Southern, and Western groundwater areas.	Section 4.2 - Dissolved Phase Contaminant Distribution, Section 4.3 - NAPL Observations
	Contaminant Depth	Shallow → Deep	Deep	Most of the LNAPL and dissolved phased contaminants are within the Upper HSU, but DNAPLs have been observed in in piezometers RGPZ-7C and RGPZ-7D, which are screened up to 148 feet below ground surface.	Section 4.2 - Dissolved Phase Contaminant Distribution, Section 4.3 - NAPL Observations

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Casmalia, CA

	Contaminant Characteristics	Generalized Remediation Difficulty Scale Increasing Difficulty →		Casmalia Site Condition	Notes	Primary Section Describing Site Condition
Geology	**Stratigraphy**	Simple Geology →	Complex Geology	Complex Geology	Surficial deposits on site include clayey soils, colluvium, alluvium, and artificial fill ranging from a few feet to up to 50 feet thick. These near-surface deposits have been reworked over a majority of the site. The alluvium generally consists of a silty clay, and is confined to drainages. Artificial fill consists of predominantly disturbed claystone with varying amounts of admixed alluvium. The surficial deposits are in hydraulic communication with the underlying weathered claystone. The Upper HSU consists of the weathered and highly fractured claystone. The Lower HSU consists of the unweathered claystone that is also fractured.	Section 4.1.5.1 - Site Hydrostratigraphic Units
	Texture of Unconsolidated Deposits	Sand →	Clay	Clay	The Upper and Lower HSU are fine grained mudstone deposits.	Section 4.1.5.1 - Site Hydrostratigraphic Units
	Degree of Heterogeneity	Homogeneous →	Heterogeneous	Heterogeneous	Discontinuous, localized deposits of alluvium have been reported at the site. Engineered fill is present throughout the site as dikes, berms, environmental barriers, and solid waste disposal units. Fill material was also placed in association with landfill capping activities, and as buttresses at the toe of some landfills. Fill was generally derived from excavation of onsite soils and consists of silty clay and pebble-to-cobble size fragments of claystone and silty claystone. Upper HSU is weathered claystone that is pervasively fractured. Lower HSU is unweathered claystone that is also fractured.	Section 4.1 - Regional and Site Hydrogeologic Setting
Hydraulics/Flow	**Hydraulic Conductivity**	High (>10^{-2} cm/sec) →	Low (<10^{-4} cm/sec)	Low	Geometric Mean Upper horizontal HSU hydraulic conductivity: 1.05 X 10^{-05} cm/sec, Geometric Lower Upper horizontal HSU hydraulic conductivity: 1.03 X 10^{-06} cm/sec	Section 4.1.4 - Regional and Site Hydrogeologic Setting, 4.1.5 - Site Hydrogeologic Physical Characteristics, 4.1.5.1.1 - Upper Hydrostratigraphic Unit, 4.1.5.1.2 - Lower Hydrostratigraphic Unit
	Temporal Variation	Little/None →	High	Medium	Water level trends for most of the Upper HSU wells showed relatively rapid response to rainfall events and a quick decline in water levels after rainfall recharge has dissipated, but significant rainfall events are relatively infrequent.	RI Appendix F, Section 3.1.3 - Groundwater Elevation Changes 1997-2009
	Vertical Flow	Little or Upward Flow Component →	Large Downward Flow Component	Large Downward Flow Component	Significant downward vertical gradients are present in onsite wells.	RI Appendix F, Table F-4. Vertical Head Differences in Nested Wells

Notes:
Based on Figure 1 from *Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration, Interim Final*, USEPA OSWER Directive 9234.2-25, September 1993.

Table A-2
Potential Chemical-Specific ARARs
Casmalia Resources Superfund Site
Casmalia, CA

Chemical-Specific ARAR	Agency	Reference	Description	Comment	ARAR or To Be Considered
Proposed Corrective Action Rule (40 CFR 264 Subpart S) Action Levels	USEPA	55 FR 30798	Sets action levels for certain chemicals in soil, exceeding action levels may trigger requirements for additional investigation or remediation.	May be used in determining whether contamination poses potential threat to human health or the environment.	Relevant and Appropriate
A Compilation of Water Quality Goals	RWQCB	CVRWQCB, August 2003, as amended 25 May 2004	Defines a procedure for selection of appropriate concentrations of chemical constituents and water quality parameters used to determine compliance with the narrative water quality objectives contained in the Basin Plan.		TBC
Designated Level Methodology for Waste Classification and Cleanup Level Determination	CVRWQCB, June 1989	CVRWQCB, June 1989	Guidance on how to classify wastes under the definitions contained in the Chapter 15 regulations to select appropriate disposal practices protective of beneficial uses of waters of the state.		TBC
Health Advisories and Water Quality Advisories	USEPA	USEPA Office of Water	Short- and long-term and life-time exposure health advisories for noncarcinogens and possible human carcinogens.	Incremental cancer risk estimates for known and probable human carcinogens are also included.	TBC
National Ambient Water Quality Criteria	USEPA/Clean Water Act	Quality Criteria for Water, 1986	Protects human health and welfare		Applicable
Water Quality Criteria	SWRCB, 1963 and 1978	Water Quality Criteria, McKee and Wolf, 1963 and 1978	Contains criteria for human health and welfare, agricultural use, and industrial use.		Applicable
Hazardous Waste - Identification	USEPA/DTSC	40 CFR 261/ 22 CCR 66261	Sets standards for classification of hazardous wastes. Establishes constituent levels for characteristic wastes and lists of wastes considered to be hazardous wastes.	All wastes generated during site activities must be evaluated to determine if they are hazardous.	Applicable
Preliminary Remediation Goals (PRGs)	USEPA	PRG Table – October 2004	Sets a PRG for potential industrial and residential uses for a variety of compounds.	May be used for general risk screening purposes or to set initial cleanup goals.	TBC
Calderon-Sher Safe Drinking Water Act	OEHHA	PHG Tables – 6 March 2006	Requires OEHHA to adopt PHGs for drinking water based on health risk assessments using the most current scientific methods for the approximately 85 chemicals for which state MCLs are presently available.	May be used for general risk screening purposes.	Relevant and Appropriate
ESLs	SFRWQCB	Screening For Environmental Concerns at Sites With Contaminated Soil and Groundwater, Interim Final, February 2005	Presents lookup tables of conservative ESLs for over 100 chemicals commonly found at sites with contaminated soil and groundwater.	May be used for general risk screening purposes.	TBC

Table A-2
Potential Chemical-Specific ARARs
Casmalia Resources Superfund Site
Casmalia, CA

Chemical-Specific ARAR	Agency	Reference	Description	Comment	ARAR or To Be Considered
California Human Health Screening Levels (CHHSLs)	Cal EPA	California Land Environmental Restoration and Reuse Act Cal-EPA, January 2005	CalEPA has developed "screening values" for 54 hazardous substances that are typically found at brownfields sites. These are human–health risk-based screening levels for potential industrial and residential uses. These values serve as reference numbers to help developers and local governments estimate the costs and extent of cleanup of contaminated sites, providing valuable information in their development decisions.	May be used for general risk screening purposes.	TBC
Proposed Corrective Action Rule (40 CFR 264 Subpart S) Action Levels	USEPA	55 CFR 30798	Sets action levels for certain chemicals in soil; exceeding action levels may trigger requirements for additional investigation or remediation.	May be used in determining whether contamination poses potential threat to human health or the environment.	TBC
A Compilation of Water Quality Goals	RWQCB	CVRWQCB, August 2003 with updates through 25 May 2004	Defines a procedure for selection of appropriate concentrations of chemical constituents and water quality parameters used to determine compliance with the narrative water quality objectives contained in the Basin Plan.		TBC
Health Advisories and Water Quality Advisories	USEPA	USEPA Office of Water	Short-term, long-term, and lifetime exposure health advisories for noncarcinogens and possible human carcinogens.	Incremental cancer risk estimates for known and probable human carcinogens are also included.	TBC
Water Quality Criteria	SWRCB, 1963 and 1978	Water Quality Criteria, McKee and Wolf, 1963 and 1978	Contains criteria for human health and welfare, agricultural use, and industrial use.		TBC
Safe Drinking Water Act - MCLs	USEPA	40 CFR 141.11 - 141.16; 141.60 - 141.63; Region IX EPA Drinking Water Standards and Health Advisory Table, February 2000	National Primary Drinking Water Standards - enforceable standards for specified contaminants in drinking water.	Relevant and appropriate for setting water quality objectives for groundwater. Lists water quality criteria for chemicals where an MCL is not established.	Relevant and Appropriate
California Safe Drinking Water Act - MCLs	DHS	22 CCR Sections 64431, 64439, 64444; 64473	California drinking water standards; primary and secondary MCLs for specified contaminants in drinking water.	Relevant and appropriate for setting water quality objectives for groundwater, to the extent that state MCLs are more stringent than federal MCLs. Lists water quality criteria for chemicals where an MCL is not established.	Relevant and Appropriate
OSHA Permissible Exposure Limits	Cal-OSHA	29 CFR 1910.1001/8 CCR 5155	Requirements for controlling employee exposure to airborne contamination during work operations; sets PELs for specified contaminants and workplace monitoring requirements.	If concentrations of any specified contaminants in air exceed the PEL, control measures (administrative or engineering controls, or PPE) will be required. This applies to dust-producing actions or actions that may encourage offgassing of VOCs.	Applicable
OSHA Worker Vinyl Chloride Exposure Standard	Cal-OSHA	29 CFR 1910.1017/8 CCR 5210	Specific standard for occupational exposure to vinyl chloride; includes requirements for monitoring, protective equipment and decontamination. The PEL for vinyl chloride is currently 1 ppm for an 8-hour TWA.	If concentrations of vinyl chloride in air exceed the PEL, control measures will be required. This applies to actions that may encourage offgassing of VOCs.	Applicable
Hazardous Waste - LDR	USEPA/DTSC	40 CFR 268/ 22 CCR 66268	Sets LDR constituent concentrations and treatment standards.	Hazardous wastes generated during site activities must meet LDR standards prior to land disposal.	Relevant and Appropriate

Table A-2
Potential Chemical-Specific ARARs
Casmalia Resources Superfund Site
Casmalia, CA

Chemical-Specific ARAR	Agency	Reference	Description	Comment	ARAR or To Be Considered
Hazardous Waste Identification	California Hazardous Waste Control Act / DTSC	22 CCR §§ 66261.1 - 66261.126	Criteria for identifying hazardous waste. Applicable if hazardous waste is encountered during implementation of response actions at the site.		Relevant and Appropriate
Hazardous Waste Generation	California Hazardous Waste Control Act / DTSC	22 CCR §§ 66262.10 - 66262.47	Provides standards applicable to generators of hazardous waste. May be applicable if hazardous waste is generated during implementation of response actions at the site. Particular provisions are described below.		Relevant and Appropriate
Hazardous Waste Determination	California Hazardous Waste Control Act / DTSC	22 CCR § 66262.11	Provides method of determining whether a waste is a hazardous waste.	Used to make determination if excavated soils or wastes or extracted leachate liquids are RCRA or nonRCRA hazardous	Relevant and Appropriate
Waste Manifesting	California Hazardous Waste Control Act / DTSC	22 CCR § 66262.23	Provides requirements for use of a hazardous waste manifest. Applicable if hazardous waste will be transported offsite.		Relevant and Appropriate
Pre-Transport Requirements	California Hazardous Waste Control Act / DTSC	22 CCR §§ 66262.30 - 66262.34	Provides requirements for packaging, labeling, marking, placarding, and permissible accumulation time before transporting hazardous waste offsite.	Applicable if hazardous waste soils are excavated and transported offsite.	Relevant and Appropriate
Applicability of General Facility Standards	California Hazardous Waste Control Act / DTSC	22 CCR § 66265.10	Provides that the regulations in Article 2 (General Facility Standards, §§ 66265.10 - 66265.25) apply to owners and operators of hazardous waste facilities.		Relevant and Appropriate
General Waste Analysis	California Hazardous Waste Control Act / DTSC	22 CCR § 66265.13	Provides standards for obtaining analyses of hazardous waste before transferring, treating, storing or disposing of such waste.		Relevant and Appropriate
Security	California Hazardous Waste Control Act / DTSC	22 CCR § 66265.14	Provides standards for prevention of unknowing entry or unauthorized entry of persons or livestock.		Relevant and Appropriate
General Inspection	California Hazardous Waste Control Act / DTSC	22 CCR § 66265.15(a)-(c)	Provides standards for facility inspection for malfunctions and deterioration. Requires development and implementation of a written schedule for inspecting equipment in order to prevent, detect, or respond to environmental or human health hazards.		Relevant and Appropriate
Personnel Training	California Hazardous Waste Control Act / DTSC	22 CCR § 66265.16(a), (b)	Provides standards for training programs and training records for facility personnel. The training requirements in the Cal-OSHA HAZWOPER standard (8 CCR § 5192) may be applicable to workers performing certain response actions at the site (although they are not ARARs because they are not environmental law requirements). Additionally, the personnel training requirements of Section 66265.16(a) and (b) may be ARARs for certain response actions at the site to the extent that they are relevant to the duties of the workers performing such actions.		Relevant and Appropriate
Ignitable, Reactive and Incompatible Wastes	California Hazardous Waste Control Act / DTSC	22 CCR § 66265.17	Provides standards to prevent accidental ignition or reaction of ignitable, reactive or incompatible wastes.	Applicable if such wastes are encountered during implementation of response actions at the site.	Relevant and Appropriate

Table A-2
Potential Chemical-Specific ARARs
Casmalia Resources Superfund Site
Casmalia, CA

Chemical-Specific ARAR	Agency	Reference	Description	Comment	ARAR or To Be Considered
Disposal/ Decontamination	California Hazardous Waste Control Act / DTSC	22 CCR § 66265.114	Provides that during the partial and final closure periods, all contaminated equipment, structures and soil must be properly disposed of or decontaminated by removing all hazardous waste and residues, except as otherwise specified.	Applicable if implementation of response actions at the site involves hazardous waste-contaminated equipment, structures or soil.	Relevant and Appropriate
Federal Clean Water Act Effluent Limitations	USEPA	33 United States Code (USC) § 1311(a)	Provides that the discharge of any pollutant is unlawful except in compliance with specified provisions. This provision will be evaluated as a potential ARAR during the FS if any of the remedial alternatives being evaluated will involve point source discharges to surface waters.	Used to determine compliance with treated water discharge limits	Relevant and Appropriate
Maximum Contaminant Levels (MCLs)	USEPA	42 USC § 300f et seq.; 40 CFR §§ 141.50-141.52; EPA Region IX Drinking Water Standards and Health Advisory Table, February 2000	National primary drinking water standards.	Used to determine if groundwater restoration is needed	Relevant and Appropriate

Notes:

ARAR = Applicable or relevant and appropriate requirement
CalEPA = California Environmental Protection Agency
CCR = California Code of Regulations
CFR = Code of Federal Regulations
CHHSL = California Human Health Screening Level
DHS = Department of Health Services
DTSC = Department of Toxic Substances Control
ESL = Environmental Screening Level
LDR = Land Disposal Restriction
MCL = Maximum Contaminant Level
OEHHA = Office of Environmental Health Hazard Assessment
OSWER = Office of Solid Waste and Emergency Response
PHGs = Public health goals
PRG = Preliminary Remediation Goals
RWQCB = Regional Water Quality Control Board
TBC = To be considered
TCE = Trichloroethene
USEPA = United States Environmental Protection Agency
VOC = Volatile organic compound

Table A-3
Dissolved Chemicals in Groundwater that Exceed MCLs
Casmalia Resources Superfund Site
Casmalia, CA

Chemical	MCL (µg/L)	Maximum Detected Concentration (µg/L)	Location	Date
1,1,1-Trichloroethane	200	410000	Gallery Well	9/30/1997
1,1,2,2-Tetrachloroethane	1	1700	PSCT-1	5/23/2002
1,1,2-Trichloroethane	5	2700	PSCT-1	5/23/2002
1,1-Dichloroethane	5	170000	PSCT-1	5/23/2002
1,1-Dichloroethylene	6	38000	PSCT-1	5/23/2002
1,2-Dichloroethane	0.5	110000	PSCT-1	5/23/2002
1,2-Dichloropropane	5	4400	PSCT-1	5/23/2002
1,2,3,4,6,7,8-HpCDD	0.00003	8.71	RIPZ-8	10/19/2006
1,2,3,4,6,7,8-HpCDF	0.00003	2.43	RIPZ-8	10/19/2006
1,2,3,4,7,8,9-HpCDF	0.00003	0.343	RIPZ-8	10/19/2006
1,2,3,4,7,8-HxCDD	0.00003	0.0162	RIPZ-8	10/19/2006
1,2,3,4,7,8-HxCDF	0.00003	1.01	RIPZ-8	10/19/2006
1,2,3,6,7,8-HxCDD	0.00003	0.491	RIPZ-8	10/19/2006
1,2,3,6,7,8-HxCDF	0.00003	0.401	RIPZ-8	10/19/2006
1,2,3,7,8,9-HxCDD	0.00003	0.0716	RIPZ-8	10/19/2006
1,2,3,7,8,9-HxCDF	0.00003	0.345	Gallery Well	11/15/2004
1,2,3,7,8-PeCDD	0.00003	0.0287	RIPZ-8	10/19/2006
1,2,3,7,8-PeCDF	0.00003	0.856	RIPZ-8	10/19/2006
2,3,4,6,7,8-HxCDF	0.00003	0.27	RIPZ-8	10/19/2006
2,3,4,7,8-PeCDF	0.00003	0.772	RIPZ-8	10/19/2006
2,3,7,8-TCDD	0.00003	0.000737	Sump 9B	4/14/2005
2,3,7,8-TCDF	0.00003	0.461	RIPZ-8	10/19/2006
Acenaphthylene	0.2 *[a]	58	Gallery Well	12/15/2004
Aluminum-Dissolved	1000	1400	RGPZ-6D	4/6/2005
Aluminum-Total	1000	150000	RGPZ-6B	3/2/2005
Antimony-Dissolved	6	14	WP-3D	6/5/1998
Antimony-Total	6	25	RGPZ-12D	5/4/2006
Arsenic-Dissolved	50	710	Pond 13	10/28/2004
Arsenic-Total	50	330	Pond A-5	11/3/2004
Barium-Total	1000	1300	RG-8B	4/6/2004
Benzene	1	39000	PSCT-1	5/23/2002
Benzo(a)anthracene	0.2 *[a]	130	Gallery Well	12/15/2004
Benzo(a)Pyrene	0.2 *[a]	34	SW-17	4/15/2005
Benzo(b)fluoranthene	0.2 *[a]	33	Gallery Well	12/15/2004
Benzo(ghi)perylene	0.2 *[a]	43	RGPZ-6B	3/2/2005
Benzo(k)fluoranthene	0.2 *[a]	35	SW-17	4/15/2005
Beryllium-Dissolved	4	8	RP-98C	9/26/1997
Beryllium-Total	4	80	WS-4	5/3/2006
Bis(2-ethylhexyl) phthalate	4	19000	Gallery Well	4/13/2005
Bromodichloromethane	100[b]	5400	Gallery Well	11/22/1999
Bromoform	100[b]	15	Gallery Well	2/11/1998
Cadmium-Dissolved	5	150	MW-18C	4/14/2005
Cadmium-Total	5	422	B-5	12/31/1997
Carbon tetrachloride	0.5	19000	Gallery Well	9/30/1997
Chlorobenzene	70	400	Gallery Well	11/17/2005
Chloroform	80 *[b]	180000	PSCT-1	5/23/2002
Chromium-Dissolved	50	110	RIMW-9	5/1/2006
Chromium-Total	50	8960	B-5	12/31/1997
Chrysene	0.2 *[a]	150	Gallery Well	12/15/2004
cis-1,2-Dichloroethene	6	200000	PSCT-1	5/23/2002
cis-1,3-Dichloropropene	0.5[c]	7.1	RAP-3A	4/26/1999
Copper-Dissolved	1000	3330	B3B	10/29/1998

Table A-3
Dissolved Chemicals in Groundwater that Exceed MCLs
Casmalia Resources Superfund Site
Casmalia, CA

Chemical	MCL (µg/L)	Maximum Detected Concentration (µg/L)	Location	Date
Copper-Total	1000	5010	B-5	12/31/1997
Dibenz(a,h)anthracene	0.2 *[a]	15	SW-17	4/15/2005
Endrin	2	4000	Gallery Well	7/18/2000
Ethylbenzene	300	34000	PSCT-1	10/22/2003
Fluoranthene	0.2 *[a]	210	Gallery Well	12/15/2004
Fluorene	0.2 *[a]	430	Gallery Well	12/15/2004
Freon 11 (Trichlorofluoromethane)	150	20000	Gallery Well	9/30/1997
Freon 113	1200	52000	Gallery Well	9/30/1997
Heptachlor	0.01	0.33	RG-7B	10/16/2003
Heptachlor epoxide	0.01	0.33	WP-3S	5/10/2001
Hexachlorobenzene	1	640	Gallery Well	11/22/1999
Lead-Dissolved	15	218	B3B	1/2/1998
Lead-Total	15	584	B-5	12/31/1997
Lindane (gamma-BHC)	0.2	0.83	RIMW-8	5/10/2006
Manganese-Dissolved	50*	44000	Gallery Well	11/15/2004
Manganese-Total	50*	44000	Gallery Well	4/13/2005
Methyl tert-butyl ether	13	7000	Gallery Well	7/18/2000
Methylene Chloride	5	1700000	PSCT-1	5/23/2002
Naphthalene	0.2 *[a]	150000	SW-17	4/15/2005
Nickel-Dissolved	100	3830	Gallery Well	11/5/1998
Nickel-Total	100	26100	Gallery Well	11/22/1999
OCDD	0.00003	112	RIPZ-8	10/19/2006
OCDF	0.00003	16	RIPZ-8	10/19/2006
o-Xylene	1750[d]	29000	PSCT-1	10/22/2003
PCBs	0.5	3000	Gallery Well	4/13/2005
PCP (pentachlorophenol)	1	81	RGPZ-6B	4/18/2005
Pyrene	0.2 *[a]	290	Gallery Well	12/15/2004
Selenium-Dissolved	50	2900	Pond 13	10/28/2004
Selenium-Total	50	1600	Pond 13	10/28/2004
Styrene	100	1100	Rd Sump	7/20/2000
Tetrachloroethylene	5	140000	Gallery Well	9/30/1997
Thallium-Dissolved	2	22	A2B	9/12/1997
Thallium-Total	2	86	A2B	9/12/1997
Toluene	150	98000	Gallery Well	9/30/1997
trans-1,2-Dichloroethene	10	2300	PSCT-1	5/23/2002
Trichloroethylene	5	120000	PSCT-1	5/23/2002
Vinyl Chloride	0.5	20000	SW-17	4/15/2005
Xylene (total)	1750	160000	PSCT-1	10/22/2003
Zinc-Dissolved	5000	7810	Gallery Well	11/5/1998
Zinc-Total	5000	6900	Gallery Well	9/30/1997

Notes:
California MCLs are listed above, unless otherwise noted.
* California MCL is not established; the federal MCL is listed.
[a] The federal MCL for PAH compounds is based on the benzo(a)pyrene MCL.
[b] MCL based on trihalomethane.
[c] MCL based on total 1,2-dichloropropene
[d] MCL based on total Xylenes

Table A-4
Potential Location-Specific ARARs
Casmalia Resources Superfund Site
Casmalia, CA

Location-Specific ARAR	Agency	Reference	Description	Comment	ARAR or To Be Considered
Location Standards for Hazardous Waste Facilities - Seismic Considerations	DTSC	27 CCR 66264.18	Specifies that portions of new facilities where transfer, treatment, storage, or disposal of hazardous waste will be conducted shall not be located within 200 feet (61 meters) of a fault that has had displacement in Holocene period.	Applicable to construction of any new treatment, storage, or disposal facilities.	Relevant and appropriate
Discharges of Waste to Land	RWQCB	23 CCR, Chapter 15	Waste management unit classification and siting and construction standards.		Relevant and appropriate
Permit Applicability	Santa Barbara County APCD	Rule 201	Provides for the issuance of permits when equipment may cause the emission of air contaminants. CERCLA Section 121(e)(1) provides that no permit is required for response actions conducted entirely onsite. Accordingly, Rule 201 will be evaluated as an ARAR only for any offsite action, subject to any further exemption that may be set forth in Rule 202.		Relevant and appropriate
Permit Exemptions	Santa Barbara County APCD	Rule 202	Sets forth exemptions to the permitting requirements of Rule 201, including exemptions for temporary equipment, internal combustion engines, numerous other categories of equipment and operations, emissions below specified thresholds, and under other circumstances as specified.		Relevant and appropriate
Visible Emissions	Santa Barbara County APCD	Rule 302	Establishes limits on visible emissions of air contaminants into the atmosphere.		Relevant and appropriate
Nuisance	Santa Barbara County APCD	Rule 303	Prohibits discharges of air contaminants or other material in violation of Health & Safety Code § 41700 in quantities that cause injury, detriment, nuisance, or annoyance to any considerable number of persons or to the public; or that endanger the comfort, repose, health or safety of such persons or the public; or that cause or have a natural tendency to cause injury or damage to business or property.		Relevant and appropriate
Particulate Matter	Santa Barbara County APCD	Rule 304	Prohibits discharges into the atmosphere of particulate matter in excess of 0.3 grain per cubic foot.		Relevant and appropriate
New Source Review	Santa Barbara County APCD	Regulation VIII	This regulation includes requirements that new sources of air emissions must meet. The rules in Regulation VIII will be evaluated as potential ARARs during the Feasibility Study (FS) if any of the remedial alternatives being evaluated will involve new sources of air emissions.		Relevant and appropriate
Storage of Volatile Organic Compounds	San Luis Obispo County Air Pollution Control District	Rule 425	Specifies regulations for storage of volatile organic compounds (VOCs) with a vapor pressure greater than or equal to 0.50 pounds per square inch absolute (psia).	The vapor pressure of the contaminated groundwater collected onsite is not likely to exceed 0.50 psia, but in the event that they do, this rule would apply.	Relevant and appropriate
Central Coast RWQCB Basin Plan	CCRWQCB	RWQCB Region 3 - Central Coast Region Basin Plan	Establishes water quality objectives.	Applicable to discharges that may effect water quality.	TBC
Survey Plat	DTSC	22 CCR § 66265.116	Provides that a survey plat, indicating location and dimension of landfill cells or other hazardous waste disposal units and certified by a professional land surveyor licensed in California, must be submitted to the local zoning authority and DTSC no later than the submission of certification of closure of the hazardous waste disposal unit.	The regulation also provides that the plat filed with the zoning authority must contain a prominently displayed note stating the owner/operator's obligation to restrict disturbance of the hazardous waste disposal unit; this provision will be evaluated in the context of any institutional controls that may be imposed in connection with the site remedy.	TBC
Post-Closure Care Requirements	DTSC	22 CCR § 66265.117	Section 66265.117 concerns post-closure care and use of the site.		Relevant and appropriate
Post-Closure Care Requirements	DTSC	22 CCR §§ 66265.118 - 66265.120	Sections 66265.118 through 66265.120 establish requirements for a post-closure plan, post-closure notices, and certification of completion of post-closure care.		Relevant and appropriate
Landfill Closure Construction	DTSC	22 CCR §§ 66265.310(a), (c) and (d)	Provides performance standards for design and construction of landfill final covers.		Applicable
Landfill Post-Closure Care	DTSC	22 CCR §§ 66265.310(b) and (e)	Provides requirements for post-closure care of landfills.		Applicable
Environmental Air and Soil Vapor Monitoring	DTSC	22 CCR §§ 66265.710 - 66265.714	Provides for environmental monitoring during the active life and post-closure period at landfills or other specified waste management units where hazardous wastes will remain after closure. Provides that environmental monitoring requirements shall be waived if it is demonstrated to the satisfaction of EPA that wastes are not migrating from the site.		Relevant and appropriate
Precipitation and Drainage Controls	SWRCB	23 CCR § 2546	Provides performance standards for design and construction of containment structures and cover materials.		Relevant and appropriate

Table A-4
Potential Location-Specific ARARs
Casmalia Resources Superfund Site
Casmalia, CA

Location-Specific ARAR	Agency	Reference	Description	Comment	ARAR or To Be Considered
Seismic Design Standards	SWRCB	23 CCR § 2547	Provides that Class I waste management units (*e.g.* , including landfills) must be designed to withstand the maximum credible earthquake without damage to the foundation or structures, which control leachate, surface drainage, erosion or gas.		Relevant and appropriate
	SWRCB	23 CCR § 2550.0(d)	Provides that Article 5 applies during the active life and the closure period of the WMU. After closure, Article 5 applies during the post-closure maintenance period under Section 2550.6 unless: 1. The WMU has been in compliance with the water quality protection standard for three consecutive years; and 2. All waste, waste residues, contaminated containment system components, contaminated subsoils, and all other contaminated materials are removed or decontaminated at closure.		Relevant and appropriate
Water Quality Monitoring and Response Programs for Waste Management Units	SWRCB	23 CCR § 2550.1(a)(4)	Requires the discharger to institute a corrective action program pursuant to Section 2550.10 to remediate unauthorized releases from waste management units.		Relevant and appropriate
Water Quality Protection Standard	SWRCB	23 CCR § 2550.2	Provides that, for each Class I WMU, RWQCB must establish water quality protection standards in the WDRs, which must consist of: 1. The list of constituents of concern (waste constituents and hazardous constituents that are reasonably expected to be in or derived from the WMU); 2. Concentration limits under Section 2550.4; and 3. Point of compliance and monitoring points under Section 2550.5. This standard applies during the active life of the WMU, the closure period, and during any Section 2550.6 compliance period.		Relevant and appropriate
Concentration Limits for Correction Action	SWRCB	23 CCR § 2550.4(c)	For a corrective action program, the RWQCB is to establish a concentration limit for a constituent of concern that is greater than the background value of that constituent only if the regional board finds that it is technologically or economically infeasible to achieve the background value for that constituent and that the constituent will not pose a substantial present or potential hazard to human health or the environment as long as the concentration limit greater than background is not exceeded.		Relevant and appropriate
	SWRCB	23 CCR § 2550.4(d)(1)	In establishing a concentration limit greater than background, the RWQCB is required to consider the potential adverse effects on ground water quality and beneficial uses, including: (A) The physical and chemical characteristics of the waste in the WMU; (B) The hydrogeological characteristics of the facility and surrounding land; (C) The quantity of groundwater and the direction of ground water flow; (D) The proximity and withdrawal rates of ground water users (E) The current and potential future uses of ground water in the area; (F) The existing quality of ground water, including other resources of contamination or pollution and their cumulative impact on the ground water quality; (G) The potential for health risks caused by human exposure to waste constituents; (H) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents; and (I) The persistence and permanence of the potential adverse effects.		Relevant and appropriate
	SWRCB	23 CCR § 2550.4(e)	Concentration limits greater than background established under Section 2550.4 shall not exceed the lowest concentration that the discharger demonstrates and the RWQCB finds is technologically and economically achievable.		Relevant and appropriate
	SWRCB	23 CCR § 2550.4(h)	A concentration limit greater than background may only be applied during corrective action, or during detection monitoring following corrective action, at monitoring points at which “statistically significant” evidence of a release has been determined.		Relevant and appropriate
Point of Compliance for Contiguous WMUs	SWRCB	23 CCR § 2550.5(a), (b)	Provides that the point of compliance is a vertical surface located at the hydraulically downgradient limit of the WMU that extends through the uppermost aquifer underlying the unit. If the facility contains contiguous WMUs and monitoring along a shared boundary would impair the integrity of a containment or structural feature of any of the WMUs, the point of compliance may be located at the hydraulically downgradient limit of an area described by an imaginary line along the outer boundary of the contiguous WMUs. This provision applies only to contiguous WMUs that have operated or have received all permits necessary for construction before July 1, 1991.		Relevant and appropriate

Table A-4
Potential Location-Specific ARARs
Casmalia Resources Superfund Site
Casmalia, CA

Location-Specific ARAR	Agency	Reference	Description	Comment	ARAR or To Be Considered
Water Quality Monitoring and Response Programs for Waste Management Units – Corrective Action	SWRCB	23 CCR §§ 2550.10(a), (b), (d), and (g)(1)	Sections 2550.10(a), (b), (d), and (g)(1) establish the requirements for a corrective action program under Chapter 15, Article 5 (Water Quality Monitoring and Response Programs for Waste Management Units).		Relevant and appropriate
Waste Management Units - General Closure Requirements	SWRCB	23 CCR §§ 2580(a), (b) and (d)	Section 2580 provides that waste management units must be closed according to an approved closure and post-closure maintenance plan that provides for continued compliance with applicable standards for waste containment and precipitation and drainage controls in Article 4 and the monitoring program requirements in Article 5.		Relevant and appropriate
Final Cover – Vegetation Requirements	SWRCB	23 CCR § 2580(e)	Subsection (e) of Section 2580 provides that vegetation must not impair the integrity of the final cover.		Relevant and appropriate
Closure and Post-Closure Maintenance Plans	SWRCB	23 CCR § 2597	Section 2597 identifies the information to be included in closure and post-closure maintenance plans. Provisions for preparing post-closure maintenance plans may be relevant and appropriate.		Relevant and appropriate
General Permit for Discharges of Storm Water Associated with Construction Activities		SWRCB Order No. 99-08-DWQ	Sets forth NPDES requirements for storm water runoff from certain construction activities that disturb land equal to one (1) acre or more. Includes substantive requirements for developing and implementing a stormwater pollution prevention plan and performing monitoring of stormwater discharges. Evaluation of this Order as a potential ARAR during the FS will include an evaluation of whether stormwater discharges from site activities, if any, are covered by an existing NPDES permit issued for the site.		Relevant and appropriate
General Permit for Discharges of Storm Water Associated with Industrial Activities		SWRCB Order No. 97-03-DWQ	Sets forth NPDES requirements for storm water runoff from certain industrial activities, excluding construction activities. Evaluation of this Order as a potential ARAR during the FS will include an evaluation of whether stormwater discharges from site activities, if any, are covered by an existing NPDES permit issued for the site.		Relevant and appropriate
Federal Endangered Species Act (ESA)	USEPA	16 USC §§ 1531 1544	Federal requirements governing endangered and threatened species. Section 1538 (Prohibited Acts) will be considered as a potential ARAR during the FS if any of the remedial alternatives being evaluated may be expected to adversely affect threatened or endangered species.	Pursuant to 50 C.F.R. § 402.14(b), EPA need not initiate formal consultation if, as a result of informal consultation or preparing a biological assessment, EPA determines (with the written concurrence of the U.S. Fish & Wildlife Service) that the response action is not likely to adversely affect listed species.	Relevant and appropriate
State Wildlife Trust Resources	California Fish and Game Code	F&GC § 711.7	Concerns state wildlife trust resources dependent on federal lands or waters, and requires payment of project filing fees by persons engaging in projects under federal license, contract or permit.		Relevant and appropriate
Rare/Endangered Native Plants	California Fish and Game Code	F&GC § 1908	Prohibits the taking of a rare or endangered native plant.		Relevant and appropriate
Rare/Endangered Native Plants	California Fish and Game Code	F&GC 1913(c)	Provides that, where a landowner has been notified by the DFG that a rare or endangered native plant is growing on such land, the owner shall notify the DFG in advance of changing the land use, to allow for the salvage of such plant.		Relevant and appropriate
Endangered and Threatened Species (Plants and Animals)	California Fish and Game Code	F&GC § 2080	Prohibits the taking, possession, purchase or sale of a threatened or endangered species, or attempting any of those prohibited acts. California plant species declared to be endangered or threatened are listed at 14 CCR Sections 670.2(a) and (b), respectively. California animal species declared to be endangered or threatened are listed at 14 CCR § 670.5.		Relevant and appropriate
Birds and Mammals	California Fish and Game Code	F&GC § 3005	Prohibits taking of birds and mammals, including taking by poisonous substances.		Relevant and appropriate
Birds-of-Prey	California Fish and Game Code	F&GC § 3503.5	Prohibits the take, possession, or destruction of any birds in the orders of Falconiformes or Strigiformes (birds-of-prey) or the take, possession, or destruction of the nest or eggs of any such bird except as otherwise provided by the F&GC or its implementing regulations.		Relevant and appropriate

Table A-4
Potential Location-Specific ARARs
Casmalia Resources Superfund Site
Casmalia, CA

Location-Specific ARAR	Agency	Reference	Description	Comment	ARAR or To Be Considered
Fully Protected Birds	California Fish and Game Code	F&GC § 3511	Prohibits the taking or possession of the fully protected birds identified in Section 3511. This Section will be considered as a potential ARAR during the FS if any of the remedial alternatives being evaluated may be expected to adversely affect the Golden eagle or other bird species covered by this statute.		Relevant and appropriate
Nongame Birds	California Fish and Game Code	F&GC § 3800	Prohibits the take of nongame birds, except in accordance with Fish & Game Commission regulations. This Section will be considered as a potential ARAR during the FS if any of the remedial alternatives being evaluated may be expected to adversely affect nongame birds covered by this statute and to the extent that this Section is more stringent than the federal standard of protection.		Relevant and appropriate
Nongame Mammals	California Fish and Game Code	F&GC § 4150	Prohibits the taking of nongame mammals (i.e., those occurring naturally in California which are not game mammals, fully protected mammals, or fur-bearing mammals) or their parts except as provided in the F&GC or its implementing regulations.		Relevant and appropriate
	California Fish and Game Code	14 CCR § 472 and § 475	Describe the exceptions to the prohibition on the take of nongame birds and mammals, and exceptions to the manner in which nongame birds and mammals may be taken.		Relevant and appropriate
Fully Protected Mammals	California Fish and Game Code	F&GC § 4700	Prohibits the taking or possession of the fully protected mammals identified in Section 4700.		Relevant and appropriate
Mountain Lions	California Fish and Game Code	F&GC § 4800	Prohibits the take, injuring, possession, transportation, or sale of any mountain lion or any part or product thereof except as specifically provided by the F&GC.		TBC
Fully Protected Reptiles and Amphibians	California Fish and Game Code	F&GC § 5050	Prohibits the taking or possession of the fully protected reptiles and amphibians identified in Section 5050.		Relevant and appropriate
Native Reptiles and Amphibians	California Fish and Game Code	14 CCR § 40	Prohibits the capture, collection, intentional killing or injuring, possession, purchase, propagation, sale, transport, import or export any native reptile or amphibian, or part thereof, except as specified.		Relevant and appropriate
Aquatic Habitat/ Species	California Fish and Game Code	F&GC § 5650	Prohibits deposit into State waters of, among other things, petroleum products (§ 5650(a)(1)), factory refuse (§ 5650(a)(2)), and certain substances or materials deleterious to fish, plants or birds (§ 5650(a)(6)).	Implementation of the RI/FS and construction of the remedy are not expected to result in a deposit to State waters, except for any potential discharge of storm water runoff to Casmalia Creek pursuant to the individual NPDES permit (i.e., waste discharge requirements) that has been issued for occasional controlled stormwater discharges, or pursuant to other waste discharge requirements for the site. Section 5650 does not apply to discharges in compliance with waste discharge requirements.	Relevant and appropriate
Water Reclamation Resolution	RWQCB	Resolution 88-160	Requires consideration of reclamation options for extracted groundwater, followed by consideration of discharge to POTW before an NPDES permit is granted.		Relevant and appropriate
Prohibits acts for federally listed species	US Fish and Wildlife Service	Endangered Species Act of 1973, as amended; Section 9(a)(1)	It is unlawful for any person subject to the jurisdiction of the United States to take any endangered or threatened species. Take is defined in Section 3(19) to mean to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.		Relevant and appropriate
Formal consultation for Federally listed species and critical habitat	US Fish and Wildlife Service	Endangered Species Act of 1973, as amended; Section 7; 50 CFR 402.14	These regulations require Federal agencies to review their actions to determine whether they "may affect" listed species or critical habitat. Formal consultation procedures must be initiated if such a situation exists, unless, with the written concurrence of the Service, the Federal agency determines through informal consultation and/or through the biological assessment process that its action is not likely to adversely affect listed species or critical habitat.	California red-legged frogs, California tiger salamanders, and designated critical habitat for California red-legged frogs are located within the project boundaries and are subject to consultation between EPA and the Service.	Relevant and appropriate
Critical habitat for California red-legged frogs	US Fish and Wildlife Service	75 FR 12816	Revised designation of critical habitat for California red-legged frog, finalized on March 17, 2010.	The site is within the boundaries of critical habitat Unit STB 2.	Relevant and appropriate
Migratory Birds	US Fish and Wildlife Service	Migratory Bird Treaty, 16 U.S.C. 703-712	The Migratory Bird Treaty Act prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior.		Relevant and appropriate

Notes:
ARAR = Applicable or relevant and appropriate requirement
CCR = California Code of Regulations
DTSC = Department of Toxic Substances Control
RWQCB = Regional Water Quality Control Board
FR = Federal Register

Table A-5
Potential Action-Specific ARARs
Casmalia Resources Superfund Site
Casmalia, CA

Action-Specific ARAR	Agency	Reference	Description	Comment	ARAR or To Be Considered
Water Quality Monitoring Requirements for Permitted Facilities (Point of Compliance)	DTSC	22 CCR 66264.95, 66264.97, 66264.98, 66264.99	Establishes reqirements, including point-of-compliance boundary, for groundwater monitoring for landfills, surface impoundments, waste piles, and land treatment units to attain compliance with water quality protection standards.	A potential ARAR for the area downgradient of the Technical Impracticability Zone, which will be located at the hydraulically downgradient limit of the waste management area (the southern-most boundary of Area 5 North).	Relevant and Appropriate
Monitoring well construction, repair, modification, desctruction and inactivity	Santa Barbara County Department of Environmental Health	County Ordinance 34A Wells	Regulations concerning the construction, repair, modification, destruction and inactivity of wells in Santa Barbara County.	References Department of Water Resources Bulletin 7481 (1981). A more recent bulletin exists, but Santa Barbara still uses the 1981 version.	Applicable
Hazardous Material/Hazardous Waste Transportation Requirements	USEPA / DOT / DTSC	40 CFR 262 / 49 CFR 172 / 22 CCR 66262	Requirements for packaging, labeling, placarding, and transporting hazardous waste.	Any hazardous wastes shipped offsite for disposal must meet the requirements for hazardous waste shipping and transportation.	Applicable
Hazardous Waste	DTSC	22 CCR 66260	Provides definitions of terms used in the hazardous waste regulations under Title 22 of the California Code of Regulations.	Applicable to activities generating wastes; wastes must be classified using generator knowledge or waste analysis.	Applicable
Hazardous Waste	DTSC	Health and Safety Code 25123.3	Remediation waste staging requirements allowing the temporary accumulation of non-RCRA contaminated soil provided that certain conditions are met.	Applicable to activities that involve temporary accumulation of non-RCRA contaminated soil. Requires an impermeable surface, controls to prevent dispersion or runoff, inspections, and certification.	Applicable
Hazardous Waste	DTSC	Health and Safety Code 25200 et. seq	Establishes tiered permitting system for facilities involved in the treatment of certain non-RCRA hazardous wastes. Sets requirements applicable to facilities subject to tiered permitting.	Alternatives treating non-RCRA hazardous waste that meet specified waste stream and quantity limitations may be subject to tiered permitting.	Relevant and Appropriate
Hazardous Waste	USEPA/DTSC	40 CFR 264, 265 Subpart K / 22 CCR 66264 and 66265	Requirements for surface impoundment (waste pile) liner to prevent any migration of wastes out of the impoundment to the adjacent subsurface soil or groundwater.	Applicable to alternatives involving hazardous waste piles.	Relevant and Appropriate
Hazardous Waste	USEPA/DTSC	40 CFR 264 Subpart X / 22 CCR 66264	Requirements for treatment in miscellaneous units.	Applicable to alternatives involving treatment in units classified as miscellaneous units.	Relevant and Appropriate
Hazardous Waste	USEPA/DTSC	40 CFR 264, 265 Subpart B / 22 CCR 66264 and 66265	General facility standards for onsite treatment, storage, or disposal of hazardous waste.	Applicable to alternatives involving the TSD of hazardous waste.	Relevant and Appropriate
Hazardous Waste	USEPA/DTSC	40 CFR 264, 265 Subpart C / 22 CCR 66264 and 66265	Preparedness and prevention requirements applicable to onsite TSD of hazardous waste. Applies to generators and TSDs.	Applicable to alternatives involving the TSD of hazardous waste.	Relevant and Appropriate
Hazardous Waste	USEPA/DTSC	40 CFR 264, 265 Subpart D / 22 CCR 66264 and 66265	Contingency Plan requirements applicable to onsite TSD of hazardous waste. Applies to generators and TSDs.	Applicable to alternatives involving the TSD of hazardous waste.	Relevant and Appropriate
Hazardous Waste	USEPA/DTSC	40 CFR 264, 265 Subpart E / 22 CCR 66264 and 66265	Manifesting, record keeping, and reporting requirements applicable to TSD facilities.	Applicable to alternatives involving the TSD of hazardous waste.	Applicable
Hazardous Waste	USEPA/DTSC	40 CFR 264, 265 Subpart F / 22 CCR 66264 and 66265	Establishes monitoring requirements for facilities that treat, store, or dispose of hazardous waste.	Applicable to alternatives involving theTSD of hazardous waste.	Relevant and Appropriate
Hazardous Waste	USEPA/DTSC	40 CFR 264, 265 Subpart G / 22 CCR 66264 and 66265	Closure and post-closure requirements for hazardous waste TSD in new onsite units.	Applicable to alternatives involving creation of new TSD units.	Relevant and Appropriate
Hazardous Waste	USEPA/DTSC	40 CFR 264, 265 Subpart N / 22 CCR 66264 and 66265	Requirements for hazardous waste landfills.	Applicable to alternatives involving land disposal of hazardous waste.	Relevant and Appropriate
Hazardous Waste	USEPA/DTSC	40 CFR 265, 264 / 22 CCR 66265, 66264	Requirements for management/storage of hazardous waste in containers.	Applicable to any hazardous wastes accumulated or stored in containers.	Applicable

Table A-5
Potential Action-Specific ARARs
Casmalia Resources Superfund Site
Casmalia, CA

Action-Specific ARAR	Agency	Reference	Description	Comment	ARAR or To Be Considered
Hazardous Waste - Corrective Action Management Units and Temporary Units	USEPA	40 CFR 264 Subpart S	Requirements for the establishment of specialized units under the corrective action program that are applicable to site remediation activities.	Applicable to activities using corrective action management units or temporary units.	Relevant and Appropriate
Hazardous Waste - LDR	USEPA/DTSC	40 CFR 268 / 22 CCR 66268	Establishes land disposal restrictions and treatment standards for hazardous wastes applicable to generators.	Any hazardous wastes generated as a result of onsite activities or by treatment systems must meet LDR requirements.	Applicable
Hazardous Waste Generator Standards	USEPA/DTSC	40 CFR 262 / 22 CCR 66262	Requirements for generation, onsite management, and offsite transportation of RCRA and non-RCRA hazardous waste.	Waste generated during site activities must be managed in accordance with these standards if determined to be a hazardous waste.	Applicable
Hazardous Waste Identification	DTSC	22 CCR 66261	Sets standards for classification of RCRA hazardous wastes and California hazardous wastes and requirements for recycling and reclamation of RCRA and California hazardous wastes.	Wastes generated during site activities (including residues from treatment operations) must be evaluated to determine if hazardous.	Relevant and Appropriate
Land Use Controls	DTSC	22 CCR 67391.1	Provides the requirements for land use covenants when contaminants will remain on land at levels that are not suitable for unrestricted use of land.		Relevant and Appropriate
Land Use Controls	DTSC	CHSC 25222.1 and 25355.5	Authorizes DTSC to enter into an agreement with a land owner to restrict the present and future use of land.		Relevant and Appropriate
OSHA Excavation Standards	Cal/OSHA	29 CFR 1926/8 CCR 1540 and 341	Includes requirements for benching, sloping or shoring of excavations to prevent cave-ins; entry into any excavation deeper than 5 feet requires a permit.	Applicable to excavation activities.	Applicable
OSHA Hazardous Waste Operations and Emergency Response	Cal/OSHA	29 CFR 1910.120/8 CCR 5192	Worker training and health and safety plan requirements for site cleanup operations.	Applicable to onsite workers engaged in sites dealing with the treatment, storage, and disposal (TSD) of hazardous waste.	Applicable
OSHA Head, Eye, Face, and Hearing Protection Standards	Cal/OSHA	29 CFR 1926 Subpart E/8 CCR 3381, 3382, 5144, 5162, and 5097	Specific details regarding personal protective equipment and noise levels for hearing protection for workers.	Applicable to activities where employees may encounter hazards requiring the use of personal protective equipment or hearing protection.	Relevant and Appropriate
OSHA Heavy Equipment Operation Standards	Cal/OSHA	29 CFR 1926/8 CCR 1590 and 3649	Requirements for safe operation of haulage, earthmoving, industrial trucks and tractors.	Applicable to activities involving the use of heavy equipment.	Applicable
OSHA Permissible Exposure Limits	Cal-OSHA	29 CFR 1910.1001/8 CCR 5155	Requirements for controlling employee exposure to airborne contamination during work operations; sets PELs for specified contaminants and workplace monitoring requirements.	If concentrations of any specified contaminants in air exceed the PEL, control measures (administrative or engineering controls, or PPE) will be required. This applies to dust-producing actions or actions that may encourage offgassing of VOCs.	Applicable
OSHA Worker Protection Programs	Cal/OSHA	29 CFR 1910.1200/8 CCR 5194 and 3203	Written program requirements include hazard communication and an illness and injury prevention plan (IIPP)	Employees who may be exposed to hazardous substances must be informed of those hazards in accordance with hazard communication requirements. All employers must develop an IIPP for providing information on safe and healthy work practices.	Applicable
OSHA Worker Vinyl Chloride Exposure Standard	Cal-OSHA	29 CFR 1910.1017/8 CCR 5210	Specific standard for occupational exposure to vinyl chloride; includes requirements for monitoring, protective equipment and decontamination. The PEL for vinyl chloride is currently 1 ppm for an 8-hour TWA.	If concentrations of vinyl chloride in air exceed the PEL, control measures will be required. This applies to actions that may encourage offgassing of VOCs.	Applicable
Porter-Cologne Water Quality Control Act	RWQCB	23 CCR Chapter 15, 2550.2, 2550.3, 2550.4, 2550.5, 2550.6	Establishes water quality protection standards consisting of COCs, concentration limits, point of compliance and monitoring points.	SWRCB Resolution 92-49 requires actions to cleanup discharge of waste to comply with Chapter 15.	Applicable
Porter-Cologne Water Quality Control Act	RWQCB	23 CCR 2511(d)	Specifies that wastes removed from the immediate place of release must be discharged in accordance with the classification and siting requirements of Chapter 15. Waste contained or left in place must comply with Chapter 15 to the extent feasible.	Applies to actions taken by or at the direction of public agencies to clean up unintentional or unauthorized discharges of waste to the environment.	Relevant and Appropriate

Table A-5
Potential Action-Specific ARARs
Casmalia Resources Superfund Site
Casmalia, CA

Action-Specific ARAR	Agency	Reference	Description	Comment	ARAR or To Be Considered
Porter-Cologne Water Quality Control Act	RWQCB	23 CCR 2550.10	Requires implementation of corrective action measures that ensure that cleanup levels are achieved throughout the zone affected by the release by removing the waste constituents or treating them in place. Source control may be required. Also requires monitoring to determine the effectiveness of the corrective actions.	Applies to cleanup activities in order to protect groundwater.	Applicable
Porter-Cologne Water Quality Control Act	RWQCB	23 CCR 2550.4	Cleanup levels must be set at background concentration levels, or, if background levels are not technologically and economically feasible, then at the lowest levels that are economically and technologically achievable. Specific factors must be considered in setting cleanup levels above background levels. Cleanup levels above background levels shall be evaluated every 5 years. If the actual concentration of a constituent is lower than its associated cleanup level, the cleanup level shall be lowered to reflect existing water quality.	Applies in setting cleanup levels for groundwater, surface water, and the unsaturated zone for all discharges of waste to land.	Applicable
Porter-Cologne Water Quality Control Act	RWQCB	23 CCR 2550.6	Establishes compliance period for monitoring for waste management unit. Requires monitoring for compliance with remedial action objectives for 3 years from the date of achieving cleanup levels.	Applies to water quality monitoring for new waste management units and for corrective action activities.	Relevant and Appropriate
Porter-Cologne Water Quality Control Act	RWQCB	23 CCR 2550.7	Requires general soil, surface water, and groundwater monitoring.	Applies to all areas at which waste has been discharged to land.	Applicable
Porter-Cologne Water Quality Control Act	RWQCB	23 CCR 2550.9	Requires an assessment of the nature and extent of the release, including a determination of the spatial distribution and concentration of each constituent.	Applies to areas at which monitoring results show statistically significant evidence of a release.	Applicable
Respiratory Protection Standard	USEPA	29 CFR Part 1910.134	Establishes standards and guidelines for respiratory protection.	Relevant and appropriate for establishing the level of respiratory protection necessary for remedial activities.	Relevant and Appropriate
Safe Drinking Water and Toxic Enforcement Act (Prop. 65)	Health and Welfare Agency	California Health and Safety Code, Division 20	Warning requirements/discharge prohibitions to water or land of any chemical listed by state as carcinogen or reproductive hazard, where chemical will pass through a source of drinking water.	Chemicals and applicable regulatory levels are listed in 22 CCR 12000, et seq.	Relevant and Appropriate
Porter-Cologne Water Quality Control Act	RWQCB	State Water Resources Control Board Resolution No. 92-49 (As amended October 2, 1996)	Resolution No. 92-49 directs the RWQCBs to ensure that water affected by an unauthorized release attains either background water quality or the best water quality which is reasonable if background water quality cannot be restored (SWRCB Resolution No. 92-49, III.G). Any alternative level of water quality less stringent than background must be consistent with the maximum benefit to the people of the state, not unreasonably affect current and probable future beneficial use of affected water, and not result in water quality less than that prescribed in the water quality control plan for the basin within which the site is located.	Applicable to discharges of waste to waters, including discharges that may affect surface waters or groundwaters.	Applicable
State Water Resources Control Board Non-Degradation Policy	SWRCB	Resolution 68-16 (as contained in the RWQCB's Water Quality Control Plan)	SWRCB policy requiring maintenance of existing water quality unless demonstrated that the change is beneficial, will not unreasonably affect present or potential uses, and will not result in water quality of lower quality than prescribed by other state policies.	Applicable to discharges of waste to waters, including discharges that may affect surface waters or groundwaters.	Relevant and Appropriate
Compliance with Clean Water Act	SWRCB	Cal. Water Code § 13370 et seq.	Requires compliance with the federal Clean Water Act requirements for point source surface water discharges. This provision will be evaluated as a potential ARAR during the Feasibility Study (FS) if any of the remedial alternatives being evaluated will involve point source discharges to surface waters.		Relevant and Appropriate

Table A-5
Potential Action-Specific ARARs
Casmalia Resources Superfund Site
Casmalia, CA

Action-Specific ARAR	Agency	Reference	Description	Comment	ARAR or To Be Considered
State Water Resources Control Board (SWRCB) "Statement of Policy with Respect to Maintaining High Quality of Waters in California" (Anti-Degradation Policy)	SWRCB	SWRCB Resolution No. 68-16, set forth at Central Coast Regional Water Quality Control Board (RWQCB) Water Quality Control Plan (Basin Plan), Appendix A-2	Policy requiring maintenance of existing water quality unless demonstrated that the change is consistent with maximum benefit to the people of the State, will not unreasonably affect present or anticipated beneficial uses, and will not result in water quality less than what is prescribed by other state policies.		Relevant and appropriate
SWRCB "Sources of Drinking Water" Policy	SWRCB	SWRCB Resolution No. 88 63, set forth at Central Coast RWQCB Basin Plan, Appendix A-9	Statement of policy that surface waters and groundwaters of the State are considered to be suitable, or potentially suitable, for municipal or domestic water supply except under specified circumstances.		Relevant and appropriate
SWRCB Policies and Procedures for Investigation of and Cleanup and Abatement of Discharges Under Water Code Section 13304	SWRCB	SWRCB Resolution No. 92 49	Specifies policies and procedures for RWQCB investigation, cleanup and abatement of discharges under Water Code Section 13304. Also includes "containment zone" policy, which allows regional board to authorize cleanups that do not achieve water quality objectives as long as contaminants remain contained within specified boundary.		Relevant and Appropriate
Industrial or Site-Specific NPDES Permits	RWQCB	SWRCB Order 97-03-DWQ	An individual permit is tailored for a specific discharge. The State or Regional Water Board issues a permit for that particular discharge based on information (type of activity, nature of discharge, receiving water quality, etc.) contained in the application.		Relevant and appropriate
General Permit for Discharges of Storm Water Associated with Construction Activities	RWQCB	SWRCB Order No. 99-08-DWQ	Sets forth NPDES requirements for stormwater runoff from certain construction activities that disturb land equal to one (1) acre or more. Includes substantive requirements for developing and implementing a stormwater pollution prevention plan and performing monitoring of stormwater discharges. Evaluation of this Order as a potential ARAR during the FS will include an evaluation of whether stormwater discharges from site activities, if any, are covered by an existing NPDES permit issued for the site.		Relevant and appropriate
General Permit for Discharges of Storm Water Associated with Industrial Activities	RWQCB	SWRCB Order No. 97-03-DWQ	Sets forth NPDES requirements for stormwater runoff from certain industrial activities, excluding construction activities. Evaluation of this Order as a potential ARAR during the FS will include an evaluation of whether stormwater discharges from site activities, if any, are covered by an existing NPDES permit issued for the site.		Relevant and appropriate
Regional Screening Levels (RSLs) calculator for soil, sediment, surface water, groundwater, and air	EPA		RSLs calculator for soil, sediment, surface water, groundwater, and air		Relevant and Appropriate
ESA and Migratory Bird Treaty Act		Section 9 of the Endangered Species Act; Section 7 of the Endangered Species Act; and the Migratory Bird Treaty Act	Section 9 of the Endangered Species Act, describing prohibitions against take; Section 7 of the Endangered Species Act, describing the mandate for Interagency Consultation; and the Migratory Bird Treaty Act, describing protections for migratory birds.		Applicable
Permit Applicability	Santa Barbara County APCD	Rule 201	Provides for the issuance of permits when equipment may cause the emission of air contaminants. CERCLA Section 121(e)(1) provides that no permit is required for response actions conducted entirely onsite. Accordingly, Rule 201 will be evaluated as an ARAR only for any offsite action, subject to any further exemption that may be set forth in Rule 202.		Relevant and Appropriate

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Potential Action-Specific ARARs
Casmalia Resources Superfund Site
Casmalia, CA

Action-Specific ARAR	Agency	Reference	Description	Comment	ARAR or To Be Considered
Permit Exemptions	Santa Barbara County APCD	Rule 202	Sets forth exemptions to the permitting requirements of Rule 201, including exemptions for temporary equipment, internal combustion engines, numerous other categories of equipment and operations, emissions below specified thresholds, and under other circumstances as specified.		Relevant and Appropriate
Visible Emissions	Santa Barbara County APCD	Rule 302	Establishes limits on visible emissions of air contaminants into the atmosphere.		Relevant and Appropriate
Nuisance	Santa Barbara County APCD	Rule 303	Prohibits discharges of air contaminants or other material in violation of Health & Safety Code § 41700 in quantities that cause injury, detriment, nuisance, or annoyance to any considerable number of persons or to the public; or that endanger the comfort, repose, health or safety of such persons or the public; or that cause or have a natural tendency to cause injury or damage to business or property.		Relevant and Appropriate
Particulate Matter	Santa Barbara County APCD	Rule 304	Prohibits discharges into the atmosphere of particulate matter in excess of 0.3 grain per cubic foot.		Relevant and Appropriate
New Source Review	Santa Barbara County APCD	Regulation VIII	This regulation includes requirements that new sources of air emissions must meet. The rules in Regulation VIII will be evaluated as potential ARARs during the FS if any of the remedial alternatives being evaluated will involve new sources of air emissions.		Relevant and Appropriate
Construction Quality Assurance	California Hazardous Waste Control Act / DTSC	22 CCR § 66265.19	Provides standards for Construction Quality Assurance Programs.		Relevant and Appropriate
Seismic and Precipitation Design Standards	California Hazardous Waste Control Act / DTSC	22 CCR § 66265.25	Provides that all cover systems required by Chapter 15 (*i.e.* , § 66265.1 et seq.) and all containment and control features that will remain after closure must be designed, constructed and maintained to withstand the maximum credible earthquake without any decrease in the level of public health and environmental protection afforded by the original design.		Relevant and Appropriate
Water Quality Monitoring and Response/Detection Monitoring	California Hazardous Waste Control Act / DTSC	22 CCR § 66265.91 and § 66265.98	Section 66265.91 identifies water quality monitoring and response programs for regulated units at hazardous waste facilities and requires owner/operators to develop a water quality sampling and analysis plan. Section 66265.98 requires owner/operators to establish a detection monitoring program.		Relevant and Appropriate
General Closure Standard	California Hazardous Waste Control Act / DTSC	22 CCR § 66265.110	Provides that Sections 66265.111-.115 (closure) and Sections 66265.116-.120 (post-closure) apply to owners and operators of all hazardous waste facilities. (Sections identified as potential ARARs below).		Relevant and Appropriate
Landfill Closure Construction	California Hazardous Waste Control Act / DTSC	22 CCR § 66265.111	Provides that the owner or operator must close the facility in a manner that: - Minimizes the need for further maintenance, and - Controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated rainfall or run-off, or waste decomposition products to the groundwater, surface water or to the atmosphere.		Relevant and Appropriate

Table A-5
Potential Action-Specific ARARs
Casmalia Resources Superfund Site
Casmalia, CA

Action-Specific ARAR	Agency	Reference	Description	Comment	ARAR or To Be Considered
Surface Impoundment Closure and Post-Closure Care Standard	California Hazardous Waste Control Act / DTSC	22 CCR § 66265.228	(a) At closure, the owner or operator shall: (1) remove or decontaminate all waste residues, contaminated containment system components (liners, etc.), contaminated subsoils, and structures and equipment contaminated with waste and leachate, and manage them as hazardous waste unless Section 66261.3(d) applies, or (2) close the impoundment and provide post-closure care as specified. (b) Sets forth requirements for maintaining and protecting the final cover and maintaining and monitoring groundwater monitoring systems and leak detection systems when wastes, waste materials or contaminated material will remain after closure.		Relevant and Appropriate
Waste Pile Closure and Post-Closure Care Standard	California Hazardous Waste Control Act / DTSC	22 CCR § 66265.258	(a) At closure, the owner or operator shall remove or decontaminate all waste residues, contaminated containment system components (liners, etc.), contaminated subsoils, and structures and equipment contaminated with waste and leachate, and manage them as hazardous waste unless Section 66261.3(d) applies, or (b) if after reasonable efforts to remove and decontaminate not all subsoils can be practicably removed or decontaminated, close facility and perform post-closure care as specified.		Relevant and Appropriate
Tank System Closure and Post-Closure Care Standard	California Hazardous Waste Control Act / DTSC	22 CCR § 66265.197	(a) At closure of a tank system, the owner or operator shall remove or decontaminate all waste residues, contaminated containment system components (liners, etc.), contaminated soils, and structures and equipment contaminated with waste and leachate, and manage them as hazardous waste unless Section 66261.3(d) applies, or (b) if not all contaminated soils can be practicably removed or decontaminated, close the tank system and perform post-closure care as specified.		Relevant and Appropriate
Standards for Tanks Not Regulated under Hazardous Waste Facility Permit or Interim Status	California Hazardous Waste Control Act / DTSC	22 CCR § 67383.1 -.5	Provide minimum standards for the management of all underground and aboveground tank systems that held hazardous waste or hazardous materials, and are to be disposed, reclaimed or closed in place, except as provided in 22 CCR Section 67383.1 (b), (c) and (d). These standards do not apply to tank systems regulated under a hazardous waste facility permit, other than a permit by rule, or to tank systems regulated under a grant of interim status.		Relevant and Appropriate

Notes:

ARAR = Applicable or relevant and appropriate requirement
SBAPCD = Santa Barbara Air Pollution Control District
CalEPA = California Environmental Protection Agency
CCR = California Code of Regulations
CEQA = California Environmental Quality Act
CFR = Code of Federal Regulations
CHSC = California Health and Safety Code
DOT = Department of Transportation
DTSC = Department of Toxic Substances Control
LDR = Land Disposal Restrictions
NPDES = National Pollutant Discharge Elimination System
OSHA = Occupational Safety and Health Administration
PEL = Permissible exposure limit
PPE = Personal protective equipment
RCRA = Resource Conservation and Recovery Act
RWQCB = Regional Water Quality Control Board
SWRCB = State Water Resources Control Board
TSD = Treatment, storage and disposal
USEPA = United States Environmental Protection Agency

Table A-6
Groundwater Concentrations Relative to Aqueous Solubility
Detections Exceeding One Percent of Solubility - Fall 2004 and Spring 2005 RI Sampling Events
Casmalia Resources Superfund Site
Casmalia, CA

Sample Location	Chemical	Aqueous Solubility (µg/L) [b]	Date Sample	Concentration (µg/L)	Percent of Solubility
DNAPL					
Gallery Well	1,1,1-Trichloroethane	1,290,000	11/15/2004	74,000	5.7
Gallery Well	1,1,1-Trichloroethane	1,290,000	12/15/2004	17,000	1.3
Gallery Well	1,1,1-Trichloroethane	1,290,000	4/13/2005	68,000	5.3
Gallery Well	1,2-Dichlorobenzene	80,000	11/15/2004	1,400	1.8
Gallery Well	1,2-Dichlorobenzene	80,000	12/15/2004	3,100	3.9
Gallery Well	1,2-Dichlorobenzene	80,000	4/13/2005	1,400	1.8
Gallery Well	**1,2-Dichlorobenzene**	80,000	**4/13/2005**	**27,000**	**33.8**
Gallery Well	Freon 113	170,000	11/15/2004	12,000	7.1
Gallery Well	Freon 113	170,000	4/13/2005	14,000	8.2
Gallery Well	Methyl Isobutyl Ketone	19,000,000	4/13/2005	300,000	1.6
Gallery Well	Methylene Chloride	13,000,000	11/15/2004	820,000	6.3
Gallery Well	Methylene Chloride	13,000,000	4/13/2005	720,000	5.5
Gallery Well	**Tetrachloroethene**	206,000	**11/15/2004**	**35,000**	**17.0**
Gallery Well	**Tetrachloroethene**	206,000	**12/15/2004**	**38,000**	**18.4**
Gallery Well	**Tetrachloroethene**	206,000	**4/13/2005**	**29,000**	**14.1**
Gallery Well	Trichloroethene	1,280,000	11/15/2004	17,000	1.3
Gallery Well	Trichloroethene	1,280,000	4/13/2005	16,000	1.3
PSCT-1	Tetrachloroethene	206,000	11/15/2004	2,400	1.2
RG-3B	1,2-Dichlorobenzene	80,000	3/2/2005	1,600	2.0
RG-3B	1,2-Dichlorobenzene	80,000	4/18/2005	1,400	1.8
RG-3B	Freon 113	170,000	3/2/2005	6,300	3.7
RG-3B	Freon 113	170,000	4/18/2005	4,500	2.6
RG-3B	Tetrachloroethene	206,000	3/2/2005	20,000	9.7
RG-3B	Tetrachloroethene	206,000	4/18/2005	16,000	7.8
RG-9B	Freon 113	170,000	10/27/2004	2,500	1.5
RG-9B	Freon 113	170,000	3/29/2005	5,000	2.9
RGPZ-5B	1,1,1-Trichloroethane	1,290,000	3/3/2005	28,000	2.2
RGPZ-5B	1,1,1-Trichloroethane	1,290,000	4/18/2005	23,000	1.8
RGPZ-5B	1,2,4-Trimethylbenzene	57,000	3/3/2005	3,000	5.3
RGPZ-5B	1,2-Dichlorobenzene	80,000	3/3/2005	5,000	6.3
RGPZ-5B	1,2-Dichlorobenzene	80,000	4/18/2005	890	1.1
RGPZ-5B	Freon 113	170,000	3/3/2005	7,200	4.2
RGPZ-5B	Freon 113	170,000	4/18/2005	4,900	2.9
RGPZ-5B	Methylene Chloride	13,000,000	3/3/2005	650,000	5.0
RGPZ-5B	Methylene Chloride	13,000,000	4/18/2005	500,000	3.8
RGPZ-5B	**Tetrachloroethene**	206,000	**3/3/2005**	**27,000**	**13.1**
RGPZ-5B	Tetrachloroethene	206,000	4/18/2005	12,000	5.8
RGPZ-6B	1,1,1-Trichloroethane	1,290,000	3/2/2005	13,000	1.0
RGPZ-6B	**1,2,4-Trimethylbenzene**	57,000	**3/2/2005**	**6,600**	**11.6**
RGPZ-6B	1,2-Dichlorobenzene	80,000	3/2/2005	2,900	3.6
RGPZ-6B	1,2-Dichlorobenzene	80,000	4/18/2005	1,900	2.4
RGPZ-6B	Freon 113	170,000	3/2/2005	11,000	6.5
RGPZ-6B	Freon 113	170,000	4/18/2005	7,200	4.2
RGPZ-6B	**Tetrachloroethene**	206,000	**3/2/2005**	**28,000**	**13.6**
RGPZ-6B	Tetrachloroethene	206,000	4/18/2005	16,000	7.8
RGPZ-6B	Trichloroethene	1,280,000	3/2/2005	19,000	1.5

Table A-6
Groundwater Concentrations Relative to Aqueous Solubility
Detections Exceeding One Percent of Solubility - Fall 2004 and Spring 2005 RI Sampling Events
Casmalia Resources Superfund Site
Casmalia, CA

Sample Location	Chemical	Aqueous Solubility (µg/L) [b]	Date Sample	Concentration (µg/L)	Percent of Solubility
RGPZ-6B	Trichloroethene	1,280,000	4/18/2005	13,000	1.0
RIMW-3	1,2-Dichlorobenzene	80,000	3/3/2005	1,400	1.8
RIMW-3	1,2-Dichlorobenzene	80,000	4/18/2005	1,700	2.1
RIMW-3	Freon 113	170,000	3/3/2005	4,000	2.4
RIMW-3	Freon 113	170,000	4/18/2005	2,900	1.7
RIMW-3	Tetrachloroethene	206,000	3/3/2005	9,800	4.8
RIMW-3	Tetrachloroethene	206,000	4/18/2005	9,800	4.8
RIMW-7	Freon 113	170,000	1/18/2005	8,100	4.8
RIMW-7	Freon 113	170,000	4/12/2005	7,700	4.5
RIMW-7	Tetrachloroethene	206,000	1/18/2005	2,800	1.4
RIMW-7	Tetrachloroethene	206,000	4/12/2005	2,300	1.1
RIMW-7	Trichloroethene	1,280,000	1/18/2005	19,000	1.5
RIMW-7	Trichloroethene	1,280,000	4/12/2005	25,000	2.0
RIMW-8	Freon 113	170,000	1/20/2005	11,000	6.5
RIMW-8	**Freon 113**	170,000	**4/7/2005**	**48,000**	**28.2**
RIMW-8	Tetrachloroethene	206,000	4/7/2005	2,400	1.2
RIPZ-8	1,1,1-Trichloroethane	1,290,000	4/18/2005	19,000	1.5
RIPZ-8	Freon 113	170,000	3/3/2005	3,100	1.8
RIPZ-8	Freon 113	170,000	4/18/2005	2,800	1.6
RIPZ-8	Tetrachloroethene	206,000	3/3/2005	5,800	2.8
RIPZ-8	Tetrachloroethene	206,000	4/18/2005	8,100	3.9
Sump 9B	1,1,1-Trichloroethane	1,290,000	4/14/2005	48,000	3.7
Sump 9B	1,2,4-Trimethylbenzene	57,000	4/14/2005	2,000	3.5
Sump 9B	**1,2,4-Trimethylbenzene**	57,000	**4/14/2005**	**72,000**	**126.3**
Sump 9B	1,2-Dichlorobenzene	80,000	11/8/2004	850	1.1
Sump 9B	1,2-Dichlorobenzene	80,000	4/14/2005	2,700	3.4
Sump 9B	**Freon 113**	170,000	**4/14/2005**	**17,000**	**10.0**
Sump 9B	Methylene Chloride	13,000,000	11/8/2004	210,000	1.6
Sump 9B	Methylene Chloride	13,000,000	4/14/2005	220,000	1.7
Sump 9B	Tetrachloroethene	206,000	11/8/2004	8,600	4.2
Sump 9B	**Tetrachloroethene**	206,000	**4/14/2005**	**43,000**	**20.9**
Sump 9B	Trichloroethene	1,280,000	4/14/2005	19,000	1.5
SW-31	Freon 113	170,000	4/5/2005	2,000	1.2
WP-8S	Freon 113	170,000	10/18/2004	7,800	4.6
WP-8S	Freon 113	170,000	4/4/2005	9,700	5.7
LNAPL					
Gallery Well	Ethylbenzene	169,000	11/15/2004	5,600	3.3
Gallery Well	Ethylbenzene	169,000	12/15/2004	7,900	4.7
Gallery Well	Ethylbenzene	169,000	4/13/2005	5,900	3.5
Gallery Well	Toluene	526,000	11/15/2004	31,000	5.9
Gallery Well	Toluene	526,000	12/15/2004	23,000	4.4
Gallery Well	Toluene	526,000	4/13/2005	32,000	6.1
Gallery Well	**Xylenes**	106,000	**11/15/2004**	**22,000**	**20.8**
Gallery Well	**Xylenes**	106,000	**12/15/2004**	**35,000**	**33.0**
Gallery Well	**Xylenes**	106,000	**4/13/2005**	**22,000**	**20.8**
RG-3B	Ethylbenzene	169,000	3/2/2005	5,400	3.2
RG-3B	Ethylbenzene	169,000	4/18/2005	4,600	2.7

Table A-6
Groundwater Concentrations Relative to Aqueous Solubility
Detections Exceeding One Percent of Solubility - Fall 2004 and Spring 2005 RI Sampling Events
Casmalia Resources Superfund Site
Casmalia, CA

Sample Location	Chemical	Aqueous Solubility (µg/L) [b]	Date Sample	Concentration (µg/L)	Percent of Solubility
RG-3B	Toluene	526,000	3/2/2005	17,000	3.2
RG-3B	Toluene	526,000	4/18/2005	16,000	3.0
RG-3B	**Xylenes**	106,000	**3/2/2005**	**22,000**	**20.8**
RG-3B	**Xylenes**	106,000	**4/18/2005**	**20,000**	**18.9**
RGPZ-5B	Ethylbenzene	169,000	3/3/2005	14,000	8.3
RGPZ-5B	Ethylbenzene	169,000	4/18/2005	5,600	3.3
RGPZ-5B	Toluene	526,000	3/3/2005	42,000	8.0
RGPZ-5B	Toluene	526,000	4/18/2005	31,000	5.9
RGPZ-5B	**Xylenes**	106,000	**3/3/2005**	**56,000**	**52.8**
RGPZ-5B	**Xylenes**	106,000	**4/18/2005**	**21,000**	**19.8**
RGPZ-6B	Ethylbenzene	169,000	3/2/2005	7,900	4.7
RGPZ-6B	Ethylbenzene	169,000	4/18/2005	4,800	2.8
RGPZ-6B	Toluene	526,000	3/2/2005	23,000	4.4
RGPZ-6B	Toluene	526,000	4/18/2005	17,000	3.2
RGPZ-6B	**Xylenes**	106,000	**3/2/2005**	**32,000**	**30.2**
RGPZ-6B	**Xylenes**	106,000	**4/18/2005**	**20,000**	**18.9**
RGPZ-6D	Xylenes	106,000	11/5/2004	1,100	1.0
RIMW-3	Ethylbenzene	169,000	3/3/2005	3,300	2.0
RIMW-3	Ethylbenzene	169,000	4/18/2005	3,500	2.1
RIMW-3	Toluene	526,000	3/3/2005	7,500	1.4
RIMW-3	Toluene	526,000	4/18/2005	6,200	1.2
RIMW-3	**Xylenes**	106,000	**3/3/2005**	**13,000**	**12.3**
RIMW-3	**Xylenes**	106,000	**4/18/2005**	**14,000**	**13.2**
RIMW-7	Xylenes	106,000	1/18/2005	4,500	4.2
RIMW-7	Xylenes	106,000	4/12/2005	5,200	4.9
RIPZ-8	Ethylbenzene	169,000	3/3/2005	3,800	2.2
RIPZ-8	Ethylbenzene	169,000	4/18/2005	6,400	3.8
RIPZ-8	Toluene	526,000	3/3/2005	8,700	1.7
RIPZ-8	Toluene	526,000	4/18/2005	15,000	2.9
RIPZ-8	**Xylenes**	106,000	**3/3/2005**	**14,000**	**13.2**
RIPZ-8	**Xylenes**	106,000	**4/18/2005**	**25,000**	**23.6**
Sump 9B	Ethylbenzene	169,000	11/8/2004	5,000	3.0
Sump 9B	**Ethylbenzene**	169,000	**4/14/2005**	**17,000**	**10.1**
Sump 9B	Toluene	526,000	11/8/2004	25,000	4.8
Sump 9B	**Toluene**	526,000	**4/14/2005**	**62,000**	**11.8**
Sump 9B	**Xylenes**	106,000	**11/8/2004**	**20,000**	**18.9**
Sump 9B	**Xylenes**	106,000	**4/14/2005**	**65,000**	**61.3**

Notes:
[a] All concentrations in micrograms per liter (µg/L).
[b] Water solubility compiled from Risk Assessment Information System (RAIS; http://risk.lsd.ornl.gov).
Wells with concentrations exceeding ten percent of solubility in bold.

Table A-7
Site Wells and Piezometers Known to Contain NAPL or Potentially Impacted by NAPL
Fall 2004 and Spring 2005 Remedial Investigation Sampling Events
Casmalia Resources Superfund Site
Casmalia, CA

Well/Piezometer	NAPL TYPE (D,L) [1]
Wells Known to Have NAPL from Gauged Measurements	
Sump 9B Companion Well	L
Sump 9B-PZ-B	L
Sump 9B-PZ-C	L
Gallery Well	D,L
GW-PZ-E2	L
GW-PZ-E3	L
GW-PZ-W	L
RG-3B	L
RG-PZ-7C	D
RG-PZ-7D	D
RIPZ-13	D,L
RIPZ-23	L
RIPZ-24	L
RIPZ-25	L
Wells Potentially Impacted by NAPL Based on Dissolved Chemistry [2]	
Gallery Well	D,L
PSCT-1	D
RG-3B	D,L
RG-9B	D
RGPZ-5B	D,L
RGPZ-6B	D,L
RGPZ-6D	L
RIMW-3	D,L
RIMW-7	D,L
RIMW-8	D
RIPZ-8	D,L
Sump 9B	D,L
SW-31	D
WP-8S	D
Potential Additional NAPL Wells Based on Core Observations During RI Drilling	
RIMW-3	L
RIMW-7	L
RIPZ-8	L
RIPZ-15	L
RIPZ-26	L
Potential Additional NAPL Wells Based on Observations During Groundwater Sampling [3]	
RGPZ-5B	L
RGPZ-6B	L
RIPZ-8	L

Notes:
1 - D - DNAPL; L - LNAPL
2 - Based on Fall 2004 and Spring 2005 water quality sampling results.
3 - Based on purging observations during Fall 2004 water quality sampling.

Table A-8
Waste Management Unit Chronology

Waste Management Unit		72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02
Landfills	Former RCRA	-	-	-	-	-	-	-	-	-	-	GR	GR/W	W	V	V	V	V	R	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	PCB	-	-	-	-	-	-	GR/W	W	W	W	W	W	W	W	W	R/V	GR	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	P/S	-	-	-	-	-	-	GR/E	E/W	W	W	W	W	W	W	W	W	W/P	P	P	P	V	-	-	-	-	-	B	C	-	C	-
	Heavy Metals	-	-	-	-	-	-	GR	E/W	W	W	W	W	W	W	W	W	W/P	P	P	P	V	-	-	-	-	-	-	-	-	C	-
	Caustic/Cyanide	-	-	-	-	-	-	E	E/W	W	W	W	W	W	W	W	W	W/P	P	P	P	V	-	-	-	-	-	-	-	-	B	C
	Acids	-	-	-	-	-	-	E	E/W	W	W	W	W	W	W	W	W	W/P	P	P	P	V	-	-	-	-	-	-	-	-	-	C
Storage/ Evaporation Ponds	Pond 1	-	-	E	E	?	E	E/W	W	W	W	W	W	W	W	W	W	R	R/GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond 2	-	-	L	L	?	W	W	W	W	W	W	W/E	W	W	W	W	W/R	R/GR	GR	GR	GR/V	SW	SW	SW	SW	SW	SW	SW	SW	V	V
	Pond 3	-	-	L	L	?	E/W	W	W	W	W	W	W	W	W	W	W	W/R	R/GR	GR	GR	GR									SW	SW
	Pond 4	-	-	-	E/L	?	E	W	W	W	W	W	W	W	W	W	W	R	R/GR	GR	GR	SW										
	Pond 5	-	-	-	-	-	-	-	E	E	W	W	W	W	W	W	W	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pond 6	-	-	-	-	-	-	E/W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pond 7	-	-	-	-	-	-	E/W	W	W	W	W	W	W	R	(converted to Pads 9A and 9B)				-	-	-	-	-	-	-	-	-	-	-	-	-
	Pond 8	-	-	-	-	-	-	W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pond 9	-	-	-	-	-	-	E/W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
	Pond 10	-	-	L	L	?	W	W	W	W	W	W	W	W	W	W	W	W/R	GR	GR	GR											
	Pond 11	-	-	-	-	-	E/W	E/W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR											
	Pond 12	-	-	-	-	-	E	E	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	GR										
	Pond 13	E	E	L	L	?	E/W	W	W	W	W	W	W	W	W	W	W	R	R	GR	GR	GR/V	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
	Pond 14	-	-	-	L	?	E	W	W	W	W	W	W	W	W/R	L	L	R/GR	R	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pond 15	-	-	-	-	-	E	E	V	V	V/E	E	E/W	W	W	W	W	R	GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond 16	-	-	W	W	W	W	W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond 17	-	-	W	W	W	W	W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond 18	-	-	L	L	L	L	L	W	W	E/R	W	W	W	W	W	W	R	GR	GR	GR	TL	TL	TL	TL	TL	TL	TL	TL	TL	TL	TL
	Pond 19	-	-	-	-	-	-	?	E/W	W	W	W	W	W	W	W	W/B	W/R	GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond 20	-	-	-	-	-	-	-	-	-	E	W	W	W	W	W	W	R/GR	GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond 21	-	-	-	-	-	-	-	GR	GR	W	W	W	W	(converted to Pad 10E)					-	-	-	-	-	-	-	-	-	-	-	-	-
	Pond 22	-	-	-	-	-	-	-	-	-	-	-	E/W	W	W	W	W	R	R	R	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond 23	-	-	-	-	-	-	-	-	-	-	-	E	E/W	W	W	W	R/GR	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pond A-1	-	-	-	-	-	-	-	-	-	E	W	W	W	W	W	W	R	R	R	GR											
	Pond A-2	-	-	-	-	-	-	-	-	-	E	W	W	W	W	W	W	R	R	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
	Pond A-3	-	-	-	-	-	-	-	-	-	E	W	W	W	W	W	W	W/R	R													
	Pond A-4	-	-	-	-	-	-	-	-	-	E	W	W	W	W	W	W	R	R	GR	GR											
	Pond A-5	-	-	-	-	-	-	-	-	-	E	W	W	W	W	W	W	R	R/SW	SW	SW	SW	SW	SW	TL	TL	TL	TL	TL	TL	TL	TL
	Pond A-6	-	-	-	-	-	-	-	-	-	E	GR	W	W	W	W	W	R	GR	GR	GR	GR	GR	V	-	-	-	-	-	-	-	-
	Pond A	-	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	R	R/GR	GR	GR	GR	-	GR/V	-	-	-	-	-	-	-	-
	Pond B	-	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W/R	GR	GR	GR	GR	-	GR/V	-	-	-	-	-	-	-	-
	Pond C	-	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	R	GR	R/GR	R/GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond D	-	-	W	W	W	W	W	W	W	W	W	W	W	W	W	W/R	R	R/GR	R/GR	R/GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond E	-	-	W	W	W	W	W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond J	-	-	W	W	W	W	W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond L	-	-	E/W	W	W	W	W	W	W	W	W	W	W	W	W	W/R	R	GR	R/GR	R/GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond M	-	-	-	W	W	W	W	E/W	W	W	W	W	W	W	W	W	R	R/GR	GR	GR	GR	-	GR	-	-	GR	V	-	-	-	
	Pond P	-	-	-	-	-	E	W	W	W	W	W	W	W	W/R	L	L/R	L/R	R	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pond R	-	-	-	-	-	W	W	W	W	W/GR	W	E	R/GR	GR	GR/L	L	R	GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond S	-	-	-	W	?	W	W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	GR	-	V	-	-	-	-	-	-	-	-
	Pond T	-	-	-	-	?	W	W	W	W/E	E	E	E	E	GR	GR/W	GR/W	R	R/GR	GR	GR	GR	-	GR	-	-	GR	V	-	-	-	
	Pond V	-	-	-	-	-	W	W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	GR	-	V	-	-	-	-	-	-	-	-
	WCCB (Pond 43)	-	-	-	-	-	-	-	-	-	-	-	-	E/W	W	W	W	W	R	GR	GR	GR	-	GR/V	-	-	-	-	-	-	-	-

Table A-8
Waste Management Unit Chronology

Waste Management Unit		72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02
Evaporation	Pad 1A	-	-	-	-	-	-	-	-	-	E	E	L	L	GR	GR	GR/V	R	R/GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
Pads	Pad 4A	-	-	W	W	W	W	W/V	V	W	W	V/W	R/GR	GR	GR	GR	V/W	R	R	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pad 7A	-	-	-	-	-	-	-	-	-	-	-	-	-	W	W	W	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pad 8A	-	-	-	-	-	-	-	-	-	-	-	-	-	GR	GR	GR	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pad 8B	-	-	-	-	-	-	-	-	-	-	-	-	-	GR	GR	GR	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pad 8C	-	-	-	-	-	-	-	-	-	-	-	-	-	GR	GR	GR	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pad 9A	-	-	-	-	-	-	-	-	-	-	-	E	E	W	W	W	R	GR	GR	GR	GR	-	V	-	-	-	-	-	-	-	-
	Pad 9B	-	-	-	-	-	-	-	-	-	-	-	E	E	W	W	W	R	GR	GR	GR	GR	-	V	-	-	-	-	-	-	-	-
	Pad 10A	-	-	-	-	-	-	-	-	-	-	-	-	-	W	W	W	R	GR	GR	V	V	-	-	-	-	-	-	-	-	-	C
	Pad 10B	-	-	-	-	-	-	-	-	-	-	-	W	W	W	?	GR	R	GR	GR	V	V	-	-	-	-	-	-	-	-	-	-
	Pad 10C	-	-	-	-	-	GR	GR	GR	W	W	W	W	W	W	W	W	R	R	GR	V	V	-	-	-	-	-	-	-	-	C	-
	Pad 10E	-	-	-	-	-	-	-	-	(Converted from Pond 21)					W	W	W	R	GR	GR	V	V	-	-	-	-	-	-	-	-	-	C
	Pad 10F	-	-	-	-	-	GR	GR	GR	W	W	W	GR	GR	GR	GR	GR	R	GR	GR	V	V	-	-	-	-	-	-	-	-	C	-
	Pad 10G	-	-	-	-	-	-	-	GR	W	W	W	GR	GR	GR	GR	GR	R	GR	GR	V	V	-	-	-	-	-	-	-	-	-	C
	Pad 18	-	-	-	-	-	-	-	-	-	-	V	W	GR	W	W	W	GR/R	R	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Sludges 1	-	-	-	-	-	-	-	W	W	W	W	W	W	W	W	W/R	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Sludges 2	-	-	-	-	-	-	-	-	-	-	-	-	-	W	W	W	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
Oil Field	S-1	-	-	-	-	-	-	-	-	W	W	W	W/GR	GR	GR	GR	GR	GR	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
Waste	S-2	-	-	-	-	-	-	-	-	-	W	W	W/GR	GR	GR	GR	GR	W/GR	GR	GR	GR	GR	-	GR	-	-	V	-	-	-	-	C
Spreading	S-3	-	-	-	-	-	-	-	-	W	W	W	W	GR	GR	GR	GR	GR	GR	GR	GR	GR	-	V	-	-	-	-	-	-	C	-
Areas	S-4	-	-	-	-	-	-	-	-	-	W	W	GR	GR	GR	GR	GR	GR	GR	GR	GR	GR	-	V	-	-	-	-	C	-	-	-
	S-5	-	-	-	-	-	-	-	-	-	-	GR	W	W	W/GR	GR	GR	W/GR	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	S-6	-	-	-	-	-	-	-	-	-	-	GR	W	W	W	W	W	W/GR	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
Waste	Well 1	-	-	-	-	-	-	-	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Disposal	Well 2	-	-	-	-	-	-	W	W	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wells	Well 3	-	-	-	-	-	-	W	W	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Well 4	-	-	-	-	-	-	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Well 5	-	-	-	-	-	-	W	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Well 6	-	-	-	-	-	-	-	W	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Well 7	-	-	-	-	-	-	-	W	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Well 8	-	-	-	-	-	-	-	-	W	W	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Well 9	-	-	-	-	-	-	-	-	(never placed in service)					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Well 10	-	-	-	-	-	-	-	-	W	W	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Well 11	-	-	-	-	-	-	-	-	-	-	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Waste	Trench 1	-	?	W	GR	?	GR	GR/V	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Disposal	Trench 2	-	-	W	W	W	W	W	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trenches	Trench 3	-	-	W	W	W	W	W	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Trench 4	-	-	-	-	-	W	W	W	GR	GR/V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Trench 5	-	-	-	-	-	W	W	W	-	GR/V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Trench 6							W	(incorporated into the PCB Landfill)							-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Trench 7	-	-	-	-	-	-	-	W	-	GR/V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Treatment	CNS	-	-	-	-	-	-	-	-	-	-	-	-	-	GR	T	T	T	T	-	-	-	-	-	-	-	D	-	-	-	-	-
Units	Pilot PACT Unit	-	-	-	-	-	-	-	-	-	-	-	-	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Oil Recovery	-	-	-	-	-	-	-	T	T	T	T	T	T	T	T	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	H_2O_2	-	-	-	-	-	-	-	-	-	-	-	-	-	T	T	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Zimpro WAO	-	-	-	-	-	-	-	-	-	-	GR	T	T	T	T	T	(Building retrofitted for proposed BLS - now used as Operations Building)														

Waste Management / Remediation Notations:
W = Waste disposal / contaminated liquids management
T = Treatment system operation
R = Remediation of soils and/or pond bottoms
P = Placement of remediate soils
C = Capping with final RCRA cap
B = Landfill buttress constructed
D = Decommissioned

Operational Notations:
SW = Conversion of excavated ponds into stormwater pond
TL = Conversion of pond into treated liquids impoundment

Photograph Notations:
L = Liquid noted in photograph - likely stormwater based on pond history
E = Excavation noted on photographs
GR = Graded area noted on photographs
V = vegetated area noted on photographs (shown for first year after remediation / grading only)
? = Activity likely based on records - photo not available
Aerial photograph available / reviewed for all years except 72, 73, 76, 93, 95, 96, 00 and 01,
Photo from unknown date in the 85/86 timeframe reviewed.

Sources:
A.T Kearney / SAIC, 1987
McClelland, 1989
Aerial Photograph review (see Appendix J)
Brierly and Lyman, 1990a-f, 1991a-l
Canonie Environmental, 1998b;

Table A-9
General Pond Information

Pond / Pad	Approx. Year Built (1)	Construction Notes (1)	Deposition Notation (1)	Class (1)	SI Unit (4)	Surface Area (acres) (2)	Surface Area (acres) (3)	Op. Capacity (mill. gall.) (2)	Op. Capacity (mill. gall.) (3)
Pond 1	77-79		1	N	SI-3	1.0	1.4	3.21	4.2
Pond 2	77-79		1	H	SI-4	1.7	2.2	1.25	4.3
Pond 3	77-78		2	H	SI-5	2.3	2	7.37	8.8
Pond 4	77-79		1	N	SI-5	1.9	2	7.62	8
Pond 5	79	no design plans	3	N	SI-7	0.9	0.7	3.02	2.4
Pond 6	77-78	enlarged 79-80	3	M	SI-9	2.2	2.6	7.62	8.1
Pond 7		converted to Pads 9A and 9B							
Pond 8	78	enlarged 79-80	2	N	SI-7	1.9	1.9	10.93	9.6
Pond 9	78		2	H	SI-5	1.7	1.8	3.00	2.7
Pond 10	77-79	enlarged 79-80	3	N	SI-7	1.8	1.8	9.11	9.2

Table A-9
General Pond Information

Pond / Pad	Approx. Year Built (1)	Construction Notes (1)	Deposition Notation (1)	Class (1)	SI Unit (4)	Surface Area (acres) (2)	Surface Area (acres) (3)	Op. Capacity (mill. gall.) (2)	Op. Capacity (mill. gall.) (3)
Pond 11	77-79	enlarged 79-80	3	N	SI-8	2.7	2.5	14.65	13.1
Pond 12	77-79	south dike moved 10' north in 84	N	N	SI-8	1.3	0.5	3.33	3.5
Pond 13	72-73	downgradient dike with 8' clay core, extends 54' bgs to 4 feet into gray claystone, modified to receive water from Pond 4 in 79	4	N	SI-6	1.5	1.3	7.10	6.2
Pond 14	78	no design plans, leakage noted in 84, pond excavated in 85	D	M	14	0.8	0.4	2.38	1.9
Pond 15	81	no design plans	D	M	SI-3	0.1	0.4	1.5	0.6
Pond 16	74	no design plans, pond silted in, overflow culvert plugged and pond taken out of service in 84	N	H	16	0.2	0.9	0.0	0.0
Pond 17	74	no design plans	1	H	SI-3	0.5	0.5	2.51	1.4
Pond 18	79	no design plans	D	N	SI-3	1.3	1.3	5.05	5.4
Pond 19	78	no design plans, expanded 79-80	3	M	SI-10	1.6	1	3.34	7.4
Pond 20	81-82	clay core barrier dam in SE corner	3	N	SI-8	0.6	0.7	2.90	1.4

Table A-9
General Pond Information

Pond / Pad	Approx. Year Built (1)	Construction Notes (1)	Deposition Notation (1)	Class (1)	SI Unit (4)	Surface Area (acres) (2)	Surface Area (acres) (3)	Op. Capacity (mill. gall.) (2)	Op. Capacity (mill. gall.) (3)
Pond 21		converted to Pad 10E							
Pond 22	84	no design plans	3	N	SI-10	0.6	0.4	3.4	3.0
Pond 23	84 (82/83)	no design plans, compacted clay material on base and sideslopes	N	N	23	0.8	0.5	1.4	0.9
Pond A-1	82	clay core barrier along downgradient edge, extends 84' bgs to 4' into the unweathered gray claystone	N	N	SI-1	2.5	2.3	15.79	14.7
Pond A-2	82	clay core barrier along downgradient edge, extends 84' bgs to 4' into the unweathered gray claystone	N	N	SI-1	2.2	1.8	13.23	15.4
Pond A-3	82	clay core barrier along downgradient edge, extends 84' bgs to 4' into the unweathered gray claystone	2	N	SI-1	2.3	1.6	13.8	14.3
Pond A-4	82	expanded capacity in 1983 by raising dike 6'	1	N	SI-1	2.2	1.8	14.35	16.4
Pond A-5	82		D	N	SI-2	2.2	2.7	12.4	14.6
Pond A-6	83	no design plans	2	M	SI-1	0.9	NR	3.07	2.7
Pond A	72-73	periodically drained to Pond S by cutting spillway and reconstructing dike until 82, siphons installed in 78, plugged by 89	D	H	A	0.5	0.9	1.31	1.3
Pond B	72-73	periodically drained to Pond M by cutting spillway and reconstructing dike until 82, pipe installed in 78, plugged by 89	D	H	B	0.5	1	2.8	2.7

Table A-9
General Pond Information

Pond / Pad	Approx. Year Built (1)	Construction Notes (1)	Deposition Notation (1)	Class (1)	SI Unit (4)	Surface Area (acres) (2)	Surface Area (acres) (3)	Op. Capacity (mill. gall.) (2)	Op. Capacity (mill. gall.) (3)
Pond C	72-73	periodically drained to Pond M by cutting spillway and reconstructing dike until 82, pipe installed in 78	D	H	C	0.8	1	5.33	5.3
Pond D	74	no design plans	D	M	D	0.2	1.4	0.0	0.0
Pond E	74	no design plans, 6-12" compacted clay constructed on base and sideslopes in 85	D	H	SI-4	0.9	0.5	2.24	2.4
Pond J	74	no design plans, 6-12" compacted clay constructed on base and sideslopes in 85	D	H	SI-4	0.9	0.9	2.9	2.4
Pond L	74	no design plans	N	H	SI-4	0.8	1.8	1.31	1.2
Pond M	75	no design plans, Pond M liquids transferred to Pond T during operation and then back to Pond M, base of both ponds raised due to accumulation of dried oil and drill cuttings	1	H	M	2.3	NR	0	3.3
Pond P	78	no design plans, leakage noted in 84, pond excavated in 85	D	M	P	0.6	0.7	2.1	2.2
Pond R	77	no design plans, silted in by 89	??	N	R	0.2	0.4	0.28	0.3
Pond S	77	no design plans	1	H	S	1.0	0.6	3.04	3

Table A-9
General Pond Information

Pond / Pad	Approx. Year Built (1)	Construction Notes (1)	Deposition Notation (1)	Class (1)	SI Unit (4)	Surface Area (acres) (2)	Surface Area (acres) (3)	Op. Capacity (mill. gall.) (2)	Op. Capacity (mill. gall.) (3)
Pond T	75	no design plans, Pond M liquids transferred to Pond T during operation and then back to Pond M, base of both ponds raised due to accumulation of dried oil and drill cuttings	D	M	T	2.3	2.1	0.0	NR
Pond V	77	no design plans	2	H	V	0.6	0.7	0.9	0.9
WCCB	newly constructed		NR	NR			.		
Pad 1A	85	not used for waste management	NR	N			1.6		
Pad 4A	85	may receive water from Pond J, drains to Pond 2	NR	N			0.9		
Pad 7A	85	receives water from riser and drains to Pond 8	NR	N			1		
Pad 8A	85	piped to receive water from site water supply riser, drains into Pond 20	NR	N			0.6		
Pad 8B	85	not used for waste management	NR	N			0.4		
Pad 8C	85	not used for waste management	NR	N			0.3		
Pad 9A	85	receives water from Pond 6, overflow from Pond R and drainage from Pad 9B; drains to Pond 6	NR	N			1.1		
Pad 9B	85	receives water from Pond 6 and loading dock area, drains to Pad 9A	NR	N			0.9		

Table A-9
General Pond Information

Pond / Pad	Approx. Year Built (1)	Construction Notes (1)	Deposition Notation (1)	Class (1)	SI Unit (4)	Surface Area (acres) (2)	Surface Area (acres) (3)	Op. Capacity (mill. gall.) (2)	Op. Capacity (mill. gall.) (3)
Pad 10A	85	receives water from Pond 6 and drainage from Pad 10E, drains into Pond 19	NR	N			0.5		
Pad 10B	85	receives water from Pond 6, drains to Pond 19	NR	N			0.3		
Pad 10C	85	receives water from Pond 6, drains to Pond 19	NR	N			1.3		
Pad 10E	85	receives water from Pond 6, drains to Pad 10A	NR	N			0.9		
Pad 10F	85	receives water from Pond 6 and Pad 10G, drains to Pond 22	NR	N			0.5		
Pad 10G	85	receives water from Pond 6 and Pad 10F	NR	N			1.1		
Pad 18	83	known as Pad 3A in 1983, receives water from Pond 18, drains into Pond 18	NR	N			1.2		
S1	79	excavated spoils used to construct road embankment downgradient of Ponds 2, 3, 4, 10 and 11	NR	NR					
S2	85	includes concrete slab at north bank, drains to Pond 5	NR	NR					
					Totals	51	62	196	205

Source Documents:

(1) Existing Surface Impoundments Closure and Post-Closure Plan (Canonie, 1989a)
(2) RCRA Permit Application (Woodward-Clyde Consultants, 1985)
(3) Environmental Impact Report (McClelland, 1989)
(4) Existing Surface Impoundment: Design and Operations Report (Woodward-Clyde Consultants, 1987a)

Depsotition Notation Legend (data from 1985 and 1986 deposit and transfer logs):

D Direct Deposit
1 First Generation Transfer
2 Second Generation Transfer

Table A-9
General Pond Information

Pond / Pad	Approx. Year Built (1)	Construction Notes (1)	Deposition Notation (1)	Class (1)	SI Unit (4)	Surface Area (acres) (2)	Surface Area (acres) (3)	Op. Capacity (mill. gall.) (2)	Op. Capacity (mill. gall.) (3)

3 Third Generation Transfer
4 Fourth Generation Transfer
N No record of deposit or transfer after 1985

Class Legend:
H Hazardous
M Marginally Hazardous
N Nonhazardous

Table A-10
Operational Pond Information

Pond / Pad	Primary Use (2)	Primary Use (4)	Primary Use (3)	Influent (3) and (4)	Effluent (3) and (4)	Received Transfers during 1985 to 1986 from Pond ____ (1)
Pond 1	R, E	S, E	R, S/E	Received overflow from Pond 2	Overflowed to Pond A-1	Ponds 10 and 18
Pond 2	R, E	S, E	R, S/E	Received overflow from Pond J and Pad 4A	Overflowed to Pond 1	Ponds 5, 10, 13, E, J, L and S
Pond 3	R, E	S, A	R, S/A	Received water from H_2O_2 unit	Overflowed to Pond 4, pumps water to Pond 10	Ponds 2, 4, 10, 13, M and A-6
Pond 4	R, E	S, A	R, S/A	Received overflow from Ponds 3 and 9; capped with oil to control odors	Overflowed to Pond 10	Ponds 10, 13, A-3 and A-5
Pond 5	R	S	R, S	Received water from Pond 10	Overflowed to Pond 8; pumped water to Pads 9B, 10C, 10E and 10G	Ponds 10, 20, E and A-3
Pond 6	LR, LC	S, A	R, S/A	Received water from Pond 19 and Pads 9A and 9B, received runoff from Acids Landfill	Overflowed to Pond 8, pumped water to Pads 9B, 10C, 10E and 10G	Ponds 1, 2, 10, 19 and A-6
Pond 7	Converted to Pads 9A and 9B					
Pond 8	R, E	S	R, S	Received water from Pond 6	Bottom drain discharged to Pond 10	Ponds 1, 3, 6, 10, 20 and A-3
Pond 9	R, E	S	R, S	Received water from Ponds V and M; capped with oil to prevent odors	Overflowed to Pond 4; pumped water to H_2O_2 unit	Ponds M and V
Pond 10	R, E	S, A	R, S, A	Received water from Ponds 4, 8 and 11	Sent water to Ponds 5, 19 and 20, and Pads 7A and 8A; sends water to underground pipeline that feeds entire facility	Ponds 1, 2, 3, 4, 5, 6, 8, 11 and A-3
Pond 11	R, E	S	R, S	Received water from Pond 12	Overflowed to Pond 10	Ponds 10, 12 , 13 and A-3

Table A-10
Operational Pond Information

Pond / Pad	Primary Use (2)	Primary Use (4)	Primary Use (3)	Influent (3) and (4)	Effluent (3) and (4)	Received Transfers during 1985 to 1986 from Pond ____ (1)
Pond 12	R, E	S	R, S	Received overflow from Pond 20, receives runoff from scale sumps; receives water from leach lines	Overflowed to Pond 11	Pond A-3
Pond 13	RS, E	RC	R, S	Fed by underground pipeline	Water used for irrigation	Pond 6
Pond 14	ALK	T	N	Used to treat alkaline wastes, discharged to Ponds E and 23; pumped to all other SI units	Sludge taken to Heavy Metals Landfill; some placed on ground between Ponds D and L	None
Pond 15	WAO, E	T, S	T, S	Received waste from Pond 18, received Stringfellow wastewater, treatment included raising pH to precipitate metals, received treated liquids from WAO unit	Overflowed to Pond 17, connected to underground pipeline; overflow pipe to Pond E	Pond 18
Pond 16	W	S	W	Received water from truck washout	"Blind" pond - no connection with other ponds	None - pond inactive
Pond 17	E	T, S	S	Received water from Ponds 15, 18, and from underground pipeline; received Stringfellow wastewater	Overflow pipe to Pond E	Pond 18
Pond 18	RCRA, E	T, S	S	Received wastewater from Pond 17 and Pad 18, received Stringfellow wastewater, received runoff from PCB Landfill	Overflowed to Pond 1; sent wastewater to Ponds 15 and 17 and to Pad 18; water vacuum trucked from pond to temporary PACT unit (used to treat Stringfellow wastewater); overflow pipe to Pond E	Pond 1, 3, 10, 19, A-3 and A-6

Table A-10
Operational Pond Information

Pond / Pad	Primary Use (2)	Primary Use (4)	Primary Use (3)	Influent (3) and (4)	Effluent (3) and (4)	Received Transfers during 1985 to 1986 from Pond ____ (1)
Pond 19	LR, LC	S, A	LR, A	Received wastewater from Pond 10 and Pads 10A and 10C; received runoff from Acid, Heavy Metal, and Caustics/Cyanides Landfills	Discharged to Pond 6	Pond 1, 2, 3, 6, 10, 16, A-3 and A-6
Pond 20	R, E	S	R, S	Received wastewater from Pond 10 and Pad 8A	Overflowed to Pond 12	Pond 10
Pond 21	Converted to Pad 10E					
Pond 22	E	S	R, S	Received wastewater from Pond 6 and Pad 10F; received portion of Heavy Metal Landfill runoff		Pond 6
Pond 23	Alt ALK	S	R, S	Received water from Ponds 3, 14 and P	"Blind" pond - no discharge	Pond 3
Pond A-1	R, E	S	R, S	Received overflow from Pond 1	Overflowed to Pond A-2	None
Pond A-2	R, E	S	R, S	Received overflow from Pond A-4, connected with Ponds A-1 and A-3	Overflowed to Pond A-3	None
Pond A-3	R, E	S	R, S	Received overflow from Ponds A-2 and A-4	Pumped to Pond A-6 and to spray evaporation; water used for irrigation and dust control on roads	Ponds 3 and A-4
Pond A-4	R, E	S	R, S	Received water from Pond A-5; received runoff/seepage from Pad 18 area	Discharged to Ponds A-2 and A-3	Ponds A-3 and A-5
Pond A-5	WAO, E	S	R, S	Received water from WCCB; received water from the WAO unit and runoff from spray evaporation areas	Overflowed to Pond A-4	None

Table A-10
Operational Pond Information

Pond / Pad	Primary Use (2)	Primary Use (4)	Primary Use (3)	Influent (3) and (4)	Effluent (3) and (4)	Received Transfers during 1985 to 1986 from Pond ____ (1)
Pond A-6	R, E	_	R, S	Received water from Pond A-3	"Blind" pond - no discharge	Pond M and A-3
Pond A	O	WR, S	WR, S	Received oil field wastes and brines	Discharged to Pond S, oil skim sent to oil recovery system	None
Pond B	O	WR, S	WR, S	Received oil field wastes and brines	Bottom drain discharged to Pond M	None
Pond C	O	WR, S	WR, S	Received oil field wastes and brines	Bottom drain discharged to Pond M	None
Pond D	W	S	WR	Received truck washout	Overflowed to Pond L	None
Pond E	AW	T, S	WR, T, S	Received acid wastes; received water from WAO unit, Pond 14 and temporary PACT unit, overflow pipe from Ponds 15, 17 and 18	Overflowed to Pond J, connected to underground pipeline	Ponds 5 and J
Pond J	ALK	T, S	WR, T, S	Received overflow from Pond E	Overflowed to Pond 2, connected to underground pipeline	Pond E
Pond L	E	S	S	Received overflow from Pond D	Overflowed to Pad 4A	Pond 6
Pond M	O	S	S	Received oil wastes from Ponds B and C, received leachate from Pesticides/Solvents Landfill, received runoff from Pond T		Ponds C, B and L
Pond P	AW	WR	WR, T	Used to treat acid wastes, discharged to Ponds 23 and E, pumped to all other SI units, discharged to Pond 18	Sludge taken to Heavy Metals Landfill; some placed on ground between Ponds D and L	None

Table A-10
Operational Pond Information

Pond / Pad	Primary Use (2)	Primary Use (4)	Primary Use (3)	Influent (3) and (4)	Effluent (3) and (4)	Received Transfers during 1985 to 1986 from Pond ____ (1)
Pond R	LR, LC	S	R, S	Received runoff from maintenance area	Discharged to Pad 9A and old Pond 7 (Pad 9B)	None - pond inactive
Pond S	O	S	S	Received oil wastes from Pond A; received runoff and reclaimed water from oil treatment area	Overflowed to Pond V	Pond A
Pond T	O	S	S	Used as sludge drying area for oil sludges (Received primarily drill cuttings per Canonie Closure Plan)		None
Pond V	O	S	S	Received overflow from Pond S	Drains to Pond 9	Pond S
WCCB		R, S	R, S	Received runoff from RCRA Landfill and West Canyon	Discharges to Pond A-5	
Pad 1A		Not used	Not used	Not used for waste management		NR
Pad 4A		E	E	Received water from Pond L and PCB Landfill	Overflowed to Pond 2	
Pad 7A		E	E	Received water from Pond 6, 10 and Acid Landfill	Culvert discharged to Pond 8	
Pad 8A		E	E	Received water from Pond 10	Overflowed to Pond 12	
Pad 8B		Not used	Not used	Not used for waste management		
Pad 8C		Not used	Not used	Not used for waste management		
Pad 9A		E, LR, LC	E	Received water from Ponds 6 and R and Pad 9B; received runoff from Pesticides/Solvents Landfill	Discharged to Pond 6	
Pad 9B		E, LR, LC	E	Received water from Pond 6; received runoff from Pesticides/Solvents and Heavy Metal/Sludge Landfills	Overflowed to Pad 9A	
Pad 10A		E, LR, LC	E	Received runoff from Pad 10E, and Heavy Metal and Caustic/Cyanide Landfills	Overflowed to Pond 19	
Pad 10B		E, LR, LC	E	Received runoff from Pad 10C	Overflowed to Pond 19	
Pad 10C		E, LR, LC	E	Received water from Pond 6	Overflowed to Pond 19	
Pad 10E		E, LR, LC	E	Received water from Pond 6	Overflowed to Pad 10A	
Pad 10F		E, LR, LC	E	Received water from Pad 10G	Overflowed to Pond 22	
Pad 10G		E, LR, LC	E	Received water from Ponds 6 and 22	Overflowed to Pad 10F	
Pad 18		E, LR, LC	E	Received water from Pond 18	Discharged to Pond 18	

Table A-10
Operational Pond Information

Pond / Pad	Primary Use (2)	Primary Use (4)	Primary Use (3)	Influent (3) and (4)	Effluent (3) and (4)	Received Transfers during 1985 to 1986 from Pond ____ (1)
S1	ST					
S2	ST					
SP1	DM					
SP2	DM					
SP3	DM					
SP4	DM					
SP5	DM					
SP6	DM					

Source Documents:

(1) Existing Surface Impoundments Closure and Post-Closure Plan (Canonie, 1989)
(2) Existing Surface Impoundments: Design and Operating Information (Woodward Clyde, 1987a)
(3) Environmental Impact Report (McClelland, 1989)
(4) RCRA Facility Assessment (AT Kearney and SAIC, 1987)

Primary Use Legend:

R	Runoff	RS	Reserve
S	Storage	AW	Acid Waste
E	Evaporation	ALK	Alkaline Waste
A	Aeration	Alt ALK	Alternative Alkaline Waste
N	Neutralization Treatment	RCRA	RCRA cleanup liquids (Stringfellow Site)
WR	Waste Receipt	WAO	Wet Air Oxidation unit effluent
T	Treatment	W	Tanker Truck Washout
LR	Landfill Runoff	O	Oil Field Wastes
LC	Leachate Control	ST	Septic tank and restaurant grease trap sludge
		DM	Drilling mud and oil field wastes; also some winery wastes

Supplemental Pond Transfer Information based on photo reviews:

1974	Transfer from Ponds C and D (and possibly E) to Pond L
1978	Transfer from Pond P to Pond 14 and then to Pond 15
1981 and 198	Transfer from Pond 16 to Pond D

Table A-11
Pond Closure Information

Pond / Pad	Closure Report (5)	Excavation and Sampling Notes (5)	Closure Rec. (6)	Status as of September 1990 (6)	Status as of March 1992 (7)
Pond 1	Feb-91	7.29' average excavation depth, 2 verification samples exceeded TCLs for metals, excavation ceased due to proximity to haul roads, groundwater and NTU Road, backfilled with material from below Pond 17	I	Some soil chemistry above TCLs, resampling and verification in progress	
Pond 2	No		C	Southeast corner contains minor organics	
Pond 3	Apr-91	6.53' average excavation depth, supplemental verification sampling indicated all below TCLs, dike between Ponds 2 and 3 completely removed	C	Verification sampling underway. North side to be closed with Pond M	
Pond 4	June 1988 (Canonie)	8' maximum excavation depth, closure samples evaluated statistically, results indicate that closure samples are statistically below TCLs	C	Some metals above background and low-level organics at south and west dike. South dike to be closed with NTU Road.	
Pond 5	Dec-90	12.2' average excavation depth, all final verification samples below TCLs	C		
Pond 6	Feb-91	report for eastern 2/3 of pond only, western 1/3 may be impacted by leachate from the P/S Landfill, 8.16' avarage excavation depth (to an apparent low spot in the claystone), all verification samples below TCLs, future closure to address closure of western pond and the northwestern portion of the pond comprised of dike material originally between Ponds 6 and 9	C - East 2/3 LF - West 1/3	East side closed, west side being considered for landfill closure.	East side closed, west side being considered for landfill closure.
Pond 7	NA		NA		
Pond 8	Oct-90	6.27' average excavation depth, all verification samples all below TCLs, closure included removal of damp soil and pipe in the northwest corner of the pond	C	Review and follow-up inspection	

Table A-11
Pond Closure Information

Pond / Pad	Closure Report (5)	Excavation and Sampling Notes (5)	Closure Rec. (6)	Status as of September 1990 (6)	Status as of March 1992 (7)
Pond 9	No		I	initial inspection - two verfication samples taken	
Pond 10	Dec-90	8.83' average excavation depth, 2 verification samples near western dike exceeded TCLs for metals, all dike material subsequently removed without additional testing	C	Dikes removed, benzene below TCLs detected at south bank	
Pond 11	Feb-91	6.36' average excavation depth, all verification samples below TCLs	C		
Pond 12	Feb-91	2.09' average excavation depth, removed damp soils in NE and NW corners of the pond, pond backfilled and coated with asphaltic emulsion, verification samples exceeded TCLs for lead, baruim and arsenic, subsequent verification samples obtained by drilling - arsenic below TCLP, lead at ND but detection limit greater than TCLP	C		
Pond 13	No		C	Organic contamination beyond northeast pond limit noted and recommended for separate closure.	
Pond 14	No		I	Initial inspection, originally considered for landfill closure, currently working on closure by removal	Requires agency walkthrough
Pond 15	Feb-91	6.2' average excavation depth, verification sample results below TCLs with the exception of barium and reactive sulfide, soil in the area of elevated concentrations subsequently excavated during Pad 18 closure	C		
Pond 16	No		C		

Table A-11
Pond Closure Information

Pond / Pad	Closure Report (5)	Excavation and Sampling Notes (5)	Closure Rec. (6)	Status as of September 1990 (6)	Status as of March 1992 (7)
Pond 17	Feb-91	5.12' average excavation depth, one verification sample location exceeded TCL for nickel, additional 20' excavation taken to facilitate drainage (used to backfill Pond 1) with no additional testing	C	Resampled for nickel - results pending	
Pond 18	No		C		
Pond 19	No		C - south dike recommended for landfill closure	Recommended for closure except for south dike and adjacent fill material	South dike and SW corner - close as landfill
Pond 20	Feb-91	4.99' average excavation depth, all verification samples below TCLs	C		
Pond 21	NA		NA		
Pond 22	No		C		
Pond 23	No		LF		close as landfill
Pond A-1	Mar-91	5.32' average excavation depth, all verification samples below TCLs, diesel fuel contamination left in south bank area (source is fuel tank across road), no additional axcavation due to proximity to road	C		
Pond A-2	Mar-91	7.14' average excavation depth, all verification samples below TCLs, 100 cy used to construct Pond A-3 access road	C		
Pond A-3	Jan-91	3.4' average excavation depth, all verification samples below TCLs	C		

Table A-11
Pond Closure Information

Pond / Pad	Closure Report (5)	Excavation and Sampling Notes (5)	Closure Rec. (6)	Status as of September 1990 (6)	Status as of March 1992 (7)
Pond A-4	Mar-91	1.32' average INITIAL excavation depth, after additional 6' excavation all verification sample results below TCLs	C		
Pond A-5	No		I	Review and follow-up inspection - verification sampling assigned, lab results pending	
Pond A-6	No		C		
Pond A	No		I		Requires agency walkthrough
Pond B	No		I		Oil seeps observed in test pits - requires agency walkthrough
Pond C	No		I		Oil seeps observed in test pits - requires agency walkthrough
Pond D	No		C		Includes washrack
Pond E	No		C		
Pond J	No		I	Recommended for closure - pending oil result evaluation	Resolve oil seep analysis
Pond L	No		C		

Table A-11
Pond Closure Information

Pond / Pad	Closure Report (5)	Excavation and Sampling Notes (5)	Closure Rec. (6)	Status as of September 1990 (6)	Status as of March 1992 (7)
Pond M	No		I	Initial inspection	
Pond P	No		I	Initial inspection - originally considered for landfill closure, currently working on closure by removal	Requires agency walkthrough
Pond R	No		LF	Recommended dlosure as landfill - observed and photodocumented	Close as landfill
Pond S	No		I		Requires agency walkthrough
Pond T	No		I	Initial inspection	Requires agency walkthrough
Pond V	No		I	Initial inspection	Requires agency walkthrough
WCCB	No		C		Requires agency walkthrough
Pad 1A	No		C		
Pad 4A	No		C		
Pad 7A	No		C		

Table A-11
Pond Closure Information

Pond / Pad	Closure Report (5)	Excavation and Sampling Notes (5)	Closure Rec. (6)	Status as of September 1990 (6)	Status as of March 1992 (7)
Pad 8A	Nov-90	1' excavation depth, the one verification sample result was below TCLs	C		
Pad 8B	Nov-90	1' excavation depth, the one verification sample result was below TCLs	C		
Pad 8C	Dec-90	1' excavation depth, nickel exceeded TCLs in 2 closure sample locations, no verification samples collected	LF		
Pad 9A	No		LF	Under consideration for landfill closure	Close as landfill
Pad 9B	No		C	Under consideration for landfill closure	Close as landfill
Pad 10A	No		C		
Pad 10B	No		C		
Pad 10C	No		C		
Pad 10E	No		C		
Pad 10F	No		C		
Pad 10G	No		C		
Pad 18	No		C	Recommended for closure - area beyond northern limit of Pad 18 to be closed with RCRA Canyon	

Table A-11
Pond Closure Information

Pond / Pad	Closure Report (5)	Excavation and Sampling Notes (5)	Closure Rec. (6)	Status as of September 1990 (6)	Status as of March 1992 (7)
S1			C		
S2			C		

Source Documents:

(5) Closure Certifications Reports for Ponds and Pads (Brierley & Lyman, 1990a-f and 1991a-l, Canonie, 1988b)
(6) Brierley and Lyman 11-9-90 lettter to RWQCB (Brierley and Lyman, 1990)
(7) Revised Groundwater Monitoring Program (Casmalia Resources, 1992)

Closure Recommendations Legend:

LF Recommended for closure as landfill
I Closure process incomplete, constituents in excess of TCLs locally left in place
C Recommended for closure

TABLE A-12
CONSTITUENTS DETECTED IN POND AND PAD SLUDGE

POND OR PAD NUMBER	CONSTITUENTS DETECTED IN BOTTOM SLUDGE
POND 1	**Inorganics -** As, Ba, Be, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - none detected **Pesticides/herbicides** - none detected
POND 2	**Inorganics** - As, Ba, Be, Cd, Cr, Cu, Pb, Ni, Ag, Zn **Volatiles** - MEK, 1,1-DCA, 1,1-DCE, ethylbenzene, methylene chloride, PCE, toluene, xylenes, 1,1,1-TCA, TCE **Semi-volatiles** - none detected **Pesticides/herbicides -** none detected
POND 3	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Zn **Volatiles** - ethyl benzene, methylene chloride, toluene, xylenes **Semi-volatiles** - none detected **Pesticides/herbicides -** none detected
POND 4	**Inorganics** - As, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride, xylenes **Semi-volatiles** - B2EHP **Pesticides/herbicides -** none detected
POND 5	**Inorganics** - As, Ba, Be, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - carbon disulfide, toluene, xylenes **Semi-volatiles** - 2-methylnaphthalene **Pesticides/herbicides -** none detected
POND 6	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - acetone, chlorobenzene, 1,1-DCA, ethyl benzene, methylene chloride, styrene, PCE, toluene, xylenes **Semi-volatiles** - anthracene, butylbenzylphthalate, 1,2-DCB, 1,4-DCB, 2-methylnaphthalene, naphthalene, nitrobenzene, phenol, 1,2,4-trichlorobenzene **Pesticides/herbicides -** none detected
POND 7	NA
POND 8	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - xylenes **Semi-volatiles** - B2EHP, di-n-butylphthalate **Pesticides/herbicides -** none detected
POND 9	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - MBK, PCE, xylenes **Semi-volatiles** - B2EHP, di-n-octylphthalate, 2-methylnaphthalene **Pesticides/herbicides -** none detected
POND 10	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - bromochloromethane, carbon disulfide, methylene chloride **Semi-volatiles** - none detected **Pesticides/herbicides -** none detected
POND 11	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride, xylenes **Semi-volatiles** - none detected **Pesticides/herbicides -** none detected
POND 12	**Inorganics** - As, Ba, Be, Cd, Cr, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - none detected **Pesticides/herbicides -** none detected
POND 13	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - B2EHP, di-n-butylphthalate **Pesticides/herbicides -** none detected
POND 14	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** -none detected **Semi-volatiles** - none detected **Pesticides/herbicides -** none detected

TABLE A-12
CONSTITUENTS DETECTED IN POND AND PAD SLUDGE

POND OR PAD NUMBER	CONSTITUENTS DETECTED IN BOTTOM SLUDGE
POND 15	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - benzene, ethyl benzene, methylene chloride, toluene, xylenes, TCE **Semi-volatiles** - B2EHP, 2-methylnaphthalene, naphthalene **Pesticides/herbicides -** 2,4-D
POND 16	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - benzene, carbon disulfide, chlorobenzene, ethyl benzene, MIBK, PCE, toluene, xylenes **Semi-volatiles** -chrysene, 2-methylnaphthalene, naphthalene, phenanthrene **Pesticides/herbicides -** none detected
POND 17	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - acetone, benzene, carbon disulfide, ethyl benzene, methylene chloride, PCE, toluene, xylenes **Semi-volatiles** - 2-methylnaphthalene **Pesticides/herbicides -** none detected
POND 18	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - none detected **Semi-volatiles** - di-n-butylphthalate **Pesticides/herbicides -** none detected
POND 19	**Inorganics** - As, Ba, Be, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - benzene, chlorobenzene, 1,1-DCA, ethyl benzene, methylene chloride, xylenes **Semi-volatiles** - di-n-butylpthtalate **Pesticides/herbicides -** none detected
POND 20	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - B2EHP **Pesticides/herbicides -** none detected
POND 21	NA
POND 22	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Se, Zn **Volatiles** - methylene chloride **Semi-volatiles** - none detected **Pesticides/herbicides -** none detected
POND 23	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - di-n-butylphthalate **Pesticides/herbicides -** none detected
POND A-1	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Se, Zn **Volatiles** - none detected **Semi-volatiles** - di-n-butylphthalate **Pesticides/herbicides -** none detected
POND A-2	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - none detected **Semi-volatiles** - none detected **Pesticides/herbicides -** none detected
POND A-3	**Inorganics** - As, Ba, Cd, Cr, Cu, Ni, Zn **Volatiles** -methylene chloride **Semi-volatiles** - none detected **Pesticides/herbicides -** none detected
POND A-4	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - none detected **Pesticides/herbicides -** none detected
POND A-5	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - cis-1,3-dichloropropene, ethyl benzene **Semi-volatiles** - anthracene, 2-methylnaphthalene, napththalene, phenanthrene **Pesticides/herbicides -** none detected
POND A-6	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - B2EHP, di-n-butylphthalate **Pesticides/herbicides -** 2,4-D

TABLE A-12
CONSTITUENTS DETECTED IN POND AND PAD SLUDGE

POND OR PAD NUMBER	CONSTITUENTS DETECTED IN BOTTOM SLUDGE
POND A	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Hg, Ni, Zn **Volatiles** - acetone, benzene, bromochloromethane, carbon disulfide, chloroform, dibromochloromethane, 1,1-DCA, ethyl benzene, MIBK, methylene chloride, PCE, toluene, xylenes **Semi-volatiles** - 2-methylnaphthalene **Pesticides/herbicides -** none detected
POND B	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Hg, Ni, Zn **Volatiles** - acetone, benzene, MEK, carbon disulfide, chloroform, 1,1-DCA, ethyl benzene, MBK, MIBK, methylene chloride, 1,1,2,2-PCA, PCE, toluene, xylenes, trans-1,2-DCE, 1,1,1-TCA, TCE **Semi-volatiles** - anthracene, B2EHP, butylbenzylphthalate, 1,2-DCB, 2-methylnaphthalene, phenol, pyrene **Pesticides/herbicides -** none detected
POND C	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - acetone, benzene, MEK, carbon disulfide, 1,1-DCA, ethyl benzene, MIBK, methylene chloride, PCE, toluene, xylenes, trans-1,2-DCE, 1,1,1-TCA **Semi-volatiles** - anthracene, B2EHP, 2-methylnaphthalene, naphthalene, phenol **Pesticides/herbicides -** none detected
POND D	**Inorganics** - Sb, As, Ba, Cd, Cr, Cu, Pb, Hg, Ni, Zn **Volatiles** - acetone, benzene, MEK, carbon disulfide, chlorobenzene, 1,1-DCA, ethyl benzene, MIBK, methylene chloride, PCE, toluene, xylenes, trans-1,2-DCE, 1,1,1-TCA **Semi-volatiles** - benzo(k)fluoranthene, B2EHP, chrycene, 1,2-DCB, fluranthene, 2-methylnaphthalene, naphthalene, phenanthrene, pyrene, 1,2,4-TCB, vinyl chloride **Pesticides/herbicides -** none detected
POND E	**Inorganics** - Sb, As, Ba, Cd, Cr, Cu, Pb, Ni, Se, Ag, Zn **Volatiles** -none detected **Semi-volatiles** - B2CEM, B2EHP, di-ni-butylphthalate, di-ni-octylphthalate, 2-methylnaphthalene, 2-methylphenol, naphthalene, phenanthrene, phenol **Pesticides/herbicides -** none detected
POND J	**Inorganics** - Sb, As, Ba, Cd, Cr, Cu, Pb, Ni, Ag, Zn **Volatiles** - 1,1-DCA, 1,1-DCE, ethyl benzene, MBK, methylene chloride, 1,1,2,2-PCA, PCE, toluene, xylenes **Semi-volatiles** - anthracene, benzyl alcohol, B2EHP, 1,2-DCB, 2,4-dimethylphenol, 2-methylnaphthalene, naphthalene, 1,2,4-TCB **Pesticides/herbicides -** none detected
POND L	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Hg, Ni, Ag, Zn **Volatiles** - benzene, chloroform 1,1-DCA, ethyl benzene, MBK, methylene chloride, PCE, toluene, xylenes, trans-1,2-DCE, 1,1,1-TCA, TCE **Semi-volatiles** - 2-methylnaphthalene, phenanthrene **Pesticides/herbicides -** none detected
POND M	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - benzene, carbon disulfide, 1,1-DCA, ethyl benzene, MIBK, PCE, toluene, xylenes, 1,1,1-TCA **Semi-volatiles** - 2-methylnaphthalene, naphthalene, phenanthrene **Pesticides/herbicides -** none detected
POND P	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - none detected **Semi-volatiles** - none detected **Pesticides/herbicides -** none detected
POND R	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Se, Zn **Volatiles** - methylene chloride **Semi-volatiles** - B2EHP, butylbenzylphthalate, pyrene **Pesticides/herbicides -** none detected
POND S	**Inorganics** - As, Ba, Be, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - benzene, carbon disulfide, 1,1-DCA, 1,1-DCE, ethyl benzene, PCE, toluene, xylenes, 1,1,1-TCA **Semi-volatiles** - 2-methylnaphthalene, naphthalene, phenanthrene, pyrene **Pesticides/herbicides -** none detected
POND T	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - benzene, carbon disulfide, 1,1-DCA, ethyl benzene, methylene chloride, PCE, toluene, xylenes, TCE **Semi-volatiles** - none detected **Pesticides/herbicides -** none detected

TABLE A-12
CONSTITUENTS DETECTED IN POND AND PAD SLUDGE

POND OR PAD NUMBER	CONSTITUENTS DETECTED IN BOTTOM SLUDGE
POND V	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Se, Zn **Volatiles** - benzene, carbon disulfide, 1,1-DCA, ethyl benzene, MIBK, PCE, toluene, xylenes, trans-1,2-DCE, 1,1,1-TCA **Semi-volatiles** - 2-methylnaphthalene, naphthalene, phenanthrene **Pesticides/herbicides -** none detected
WCCB (Pond 43)	Not Tested
PAD 1A	NA
PAD 4A	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - B2EHP, di-n-butylphthalate **Pesticides/herbicides -** none detected
PAD 7A	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - toluene **Semi-volatiles** - none detected **Pesticides/herbicides -** none detected
PAD 8A	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - B2EHP, butylbenzylphthalate **Pesticides/herbicides -** none detected
PAD 8B	NA
PAD 8C	NA
PAD 9A	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - B2EHP, butylbenzylphthalate **Pesticides/herbicides -** none detected
PAD 9B	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - di-n-butylphthalate **Pesticides/herbicides -** none detected
PAD 10A	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - B2EHP, butylbenzylphthalate, di-n-octylphthalate **Pesticides/herbicides -** none detected
PAD 10B	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - B2EHP **Pesticides/herbicides -** none detected
PAD 10C	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - anthracene, butylbenzylphthalate, pyrene **Pesticides/herbicides -** none detected
PAD 10E	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - B2EHP **Pesticides/herbicides -** none detected
PAD 10F	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - B2EHP **Pesticides/herbicides -** none detected
PAD 10G	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - none detected **Pesticides/herbicides -** none detected

TABLE A-12
CONSTITUENTS DETECTED IN POND AND PAD SLUDGE

POND OR PAD NUMBER	CONSTITUENTS DETECTED IN BOTTOM SLUDGE
PAD 18	**Inorganics** - As, Ba, Cd, Cr, Cu, Pb, Ni, Zn **Volatiles** - methylene chloride **Semi-volatiles** - di-n-butylphthalate **Pesticides/herbicides -** none detected
SLUDGES 1	Not tested
SLUDGES 2	Not tested

Source:

Existing Surface Impoundment Closure and Post-Closure Plan, (Appendix C, Volume 2 of 3), (Canonie, 1989)

Table A-13a. Aggressive Groundwater Restoration Alternative Costs - Area 5 North
Hydraulic Extraction, Aboveground Treatment, and Source Removal Cost Estimate

Casmalia Resources Superfund Site
Casmalia, CA

Description	Estimated Quantity	Unit	Unit Cost	Estimated Cost	Comments
Capital Costs					
AREA 5 NORTH **SOURCE REMEDIATION**					
P/S LANDFILL					
Erect moveable containment tent structure	1	ea	$ 125,000	$ 125,000	
Air scrubbing vent system	1	ea	$ 500,000	$ 500,000	
Air monitoring/sampling - 2/day	9,111	ea	$ 500	$ 4,555,350	
Level A PPE Upgrade	4,555	day	$ 500	$ 2,277,675	
Site clearing/grubbing	18	acre	$ 5,000	$ 91,827	
Excavation/handling of waste	1,518,450	cy	$ 100	$ 151,845,000	Special emission requirements for working in negative pressure environment, equipment for potential explosive conditions, meticulous exposure and handling of drums and wastes
Decontamination of equipment/personnel	5%	of	$ 151,845,000	$ 7,592,250	
Equipment maintenance, refueling	5%	of	$ 151,845,000	$ 7,592,250	
Confirmation sampling - sidewall	525	ea	$ 500	$ 262,295	
Labpack of drums/containers (50% of total waste)	1,138,838	ton	$ 5,000	$ 5,694,187,500	Assumes $500/drum and drum capacity = 200 lb. Includes analytical, waste profiling, packing, handling overpack, and directing to proper waste stream; assumes 50% of total waste present in drums or containers
Transport waste to US Ecology Landfill, Beatty, NV	2,277,675	ton	$ 50	$ 113,883,750	
Disposal @ US Ecology Landfill, Beatty, NV	2,277,675	ton	$ 200	$ 455,535,000	Includes BOE fee.
Import, grade, and compact clean fill for vegetative cover	1,670,295	cy	$ 20	$ 33,405,900	Assumes backfill to grade, includes 10% fill shrinkage during compaction
Hydroseeding	18	acre	$ 5,000	$ 91,827	
			Subtotal	**$ 6,471,945,625**	
METALS LANDFILL					
Erect moveable containment tent structure	1	ea	$ 125,000	$ 125,000	
Air scrubbing vent system	1	ea	$ 500,000	$ 500,000	
Air monitoring/sampling - 2/day	3,594	ea	$ 500	$ 1,797,000	
Level A PPE Upgrade	1,797	day	$ 500	$ 898,500	
Site clearing/grubbing	11	acre	$ 5,000	$ 55,096	
Excavation/handling of waste	599,000	cy	$ 100	$ 59,900,000	Special emission requirements for working in negative pressure environment, equipment for potential explosive conditions, meticulous exposure and handling of drums and wastes
Decontamination of equipment/personnel	5%	of	$ 59,900,000	$ 2,995,000	
Equipment maintenance, refueling	5%	of	$ 59,900,000	$ 2,995,000	
Confirmation sampling - sidewall	315	ea	$ 500	$ 157,377	
Labpack of drums/containers (50% of total waste)	449,250	ton	$ 5,000	$ 2,246,250,000	Assumes $500/drum and drum capacity = 200 lb. Includes analytical, waste profiling, packing, handling overpack, and directing to proper waste stream; assumes 50% of total waste present in drums or containers
Transport waste to US Ecology Landfill, Beatty, NV	898,500	ton	$ 50	$ 44,925,000	

Table A-13a. Aggressive Groundwater Restoration Alternative Costs - Area 5 North
Hydraulic Extraction, Aboveground Treatment, and Source Removal Cost Estimate

Casmalia Resources Superfund Site
Casmalia, CA

Description	Estimated Quantity	Unit	Unit Cost	Estimated Cost	Comments
Disposal @ US Ecology Landfill, Beatty, NV	898,500	ton	$ 200	$ 179,700,000	Includes BOE Fee
Import, grade, and compact clean fill for vegetative cover	658,900	cy	$ 20	$ 13,178,000	Assumes backfill to grade, includes 10% fill shrinkage during compaction
Hydroseeding	11	acre	$ 5,000	$ 55,096	
			Subtotal	**$ 2,553,531,070**	
CAUSTICS/CYANIDES LANDFILL					
Erect moveable containment tent structure	1	ea	$ 125,000	$ 125,000	
Air scrubbing vent system	1	ea	$ 500,000	$ 500,000	
Air monitoring/sampling - 2/day	4,522	ea	$ 500	$ 2,261,010	
Level A PPE Upgrade	2,261	day	$ 500	$ 1,130,505	
Site clearing/grubbing	6	acre	$ 5,000	$ 30,992	
Excavation/handling of waste	753,670	cy	$ 100	$ 75,367,000	Special emission requirements for working in negative pressure environment, equipment for potential explosive conditions, meticulous exposure and handling of drums and wastes
Decontamination of equipment/personnel	5%	of	$ 75,367,000	$ 3,768,350	
Equipment maintenance, refueling	5%	of	$ 75,367,000	$ 3,768,350	
Confirmation sampling - sidewall	177	ea	$ 500	$ 88,525	
Labpack of drums/containers (50% of total waste)	565,253	ton	$ 5,000	$ 2,826,262,500	Assumes $500/drum and drum capacity = 200 lb. Includes analytical, waste profiling, packing, handling overpack, and directing to proper waste stream; assumes 50% of total waste present in drums or containers
Transport waste to US Ecology Landfill, Beatty, NV	1,130,505	ton	$ 50	$ 56,525,250	
Disposal @ US Ecology Landfill, Beatty, NV	1,130,505	ton	$ 200	$ 226,101,000	Includes BOE Fee
Import, grade, and compact clean fill for vegetative cover	829,037	cy	$ 20	$ 16,580,740	Assumes backfill to grade, includes 10% fill shrinkage during compaction
Hydroseeding	6	acre	$ 5,000	$ 30,992	
			Subtotal	**$ 3,212,540,213**	
ACIDS LANDFILL					
Erect moveable containment tent structure	1	ea	$ 125,000	$ 125,000	
Air scrubbing vent system	1	ea	$ 500,000	$ 500,000	
Air monitoring/sampling - 2/day	1,355	ea	$ 500	$ 677,310	
Level A PPE Upgrade	677	day	$ 500	$ 338,655	
Site clearing/grubbing	6	acre	$ 5,000	$ 27,548	
Excavation/handling of waste	225,770	cy	$ 100	$ 22,577,000	Special emission requirements for working in negative pressure environment, equipment for potential explosive conditions, meticulous exposure and handling of drums and wastes
Decontamination of equipment/personnel	5%	of	$ 22,577,000	$ 1,128,850	
Equipment maintenance, refueling	5%	of	$ 22,577,000	$ 1,128,850	
Confirmation sampling - sidewall	157	ea	$ 500	$ 78,689	
Labpack of drums/containers (50% of total waste)	169,328	ton	$ 5,000	$ 846,637,500	Assumes $500/drum and drum capacity = 200 lb. Includes analytical, waste profiling, packing, handling overpack, and directing to proper waste stream; assumes 50% of total waste present in drums or containers
Transport waste to US Ecology Landfill, Beatty, NV	338,655	ton	$ 50	$ 16,932,750	

Table A-13a. Aggressive Groundwater Restoration Alternative Costs - Area 5 North
Hydraulic Extraction, Aboveground Treatment, and Source Removal Cost Estimate

Casmalia Resources Superfund Site
Casmalia, CA

Description	Estimated Quantity	Unit	Unit Cost	Estimated Cost	Comments
Disposal @ US Ecology Landfill, Beatty, NV	338,655	ton	$ 200	$ 67,731,000	Includes BOE Fee
Import, grade, and compact clean fill for vegetative cover	248,347	cy	$ 20	$ 4,966,940	Assumes backfill to grade, includes 10% fill shrinkage during compaction
Hydroseeding	6	acre	$ 5,000	$ 27,548	
			Subtotal	**$ 962,877,640**	
PCB LANDFILL					
Erect moveable containment tent structure	1	ea	$ 125,000	$ 125,000	
Air scrubbing vent system	1	ea	$ 500,000	$ 500,000	
Air monitoring/sampling - 2/day	2,342	ea	$ 500	$ 1,171,200	
Level A PPE Upgrade	1,171	day	$ 500	$ 585,600	
Site clearing/grubbing	5	acre	$ 5,000	$ 24,105	
Excavation/handling of waste	390,400	cy	$ 100	$ 39,040,000	Special emission requirements for working in negative pressure environment, equipment for potential explosive conditions, meticulous exposure and handling of drums and wastes
Decontamination of equipment/personnel	5%	of	$ 39,040,000	$ 1,952,000	
Equipment maintenance, refueling	5%	of	$ 39,040,000	$ 1,952,000	
Confirmation sampling - sidewall	138	ea	$ 500	$ 68,852	
Labpack of drums/containers (50% of total waste)	292,800	ton	$ 5,000	$ 1,464,000,000	Assumes $500/drum and drum capacity = 200 lb. Includes analytical, waste profiling, packing, handling overpack, and directing to proper waste stream; assumes 50% of total waste present in drums or containers
Transport waste to US Ecology Landfill, Beatty, NV	585,600	ton	$ 50	$ 29,280,000	
Disposal @ US Ecology Landfill, Beatty, NV	585,600	ton	$ 200	$ 117,120,000	Includes BOE Fee
Import, grade, and compact clean fill for vegetative cover	429,440	cy	$ 20	$ 8,588,800	Assumes backfill to grade, includes 10% fill shrinkage during compaction
Hydroseeding	5	acre	$ 5,000	$ 24,105	
			Subtotal	**$ 1,664,431,662**	
BURIAL TRENCH AREA/CENTRAL DRAINAGE AREA					
Erect moveable containment tent structure	1	ea	$ 125,000	$ 125,000	
Air scrubbing vent system	1	ea	$ 500,000	$ 500,000	
Air monitoring/sampling - 2/day	2,364	ea	$ 500	$ 1,182,000	
Level A PPE Upgrade	1,182	day	$ 500	$ 591,000	
Site clearing/grubbing	12	acre	$ 5,000	$ 58,550	
Excavation/handling of waste	394,000	cy	$ 100	$ 39,400,000	Special emission requirements for working in negative pressure environment, equipment for potential explosive conditions, meticulous exposure and handling of drums and wastes
Decontamination of equipment/personnel	5%	of	$ 39,400,000	$ 1,970,000	
Equipment maintenance, refueling	5%	of	$ 39,400,000	$ 1,970,000	
Confirmation sampling - side & bottom	691	ea	$ 500	$ 345,574	
Transport waste to US Ecology Landfill, Beatty, NV	591,000	ton	$ 50	$ 29,550,000	
Disposal @ US Ecology Landfill, Beatty, NV	591,000	ton	$ 200	$ 118,200,000	Includes BOE Fee
Import, grade, and compact clean fill for vegetative cover	433,400	cy	$ 20	$ 8,668,000	Assumes backfill to grade, includes 10% fill shrinkage during compaction
Hydroseeding	12	acre	$ 5,000	$ 58,550	
			Subtotal	**$ 202,618,674**	

Table A-13a. Aggressive Groundwater Restoration Alternative Costs - Area 5 North
Hydraulic Extraction, Aboveground Treatment, and Source Removal Cost Estimate

Casmalia Resources Superfund Site
Casmalia, CA

Description	Estimated Quantity	Unit	Unit Cost	Estimated Cost	Comments
Mobilization	1	ls	$ 500,000	$ 500,000	
Surveying	1	ls	$ 500,000	$ 500,000	
General NPDES permit revision	1	ls	$ 50,000	$ 50,000	
			Subtotal	**$ 1,050,000**	
GROUNDWATER/NAPL EXTRACTION AND TREATMENT					
Upper HSU Groundwater Extraction Wells	40	ea	$ 80,000	$ 3,200,000	
Lower HSU Groundwater Extraction Wells	14	ea	$ 100,000	$ 1,400,000	
Upper HSU DNAPL and LNAPL Extraction Wells	10	ea	$ 80,000	$ 800,000	
Upper HSU DNAPL Extraction Wells	5	ea	$ 80,000	$ 400,000	
Lower HSU DNAPL Extraction Wells	5	ea	$ 100,000	$ 500,000	
Well Headworks/Vault/Extraction Pumps	74	ea	$ 5,000	$ 370,000	
Treatment System fractional cost	100%	of	$ 7,069,000	$ 7,069,000	
			Subtotal	**$ 13,739,000**	
			Direct Capital Subtotal	**$ 15,082,733,883**	
			Contingency (50%)	**$ 7,541,366,942**	
			Direct Capital Total	**$ 22,624,100,825**	
Project/Construction Management, Health and Safety					
Remedial Design/Engineering	5%	of	$ 15,082,733,883	$ 754,136,694	
Project Management, Agency Reporting/Coordination	3%	of	$ 15,082,733,883	$ 452,482,016	
EPA Oversight costs	10%	of	$ 15,082,733,883	$ 1,508,273,388	
Contruction Management	5%	of	$ 15,082,733,883	$ 754,136,694	
Health and Safety	2%	of	$ 15,082,733,883	$ 301,654,678	
			Total PM/MC/H&S Cost	**$ 3,770,683,471**	
			Total Capital Cost	**$ 26,394,784,296**	
Annual Operation and Maintenance Costs					
Hydraulic Extraction and Treatment System Annual Operation and Maintenance Fractional Costs	100%	of	$ 1,862,450	$ 1,862,450	
			Subtotal Annual O&M Direct Cost	**$ 1,862,450**	
			Contingency (50%)	**$ 931,225**	
			Total Annual O&M Direct Cost	**$ 2,793,675**	
Annual O&M Project Management					
Project Management, Technical Support, Agency Reporting/Coordination	5%	of	$ 1,862,450	$ 93,123	
			Total Annual O&M PM Cost	**$ 93,123**	
			Total Annual O&M Cost	**$ 2,886,798**	
Periodic Costs					
US EPA Five-year Review (5, 10, 15, 20, 25 and 30	6	5-yr	$ 35,000	$ 210,000	
Replace Entire Groundwater Treatment System Fractional Cost	1	100-yr	$ 7,069,000	$ 7,069,000	Assumes replacement of entire groundwater treatment system within 100 yrs. Fractional cost applied per groundwater area.

Table A-13a. Aggressive Groundwater Restoration Alternative Costs - Area 5 North
Hydraulic Extraction, Aboveground Treatment, and Source Removal Cost Estimate

Casmalia Resources Superfund Site
Casmalia, CA

Description		Estimated Quantity	Unit	Unit Cost	Estimated Cost	Comments
Present Value Analysis						
Cost	**Year**	**Total Cost (2012 $K)**	**Cost/Year (2012 $K)**	**Net Present Value (in 2012 $K) at 3% DF**	**Net Present Value (in 2012 $K) at 7% DF**	
Capital Cost	0	26,394,784	NA	26,394,784	26,394,784	
Annual O&M Cost (post construction)	0 - 30	86,814	2,894	56,720	35,909	
Annual O&M Cost (post construction)	31 - 100	209,145	2,988	35,849	5,558	
Total Present Value of Alternative (Capital + 30 Year O&M)				**$26,451,504,000**	**$26,430,694,000**	
Total Present Value of Alternative (Capital + 100 Year O&M)				**$26,487,353,000**	**$26,436,251,000**	

Table A-13b. Aggressive Groundwater Restoration Alternative
Aboveground Treatment Backup Cost Estimate

Casmalia Resources Superfund Site
Casmalia, CA

Description	Estimated Quantity	Unit	Unit Cost	Estimated Cost
Direct Capital Costs				
GROUNDWATER TREATMENT				
Additional GW Characterization/Design Support/Bench Scale Test	1	ls	$ 500,000	$ 500,000
Mobilization/Demobilization	1	ls	$ 200,000	$ 200,000
Electrical and Natural Gas Service/Hookup	1	ls	$ 100,000	$ 100,000
Site Preparation/Geophysical/Private Subsurface Utility Locate	1	ls	$ 100,000	$ 100,000
Therm Oxidizer flow rate - 500 cfm	1	ls	$ 100,000	$ 100,000
Advanced Oxidation Treatment system (UV+TiO2) 55 gpm	1	ls	$ 520,000	$ 520,000
Air Stripping Unit+Blower (QED 8.6)	2	ea	$ 85,000	$ 170,000
Hydro-cyclone with Autodrain	1	ea	$ 10,000	$ 10,000
Carbon Adsorption Vessels - LPGAC (3-3,000 lb) with manifolding	3	ea	$ 10,000	$ 30,000
Chemical Feed (Inline)- Demulsifying, Acidification, Neutralization Units with controls	3	ea	$ 3,000	$ 9,000
Scrubber for Thermal Ox Effluent	1	ea	$ 140,000	$ 140,000
Reverse Osmosis Units (Pair in series @ 70 gpm)	2	ea	$ 290,000	$ 580,000
Reject concentrator (3-module VSEP system)	1	ea	$ 700,000	$ 700,000
Misc Treat System: OWS, Tanks, Piping, Pumps, Bag Filters	1	ls	$ 280,000	$ 280,000
Housing- Equipment Pad/Enclosure/Fence	1	ea	$ 100,000	$ 100,000
Treatment System Installation and Startup	1	ls	$ 280,000	$ 280,000
Control and Instrumentation	1	ls	$ 70,000	$ 70,000
Misc: equipment rentals, Health and Safety, PID/FID	1	ls	$ 70,000	$ 70,000
Trenching, Piping, Cables, Backfill and Resurfacing	30,000	lf	$ 75	$ 2,250,000
Evaporation Pond construction (3.1 acres)				
Grading 3.1 acre pond bottom south of PSCT	20,000	cy	$ 6	$ 120,000
Foundation layer	20,000	cy	$ 6	$ 120,000
HDPE membrane	140,000	sf	$ 0.80	$ 112,000
Drainage layer, filter fabric	140,000	sf	$ 0.60	$ 84,000
Gravel layer, 6"	2,600	cy	$ 15	$ 39,000
Soil cover for pond bottom, 2'	10,400	cy	$ 10	$ 104,000
Erosion control for sideslopes	1.7	acres	$ 8,700	$ 14,790
Revegetation/hydroseeding	1.7	acres	$ 5,000	$ 8,500
Equipment Rentals, ODCs	1	ls	$ 8,000	$ 8,000
Site-specific NPDES permit RWQCB admin	1	ls	$ 100,000	$ 100,000
Site-specific NPDES permit Basin Plan exemption	1	ls	$ 150,000	$ 150,000
			Direct Capital Subtotal	**$ 7,069,000**
Annual Operation and Maintenance Cost				
Fuel: Natural Gas	12	mths	$ 3,000	$ 36,000
Electricity	12	mths	$ 25,000	$ 300,000
Operations & Maintenance, Sampling	12	mths	$ 50,000	$ 600,000
Chemicals : Acids, Titanium Dioxide, antiscaling/neutralizing/ defoaming/demulsifying/RO cleaning agents	12	mths	$ 12,000	$ 144,000
Carbon - Liquid Phase (4-3,000lb changeouts, annually)	12	mths	$ 1,500	$ 18,000
Groundwater/Vapor Treatment System Influent/Effluent/NPDES Monitoring/Lab Costs, Wellhead Lab Costs	12	mths	$ 14,000	$ 168,000
Project Management/Consultant support/Compliance reports	12	mths	$ 9,000	$ 108,000
NAPL/membrane/filter/misc waste disposal	12	mths	$ 8,000	$ 96,000
RO membrane replacement	12	mths	$ 4,000	$ 48,000
UV bulb replacement	12	mths	$ 7,000	$ 84,000
Well Re-development (once per year)	1	annual	$ 16,000	$ 16,000
System overhaul	2	annual	$ 20,000	$ 40,000
Miscellaneous: Equipment rentals, H&S	12	mths	$ 2,000	$ 24,000
Parts replacement (5% of Capital costs)	5%	of	$ 2,609,000	$ 130,450
Evaporation Pond Maintenance	12	mths	$ 4,167	$ 50,000
			Annual Operation and Maintenance Subtotal	**$ 1,862,450**

NOTES/ASSUMPTIONS

1. Hydraulic extraction system: Uses 54 groundwater extraction wells, 20 NAPL extraction wells, max extraction flow rate of ~55 gpm.
2. Water is treated by sequential oil-water separator (OWS), filtration, air stripper, advanced oxidation (UV+TiO2), reverse osmosis, filtration, and polished by LPGAC before NPDES discharge.
3. RO reject brine (concentrated treated groundwater) would be further concentrated via VSEP and pumped to a new 3.1-acre treated liquids pond for evaporation.

Table A-14
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Casmalia, CA

Technology Type/ Process Option	Description	Contaminant Scenario	Effectiveness	Implementability	Cost	Screening Comments
GROUNDWATER AND NAPL						
Institutional Controls						
Institutional Controls - Groundwater Use Restrictions - Well Restrictions - Restrictive Covenants (deed restrictions) - Zoning Restrictions - Informational Tools - Long-Term Stewardship Tools	Institutional controls (ICs) are legal and administrative controls applied to properties to minimize the potential for human exposure to residual contamination and protect the integrity of the remedy. ICs work by controlling land or resource use and by providing information that helps modify use of the property. Restrictive covenants (deed restrictions) are a commonly used form of IC that runs with the land over the long term even if property ownership changes.	Dissolved contaminants in groundwater NAPL	Good Effective for preventing exposure to impacted groundwater because deed restrictions run with the land even if ownership changes.	Good Technically implementable provided specific legal requirements and authority can be met.	Low	Retained Applicable in combination with other technologies.
Groundwater Monitoring - Upper HSU - Lower HSU	Long-term monitoring of the groundwater well network to assess plume stability and NAPL and contaminant concentration trends over time. This includes monitoring of Upper HSU and Lower HSU saturated zones.	Dissolved contaminants in groundwater NAPL	Good Effective for monitoring contaminant concentration over time.	Good Monitoring well network is already established.	Low to Moderate	Retained Applicable in combination with other technologies for use with Upper HSU and Lower HSU groundwater zones.
Containment						
Slurry Walls Impermeable Barriers	Install impermeable or low permeability barriers such as a slurry wall on the downgradient side of the NAPL to a depth below the NAPL in the saturated zone. Materials for barriers include cement slurry, soil bentonite, clay, etc. Long-term monitoring would be required.	Dissolved contaminants in groundwater NAPL	Good Effective at preventing groundwater contaminant migration and as a barrier that enhances groundwater extraction/treatment systems. Does not reduce toxicity or mass but reduces potential for migration and exposure.	Moderate to Good Has been implemented successfully at the site. Used in concert with groundwater extraction, this technology is implementable within shallow and accessible areas (e.g. P/S Landfill clay barrier).	Moderate to High	Retained Because it is an effective technology at preventing groundwater migration in the Upper HSU. Applicable for groundwater in all three subareas: Area 5 North, 5 South and 5 West. Currently this technology is operating effectively at the P/S Landfill clay barrier and the Perimeter Control Trench (PCT) clay barrier. This technology is used in concert with hydraulic extraction at the PCTs to prevent offsite migration of impacted groundwater. Not applicable in the Lower HSU because implementing a slurry wall or other barrier would not be feasible in the Lower HSU, which is over 1,000 feet thick. However, the very low permeability (hydraulic conductivity of $1x10^{-6}$ cm/s) minimizes potential migration is a natural barrier or control.

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Hydraulic Barrier or Hydraulic Control	Extraction and injection wells or trenches are used to create a hydraulic barrier by the formation of a cone of depression to restrict groundwater flow and contaminant migration. Or extraction alone to provide hydraulic control and prevent offsite migration. Treatment of groundwater may be required depending on contaminants present and end disposal option. Long-term monitoring would be required.	Dissolved contaminants in groundwater NAPL	Moderate to Good Effective in the weathered, fractured Upper HSU lithology using trenches for extraction. Significant energy usage and greenhouse gas (GHG) emissions over the long term.	Moderate to Good Technically implementable for Upper HSU only. Fractures cause preferential pathways and uneven capture.	High	Retained This is similar to current extraction based hydraulic control at the PCTs that prevent impacted groundwater from being transported offsite. However, this will require active groundwater pumping in perpetuity. Applicable for groundwater in all three subareas: Area 5 North, 5 South and 5 West. Significant long-term GHG impacts on environment. GHG impacts may be less significant if the overall pumping rates are significantly decreased due to anticipated capping remedies.
Phytoremediation	Use of plants and trees as a containment approach to extract contaminated groundwater and help with hydraulic control to prevent migration of contaminated groundwater. Phytoremediation can also be used to remediate or stabilize contaminants in vadose zone soil, sediments and surface water.	Dissolved contaminants in groundwater	Moderate Effectiveness limited by depth of water table, elevated concentrations of contaminants and weathered claystone soil type that will limit the types of vegetation that can grow.	Moderate Challenges anticipated with water table that is deep compared to typical plant root zones and weathered claystone soil type that limits the types of vegetation that can grow.	Low to Moderate	Retained Potential applications in limited areas of the site with a shallow water table or would need a groundwater extraction to supply water to plants. Applicable in portions of Area 5 South and Area 5 West where the water table is shallow and organic and inorganic contaminant concentrations are low and less impacting to plants. However, TDS concentrations are high and can pose a challenge to plant growth. Also, water table elevations are expected to be lowered in the future due to the anticipated capping remedies. Not applicable in Lower HSU because of the greater depth to water unless groundwater is pumped through extraction wells.
Passive In Situ Treatment						
Monitored Natural Attenuation Intrinsic biodegradation	Reduction of dissolved concentrations through naturally occurring processes such as dilution, volatilization, biodegradation, or adsorption. Long-term groundwater monitoring would be required.	Dissolved contaminants in groundwater NAPL	Low to Moderate Chlorinated and petroleum VOCs are amenable to biodegradation, but mass reduction in the source area is very slow. Reductive dechlorination of chlorinated ethenes has potential to produce toxic byproducts. Effectiveness evaluated through monitoring.	Moderate to Good Adequate network of monitoring wells are already in place.	Low	Retained Though this technology is rated low for effectiveness/mass removal, it is retained because it is a cost-effective approach that can reduce dissolved contaminant mass over a long period of time. Applicable primarily to Area 5 South, Area 5 West south of the PSCT where natural attenuation plays a significant role in contaminant destruction. Also applicable to the Area 5 North in the Lower HSU.

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Permeable Reactive Barriers (PRBs) Reactive Walls (ZVI) Funnel and Gate Biobarriers (Carbon source) Injection well barrier	Installation of PRBs (in situ reactive walls) in the subsurface across the direction of NAPL/groundwater flow to passively treat contamination typically using deep trenches. Funnel and gate is a type of construction where impermeable slurry walls are used to direct groundwater flow through a narrow region called a funnel that is filled with a reactive medium (e.g. zero valent iron [ZVI]). For a mixed chlorinated and petroleum VOC plume a combination of materials have been used in the barrier (ZVI, carbon source, activated carbon, microbes, etc.) which involve chemical reduction and anaerobic biodegradation. PRBs can also be installed using a series of closely-spaced direct push injection points or closely spaced wells.	Dissolved contaminants in groundwater NAPL	Moderate to Good Effective for reduction of dissolved VOCs and acting as a barrier. ZVI alone is not effective for petroleum hydrocarbons. A combination of barrier materials would be required to address a mixed chlorinated and petroleum VOC plume. Not proven effective for NAPL mass removal.	Moderate to Good Typically implementable as a reactive wall up to depths of less than 50 feet. Locally contamination has been found deeper up to 140 feet below ground surface and trenching cannot be implemented at those depths.	High	Retained PRBs have been successfully used as a containment remedial option for depths in the range of 40-50 feet below ground surface. ZVI and carbon have been useful reactive media for reductive or biological degradation of chlorinated solvents. Applicable to Area 5 South where low levels of chlorinated solvents and metals are the dominant contaminants. Applications in Area 5 North would be very challenging with very high VOC concentrations and in close proximity to NAPL. Area 5 West with a mix of low levels of metals is potentially applicable but challenges can be expected with a mix of different metals with different redox chemistries. PRBs using injection wells are not retained for this site due to the challenges with injection in the weathered claystone formation.
Active In Situ Treatment						
Air Sparging	Involves injection of compressed air through injection wells to strip and biodegrade hydrocarbons with volatiles captured in vadose zone by soil vapor extraction. Sparging wells would need to be screened in the top 30 to 40 feet of the groundwater table zone.	Dissolved VOCs in groundwater NAPL	Poor to Moderate Not effective in low permeability fractured or weathered bedrock conditions, especially because it has to be applied over a large thickness (>30 feet) of saturated zone. Air will flow in preferential pathways in fractures and remediation will be highly nonuniform.[6, 7]	Moderate Challenges with air injection in low permeability, heterogeneous weathered/fractured bedrock conditions. Would need very closely spaced points.	High	Not retained Because of poor effectiveness and implementation difficulties in this low permeability heterogeneous subsurface where the preferential pathways of injected air flow and low air flow allowed will make it ineffective. See Note [6,7] below.
In Situ Thermal Desorption (ISTD)	ISTD is equivalent to a thermally enhanced soil vapor extraction. Involves heating deep soil using thermal wells that use resistive heating elements with associated vapor extraction to remove volatilized contaminants. Soil is heated by thermal conduction, and no current flows through soil.	Dissolved contaminants in groundwater NAPL	Moderate Due to challenges with uniformly capturing heated vapors and nonuniform heating in this fractured bedrock lithology. [6,7] Significant energy consumption and GHG emissions.	Moderate High density of vapor wells would be required to capture vapors. Low permeability conditions could be challenging for vapor flow. Available through only one vendor.	Very High	Retained This technology is considered better than the other thermal technologies for this site and is retained as an example of a thermal technology for alternative screening evaluation. Applicable to NAPL and VOC impacted areas in Area 5 North. VOC concentrations in Area 5 South are too low for this technology to be cost effective. Effectiveness for DNAPL in the Lower HSU is highly uncertain with the very low permeability and challenges with effective extraction of heated vapors. Also, exact extent of DNAPL is not known and hence not applicable for Lower HSU.

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Electric Resistance Heating (ERH)	Electric resistance heating involves heating soil (about 200°F) by passing a current directly through soil using electrodes placed in soil. In the saturated zone, sufficient electric power is applied to boil the water and volatilize the NAPL. The vapor and steam from the heated zone are extracted by vacuum extraction and treated in aboveground systems.	Dissolved contaminants in groundwater NAPL	Poor to Moderate Due to challenges with uniformly capturing heated vapors and nonuniform heating in this low permeability weathered or fractured bedrock lithology. [6,7] Significant energy consumption and GHG emissions.	Moderate Technically implementable in Upper HSU only. High density of vapor wells would be required to capture vapors due to low permeability weathered/fractured bedrock.	Very High	Not retained Because of implementation and effectiveness challenges and very high cost compared to other technologies. Also, significant environmental impacts with high GHG emissions and associated impacts compared to other greener in situ remediation options. See Note [6,7] below.
In Situ Chemical Oxidation (ISCO) - $KMnO_4$ (Permanganate) - Ozone - H_2O_2 + Fe (Fentons reagent) - Peroxone (H_2O_2 + O_3) - Persulfate - RegenOx™ (Percarbonate+H_2O_2)	Strongly oxidizing chemicals (such as Ozone, H_2O_2, $KMnO_4$) are injected into the subsurface to oxidize the NAPL in situ. The added oxidant also enhances biodegradation of residual contamination in the long term. Permanganate is the most successfully used oxidant especially for chlorinated solvent contamination including DNAPL areas.	Dissolved contaminants in groundwater NAPL	Poor to Moderate Due to low permeability weathered or fractured bedrock lithology, injection technologies would face significant challenges in contacting the contaminants in the matrix. Most injectate would flow in fractures.[6,7]	Moderate Challenges with injection into low permeability, heterogeneous, weathered or fractured bedrock. Injection attempted with hydraulic fracturing would be nonuniform.	High	Not retained Because injection technologies have significant limitations with effectiveness and implementability in this lithology. Typically chemical oxidation technologies are not used with passive barrier type approaches because oxidants are fast reacting and are consumed quickly. See Note [6,7] below.
Enhanced Anaerobic Bioremediation/ Bioaugmentation - Emulsified vegetable oil (EVO) - Emulsified Oil Substrate (EOS) - Molasses - EHC, DARAMEND (Adventus) - HRC™ (Regenesis) - Microbes (dehalococcoides,KB-1) - Cometabolism (methane sparging)	Direct injection of substrates/nutrients/microbes or placement in reactive barriers to enhance in situ bioremediation (bioaugmentation) of VOCs (often used for chlorinated VOCs). Also, can be implemented as groundwater extraction followed by aboveground substrate/nutrient injection and subsequent re-injection into the saturated zone.	Dissolved contaminants in groundwater NAPL	Moderate Effective only for reactive barriers or funnel and gate type applications. Not for direct injection.	Moderate Only for reactive barrier or funnel and gate type application and not for injection.	High	Not retained Has potential applicability to chlorinated solvent remediation in a funnel and gate or reactive barrier application where the gate is an anaerobic biobarrier. However, an ISCR barrier discussed below is likely to be better suited for this application because the biobarrier would need more frequent replacement while ZVI would last longer.
In Situ Chemical Reduction (ISCR) ISCR+in situ bioremediation - Zero Valent Iron - EHC (Adventus, Carbon + ZVI)	Direct injection or placement of ZVI in reactive barriers or funnel and gate applications to reduce chlorinated solvents or metals without groundwater extraction. Also, a combination of ISCR with bioremediation can be implemented when ZVI is combined with a carbon source.	Dissolved contaminants in groundwater NAPL	Moderate Effective only for reactive barriers or funnel and gate type applications. Not for direct injection.	Moderate Technical challenges with injection into fractured bedrock formation.	High	Retained for use as a gate material for dissolved groundwater and for direct injection for NAPL. Has potential applicability to chlorinated solvent remediation mostly in a funnel and gate or reactive barrier application where the gate uses ZVI or ZVI+carbon by ISCR. Applicable primarily for the Upper HSU because that would be the focus of the PRBs. Not applicable for the Lower HSU because a PRB barrier would not be effective where the Lower HSU is over 1,000 feet thick.

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Extraction Wells						
Vertical Wells	Series of wells to extract impacted groundwater as part of hydraulic control or extract NAPL as source control to limit contaminant migration. They can be used to remove LNAPL and DNAPL mass from the subsurface, hydraulically control LNAPL migration, and partially control DNAPL migration.	Dissolved contaminants in groundwater NAPL	Moderate Limited effectiveness due to the low permeability weathered or fractured bedrock lithology. The lithology significantly reduces the potential extraction flow rate and capture zone. This option is rated higher at moderate because vertical wells used with large diameter boreholes or inside trench wells would be better than vertical wells in conventional 8 or 10-inch boreholes.	Moderate to Good Installation of wells is good for implementability but a large number of closely-spaced wells will be required and hence rated lower than good.	Moderate	Retained for use to extract groundwater and also to selectively extract NAPL. Hydraulic control of DNAPL is only partially effective because DNAPL migration is density driven and only partially influenced by hydraulic gradients. Removal of the mobile DNAPL source is necessary to control DNAPL migration.
Trench Wells	Deep trenches that extend below water table to extract impacted groundwater as part of hydraulic control or source control to ensure DNAPL or dissolved contaminant migration is limited. They can be used to remove LNAPL and DNAPL mass from the subsurface, hydraulically control LNAPL migration, and partially control DNAPL migration.	Dissolved contaminants in groundwater NAPL	Moderate to Good Better effectiveness based on intercepting a larger cross section of groundwater flow.	Moderate Some technical challenges and safety risks with deep trenches with vertical sidewalls. However, these have been implemented at this site.	High	Retained for use to extract dissolved phase groundwater.
Horizontal Wells	Horizontal wells are installed by directional drilling methods that extend several hundreds of feet long to access a greater portion of the saturated zone. They can be used to extract impacted groundwater as part of hydraulic control or extract NAPL as source control to ensure DNAPL or dissolved contaminant migration is limited. These wells have the potential to access contaminated groundwater under landfills without drilling through waste.	Dissolved contaminants in groundwater NAPL	Moderate Effectiveness is not as good as trench wells that can access a larger cross section of groundwater flow and achieve better extraction rates in this low permeability bedrock lithology. This option potentially allows access to groundwater under landfills without drilling through wastes as with vertical wells.	Poor to Moderate Significant technical challenges anticipated with horizontal drilling under landfills. Concerns with drilling into waste because the exact landfill bottom elevations are not known.	High	Retained for evaluation of alternative involving dewatering P/S Landfill to address source control objective. Hydraulic control of DNAPL is only partially effective because DNAPL migration is density driven and only partially influenced by hydraulic gradients. Removal of the mobile DNAPL source is necessary to control DNAPL migration.

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Ex Situ Treatment						
Hydraulic Extraction Pump and Treat - Upper HSU wells - Lower HSU wells	Groundwater is extracted from subsurface wells creating a sufficient hydraulic gradient to mobilize NAPL or extraction dissolved VOCs. The recovered NAPL is destroyed or recycled, and groundwater is treated in aboveground equipment and discharged. The extraction technology is viable for the Upper HSU groundwater but is also considered to a limited extent with the Lower HSU groundwater where permeability and extraction rates are even lower.	Dissolved contaminants in groundwater NAPL	Moderate Effectiveness is limited by the weathered bedrock conditions and low aquifer conductivity in the Upper HSU. NAPL mass removal efficiency is low. Effectiveness is poorer with the Lower HSU groundwater because of the very low permeability claystone bedrock.	Moderate Limitations with this site lithology and low conductivity aquifer conditions in the Upper HSU. Limitations are more significant with Lower HSU groundwater.	Very High	Retained For NAPL in Upper HSU, mass reduction efficiency is low but VOC contaminant mass can be reduced in the dissolved phase. Cost depends on the density of wells and is generally very high because of the long term of operation. For dissolved plume in Upper HSU, this technology can serve as a control or containment feature and is used currently at the site. For Lower HSU, the permeability of the claystone bedrock is even lower and extraction rates are expected to be miniscule. Based on experience with purging monitoring wells, these wells recharge extremely slowly sometimes taking weeks to recharge one casing volume. [8]
Dual-Phase Extraction Multi-Phase Extraction	High vacuum (>20-inch Hg) is applied to subsurface wells to remove vapors, groundwater and NAPL, which are treated aboveground. When the water table is deep, vacuum alone may not be able to extract significant liquids. Groundwater extraction pumps may be required for liquids extraction.	Dissolved contaminants in groundwater NAPL	Poor to Moderate Not effective in this site lithology due to the uneven fractures and inability to apply vacuum evenly [6,7]. Vacuum is not expected to significantly enhance liquids extraction in this formation compared to conventional hydraulic extraction.	Moderate Limitations in radius of influence in this fractured bedrock lithology needing very closely spaced wells.	High	Not retained Because of limited radius of influence and effectiveness in this low permeability, fractured bedrock subsurface. See Note [6,7].
NAPL Skimmers	Active or passive skimmers are placed in groundwater wells to remove any accumulating free product for collection in a tank and offsite disposal. Applicable for LNAPL and DNAPL.	NAPL	Moderate Effective for removal of free product that comes into a well. Does not apply a gradient to enhance NAPL entry into well.	Moderate to Good Implementable for LNAPL and DNAPL that enters well.	Low	Retained Because it can be effective for removal of DNAPL and LNAPL that comes into a well. Can be used for DNAPL-only skimming by optimizing the well construction for DNAPL entry into the well.

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Enhanced NAPL Recovery	Flushing with solvents (incl. water), surfactants and other chemicals to dissolve or alter the physical properties of the NAPL to make it more easily extractable. This could be potentially applicable for LNAPL or DNAPL. An example of an application for a DNAPL extraction is called "waterflood oil recovery" approach. Key to optimizing DNAPL extraction with this approach is maintaining maximum DNAPL saturation. Also, this technology has been utilized primarily in aquifers that have high conductivity (e.g. $1x10^{-3}$ cm/s) such as alluvial aquifers.	NAPL	Poor to Moderate Effectiveness is rated low because it is not expected to be effective in this site lithology that includes a low permeability ($1x10^{-5}$ cm/s) weathered claystone overlying even lower permeability ($1x10^{-6}$ cm/s) fractured claystone bedrock. Flow will be in preferential pathways along fractures [6,7]. Example application is a site with a high conductivity alluvial aquifer that is very different from this site.	Poor to Moderate Challenges with reinjection of extracted groundwater in this low permeability aquifer to enhance DNAPL pooling and recovery. Challenges with large diameter well installation or use of trench wells in the southern portion of the P/S Landfill where the largest amount of NAPL is believed to be present.	High	Not retained Because this technology works optimally in highly permeable alluvial (e.g. 10^{-3} cm/s) aquifers. The use of the waterflood approach would involve extraction of groundwater overlying DNAPL and reinjection to enhance DNAPL accumulation for recovery. The low permeability of the Upper HSU would make reinjection difficult and further complicated by the high TDS and biofouling that would significantly impact and restrict the injection operations. See Note [6,7].
Disposal/Discharge/Reuse						
Onsite Discharge	Onsite discharge of treated or extracted groundwater and uncapped areas stormwater to evaporation ponds. Evaporation is currently an actively used approach for disposal of treated groundwater. Evaporation rates at the site are high in the range of 44 to 48 inches per year. Evaporation pond sediments will accumulate inorganics deposited over a period of time and will need to be cleaned. Also, the CLRF and CTS species would need to be protected by using drift fences around the length of the pond.	Metals, TDS, suspended solids	Good Effective for disposal of treated groundwater that does not contain VOCs and organics but is elevated in TDS and inorganics. Pond sediments would need to be cleaned periodically. CLRF and CTS species will need to be protected.	Good Limited challenges with implementation and CLRF and CTS species would need to be protected and pond sediments periodically cleaned.	Low	Retained Because evaporation ponds are a cost effective means of addressing high TDS and inorganics in treated groundwater. However, onsite handling of treated water is limited by the available size of the onsite evaporation pond. If groundwater extraction rates are too high to be handled by the onsite evaporation pond, then more complex groundwater treatment should be considered to enable offsite discharge of treated groundwater.
Enhanced evaporation	Enhanced evaporation refers to an evaporation technology used in the mine industry to address water disposal. An example of this technology is Turbomist equipment (by Slimline Inc.) that sprays the water in a fine mist from jets with a blower.	Metals, TDS, suspended solids	Good Effective for disposal of treated groundwater that is high in TDS, suspended solids and metals.	Moderate to Good Would need to meet the substantive requirements of the SBCAPCD with regards to air emissions.	Moderate	Retained Because it is an effective technology that can reduce the volume of water especially in those wet years when extracted groundwater and stormwater volumes peak.
Offsite Discharge	Offsite discharge of extracted groundwater that is treated to remove contaminants such as VOCs, NAPL, metals and TDS with a complex treatment system (such as advanced oxidation, air stripping, LPGAC and reverse osmosis) to meet site-specific offsite NPDES discharge limits. The offsite discharge option is required when the extraction flow rates are high and the water cannot be handled in the onsite evaporation ponds.	VOCs, Other Organics, Metals	Moderate to Good Effective for discharge of treated groundwater though some effectiveness concerns exist with meeting stringent NPDES limits especially for inorganics.	Moderate Some technical challenges and reliability concerns with discharge quality and compliance with permit limits. Community concerns with offsite discharge of groundwater from the site.	High	Retained Because it is the only option available if high groundwater extraction flow rates are considered that could not be handled in the onsite evaporation ponds.

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	Offsite disposal of highly contaminated leachate liquids and NAPL to a permitted TSDF where liquids are treated by incineration or other processes.	High levels of VOCs and Other organics, NAPLs	Good Effective in disposing of highly contaminated liquids but concerns exist with potential long-term liabilities of offsite disposal and transportation risks.	Good Because it is currently implemented for Gallery Well liquids and NAPL disposal.	High	Retained Currently used approach for disposal of Gallery Well liquids and NAPL.
STORMWATER						
Stormwater Controls - BMPs - Surface drains - Detention basin - Swales - Erosion Controls	Involves installing drainage improvements, swales, BMPs to improve stormwater collection through drains and swales and sediment settling and filtration in detention basins.	Metals, VOCs, SVOCs and other organics in surface water, potential sediment/ contaminant migration	Moderate to Good Effectiveness can be limited by site-specific factors including alignment and location of drainage.	Moderate Site-specific challenges can be anticipated.	Moderate to High	Retained Because these controls are important to divert rainwater through drains/swales to minimize contact with impacted soils and ensure a clean runoff.
Onsite Discharge	Onsite discharge of uncapped areas stormwater to evaporation ponds. Evaporation is currently an actively used approach for disposal of treated groundwater as discussed earlier. Evaporation rates at the site are high in the range of 44 to 48 inches per year. Evaporation pond sediments will accumulate inorganics deposited over a period of time and will need to be cleaned.	Metals, TDS, suspended solids	Good Effective for disposal of treated groundwater that does not contain VOCs and organics but is elevated in TDS and inorganics. Pond sediments would need to be cleaned periodically. CRLFs and CTS species will need to be protected.	Good Limited challenges with implementation and CRLF and CTS species would need to be protected and pond sediments periodically cleaned.	Low	Retained Because evaporation ponds are a cost effective means of addressing inorganics or TDS in stormwater.
Constructed Wetlands	Using constructed or artificial wetlands to treat surface water with low levels (low □g/L concentrations) of metals, VOCs and other organics using natural geochemical and biological processes inherent in a functioning wetland ecosystem. Wetlands would primarily serve to filter and degrade contaminants. Constructed wetlands would typically include organic rich soils, plants, algae, microbes, fungi, etc.	Low levels of metals, VOCs, other organics, TDS, suspended solids	Good Effective for treating low levels of VOCs, other organics. Not typically known to be effective for high TDS.	Good The B Drainage Wetlands is an example of a constructed wetland though it primarily addresses stormwater flows from the site.	Moderate	Retained Because this technology is effective and there is already an example of the B Drainage Wetlands that has been operating effectively.
Enhanced evaporation	Enhanced evaporation refers to an evaporation technology used in the mine industry to address water disposal. An example of this technology is Turbomist (by Slimline Inc.) that sprays the water in a fine mist from jets with a blower.	Metals, TDS, suspended solids	Good Effective for disposal of treated groundwater that is high in TDS, suspended solids and metals.	Moderate to Good Would need to meet the substantive requirements of the SBCAPCD with regards to air emissions.	Moderate	Retained Because it is an effective technology that can reduce the volume of water especially in those wet years when extracted groundwater and stormwater volumes peak.

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Offsite Discharge	Offsite discharge of surface water from capped or uncapped areas in accordance with the site's General NPDES permit	Low levels of Metals, Organics	Good Effective for discharge of clean capped stormwater and from uncapped areas with BMPs.	Good No challenges with capped flows but some uncertainty with uncapped areas stormwater quality and ability to discharge offsite under the General Permit.	Low	Retained Because it is the favored approach for discharge offsite of clean stormwater from capped and unimpacted areas.

NOTES

1. Definitions of Criteria :
   -Effectiveness is ability of the remedial technology to achieve the RAOs;
   -Implementability is a measure of the technical and administrative feasibility of constructing, operating and maintaining a remedial alternative; and
   -Cost refers to a relative cost compared with other technologies in same technology type. Costs will be refined later in the FS process.
2. Table uses a five-point rating scheme: Good, Moderate to Good, Moderate, Poor to Moderate, Poor.
   For Cost, the table uses a five-point rating scheme: Low, Low to Moderate, Moderate, Moderate to High, High.
3. Technologies for NAPL are rated based on remedial objectives addressing source migration potential, risk to onsite workers, and containment.
4. Retained technologies in table are identified as shaded rows.
5. A Technical Impracticability (TI) waiver for chemical-specific groundwater ARARs as presented in the TI evaluation (Appendix A) is assumed to be granted by the USEPA.
6. Section 4 of the RI states that the geometric mean of the hydraulic conductivity of Upper HSU weathered claystone is approximately $1x10^{-5}$ cm/s while the Lower HSU mean is $1x10^{-6}$ cm/s and that fractures control hydraulic conductivity in both the Upper HSU and Lower HSU.
7. Important points to note in evaluating in situ technologies in this fractured bedrock site lithology a) a fractured bedrock with a $1x10^{-5}$ cm/s conductivity is significantly worse with respect to in situ remediation effectiveness from an unconsolidated formation with the same conductivity because with a fractured bedrock a majority of the flow (depending on in situ remediation approach it could be vapor extraction flow or reagent injection flow, etc.) is going to be through the fractures while in an unconsolidated formation this will be more uniformly distributed; b) a majority of the porosity in the Upper HSU is in the matrix (>40%) while the porosity of the fractures is <5% which implies that a majority of the contaminants would likely be in the matrix where the available porosity is located. Hence, addressing the fracture porosity with the in situ remediation approach will not address a significant portion of the contamination in the matrix.
8. For the Lower HSU groundwater contamination, only groundwater monitoring and limited hydraulic extraction is retained for evaluation with remedial alternatives.

Table A-15
Screening of Technologies – Extracted Groundwater and Vapor Treatment
Casmalia Resources Superfund Site
Casmalia, CA

Technology Type	Description	Contaminant Scenario	Effectiveness	Implementability	Cost	Screening Comments
EXTRACTED GROUNDWATER TREATMENT TECHNOLOGIES						
Liquid Phase Granular Activated Carbon (LPGAC) Powdered Activated Carbon (PAC)	Using LPGAC in a series of vessels to adsorb dissolved organic contamination in groundwater in aboveground treatment systems. Powdered Activated Carbon is used in wastewater treatment and has been used for some groundwater applications including landfill leachate treatment.	Dissolved VOCs and other organics in groundwater	Good Well proven for most VOCs at low to moderate concentrations except for a few such as vinyl chloride, methylene chloride.	Good Technically implementable.	Moderate to High	Retained Because it is an effective technology for VOCs in groundwater for low to moderate concentrations and as a polishing technology.
Synthetic resin - Macroporous Polymer Extraction (MPPE)	Using synthetic resins or polymeric beads to adsorb dissolved organic contamination in aboveground groundwater treatment systems	Dissolved VOCs and other organics in groundwater	Good MPPE has been more effective and is a viable option to be considered for aboveground treatment of high VOC and other organics in groundwater.	Moderate to Good Technically implementable but some uncertainty with reliability and limited number of vendors.	Very High	Retained for treating highly concentrated DNAPL groundwater stream Because it is an effective technology but limited number of full scale applications in groundwater remediation applications.
Air stripper	Using air stripper to strip VOCs from extracted groundwater that uses air injection from a blower. Air strippers can be in a packed bed or a parallel tray configuration.	Dissolved VOCs in groundwater	Good For those VOCs that have a high Henry's law constant and are easily stripped.	Good Technically implementable but challenges with high TDS in groundwater. May need acidification to solids in solution.	Moderate	Retained for use as part of a treatment train Because it is an effective technology for VOCs in groundwater. However, high dissolved solids in groundwater pose operational problems. Acidification prior to stripping can retain solids in solution.
Bioreactors	Bioreactors involved treatment of influent water with aerobic or anaerobic biodegradation including addition of microbes and nutrients and the use of media for growth of microbes. Fixed film or fluidized bed bioreactors are examples. Bio-PACT is an example of a combined bioreactor and activated carbon system.	Dissolved VOCs and other organics in groundwater	Good Has been used effectively in landfill leachate applications.	Good Has been used effectively in landfill leachate applications but some challenges with meeting air quality requirements of local agencies.	High	Retained for use as part of a treatment train. Because it has been used in landfill leachate treatment applications with VOCs and other organics.
Chemical oxidation/Advanced oxidation - Peroxide - Ozone - UV	Using injected oxidant chemicals such as peroxide or ozone in piping or reactors to oxidize organics. Also, UV-based enhanced photooxidation can similarly degrade organics dissolved in extracted water.	Dissolved VOCs and other organics in groundwater	Good Is effective for organics oxidation but can produce secondary byproducts that may need treatment such as ketones.	Good Technically implementable.	High	Retained for use as part of a treatment train Because it is an effective technology for VOCs and other organics in groundwater.
Ion Exchange	Uses ion exchange resins to adsorb anions or cations in groundwater to remove metals and other contaminants.	Dissolved metals, anions or cations in groundwater	Moderate to Good Effective for treatment of stormwater or treated water in ponds for discharge to storm drain (NPDES discharge).	Moderate to Good Technically implementable.	High	Not retained Because it is rated lower than reverse osmosis with respect to ability to handle high TDS.
Reverse Osmosis	Uses high pressure to push contaminated water through a semipermeable membrane that allows water to pass through but does not allow the contaminants such as dissolved metals or other inorganics/anions to pass through.	Dissolved metals and anions, TDS in groundwater	Good Effective for treatment of stormwater or treated water in ponds for discharge to storm drain (NPDES discharge).	Good Technically implementable.	High	Retained Because it is an effective technology for metals and high TDS in groundwater.

Table A-15
Screening of Technologies – Extracted Groundwater and Vapor Treatment
Casmalia Resources Superfund Site
Casmalia, CA

Technology Type	Description	Contaminant Scenario	Effectiveness	Implementability	Cost	Screening Comments
Membrane filtration - Vibratory Shear Enhanced Process (VSEP)	Uses membranes with nano or microfiltration techniques to remove fine particulate metal, inorganics or other contamination. VSEP is a vibrating membrane filtration process that is effective for metals and other inorganics.	Dissolved metals and other inorganics in groundwater	Good Effective for treatment of stormwater or treated water in ponds for discharge to storm drain (NPDES discharge).	Good Technically implementable.	Moderate to High	Retained Because it is an effective technology for metals in groundwater.
Oil-Water separator	Using oil-water separators to remove any extracted LNAPL or DNAPL prior to water treatment	Dissolved contaminants in groundwater NAPL	Good Effective for NAPL removal in extracted groundwater, especially LNAPL.	Good Technically implementable.	Moderate to High	Retained for use as part of a treatment train Because it is an effective technology for NAPL separation in groundwater.
Acidification/Neutralization	Acidification involves adding acid to reduce pH that is considered for use before the air stripper to keep solids in solution (reduce deposits in stripper). Neutralization is adding a base after air stripping prior to other treatment steps.	Dissolved VOCs and other organics in groundwater	Good Effective approach to keep metals and solids in solution in air stripper	Good Has been widely implemented in air stripping treatment.	Moderate to High	Retained for use with air stripping if needed.
EXTRACTED VAPOR TREATMENT TECHNOLOGIES						
Thermal oxidation - Thermal oxidizer - Internal Combustion Engine - Catalytic oxidizer - Catox + scrubber (for Cl-solvents) - Flameless thermal oxidizer	Treatment of extracted vapors containing hydrocarbons or VOCs by thermal destruction in oxidizers that burn fuels such as natural gas or propane. This includes oxidizers that destroy VOCs on heated catalysts, which is also an effective option for chlorinated solvent vapors. Flameless oxidizers refer to VOC destruction on heated ceramic media without direct contact with the flame.	VOCs in extracted vapor	Good Technology is well proven.	Moderate to Good Some challenges may be encountered due to community concerns with formation of dioxins.	Moderate to High	Retained Because it is one of the most effective technologies for treatment of high VOC concentrations in the vapor phase.
Adsorption - Granular activated carbon (GAC) - Polymeric resin - VPGAC and Steam Regeneration	Treatment of extracted vapors by adsorption of hydrocarbons or VOCs in media such as vapor phase carbon or polymeric resins. The adsorption media is either taken offsite for recycling/reuse or regenerated onsite. Carbon can be regenerated onsite using steam.	VOCs in extracted vapor	Good Technology is well proven. VPGAC is typically used at low vapor concentrations.	Good If onsite regeneration is selected, then waste steam such as VOC impacted groundwater and NAPL will need to be disposed offsite or treated onsite.	Moderate to High	Retained for GAC. Cost effectiveness is better at lower vapor concentrations. Onsite steam regeneration cost is very high but offsite regeneration is more cost effective. Resin systems have not been adopted widely because of cost and operational difficulties with regeneration.
Refrigeration/Condensation	Treatment of extracted vapors containing VOCs by cooling and compressing to condense and remove VOCs. Condensed contaminants are removed as liquids and either taken offsite for treatment/disposal or treated onsite.	VOCs in extracted vapor	Good This technology is not widely used in the site remediation field.	Moderate Only one vendor (GEO) is available	Very High	Not retained. Refrigeration systems are not commonly used in remediation applications but it may be a viable option if extracted Cl-VOC vapor is very high.
Acid scrubber	Treatment of extracted vapors containing acids (e.g. HCl from catalytic oxidizer) by an acid scrubber where the vapors are contacted with a spray of alkaline (e.g. NaOH) water to dissolve and neutralize the acid.	Acids in vapor	Good Technology is readily available.	Good Readily implementable.	High	Retained For specific application with catalytic oxidation of chlorinated vapors if needed.

Table A-15
Screening of Technologies – Extracted Groundwater and Vapor Treatment
Casmalia Resources Superfund Site
Casmalia, CA

NOTES

1. Definitions of Criteria :
   -Effectiveness is ability of the remedial technology to achieve the RAOs;
   -Implementability is a measure of the technical and administrative feasibility of constructing, operating and maintaining a remedial alternative; and,
   -Cost refers to a relative cost compared with other technologies in same technology type. Costs will be refined later in the FS process.
2. Table uses a five-point rating scheme: Good, Moderate to Good, Moderate, Poor to Moderate, Poor.
   For Cost, the table uses a five-point rating scheme: Low, Low to Moderate, Moderate, Moderate to High, High.
3. Retained technologies in table are identified as shaded rows.

FIGURES

FOR ALL APPENDIX A FIGURES, PLEASE REFER TO:

Appendix A Figures.pdf.

ATTACHMENT A-1

CALCULATIONS OF TIME FOR DIFFUSIVE DISAPPEARANCE OF DNAPL IN FRACTURES AND FOR DIFFUSION FROM FRACTURED CLAY MATRIX

LIST OF TABLES

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Table A1-2 Calculations of Time for Diffusive Disappearance of DNAPL in Fractures
Table A1-3 Input Parameters Used in Calculations for Diffusion from Fractured Clay Matrix
Table A1-4 Calculations for Diffusion from Fractured Clay Matrix

Table A1-1
Input Parameters Used in Calculations of Time for Diffusive Disappearance of DNAPL in Fractures
TI Evaluation
Final Feasibility Study
Casmalia Resources Superfund Site

	Units	Tetrachloroethene	Trichloroethene	Source
Chemical Properties				
Density (ρ)	g/cm^3	1.623	1.4642	USEPA Region 3,6,9 RSLs - May 2010
Aqueous Solubility (S_w)	mg/L	206	1,280	USEPA Region 3,6,9 RSLs - May 2010
Organic Carbon Partition Coefficient (K_{oc})	mL/g	94.94	60.70	USEPA Region 3,6,9 RSLs - May 2010
Free-Solution Diffusion Coefficient (D_o)	cm^2/s	9.50E-06	1.01E-05	USEPA Region 3,6,9 RSLs - May 2010
Porous Matrix Properties				
Porosity (φ)	dimensionless	0.44	0.44	Mean Value for Lower HSU from RI Section 4.5.2.4 - CSC (2011)
Bulk Density (ρ_b)	g/cm^3	1.86	1.86	RI Attachment M-4 - CSC (2011)
Fraction Organic Carbon (f_{oc})	dimensionless	0.00472	0.00472	Median Value from RI Table M4-1 - CSC (2011)
Apparent Tortuosity (τ)	dimensionless	0.03	0.03	RI Diffusion Tests of Core Samples - Golder Associates Ltd. (2007)
Effective Diffusion Coefficient (D_e)	cm^2/s	2.85E-07	3.03E-07	$D_e = D_o \times \tau$
Chemical/Porous Matrix Properties				
Distribution Coefficient (K_d)	mL/g	0.4481168	0.286504	$K_d = K_{oc} \times f_{oc}$
Retardation Factor (R)	dimensionless	2.89	2.21	$R = 1 + (\rho_b/\varphi) \times K_d$
Fracture Properties				
Fracture Aperture (b)	cm	0.0033	0.0033	Median Value for Lower HSU from RI Table 4-5 - CSC (2011)

Objective: Determine the time between the first arrival of DNAPL in a fracture and the complete disappearance of DNAPL in the fracture due to diffusion into the porous matrix.

References: Parker, B. L., R. W. Gillham, and J. A. Cherry, 1994, "Diffusive Disappearance of Immiscible-Phase Organic Liquids in Fractured Geologic Media," *Ground Water*, Vol 32, No. 5, pp. 805-820.

Parker, B. L., J. A. Cherry, and R. W. Gillham, 1996, "Effects of Molecular Diffusion on DNAPL Behavior in Fractured Porous Media," in *Dense Chlorinated Solvents and other DNAPLs in Groundwater*, J. F Pankow and J. A Cherry, Editors, Waterloo Press, pp. 355-393.

Procedure: Use the analysis and mathematical functions provided by Parker et al. (1994, 1996) to determine the time required for the diffusive loss of DNAPL in a parallel-plate fracture. Parker et al. (1994, 1996) provide a relationship giving the total DNAPL mass diffused into the porous matrix per unit area of fracture face, which can be solved for DNAPL disappearance time when the total diffusive mass loss equals all of the DNAPL originally in the fracture. Worksheet calculations and setup were checked against two examples in Parker et al. (1994).

Tetrachloroethene

Chemical Properties

Density (ρ):	$\rho := 1.623$	g/cm^3
Aqueous Solubility (S_w):	$S_w := 206$	mg/L
	$S_w := 206 \cdot 0.000001$	g/cm^3
Organic Carbon Partition Coefficient (K_{oc}):	$K_{oc} := 94.94$	mL/g
Free-Solution Diffusion Coefficient (D_o):	$D_o := 9.5 \cdot 10^{-6}$	cm^2/s

Porous Matrix Properties

Porosity (φ):	$\varphi := 0.44$		dimensionless
Bulk Density (ρ_b):	$\rho_b := 1.86$		g/cm^3
Fraction Organic Carbon (f_{oc}):	$f_{oc} := 0.00472$		dimensionless
Apparent Tortuosity (τ):	$\tau := 0.03$		dimensionless
Effective Diffusion Coefficient (D_e):	$D_e := D_o \cdot \tau$	$D_e = 2.85 \times 10^{-7}$	cm^2/s

Chemical/Porous Matrix Properties

Distribution Coefficient (K_d):	$K_d := K_{oc} \cdot f_{oc}$	$K_d = 0.448117$	mL/g
Retardation Factor (R_f):	$R_f := 1 + \frac{\rho_b}{\varphi} \cdot K_d$	$R_f = 2.89$	dimensionless

Fracture Properties

Fracture Aperture (b):	$b := 0.0033$	cm

DNAPL Diffusive Dissappearance Time (t_d)

$$t_d := \frac{\pi \cdot \rho^2}{16 \cdot S_w^{\,2} \cdot \varphi^2 \cdot D_e \cdot R_f} \cdot b^2 \qquad t_d = 8.311 \times 10^8 \text{ sec}$$

$$\frac{t_d}{86400} = 9619.47 \text{ days}$$

Trichloroethene

Chemical Properties

Density (ρ): $\rho := 1.4642$ g/cm^3

Aqueous Solubility (S_w): $S_w := 1280$ mg/L

$S_w := 1280 \cdot 0.000001$ g/cm^3

Organic Carbon Partition Coefficient (K_{oc}): $K_{oc} := 60.70$ mL/g

Free-Solution Diffusion Coefficient (D_o): $D_o := 1.01 \cdot 10^{-5}$ cm^2/s

Porous Matrix Properties

Porosity (φ): $\varphi := 0.44$ dimensionless

Bulk Density (ρ_b): $\rho_b := 1.86$ g/cm^3

Fraction Organic Carbon (f_{oc}): $f_{oc} := 0.00472$ dimensionless

Apparent Tortuosity (τ): $\tau := 0.03$ dimensionless

Effective Diffusion Coefficient (D_e): $D_e := D_o \cdot \tau$ $D_e = 3.03 \times 10^{-7}$ cm^2/s

Chemical/Porous Matrix Properties

Distribution Coefficient (K_d): $K_d := K_{oc} \cdot f_{oc}$ $K_d = 0.286504$ mL/g

Retardation Factor (R_f): $R_f := 1 + \frac{\rho_b}{\varphi} \cdot K_d$ $R_f = 2.21$ dimensionless

Fracture Properties

Fracture Aperture (b): $b := 0.0033$ cm

DNAPL Diffusive Dissappearance Time (t_d)

$$t_d := \frac{\pi \cdot \rho^2}{16 \cdot S_w^{\,2} \cdot \varphi^2 \cdot D_e \cdot R_f} \cdot b^2$$

$t_d = 2.157 \times 10^7$ sec

$\frac{t_d}{86400} = 249.67$ days

Table A1-3
Input Parameters Used in Calculations for Diffusion from Fractured Clay Matrix
TI Evaluation
Final Feasibility Study
Casmalia Resources Superfund Site

	Units	Tetrachloroethene	Trichloroethene	Source
Chemical Properties				
Density (ρ_n)	g/cm^3	1.623	1.4642	USEPA Region 3,6,9 RSLs - May 2010
Aqueous Solubility (ρ_{nsol})	mg/L	206	1,280	USEPA Region 3,6,9 RSLs - May 2010
Organic Carbon Partition Coefficient (K_{oc})	mL/g	94.94	60.70	USEPA Region 3,6,9 RSLs - May 2010
Free-Solution Diffusion Coefficient (D_w)	cm^2/s	9.50E-06	1.01E-05	USEPA Region 3,6,9 RSLs - May 2010
Porous Matrix Properties				
Porosity (φ)	dimensionless	0.44	0.44	Mean Value for Lower HSU RI Section 4.5.2.4 - CSC (2011)
Bulk Density (ρ_b)	g/cm^3	1.86	1.86	RI Attachment M-4 - CSC (2011)
Water Saturation (S_w)	dimensionless	1.00	1.00	Assumed (below water table)
Fraction Organic Carbon (f_{oc})	dimensionless	0.00472	0.00472	Median Value from RI Table M4-1 - CSC (2011)
Apparent Tortuosity (φ^p)	dimensionless	0.03	0.03	RI Diffusion Tests of Core Samples - Golder Associates Ltd. (2007)
Effective Diffusion Coefficient (D_{ew})	cm^2/s	2.85E-07	3.03E-07	$D_{ew} = D_w \times \varphi^p \times S_w^{7/3} = D_w \times \varphi^p$ for S_w = 1.0 - Parker et al. (1994)
Chemical/Porous Matrix Properties				
Distribution Coefficient (K_d)	mL/g	0.4481168	0.286504	$K_d = K_{oc} \times f_{oc}$
Retardation Factor (R_w)	dimensionless	2.89	2.21	$R_w = 1 + (\rho_b/\varphi) \times K_d$
Fracture Properties				
Fracture Spacing (L)	cm	258	258	Median Value for Lower HSU from RI Figure E-22 and Attachment E-7 - CSC (2011)
Fracture Aperture (b)	cm	0.0033	0.0033	Median Value for Lower HSU from RI Table 4-5 - CSC (2011)
Initial and Target Chemical Concentrations				
Initial Total Chemical Concentration (ρ_{oT})	mg/L	62.278	56.184	$\rho_{oT} = (1/2 \times b \times L \times 6 \times \rho_n)/L^3$ - Parker et al. (1997)
Target Chemical Concentration (ρ_w)	mg/L	0.005	0.005	MCLs - 22 CCR 64444

Objective: Determine the time required for a mass of contaminant, after it has dissolved from the fractures and diffused into the low permeability clay matrix, to diffuse back out of that matrix into the fracture in response to that fracture being continually flushed with clean water. The time to be calculated is the time for concentrations in the block to decrease to some criteria, such as a regulatory standard.

References:

Parker, B. L., R. W. Gillham, and J. A. Cherry, 1994, "Diffusive Disappearance of Immiscible-Phase Organic Liquids in Fractured Geologic Media," *Ground Water*, Vol 32, No. 5, pp. 805-820.

Parker, B. L., J. A. Cherry, and R. W. Gillham, 1996, "Effects of Molecular Diffusion on DNAPL Behavior in Fractured Porous Media," in *Dense Chlorinated Solvents and other DNAPLs in Groundwater*, J. F Pankow and J. A Cherry, Editors, Waterloo Press, pp. 355-393.

Parker, B. L., D. B. McWhorter, and J. A. Cherry, 1997, "Diffusive Loss of Non-Aqueous Phase Organic Solvents from Idealized Fracture Networks in Geologic Media," *Ground Water*, Vol 35, No. 6, pp. 1077-1088.

Shackelford, C.D., and D.E. Daniel, 1991, "Diffusion in Saturated Soil. I: Background," Journal of Geotechnical Engineering, Vol. 117, No. 3, March, pp. 467-484.

Procedure: Use the analysis and mathematical functions provided by Parker et al., (1996, 1997) to determine the time required for a mass of contaminant equal to one times the fracture DNAPL storage capacity to diffuse back out of the clay matrix. Parker et al., (1996, 1997) provide a relationship giving mass remaining in the matrix at a time after the fracture started being flushed with clean water. This relationship is solved here for the time at which the mass remaining gives a concentration equal to regulatory standards for that contaminant. Worksheet calculations and setup were checked against two unpublished examples.

List of symbols used in calculations:

ρ_n = DNAPL density

ρ_{nsol} = DNAPL aqueous solubility

K_{oc} = organic carbon partition coefficient

L = fracture length (of cubic fracture, and thus, spacing length)

D_w = free-solution diffusion coefficient

ϕ = matrix porosity

f_{oc} = fraction of organic carbon in matrix material

S_w = water saturation

ρ_b = matrix bulk density

b = fracture aperture

p = empirical parameter for effective diffusion calculation

TOL = Mathcad worksheet calculation tolerance level

ϕ^p = apparent tortuosity

ρ_w = target chemical concentration

D_{ew} = effective diffusion coefficient

K_D = distribution coefficient

R_w = "retardation" coefficient (a storage factor)

ρ_{ow} = also equal to DNAPL aqueous solubility

ρ_{oT} = average initial total chemical concentration

mass = original DNAPL mass in fracture

block = storage capacity of matrix block for dissolved and sorbed contaminant

t_R = time

m = meter

cm = centimeter

kg = kilograms

gm = grams

mg = milligrams

mL = milliliters

sec = second

Contaminant diffusion out of matrix, into flushed, clean fractures.

Tetrachloroethene

Parameters:

$\rho_n := 1623 \cdot \frac{kg}{m^3}$ $\rho_{nsol} := 206 \cdot \frac{mg}{liter}$ $K_{oc} := 94.94 \cdot \frac{mL}{gm}$ $L := 258 \cdot cm$ $D_w := 9.5 \cdot 10^{-6} \cdot \frac{cm^2}{sec}$ $\phi := 0.44$ $f_{oc} := 0.00472$

$S_w := 1.0$ $\rho_b := 1.86 \cdot \frac{gm}{cm^3}$ $b := 3.3 \cdot 10^{-5} \cdot m$ $p := 4.29$ $TOL := 1 \cdot 10^{-6}$ $\phi^p = 0.03$ $\rho_w := 0.005 \cdot \frac{mg}{liter}$

Relationships:

$D_{ew} := D_w \cdot \phi^p \cdot S_w^{\frac{7}{3}}$ $K_D := f_{oc} \cdot K_{oc}$ $R_w := 1 + \frac{\rho_b \cdot K_D}{\phi}$ $\alpha := \frac{D_{ew}}{R_w}$ $\rho_{ow} := \rho_{nsol}$

$\rho_T(\rho_w) := S_w \cdot \phi \cdot R_w \cdot \rho_w$

$D_{ew} = 2.806 \times 10^{-7} \cdot \frac{cm^2}{sec}$ $R_w = 2.894$ $\alpha = 9.696 \times 10^{-12} m^2 \cdot s^{-1}$

Average total concentration:

(Total mass in the fracture associated with each matrix block:)

$\rho_{oT} := \frac{\frac{1}{2} \cdot b \cdot L^2 \cdot 6 \cdot \rho_n}{L^3}$ $\rho_{oT} = 62.278 \cdot \frac{mg}{liter}$

$mass := \frac{1}{2} \cdot b \cdot L^2 \cdot 6 \cdot \rho_n$ $block := L^3 \cdot \phi \cdot \rho_{nsol} \cdot R_w$

$mass = 1.07 \times 10^3 \cdot gm$ $block = 4.505 \times 10^3 \cdot gm$

and using the Fourier Series:

$$P(t_R) := \frac{8}{\pi^2} \cdot \sum_{n=0}^{100} \left[(2 \cdot n + 1)^{-2} \cdot \exp\left[\frac{-(2 \cdot n + 1)^2 \cdot \pi^2 \cdot \alpha \cdot t_R}{L^2} \right] \right]$$

Under the initial condition $\rho_T = \rho_{oT}$ everywhere, and the boundary condition $\rho_T = 0$, the total mass remaining in the matrix is given by:

$M(t_R) := \rho_{oT} \cdot L^3 \cdot P(t_R)^3$

$\rho_w = 5 \times 10^{-3} \cdot \frac{mg}{liter}$ $t_R := 1000 \cdot day$ (seed value for root solver)

$root\left[M(t_R) - \left(\rho_T(\rho_w) \cdot L^3\right), t_R\right] = 2.297 \times 10^6 \cdot day$

$root\left[M(t_R) - \left(\rho_T(\rho_w) \cdot L^3\right), t_R\right] = 6.288 \times 10^3 \cdot yr$

$\frac{M(6288 \cdot yr)}{\phi \cdot R_w \cdot L^3} = 0.005 \cdot \frac{mg}{liter}$

Time for diffusion out of blocks to reach water concentration of 5 ppb is approximately 6300 years.

Contaminant diffusion out of matrix, into flushed, clean fractures.

Trichloroethene

Parameters:

$\rho_n := 1464.2 \cdot \frac{kg}{m^3}$ $\rho_{nsol} := 1280 \cdot \frac{mg}{liter}$ $K_{oc} := 60.7 \cdot \frac{mL}{gm}$ $L := 258 \cdot cm$ $D_w := 1.0 \cdot 10^{-5} \cdot \frac{cm^2}{sec}$ $\phi := 0.44$ $f_{oc} := 0.00472$

$S_w := 1.0$ $\rho_b := 1.86 \cdot \frac{gm}{cm^3}$ $b := 3.3 \cdot 10^{-5} \cdot m$ $p := 4.29$ $TOL := 1 \cdot 10^{-6}$ $\phi^p = 0.03$ $\rho_w := 0.005 \cdot \frac{mg}{liter}$

Relationships:

$D_{ew} := D_w \cdot \phi^p \cdot S_w^{\frac{7}{3}}$ $K_D := f_{oc} \cdot K_{oc}$ $R_w := 1 + \frac{\rho_b \cdot K_D}{\phi}$ $\alpha := \frac{D_{ew}}{R_w}$ $\rho_{ow} := \rho_{nsol}$

$\rho_T(\rho_w) := S_w \cdot \phi \cdot R_w \cdot \rho_w$

$R_w = 2.211$ $\alpha = 1.336 \times 10^{-11} m^2 \cdot s^{-1}$

Average total concentration:

(Total mass in the fracture associated with each matrix block:)

$$\rho_{oT} := \frac{\frac{1}{2} \cdot b \cdot L^2 \cdot 6 \cdot \rho_n}{L^3} \qquad \rho_{oT} = 56.184 \cdot \frac{mg}{liter}$$

$$mass := \frac{1}{2} \cdot b \cdot L^2 \cdot 6 \cdot \rho_n \quad block := L^3 \cdot \phi \cdot \rho_{nsol} \cdot R_w$$

$$mass = 964.884 \cdot gm \quad block = 2.139 \times 10^4 \cdot gm$$

and using the Fourier Series:

$$P(t_R) := \frac{8}{\pi^2} \cdot \sum_{n=0}^{100} \left[(2 \cdot n + 1)^{-2} \cdot \exp\left[\frac{-(2 \cdot n + 1)^2 \cdot \pi^2 \cdot \alpha \cdot t_R}{L^2} \right] \right]$$

Under the initial condition $\rho_T = \rho_{oT}$ everywhere, and the boundary condition $\rho_T = 0$, the total mass remaining in the matrix is given by:

$$M(t_R) := \rho_{oT} \cdot L^3 \cdot P(t_R)^3$$

$\rho_w = 5 \times 10^{-3} \cdot \frac{mg}{liter}$ $t_R := 1000 \cdot day$ (seed value for root solver)

$$root\left[M(t_R) - \left(\rho_T(\rho_w) \cdot L^3\right), t_R\right] = 1.699 \times 10^6 \cdot day$$

$$root\left[M(t_R) - \left(\rho_T(\rho_w) \cdot L^3\right), t_R\right] = 4.652 \times 10^3 \cdot yr$$

$$\frac{M(4652 \cdot yr)}{\phi \cdot R_w \cdot L^3} = 0.005 \cdot \frac{mg}{liter}$$

Time for diffusion out of blocks to reach water concentration of 5 µg/L is approximately 4650 years.

ATTACHMENT A-2

NUMERICAL MODELING TIME FRAME DEMONSTRATION

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LIST OF ACRONYMS

CSC	Casmalia Resources Superfund Site Steering Committee
DNAPL	Dense non-aqueous phase liquid
HSU	Hydrostratigraphic Unit
PCE	Tetrachloroethene
PCT	Perimeter Control Trench
PSCT	Perimeter Source Control Trench
TCE	Trichloroethene
RI	Remedial Investigation

1.0 Numerical Modeling Time Frame Demonstration

The remediation time frame after complete removal of the dense non-aqueous phase liquid (DNAPL) and dissolved metals sources was evaluated with the numerical model code FRACTRAN. FRACTRAN is a two-dimensional, finite-element, solute transport model code developed by the University of Waterloo (Sudicky and McLaren, 1997). The model simulates combined steady-state groundwater flow and transient solute transport in porous or discretely-fractured porous media. FRACTRAN has been verified to analytical solutions and has been peer-reviewed in technical journals (Sudicky, 1989; Sudicky and McLaren, 1992; Harrison, et al., 1992).

For this remedial time frame analysis, simplified conceptual vertical profile models were constructed with FRACTRAN for Area 5 North. The design and construction of the models are described in the following subsections.

2.0 Model Design

This subsection describes the principal design elements of the FRACTRAN models. These design elements include the model grid and layering, the flow and transport boundary conditions, the porous matrix and fracture parameters, and other physical parameters used in the model simulations.

2.1 Model Grid

The model grid constructed for the FRACTRAN models is a variably-spaced, finite-element grid composed of linear rectangular elements. The model grid is approximately 980 feet (300 meters) in length and 160 feet (50 meters) in depth (Figure A2-1).

2.2 Model Grid Layers

The shallow groundwater flow systems Casmalia Resources Superfund Site (site) are represented in the model as six layers (Figure A2-1). The upper three layers (layers 1 through 3) represent the weathered claystones in the Upper Hydrostratigraphic Unit (HSU). The lower three layers (layers 4 through 6) represent the unweathered claystones in the Lower HSU. These six layers correspond to the upper six layers of the site-wide groundwater flow model that was developed for the Remedial Investigation (RI) (Casmalia Resources Superfund Site Steering Committee [CSC], 2011).

2.3 Flow Conditions

Flow conditions in the FRACTRAN models are simulated as confined as a simplifying assumption in model design. FRACTRAN is limited to simulating confined flow conditions (Sudicky and McLaren, 1997).

2.4 Flow Boundaries and Initial Flow Conditions

The flow boundaries of a groundwater model define the head elevation or groundwater flow rate along the boundaries of the model domain. These boundary conditions represent the effects of hydrogeologic conditions outside the model domain.

Constant-head (also known as Dirichlet or first-type) boundaries were used along the top, bottom, left, and right boundaries of the model grids. These constant-head boundaries simulate the horizontal and vertical hydraulic gradient observed in Area 5 North. The elevations of the constant-head boundaries were set to simulate a uniform horizontal gradient of 0.11 foot/foot and uniform vertical gradient of 0.15 foot/foot, the average horizontal and vertical hydraulic gradients in Area 5 North (CSC, 2011).

2.5 Transport Boundaries and Initial Transport Conditions

The transport boundary conditions define the solute concentrations or solute flux along the boundaries of the model domain. They also simulate hydrogeologic and source conditions that control the migration of dissolved contaminants in groundwater flow systems.

A constant-concentration (also known as Dirichlet or first-type) boundary was used in the FRACTRAN models to simulate a conceptual DNAPL source along the Upper/Lower HSU contact and extending downward into the Lower HSU (Figure A2-1). A concentration of 12.8 milligrams per liter was used to simulate a trichloroethene (TCE) DNAPL source and a concentration of 2.06 milligrams per liter was used to simulate a tetrachloroethene (PCE) source (Table A2-1). These concentrations are approximately equal to 1% of the aqueous solubility of TCE and PCE, respectively (Cohen et al., 1993).

A third-type concentration (also known as Cauchy or mixed-type) boundary was used in the FRACTRAN models to simulate conceptual dissolved source of arsenic, cadmium, nickel, and selenium along the top of the model grids (Figure A2-1). The boundary concentrations used in the model for the arsenic, cadmium, nickel, and selenium sources are summarized in Table A2-1 and were set at representative concentrations of these metals in Area 5 North during the RI (CSC, 2011).

2.6 Porous Matrix Parameters

The parameters for the unfractured porous matrix used in the FRACTRAN model are summarized in Table A2-1. A hydraulic conductivity of 3.4×10^{-8} centimeters per second was used for the unfractured porous matrix of the unweathered claystones in the Lower HSU (layers 4 through 6) based on the results of packer tests (CSC, 2011). Since there are no measured values for hydraulic conductivity of the unfractured porous matrix of the weathered claystones in the Upper HSU, a hydraulic conductivity of 3.4×10^{-7} centimeters per second was assumed for the porous matrix of layers 1 through 3 (Upper HSU), a value an order of magnitude higher than the Lower HSU claystones based on the measured hydraulic conductivities of poorly fractured weathered claystones at the site (CSC, 2011). A porosity of 0.48 was used for the Upper HSU claystones (layers 1 through 3) and a porosity of 0.44 was used for the Lower HSU claystones (layers 4 through 6) based on results of laboratory measurements of core samples (CSC, 2011). Uniform values of hydraulic conductivity and porosity were used for the model layers

representing the Upper and Lower HSUs as a simplifying assumption in the design of the model.

Because hydrodynamic dispersion due to mechanical mixing is likely to be negligible in claystones where groundwater velocities are very small (Harrison, et al., 1992), longitudinal and transverse dispersivity values are assumed to equal zero in the model layers representing the Upper and Lower HSUs.

The free-solution diffusion coefficients used for the chemicals in the transport simulations are from published values and are summarized in Table A2-1. Uniform apparent tortuosities of 0.02 and 0.03 were used for the Upper and Lower HSUs, respectively, to estimate the effective diffusion coefficients of the chemicals in the model simulations based on diffusion testing of core samples from the site (Golder Associates, Ltd., 2007). A retardation factor of 1.0 (no sorption of chemicals to the organic or inorganic fractions of the porous matrix) was used as a conservative assumption in the model simulations.

2.7 Fracture Parameters

The fracture parameters used in the FRACTRAN model are summarized in Table A2-1. These parameters represent the properties of the interconnected fracture network in the Upper and Lowers HSUs. A fracture density of 0.1 was used in layers 4 through 6 (Lower HSU) to produce an approximate fracture spacing of 6 feet (2.0 meters), the median fracture spacing measured in the RI well borings (CSC, 2011). A uniform fracture aperture of 33 microns was used for the Lower HSU claystones (layers 4 through 6) based on the results of packer tests (CSC, 2011). There are no reliable measured values for the fracture spacing and aperture in the Upper HSU claystones because the fracturing is highly variable and the result of physical and diagenetic alteration of the surface exposure of the claystone (CSC, 2011). Therefore, conservative values for the fracture spacing and aperture in the Upper HSU claystones were used in the model simulations. A vertical fracture density of 0.8, which produced an approximate fracture spacing of 3 feet (1.0 meter), and a uniform fracture aperture of 60 microns were used as conservative values for the Upper HSU claystones (layers 1 through 3). A uniform spacing, aperture, and dispersivity were used in each layer as a simplifying assumption in the design of the model.

2.8 Other Non-Varying Physical Parameters

Other non-varying physical parameters used in the FRACTRAN simulations are:

- Fluid (water) density – 1,000 kilograms/meter^3 (1.0 gram/centimeter^3);
- Fluid (water) viscosity - 86.4 kilograms/day-meter (0.01 poise);
- Gravitational acceleration - 7.3223 x 10^{10} meters/day^2 (9.81 meters/second^2);

3.0 Simulation Results

3.1 DNAPL

This section describes the DNAPL modeling results.

3.1.1 Trichloroethene DNAPL Source

The TCE DNAPL model was first solved for a simulation time of 30 years, the approximate time since the landfill construction at the site was completed (CSC, 2011), with the constant-concentration boundary representing the conceptual DNAPL source area along the Upper/Lower HSU contact in the model. The results of the simulation are shown in Figure A2-2. This simulation shows the dissolved-phase plume concentrations downgradient of the source area 30 years after a volatile organic compound release (with DNAPL present along the Upper/Lower HSU contact and extending into the Lower HSU). The DNAPL modeling result figures (Figures A2-1 through A2-9) also show the conceptual locations of the Perimeter Source Control Trench (PSCT) and the Perimeter Control Trenches (PCTs) based on distance from the DNAPL source location. Although shown on these figures, these extraction features are not incorporated into the FRACTRAN model.

3.1.2 Trichloroethene DNAPL Source Removed

To simulate TCE DNAPL source removal, the constant-concentration boundary representing the DNAPL source area was removed from the model and the model was solved for future conditions at simulation times of 30 years, 100 years, and 500 years using the concentration solutions from the DNAPL source simulations as the initial concentrations conditions. The results of the simulations are shown in Figures A2-3 to A2-5. These simulations represent the dissolved-phase plume concentrations 30 years, 100 years, and 500 years after complete DNAPL source removal.

3.1.3 Tetrachloroethene DNAPL Source

The PCE DNAPL model was first solved for a simulation time of 30 years, the approximate time since the landfill construction at the site was completed (CSC, 2011), with the constant-concentration boundary representing the conceptual DNAPL source area along the Upper/Lower HSU contact in the model. The results of the simulation are shown in Figure A2-6. This simulation shows the dissolved-phase plume concentrations downgradient of the source area 30 years after a volatile organic compound release (with DNAPL present along the Upper/Lower HSU contact and extending into the Lower HSU).

3.1.4 Tetrachloroethene DNAPL Source Removed

To simulate PCE DNAPL source removal, the constant-concentration boundary representing the DNAPL source area was removed from the model and the model was solved for future conditions at simulation times of 30 years, 100 years, and 500 years using the concentration solutions from the DNAPL source simulations as the initial concentrations conditions. The results of the simulations are shown in Figures A2-6 to A2-9. These simulations represent the dissolved-phase plume concentrations 30 years, 100 years, and 500 years after complete DNAPL source removal.

3.1.5 Remediation Time Frame after Complete DNAPL Removal

These simulations show that if all DNAPL could be removed immediately, there would be an eventual decrease in downgradient groundwater concentrations, but the change would occur very slowly, and the DNAPL removal would have very little impact on future downgradient

groundwater concentrations in the Upper and Lower HSU. The time frame for achieving groundwater concentrations at cleanup standards if the DNAPL were removed would be more than 500 years. Given the fact that the DNAPL cannot be completely removed, the groundwater concentrations will probably remain above cleanup levels for an indeterminate amount of time.

3.2 Dissolved Metals

3.2.1 Arsenic

The dissolved arsenic model results are discussed below.

3.2.1.1 Arsenic Source

The dissolved arsenic model was first solved for a simulation time of 30 years, the approximate time since the landfill construction at the site was completed (CSC, 2011), with the third-type concentration boundary representing the conceptual dissolved arsenic source area along the top of the model grid. The results of the simulation are shown in Figure A2-10. This simulation shows the dissolved arsenic concentrations downgradient of the source area 30 years after release to the groundwater flow system. The dissolved metals modeling result figures (Figures A2-10 through A2-21) do not show the conceptual locations of the PSCT and PCTs because unlike the DNAPL sources, the sources of the dissolved metals do not appear to be localized. Showing a conceptual distance from a diffuse source to a site feature is not relevant.

3.2.1.2 Arsenic Source Removed

To simulate arsenic source removal, the third-type concentration boundary representing the conceptual arsenic source area was removed from the model and the model was solved for future conditions at a simulation time of 30 years and at a simulation time required to achieve cleanup standards using the concentration solution from the arsenic source simulation as the initial concentration condition. The results of the model for simulation times of 30 years and 420 years are shown in Figures A2-11 and A2-12, respectively.

This simulation indicates that the time frame for achieving groundwater concentrations at cleanup standards if the dissolved arsenic sources were removed would be approximately 420 years. Given the fact that the arsenic sources cannot be completely removed from Area 5 North, the groundwater concentrations would probably remain above cleanup levels for a longer period of time than shown in the model simulations.

3.2.2 Cadmium

The dissolved cadmium model results are discussed below.

3.2.2.1 Cadmium Source

The dissolved cadmium model was first solved for a simulation time of 30 years, the approximate time since the landfill construction at the site was completed (CSC, 2011), with the third-type concentration boundary representing the conceptual dissolved cadmium source area along the top of the model grid. The results of the simulation are shown in Figure A2-13. This

simulation shows the dissolved cadmium concentrations downgradient of the source area 30 years after release to the groundwater flow system.

3.2.2.2 Cadmium Source Removed

To simulate cadmium source removal, the third-type concentration boundary representing the conceptual cadmium source area was removed from the model and the model was solved for future conditions at a simulation time of 30 years and at a simulation time required to achieve cleanup standards using the concentration solutions from the cadmium source simulation as the initial concentration condition. The results of the model for simulation times of 30 years and 170 years are shown in Figures A2-14 and A2-15, respectively.

This simulation indicates that the time frame for achieving groundwater concentrations at cleanup standards if the dissolved cadmium sources were removed would be approximately 170 years. Given the fact that the cadmium sources cannot be completely removed from Area 5 North, the groundwater concentrations would probably remain above cleanup levels for a longer period of time than shown in the model simulations.

3.2.3 Nickel

The dissolved nickel model results are discussed below.

3.2.3.1 Nickel Source

The dissolved nickel model was first solved for a simulation time of 30 years, the approximate time since the landfill construction at the site was completed (CSC, 2011), with the third-type concentration boundary representing the conceptual dissolved nickel source area along the top of the model grid. The results of the simulation are shown in Figure A2-16. This simulation shows the dissolved nickel concentrations downgradient of the source area 30 years after release to the groundwater flow system.

3.2.3.2 Nickel Source Removed

To simulate nickel source removal, the third-type concentration boundary representing the conceptual nickel source area was removed from the model and the model was solved for future conditions at a simulation time of 30 years and at a simulation time required to achieve cleanup standards using the concentration solution from the nickel source simulation as the initial concentration condition. The results of the model for simulation times of 30 years and 190 years are shown in Figures A2-17 and A2-18, respectively.

This simulation indicates that the time frame for achieving groundwater concentrations at cleanup standards if the dissolved nickel sources were removed would be approximately 190 years. Given the fact that the nickel sources cannot be completely removed from Area 5 North, the groundwater concentrations would probably remain above cleanup levels for a longer period of time than shown in the model simulations.

3.2.4 Selenium

The dissolved selenium model results are discussed below.

3.2.4.1 Selenium Source

The dissolved selenium model was first solved for a simulation time of 30 years, the approximate time since the landfill construction at the site was completed (CSC, 2011), with the third-type concentration boundary representing the conceptual dissolved selenium source area along the top of the model grid. The results of the simulation are shown in Figure A2-19. This simulation shows the dissolved selenium concentrations downgradient of the source area 30 years after release to the groundwater flow system.

3.2.4.2 Selenium Source Removed

To simulate selenium source removal, the third-type concentration boundary representing the conceptual selenium source area was removed from the model and the model was solved for future conditions at a simulation time of 30 years and at a simulation time required to achieve cleanup standards using the concentration solution from the selenium source simulation as the initial concentration condition. The results of the model for simulation times of 30 years and 180 years are shown in Figures A2-20 and A2-21, respectively.

This simulation indicates that the time frame for achieving groundwater concentrations at cleanup standards if the dissolved selenium sources were removed would be approximately 180 years. Given the fact that the selenium sources cannot be completely removed from Area 5 North, the groundwater concentrations would probably remain above cleanup levels for a longer period of time than shown in the model simulations.

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Sudicky, E.A., and R.G. McLaren, 1997. *FRACTRAN 5.01: User’s Guide, An Efficient Simulator for Two-Dimensional, Saturated, Groundwater Flow and Solute Transport in Porous or Discretely-Fractured Porous Formations*. University of Waterloo, Waterloo, Ontario, Canada, 97 pp.

Table A2-1
Porous Matrix, Fracture and Chemical Parameters
Fracture Flow and Transport Model
Casmalia Resources Superfund Site
Casmalia, California

Porous Matrix

Hydrostratigraphic Unit	Layer Number	Thickness b (ft)	Hydraulic Conductivity[1] K_h (cm/sec)	K_v (cm/sec)	Porosity[2] n (%)	Bulk Density[3] ρ_b (gm/cm^3)	Dispersivity[4] Longitudinal α_L (m)	Transverse α_T (m)	Apparent Tortuosity[5] τ	Effective Dispersion Coefficient[6] Trichloroethene D_e (cm^2/sec)	Tetrachloroethene D_e (cm^2/sec)	Arsenic D_e (cm^2/sec)	Cadmium D_e (cm^2/sec)	Nickel D_e (cm^2/sec)	Selenium D_e (cm^2/sec)	Retardation Factor[7] R
Upper	1	5	3.40E-07	3.40E-07	0.48	1.884	0	0	0.02	2.02E-07	1.88E-07	2.60E-07	1.00E-06	1.32E-07	2.60E-07	1.0
	2	5	3.40E-07	3.40E-07	0.48	1.884	0	0	0.02	2.02E-07	1.88E-07	2.60E-07	1.00E-06	1.32E-07	2.60E-07	1.0
	3	5	3.40E-07	3.40E-07	0.48	1.884	0	0	0.02	2.02E-07	1.88E-07	2.60E-07	1.00E-06	1.32E-07	2.60E-07	1.0
Lower	4	25	3.40E-08	3.40E-08	0.44	1.952	0	0	0.03	3.03E-07	2.82E-07	3.90E-07	1.00E-06	1.98E-07	3.90E-07	1.0
	5	50	3.40E-08	3.40E-08	0.44	1.952	0	0	0.03	3.03E-07	2.82E-07	3.90E-07	1.00E-06	1.98E-07	3.90E-07	1.0
	6	75	3.40E-08	3.40E-08	0.44	1.952	0	0	0.03	3.03E-07	2.82E-07	3.90E-07	1.00E-06	1.98E-07	3.90E-07	1.0

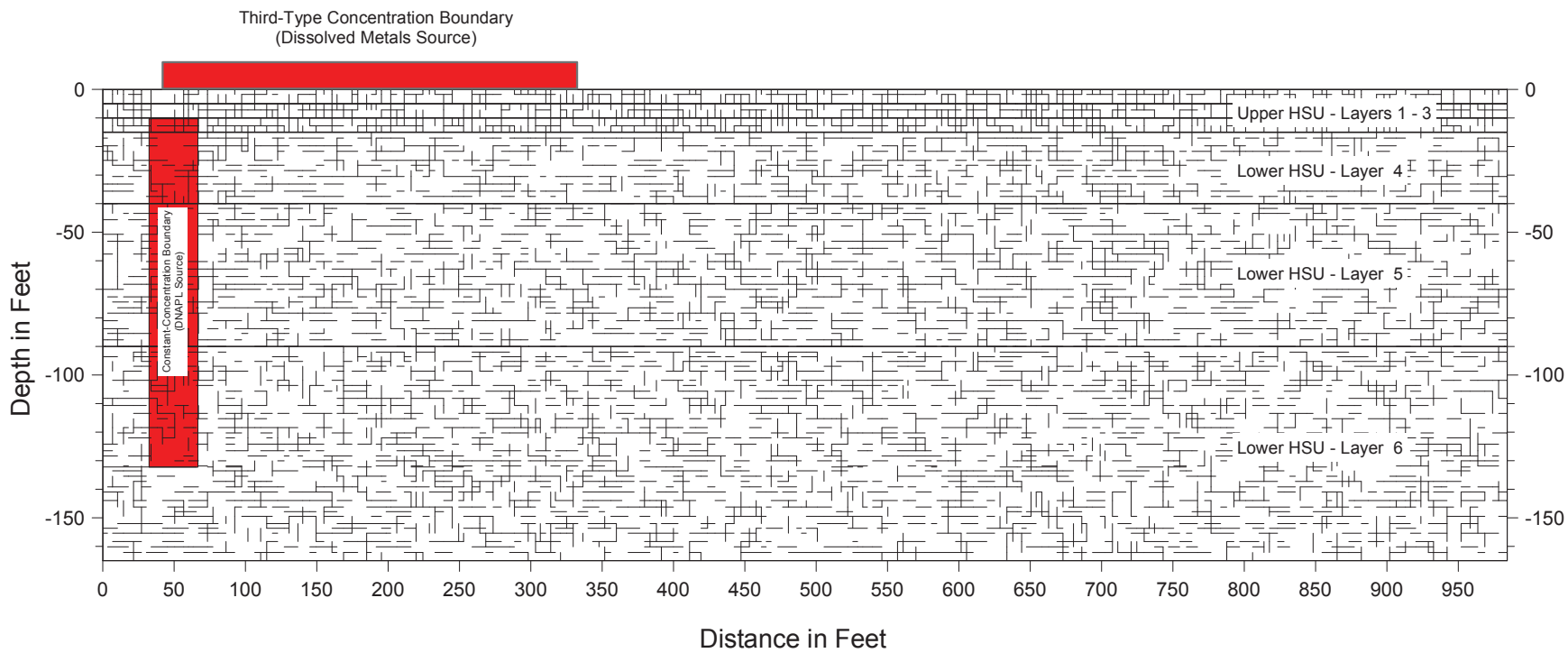
Fractures

Hydrostratigraphic Unit	Layer Number	Thickness b (ft)	Aperture[8] (microns)	Fracture Density	Length Range (m)	Longitudinal Dispersivity α_L[9] (m)	Retardation Factor[7] R
Upper	1	5	60	0.8	0.5 - 1.0	0.1	1.0
	2	5	60	0.8	0.5 - 1.0	0.1	1.0
	3	5	60	0.8	0.5 - 1.0	0.1	1.0
Lower	4	25	33	0.1	1.0 - 2.0	0.1	1.0
	5	50	33	0.1	1.0 - 2.0	0.1	1.0
	6	75	33	0.1	1.0 - 2.0	0.1	1.0

Chemicals

Chemical	Initial Concentration[10] C_0	Free-Solution Dispersion Coefficient[11] D_0 (cm^2/sec)
Trichloroethene	12.8 mg/L	1.01E-05
Tetrachloroethene	2.06 mg/L	9.40E-06
Arsenic	300 µg/L	1.30E-05
Cadmium	35 µg/L	7.17E-06
Nickel	600 µg/L	6.61E-06
Selenium	450 µg/L	1.30E-05

Notes:
[1]Average value for Lower HSU matrix for intervals with no fractures from Table 4-5, Casmalia Resources Superfund Site Steering Committee (CSC), *Final Remedial Investigation Report, Casmalia Resources Superfund Site* (RI; CSC, 2011). Upper HSU estimated (no values available for unfractured Upper HSU).
[2]Average values from RI Section 4.5.2.4, (CSC, 2011)
[3]$\rho b = \rho s - [n \times (\rho s - \rho w)]$, where $\rho s = 2.7$ gm/cm^3 and $\rho w = 1.0$ gm/cm^3
[4]Hydrodynamic dispersion negligible in low permeability claystones where groundwater velocities are very small (Harrison et al., 1992)
[5]*Diffusion Testing on Core Samples, Casmalia, California* (Golder Associates Ltd, 2005 and 2007)
[6]$D_e = D_0 \times \tau$, Model solutions for Cadmium were unobtainable at values for D_e less than 1.00E-6 cm^2/sec
[7]No sorption of chemicals onto porous matrix assumed as conservative assumption in model simulations
[8]Lower HSU median value from Table 4-5 (CSC, 2011). Conservative estimate used for Upper HSU (no values available).
[9]Typical value for fractured clays (Sudicky and McLaren, 1992)
[10]Trichloroethene and tetrachloroethene equal to 1% of the aqueous solubility, other chemicals equal to representative concentrations (CSC, 2011)
[11]Trichloroethene and tetrachloroethene (Parker et. al., 1994), cadmium (Foose et al., 2002), nickel (CRC Press, 2000), arsenic and selenium estimated based on Shackelford and Daniel (1991)
Full reference citations provided in Section 4.0 of Attachment A-2
ft = feet
cm/sec = centimeters per second
gm/cm^3 = grams per cubic centimeter
m = meters
cm^2/sec = square centimeters per second
mg/L = milligrams per liter
µg/L = micrograms per liter



Model Design
Fracture Flow and Transport Model
Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE
A2-1

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
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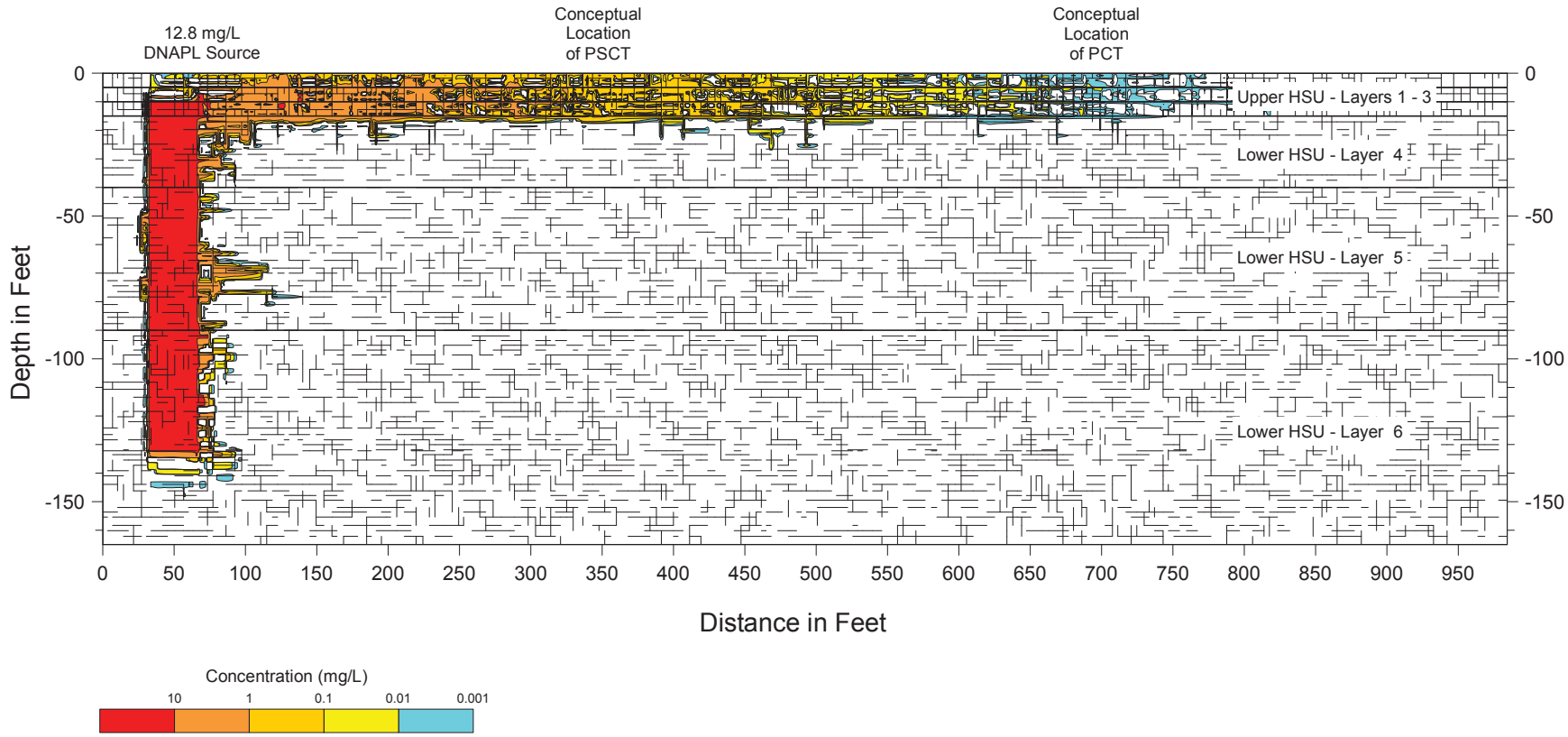

Trichlorethene DNAPL Source
Simulation Time - 30 Years
Fracture Flow and Transport Model

Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-2

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
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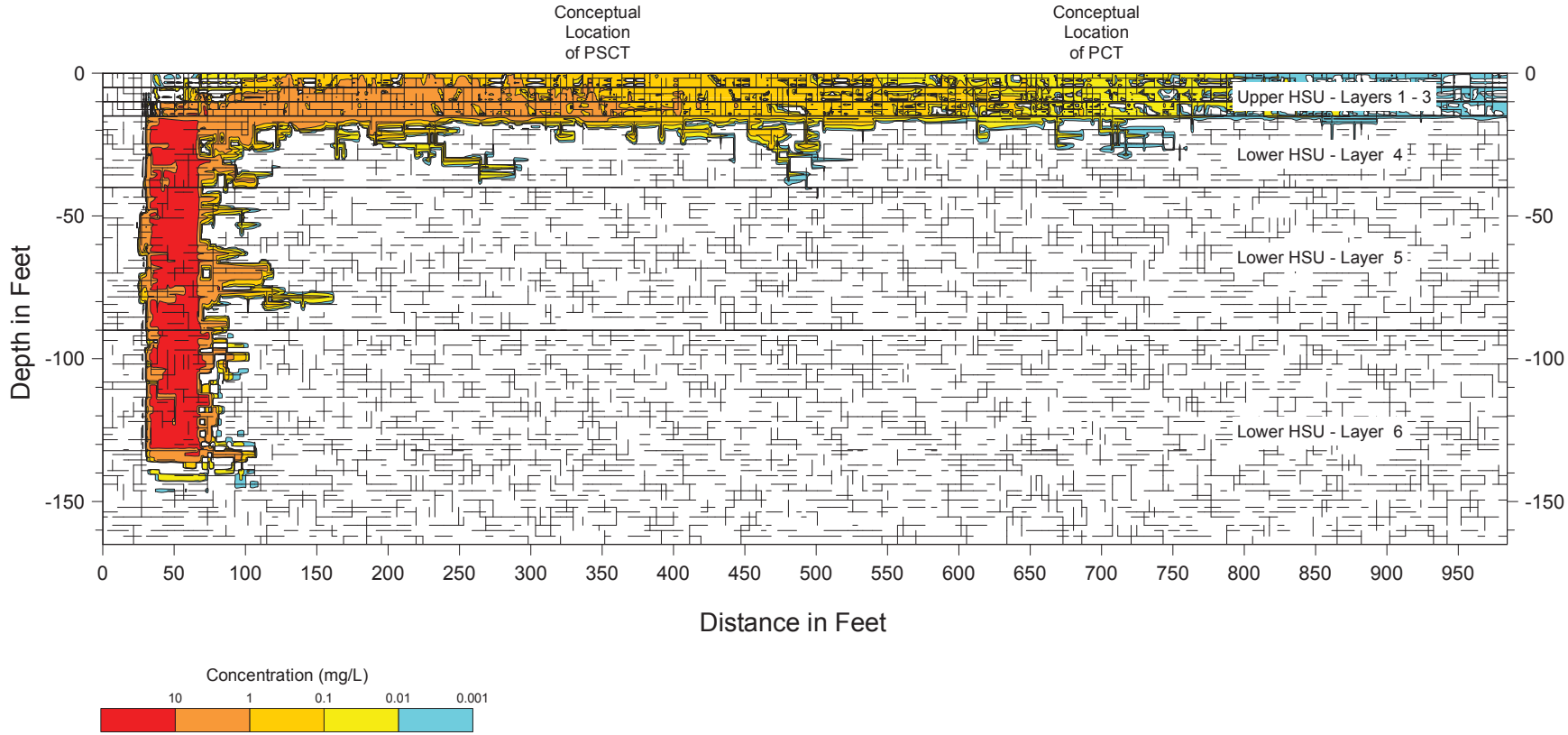
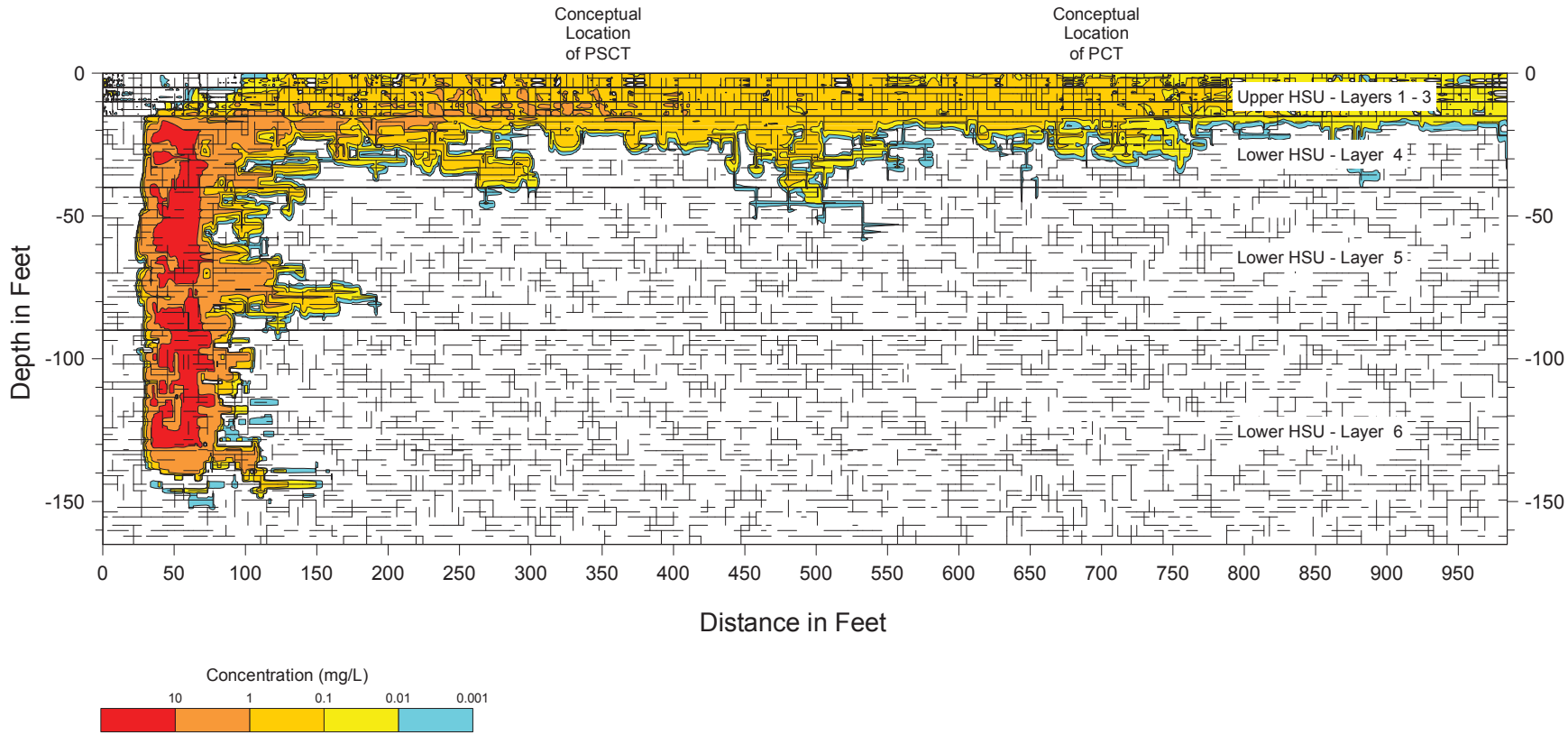


Trichloroethene DNAPL Source Removed
Simulation Time - 30 Years After Source Removal
Fracture Flow and Transport Model
Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-3

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
TFC	0020784 00.01	BB		08/2014	



Trichlorethene DNAPL Source Removed
Simulation Time - 100 Years After Source Removal
Fracture Flow and Transport Model
Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-4

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
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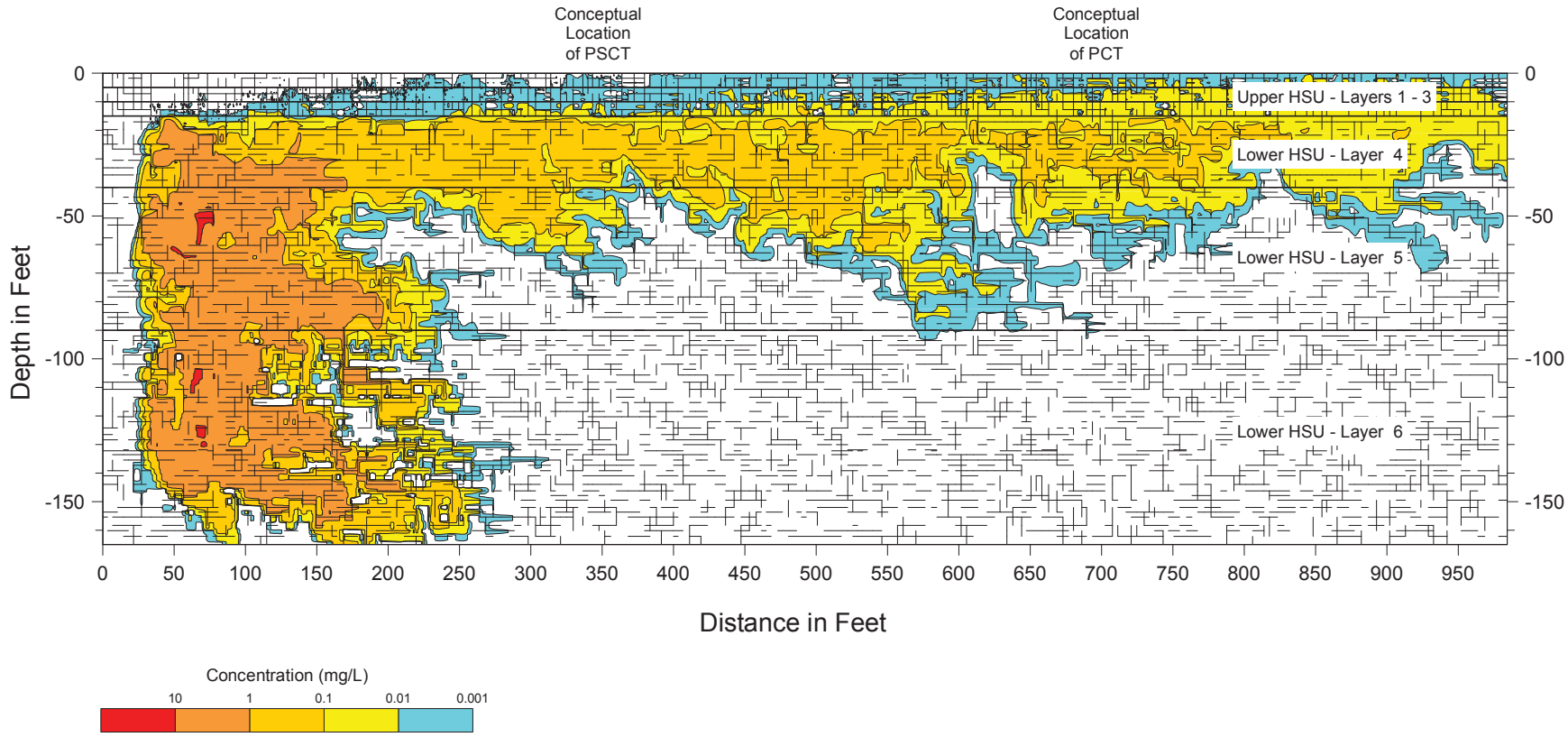

Trichlorethene DNAPL Source Removed
Simulation Time - 500 Years After Source Removal
Fracture Flow and Transport Model

Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-5

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
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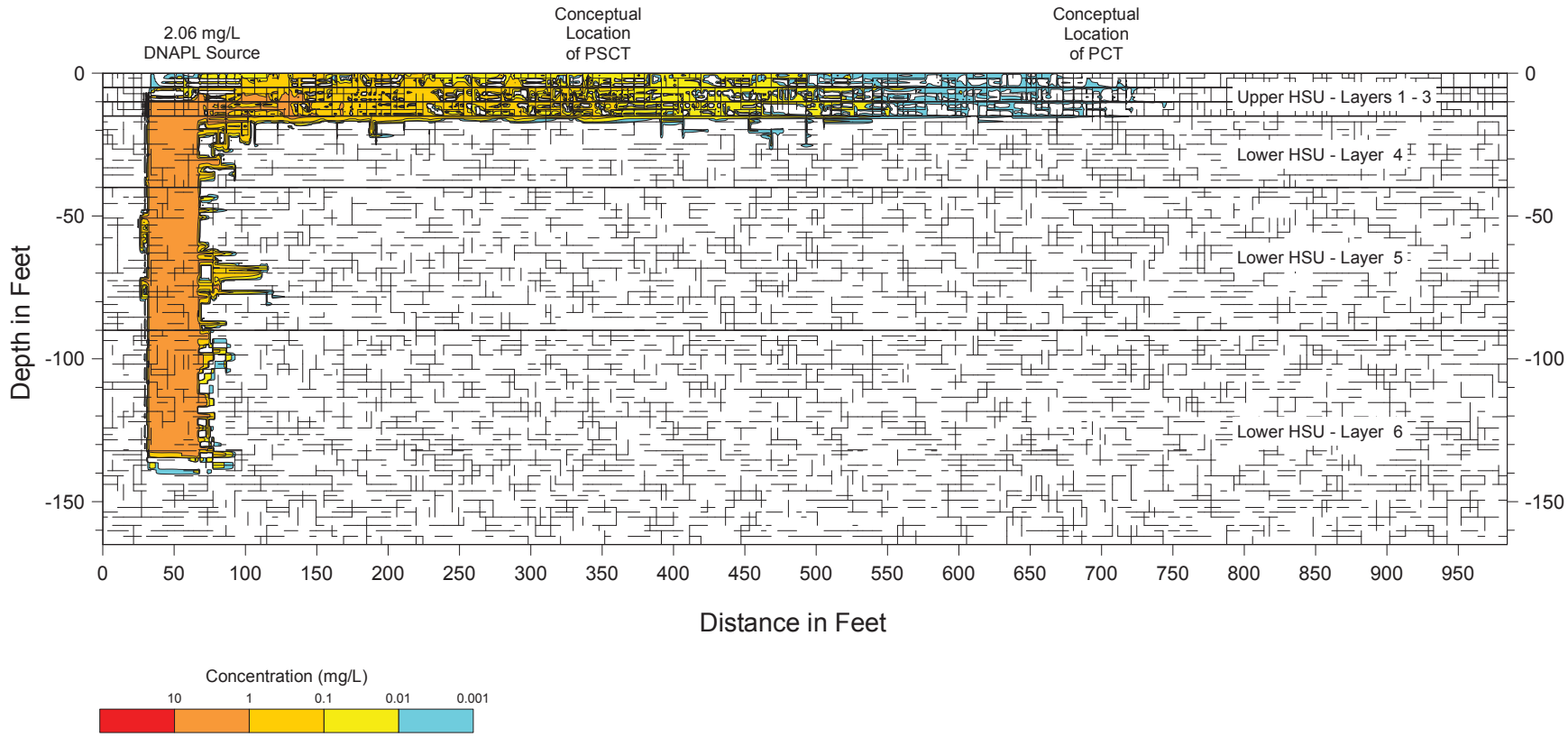

Tetachloroethene DNAPL Source
Simulation Time - 30 Years
Fracture Flow and Transport Model
Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-6

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
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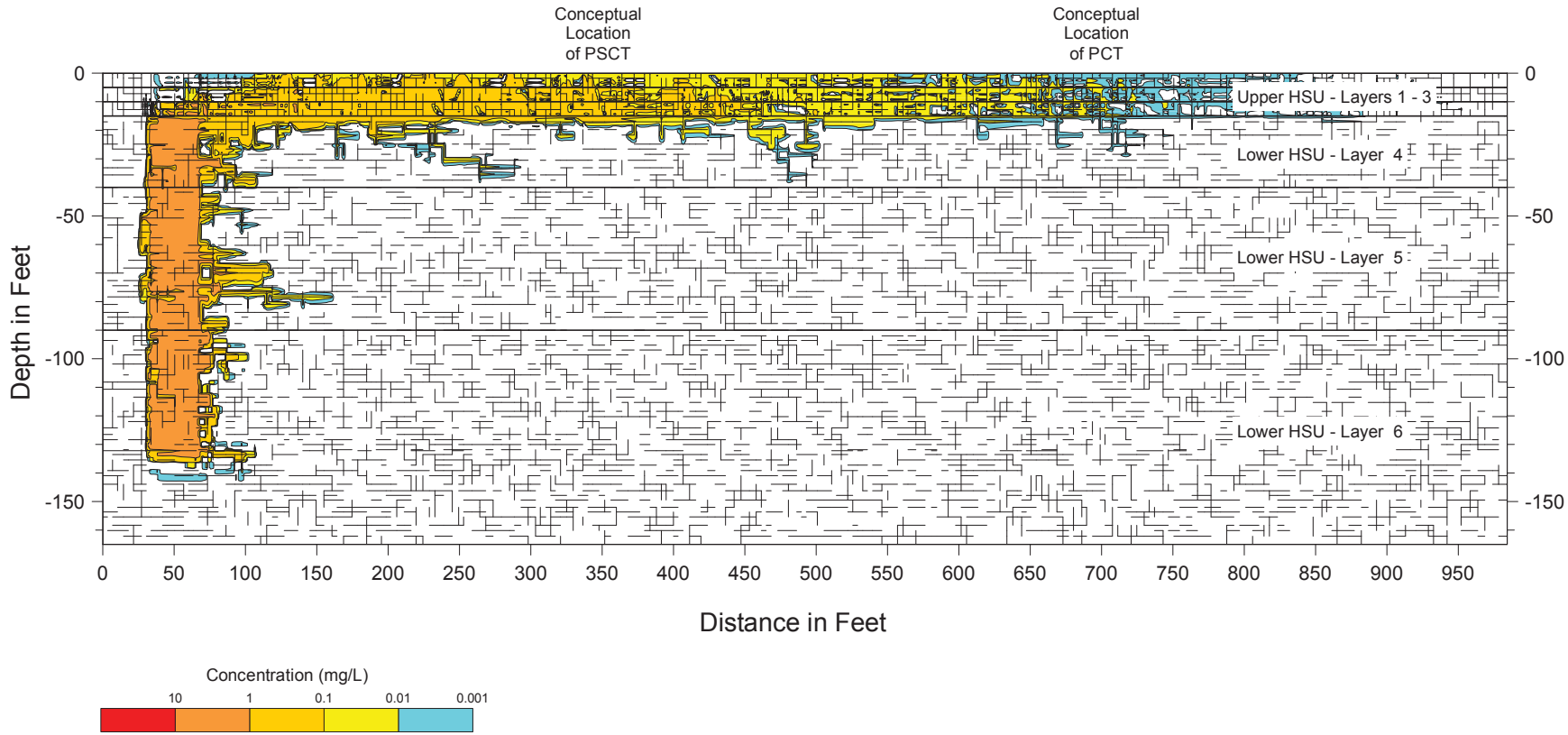

Tetrachloroethene DNAPL Source Removed
Simulation Time - 30 Years After Source Removal
Fracture Flow and Transport Model
Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-7

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
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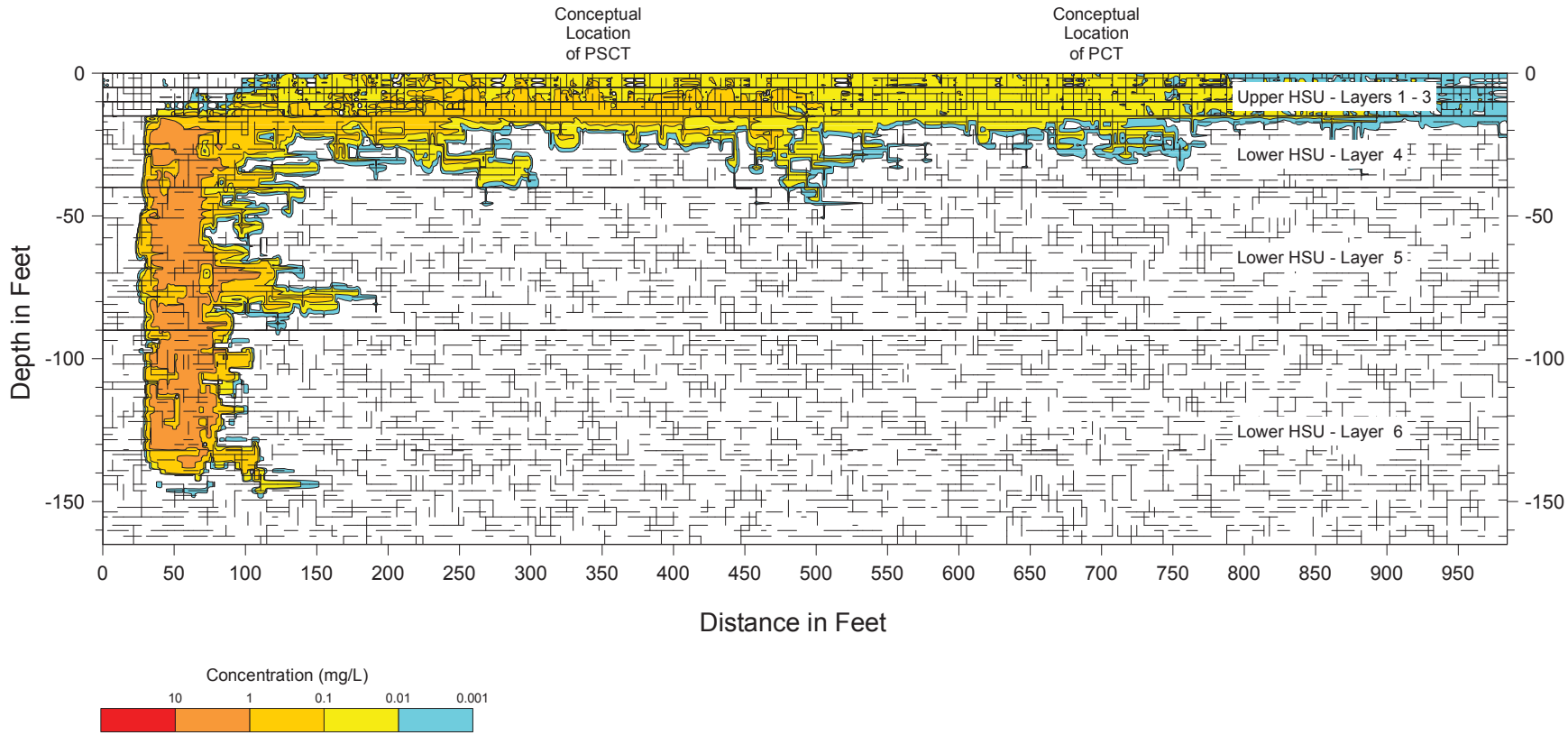


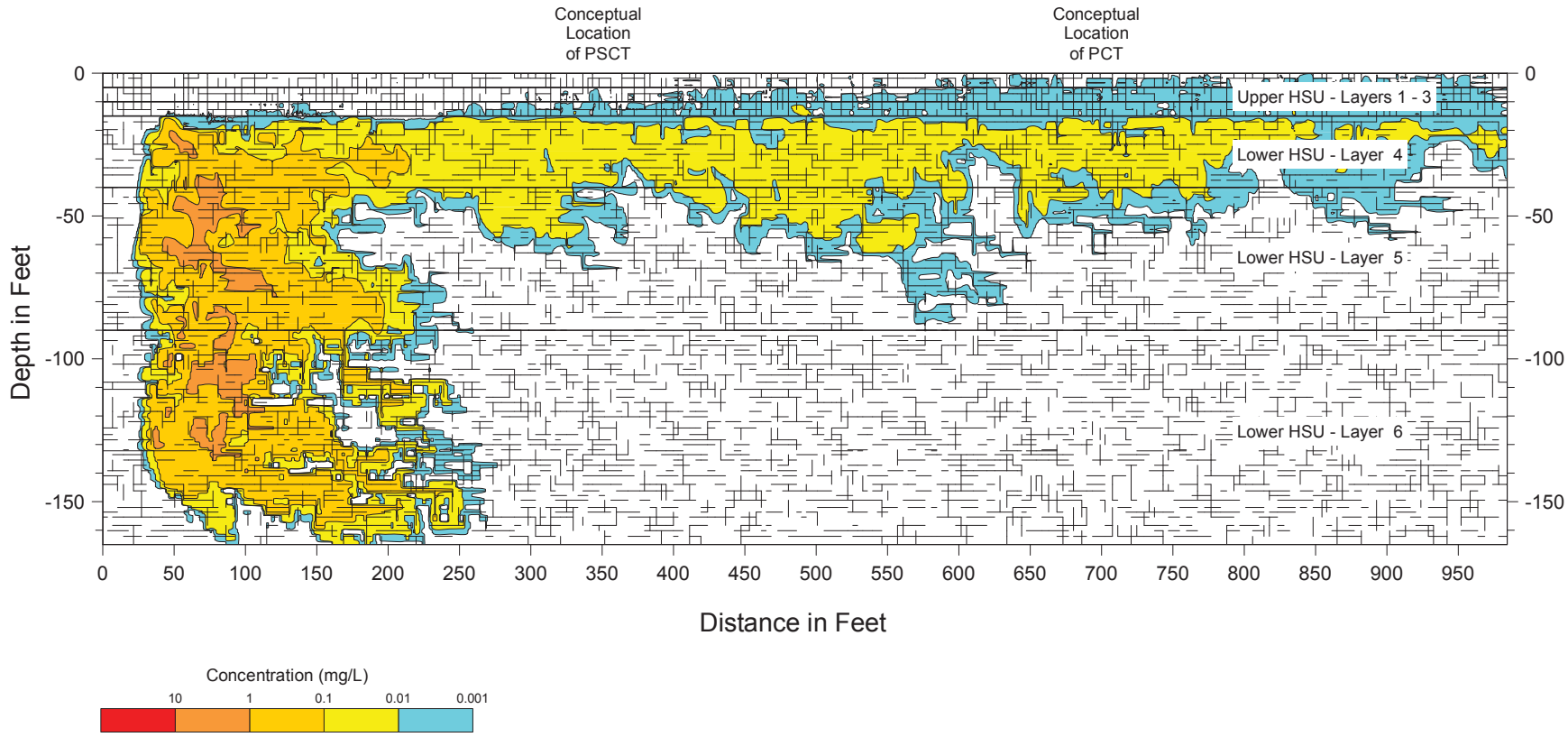
Tetrachloroethene DNAPL Source Removed
Simulation Time - 100 Years After Source Removal
Fracture Flow and Transport Model

Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-8

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
TFC	0020784 00.01	BB		08/2014	



Tetrachloroethene DNAPL Source Removed
Simulation Time - 500 Years After Source Removal
Fracture Flow and Transport Model

Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-9

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
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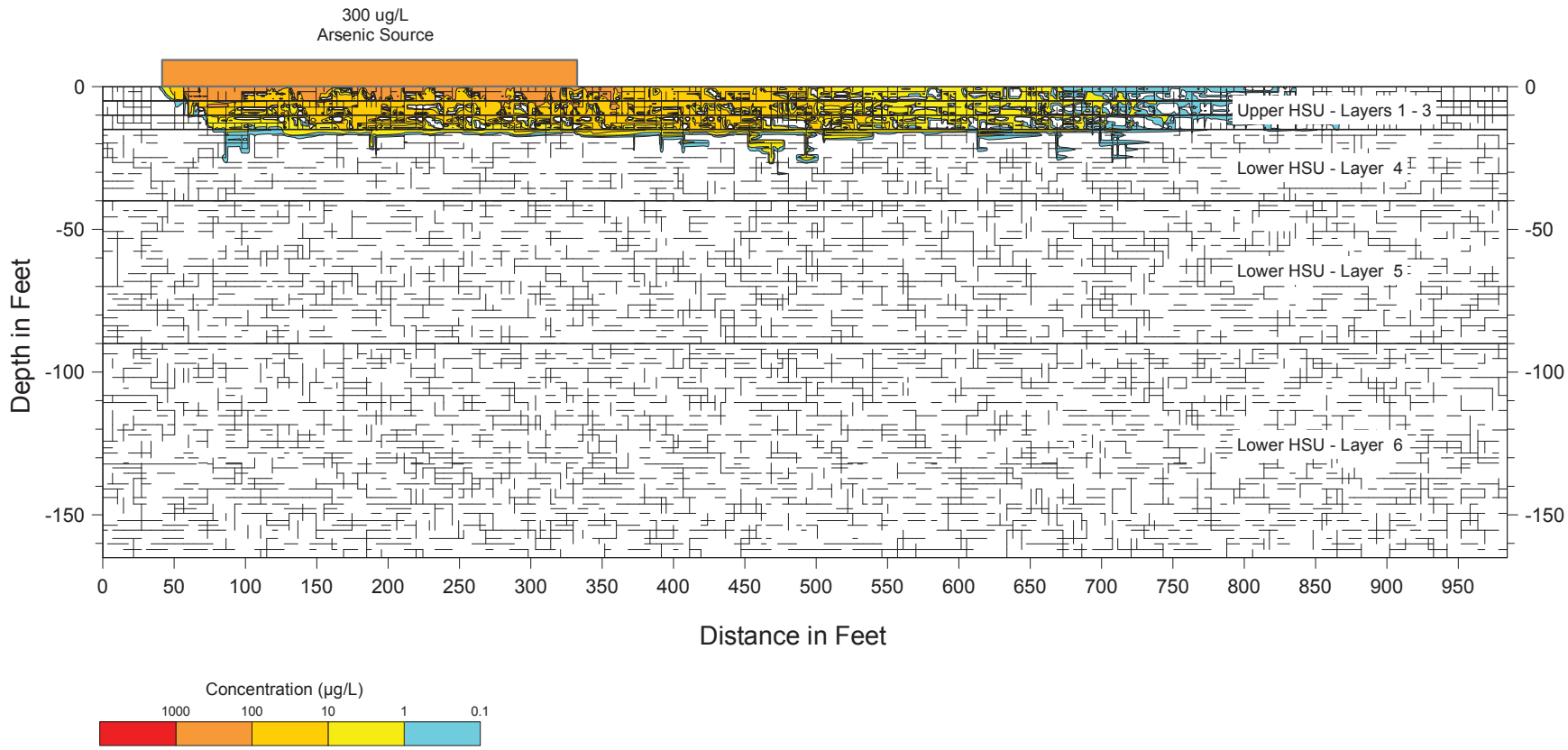

Area 5 North Arsenic Source
Simulation Time - 30 Years
Fracture Flow and Transport Model
Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-10

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
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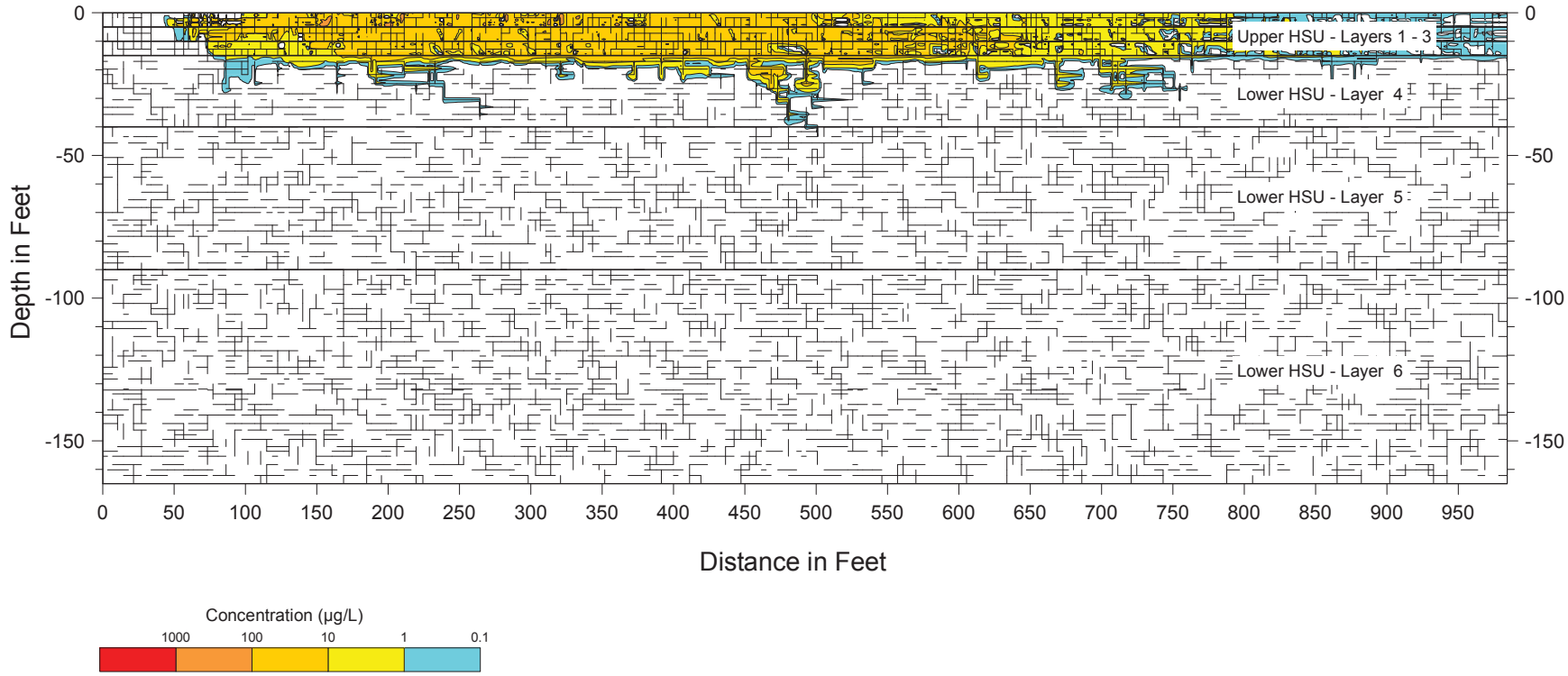

Area 5 North Arsenic Source Removed
Simulation Time - 30 Years After Source Removal
Fracture Flow and Transport Model
Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-11

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
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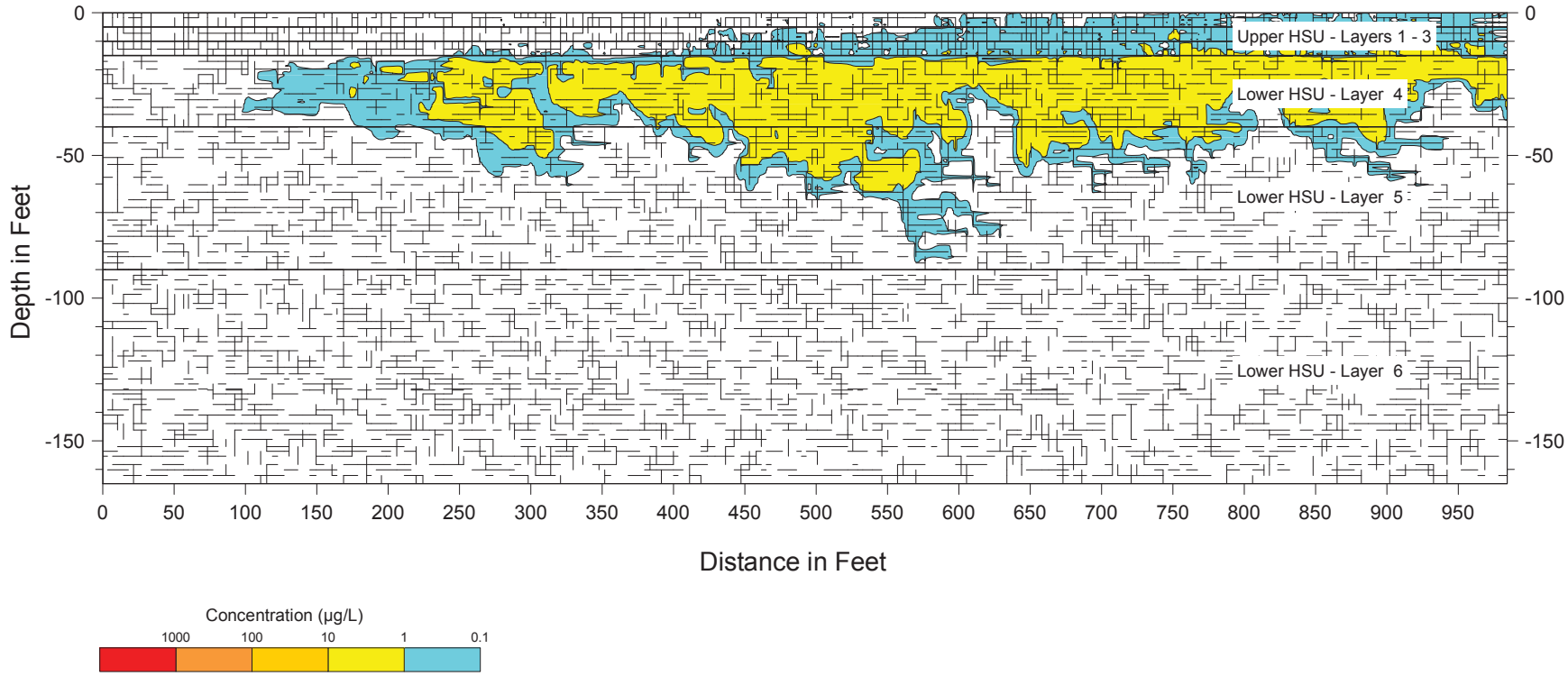

Area 5 North Arsenic Source Removed
Simulation Time - 420 Years After Source Removal
Fracture Flow and Transport Model
Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-12

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
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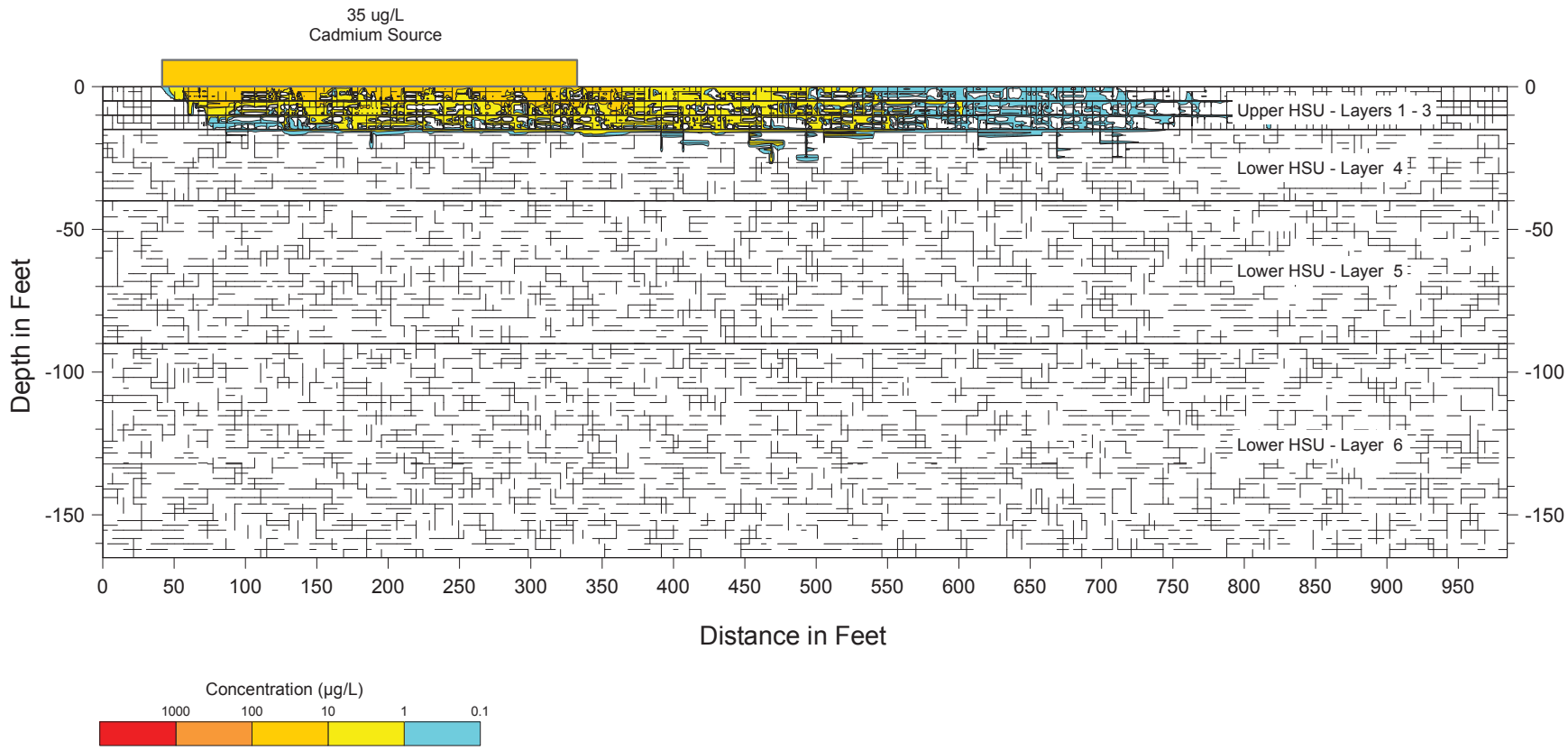

Area 5 North Cadmium Source
Simulation Time - 30 Years
Fracture Flow and Transport Model
Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-13

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
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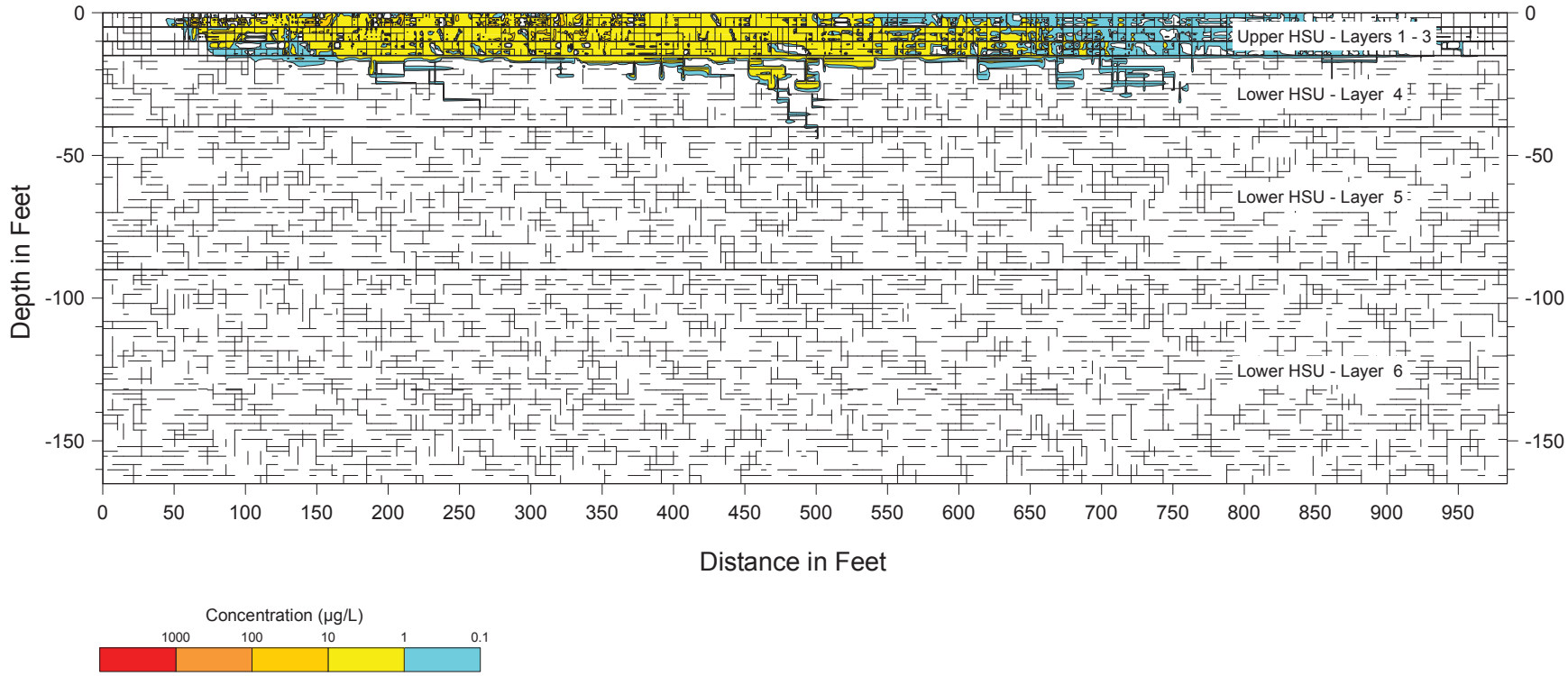
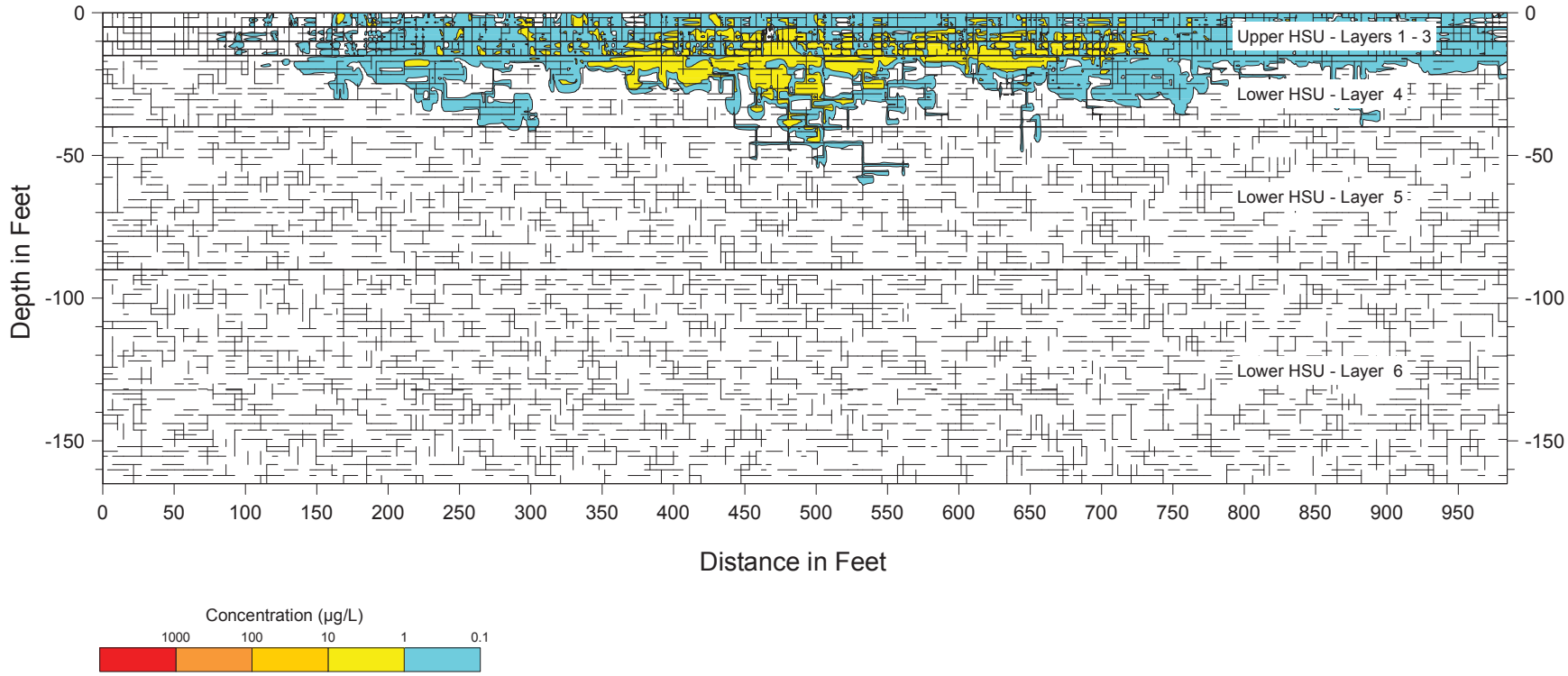


Area 5 North Cadmium Source Removed
Simulation Time - 30 Years After Source Removal
Fracture Flow and Transport Model
Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-14

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
TFC	0020784 00.01	BB		08/2014	

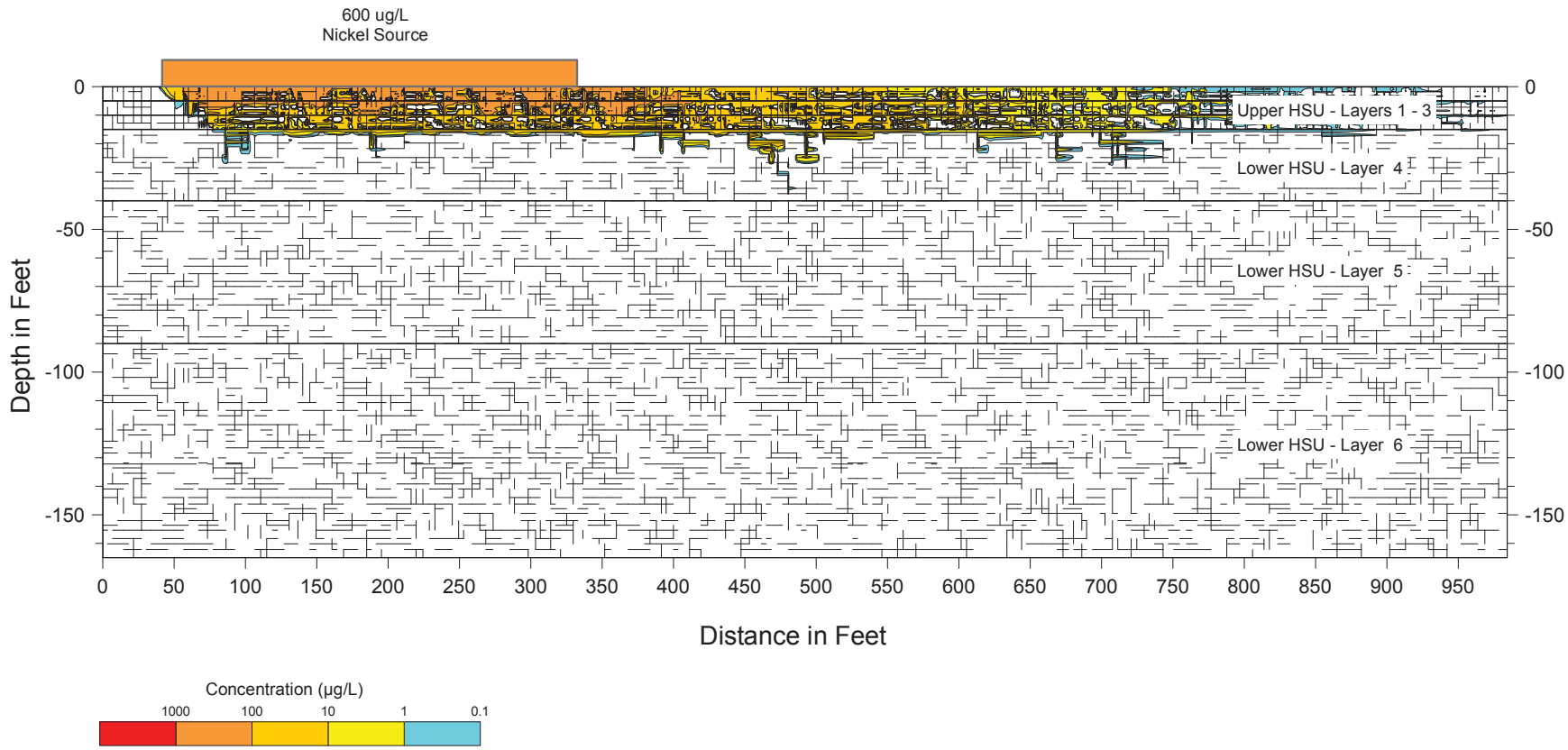


Area 5 North Cadmium Source Removed
Simulation Time - 170 Years After Source Removal
Fracture Flow and Transport Model
Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-15

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
TFC	0020784 00.01	BB		08/2014	

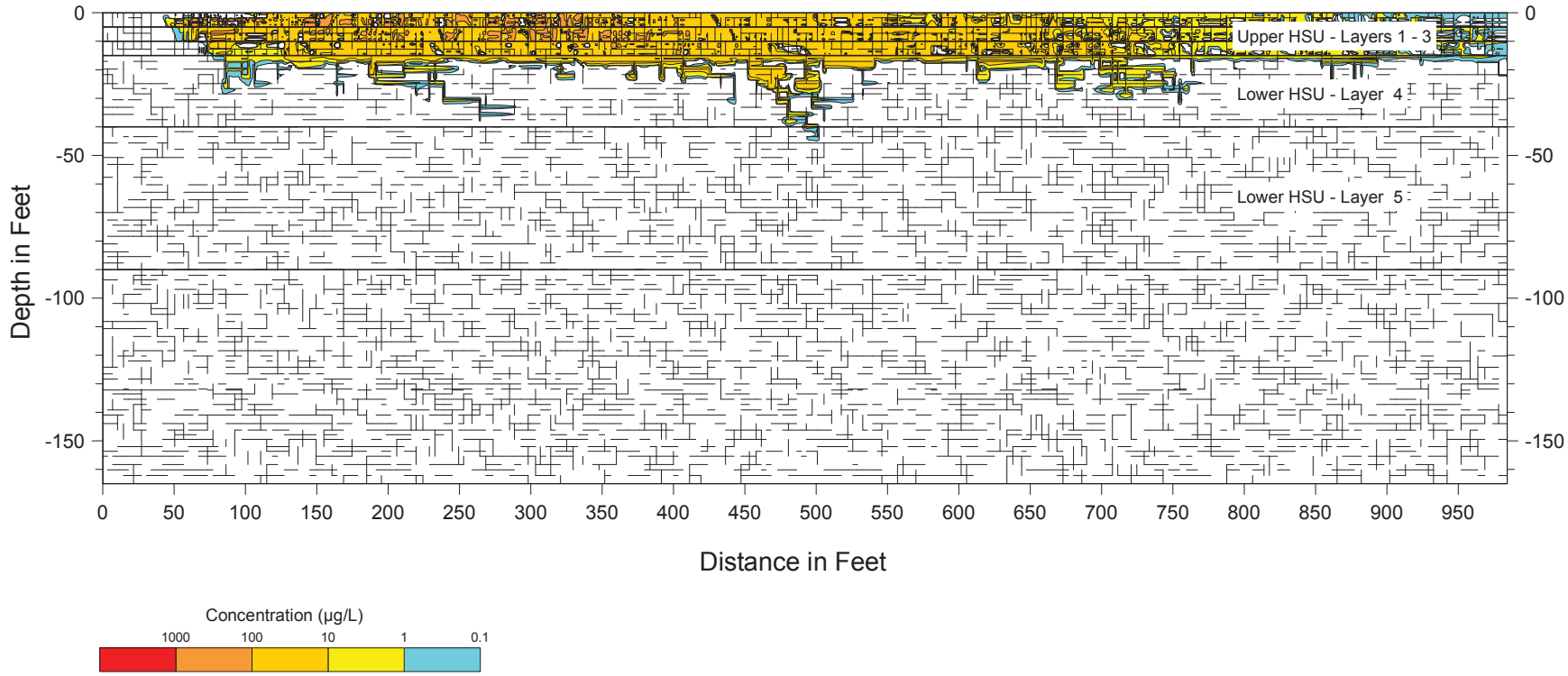


Area 5 North Nickel Source
Simulation Time - 30 Years
Fracture Flow and Transport Model

Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE
A2-16

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
TFC	0020784 00.01	BB		08/2012	



Area 5 North Nickel Source Removed
Simulation Time - 30 Years After Source Removal
Fracture Flow and Transport Model
Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-17

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
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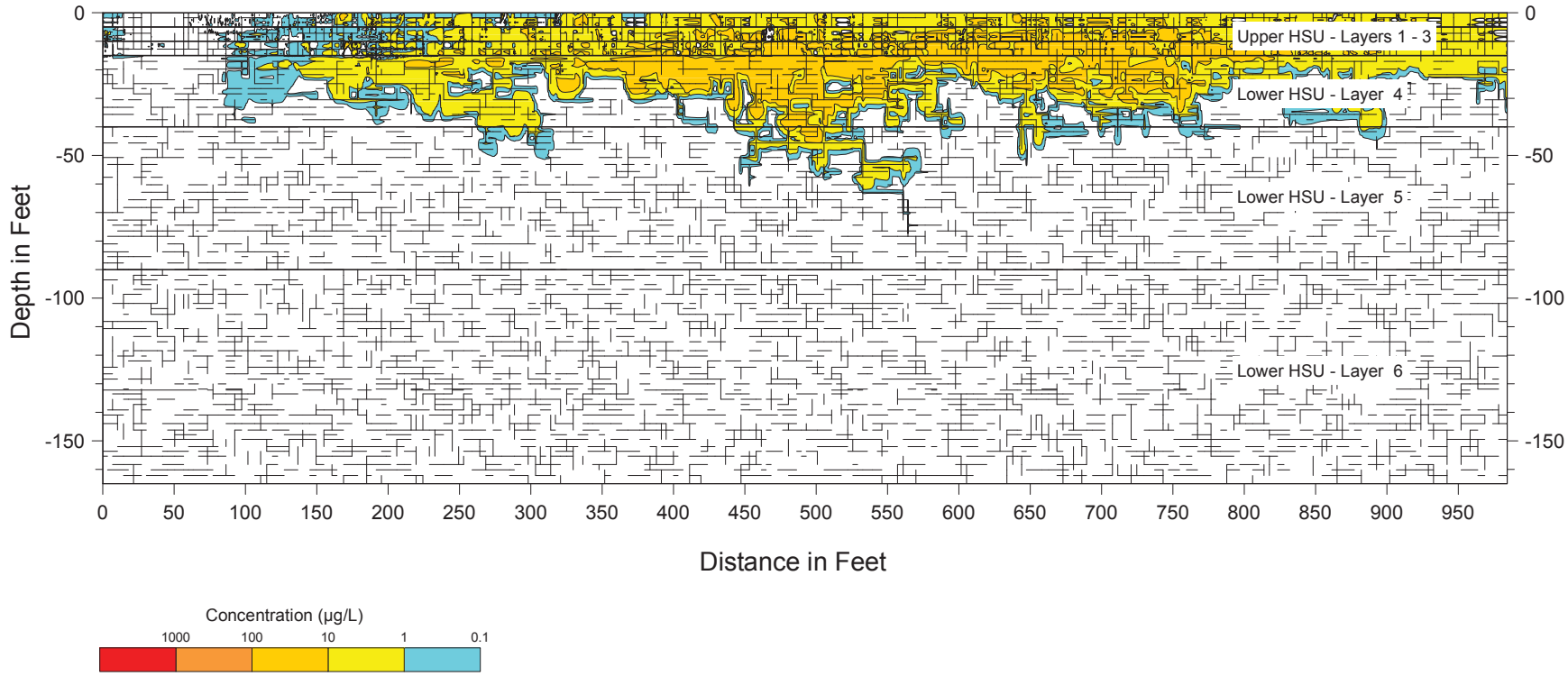

Area 5 North Nickel Source Removed
Simulation Time - 190 Years After Source Removal
Fracture Flow and Transport Model
Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-18

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
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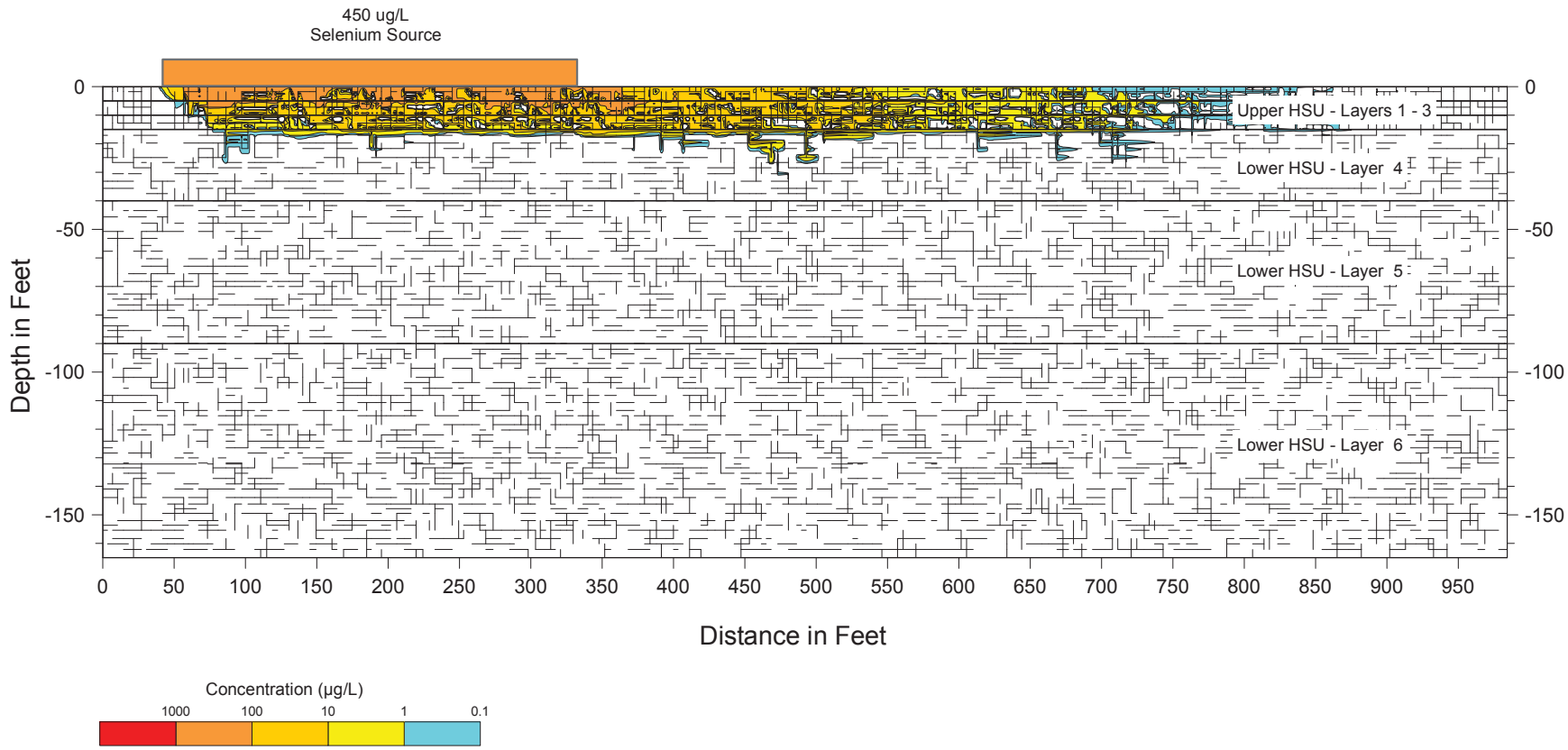
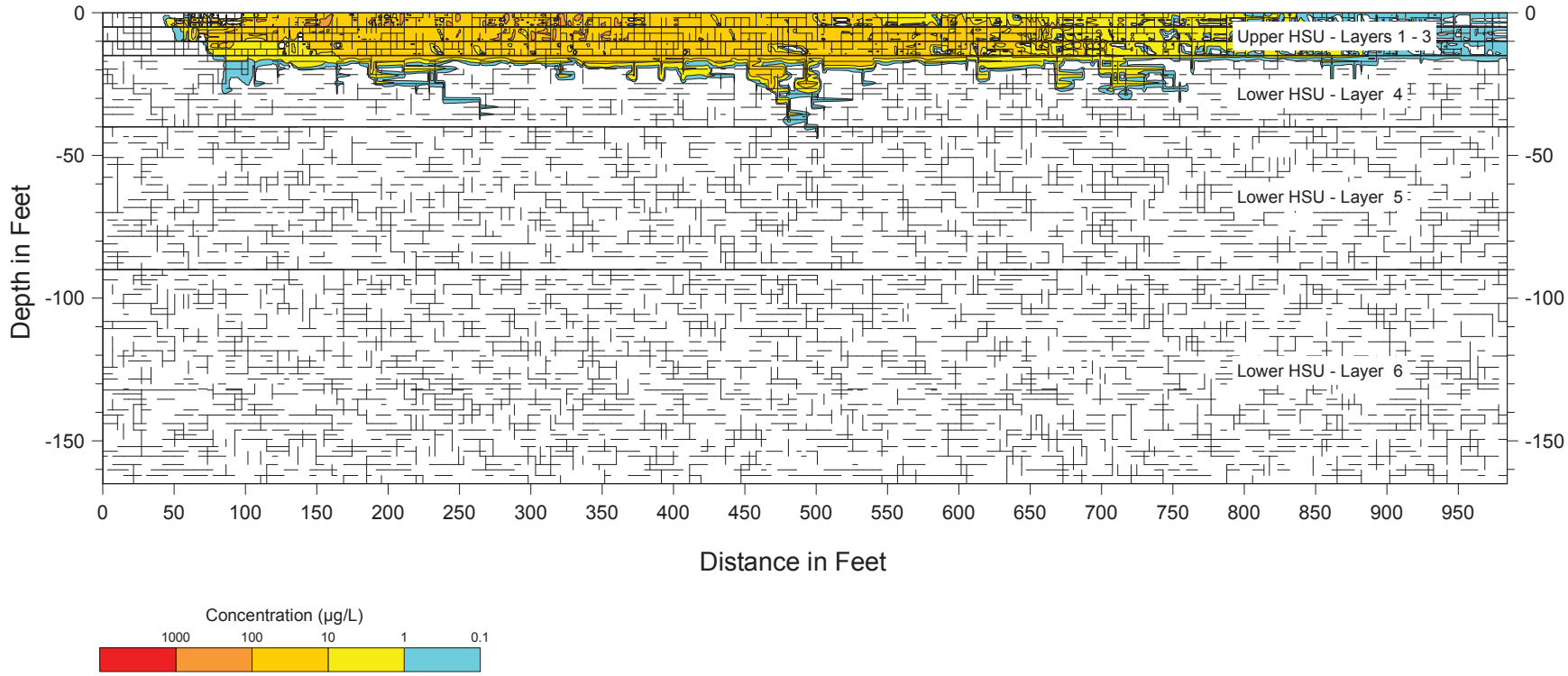


Area 5 North Selenium Source
Simulation Time - 30 Years
Fracture Flow and Transport Model
Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-19

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
TFC	0020784 00.01	BB		08/2014	

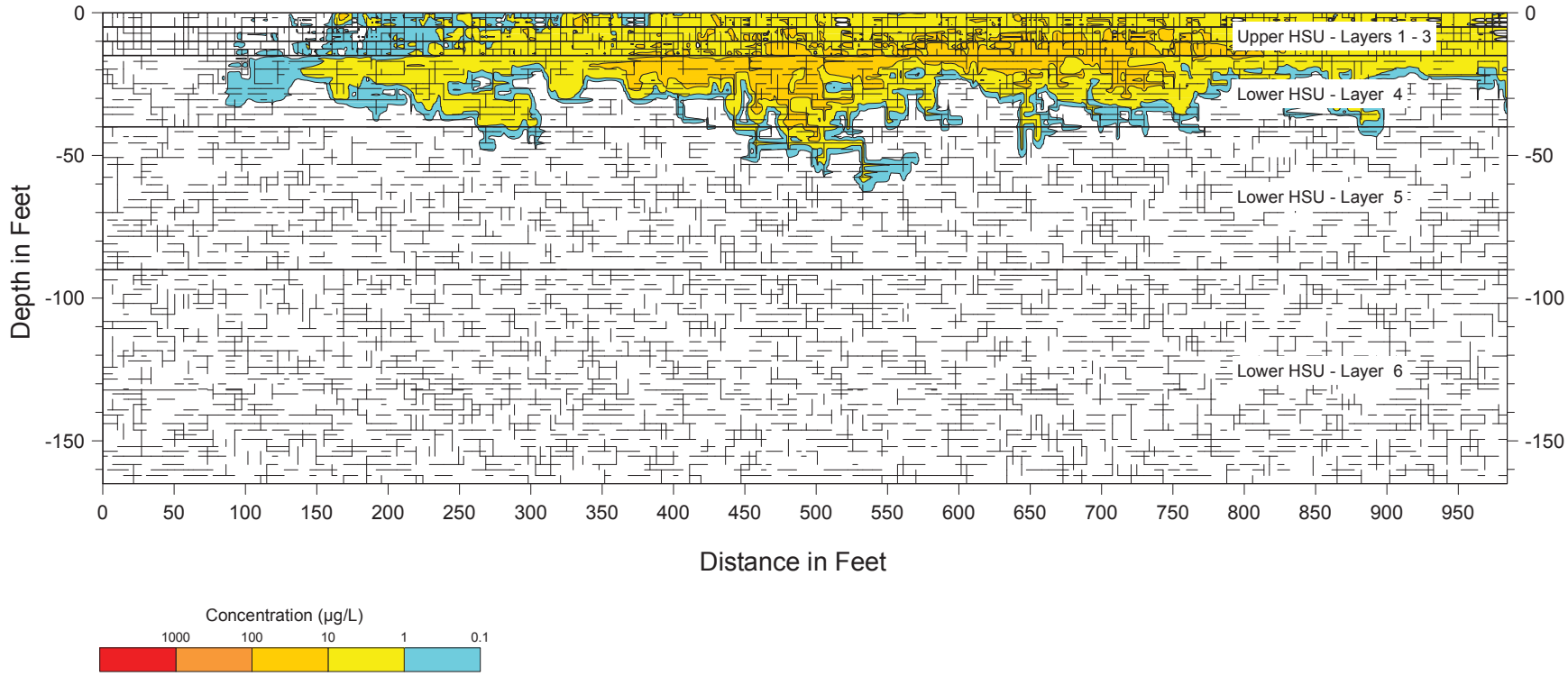


Area 5 North Selenium Source Removed
Simulation Time - 30 Years After Source Removal
Fracture Flow and Transport Model
Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-20

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
TFC	0020784 00.01	BB		08/2014	



Area 5 North Selenium Source Removed
Simulation Time - 180 Years After Source Removal
Fracture Flow and Transport Model
Final Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

FIGURE

A2-21

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
TFC	0020784 00.01	BB		08/2014	

ATTACHMENT A-3

NAPL ELEVATIONS, THICKNESSES, HYDROGRAPHS, AND RECOVERY RATES

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Figure A3-5 DNAPL Recovery Rates, Tank Accumulations
Figure A3-6 DNAPL Thickness Over Time, December 1997 - December 2011

Table A3-1. NAPL Elevations
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
Gallery Well	2/1/1998	556.61	30.60	526.01	69.40	8.54	487.21	D
Gallery Well	2/2/1998	556.61	30.40	526.21	69.40	8.54	487.21	D
Gallery Well	2/3/1998	556.61	30.60	526.01	69.35	8.59	487.26	D
Gallery Well	2/4/1998	556.61	30.50	526.11	69.20	8.74	487.41	D
Gallery Well	2/5/1998	556.61	30.35	526.26	70.00	7.94	486.61	D
Gallery Well	2/7/1998	556.61	30.30	526.31	69.80	8.14	486.81	D
Gallery Well	2/8/1998	556.61	30.20	526.41	69.40	8.54	487.21	D
Gallery Well	2/10/1998	556.61	30.70	525.91	69.85	8.09	486.76	D
Gallery Well	2/11/1998	556.61	30.03	526.58	69.90	8.04	486.71	D
Gallery Well	2/12/1998	556.61	37.80	518.81	69.65	8.29	486.96	D
Gallery Well	2/13/1998	556.61	34.85	521.76	69.35	8.59	487.26	D
Gallery Well	2/14/1998	556.61	32.80	523.81	68.70	9.24	487.91	D
Gallery Well	2/15/1998	556.61	30.10	526.51	69.00	8.94	487.61	D
Gallery Well	2/16/1998	556.61	30.20	526.41	69.15	8.79	487.46	D
Gallery Well	2/17/1998	556.61	46.58	510.03	69.00	8.94	487.61	D
Gallery Well	2/18/1998	556.61	32.80	523.81	67.20	10.74	489.41	D
Gallery Well	2/19/1998	556.61	31.40	525.21	68.38	9.56	488.23	D
Gallery Well	2/20/1998	556.61	30.10	526.51	70.10	7.84	486.51	D
Gallery Well	2/21/1998	556.61	30.04	526.57	71.40	6.54	485.21	D
Gallery Well	2/22/1998	556.61	31.00	525.61	70.70	7.24	485.91	D
Gallery Well	2/23/1998	556.61	30.04	526.57	70.90	7.04	485.71	D
Gallery Well	2/24/1998	556.61	39.75	516.86	70.32	7.62	486.29	D
Gallery Well	2/25/1998	556.61	31.30	525.31	70.54	7.40	486.07	D
Gallery Well	2/26/1998	556.61	31.30	525.31	71.00	6.94	485.61	D
Gallery Well	2/27/1998	556.61	30.00	526.61	71.00	6.94	485.61	D
Gallery Well	2/28/1998	556.61	62.85	493.76	70.66	7.28	485.95	D
Gallery Well	3/1/1998	556.61	30.30	526.31	70.40	7.54	486.21	D
Gallery Well	3/1/1998	556.61	34.56	522.05	70.42	7.52	486.19	D
Gallery Well	3/2/1998	556.61	30.30	526.31	70.35	7.59	486.26	D
Gallery Well	3/3/1998	556.61	30.05	526.56	70.38	7.56	486.23	D
Gallery Well	3/4/1998	556.61	30.48	526.13	70.35	7.59	486.26	D
Gallery Well	3/5/1998	556.61	38.75	517.86	70.42	7.52	486.19	D
Gallery Well	3/6/1998	556.61	60.43	496.18	70.36	7.58	486.25	D
Gallery Well	3/7/1998	556.61	60.00	496.61	70.40	7.54	486.21	D
Gallery Well	3/7/1998	556.61	30.04	526.57	70.50	7.44	486.11	D
Gallery Well	3/8/1998	556.61	34.90	521.71	70.42	7.52	486.19	D
Gallery Well	3/9/1998	556.61	58.55	498.06	70.40	7.54	486.21	D
Gallery Well	3/10/1998	556.61	60.60	496.01	70.43	7.51	486.18	D
Gallery Well	3/10/1998	556.61	31.38	525.23	70.45	7.49	486.16	D
Gallery Well	3/11/1998	556.61	30.02	526.59	70.44	7.50	486.17	D
Gallery Well	3/12/1998	556.61	32.30	524.31	70.42	7.52	486.19	D
Gallery Well	3/13/1998	556.61	48.30	508.31	70.46	7.48	486.15	D
Gallery Well	3/13/1998	556.61	60.40	496.21	70.38	7.56	486.23	D
Gallery Well	3/14/1998	556.61	50.00	506.61	70.41	7.53	486.20	D
Gallery Well	3/15/1998	556.61	59.70	496.91	70.42	7.52	486.19	D
Gallery Well	3/16/1998	556.61	33.30	523.31	70.42	7.52	486.19	D
Gallery Well	3/17/1998	556.61	60.70	495.91	70.42	7.52	486.19	D
Gallery Well	3/18/1998	556.61	59.60	497.01	70.40	7.54	486.21	D
Gallery Well	3/19/1998	556.61	61.00	495.61	70.40	7.54	486.21	D
Gallery Well	3/19/1998	556.61	57.66	498.95	70.44	7.50	486.17	D
Gallery Well	3/20/1998	556.61	60.75	495.86	70.44	7.50	486.17	D
Gallery Well	3/21/1998	556.61	60.45	496.16	70.38	7.56	486.23	D
Gallery Well	3/22/1998	556.61	61.00	495.61	70.48	7.46	486.13	D
Gallery Well	3/23/1998	556.61	54.30	502.31	70.43	7.51	486.18	D
Gallery Well	3/24/1998	556.61	30.02	526.59	70.46	7.48	486.15	D
Gallery Well	3/24/1998	556.61	30.40	526.21	70.47	7.47	486.14	D
Gallery Well	3/25/1998	556.61	30.04	526.57	70.42	7.52	486.19	D
Gallery Well	3/26/1998	556.61	61.88	494.73	71.20	6.74	485.41	D
Gallery Well	3/27/1998	556.61	61.87	494.74	71.22	6.72	485.39	D
Gallery Well	3/29/1998	556.61	30.05	526.56	71.20	6.74	485.41	D
Gallery Well	3/30/1998	556.61	30.20	526.41	70.90	7.04	485.71	D
Gallery Well	3/31/1998	556.61	48.50	508.11	70.90	7.04	485.71	D
Gallery Well	4/1/1998	556.61	30.12	526.49	71.20	6.74	485.41	D

Table A3-1. NAPL Elevations
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
Gallery Well	4/2/1998	556.61	30.82	525.79	71.28	6.66	485.33	D
Gallery Well	4/3/1998	556.61	58.90	497.71	70.90	7.04	485.71	D
Gallery Well	4/4/1998	556.61	59.50	497.11	70.95	6.99	485.66	D
Gallery Well	4/5/1998	556.61	30.60	526.01	70.80	7.14	485.81	D
Gallery Well	4/6/1998	556.61	59.62	496.99	70.38	7.56	486.23	D
Gallery Well	4/7/1998	556.61	54.40	502.21	70.85	7.09	485.76	D
Gallery Well	4/8/1998	556.61	61.30	495.31	70.90	7.04	485.71	D
Gallery Well	4/9/1998	556.61	61.25	495.36	70.92	7.02	485.69	D
Gallery Well	4/10/1998	556.61	41.20	515.41	70.88	7.06	485.73	D
Gallery Well	4/11/1998	556.61	59.09	497.52	70.24	7.70	486.37	D
Gallery Well	4/12/1998	556.61	45.15	511.46	70.15	7.79	486.46	D
Gallery Well	4/13/1998	556.61	30.02	526.59	70.60	7.34	486.01	D
Gallery Well	4/14/1998	556.61	30.07	526.54	70.44	7.50	486.17	D
Gallery Well	4/15/1998	556.61	30.12	526.49	70.63	7.31	485.98	D
Gallery Well	4/16/1998	556.61	59.68	496.93	70.28	7.66	486.33	D
Gallery Well	4/17/1998	556.61	30.02	526.59	70.68	7.26	485.93	D
Gallery Well	4/18/1998	556.61	39.30	517.31	70.70	7.24	485.91	D
Gallery Well	4/19/1998	556.61	30.25	526.36	70.50	7.44	486.11	D
Gallery Well	4/20/1998	556.61	56.67	499.94	70.47	7.47	486.14	D
Gallery Well	4/21/1998	556.61	42.70	513.91	70.40	7.54	486.21	D
Gallery Well	4/22/1998	556.61	57.58	499.03	70.42	7.52	486.19	D
Gallery Well	4/23/1998	556.61	60.00	496.61	70.38	7.56	486.23	D
Gallery Well	4/24/1998	556.61	59.00	497.61	70.40	7.54	486.21	D
Gallery Well	4/25/1998	556.61	30.17	526.44	70.35	7.59	486.26	D
Gallery Well	4/26/1998	556.61	30.07	526.54	70.54	7.40	486.07	D
Gallery Well	4/27/1998	556.61	30.08	526.53	70.43	7.51	486.18	D
Gallery Well	4/28/1998	556.61	58.75	497.86	70.45	7.49	486.16	D
Gallery Well	4/29/1998	556.61	60.72	495.89	70.40	7.54	486.21	D
Gallery Well	4/30/1998	556.61	60.98	495.63	70.77	7.17	485.84	D
Gallery Well	5/1/1998	556.61	30.20	526.41	70.34	7.60	486.27	D
Gallery Well	5/2/1998	556.61	32.75	523.86	70.30	7.64	486.31	D
Gallery Well	5/3/1998	556.61	30.03	526.58	70.50	7.44	486.11	D
Gallery Well	5/4/1998	556.61	30.14	526.47	70.44	7.50	486.17	D
Gallery Well	5/5/1998	556.61	33.10	523.51	70.30	7.64	486.31	D
Gallery Well	5/6/1998	556.61	30.40	526.21	70.34	7.60	486.27	D
Gallery Well	5/7/1998	556.61	30.03	526.58	70.55	7.39	486.06	D
Gallery Well	5/8/1998	556.61	30.07	526.54	70.37	7.57	486.24	D
Gallery Well	5/9/1998	556.61	30.05	526.56	70.40	7.54	486.21	D
Gallery Well	5/10/1998	556.61	30.80	525.81	73.20	4.74	483.41	D
Gallery Well	5/11/1998	556.61	30.04	526.57	70.38	7.56	486.23	D
Gallery Well	5/12/1998	556.61	60.30	496.31	70.55	7.39	486.06	D
Gallery Well	5/13/1998	556.61	60.50	496.11	70.46	7.48	486.15	D
Gallery Well	5/14/1998	556.61	59.60	497.01	70.43	7.51	486.18	D
Gallery Well	5/15/1998	556.61	59.80	496.81	70.52	7.42	486.09	D
Gallery Well	5/16/1998	556.61	30.04	526.57	70.42	7.52	486.19	D
Gallery Well	5/17/1998	556.61	30.03	526.58	70.38	7.56	486.23	D
Gallery Well	5/18/1998	556.61	59.10	497.51	70.45	7.49	486.16	D
Gallery Well	5/19/1998	556.61	33.35	523.26	70.32	7.62	486.29	D
Gallery Well	5/20/1998	556.61	32.30	524.31	70.38	7.56	486.23	D
Gallery Well	5/21/1998	556.61	60.25	496.36	70.48	7.46	486.13	D
Gallery Well	5/22/1998	556.61	30.80	525.81	70.45	7.49	486.16	D
Gallery Well	5/23/1998	556.61	31.50	525.11	70.37	7.57	486.24	D
Gallery Well	5/24/1998	556.61	30.27	526.34	70.42	7.52	486.19	D
Gallery Well	5/25/1998	556.61	57.45	499.16	70.46	7.48	486.15	D
Gallery Well	5/26/1998	556.61	30.17	526.44	70.34	7.60	486.27	D
Gallery Well	5/27/1998	556.61	30.24	526.37	70.37	7.57	486.24	D
Gallery Well	5/28/1998	556.61	32.80	523.81	70.38	7.56	486.23	D
Gallery Well	5/29/1998	556.61	30.18	526.43	70.39	7.55	486.22	D
Gallery Well	5/30/1998	556.61	30.72	525.89	70.33	7.61	486.28	D
Gallery Well	5/31/1998	556.61	59.90	496.71	70.42	7.52	486.19	D
Gallery Well	6/1/1998	556.61	33.75	522.86	70.50	7.44	486.11	D
Gallery Well	6/2/1998	556.61	31.55	525.06	70.33	7.61	486.28	D
Gallery Well	6/3/1998	556.61	30.40	526.21	70.47	7.47	486.14	D

Table A3-1. NAPL Elevations
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
Gallery Well	6/4/1998	556.61	30.13	526.48	70.42	7.52	486.19	D
Gallery Well	6/5/1998	556.61	31.82	524.79	70.45	7.49	486.16	D
Gallery Well	6/6/1998	556.61	59.50	497.11	70.40	7.54	486.21	D
Gallery Well	6/7/1998	556.61	31.70	524.91	70.46	7.48	486.15	D
Gallery Well	6/8/1998	556.61	31.70	524.91	70.30	7.64	486.31	D
Gallery Well	6/9/1998	556.61	52.50	504.11	70.36	7.58	486.25	D
Gallery Well	6/10/1998	556.61	30.32	526.29	70.48	7.46	486.13	D
Gallery Well	6/11/1998	556.61	30.17	526.44	70.38	7.56	486.23	D
Gallery Well	6/12/1998	556.61	30.19	526.42	70.42	7.52	486.19	D
Gallery Well	6/13/1998	556.61	59.20	497.41	70.42	7.52	486.19	D
Gallery Well	6/14/1998	556.61	58.85	497.76	70.39	7.55	486.22	D
Gallery Well	6/15/1998	556.61	46.85	509.76	70.45	7.49	486.16	D
Gallery Well	6/16/1998	556.61	33.70	522.91	70.42	7.52	486.19	D
Gallery Well	6/17/1998	556.61	32.50	524.11	70.32	7.62	486.29	D
Gallery Well	6/18/1998	556.61	33.35	523.26	70.50	7.44	486.11	D
Gallery Well	6/19/1998	556.61	30.14	526.47	70.43	7.51	486.18	D
Gallery Well	6/20/1998	556.61	30.12	526.49	70.44	7.50	486.17	D
Gallery Well	6/21/1998	556.61	33.75	522.86	70.37	7.57	486.24	D
Gallery Well	6/22/1998	556.61	58.36	498.25	70.44	7.50	486.17	D
Gallery Well	6/23/1998	556.61	60.70	495.91	70.42	7.52	486.19	D
Gallery Well	6/24/1998	556.61	31.82	524.79	70.39	7.55	486.22	D
Gallery Well	6/25/1998	556.61	30.50	526.11	70.44	7.50	486.17	D
Gallery Well	6/26/1998	556.61	35.40	521.21	70.30	7.64	486.31	D
Gallery Well	6/27/1998	556.61	56.65	499.96	70.36	7.58	486.25	D
Gallery Well	6/28/1998	556.61	33.80	522.81	70.44	7.50	486.17	D
Gallery Well	6/29/1998	556.61	58.37	498.24	70.46	7.48	486.15	D
Gallery Well	6/30/1998	556.61	30.12	526.49	70.38	7.56	486.23	D
Gallery Well	7/1/1998	556.61	33.10	523.51	70.14	7.80	486.47	D
Gallery Well	7/2/1998	556.61	30.94	525.67	70.28	7.66	486.33	D
Gallery Well	7/3/1998	556.61	30.18	526.43	70.42	7.52	486.19	D
Gallery Well	7/4/1998	556.61	30.28	526.33	70.52	7.42	486.09	D
Gallery Well	7/5/1998	556.61	30.12	526.49	70.36	7.58	486.25	D
Gallery Well	7/6/1998	556.61	31.88	524.73	70.34	7.60	486.27	D
Gallery Well	7/7/1998	556.61	30.80	525.81	70.36	7.58	486.25	D
Gallery Well	7/8/1998	556.61	32.00	524.61	70.38	7.56	486.23	D
Gallery Well	7/9/1998	556.61	30.90	525.71	70.31	7.63	486.30	D
Gallery Well	7/10/1998	556.61	59.80	496.81	70.40	7.54	486.21	D
Gallery Well	7/11/1998	556.61	34.60	522.01	70.15	7.79	486.46	D
Gallery Well	7/12/1998	556.61	30.52	526.09	70.48	7.46	486.13	D
Gallery Well	7/13/1998	556.61	30.17	526.44	70.44	7.50	486.17	D
Gallery Well	7/14/1998	556.61	30.30	526.31	70.52	7.42	486.09	D
Gallery Well	7/15/1998	556.61	31.98	524.63	70.54	7.40	486.07	D
Gallery Well	7/16/1998	556.61	60.02	496.59	70.50	7.44	486.11	D
Gallery Well	7/17/1998	556.61	59.80	496.81	70.55	7.39	486.06	D
Gallery Well	7/18/1998	556.61	30.16	526.45	70.42	7.52	486.19	D
Gallery Well	7/19/1998	556.61	34.80	521.81	70.15	7.79	486.46	D
Gallery Well	7/20/1998	556.61	36.00	520.61	70.32	7.62	486.29	D
Gallery Well	7/21/1998	556.61	30.15	526.46	70.43	7.51	486.18	D
Gallery Well	7/22/1998	556.61	32.70	523.91	70.22	7.72	486.39	D
Gallery Well	7/23/1998	556.61	60.30	496.31	70.45	7.49	486.16	D
Gallery Well	7/24/1998	556.61	30.15	526.46	70.34	7.60	486.27	D
Gallery Well	7/25/1998	556.61	31.70	524.91	70.32	7.62	486.29	D
Gallery Well	7/26/1998	556.61	30.80	525.81	70.42	7.52	486.19	D
Gallery Well	7/27/1998	556.61	33.30	523.31	70.44	7.50	486.17	D
Gallery Well	7/28/1998	556.61	30.40	526.21	70.47	7.47	486.14	D
Gallery Well	7/29/1998	556.61	32.98	523.63	70.47	7.47	486.14	D
Gallery Well	7/30/1998	556.61	31.00	525.61	70.41	7.53	486.20	D
Gallery Well	7/31/1998	556.61	30.18	526.43	70.43	7.51	486.18	D
Gallery Well	8/1/1998	556.61	33.70	522.91	70.34	7.60	486.27	D
Gallery Well	8/2/1998	556.61	33.20	523.41	70.32	7.62	486.29	D
Gallery Well	8/3/1998	556.61	30.68	525.93	70.50	7.44	486.11	D
Gallery Well	8/4/1998	556.61	32.00	524.61	70.37	7.57	486.24	D
Gallery Well	8/5/1998	556.61	33.20	523.41	70.45	7.49	486.16	D

Table A3-1. NAPL Elevations
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
Gallery Well	8/6/1998	556.61	32.30	524.31	70.48	7.46	486.13	D
Gallery Well	8/7/1998	556.61	32.20	524.41	70.38	7.56	486.23	D
Gallery Well	8/8/1998	556.61	30.40	526.21	70.48	7.46	486.13	D
Gallery Well	8/9/1998	556.61	32.40	524.21	70.45	7.49	486.16	D
Gallery Well	8/10/1998	556.61	30.78	525.83	70.50	7.44	486.11	D
Gallery Well	8/11/1998	556.61	30.30	526.31	70.42	7.52	486.19	D
Gallery Well	8/12/1998	556.61	30.58	526.03	70.45	7.49	486.16	D
Gallery Well	8/13/1998	556.61	31.00	525.61	70.44	7.50	486.17	D
Gallery Well	8/14/1998	556.61	31.85	524.76	70.32	7.62	486.29	D
Gallery Well	8/15/1998	556.61	34.30	522.31	70.44	7.50	486.17	D
Gallery Well	8/16/1998	556.61	30.13	526.48	70.47	7.47	486.14	D
Gallery Well	8/17/1998	556.61	30.12	526.49	70.44	7.50	486.17	D
Gallery Well	8/18/1998	556.61	32.47	524.14	70.55	7.39	486.06	D
Gallery Well	8/19/1998	556.61	32.10	524.51	70.50	7.44	486.11	D
Gallery Well	8/20/1998	556.61	31.00	525.61	70.38	7.56	486.23	D
Gallery Well	8/21/1998	556.61	32.10	524.51	70.37	7.57	486.24	D
Gallery Well	8/22/1998	556.61	33.80	522.81	70.27	7.67	486.34	D
Gallery Well	8/23/1998	556.61	32.90	523.71	70.35	7.59	486.26	D
Gallery Well	8/24/1998	556.61	31.50	525.11	70.25	7.69	486.36	D
Gallery Well	8/25/1998	556.61	31.70	524.91	70.35	7.59	486.26	D
Gallery Well	8/26/1998	556.61	58.20	498.41	70.40	7.54	486.21	D
Gallery Well	8/27/1998	556.61	30.60	526.01	70.40	7.54	486.21	D
Gallery Well	8/28/1998	556.61	57.75	498.86	70.42	7.52	486.19	D
Gallery Well	8/29/1998	556.61	31.80	524.81	70.40	7.54	486.21	D
Gallery Well	8/30/1998	556.61	30.13	526.48	70.37	7.57	486.24	D
Gallery Well	8/31/1998	556.61	59.85	496.76	70.40	7.54	486.21	D
Gallery Well	9/1/1998	556.61	39.50	517.11	70.37	7.57	486.24	D
Gallery Well	9/2/1998	556.61	30.98	525.63	70.38	7.56	486.23	D
Gallery Well	9/3/1998	556.61	30.35	526.26	70.40	7.54	486.21	D
Gallery Well	9/4/1998	556.61	35.70	520.91	70.36	7.58	486.25	D
Gallery Well	9/5/1998	556.61	30.20	526.41	70.40	7.54	486.21	D
Gallery Well	9/6/1998	556.61	31.70	524.91	NA	NA	NA	D
Gallery Well	9/7/1998	556.61	32.75	523.86	70.46	7.48	486.15	D
Gallery Well	9/8/1998	556.61	32.80	523.81	70.44	7.50	486.17	D
Gallery Well	9/9/1998	556.61	30.11	526.50	70.47	7.47	486.14	D
Gallery Well	9/10/1998	556.61	31.60	525.01	70.42	7.52	486.19	D
Gallery Well	9/11/1998	556.61	30.30	526.31	70.40	7.54	486.21	D
Gallery Well	9/12/1998	556.61	31.60	525.01	70.20	7.74	486.41	D
Gallery Well	9/13/1998	556.61	31.50	525.11	70.50	7.44	486.11	D
Gallery Well	9/14/1998	556.61	31.10	525.51	70.47	7.47	486.14	D
Gallery Well	9/15/1998	556.61	32.45	524.16	70.42	7.52	486.19	D
Gallery Well	9/16/1998	556.61	30.23	526.38	70.44	7.50	486.17	D
Gallery Well	9/17/1998	556.61	31.50	525.11	70.40	7.54	486.21	D
Gallery Well	9/18/1998	556.61	30.60	526.01	70.42	7.52	486.19	D
Gallery Well	9/19/1998	556.61	31.52	525.09	70.35	7.59	486.26	D
Gallery Well	9/20/1998	556.61	31.80	524.81	70.47	7.47	486.14	D
Gallery Well	9/21/1998	556.61	30.11	526.50	70.43	7.51	486.18	D
Gallery Well	9/22/1998	556.61	31.40	525.21	70.30	7.64	486.31	D
Gallery Well	9/23/1998	556.61	31.40	525.21	70.45	7.49	486.16	D
Gallery Well	9/24/1998	556.61	31.30	525.31	70.42	7.52	486.19	D
Gallery Well	9/25/1998	556.61	31.60	525.01	70.30	7.64	486.31	D
Gallery Well	9/26/1998	556.61	30.20	526.41	70.20	7.74	486.41	D
Gallery Well	9/27/1998	556.61	30.10	526.51	70.45	7.49	486.16	D
Gallery Well	9/28/1998	556.61	30.24	526.37	70.42	7.52	486.19	D
Gallery Well	9/29/1998	556.61	30.80	525.81	70.34	7.60	486.27	D
Gallery Well	9/30/1998	556.61	30.20	526.41	70.40	7.54	486.21	D
Gallery Well	10/1/1998	556.61	31.30	525.31	70.32	7.62	486.29	D
Gallery Well	10/2/1998	556.61	31.45	525.16	70.37	7.57	486.24	D
Gallery Well	10/3/1998	556.61	34.10	522.51	70.55	7.39	486.06	D
Gallery Well	10/4/1998	556.61	32.40	524.21	70.34	7.60	486.27	D
Gallery Well	10/5/1998	556.61	32.55	524.06	70.40	7.54	486.21	D
Gallery Well	10/6/1998	556.61	32.00	524.61	70.35	7.59	486.26	D
Gallery Well	10/7/1998	556.61	32.30	524.31	70.10	7.84	486.51	D

Table A3-1. NAPL Elevations
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
Gallery Well	10/8/1998	556.61	32.45	524.16	70.34	7.60	486.27	D
Gallery Well	10/9/1998	556.61	32.50	524.11	70.00	7.94	486.61	D
Gallery Well	10/10/1998	556.61	31.70	524.91	70.10	7.84	486.51	D
Gallery Well	10/12/1998	556.61	32.70	523.91	70.30	7.64	486.31	D
Gallery Well	10/13/1998	556.61	32.30	524.31	70.32	7.62	486.29	D
Gallery Well	10/14/1998	556.61	30.30	526.31	70.40	7.54	486.21	D
Gallery Well	10/15/1998	556.61	31.45	525.16	70.25	7.69	486.36	D
Gallery Well	10/16/1998	556.61	31.10	525.51	70.48	7.46	486.13	D
Gallery Well	10/17/1998	556.61	30.78	525.83	70.40	7.54	486.21	D
Gallery Well	10/18/1998	556.61	30.60	526.01	70.42	7.52	486.19	D
Gallery Well	10/19/1998	556.61	30.63	525.98	70.35	7.59	486.26	D
Gallery Well	10/20/1998	556.61	30.25	526.36	70.36	7.58	486.25	D
Gallery Well	10/21/1998	556.61	31.30	525.31	70.26	7.68	486.35	D
Gallery Well	10/22/1998	556.61	30.85	525.76	70.30	7.64	486.31	D
Gallery Well	10/23/1998	556.61	30.95	525.66	70.34	7.60	486.27	D
Gallery Well	10/24/1998	556.61	30.05	526.56	70.33	7.61	486.28	D
Gallery Well	10/25/1998	556.61	30.50	526.11	70.37	7.57	486.24	D
Gallery Well	10/26/1998	556.61	30.70	525.91	70.44	7.50	486.17	D
Gallery Well	10/27/1998	556.61	31.40	525.21	70.28	7.66	486.33	D
Gallery Well	10/28/1998	556.61	30.95	525.66	70.30	7.64	486.31	D
Gallery Well	10/29/1998	556.61	30.60	526.01	70.37	7.57	486.24	D
Gallery Well	10/30/1998	556.61	31.00	525.61	70.36	7.58	486.25	D
Gallery Well	10/31/1998	556.61	31.30	525.31	70.37	7.57	486.24	D
Gallery Well	11/1/1998	556.61	31.02	525.59	70.32	7.62	486.29	D
Gallery Well	11/2/1998	556.61	31.25	525.36	70.10	7.84	486.51	D
Gallery Well	11/3/1998	556.61	30.20	526.41	70.30	7.64	486.31	D
Gallery Well	11/4/1998	556.61	31.10	525.51	70.44	7.50	486.17	D
Gallery Well	11/5/1998	556.61	31.70	524.91	70.38	7.56	486.23	D
Gallery Well	11/6/1998	556.61	32.45	524.16	70.30	7.64	486.31	D
Gallery Well	11/8/1998	556.61	30.11	526.50	70.54	7.40	486.07	D
Gallery Well	11/9/1998	556.61	30.22	526.39	70.36	7.58	486.25	D
Gallery Well	11/10/1998	556.61	30.60	526.01	70.35	7.59	486.26	D
Gallery Well	11/11/1998	556.61	30.22	526.39	70.38	7.56	486.23	D
Gallery Well	11/12/1998	556.61	30.37	526.24	70.13	7.81	486.48	D
Gallery Well	11/13/1998	556.61	31.00	525.61	70.25	7.69	486.36	D
Gallery Well	11/14/1998	556.61	30.60	526.01	70.30	7.64	486.31	D
Gallery Well	11/15/1998	556.61	30.78	525.83	70.25	7.69	486.36	D
Gallery Well	11/16/1998	556.61	30.82	525.79	70.27	7.67	486.34	D
Gallery Well	11/17/1998	556.61	30.16	526.45	70.30	7.64	486.31	D
Gallery Well	11/18/1998	556.61	30.50	526.11	70.55	7.39	486.06	D
Gallery Well	11/19/1998	556.61	30.15	526.46	70.45	7.49	486.16	D
Gallery Well	11/20/1998	556.61	30.12	526.49	70.55	7.39	486.06	D
Gallery Well	11/21/1998	556.61	30.10	526.51	70.45	7.49	486.16	D
Gallery Well	11/22/1998	556.61	30.10	526.51	70.50	7.44	486.11	D
Gallery Well	11/23/1998	556.61	30.14	526.47	70.48	7.46	486.13	D
Gallery Well	11/24/1998	556.61	30.22	526.39	70.45	7.49	486.16	D
Gallery Well	11/25/1998	556.61	30.40	526.21	70.42	7.52	486.19	D
Gallery Well	11/27/1998	556.61	30.10	526.51	70.25	7.69	486.36	D
Gallery Well	11/28/1998	556.61	30.10	526.51	70.40	7.54	486.21	D
Gallery Well	11/29/1998	556.61	30.75	525.86	70.45	7.49	486.16	D
Gallery Well	11/30/1998	556.61	31.15	525.46	70.28	7.66	486.33	D
Gallery Well	12/1/1998	556.61	31.10	525.51	70.38	7.56	486.23	D
Gallery Well	12/3/1998	556.61	31.00	525.61	70.34	7.60	486.27	D
Gallery Well	12/4/1998	556.61	31.10	525.51	70.35	7.59	486.26	D
Gallery Well	12/5/1998	556.61	31.60	525.01	70.25	7.69	486.36	D
Gallery Well	12/6/1998	556.61	31.95	524.66	70.25	7.69	486.36	D
Gallery Well	12/7/1998	556.61	32.60	524.01	70.28	7.66	486.33	D
Gallery Well	12/8/1998	556.61	32.05	524.56	70.34	7.60	486.27	D
Gallery Well	12/9/1998	556.61	31.82	524.79	70.25	7.69	486.36	D
Gallery Well	12/11/1998	556.61	31.00	525.61	70.30	7.64	486.31	D
Gallery Well	12/12/1998	556.61	31.20	525.41	70.35	7.59	486.26	D
Gallery Well	12/13/1998	556.61	31.20	525.41	70.34	7.60	486.27	D
Gallery Well	12/14/1998	556.61	31.25	525.36	70.32	7.62	486.29	D

Table A3-1. NAPL Elevations
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
Gallery Well	12/15/1998	556.61	31.20	525.41	70.35	7.59	486.26	D
Gallery Well	12/16/1998	556.61	31.05	525.56	70.38	7.56	486.23	D
Gallery Well	12/17/1998	556.61	31.10	525.51	70.28	7.66	486.33	D
Gallery Well	12/19/1998	556.61	31.26	525.35	70.35	7.59	486.26	D
Gallery Well	12/20/1998	556.61	31.50	525.11	70.10	7.84	486.51	D
Gallery Well	12/21/1998	556.61	32.05	524.56	70.32	7.62	486.29	D
Gallery Well	12/22/1998	556.61	31.40	525.21	70.30	7.64	486.31	D
Gallery Well	12/23/1998	556.61	32.50	524.11	70.35	7.59	486.26	D
Gallery Well	12/24/1998	556.61	31.70	524.91	70.34	7.60	486.27	D
Gallery Well	12/25/1998	556.61	30.55	526.06	70.32	7.62	486.29	D
Gallery Well	12/26/1998	556.61	31.22	525.39	70.15	7.79	486.46	D
Gallery Well	12/27/1998	556.61	31.30	525.31	70.35	7.59	486.26	D
Gallery Well	12/28/1998	556.61	31.37	525.24	70.42	7.52	486.19	D
Gallery Well	12/29/1998	556.61	31.30	525.31	70.36	7.58	486.25	D
Gallery Well	12/30/1998	556.61	31.60	525.01	70.34	7.60	486.27	D
Gallery Well	12/31/1998	556.61	31.30	525.31	70.32	7.62	486.29	D
Gallery Well	1/1/1999	556.61	31.15	525.46	70.25	7.69	486.36	D
Gallery Well	1/2/1999	556.61	32.00	524.61	70.30	7.64	486.31	D
Gallery Well	1/3/1999	556.61	31.85	524.76	70.25	7.69	486.36	D
Gallery Well	1/4/1999	556.61	31.90	524.71	70.26	7.68	486.35	D
Gallery Well	1/5/1999	556.61	31.71	524.90	70.32	7.62	486.29	D
Gallery Well	1/6/1999	556.61	31.30	525.31	70.36	7.58	486.25	D
Gallery Well	1/7/1999	556.61	30.99	525.62	70.34	7.60	486.27	D
Gallery Well	1/8/1999	556.61	30.92	525.69	70.37	7.57	486.24	D
Gallery Well	1/9/1999	556.61	30.88	525.73	70.35	7.59	486.26	D
Gallery Well	1/10/1999	556.61	31.98	524.63	70.26	7.68	486.35	D
Gallery Well	1/11/1999	556.61	30.84	525.77	70.28	7.66	486.33	D
Gallery Well	1/12/1999	556.61	31.00	525.61	70.20	7.74	486.41	D
Gallery Well	1/13/1999	556.61	30.80	525.81	70.09	7.85	486.52	D
Gallery Well	1/14/1999	556.61	30.75	525.86	70.33	7.61	486.28	D
Gallery Well	1/15/1999	556.61	30.71	525.90	70.12	7.82	486.49	D
Gallery Well	1/17/1999	556.61	30.83	525.78	70.34	7.60	486.27	D
Gallery Well	1/18/1999	556.61	31.02	525.59	70.32	7.62	486.29	D
Gallery Well	1/19/1999	556.61	30.88	525.73	70.30	7.64	486.31	D
Gallery Well	1/20/1999	556.61	30.64	525.97	70.22	7.72	486.39	D
Gallery Well	1/21/1999	556.61	31.12	525.49	70.24	7.70	486.37	D
Gallery Well	1/22/1999	556.61	31.00	525.61	70.30	7.64	486.31	D
Gallery Well	1/23/1999	556.61	30.87	525.74	70.32	7.62	486.29	D
Gallery Well	1/24/1999	556.61	30.90	525.71	70.28	7.66	486.33	D
Gallery Well	1/25/1999	556.61	30.80	525.81	70.33	7.61	486.28	D
Gallery Well	1/26/1999	556.61	31.20	525.41	70.32	7.62	486.29	D
Gallery Well	1/27/1999	556.61	31.08	525.53	70.11	7.83	486.50	D
Gallery Well	1/28/1999	556.61	31.00	525.61	70.30	7.64	486.31	D
Gallery Well	1/29/1999	556.61	31.00	525.61	70.37	7.57	486.24	D
Gallery Well	1/30/1999	556.61	31.15	525.46	70.10	7.84	486.51	D
Gallery Well	1/31/1999	556.61	31.45	525.16	70.10	7.84	486.51	D
Gallery Well	2/1/1999	556.61	31.67	524.94	70.37	7.57	486.24	D
Gallery Well	2/2/1999	556.61	31.52	525.09	70.30	7.64	486.31	D
Gallery Well	2/3/1999	556.61	31.22	525.39	70.32	7.62	486.29	D
Gallery Well	2/4/1999	556.61	30.85	525.76	70.31	7.63	486.30	D
Gallery Well	2/5/1999	556.61	31.10	525.51	70.38	7.56	486.23	D
Gallery Well	2/6/1999	556.61	31.55	525.06	70.33	7.61	486.28	D
Gallery Well	2/7/1999	556.61	31.35	525.26	70.34	7.60	486.27	D
Gallery Well	2/8/1999	556.61	31.15	525.46	70.33	7.61	486.28	D
Gallery Well	2/9/1999	556.61	31.30	525.31	70.33	7.61	486.28	D
Gallery Well	2/10/1999	556.61	31.49	525.12	70.05	7.89	486.56	D
Gallery Well	2/11/1999	556.61	31.30	525.31	70.37	7.57	486.24	D
Gallery Well	2/12/1999	556.61	31.40	525.21	70.38	7.56	486.23	D
Gallery Well	2/13/1999	556.61	31.45	525.16	70.05	7.89	486.56	D
Gallery Well	2/14/1999	556.61	31.95	524.66	70.20	7.74	486.41	D
Gallery Well	2/17/1999	556.61	31.30	525.31	70.34	7.60	486.27	D
Gallery Well	2/18/1999	556.61	31.51	525.10	70.36	7.58	486.25	D
Gallery Well	2/19/1999	556.61	31.27	525.34	70.34	7.60	486.27	D

Table A3-1. NAPL Elevations
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
Gallery Well	2/20/1999	556.61	31.27	525.34	70.35	7.59	486.26	D
Gallery Well	2/21/1999	556.61	31.69	524.92	70.30	7.64	486.31	D
Gallery Well	2/22/1999	556.61	31.90	524.71	70.32	7.62	486.29	D
Gallery Well	2/23/1999	556.61	31.90	524.71	70.33	7.61	486.28	D
Gallery Well	2/24/1999	556.61	31.46	525.15	70.04	7.90	486.57	D
Gallery Well	2/25/1999	556.61	31.50	525.11	70.31	7.63	486.30	D
Gallery Well	2/26/1999	556.61	31.50	525.11	70.34	7.60	486.27	D
Gallery Well	2/27/1999	556.61	31.50	525.11	70.20	7.74	486.41	D
Gallery Well	2/28/1999	556.61	31.55	525.06	70.25	7.69	486.36	D
Gallery Well	3/1/1999	556.61	31.81	524.80	70.15	7.79	486.46	D
Gallery Well	3/1/1999	556.61	46.11	510.50	70.15	7.79	486.46	D
Gallery Well	3/2/1999	556.61	43.90	512.71	70.32	7.62	486.29	D
Gallery Well	3/3/1999	556.61	39.50	517.11	70.31	7.63	486.30	D
Gallery Well	3/4/1999	556.61	55.85	500.76	70.29	7.65	486.32	D
Gallery Well	3/5/1999	556.61	55.12	501.49	70.36	7.58	486.25	D
Gallery Well	3/6/1999	556.61	62.43	494.18	70.34	7.60	486.27	D
Gallery Well	3/7/1999	556.61	62.70	493.91	70.37	7.57	486.24	D
Gallery Well	3/8/1999	556.61	36.70	519.91	70.34	7.60	486.27	D
Gallery Well	3/9/1999	556.61	38.55	518.06	70.33	7.61	486.28	D
Gallery Well	3/10/1999	556.61	43.35	513.26	70.32	7.62	486.29	D
Gallery Well	3/11/1999	556.61	42.40	514.21	70.32	7.62	486.29	D
Gallery Well	3/12/1999	556.61	36.10	520.51	70.34	7.60	486.27	D
Gallery Well	3/13/1999	556.61	31.80	524.81	70.25	7.69	486.36	D
Gallery Well	3/14/1999	556.61	31.75	524.86	70.20	7.74	486.41	D
Gallery Well	3/15/1999	556.61	48.95	507.66	70.35	7.59	486.26	D
Gallery Well	3/16/1999	556.61	37.55	519.06	70.33	7.61	486.28	D
Gallery Well	3/17/1999	556.61	55.22	501.39	70.30	7.64	486.31	D
Gallery Well	3/18/1999	556.61	35.00	521.61	70.32	7.62	486.29	D
Gallery Well	3/19/1999	556.61	43.85	512.76	70.34	7.60	486.27	D
Gallery Well	3/20/1999	556.61	40.25	516.36	70.30	7.64	486.31	D
Gallery Well	3/21/1999	556.61	43.26	513.35	70.32	7.62	486.29	D
Gallery Well	3/22/1999	556.61	37.00	519.61	70.35	7.59	486.26	D
Gallery Well	3/23/1999	556.61	36.20	520.41	70.31	7.63	486.30	D
Gallery Well	3/24/1999	556.61	36.40	520.21	70.32	7.62	486.29	D
Gallery Well	3/25/1999	556.61	38.00	518.61	70.35	7.59	486.26	D
Gallery Well	3/26/1999	556.61	43.20	513.41	70.34	7.60	486.27	D
Gallery Well	3/27/1999	556.61	31.00	525.61	70.05	7.89	486.56	D
Gallery Well	3/28/1999	556.61	60.65	495.96	70.15	7.79	486.46	D
Gallery Well	3/29/1999	556.61	55.03	501.58	70.28	7.66	486.33	D
Gallery Well	3/30/1999	556.61	53.20	503.41	70.32	7.62	486.29	D
Gallery Well	3/31/1999	556.61	38.90	517.71	70.35	7.59	486.26	D
Gallery Well	4/1/1999	556.61	30.87	525.74	70.40	7.54	486.21	D
Gallery Well	4/2/1999	556.61	30.98	525.63	70.37	7.57	486.24	D
Gallery Well	4/3/1999	556.61	30.80	525.81	70.38	7.56	486.23	D
Gallery Well	4/4/1999	556.61	30.70	525.91	70.26	7.68	486.35	D
Gallery Well	4/5/1999	556.61	30.35	526.26	70.34	7.60	486.27	D
Gallery Well	4/6/1999	556.61	30.20	526.41	70.35	7.59	486.26	D
Gallery Well	4/7/1999	556.61	30.55	526.06	70.20	7.74	486.41	D
Gallery Well	4/8/1999	556.61	30.40	526.21	70.32	7.62	486.29	D
Gallery Well	4/9/1999	556.61	30.44	526.17	70.29	7.65	486.32	D
Gallery Well	4/10/1999	556.61	30.20	526.41	70.30	7.64	486.31	D
Gallery Well	4/11/1999	556.61	30.00	526.61	72.10	5.84	484.51	D
Gallery Well	4/12/1999	556.61	30.22	526.39	70.28	7.66	486.33	D
Gallery Well	4/13/1999	556.61	30.18	526.43	70.39	7.55	486.22	D
Gallery Well	4/14/1999	556.61	30.17	526.44	70.38	7.56	486.23	D
Gallery Well	4/15/1999	556.61	30.13	526.48	70.40	7.54	486.21	D
Gallery Well	4/16/1999	556.61	30.17	526.44	70.38	7.56	486.23	D
Gallery Well	4/17/1999	556.61	30.16	526.45	70.39	7.55	486.22	D
Gallery Well	4/18/1999	556.61	30.15	526.46	70.36	7.58	486.25	D
Gallery Well	4/19/1999	556.61	30.20	526.41	70.31	7.63	486.30	D
Gallery Well	4/20/1999	556.61	30.20	526.41	70.32	7.62	486.29	D
Gallery Well	4/21/1999	556.61	30.18	526.43	70.34	7.60	486.27	D
Gallery Well	4/22/1999	556.61	30.18	526.43	70.32	7.62	486.29	D

Table A3-1. NAPL Elevations
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
Gallery Well	4/23/1999	556.61	30.25	526.36	70.31	7.63	486.30	D
Gallery Well	4/24/1999	556.61	30.10	526.51	70.15	7.79	486.46	D
Gallery Well	4/25/1999	556.61	30.00	526.61	70.45	7.49	486.16	D
Gallery Well	4/26/1999	556.61	30.14	526.47	70.34	7.60	486.27	D
Gallery Well	4/27/1999	556.61	30.15	526.46	70.32	7.62	486.29	D
Gallery Well	4/28/1999	556.61	30.18	526.43	70.39	7.55	486.22	D
Gallery Well	4/29/1999	556.61	30.15	526.46	70.40	7.54	486.21	D
Gallery Well	4/30/1999	556.61	30.17	526.44	70.41	7.53	486.20	D
Gallery Well	5/1/1999	556.61	30.20	526.41	70.40	7.54	486.21	D
Gallery Well	5/2/1999	556.61	30.14	526.47	70.42	7.52	486.19	D
Gallery Well	5/3/1999	556.61	30.17	526.44	70.35	7.59	486.26	D
Gallery Well	5/4/1999	556.61	30.22	526.39	70.38	7.56	486.23	D
Gallery Well	5/5/1999	556.61	30.19	526.42	70.35	7.59	486.26	D
Gallery Well	5/6/1999	556.61	30.17	526.44	70.42	7.52	486.19	D
Gallery Well	5/7/1999	556.61	30.18	526.43	70.36	7.58	486.25	D
Gallery Well	5/8/1999	556.61	30.50	526.11	70.40	7.54	486.21	D
Gallery Well	5/9/1999	556.61	30.12	526.49	70.50	7.44	486.11	D
Gallery Well	5/10/1999	556.61	30.13	526.48	70.42	7.52	486.19	D
Gallery Well	5/11/1999	556.61	30.14	526.47	70.40	7.54	486.21	D
Gallery Well	5/12/1999	556.61	30.12	526.49	70.43	7.51	486.18	D
Gallery Well	5/13/1999	556.61	30.16	526.45	70.45	7.49	486.16	D
Gallery Well	5/14/1999	556.61	30.16	526.45	70.44	7.50	486.17	D
Gallery Well	5/15/1999	556.61	30.12	526.49	70.42	7.52	486.19	D
Gallery Well	5/16/1999	556.61	30.10	526.51	70.46	7.48	486.15	D
Gallery Well	5/17/1999	556.61	30.18	526.43	70.38	7.56	486.23	D
Gallery Well	5/18/1999	556.61	30.19	526.42	70.41	7.53	486.20	D
Gallery Well	5/19/1999	556.61	30.17	526.44	70.42	7.52	486.19	D
Gallery Well	5/20/1999	556.61	30.19	526.42	70.42	7.52	486.19	D
Gallery Well	5/21/1999	556.61	30.15	526.46	70.42	7.52	486.19	D
Gallery Well	5/22/1999	556.61	30.11	526.50	70.40	7.54	486.21	D
Gallery Well	5/23/1999	556.61	30.05	526.56	70.40	7.54	486.21	D
Gallery Well	5/24/1999	556.61	30.10	526.51	70.44	7.50	486.17	D
Gallery Well	5/25/1999	556.61	30.13	526.48	70.44	7.50	486.17	D
Gallery Well	5/26/1999	556.61	30.17	526.44	70.38	7.56	486.23	D
Gallery Well	5/27/1999	556.61	30.12	526.49	70.48	7.46	486.13	D
Gallery Well	5/28/1999	556.61	30.12	526.49	70.43	7.51	486.18	D
Gallery Well	5/29/1999	556.61	30.13	526.48	70.46	7.48	486.15	D
Gallery Well	5/30/1999	556.61	30.11	526.50	70.47	7.47	486.14	D
Gallery Well	5/31/1999	556.61	30.23	526.38	70.42	7.52	486.19	D
Gallery Well	6/1/1999	556.61	30.40	526.21	70.38	7.56	486.23	D
Gallery Well	6/2/1999	556.61	30.18	526.43	70.42	7.52	486.19	D
Gallery Well	6/3/1999	556.61	30.19	526.42	70.42	7.52	486.19	D
Gallery Well	6/4/1999	556.61	30.19	526.42	70.40	7.54	486.21	D
Gallery Well	6/5/1999	556.61	30.11	526.50	70.40	7.54	486.21	D
Gallery Well	6/6/1999	556.61	30.00	526.61	70.41	7.53	486.20	D
Gallery Well	6/8/1999	556.61	30.09	526.52	70.40	7.54	486.21	D
Gallery Well	6/9/1999	556.61	30.11	526.50	70.42	7.52	486.19	D
Gallery Well	6/10/1999	556.61	30.16	526.45	70.45	7.49	486.16	D
Gallery Well	6/11/1999	556.61	44.20	512.41	70.47	7.47	486.14	D
Gallery Well	6/12/1999	556.61	30.38	526.23	70.45	7.49	486.16	D
Gallery Well	6/13/1999	556.61	43.10	513.51	70.46	7.48	486.15	D
Gallery Well	6/14/1999	556.61	30.10	526.51	70.51	7.43	486.10	D
Gallery Well	6/15/1999	556.61	30.08	526.53	70.48	7.46	486.13	D
Gallery Well	6/16/1999	556.61	30.13	526.48	70.50	7.44	486.11	D
Gallery Well	6/17/1999	556.61	30.15	526.46	70.45	7.49	486.16	D
Gallery Well	6/18/1999	556.61	30.17	526.44	70.38	7.56	486.23	D
Gallery Well	6/19/1999	556.61	30.10	526.51	70.25	7.69	486.36	D
Gallery Well	6/20/1999	556.61	30.05	526.56	70.30	7.64	486.31	D
Gallery Well	6/21/1999	556.61	30.11	526.50	70.50	7.44	486.11	D
Gallery Well	6/22/1999	556.61	30.12	526.49	70.47	7.47	486.14	D
Gallery Well	6/23/1999	556.61	30.18	526.43	70.38	7.56	486.23	D
Gallery Well	6/24/1999	556.61	30.14	526.47	70.41	7.53	486.20	D
Gallery Well	6/25/1999	556.61	30.13	526.48	70.40	7.54	486.21	D

Table A3-1. NAPL Elevations
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
Gallery Well	6/26/1999	556.61	30.12	526.49	70.42	7.52	486.19	D
Gallery Well	6/27/1999	556.61	30.13	526.48	70.46	7.48	486.15	D
Gallery Well	6/28/1999	556.61	30.16	526.45	70.42	7.52	486.19	D
Gallery Well	6/29/1999	556.61	30.11	526.50	70.40	7.54	486.21	D
Gallery Well	6/30/1999	556.61	30.10	526.51	70.35	7.59	486.26	D
Gallery Well	7/1/1999	556.61	30.13	526.48	70.43	7.51	486.18	D
Gallery Well	7/2/1999	556.61	30.13	526.48	70.38	7.56	486.23	D
Gallery Well	7/3/1999	556.61	30.12	526.49	70.40	7.54	486.21	D
Gallery Well	7/4/1999	556.61	30.00	526.61	70.35	7.59	486.26	D
Gallery Well	7/5/1999	556.61	30.11	526.50	70.42	7.52	486.19	D
Gallery Well	7/6/1999	556.61	30.10	526.51	70.40	7.54	486.21	D
Gallery Well	7/7/1999	556.61	30.13	526.48	70.34	7.60	486.27	D
Gallery Well	7/8/1999	556.61	30.14	526.47	70.38	7.56	486.23	D
Gallery Well	7/9/1999	556.61	25.03	531.58	70.54	7.40	486.07	D
Gallery Well	7/9/1999	556.61	24.50	532.11	70.50	7.44	486.11	D
Gallery Well	7/9/1999	556.61	24.47	532.14	70.55	7.39	486.06	D
Gallery Well	7/10/1999	556.61	24.33	532.28	70.62	7.32	485.99	D
Gallery Well	7/21/1999	556.61	24.28	532.33	ND	ND	ND	D
Gallery Well	7/22/1999	556.61	25.25	531.36	ND	ND	ND	D
Gallery Well	7/23/1999	556.61	25.58	531.03	ND	ND	ND	D
Gallery Well	7/24/1999	556.61	25.28	531.33	ND	ND	ND	D
Gallery Well	7/25/1999	556.61	25.52	531.09	ND	ND	ND	D
Gallery Well	7/26/1999	556.61	25.63	530.98	ND	ND	ND	D
Gallery Well	7/27/1999	556.61	25.62	530.99	70.50	7.44	486.11	D
Gallery Well	7/28/1999	556.61	25.50	531.11	70.35	7.59	486.26	D
Gallery Well	7/29/1999	556.61	25.93	530.68	70.38	7.56	486.23	D
Gallery Well	7/30/1999	556.61	26.00	530.61	70.40	7.54	486.21	D
Gallery Well	8/3/1999	556.61	25.55	531.06	70.15	7.79	486.46	D
Gallery Well	8/4/1999	556.61	26.01	530.60	70.41	7.53	486.20	D
Gallery Well	8/5/1999	556.61	26.00	530.61	70.30	7.64	486.31	D
Gallery Well	8/6/1999	556.61	26.11	530.50	70.33	7.61	486.28	D
Gallery Well	8/7/1999	556.61	25.68	530.93	70.44	7.50	486.17	D
Gallery Well	8/8/1999	556.61	25.90	530.71	70.36	7.58	486.25	D
Gallery Well	8/9/1999	556.61	26.00	530.61	70.29	7.65	486.32	D
Gallery Well	8/10/1999	556.61	25.84	530.77	70.15	7.79	486.46	D
Gallery Well	8/11/1999	556.61	26.10	530.51	70.32	7.62	486.29	D
Gallery Well	8/12/1999	556.61	26.18	530.43	70.20	7.74	486.41	D
Gallery Well	8/13/1999	556.61	26.22	530.39	70.24	7.70	486.37	D
Gallery Well	8/14/1999	556.61	25.97	530.64	70.16	7.78	486.45	D
Gallery Well	8/15/1999	556.61	25.83	530.78	70.50	7.44	486.11	D
Gallery Well	8/16/1999	556.61	26.10	530.51	70.35	7.59	486.26	D
Gallery Well	8/17/1999	556.61	26.20	530.41	70.32	7.62	486.29	D
Gallery Well	8/18/1999	556.61	26.30	530.31	70.30	7.64	486.31	D
Gallery Well	8/19/1999	556.61	26.35	530.26	70.33	7.61	486.28	D
Gallery Well	8/20/1999	556.61	26.33	530.28	70.32	7.62	486.29	D
Gallery Well	8/21/1999	556.61	26.78	529.83	70.33	7.61	486.28	D
Gallery Well	8/22/1999	556.61	26.90	529.71	70.30	7.64	486.31	D
Gallery Well	8/23/1999	556.61	26.30	530.31	70.36	7.58	486.25	D
Gallery Well	8/29/1999	556.61	25.70	530.91	70.22	7.72	486.39	D
Gallery Well	8/30/1999	556.61	NA	NA	70.32	7.62	486.29	D
Gallery Well	8/31/1999	556.61	30.10	526.51	70.38	7.56	486.23	D
Gallery Well	9/1/1999	556.61	30.13	526.48	70.35	7.59	486.26	D
Gallery Well	9/2/1999	556.61	30.84	525.77	70.32	7.62	486.29	D
Gallery Well	9/3/1999	556.61	30.30	526.31	70.33	7.61	486.28	D
Gallery Well	9/5/1999	556.61	30.15	526.46	70.30	7.64	486.31	D
Gallery Well	9/6/1999	556.61	33.44	523.17	70.46	7.48	486.15	D
Gallery Well	9/7/1999	556.61	36.35	520.26	70.89	7.05	485.72	D
Gallery Well	9/9/1999	556.61	33.30	523.31	70.50	7.44	486.11	D
Gallery Well	9/10/1999	556.61	37.90	518.71	70.80	7.14	485.81	D
Gallery Well	9/11/1999	556.61	33.54	523.07	70.64	7.30	485.97	D
Gallery Well	9/13/1999	556.61	56.00	500.61	70.65	7.29	485.96	D
Gallery Well	9/14/1999	556.61	41.92	514.69	70.68	7.26	485.93	D
Gallery Well	9/15/1999	556.61	44.95	511.66	70.58	7.36	486.03	D

Table A3-1. NAPL Elevations
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
Gallery Well	9/15/1999	556.61	40.90	515.71	70.65	7.29	485.96	D
Gallery Well	9/17/1999	556.61	50.70	505.91	70.82	7.12	485.79	D
Gallery Well	9/18/1999	556.61	32.65	523.96	70.65	7.29	485.96	D
Gallery Well	9/19/1999	556.61	45.27	511.34	70.58	7.36	486.03	D
Gallery Well	9/20/1999	556.61	33.12	523.49	70.57	7.37	486.04	D
Gallery Well	9/21/1999	556.61	34.81	521.80	70.42	7.52	486.19	D
Gallery Well	9/22/1999	556.61	39.11	517.50	70.38	7.56	486.23	D
Gallery Well	9/23/1999	556.61	41.20	515.41	70.41	7.53	486.20	D
Gallery Well	9/24/1999	556.61	34.67	521.94	70.38	7.56	486.23	D
Gallery Well	9/25/1999	556.61	32.16	524.45	70.40	7.54	486.21	D
Gallery Well	9/27/1999	556.61	33.78	522.83	70.50	7.44	486.11	D
Gallery Well	9/28/1999	556.61	34.35	522.26	70.51	7.43	486.10	D
Gallery Well	9/29/1999	556.61	32.80	523.81	70.39	7.55	486.22	D
Gallery Well	9/30/1999	556.61	33.25	523.36	70.54	7.40	486.07	D
Gallery Well	10/1/1999	556.61	32.75	523.86	70.53	7.41	486.08	D
Gallery Well	10/3/1999	556.61	40.05	516.56	70.56	7.38	486.05	D
Gallery Well	10/4/1999	556.61	34.40	522.21	70.55	7.39	486.06	D
Gallery Well	10/5/1999	556.61	37.12	519.49	70.60	7.34	486.01	D
Gallery Well	10/6/1999	556.61	42.68	513.93	70.62	7.32	485.99	D
Gallery Well	10/7/1999	556.61	25.86	530.75	70.48	7.46	486.13	D
Gallery Well	10/8/1999	556.61	34.57	522.04	70.52	7.42	486.09	D
Gallery Well	10/9/1999	556.61	35.16	521.45	70.44	7.50	486.17	D
Gallery Well	10/10/1999	556.61	37.82	518.79	70.39	7.55	486.22	D
Gallery Well	10/11/1999	556.61	36.55	520.06	70.49	7.45	486.12	D
Gallery Well	10/12/1999	556.61	32.80	523.81	70.52	7.42	486.09	D
Gallery Well	10/13/1999	556.61	33.42	523.19	70.51	7.43	486.10	D
Gallery Well	10/15/1999	556.61	35.35	521.26	70.50	7.44	486.11	D
Gallery Well	10/16/1999	556.61	33.55	523.06	70.52	7.42	486.09	D
Gallery Well	10/17/1999	556.61	31.95	524.66	70.55	7.39	486.06	D
Gallery Well	10/18/1999	556.61	36.52	520.09	70.59	7.35	486.02	D
Gallery Well	10/19/1999	556.61	31.95	524.66	70.55	7.39	486.06	D
Gallery Well	10/20/1999	556.61	38.80	517.81	70.43	7.51	486.18	D
Gallery Well	10/21/1999	556.61	33.50	523.11	70.47	7.47	486.14	D
Gallery Well	10/22/1999	556.61	33.85	522.76	70.51	7.43	486.10	D
Gallery Well	10/23/1999	556.61	33.39	523.22	70.40	7.54	486.21	D
Gallery Well	10/25/1999	556.61	36.50	520.11	70.50	7.44	486.11	D
Gallery Well	11/2/1999	561.20	39.00	522.20	ND	ND	ND	D
Gallery Well	11/3/1999	561.20	43.40	517.80	ND	ND	ND	D
Gallery Well	11/4/1999	561.20	36.50	524.70	ND	ND	ND	D
Gallery Well	11/5/1999	561.20	36.30	524.90	ND	ND	ND	D
Gallery Well	11/8/1999	561.20	39.95	521.25	ND	ND	ND	D
Gallery Well	11/9/1999	561.20	41.88	519.32	76.63	1.31	484.57	D
Gallery Well	11/10/1999	561.20	37.35	523.85	76.41	1.53	484.79	D
Gallery Well	11/11/1999	561.20	37.60	523.60	76.67	1.27	484.53	D
Gallery Well	11/13/1999	561.20	41.19	520.01	76.63	1.31	484.57	D
Gallery Well	11/14/1999	561.20	39.35	521.85	76.50	1.44	484.70	D
Gallery Well	11/15/1999	561.20	37.00	524.20	76.33	1.61	484.87	D
Gallery Well	11/16/1999	561.20	39.75	521.45	76.64	1.30	484.56	D
Gallery Well	11/17/1999	561.20	40.40	520.80	76.65	1.29	484.55	D
Gallery Well	11/18/1999	561.20	36.03	525.17	ND	ND	ND	D
Gallery Well	11/19/1999	561.20	36.30	524.90	76.61	1.33	484.59	D
Gallery Well	11/22/1999	561.20	41.97	519.23	76.67	1.27	484.53	D
Gallery Well	11/23/1999	561.20	41.00	520.20	75.64	2.30	485.56	D
Gallery Well	11/24/1999	561.20	40.45	520.75	ND	ND	ND	D
Gallery Well	11/25/1999	561.20	42.92	518.28	ND	ND	ND	D
Gallery Well	11/27/1999	561.20	36.17	525.03	ND	ND	ND	D
Gallery Well	11/28/1999	561.20	36.50	524.70	75.55	2.39	485.65	D
Gallery Well	11/29/1999	561.20	38.04	523.16	75.58	2.36	485.62	D
Gallery Well	11/30/1999	561.20	37.80	523.40	ND	ND	ND	D
Gallery Well	12/1/1999	561.20	42.65	518.55	ND	ND	ND	D
Gallery Well	12/2/1999	561.20	37.55	523.65	75.55	2.39	485.65	D
Gallery Well	12/3/1999	561.20	36.05	525.15	76.68	1.26	484.52	D
Gallery Well	12/4/1999	561.20	36.34	524.86	75.61	2.33	485.59	D

Table A3-1. NAPL Elevations
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Casmalia Resources Superfund Site
Casmalia, California

Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
Gallery Well	8/1/2002 (1)	561.20	52.84	508.36	77.32	0.62	483.88	D
Gallery Well	8/8/2002 (1)	561.20	54.42	506.78	77.25	0.69	483.95	D
Gallery Well	8/15/2002 (1)	561.20	57.80	503.40	76.90	1.04	484.30	D
Gallery Well	6/11/2003 (1)	561.20	51.13	510.07	77.10	0.84	484.10	D
Gallery Well	7/31/2003 (1)	561.20	53.00	508.20	76.20	1.74	485.00	D
Gallery Well	9/2/2003 (1)	561.20	57.10	504.10	74.50	3.44	486.70	D
Gallery Well	10/9/2003 (1)	561.20	54.90	506.30	76.40	1.54	484.80	D
Gallery Well	11/13/2003 (1)	561.20	54.35	506.85	77.35	0.59	483.85	D
Gallery Well	12/18/2003 (1)	561.20	56.90	504.30	76.15	1.79	485.05	D
Gallery Well	1/20/2004 (1)	561.20	62.30	498.90	76.90	1.04	484.30	D
Gallery Well	2/24/2004 (1)	561.20	54.53	506.67	76.70	1.24	484.50	D
Gallery Well	3/23/2004 (1)	561.20	61.25	499.95	75.85	2.09	485.35	D
Gallery Well	4/20/2004 (1)	561.20	53.40	507.80	76.41	1.53	484.79	D
Gallery Well	5/21/2004 (1)	561.20	67.20	494.00	76.00	1.94	485.20	D
Gallery Well	8/24/2004 (1)	561.20	67.44	493.76	75.26	2.68	485.94	D
Gallery Well	3/15/2005 (1)	561.20	64.15	497.05	75.20	2.74	486.00	D
Gallery Well	10/6/2005 (1)	561.20	64.27	496.93	74.03	3.91	487.17	D
RGPZ-7C	1/23/2003	466.83	9.40	457.43	93.45	8.55	373.38	D
RGPZ-7C	4/30/2003	466.83	10.25	456.58	93.71	8.29	373.12	D
RGPZ-7C	5/27/2003	466.83	9.92	456.91	93.60	8.40	373.23	D
RGPZ-7C	5/27/2003	466.83	14.50	452.33	94.44	7.56	372.39	D
RGPZ-7C	6/6/2003	466.83	9.85	456.98	92.21	9.79	374.62	D
RGPZ-7C	6/24/2003	466.83	9.81	457.02	92.25	9.75	374.58	D
RGPZ-7C	7/2/2003	466.83	9.88	456.95	92.30	9.70	374.53	D
RGPZ-7C	7/9/2003	466.83	9.95	456.88	92.30	9.70	374.53	D
RGPZ-7C	8/14/2003	466.83	10.41	456.42	92.50	9.50	374.33	D
RGPZ-7C	9/17/2003	466.83	10.48	456.35	92.55	9.45	374.28	D
RGPZ-7C	10/16/2003	466.83	10.62	456.21	92.45	9.55	374.38	D
RGPZ-7C	11/13/2003	466.83	10.67	456.16	92.57	9.43	374.26	D
RGPZ-7C	12/18/2003	466.83	10.76	456.07	92.52	9.48	374.31	D
RGPZ-7C	1/20/2004	466.83	11.50	455.33	93.10	8.90	373.73	D
RGPZ-7C	2/24/2004	466.83	11.53	455.30	93.16	8.84	373.67	D
RGPZ-7C	3/23/2004	466.83	9.83	457.00	91.57	10.43	375.26	D
RGPZ-7C	4/20/2004	466.83	9.50	457.33	91.31	10.69	375.52	D
RGPZ-7C	5/20/2004	466.83	9.73	457.10	91.37	10.63	375.46	D
RGPZ-7C	6/21/2004	466.83	10.30	456.53	91.65	10.35	375.18	D
RGPZ-7C	7/22/2004	466.83	10.10	456.73	91.90	10.10	374.93	D
RGPZ-7C	8/24/2004	466.83	10.30	456.53	91.90	10.10	374.93	D
RGPZ-7C	10/8/2004	466.83	10.40	456.43	91.82	10.18	375.01	D
RGPZ-7C	11/30/2004	466.83	12.55	454.28	93.12	8.88	373.71	D
RGPZ-7C	12/15/2004	466.83	13.00	453.83	93.30	8.70	373.53	D
RGPZ-7C	1/25/2005	466.83	7.80	459.03	88.15	13.85	378.68	D
RGPZ-7C	2/24/2005	466.83	7.90	458.93	88.43	13.57	378.40	D
RGPZ-7C	3/23/2005	466.83	6.62	460.21	86.67	15.33	380.16	D
RGPZ-7C	4/26/2005	466.83	7.03	459.80	87.36	14.64	379.47	D
RGPZ-7C	5/31/2005	466.83	8.61	458.22	89.02	12.98	377.81	D
RGPZ-7C	6/21/2005	466.83	9.15	457.68	89.20	12.80	377.63	D
RGPZ-7C	10/6/2005	466.83	10.10	456.73	90.12	11.88	376.71	D
RGPZ-7C	1/19/2006	466.83	8.40	458.43	88.41	13.59	378.42	D
RGPZ-7C	3/27/2006	466.83	8.15	458.68	87.80	14.20	379.03	D
RGPZ-7C	6/26/2006	466.83	9.13	457.70	88.96	13.04	377.87	D
RGPZ-7C	9/20/2006	466.83	10.35	456.48	90.05	11.95	376.78	D
RGPZ-7C	12/11/2006	466.83	8.82	458.01	87.03	14.97	379.80	D
RGPZ-7C	3/14/2007	466.83	8.40	458.43	86.48	15.52	380.35	D
RGPZ-7C	6/28/2007	466.83	8.85	457.98	86.58	15.42	380.25	D
RGPZ-7C	9/21/2007	466.83	8.80	458.03	86.40	15.60	380.43	D
RGPZ-7C	12/27/2007	466.83	9.01	457.82	86.61	15.39	380.22	D
RGPZ-7C	3/31/2008	466.83	4.60	462.23	82.11	19.89	384.72	D
RGPZ-7C	6/30/2008	466.83	6.50	460.33	84.02	17.98	382.81	D
RGPZ-7C	9/25/2008	466.83	7.40	459.43	84.20	17.80	382.63	D
RGPZ-7C	12/23/2008	466.83	7.78	459.05	84.20	17.80	382.63	D
RGPZ-7C	3/31/2009	466.83	4.10	462.73	84.30	17.70	382.53	D
RGPZ-7C	6/22/2009	466.83	7.95	458.88	85.26	16.74	381.57	D

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Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
RGPZ-7C	9/18/2009	466.83	8.70	458.13	85.80	16.20	381.03	D
RGPZ-7C	12/21/2009	466.83	8.93	457.90	85.96	16.04	380.87	D
RGPZ-7C	3/9/2010	466.83	5.39	461.44	83.58	18.42	383.25	D
RGPZ-7C	12/16/2010	466.83	7.75	459.08	83.64	18.36	383.19	D
RGPZ-7C	3/22/2011	466.83	4.02	462.81	81.31	20.69	385.52	D
RGPZ-7C	6/27/2011	466.83	6.69	460.14	81.58	20.42	385.25	D
RGPZ-7C	10/31/2011	466.83	6.81	460.02	84.08	17.92	382.75	D
RGPZ-7C	12/28/2011	466.83	7.20	459.63	84.65	17.35	382.18	D
RGPZ-7D	1/23/2003	467.78	8.30	459.48	148.99	1.31	318.79	D
RGPZ-7D	4/30/2003	467.78	8.71	459.07	149.21	1.09	318.57	D
RGPZ-7D	5/27/2003	467.78	8.41	459.37	148.80	1.50	318.98	D
RGPZ-7D	5/27/2003	467.78	11.75	456.03	150.30	0.00	317.48	D
RGPZ-7D	6/6/2003	467.78	9.25	458.53	149.70	0.60	318.08	D
RGPZ-7D	6/24/2003	467.78	8.77	459.01	149.61	0.69	318.17	D
RGPZ-7D	7/2/2003	467.78	8.86	458.92	149.62	0.68	318.16	D
RGPZ-7D	7/9/2003	467.78	8.85	458.93	149.55	0.75	318.23	D
RGPZ-7D	8/14/2003	467.78	9.21	458.57	149.57	0.73	318.21	D
RGPZ-7D	9/17/2003	467.78	9.45	458.33	149.55	0.75	318.23	D
RGPZ-7D	10/16/2003	466.83	10.62	456.21	92.45	57.85	374.38	D
RGPZ-7D	11/13/2003	466.83	10.67	456.16	92.57	57.73	374.26	D
RGPZ-7D	12/18/2003	466.83	10.76	456.07	92.52	57.78	374.31	D
RGPZ-7D	1/20/2004	466.83	11.50	455.33	93.10	57.20	373.73	D
RGPZ-7D	2/24/2004	466.83	11.53	455.30	93.16	57.14	373.67	D
RGPZ-7D	3/23/2004	466.83	9.83	457.00	91.57	58.73	375.26	D
RGPZ-7D	4/20/2004	467.78	8.10	459.68	149.50	0.80	318.28	D
RGPZ-7D	5/20/2004	467.78	8.58	459.20	149.53	0.77	318.25	D
RGPZ-7D	6/21/2004	467.78	9.20	458.58	149.65	0.65	318.13	D
RGPZ-7D	7/22/2004	467.78	9.16	458.62	149.50	0.80	318.28	D
RGPZ-7D	8/24/2004	467.78	9.40	458.38	149.62	0.68	318.16	D
RGPZ-7D	10/8/2004	467.78	9.65	458.13	149.65	0.65	318.13	D
RGPZ-7D	11/30/2004	467.78	9.72	458.06	149.60	0.70	318.18	D
RGPZ-7D	12/15/2004	467.78	9.81	457.97	149.61	0.69	318.17	D
RGPZ-7D	1/25/2005	467.78	4.05	463.73	149.52	0.78	318.26	D
RGPZ-7D	2/24/2005	467.78	4.52	463.26	149.55	0.75	318.23	D
RGPZ-7D	3/23/2005	467.78	4.16	463.62	149.61	0.69	318.17	D
RGPZ-7D	4/26/2005	467.78	5.18	462.60	149.63	0.67	318.15	D
RGPZ-7D	5/31/2005	467.78	6.19	461.59	149.64	0.66	318.14	D
RGPZ-7D	6/21/2005	467.78	6.51	461.27	149.55	0.75	318.23	D
RGPZ-7D	10/6/2005	467.78	7.82	459.96	149.41	0.89	318.37	D
RGPZ-7D	1/19/2006	467.78	8.61	459.17	149.70	0.60	318.08	D
RGPZ-7D	3/27/2006	467.78	8.80	458.98	149.53	0.77	318.25	D
RGPZ-7D	6/26/2006	467.78	8.90	458.88	149.58	0.72	318.20	D
RGPZ-7D	9/20/2006	467.78	9.10	458.68	149.63	0.67	318.15	D
RGPZ-7D	12/11/2006	467.78	9.10	458.68	149.60	0.70	318.18	D
RGPZ-7D	3/14/2007	467.78	7.40	460.38	149.53	0.77	318.25	D
RGPZ-7D	6/28/2007	467.78	9.77	458.01	149.57	0.73	318.21	D
RGPZ-7D	9/21/2007	467.78	9.90	457.88	147.58	2.72	320.20	D
RGPZ-7D	12/27/2007	467.78	9.80	457.98	149.55	0.75	318.23	D
RGPZ-7D	3/31/2008	467.78	10.63	457.15	149.48	0.82	318.30	D
RGPZ-7D	6/30/2008	467.78	9.28	458.50	149.10	1.20	318.68	D
RGPZ-7D	9/25/2008	467.78	8.96	458.82	NA	NA	NA	D
RGPZ-7D	12/23/2008	467.78	8.77	459.01	149.42	0.88	318.36	D
RGPZ-7D	3/31/2009	467.78	7.45	460.33	NA	NA	NA	D
RGPZ-7D	6/22/2009	467.78	8.40	459.38	NA	NA	NA	D
RGPZ-7D	9/18/2009	467.78	9.50	458.28	NA	NA	NA	D
RGPZ-7D	12/21/2009	467.78	8.23	459.55	149.51	0.79	318.27	D
RGPZ-7D	3/9/2010	467.78	8.30	459.48	149.45	0.85	318.33	D
RGPZ-7D	12/16/2010	467.78	7.58	460.20	149.27	1.03	318.51	D
RGPZ-7D	3/22/2011	467.78	7.84	459.94	149.30	1.00	318.48	D
RGPZ-7D	6/27/2011	467.78	7.06	460.72	149.27	1.03	318.51	D
RGPZ-7D	10/31/2011	467.78	6.78	461.00	ND	ND	ND	D
RGPZ-7D	12/28/2011	467.78	6.71	461.07	149.42	0.88	318.36	D
RIPZ-13	9/14/2007	595.48	80.52	514.96	90.95	8.45	504.53	D

Table A3-1. NAPL Elevations
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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
RIPZ-13	9/17/2007	595.48	80.60	514.88	90.56	8.84	504.92	D
RIPZ-13	9/18/2007	595.48	80.82	514.66	90.77	8.63	504.71	D
RIPZ-13	9/19/2007	595.48	80.90	514.58	90.72	8.68	504.76	D
RIPZ-13	9/20/2007	595.48	80.75	514.73	90.70	8.70	504.78	D
RIPZ-13	9/27/2007	595.48	80.92	514.56	91.34	8.06	504.14	D
RIPZ-13	10/4/2007	595.48	80.81	514.67	90.43	8.97	505.05	D
RIPZ-13	10/11/2007	595.48	80.98	514.50	89.97	9.43	505.51	D
RIPZ-13	10/18/2007	595.48	81.10	514.38	89.61	9.79	505.87	D
RIPZ-13	11/15/2007	595.48	80.90	514.58	85.40	14.00	510.08	D
RIPZ-13	12/13/2007	595.48	81.54	513.94	85.21	14.19	510.27	D
RIPZ-13	1/17/2008	595.48	81.10	514.38	85.33	14.07	510.15	D
RIPZ-13	2/13/2008	595.48	81.42	514.06	85.90	13.50	509.58	D
RIPZ-13	3/13/2008	595.48	82.25	513.23	85.82	13.58	509.66	D
RIPZ-13	4/17/2008	595.48	81.14	514.34	85.51	13.89	509.97	D
RIPZ-13	5/22/2008	595.48	81.17	514.31	85.41	13.99	510.07	D
RIPZ-13	6/19/2008	595.48	81.26	514.22	85.53	13.87	509.95	D
RIPZ-13	7/17/2008	595.48	81.30	514.18	85.59	13.81	509.89	D
RIPZ-13	8/20/2008	595.48	81.38	514.10	85.52	13.88	509.96	D
RIPZ-13	9/17/2008	595.48	81.28	514.20	85.54	13.86	509.94	D
RIPZ-13	12/16/2008	595.48	81.26	514.22	85.53	13.87	509.95	D
RIPZ-13	3/23/2009	595.48	81.50	513.98	85.70	13.70	509.78	D
RIPZ-13	3/24/2009	595.48	81.50	513.98	85.70	13.70	509.78	D
RIPZ-13	3/25/2009	595.48	81.55	513.93	89.50	9.90	505.98	D
RIPZ-13	3/26/2009	595.48	81.74	513.74	89.72	9.68	505.76	D
RIPZ-13	3/27/2009	595.48	81.78	513.70	90.20	9.20	505.28	D
RIPZ-13	3/30/2009	595.48	81.73	513.75	90.86	8.54	504.62	D
RIPZ-13	3/31/2009	595.48	81.41	514.07	91.18	8.22	504.30	D
RIPZ-13	4/1/2009	595.48	82.18	513.30	94.22	5.18	501.26	D
RIPZ-13	4/2/2009	595.48	82.09	513.39	96.52	2.88	498.96	D
RIPZ-13	4/3/2009	595.48	82.52	512.96	96.75	2.65	498.73	D
RIPZ-13	4/6/2009	595.48	82.30	513.18	95.08	4.32	500.40	D
RIPZ-13	4/7/2009	595.48	81.54	513.94	94.76	4.64	500.72	D
RIPZ-13	4/8/2009	595.48	81.46	514.02	94.43	4.97	501.05	D
RIPZ-13	4/9/2009	595.48	81.43	514.05	94.16	5.24	501.32	D
RIPZ-13	4/10/2009	595.48	81.57	513.91	94.01	5.39	501.47	D
RIPZ-13	4/13/2009	595.48	81.51	513.97	93.43	5.97	502.05	D
RIPZ-13	4/14/2009	595.48	81.48	514.00	93.23	6.17	502.25	D
RIPZ-13	4/15/2009	595.48	81.31	514.17	93.03	6.37	502.45	D
RIPZ-13	4/16/2009	595.48	81.30	514.18	92.93	6.47	502.55	D
RIPZ-13	4/20/2009	595.48	81.53	513.95	92.55	6.85	502.93	D
RIPZ-13	4/27/2009	595.48	81.52	513.96	92.36	7.04	503.12	D
RIPZ-13	5/4/2009	595.48	81.38	514.10	92.36	7.04	503.12	D
RIPZ-13	5/11/2009	595.48	81.49	513.99	92.26	7.14	503.22	D
RIPZ-13	5/18/2009	595.48	81.48	514.00	92.16	7.24	503.32	D
RIPZ-13	6/1/2009	595.48	81.46	514.02	92.09	7.31	503.39	D
RIPZ-13	6/22/2009	595.48	82.49	512.99	92.09	7.31	503.39	D
RIPZ-13	9/22/2009	595.48	81.38	514.10	92.15	7.25	503.33	D
RIPZ-13	12/21/2009	595.48	81.38	514.10	91.81	7.59	503.67	D
RIPZ-13	3/9/2010	595.48	81.36	514.12	90.83	8.57	504.65	D
RIPZ-13	12/16/2010	595.48	81.25	514.23	85.33	14.07	510.15	D
RIPZ-13	6/27/2011	595.48	81.30	514.18	85.37	14.03	510.11	D
RIPZ-13	10/31/2011	595.48	80.55	514.93	84.71	14.69	510.77	D
RIPZ-13	12/28/2011	595.48	80.66	514.82	85.61	13.79	509.87	D
RIPZ-27	9/22/2009	559.13	43.30	515.83	74.46	2.84	484.67	D
RIPZ-27	12/21/2009	559.13	58.53	500.60	71.05	6.25	488.08	D
RIPZ-27	3/9/2010	559.13	62.67	496.46	72.70	4.60	486.43	D
RIPZ-27	12/16/2010	559.13	61.74	497.39	75.23	2.07	483.90	D
RIPZ-27	6/27/2011	559.13	61.62	497.51	75.68	1.62	483.45	D
RIPZ-27	10/31/2011	559.13	60.29	498.84	74.43	2.87	484.70	D
RIPZ-27	12/28/2011	559.13	58.62	500.51	76.30	1.00	482.83	D
Gallery Well	5/15/2001	561.20			61.14		500.06	L
Gallery Well	5/22/2001	561.20			59.55		501.65	L
Gallery Well	5/29/2001	561.20			61.38		499.82	L

Table A3-1. NAPL Elevations
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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
Gallery Well	6/16/2001	561.20			61.20		500.00	L
Gallery Well	6/20/2001	561.20			61.40		499.80	L
Gallery Well	6/28/2001	561.20			63.67		497.53	L
Gallery Well	7/3/2001	561.20			63.96		497.24	L
Gallery Well	7/10/2001	561.20			63.53		497.67	L
Gallery Well	7/17/2001	561.20			64.80		496.40	L
Gallery Well	7/24/2001	561.20			63.17		498.03	L
Gallery Well	7/31/2001	561.20			64.38		496.82	L
Gallery Well	8/7/2001	561.20			64.75		496.45	L
Gallery Well	8/14/2001	561.20			66.58		494.62	L
Gallery Well	8/17/2001	561.20			63.98		497.22	L
Gallery Well	8/24/2001	561.20			66.23		494.97	L
Gallery Well	8/31/2001	561.20			65.52		495.68	L
Gallery Well	9/7/2001	561.20			65.96		495.24	L
Gallery Well	9/14/2001	561.20			64.85		496.35	L
Gallery Well	9/21/2001	561.20			66.73		494.47	L
Gallery Well	9/28/2001	561.20			67.61		493.59	L
Gallery Well	10/3/2001	561.20			63.58		497.62	L
Gallery Well	10/7/2001	561.20			65.90		495.30	L
Gallery Well	10/14/2001	561.20			65.55		495.65	L
Gallery Well	10/21/2001	561.20			70.45		490.75	L
Gallery Well	10/28/2001	561.20			67.60		493.60	L
Gallery Well	11/3/2001	561.20			65.14		496.06	L
Gallery Well	11/10/2001	561.20			66.14		495.06	L
Gallery Well	11/17/2001	561.20			68.54		492.66	L
Gallery Well	11/24/2001	561.20			65.61		495.59	L
Gallery Well	11/30/2001	561.20			65.10		496.10	L
Gallery Well	12/3/2001	561.20			64.80		496.40	L
Gallery Well	12/10/2001	561.20			64.15		497.05	L
Gallery Well	12/17/2001	561.20			66.00		495.20	L
Gallery Well	12/24/2001	561.20			65.46		495.74	L
Gallery Well	12/31/2001	561.20			68.51		492.69	L
Gallery Well	1/7/2002	561.20			72.00		489.20	L
Gallery Well	1/13/2002	561.20			67.59		493.61	L
Gallery Well	1/21/2002	561.20			67.40		493.80	L
Gallery Well	1/28/2002	561.20			65.90		495.30	L
Gallery Well	2/4/2002	561.20			70.80		490.40	L
Gallery Well	2/11/2002	561.20			65.50		495.70	L
Gallery Well	2/18/2002	561.20			65.30		495.90	L
Gallery Well	2/25/2002	561.20			67.15		494.05	L
Gallery Well	3/4/2002	561.20			72.55		488.65	L
Gallery Well	3/11/2002	561.20			64.51		496.69	L
Gallery Well	3/18/2002	561.20			66.70		494.50	L
Gallery Well	3/25/2002	561.20			63.20		498.00	L
Gallery Well	4/1/2002	561.20			64.30		496.90	L
Gallery Well	4/8/2002	561.20			63.70		497.50	L
Gallery Well	4/15/2002	561.20			63.70		497.50	L
Gallery Well	4/22/2002	561.20			64.00		497.20	L
Gallery Well	4/29/2002	561.20			65.07		496.13	L
Gallery Well	5/6/2002	561.20			64.90		496.30	L
Gallery Well	5/13/2002	561.20			65.80		495.40	L
Gallery Well	5/20/2002	561.20			64.60		496.60	L
Gallery Well	5/28/2002	561.20			65.90		495.30	L
Gallery Well	6/3/2002	561.20			66.00		495.20	L
Gallery Well	6/10/2002	561.20			65.00		496.20	L
Gallery Well	6/17/2002	561.20			69.60		491.60	L
Gallery Well	6/24/2002	561.20			65.60		495.60	L
Gallery Well	7/1/2002	561.20			66.25		494.95	L
Gallery Well	7/8/2002	561.20			66.02		495.18	L
Gallery Well	7/15/2002	561.20			66.26		494.94	L
Gallery Well	7/22/2002	561.20			66.12		495.08	L
Gallery Well	7/29/2002	561.20			65.95		495.25	L
Gallery Well	8/1/2002	561.20			45.45		515.75	L

Table A3-1. NAPL Elevations
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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
Gallery Well	8/5/2002	561.20			64.00		497.20	L
Gallery Well	8/12/2002	561.20			63.20		498.00	L
Gallery Well	8/19/2002	561.20			68.30		492.90	L
Gallery Well	8/26/2002	561.20			64.70		496.50	L
Gallery Well	9/4/2002	561.20			66.20		495.00	L
Gallery Well	9/9/2002	561.20			67.30		493.90	L
Gallery Well	9/17/2002	561.20			65.95		495.25	L
Gallery Well	9/23/2002	561.20			68.80		492.40	L
Gallery Well	9/30/2002	561.20			65.00		496.20	L
Gallery Well	10/7/2002	561.20			63.70		497.50	L
Gallery Well	10/14/2002	561.20			64.90		496.30	L
Gallery Well	10/21/2002	561.20			64.95		496.25	L
Gallery Well	10/28/2002	561.20			64.40		496.80	L
Gallery Well	11/5/2002	561.20			64.30		496.90	L
Gallery Well	11/11/2002	561.20			64.70		496.50	L
Gallery Well	11/18/2002	561.20			64.40		496.80	L
Gallery Well	11/25/2002	561.20			65.05		496.15	L
Gallery Well	12/2/2002	561.20			65.10		496.10	L
Gallery Well	12/9/2002	561.20			67.10		494.10	L
Gallery Well	12/18/2002	561.20			65.83		495.37	L
Gallery Well	12/23/2002	561.20			64.80		496.40	L
Gallery Well	12/30/2002	561.20			63.70		497.50	L
Gallery Well	1/6/2003	561.20			64.00		497.20	L
Gallery Well	1/13/2003	561.20			63.60		497.60	L
Gallery Well	1/20/2003	561.20			65.40		495.80	L
Gallery Well	1/27/2003	561.20			65.45		495.75	L
Gallery Well	2/3/2003	561.20			63.30		497.90	L
Gallery Well	2/10/2003	561.20			64.20		497.00	L
Gallery Well	2/17/2003	561.20			64.30		496.90	L
Gallery Well	2/24/2003	561.20			64.50		496.70	L
Gallery Well	3/3/2003	561.20			64.70		496.50	L
Gallery Well	3/10/2003	561.20			64.45		496.75	L
Gallery Well	3/17/2003	561.20			64.23		496.97	L
Gallery Well	3/24/2003	561.20			63.80		497.40	L
Gallery Well	3/31/2003	561.20			63.00		498.20	L
Gallery Well	4/7/2003	561.20			63.40		497.80	L
Gallery Well	4/14/2003	561.20			63.10		498.10	L
Gallery Well	4/21/2003	561.20			63.10		498.10	L
Gallery Well	4/28/2003	561.20			64.80		496.40	L
Gallery Well	5/5/2003	561.20			63.10		498.10	L
Gallery Well	5/12/2003	561.20			63.40		497.80	L
Gallery Well	5/19/2003	561.20			63.80		497.40	L
Gallery Well	5/28/2003	561.20			39.12		522.08	L
Gallery Well	6/2/2003	561.20			63.10		498.10	L
Gallery Well	6/9/2003	561.20			63.70		497.50	L
Gallery Well	6/16/2003	561.20			65.00		496.20	L
Gallery Well	6/23/2003	561.20			64.30		496.90	L
Gallery Well	6/30/2003	561.20			65.40		495.80	L
Gallery Well	7/7/2003	561.20			64.60		496.60	L
Gallery Well	7/14/2003	561.20			64.63		496.57	L
Gallery Well	7/21/2003	561.20			64.60		496.60	L
Gallery Well	7/28/2003	561.20			64.95		496.25	L
Gallery Well	8/4/2003	561.20			63.70		497.50	L
Gallery Well	8/11/2003	561.20			63.70		497.50	L
Gallery Well	8/18/2003	561.20			63.10		498.10	L
Gallery Well	8/25/2003	561.20			64.60		496.60	L
Gallery Well	9/2/2003	561.20			60.05		501.15	L
Gallery Well	9/8/2003	561.20			64.35		496.85	L
Gallery Well	9/15/2003	561.20			64.55		496.65	L
Gallery Well	9/22/2003	561.20			63.70		497.50	L
Gallery Well	9/29/2003	561.20			63.73		497.47	L
Gallery Well	10/6/2003	561.20			63.20		498.00	L
Gallery Well	10/13/2003	561.20			64.00		497.20	L

Table A3-1. NAPL Elevations
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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
Gallery Well	10/20/2003	561.20			61.50		499.70	L
Gallery Well	10/27/2003	561.20			66.10		495.10	L
Gallery Well	11/3/2003	561.20			64.00		497.20	L
Gallery Well	11/10/2003	561.20			63.95		497.25	L
Gallery Well	11/17/2003	561.20			64.90		496.30	L
Gallery Well	11/24/2003	561.20			63.90		497.30	L
Gallery Well	12/1/2003	561.20			66.10		495.10	L
Gallery Well	12/8/2003	561.20			64.40		496.80	L
Gallery Well	12/15/2003	561.20			63.70		497.50	L
Gallery Well	12/22/2003	561.20			64.85		496.35	L
Gallery Well	12/29/2003	561.20			67.50		493.70	L
Gallery Well	1/6/2004	561.20			63.90		497.30	L
Gallery Well	1/12/2004	561.20			65.10		496.10	L
Gallery Well	1/19/2004	561.20			64.20		497.00	L
Gallery Well	1/26/2004	561.20			66.15		495.05	L
Gallery Well	2/2/2004	561.20			64.80		496.40	L
Gallery Well	2/9/2004	561.20			64.90		496.30	L
Gallery Well	2/16/2004	561.20			63.65		497.55	L
Gallery Well	2/23/2004	561.20			64.10		497.10	L
Gallery Well	3/1/2004	561.20			65.30		495.90	L
Gallery Well	3/8/2004	561.20			65.25		495.95	L
Gallery Well	3/15/2004	561.20			64.80		496.40	L
Gallery Well	3/22/2004	561.20			65.10		496.10	L
Gallery Well	3/29/2004	561.20			65.23		495.97	L
Gallery Well	4/5/2004	561.20			65.85		495.35	L
Gallery Well	4/12/2004	561.20			63.90		497.30	L
Gallery Well	4/19/2004	561.20			63.20		498.00	L
Gallery Well	4/26/2004	561.20			65.10		496.10	L
Gallery Well	5/3/2004	561.20			63.10		498.10	L
Gallery Well	5/12/2004	561.20			65.90		495.30	L
Gallery Well	5/17/2004	561.20			66.10		495.10	L
Gallery Well	5/24/2004	561.20			66.40		494.80	L
Gallery Well	6/2/2004	561.20			64.65		496.55	L
Gallery Well	6/7/2004	561.20			64.65		496.55	L
Gallery Well	6/14/2004	561.20			64.45		496.75	L
Gallery Well	6/21/2004	561.20			65.75		495.45	L
Gallery Well	6/28/2004	561.20			66.70		494.50	L
Gallery Well	7/6/2004	561.20			65.60		495.60	L
Gallery Well	7/12/2004	561.20			65.70		495.50	L
Gallery Well	7/19/2004	561.20			64.10		497.10	L
Gallery Well	7/26/2004	561.20			65.35		495.85	L
Gallery Well	8/2/2004	561.20			65.20		496.00	L
Gallery Well	8/9/2004	561.20			66.20		495.00	L
Gallery Well	8/16/2004	561.20			65.30		495.90	L
Gallery Well	8/23/2004	561.20			66.55		494.65	L
Gallery Well	8/30/2004	561.20			65.40		495.80	L
Gallery Well	9/7/2004	561.20			64.40		496.80	L
Gallery Well	9/13/2004	561.20			65.05		496.15	L
Gallery Well	9/20/2004	561.20			64.00		497.20	L
Gallery Well	9/27/2004	561.20			66.45		494.75	L
Gallery Well	10/4/2004	561.20			66.73		494.47	L
Gallery Well	10/11/2004	561.20			63.10		498.10	L
Gallery Well	10/21/2004	561.20			66.00		495.20	L
Gallery Well	10/25/2004	561.20			65.75		495.45	L
Gallery Well	11/1/2004	561.20			65.70		495.50	L
Gallery Well	11/9/2004	561.20			65.35		495.85	L
Gallery Well	11/15/2004	561.20			65.10		496.10	L
Gallery Well	11/22/2004	561.20			67.05		494.15	L
Gallery Well	11/29/2004	561.20			66.40		494.80	L
Gallery Well	12/6/2004	561.20			65.45		495.75	L
Gallery Well	12/14/2004	561.20			43.75		517.45	L
Gallery Well	12/20/2004	561.20			64.25		496.95	L
Gallery Well	12/31/2004	561.20			66.00		495.20	L

Table A3-1. NAPL Elevations
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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
Gallery Well	1/4/2005	561.20			66.15		495.05	L
Gallery Well	1/14/2005	561.20			64.80		496.40	L
Gallery Well	1/18/2005	561.20			65.55		495.65	L
Gallery Well	1/24/2005	561.20			65.15		496.05	L
Gallery Well	2/1/2005	561.20			63.90		497.30	L
Gallery Well	2/7/2005	561.20			66.40		494.80	L
Gallery Well	2/15/2005	561.20			65.60		495.60	L
Gallery Well	2/24/2005	561.20			64.38		496.82	L
Gallery Well	3/1/2005	561.20			64.25		496.95	L
Gallery Well	3/7/2005	561.20			64.65		496.55	L
Gallery Well	3/16/2005	561.20			66.00		495.20	L
Gallery Well	3/24/2005	561.20			67.05		494.15	L
Gallery Well	3/28/2005	561.20			66.55		494.65	L
Gallery Well	4/9/2005	561.20			65.70		495.50	L
Gallery Well	4/14/2005	561.20			66.95		494.25	L
Gallery Well	4/22/2005	561.20			65.80		495.40	L
Gallery Well	4/28/2005	561.20			64.78		496.42	L
Gallery Well	5/2/2005	561.20			65.03		496.17	L
Gallery Well	5/13/2005	561.20			64.45		496.75	L
Gallery Well	5/19/2005	561.20			66.20		495.00	L
Gallery Well	5/30/2005	561.20			64.84		496.36	L
Gallery Well	6/8/2005	561.20			63.12		498.08	L
Gallery Well	6/15/2005	561.20			64.30		496.90	L
Gallery Well	6/24/2005	561.20			64.45		496.75	L
Gallery Well	7/13/2005	561.20			64.13		497.07	L
Gallery Well	8/31/2005	561.20			64.04		497.16	L
Gallery Well	9/12/2005	561.20			63.24		497.96	L
Gallery Well	10/20/2005	561.20			65.49		495.71	L
Gallery Well	11/10/2005	561.20			63.74		497.46	L
Gallery Well	12/27/2005	561.20			73.34		487.86	L
Gallery Well	1/18/2006	561.20			63.00		498.20	L
Gallery Well	2/14/2006	561.20			64.88		496.32	L
Gallery Well	3/3/2006	561.20			67.10		494.10	L
Gallery Well	4/18/2006	561.20			64.85		496.35	L
Gallery Well	6/26/2006	561.20			64.76		496.44	L
Gallery Well	9/20/2006	561.20			65.96		495.24	L
Gallery Well	12/11/2006	561.20			67.20		494.00	L
Gallery Well	2/9/2007	561.20			67.89		493.31	L
Gallery Well	3/14/2007	561.20			64.30		496.90	L
Gallery Well	6/27/2007	561.20			66.80		494.40	L
Gallery Well	9/20/2007	561.20			65.45		495.75	L
Gallery Well	12/27/2007	561.20			65.74		495.46	L
Gallery Well	3/25/2008	561.20			65.84		495.36	L
Gallery Well	6/30/2008	561.20			66.41		494.79	L
Gallery Well	9/10/2008	561.20			64.85		496.35	L
Gallery Well	12/16/2008	561.20			66.63		494.57	L
Gallery Well	3/31/2009	561.20			65.38		495.82	L
Gallery Well	12/21/2009	561.20			69.60		491.60	L
Gallery Well	3/9/2010	561.20			65.38		495.82	L
Gallery Well	2/1/2011	561.20			64.70		496.50	L
Gallery Well	6/27/2011	561.20			64.85		496.35	L
Gallery Well	12/28/2011	561.20			65.60		495.60	L
GW-PZ-W	5/15/2001	561.39	37.97	523.42	ND	ND	ND	L
GW-PZ-W	5/22/2001	561.39	37.72	523.67	ND	ND	ND	L
GW-PZ-W	5/29/2001	561.39	37.57	523.82	ND	ND	ND	L
GW-PZ-W	6/16/2001	561.39	37.29	524.10	ND	ND	ND	L
GW-PZ-W	6/20/2001	561.39	37.18	524.21	ND	ND	ND	L
GW-PZ-W	6/28/2001	561.39	35.95	525.44	ND	ND	ND	L
GW-PZ-W	7/3/2001	561.39	37.00	524.39	ND	ND	ND	L
GW-PZ-W	7/10/2001	561.39	37.63	523.76	ND	ND	ND	L
GW-PZ-W	7/17/2001	561.39	37.77	523.62	ND	ND	ND	L
GW-PZ-W	7/24/2001	561.39	37.50	523.89	ND	ND	ND	L
GW-PZ-W	7/31/2001	561.39	38.21	523.18	ND	ND	ND	L

Table A3-1. NAPL Elevations
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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
GW-PZ-W	8/7/2001	561.39	38.41	522.98	ND	ND	ND	L
GW-PZ-W	8/14/2001	561.39	38.74	522.65	ND	ND	ND	L
GW-PZ-W	8/17/2001	561.39	38.71	522.68	ND	ND	ND	L
GW-PZ-W	8/24/2001	561.39	38.73	522.66	ND	ND	ND	L
GW-PZ-W	8/31/2001	561.39	38.84	522.55	ND	ND	ND	L
GW-PZ-W	9/7/2001	561.39	39.14	522.25	ND	ND	ND	L
GW-PZ-W	9/14/2001	561.39	39.10	522.29	ND	ND	ND	L
GW-PZ-W	9/21/2001	561.39	39.40	521.99	ND	ND	ND	L
GW-PZ-W	9/28/2001	561.39	39.60	521.79	ND	ND	ND	L
GW-PZ-W	10/3/2001	561.39	39.73	521.66	ND	ND	ND	L
GW-PZ-W	10/7/2001	561.39	39.76	521.63	ND	ND	ND	L
GW-PZ-W	10/14/2001	561.39	39.77	521.62	ND	ND	ND	L
GW-PZ-W	10/21/2001	561.39	40.10	521.29	ND	ND	ND	L
GW-PZ-W	10/28/2001	561.39	40.90	520.49	ND	ND	ND	L
GW-PZ-W	11/3/2001	561.39	41.11	520.28	ND	ND	ND	L
GW-PZ-W	11/10/2001	561.39	41.00	520.39	ND	ND	ND	L
GW-PZ-W	11/17/2001	561.39	41.10	520.29	ND	ND	ND	L
GW-PZ-W	11/24/2001	561.39	41.16	520.23	ND	ND	ND	L
GW-PZ-W	11/30/2001	561.39	41.50	519.89	ND	ND	ND	L
GW-PZ-W	12/3/2001	561.39	41.50	519.89	ND	ND	ND	L
GW-PZ-W	12/10/2001	561.39	41.30	520.09	ND	ND	ND	L
GW-PZ-W	12/17/2001	561.39	41.80	519.59	ND	ND	ND	L
GW-PZ-W	12/24/2001	561.39	41.67	519.72	ND	ND	ND	L
GW-PZ-W	12/31/2001	561.39	41.74	519.65	ND	ND	ND	L
GW-PZ-W	1/7/2002	561.39	42.00	519.39	ND	ND	ND	L
GW-PZ-W	1/13/2002	561.39	41.62	519.77	41.55	0.07	519.84	L
GW-PZ-W	1/21/2002	561.39	41.90	519.49	41.71	0.19	519.68	L
GW-PZ-W	1/28/2002	561.39	41.88	519.51	41.77	0.11	519.62	L
GW-PZ-W	2/4/2002	561.39	42.12	519.27	42.02	0.10	519.37	L
GW-PZ-W	2/11/2002	561.39	42.16	519.23	42.07	0.09	519.32	L
GW-PZ-W	2/18/2002	561.39	42.05	519.34	41.97	0.08	519.42	L
GW-PZ-W	2/25/2002	561.39	42.22	519.17	42.17	0.05	519.22	L
GW-PZ-W	3/4/2002	561.39	42.55	518.84	42.50	0.05	518.89	L
GW-PZ-W	3/11/2002	561.39	42.48	518.91	42.40	0.08	518.99	L
GW-PZ-W	3/18/2002	561.39	42.45	518.94	42.40	0.05	518.99	L
GW-PZ-W	3/25/2002	561.39	42.51	518.88	42.48	0.03	518.91	L
GW-PZ-W	4/1/2002	561.39	42.61	518.78	42.57	0.04	518.82	L
GW-PZ-W	4/8/2002	561.39	42.95	518.44	42.83	0.12	518.56	L
GW-PZ-W	4/15/2002	561.39	43.00	518.39	42.80	0.20	518.59	L
GW-PZ-W	4/22/2002	561.39	43.35	518.04	43.00	0.35	518.39	L
GW-PZ-W	4/29/2002	561.39	43.40	517.99	43.10	0.30	518.29	L
GW-PZ-W	5/6/2002	561.39	43.65	517.74	43.21	0.44	518.18	L
GW-PZ-W	5/13/2002	561.39	43.73	517.66	43.35	0.38	518.04	L
GW-PZ-W	5/20/2002	561.39	43.88	517.51	43.38	0.50	518.01	L
GW-PZ-W	5/28/2002	561.39	44.00	517.39	43.70	0.30	517.69	L
GW-PZ-W	6/3/2002	561.39	44.74	516.65	43.75	0.99	517.64	L
GW-PZ-W	6/10/2002	561.39	44.87	516.52	43.75	1.12	517.64	L
GW-PZ-W	6/17/2002	561.39	45.24	516.15	44.00	1.24	517.39	L
GW-PZ-W	6/24/2002	561.39	45.44	515.95	44.02	1.42	517.37	L
GW-PZ-W	7/1/2002	560.98	45.75	515.23	44.13	1.62	516.85	L
GW-PZ-W	7/8/2002	560.98	47.97	513.01	44.15	3.82	516.83	L
GW-PZ-W	7/15/2002	560.98	46.20	514.78	44.22	1.98	516.76	L
GW-PZ-W	7/22/2002	560.98	46.29	514.69	44.12	2.17	516.86	L
GW-PZ-W	7/29/2002	560.98	46.40	514.58	44.20	2.20	516.78	L
GW-PZ-W	8/1/2002	560.98	46.11	514.87	43.91	2.20	517.07	L
GW-PZ-W	8/5/2002	560.98	46.40	514.58	44.10	2.30	516.88	L
GW-PZ-W	8/12/2002	560.98	46.30	514.68	43.45	2.85	517.53	L
GW-PZ-W	8/19/2002	560.98	46.45	514.53	44.30	2.15	516.68	L
GW-PZ-W	8/26/2002	560.98	46.98	514.00	44.43	2.55	516.55	L
GW-PZ-W	9/4/2002	560.98	47.18	513.80	44.40	2.78	516.58	L
GW-PZ-W	9/9/2002	560.98	47.50	513.48	44.53	2.97	516.45	L
GW-PZ-W	9/17/2002	560.98	47.70	513.28	45.50	2.20	515.48	L
GW-PZ-W	9/23/2002	560.98	47.70	513.28	44.55	3.15	516.43	L

Table A3-1. NAPL Elevations
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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
GW-PZ-W	9/30/2002	560.98	47.80	513.18	44.55	3.25	516.43	L
GW-PZ-W	10/7/2002	560.98	47.70	513.28	44.50	3.20	516.48	L
GW-PZ-W	10/14/2002	560.98	47.70	513.28	44.50	3.20	516.48	L
GW-PZ-W	10/21/2002	560.98	47.60	513.38	44.50	3.10	516.48	L
GW-PZ-W	10/28/2002	560.98	47.60	513.38	44.50	3.10	516.48	L
GW-PZ-W	11/5/2002	560.98	47.60	513.38	44.50	3.10	516.48	L
GW-PZ-W	11/11/2002	560.98	47.65	513.33	44.55	3.10	516.43	L
GW-PZ-W	11/18/2002	560.98	47.65	513.33	44.50	3.15	516.48	L
GW-PZ-W	11/25/2002	560.98	47.57	513.41	44.34	3.23	516.64	L
GW-PZ-W	12/2/2002	560.98	47.75	513.23	44.45	3.30	516.53	L
GW-PZ-W	12/9/2002	560.98	47.90	513.08	44.50	3.40	516.48	L
GW-PZ-W	12/18/2002	560.98	47.90	513.08	44.60	3.30	516.38	L
GW-PZ-W	12/23/2002	560.98	47.73	513.25	44.35	3.38	516.63	L
GW-PZ-W	12/30/2002	560.98	47.90	513.08	44.45	3.45	516.53	L
GW-PZ-W	1/6/2003	560.98	47.70	513.28	44.20	3.50	516.78	L
GW-PZ-W	1/13/2003	560.98	47.80	513.18	44.35	3.45	516.63	L
GW-PZ-W	1/20/2003	560.98	47.60	513.38	44.25	3.35	516.73	L
GW-PZ-W	1/27/2003	560.98	47.50	513.48	44.10	3.40	516.88	L
GW-PZ-W	2/3/2003	560.98	47.41	513.57	44.10	3.31	516.88	L
GW-PZ-W	2/10/2003	560.98	47.40	513.58	44.05	3.35	516.93	L
GW-PZ-W	2/17/2003	560.98	47.40	513.58	44.10	3.30	516.88	L
GW-PZ-W	2/24/2003	560.98	47.10	513.88	43.80	3.30	517.18	L
GW-PZ-W	3/3/2003	560.98	47.20	513.78	43.95	3.25	517.03	L
GW-PZ-W	3/10/2003	560.98	47.15	513.83	43.90	3.25	517.08	L
GW-PZ-W	3/17/2003	560.98	47.10	513.88	43.88	3.22	517.10	L
GW-PZ-W	3/24/2003	560.98	47.05	513.93	43.80	3.25	517.18	L
GW-PZ-W	3/31/2003	560.98	46.90	514.08	43.65	3.25	517.33	L
GW-PZ-W	4/7/2003	560.98	46.85	514.13	43.73	3.12	517.25	L
GW-PZ-W	4/14/2003	560.98	47.70	513.28	43.60	4.10	517.38	L
GW-PZ-W	4/21/2003	560.98	46.70	514.28	43.50	3.20	517.48	L
GW-PZ-W	4/28/2003	560.98	46.70	514.28	43.55	3.15	517.43	L
GW-PZ-W	5/5/2003	560.98	46.70	514.28	43.55	3.15	517.43	L
GW-PZ-W	5/12/2003	560.98	46.50	514.48	43.40	3.10	517.58	L
GW-PZ-W	5/19/2003	560.98	46.50	514.48	43.35	3.15	517.63	L
GW-PZ-W	5/28/2003	560.98	44.55	516.43	41.36	3.19	519.62	L
GW-PZ-W	6/2/2003	560.98	44.98	516.00	41.90	3.08	519.08	L
GW-PZ-W	6/9/2003	560.98	45.35	515.63	42.30	3.05	518.68	L
GW-PZ-W	6/16/2003	560.98	45.60	515.38	42.60	3.00	518.38	L
GW-PZ-W	6/23/2003	560.98	46.05	514.93	42.80	3.25	518.18	L
GW-PZ-W	6/30/2003	560.98	46.03	514.95	43.00	3.03	517.98	L
GW-PZ-W	7/7/2003	560.98	46.05	514.93	43.02	3.03	517.96	L
GW-PZ-W	7/14/2003	560.98	46.20	514.78	43.10	3.10	517.88	L
GW-PZ-W	7/21/2003	560.98	46.35	514.63	43.20	3.15	517.78	L
GW-PZ-W	7/28/2003	560.98	46.35	514.63	43.25	3.10	517.73	L
GW-PZ-W	8/4/2003	560.98	46.33	514.65	43.30	3.03	517.68	L
GW-PZ-W	8/11/2003	560.98	46.30	514.68	43.23	3.07	517.75	L
GW-PZ-W	8/18/2003	560.98	46.25	514.73	43.20	3.05	517.78	L
GW-PZ-W	8/25/2003	560.98	46.30	514.68	43.27	3.03	517.71	L
GW-PZ-W	9/2/2003	560.98	46.20	514.78	43.20	3.00	517.78	L
GW-PZ-W	9/8/2003	560.98	46.10	514.88	43.12	2.98	517.86	L
GW-PZ-W	9/15/2003	560.98	46.10	514.88	43.20	2.90	517.78	L
GW-PZ-W	9/22/2003	560.98	45.95	515.03	43.05	2.90	517.93	L
GW-PZ-W	9/29/2003	560.98	46.08	514.90	43.10	2.98	517.88	L
GW-PZ-W	10/6/2003	560.98	45.90	515.08	43.05	2.85	517.93	L
GW-PZ-W	10/13/2003	560.98	46.00	514.98	43.15	2.85	517.83	L
GW-PZ-W	10/20/2003	560.98	45.82	515.16	43.00	2.82	517.98	L
GW-PZ-W	10/27/2003	560.98	46.00	514.98	43.20	2.80	517.78	L
GW-PZ-W	11/3/2003	560.98	46.10	514.88	43.21	2.89	517.77	L
GW-PZ-W	11/10/2003	560.98	46.00	514.98	43.23	2.77	517.75	L
GW-PZ-W	11/17/2003	560.98	46.15	514.83	43.35	2.80	517.63	L
GW-PZ-W	11/24/2003	560.98	46.00	514.98	43.25	2.75	517.73	L
GW-PZ-W	12/1/2003	560.98	46.10	514.88	43.40	2.70	517.58	L
GW-PZ-W	12/8/2003	560.98	46.13	514.85	43.45	2.68	517.53	L

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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
GW-PZ-W	12/15/2003	560.98	46.20	514.78	43.55	2.65	517.43	L
GW-PZ-W	12/22/2003	560.98	46.15	514.83	43.50	2.65	517.48	L
GW-PZ-W	12/29/2003	560.98	45.80	515.18	43.36	2.44	517.62	L
GW-PZ-W	1/6/2004	560.98	45.52	515.46	42.90	2.62	518.08	L
GW-PZ-W	1/12/2004	560.98	45.60	515.38	43.00	2.60	517.98	L
GW-PZ-W	1/19/2004	560.98	45.50	515.48	42.94	2.56	518.04	L
GW-PZ-W	1/26/2004	560.98	45.50	515.48	42.95	2.55	518.03	L
GW-PZ-W	2/2/2004	560.98	45.40	515.58	42.90	2.50	518.08	L
GW-PZ-W	2/9/2004	560.98	45.50	515.48	42.92	2.58	518.06	L
GW-PZ-W	2/16/2004	560.98	45.50	515.48	43.00	2.50	517.98	L
GW-PZ-W	2/23/2004	560.98	45.20	515.78	42.80	2.40	518.18	L
GW-PZ-W	3/1/2004	560.98	45.40	515.58	43.05	2.35	517.93	L
GW-PZ-W	3/8/2004	560.98	45.50	515.48	43.15	2.35	517.83	L
GW-PZ-W	3/15/2004	560.98	45.50	515.48	43.15	2.35	517.83	L
GW-PZ-W	3/22/2004	560.98	45.30	515.68	43.00	2.30	517.98	L
GW-PZ-W	3/29/2004	560.98	45.45	515.53	43.10	2.35	517.88	L
GW-PZ-W	4/5/2004	560.98	44.65	516.33	42.40	2.25	518.58	L
GW-PZ-W	4/12/2004	560.98	44.90	516.08	42.60	2.30	518.38	L
GW-PZ-W	4/19/2004	560.98	45.05	515.93	42.80	2.25	518.18	L
GW-PZ-W	4/26/2004	560.98	45.00	515.98	42.73	2.27	518.25	L
GW-PZ-W	5/3/2004	560.98	44.90	516.08	42.70	2.20	518.28	L
GW-PZ-W	5/12/2004	560.98	44.80	516.18	42.60	2.20	518.38	L
GW-PZ-W	5/17/2004	560.98	44.80	516.18	42.75	2.05	518.23	L
GW-PZ-W	5/24/2004	560.98	44.95	516.03	42.75	2.20	518.23	L
GW-PZ-W	6/2/2004	560.98	44.80	516.18	42.60	2.20	518.38	L
GW-PZ-W	6/7/2004	560.98	44.70	516.28	42.60	2.10	518.38	L
GW-PZ-W	6/14/2004	560.98	44.70	516.28	42.55	2.15	518.43	L
GW-PZ-W	6/21/2004	560.98	44.70	516.28	42.60	2.10	518.38	L
GW-PZ-W	6/28/2004	560.98	44.70	516.28	42.60	2.10	518.38	L
GW-PZ-W	7/6/2004	560.98	44.70	516.28	42.60	2.10	518.38	L
GW-PZ-W	7/12/2004	560.98	44.55	516.43	42.30	2.25	518.68	L
GW-PZ-W	7/19/2004	560.98	44.70	516.28	42.60	2.10	518.38	L
GW-PZ-W	7/26/2004	560.98	44.50	516.48	42.50	2.00	518.48	L
GW-PZ-W	8/2/2004	560.98	45.00	515.98	42.53	2.47	518.45	L
GW-PZ-W	8/9/2004	560.98	44.40	516.58	42.37	2.03	518.61	L
GW-PZ-W	8/16/2004	560.98	44.35	516.63	42.40	1.95	518.58	L
GW-PZ-W	8/23/2004	560.98	44.40	516.58	42.40	2.00	518.58	L
GW-PZ-W	8/30/2004	560.98	44.40	516.58	42.50	1.90	518.48	L
GW-PZ-W	9/7/2004	560.98	44.30	516.68	42.40	1.90	518.58	L
GW-PZ-W	9/13/2004	560.98	44.35	516.63	42.40	1.95	518.58	L
GW-PZ-W	9/20/2004	560.98	44.50	516.48	42.60	1.90	518.38	L
GW-PZ-W	9/27/2004	560.98	44.40	516.58	42.54	1.86	518.44	L
GW-PZ-W	10/4/2004	560.98	44.45	516.53	42.60	1.85	518.38	L
GW-PZ-W	10/11/2004	560.98	44.30	516.68	42.45	1.85	518.53	L
GW-PZ-W	10/21/2004	560.98	44.40	516.58	42.55	1.85	518.43	L
GW-PZ-W	10/25/2004	560.98	44.40	516.58	42.58	1.82	518.40	L
GW-PZ-W	11/1/2004	560.98	44.70	516.28	42.85	1.85	518.13	L
GW-PZ-W	11/9/2004	560.98	44.60	516.38	42.80	1.80	518.18	L
GW-PZ-W	11/15/2004	560.98	44.50	516.48	42.71	1.79	518.27	L
GW-PZ-W	11/22/2004	560.98	44.40	516.58	42.65	1.75	518.33	L
GW-PZ-W	11/29/2004	560.98	44.75	516.23	43.00	1.75	517.98	L
GW-PZ-W	12/6/2004	560.98	44.53	516.45	42.62	1.91	518.36	L
GW-PZ-W	12/14/2004	560.98	44.58	516.40	42.90	1.68	518.08	L
GW-PZ-W	12/20/2004	560.98	42.95	518.03	42.24	0.71	518.74	L
GW-PZ-W	12/31/2004	560.98	43.08	517.90	42.80	0.28	518.18	L
GW-PZ-W	1/4/2005	560.98	43.18	517.80	42.85	0.33	518.13	L
GW-PZ-W	1/14/2005	560.98	43.57	517.41	43.00	0.57	517.98	L
GW-PZ-W	1/18/2005	560.98	43.53	517.45	43.00	0.53	517.98	L
GW-PZ-W	1/24/2005	560.98	43.17	517.81	42.64	0.53	518.34	L
GW-PZ-W	2/1/2005	560.98	43.35	517.63	42.80	0.55	518.18	L
GW-PZ-W	2/7/2005	560.98	43.15	517.83	42.68	0.47	518.30	L
GW-PZ-W	2/15/2005	560.98	43.10	517.88	42.70	0.40	518.28	L
GW-PZ-W	2/24/2005	560.98	43.10	517.88	42.70	0.40	518.28	L

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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
GW-PZ-W	3/1/2005	560.98	43.05	517.93	42.60	0.45	518.38	L
GW-PZ-W	3/7/2005	560.98	43.02	517.96	42.52	0.50	518.46	L
GW-PZ-W	3/16/2005	560.98	42.75	518.23	42.45	0.30	518.53	L
GW-PZ-W	3/24/2005	560.98	42.66	518.32	42.28	0.38	518.70	L
GW-PZ-W	3/28/2005	560.98	42.53	518.45	42.15	0.38	518.83	L
GW-PZ-W	4/9/2005	560.98	42.30	518.68	41.95	0.35	519.03	L
GW-PZ-W	4/14/2005	560.98	42.40	518.58	41.96	0.44	519.02	L
GW-PZ-W	4/22/2005	560.98	42.05	518.93	41.70	0.35	519.28	L
GW-PZ-W	4/28/2005	560.98	41.80	519.18	41.59	0.21	519.39	L
GW-PZ-W	5/2/2005	560.98	41.85	519.13	41.50	0.35	519.48	L
GW-PZ-W	5/13/2005	560.98	41.50	519.48	41.15	0.35	519.83	L
GW-PZ-W	5/19/2005	560.98	41.50	519.48	41.05	0.45	519.93	L
GW-PZ-W	5/30/2005	560.98	41.15	519.83	40.76	0.39	520.22	L
GW-PZ-W	6/8/2005	560.98	40.85	520.13	40.58	0.27	520.40	L
GW-PZ-W	6/15/2005	560.98	40.35	520.63	40.25	0.10	520.73	L
GW-PZ-W	6/24/2005	560.98	40.17	520.81	40.12	0.05	520.86	L
GW-PZ-W	7/13/2005	560.98	40.05	520.93	39.94	0.11	521.04	L
GW-PZ-W	8/31/2005	560.98	39.30	521.68	39.15	0.15	521.83	L
GW-PZ-W	9/12/2005	560.98	39.30	521.68	39.11	0.19	521.87	L
GW-PZ-W	10/20/2005	560.98	39.11	521.87	38.90	0.21	522.08	L
GW-PZ-W	11/10/2005	560.98	39.40	521.58	39.11	0.29	521.87	L
GW-PZ-W	12/27/2005	560.98	39.46	521.52	39.35	0.11	521.63	L
GW-PZ-W	1/18/2006	560.98	39.61	521.37	39.34	0.27	521.64	L
GW-PZ-W	2/14/2006	560.98	39.47	521.51	39.35	0.12	521.63	L
GW-PZ-W	3/3/2006	560.98	39.75	521.23	38.64	1.11	522.34	L
GW-PZ-W	4/18/2006	560.98	39.87	521.11	39.81	0.06	521.17	L
GW-PZ-W	6/26/2006	560.98	39.70	521.28	39.59	0.11	521.39	L
GW-PZ-W	9/20/2006	560.98	39.70	521.28	39.62	0.08	521.36	L
GW-PZ-W	12/11/2006	560.98	40.77	520.21	40.70	0.07	520.28	L
GW-PZ-W	2/9/2007	560.98	41.18	519.80	41.10	0.08	519.88	L
GW-PZ-W	3/14/2007	560.98	41.43	519.55	41.40	0.03	519.58	L
GW-PZ-W	6/28/2007	560.98	42.05	518.93	42.04	0.01	518.94	L
GW-PZ-W	9/20/2007	560.98	42.20	518.78	42.11	0.09	518.87	L
GW-PZ-W	12/27/2007	560.98	43.20	517.78	43.19	0.01	517.79	L
GW-PZ-W	3/25/2008	560.98	42.83	518.15	42.80	0.03	518.18	L
GW-PZ-W	6/30/2008	560.98	42.83	518.15	42.79	0.04	518.19	L
GW-PZ-W	9/10/2008	560.98	43.48	517.50	43.29	0.19	517.69	L
GW-PZ-W	12/16/2008	560.98	43.56	517.42	43.44	0.12	517.54	L
GW-PZ-W	3/31/2009	560.98	44.04	516.94	44.00	0.04	516.98	L
GW-PZ-W	1/14/2010	560.98	45.90	515.08	45.28	0.62	515.70	L
GW-PZ-W	3/31/2010	560.98	46.25	514.73	45.61	0.64	515.37	L
GW-PZ-W	2/1/2011	560.98	45.30	515.68	44.55	0.75	516.43	L
GW-PZ-W	6/27/2011	560.98	41.13	519.85	39.64	1.49	521.34	L
GW-PZ-W	12/28/2011	560.98	40.94	520.04	39.86	1.08	521.12	L
GW-PZ-E1	9/20/2007	558.35	47.60	510.75	40.20	7.40	518.15	L
GW-PZ-E1	12/27/2007	558.35	48.90	509.45	40.10	8.80	518.25	L
GW-PZ-E1	3/25/2008	558.35	48.88	509.47	40.07	8.81	518.28	L
GW-PZ-E1	6/30/2008	558.35	49.10	509.25	40.13	8.97	518.22	L
GW-PZ-E1	9/10/2008	558.35	46.95	511.40	40.24	6.71	518.11	L
GW-PZ-E1	12/16/2008	558.35	47.49	510.86	40.50	6.99	517.85	L
GW-PZ-E1	3/31/2009	558.35	47.80	510.55	41.10	6.70	517.25	L
GW-PZ-E1	1/14/2010	558.35	49.00	509.35	42.44	6.56	515.91	L
GW-PZ-E1	3/31/2010	558.35	48.69	509.66	42.44	6.25	515.91	L
GW-PZ-E1	2/1/2011	558.35	47.08	511.27	41.35	5.73	517.00	L
GW-PZ-E1	6/27/2011	558.35	43.19	515.16	37.81	5.38	520.54	L
GW-PZ-E1	12/28/2011	558.35	43.01	515.34	36.98	6.03	521.37	L
GW-PZ-E2	5/15/2001	556.69	33.93	522.76	ND	ND	ND	L
GW-PZ-E2	5/22/2001	556.69	32.97	523.72	ND	ND	ND	L
GW-PZ-E2	5/29/2001	556.69	32.58	524.11	ND	ND	ND	L
GW-PZ-E2	6/16/2001	556.69	33.01	523.68	ND	ND	ND	L
GW-PZ-E2	6/20/2001	556.69	32.90	523.79	ND	ND	ND	L
GW-PZ-E2	6/28/2001	556.69	31.95	524.74	ND	ND	ND	L
GW-PZ-E2	7/3/2001	556.69	32.28	524.41	ND	ND	ND	L

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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
GW-PZ-E2	7/10/2001	556.69	33.00	523.69	ND	ND	ND	L
GW-PZ-E2	7/17/2001	556.69	33.36	523.33	ND	ND	ND	L
GW-PZ-E2	7/24/2001	556.69	33.48	523.21	ND	ND	ND	L
GW-PZ-E2	7/31/2001	556.69	33.90	522.79	ND	ND	ND	L
GW-PZ-E2	8/7/2001	556.69	34.15	522.54	ND	ND	ND	L
GW-PZ-E2	8/14/2001	556.69	34.24	522.45	ND	ND	ND	L
GW-PZ-E2	8/17/2001	556.69	35.95	520.74	34.86	1.09	521.83	L
GW-PZ-E2	8/24/2001	556.69	34.55	522.14	34.39	0.16	522.30	L
GW-PZ-E2	8/31/2001	556.69	34.60	522.09	34.50	0.10	522.19	L
GW-PZ-E2	9/7/2001	556.69	34.91	521.78	34.79	0.12	521.90	L
GW-PZ-E2	9/14/2001	556.69	35.01	521.68	34.90	0.11	521.79	L
GW-PZ-E2	9/21/2001	556.69	35.28	521.41	35.15	0.13	521.54	L
GW-PZ-E2	9/28/2001	556.69	35.43	521.26	35.18	0.25	521.51	L
GW-PZ-E2	10/3/2001	556.69	35.30	521.39	35.11	0.19	521.58	L
GW-PZ-E2	10/7/2001	556.69	35.80	520.89	35.41	0.39	521.28	L
GW-PZ-E2	10/14/2001	556.69	35.71	520.98	35.45	0.26	521.24	L
GW-PZ-E2	10/21/2001	556.69	36.39	520.30	36.04	0.35	520.65	L
GW-PZ-E2	10/28/2001	556.69	36.45	520.24	36.25	0.20	520.44	L
GW-PZ-E2	11/3/2001	556.69	36.33	520.36	36.30	0.03	520.39	L
GW-PZ-E2	11/10/2001	556.69	36.52	520.17	36.32	0.20	520.37	L
GW-PZ-E2	11/17/2001	556.69	36.50	520.19	36.50	0.00	520.19	L
GW-PZ-E2	11/24/2001	556.69	36.70	519.99	36.41	0.29	520.28	L
GW-PZ-E2	11/30/2001	556.69	36.83	519.86	36.53	0.30	520.16	L
GW-PZ-E2	12/3/2001	556.69	36.97	519.72	36.58	0.39	520.11	L
GW-PZ-E2	12/10/2001	556.69	36.80	519.89	36.50	0.30	520.19	L
GW-PZ-E2	12/17/2001	556.69	37.30	519.39	37.00	0.30	519.69	L
GW-PZ-E2	12/24/2001	556.69	37.38	519.31	37.03	0.35	519.66	L
GW-PZ-E2	12/31/2001	556.69	37.36	519.33	36.97	0.39	519.72	L
GW-PZ-E2	1/7/2002	556.69	38.00	518.69	37.30	0.70	519.39	L
GW-PZ-E2	1/13/2002	556.69	38.12	518.57	37.25	0.87	519.44	L
GW-PZ-E2	1/21/2002	556.69	38.30	518.39	37.60	0.70	519.09	L
GW-PZ-E2	1/28/2002	556.69	38.30	518.39	37.70	0.60	518.99	L
GW-PZ-E2	2/4/2002	556.69	38.65	518.04	37.98	0.67	518.71	L
GW-PZ-E2	2/11/2002	556.69	38.74	517.95	38.05	0.69	518.64	L
GW-PZ-E2	2/18/2002	556.69	38.60	518.09	37.95	0.65	518.74	L
GW-PZ-E2	2/25/2002	556.69	38.30	518.39	38.08	0.22	518.61	L
GW-PZ-E2	3/4/2002	556.69	39.40	517.29	38.60	0.80	518.09	L
GW-PZ-E2	3/11/2002	556.69	39.23	517.46	38.35	0.88	518.34	L
GW-PZ-E2	3/18/2002	556.69	39.00	517.69	38.20	0.80	518.49	L
GW-PZ-E2	3/25/2002	556.69	39.20	517.49	38.37	0.83	518.32	L
GW-PZ-E2	4/1/2002	556.69	39.35	517.34	38.42	0.93	518.27	L
GW-PZ-E2	4/8/2002	556.69	39.82	516.87	38.80	1.02	517.89	L
GW-PZ-E2	4/15/2002	556.69	39.80	516.89	38.77	1.03	517.92	L
GW-PZ-E2	4/22/2002	556.69	40.07	516.62	39.54	0.53	517.15	L
GW-PZ-E2	4/29/2002	556.69	40.55	516.14	39.51	1.04	517.18	L
GW-PZ-E2	5/6/2002	556.69	41.00	515.69	39.74	1.26	516.95	L
GW-PZ-E2	5/13/2002	556.69	40.45	516.24	39.77	0.68	516.92	L
GW-PZ-E2	5/20/2002	556.69	40.91	515.78	40.09	0.82	516.60	L
GW-PZ-E2	5/28/2002	556.69	41.00	515.69	40.30	0.70	516.39	L
GW-PZ-E2	6/3/2002	556.69	41.65	515.04	40.62	1.03	516.07	L
GW-PZ-E2	6/10/2002	556.69	41.50	515.19	40.60	0.90	516.09	L
GW-PZ-E2	6/17/2002	556.69	42.00	514.69	41.10	0.90	515.59	L
GW-PZ-E2	6/24/2002	556.69	42.00	514.69	41.10	0.90	515.59	L
GW-PZ-E2	7/1/2002	557.19	41.98	515.21	40.20	1.78	516.99	L
GW-PZ-E2	7/8/2002	557.19	41.98	515.21	41.30	0.68	515.89	L
GW-PZ-E2	7/15/2002	557.19	42.20	514.99	41.34	0.86	515.85	L
GW-PZ-E2	7/22/2002	557.19	42.20	514.99	41.30	0.90	515.89	L
GW-PZ-E2	7/29/2002	557.19	42.70	514.49	41.40	1.30	515.79	L
GW-PZ-E2	8/1/2002	557.19	41.90	515.29	41.15	0.75	516.04	L
GW-PZ-E2	8/5/2002	557.19	41.80	515.39	41.05	0.75	516.14	L
GW-PZ-E2	8/12/2002	557.19	41.57	515.62	40.74	0.83	516.45	L
GW-PZ-E2	8/19/2002	557.19	41.70	515.49	40.82	0.88	516.37	L
GW-PZ-E2	8/26/2002	557.19	41.98	515.21	41.14	0.84	516.05	L

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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
GW-PZ-E2	9/4/2002	557.19	41.92	515.27	41.40	0.52	515.79	L
GW-PZ-E2	9/9/2002	557.19	42.25	514.94	41.30	0.95	515.89	L
GW-PZ-E2	9/17/2002	557.19	42.20	514.99	41.40	0.80	515.79	L
GW-PZ-E2	9/23/2002	557.19	42.20	514.99	41.45	0.75	515.74	L
GW-PZ-E2	9/30/2002	557.19	42.20	514.99	41.40	0.80	515.79	L
GW-PZ-E2	10/7/2002	557.19	42.00	515.19	41.34	0.66	515.85	L
GW-PZ-E2	10/14/2002	557.19	42.00	515.19	41.37	0.63	515.82	L
GW-PZ-E2	10/21/2002	557.19	42.10	515.09	41.37	0.73	515.82	L
GW-PZ-E2	10/28/2002	557.19	42.25	514.94	41.23	1.02	515.96	L
GW-PZ-E2	11/5/2002	557.19	42.25	514.94	41.23	1.02	515.96	L
GW-PZ-E2	11/11/2002	557.19	42.20	514.99	41.28	0.92	515.91	L
GW-PZ-E2	11/18/2002	557.19	42.10	515.09	41.25	0.85	515.94	L
GW-PZ-E2	11/25/2002	557.19	42.05	515.14	41.30	0.75	515.89	L
GW-PZ-E2	12/2/2002	557.19	42.25	514.94	41.30	0.95	515.89	L
GW-PZ-E2	12/9/2002	557.19	42.00	515.19	41.35	0.65	515.84	L
GW-PZ-E2	12/18/2002	557.19	42.00	515.19	41.30	0.70	515.89	L
GW-PZ-E2	12/23/2002	557.19	41.90	515.29	41.25	0.65	515.94	L
GW-PZ-E2	12/30/2002	557.19	41.80	515.39	41.20	0.60	515.99	L
GW-PZ-E2	1/6/2003	557.19	41.70	515.49	41.10	0.60	516.09	L
GW-PZ-E2	1/13/2003	557.19	41.60	515.59	41.05	0.55	516.14	L
GW-PZ-E2	1/20/2003	557.19	41.50	515.69	41.04	0.46	516.15	L
GW-PZ-E2	1/27/2003	557.19	41.50	515.69	41.10	0.40	516.09	L
GW-PZ-E2	2/3/2003	557.19	41.40	515.79	40.90	0.50	516.29	L
GW-PZ-E2	2/10/2003	557.19	41.35	515.84	40.85	0.50	516.34	L
GW-PZ-E2	2/17/2003	557.19	41.35	515.84	40.83	0.52	516.36	L
GW-PZ-E2	2/24/2003	557.19	41.35	515.84	40.70	0.65	516.49	L
GW-PZ-E2	3/3/2003	557.19	41.30	515.89	40.80	0.50	516.39	L
GW-PZ-E2	3/10/2003	557.19	41.40	515.79	40.70	0.70	516.49	L
GW-PZ-E2	3/17/2003	557.19	41.32	515.87	40.50	0.82	516.69	L
GW-PZ-E2	3/24/2003	557.19	41.45	515.74	40.60	0.85	516.59	L
GW-PZ-E2	3/31/2003	557.19	41.42	515.77	40.55	0.87	516.64	L
GW-PZ-E2	4/7/2003	557.19	41.20	515.99	40.45	0.75	516.74	L
GW-PZ-E2	4/14/2003	557.19	40.80	516.39	40.35	0.45	516.84	L
GW-PZ-E2	4/21/2003	557.19	40.80	516.39	40.15	0.65	517.04	L
GW-PZ-E2	4/28/2003	557.19	40.70	516.49	40.25	0.45	516.94	L
GW-PZ-E2	5/5/2003	557.19	40.65	516.54	40.10	0.55	517.09	L
GW-PZ-E2	5/12/2003	557.19	40.50	516.69	40.00	0.50	517.19	L
GW-PZ-E2	5/19/2003	557.19	40.50	516.69	39.95	0.55	517.24	L
GW-PZ-E2	5/28/2003	557.19	38.22	518.97	37.88	0.34	519.31	L
GW-PZ-E2	6/2/2003	557.19	38.74	518.45	38.17	0.57	519.02	L
GW-PZ-E2	6/9/2003	557.19	39.02	518.17	38.37	0.65	518.82	L
GW-PZ-E2	6/16/2003	557.19	39.44	517.75	38.80	0.64	518.39	L
GW-PZ-E2	6/23/2003	557.19	39.70	517.49	39.02	0.68	518.17	L
GW-PZ-E2	6/30/2003	557.19	39.90	517.29	39.23	0.67	517.96	L
GW-PZ-E2	7/7/2003	557.19	39.92	517.27	39.25	0.67	517.94	L
GW-PZ-E2	7/14/2003	557.19	40.20	516.99	39.50	0.70	517.69	L
GW-PZ-E2	7/21/2003	557.19	40.20	516.99	39.60	0.60	517.59	L
GW-PZ-E2	7/28/2003	557.19	40.35	516.84	39.70	0.65	517.49	L
GW-PZ-E2	8/4/2003	557.19	40.30	516.89	39.75	0.55	517.44	L
GW-PZ-E2	8/11/2003	557.19	40.18	517.01	39.70	0.48	517.49	L
GW-PZ-E2	8/18/2003	557.19	40.20	516.99	39.70	0.50	517.49	L
GW-PZ-E2	8/25/2003	557.19	40.18	517.01	39.70	0.48	517.49	L
GW-PZ-E2	9/2/2003	557.19	40.03	517.16	39.50	0.53	517.69	L
GW-PZ-E2	9/8/2003	557.19	40.17	517.02	39.80	0.37	517.39	L
GW-PZ-E2	9/15/2003	557.19	40.00	517.19	39.43	0.57	517.76	L
GW-PZ-E2	9/22/2003	557.19	39.90	517.29	39.30	0.60	517.89	L
GW-PZ-E2	9/29/2003	557.19	40.37	516.82	39.47	0.90	517.72	L
GW-PZ-E2	10/6/2003	557.19	40.10	517.09	39.43	0.67	517.76	L
GW-PZ-E2	10/13/2003	557.19	40.15	517.04	39.50	0.65	517.69	L
GW-PZ-E2	10/20/2003	557.19	39.70	517.49	39.13	0.57	518.06	L
GW-PZ-E2	10/27/2003	557.19	40.40	516.79	39.75	0.65	517.44	L
GW-PZ-E2	11/3/2003	557.19	40.30	516.89	39.60	0.70	517.59	L
GW-PZ-E2	11/10/2003	557.19	40.35	516.84	39.66	0.69	517.53	L

Table A3-1. NAPL Elevations
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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
GW-PZ-E2	11/17/2003	557.19	40.45	516.74	39.84	0.61	517.35	L
GW-PZ-E2	11/24/2003	557.19	40.30	516.89	39.75	0.55	517.44	L
GW-PZ-E2	12/1/2003	557.19	40.45	516.74	39.90	0.55	517.29	L
GW-PZ-E2	12/8/2003	557.19	40.60	516.59	39.98	0.62	517.21	L
GW-PZ-E2	12/15/2003	557.19	40.50	516.69	40.05	0.45	517.14	L
GW-PZ-E2	12/22/2003	557.19	40.60	516.59	40.00	0.60	517.19	L
GW-PZ-E2	12/29/2003	557.19	40.62	516.57	39.95	0.67	517.24	L
GW-PZ-E2	1/6/2004	557.19	40.46	516.73	39.55	0.91	517.64	L
GW-PZ-E2	1/12/2004	557.19	40.40	516.79	39.50	0.90	517.69	L
GW-PZ-E2	1/19/2004	557.19	40.30	516.89	39.40	0.90	517.79	L
GW-PZ-E2	1/26/2004	557.19	40.30	516.89	39.40	0.90	517.79	L
GW-PZ-E2	2/2/2004	557.19	40.22	516.97	39.50	0.72	517.69	L
GW-PZ-E2	2/9/2004	557.19	40.23	516.96	39.75	0.48	517.44	L
GW-PZ-E2	2/16/2004	557.19	40.35	516.84	39.60	0.75	517.59	L
GW-PZ-E2	2/23/2004	557.19	40.10	517.09	39.30	0.80	517.89	L
GW-PZ-E2	3/1/2004	557.19	40.43	516.76	39.70	0.73	517.49	L
GW-PZ-E2	3/8/2004	557.19	40.50	516.69	39.80	0.70	517.39	L
GW-PZ-E2	3/15/2004	557.19	40.45	516.74	39.70	0.75	517.49	L
GW-PZ-E2	3/22/2004	557.19	40.50	516.69	39.70	0.80	517.49	L
GW-PZ-E2	3/29/2004	557.19	40.50	516.69	39.80	0.70	517.39	L
GW-PZ-E2	4/5/2004	557.19	39.80	517.39	38.90	0.90	518.29	L
GW-PZ-E2	4/12/2004	557.19	40.20	516.99	39.05	1.15	518.14	L
GW-PZ-E2	4/19/2004	557.19	40.25	516.94	39.10	1.15	518.09	L
GW-PZ-E2	4/26/2004	557.19	40.30	516.89	39.20	1.10	517.99	L
GW-PZ-E2	5/3/2004	557.19	40.20	516.99	39.05	1.15	518.14	L
GW-PZ-E2	5/12/2004	557.19	40.15	517.04	38.95	1.20	518.24	L
GW-PZ-E2	5/17/2004	557.19	40.25	516.94	39.10	1.15	518.09	L
GW-PZ-E2	5/24/2004	557.19	40.34	516.85	39.15	1.19	518.04	L
GW-PZ-E2	6/2/2004	557.19	40.10	517.09	38.95	1.15	518.24	L
GW-PZ-E2	6/7/2004	557.19	40.10	517.09	38.90	1.20	518.29	L
GW-PZ-E2	6/14/2004	557.19	40.20	516.99	39.00	1.20	518.19	L
GW-PZ-E2	6/21/2004	557.19	40.20	516.99	39.00	1.20	518.19	L
GW-PZ-E2	6/28/2004	557.19	40.10	517.09	38.90	1.20	518.29	L
GW-PZ-E2	7/6/2004	557.19	40.15	517.04	38.90	1.25	518.29	L
GW-PZ-E2	7/12/2004	557.19	40.10	517.09	38.77	1.33	518.42	L
GW-PZ-E2	7/19/2004	557.19	40.20	516.99	38.80	1.40	518.39	L
GW-PZ-E2	7/26/2004	557.19	40.20	516.99	38.80	1.40	518.39	L
GW-PZ-E2	8/2/2004	557.19	40.12	517.07	38.74	1.38	518.45	L
GW-PZ-E2	8/9/2004	557.19	39.90	517.29	38.60	1.30	518.59	L
GW-PZ-E2	8/16/2004	557.19	39.90	517.29	38.55	1.35	518.64	L
GW-PZ-E2	8/23/2004	557.19	39.90	517.29	38.55	1.35	518.64	L
GW-PZ-E2	8/30/2004	557.19	39.90	517.29	38.55	1.35	518.64	L
GW-PZ-E2	9/7/2004	557.19	40.00	517.19	38.55	1.45	518.64	L
GW-PZ-E2	9/13/2004	557.19	39.92	517.27	38.80	1.12	518.39	L
GW-PZ-E2	9/20/2004	557.19	40.00	517.19	38.70	1.30	518.49	L
GW-PZ-E2	9/27/2004	557.19	40.03	517.16	38.70	1.33	518.49	L
GW-PZ-E2	10/4/2004	557.19	41.18	516.01	38.85	2.33	518.34	L
GW-PZ-E2	10/11/2004	557.19	39.95	517.24	38.33	1.62	518.86	L
GW-PZ-E2	10/21/2004	557.19	40.07	517.12	38.75	1.32	518.44	L
GW-PZ-E2	10/25/2004	557.19	40.17	517.02	38.87	1.30	518.32	L
GW-PZ-E2	11/1/2004	557.19	40.45	516.74	39.10	1.35	518.09	L
GW-PZ-E2	11/9/2004	557.19	40.23	516.96	39.00	1.23	518.19	L
GW-PZ-E2	11/15/2004	557.19	40.18	517.01	38.94	1.24	518.25	L
GW-PZ-E2	11/22/2004	557.19	40.26	516.93	38.93	1.33	518.26	L
GW-PZ-E2	11/29/2004	557.19	40.60	516.59	39.18	1.42	518.01	L
GW-PZ-E2	12/6/2004	557.19	40.05	517.14	38.93	1.12	518.26	L
GW-PZ-E2	12/14/2004	557.19	39.98	517.21	38.90	1.08	518.29	L
GW-PZ-E2	12/20/2004	557.19	40.10	517.09	38.64	1.46	518.55	L
GW-PZ-E2	12/31/2004	557.19	40.68	516.51	38.84	1.84	518.35	L
GW-PZ-E2	1/4/2005	557.19	40.64	516.55	38.77	1.87	518.42	L
GW-PZ-E2	1/14/2005	557.19	40.95	516.24	39.30	1.65	517.89	L
GW-PZ-E2	1/18/2005	557.19	40.92	516.27	39.48	1.44	517.71	L
GW-PZ-E2	1/24/2005	557.19	40.48	516.71	38.61	1.87	518.58	L

Table A3-1. NAPL Elevations
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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
GW-PZ-E2	2/1/2005	557.19	40.60	516.59	38.90	1.70	518.29	L
GW-PZ-E2	2/7/2005	557.19	40.68	516.51	38.93	1.75	518.26	L
GW-PZ-E2	2/15/2005	557.19	40.55	516.64	38.90	1.65	518.29	L
GW-PZ-E2	2/24/2005	557.19	40.80	516.39	38.85	1.95	518.34	L
GW-PZ-E2	3/1/2005	557.19	40.60	516.59	38.82	1.78	518.37	L
GW-PZ-E2	3/7/2005	557.19	40.55	516.64	38.77	1.78	518.42	L
GW-PZ-E2	3/16/2005	557.19	40.50	516.69	38.70	1.80	518.49	L
GW-PZ-E2	3/24/2005	557.19	40.32	516.87	38.50	1.82	518.69	L
GW-PZ-E2	3/28/2005	557.19	40.37	516.82	38.40	1.97	518.79	L
GW-PZ-E2	4/9/2005	557.19	39.92	517.27	38.00	1.92	519.19	L
GW-PZ-E2	4/14/2005	557.19	39.90	517.29	38.03	1.87	519.16	L
GW-PZ-E2	4/22/2005	557.19	39.65	517.54	37.80	1.85	519.39	L
GW-PZ-E2	4/28/2005	557.19	39.10	518.09	37.20	1.90	519.99	L
GW-PZ-E2	5/2/2005	557.19	39.13	518.06	37.50	1.63	519.69	L
GW-PZ-E2	5/13/2005	557.19	38.40	518.79	37.10	1.30	520.09	L
GW-PZ-E2	5/19/2005	557.19	38.00	519.19	36.94	1.06	520.25	L
GW-PZ-E2	5/30/2005	557.19	38.12	519.07	37.04	1.08	520.15	L
GW-PZ-E2	6/8/2005	557.19	38.05	519.14	36.80	1.25	520.39	L
GW-PZ-E2	6/15/2005	557.19	36.95	520.24	35.98	0.97	521.21	L
GW-PZ-E2	6/24/2005	557.19	37.09	520.10	35.92	1.17	521.27	L
GW-PZ-E2	7/13/2005	557.19	36.86	520.33	35.50	1.36	521.69	L
GW-PZ-E2	8/31/2005	557.19	36.39	520.80	34.80	1.59	522.39	L
GW-PZ-E2	9/12/2005	557.19	36.50	520.69	34.61	1.89	522.58	L
GW-PZ-E2	10/20/2005	557.19	36.26	520.93	34.30	1.96	522.89	L
GW-PZ-E2	11/10/2005	557.19	36.40	520.79	34.49	1.91	522.70	L
GW-PZ-E2	12/27/2005	557.19	36.58	520.61	34.85	1.73	522.34	L
GW-PZ-E2	1/18/2006	557.19	36.50	520.69	34.88	1.62	522.31	L
GW-PZ-E2	2/14/2006	557.19	36.73	520.46	35.25	1.48	521.94	L
GW-PZ-E2	3/3/2006	557.19	36.10	521.09	35.25	0.85	521.94	L
GW-PZ-E2	4/18/2006	557.19	36.74	520.45	35.31	1.43	521.88	L
GW-PZ-E2	6/26/2006	557.19	36.96	520.23	36.10	0.86	521.09	L
GW-PZ-E2	9/20/2006	557.19	36.93	520.26	36.07	0.86	521.12	L
GW-PZ-E2	12/11/2006	557.19	37.26	519.93	36.45	0.81	520.74	L
GW-PZ-E2	2/9/2007	557.19	38.42	518.77	37.05	1.37	520.14	L
GW-PZ-E2	3/14/2007	557.19	38.87	518.32	37.50	1.37	519.69	L
GW-PZ-E2	6/28/2007	557.19	42.20	514.99	NA	NA	NA	L
GW-PZ-E2	9/20/2007	557.19	39.93	517.26	37.79	2.14	519.40	L
GW-PZ-E2	12/27/2007	557.19	ND	ND	39.50	5.50	517.69	L
GW-PZ-E2	3/25/2008	557.19	NA	NA	NA	NA	NA	L
GW-PZ-E2	6/30/2008	557.19	NA	NA	NA	NA	NA	L
GW-PZ-E2	9/10/2008	557.19	41.26	515.93	39.20	2.06	517.99	L
GW-PZ-E2	12/16/2008	557.19	41.44	515.75	39.40	2.04	517.79	L
GW-PZ-E2	3/31/2009	557.19	42.35	514.84	40.02	2.33	517.17	L
GW-PZ-E2	1/14/2010	557.19	42.95	514.24	41.63	1.32	515.56	L
GW-PZ-E2	3/31/2010	557.19	43.93	513.26	41.68	2.25	515.51	L
GW-PZ-E2	2/1/2011	557.19	42.74	514.45	40.20	2.54	516.99	L
GW-PZ-E2	6/27/2011	557.19	40.56	516.63	36.67	3.89	520.52	L
GW-PZ-E2	12/28/2011	557.19	39.69	517.50	34.68	5.01	522.51	L
GW-PZ-E3	5/15/2001	553.66	35.23	518.43	26.58	8.65	527.08	L
GW-PZ-E3	5/22/2001	553.66	35.08	518.58	26.54	8.54	527.12	L
GW-PZ-E3	5/29/2001	553.66	35.27	518.39	26.38	8.89	527.28	L
GW-PZ-E3	6/16/2001	553.66	37.60	516.06	28.62	8.98	525.04	L
GW-PZ-E3	6/20/2001	553.66	37.50	516.16	28.56	8.94	525.10	L
GW-PZ-E3	6/28/2001	553.66	37.00	516.66	28.15	8.85	525.51	L
GW-PZ-E3	7/3/2001	553.66	37.32	516.34	28.56	8.76	525.10	L
GW-PZ-E3	7/10/2001	553.66	37.22	516.44	28.96	8.26	524.70	L
GW-PZ-E3	7/17/2001	553.66	37.50	516.16	29.20	8.30	524.46	L
GW-PZ-E3	7/24/2001	553.66	37.39	516.27	29.06	8.33	524.60	L
GW-PZ-E3	7/31/2001	553.66	37.70	515.96	29.56	8.14	524.10	L
GW-PZ-E3	8/7/2001	553.66	37.57	516.09	29.70	7.87	523.96	L
GW-PZ-E3	8/14/2001	553.66	37.66	516.00	30.05	7.61	523.61	L
GW-PZ-E3	8/17/2001	553.66	37.65	516.01	30.06	7.59	523.60	L
GW-PZ-E3	8/24/2001	553.66	37.75	515.91	30.20	7.55	523.46	L

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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
GW-PZ-E3	8/31/2001	553.66	37.57	516.09	30.40	7.17	523.26	L
GW-PZ-E3	9/7/2001	553.66	37.73	515.93	30.54	7.19	523.12	L
GW-PZ-E3	9/14/2001	553.66	37.85	515.81	30.72	7.13	522.94	L
GW-PZ-E3	9/21/2001	553.66	37.75	515.91	31.07	6.68	522.59	L
GW-PZ-E3	9/28/2001	553.66	37.96	515.70	31.26	6.70	522.40	L
GW-PZ-E3	10/3/2001	553.66	37.70	515.96	31.29	6.41	522.37	L
GW-PZ-E3	10/7/2001	553.66	37.92	515.74	31.40	6.52	522.26	L
GW-PZ-E3	10/14/2001	553.66	37.95	515.71	31.46	6.49	522.20	L
GW-PZ-E3	10/21/2001	553.66	38.22	515.44	31.73	6.49	521.93	L
GW-PZ-E3	10/28/2001	553.66	38.05	515.61	32.03	6.02	521.63	L
GW-PZ-E3	11/3/2001	553.66	38.08	515.58	32.25	5.83	521.41	L
GW-PZ-E3	11/10/2001	553.66	38.20	515.46	32.28	5.92	521.38	L
GW-PZ-E3	11/17/2001	553.66	38.47	515.19	32.40	6.07	521.26	L
GW-PZ-E3	11/24/2001	553.66	38.25	515.41	32.53	5.72	521.13	L
GW-PZ-E3	11/30/2001	553.66	38.28	515.38	32.05	6.23	521.61	L
GW-PZ-E3	12/3/2001	553.66	38.15	515.51	33.00	5.15	520.66	L
GW-PZ-E3	12/10/2001	553.66	38.05	515.61	32.90	5.15	520.76	L
GW-PZ-E3	12/17/2001	553.66	39.95	513.71	33.30	6.65	520.36	L
GW-PZ-E3	12/24/2001	553.66	39.90	513.76	33.40	6.50	520.26	L
GW-PZ-E3	12/31/2001	553.66	38.24	515.42	33.55	4.69	520.11	L
GW-PZ-E3	1/7/2002	553.66	39.95	513.71	33.95	6.00	519.71	L
GW-PZ-E3	1/13/2002	553.66	38.65	515.01	33.87	4.78	519.79	L
GW-PZ-E3	1/21/2002	553.66	39.35	514.31	34.00	5.35	519.66	L
GW-PZ-E3	1/28/2002	553.66	38.40	515.26	34.15	4.25	519.51	L
GW-PZ-E3	2/4/2002	553.66	39.95	513.71	34.40	5.55	519.26	L
GW-PZ-E3	2/11/2002	553.66	39.94	513.72	34.45	5.49	519.21	L
GW-PZ-E3	2/18/2002	553.66	38.10	515.56	34.50	3.60	519.16	L
GW-PZ-E3	2/25/2002	553.66	38.20	515.46	34.60	3.60	519.06	L
GW-PZ-E3	3/4/2002	553.66	39.95	513.71	34.85	5.10	518.81	L
GW-PZ-E3	3/11/2002	553.66	38.16	515.50	34.83	3.33	518.83	L
GW-PZ-E3	3/18/2002	553.66	38.40	515.26	35.00	3.40	518.66	L
GW-PZ-E3	3/25/2002	553.66	38.00	515.66	35.03	2.97	518.63	L
GW-PZ-E3	4/1/2002	553.66	38.14	515.52	35.13	3.01	518.53	L
GW-PZ-E3	4/8/2002	553.66	38.21	515.45	35.35	2.86	518.31	L
GW-PZ-E3	4/15/2002	553.66	38.20	515.46	35.40	2.80	518.26	L
GW-PZ-E3	4/22/2002	553.66	38.34	515.32	35.06	3.28	518.60	L
GW-PZ-E3	4/29/2002	553.66	38.20	515.46	35.72	2.48	517.94	L
GW-PZ-E3	5/6/2002	553.66	38.22	515.44	35.86	2.36	517.80	L
GW-PZ-E3	5/13/2002	553.66	38.18	515.48	35.95	2.23	517.71	L
GW-PZ-E3	5/20/2002	553.66	38.18	515.48	36.00	2.18	517.66	L
GW-PZ-E3	5/28/2002	553.66	38.30	515.36	36.24	2.06	517.42	L
GW-PZ-E3	6/3/2002	553.66	38.22	515.44	36.40	1.82	517.26	L
GW-PZ-E3	6/10/2002	553.66	38.10	515.56	36.50	1.60	517.16	L
GW-PZ-E3	6/17/2002	553.66	38.20	515.46	36.70	1.50	516.96	L
GW-PZ-E3	6/24/2002	553.66	38.25	515.41	36.80	1.45	516.86	L
GW-PZ-E3	7/1/2002	553.66	38.20	515.46	36.86	1.34	516.80	L
GW-PZ-E3	7/8/2002	553.66	38.40	515.26	37.00	1.40	516.66	L
GW-PZ-E3	7/15/2002	553.66	38.26	515.40	37.06	1.20	516.60	L
GW-PZ-E3	7/22/2002	553.66	38.30	515.36	37.20	1.10	516.46	L
GW-PZ-E3	7/29/2002	553.66	38.50	515.16	37.25	1.25	516.41	L
GW-PZ-E3	8/1/2002	553.66	38.31	515.35	37.15	1.16	516.51	L
GW-PZ-E3	8/5/2002	553.66	38.20	515.46	37.15	1.05	516.51	L
GW-PZ-E3	8/12/2002	553.66	38.27	515.39	37.04	1.23	516.62	L
GW-PZ-E3	8/19/2002	553.66	38.02	515.64	36.90	1.12	516.76	L
GW-PZ-E3	8/26/2002	553.66	38.40	515.26	37.30	1.10	516.36	L
GW-PZ-E3	9/4/2002	553.66	38.35	515.31	37.34	1.01	516.32	L
GW-PZ-E3	9/9/2002	553.66	38.40	515.26	37.50	0.90	516.16	L
GW-PZ-E3	9/17/2002	553.66	38.50	515.16	37.50	1.00	516.16	L
GW-PZ-E3	9/23/2002	553.66	39.70	513.96	37.80	1.90	515.86	L
GW-PZ-E3	9/30/2002	553.66	39.20	514.46	37.65	1.55	516.01	L
GW-PZ-E3	10/7/2002	553.66	38.60	515.06	37.70	0.90	515.96	L
GW-PZ-E3	10/14/2002	553.66	39.90	513.76	37.70	2.20	515.96	L
GW-PZ-E3	10/21/2002	553.66	38.35	515.31	37.60	0.75	516.06	L

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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
GW-PZ-E3	10/28/2002	553.66	38.30	515.36	37.54	0.76	516.12	L
GW-PZ-E3	11/5/2002	553.66	38.30	515.36	37.54	0.76	516.12	L
GW-PZ-E3	11/11/2002	553.66	38.30	515.36	37.50	0.80	516.16	L
GW-PZ-E3	11/18/2002	553.66	38.25	515.41	37.50	0.75	516.16	L
GW-PZ-E3	11/25/2002	553.66	38.24	515.42	37.45	0.79	516.21	L
GW-PZ-E3	12/2/2002	553.66	38.20	515.46	37.50	0.70	516.16	L
GW-PZ-E3	12/9/2002	553.66	38.30	515.36	37.55	0.75	516.11	L
GW-PZ-E3	12/18/2002	553.66	38.10	515.56	37.55	0.55	516.11	L
GW-PZ-E3	12/23/2002	553.66	38.02	515.64	37.50	0.52	516.16	L
GW-PZ-E3	12/30/2002	553.66	38.10	515.56	37.50	0.60	516.16	L
GW-PZ-E3	1/6/2003	553.66	38.00	515.66	37.45	0.55	516.21	L
GW-PZ-E3	1/13/2003	553.66	38.00	515.66	37.40	0.60	516.26	L
GW-PZ-E3	1/20/2003	553.66	38.10	515.56	37.38	0.72	516.28	L
GW-PZ-E3	1/27/2003	553.66	38.10	515.56	37.40	0.70	516.26	L
GW-PZ-E3	2/3/2003	553.66	37.90	515.76	37.30	0.60	516.36	L
GW-PZ-E3	2/10/2003	553.66	37.90	515.76	37.20	0.70	516.46	L
GW-PZ-E3	2/17/2003	553.66	37.90	515.76	37.20	0.70	516.46	L
GW-PZ-E3	2/24/2003	553.66	37.80	515.86	37.15	0.65	516.51	L
GW-PZ-E3	3/3/2003	553.66	37.80	515.86	37.12	0.68	516.54	L
GW-PZ-E3	3/10/2003	553.66	37.80	515.86	37.05	0.75	516.61	L
GW-PZ-E3	3/17/2003	553.66	37.75	515.91	37.00	0.75	516.66	L
GW-PZ-E3	3/24/2003	553.66	37.70	515.96	37.00	0.70	516.66	L
GW-PZ-E3	3/31/2003	553.66	37.70	515.96	36.90	0.80	516.76	L
GW-PZ-E3	4/7/2003	553.66	37.30	516.36	36.85	0.45	516.81	L
GW-PZ-E3	4/14/2003	553.66	37.20	516.46	36.80	0.40	516.86	L
GW-PZ-E3	4/21/2003	553.66	37.30	516.36	36.70	0.60	516.96	L
GW-PZ-E3	4/28/2003	553.66	37.35	516.31	36.65	0.70	517.01	L
GW-PZ-E3	5/5/2003	553.66	37.30	516.36	36.65	0.65	517.01	L
GW-PZ-E3	5/12/2003	553.66	37.50	516.16	36.50	1.00	517.16	L
GW-PZ-E3	5/19/2003	553.66	37.60	516.06	36.46	1.14	517.20	L
GW-PZ-E3	5/28/2003	553.66	35.14	518.52	34.91	0.23	518.75	L
GW-PZ-E3	6/2/2003	553.66	35.85	517.81	35.14	0.71	518.52	L
GW-PZ-E3	6/9/2003	553.66	36.72	516.94	35.36	1.36	518.30	L
GW-PZ-E3	6/16/2003	553.66	37.40	516.26	35.60	1.80	518.06	L
GW-PZ-E3	6/23/2003	553.66	37.60	516.06	35.55	2.05	518.11	L
GW-PZ-E3	6/30/2003	553.66	37.55	516.11	35.80	1.75	517.86	L
GW-PZ-E3	7/7/2003	553.66	37.62	516.04	35.85	1.77	517.81	L
GW-PZ-E3	7/14/2003	553.66	37.68	515.98	35.95	1.73	517.71	L
GW-PZ-E3	7/21/2003	553.66	37.75	515.91	36.04	1.71	517.62	L
GW-PZ-E3	7/28/2003	553.66	37.80	515.86	36.10	1.70	517.56	L
GW-PZ-E3	8/4/2003	553.66	37.74	515.92	36.10	1.64	517.56	L
GW-PZ-E3	8/11/2003	553.66	37.75	515.91	36.10	1.65	517.56	L
GW-PZ-E3	8/18/2003	553.66	37.70	515.96	36.35	1.35	517.31	L
GW-PZ-E3	8/25/2003	553.66	37.75	515.91	36.15	1.60	517.51	L
GW-PZ-E3	9/2/2003	553.66	37.70	515.96	36.12	1.58	517.54	L
GW-PZ-E3	9/8/2003	553.66	37.75	515.91	36.10	1.65	517.56	L
GW-PZ-E3	9/15/2003	553.66	37.70	515.96	36.10	1.60	517.56	L
GW-PZ-E3	9/22/2003	553.66	37.80	515.86	36.05	1.75	517.61	L
GW-PZ-E3	9/29/2003	553.66	37.82	515.84	36.12	1.70	517.54	L
GW-PZ-E3	10/6/2003	553.66	37.80	515.86	36.10	1.70	517.56	L
GW-PZ-E3	10/13/2003	553.66	37.80	515.86	36.15	1.65	517.51	L
GW-PZ-E3	10/20/2003	553.66	37.50	516.16	36.10	1.40	517.56	L
GW-PZ-E3	10/27/2003	553.66	37.80	515.86	36.30	1.50	517.36	L
GW-PZ-E3	11/3/2003	553.66	37.80	515.86	36.30	1.50	517.36	L
GW-PZ-E3	11/10/2003	553.66	37.80	515.86	36.35	1.45	517.31	L
GW-PZ-E3	11/17/2003	553.66	38.00	515.66	36.53	1.47	517.13	L
GW-PZ-E3	11/24/2003	553.66	37.75	515.91	36.50	1.25	517.16	L
GW-PZ-E3	12/1/2003	553.66	37.90	515.76	36.60	1.30	517.06	L
GW-PZ-E3	12/8/2003	553.66	38.05	515.61	36.80	1.25	516.86	L
GW-PZ-E3	12/15/2003	553.66	38.00	515.66	36.75	1.25	516.91	L
GW-PZ-E3	12/22/2003	553.66	38.02	515.64	36.75	1.27	516.91	L
GW-PZ-E3	12/29/2003	553.66	38.02	515.64	36.67	1.35	516.99	L
GW-PZ-E3	1/6/2004	553.66	37.97	515.69	36.50	1.47	517.16	L

Table A3-1. NAPL Elevations
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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
GW-PZ-E3	1/12/2004	553.66	38.10	515.56	36.50	1.60	517.16	L
GW-PZ-E3	1/19/2004	553.66	38.00	515.66	36.40	1.60	517.26	L
GW-PZ-E3	1/26/2004	553.66	38.06	515.60	36.42	1.64	517.24	L
GW-PZ-E3	2/2/2004	553.66	38.10	515.56	36.45	1.65	517.21	L
GW-PZ-E3	2/9/2004	553.66	38.15	515.51	36.60	1.55	517.06	L
GW-PZ-E3	2/16/2004	553.66	38.25	515.41	36.55	1.70	517.11	L
GW-PZ-E3	2/23/2004	553.66	38.10	515.56	36.45	1.65	517.21	L
GW-PZ-E3	3/1/2004	553.66	38.26	515.40	36.60	1.66	517.06	L
GW-PZ-E3	3/8/2004	553.66	39.55	514.11	36.70	2.85	516.96	L
GW-PZ-E3	3/15/2004	553.66	39.31	514.35	36.70	2.61	516.96	L
GW-PZ-E3	3/22/2004	553.66	39.80	513.86	36.65	3.15	517.01	L
GW-PZ-E3	3/29/2004	553.66	40.00	513.66	36.70	3.30	516.96	L
GW-PZ-E3	4/5/2004	555.94	38.10	517.84	36.10	2.00	519.84	L
GW-PZ-E3	4/12/2004	555.94	38.20	517.74	36.15	2.05	519.79	L
GW-PZ-E3	4/19/2004	555.94	39.80	516.14	36.30	3.50	519.64	L
GW-PZ-E3	4/26/2004	555.94	39.85	516.09	36.30	3.55	519.64	L
GW-PZ-E3	5/3/2004	555.94	39.80	516.14	36.30	3.50	519.64	L
GW-PZ-E3	5/12/2004	555.94	38.33	517.61	36.20	2.13	519.74	L
GW-PZ-E3	5/17/2004	555.94	39.85	516.09	36.20	3.65	519.74	L
GW-PZ-E3	5/24/2004	555.94	39.88	516.06	36.25	3.63	519.69	L
GW-PZ-E3	6/2/2004	555.94	39.85	516.09	36.10	3.75	519.84	L
GW-PZ-E3	6/7/2004	555.94	39.85	516.09	36.10	3.75	519.84	L
GW-PZ-E3	6/14/2004	555.94	39.85	516.09	36.05	3.80	519.89	L
GW-PZ-E3	6/21/2004	555.94	39.90	516.04	36.10	3.80	519.84	L
GW-PZ-E3	6/28/2004	555.94	39.90	516.04	36.00	3.90	519.94	L
GW-PZ-E3	7/6/2004	555.94	39.90	516.04	36.00	3.90	519.94	L
GW-PZ-E3	7/12/2004	555.94	39.90	516.04	35.93	3.97	520.01	L
GW-PZ-E3	7/19/2004	555.94	39.90	516.04	35.90	4.00	520.04	L
GW-PZ-E3	7/26/2004	555.94	39.90	516.04	35.90	4.00	520.04	L
GW-PZ-E3	8/2/2004	555.94	39.90	516.04	35.85	4.05	520.09	L
GW-PZ-E3	8/9/2004	555.94	39.90	516.04	35.80	4.10	520.14	L
GW-PZ-E3	8/16/2004	555.94	39.88	516.06	35.80	4.08	520.14	L
GW-PZ-E3	8/23/2004	555.94	39.90	516.04	35.82	4.08	520.12	L
GW-PZ-E3	8/30/2004	555.94	39.90	516.04	35.85	4.05	520.09	L
GW-PZ-E3	9/7/2004	555.94	39.90	516.04	35.82	4.08	520.12	L
GW-PZ-E3	9/13/2004	555.94	39.92	516.02	35.90	4.02	520.04	L
GW-PZ-E3	9/20/2004	555.94	39.93	516.01	35.91	4.02	520.03	L
GW-PZ-E3	9/27/2004	555.94	39.97	515.97	36.00	3.97	519.94	L
GW-PZ-E3	10/4/2004	555.94	39.95	515.99	36.05	3.90	519.89	L
GW-PZ-E3	10/11/2004	555.94	39.93	516.01	36.00	3.93	519.94	L
GW-PZ-E3	10/21/2004	555.94	39.97	515.97	36.02	3.95	519.92	L
GW-PZ-E3	10/25/2004	555.94	39.93	516.01	36.10	3.83	519.84	L
GW-PZ-E3	11/1/2004	555.94	39.95	515.99	36.20	3.75	519.74	L
GW-PZ-E3	11/9/2004	555.94	39.95	515.99	36.25	3.70	519.69	L
GW-PZ-E3	11/15/2004	555.94	39.93	516.01	36.20	3.73	519.74	L
GW-PZ-E3	11/22/2004	555.94	39.95	515.99	36.20	3.75	519.74	L
GW-PZ-E3	11/29/2004	555.94	39.95	515.99	36.30	3.65	519.64	L
GW-PZ-E3	12/6/2004	555.94	39.95	515.99	36.37	3.58	519.57	L
GW-PZ-E3	12/14/2004	555.94	39.96	515.98	36.40	3.56	519.54	L
GW-PZ-E3	12/20/2004	555.94	39.95	515.99	36.02	3.93	519.92	L
GW-PZ-E3	12/31/2004	555.94	40.03	515.91	36.25	3.78	519.69	L
GW-PZ-E3	1/4/2005	555.94	40.00	515.94	36.30	3.70	519.64	L
GW-PZ-E3	1/14/2005	555.94	40.02	515.92	36.50	3.52	519.44	L
GW-PZ-E3	1/18/2005	555.94	40.05	515.89	36.56	3.49	519.38	L
GW-PZ-E3	1/24/2005	555.94	40.03	515.91	36.40	3.63	519.54	L
GW-PZ-E3	2/1/2005	555.94	40.07	515.87	38.50	1.57	517.44	L
GW-PZ-E3	2/7/2005	555.94	39.85	516.09	36.30	3.55	519.64	L
GW-PZ-E3	2/15/2005	555.94	39.85	516.09	36.30	3.55	519.64	L
GW-PZ-E3	2/24/2005	555.94	39.92	516.02	36.13	3.79	519.81	L
GW-PZ-E3	3/1/2005	555.94	40.02	515.92	36.25	3.77	519.69	L
GW-PZ-E3	3/7/2005	555.94	39.81	516.13	36.07	3.74	519.87	L
GW-PZ-E3	3/16/2005	555.94	39.98	515.96	35.95	4.03	519.99	L
GW-PZ-E3	3/24/2005	555.94	40.05	515.89	36.00	4.05	519.94	L

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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
GW-PZ-E3	3/28/2005	555.94	ND	ND	38.75	6.25	517.19	L
GW-PZ-E3	4/9/2005	555.94	ND	ND	35.40	9.60	520.54	L
GW-PZ-E3	4/14/2005	555.94	ND	ND	35.25	9.75	520.69	L
GW-PZ-E3	4/22/2005	555.94	38.60	517.34	35.05	3.55	520.89	L
GW-PZ-E3	4/28/2005	555.94	38.40	517.54	34.90	3.50	521.04	L
GW-PZ-E3	5/2/2005	555.94	38.20	517.74	34.70	3.50	521.24	L
GW-PZ-E3	5/13/2005	555.94	37.90	518.04	34.25	3.65	521.69	L
GW-PZ-E3	5/19/2005	555.94	37.80	518.14	34.05	3.75	521.89	L
GW-PZ-E3	5/30/2005	555.94	37.31	518.63	33.73	3.58	522.21	L
GW-PZ-E3	6/8/2005	555.94	37.35	518.59	33.55	3.80	522.39	L
GW-PZ-E3	6/15/2005	555.94	37.31	518.63	33.30	4.01	522.64	L
GW-PZ-E3	6/24/2005	555.94	37.21	518.73	33.10	4.11	522.84	L
GW-PZ-E3	7/13/2005	555.94	37.18	518.76	32.50	4.68	523.44	L
GW-PZ-E3	8/31/2005	555.94	36.26	519.68	31.86	4.40	524.08	L
GW-PZ-E3	9/12/2005	555.94	37.05	518.89	31.83	5.22	524.11	L
GW-PZ-E3	10/20/2005	555.94	37.54	518.40	31.58	5.96	524.36	L
GW-PZ-E3	11/10/2005	555.94	37.80	518.14	31.85	5.95	524.09	L
GW-PZ-E3	12/27/2005	555.94	38.20	517.74	32.10	6.10	523.84	L
GW-PZ-E3	1/18/2006	555.94	38.15	517.79	33.04	5.11	522.90	L
GW-PZ-E3	2/14/2006	555.94	37.86	518.08	32.22	5.64	523.72	L
GW-PZ-E3	3/3/2006	555.94	37.28	518.66	32.50	4.78	523.44	L
GW-PZ-E3	4/18/2006	555.94	37.92	518.02	32.57	5.35	523.37	L
GW-PZ-E3	6/26/2006	555.94	37.70	518.24	32.49	5.21	523.45	L
GW-PZ-E3	9/20/2006	555.94	37.75	518.19	32.39	5.36	523.55	L
GW-PZ-E3	12/11/2006	555.94	38.53	517.41	33.25	5.28	522.69	L
GW-PZ-E3	2/9/2007	555.94	39.10	516.84	33.88	5.22	522.06	L
GW-PZ-E3	3/14/2007	555.94	38.52	517.42	34.25	4.27	521.69	L
GW-PZ-E3	6/28/2007	555.94	39.96	515.98	35.10	4.86	520.84	L
GW-PZ-E3	9/20/2007	555.94	39.24	516.70	35.50	3.74	520.44	L
GW-PZ-E3	12/27/2007	555.94	39.20	516.74	36.50	2.70	519.44	L
GW-PZ-E3	3/25/2008	555.94	39.07	516.87	36.65	2.42	519.29	L
GW-PZ-E3	6/30/2008	555.94	39.44	516.50	36.83	2.61	519.11	L
GW-PZ-E3	9/10/2008	555.94	39.28	516.66	36.93	2.35	519.01	L
GW-PZ-E3	12/16/2008	555.94	39.63	516.31	37.11	2.52	518.83	L
GW-PZ-E3	3/31/2009	555.94	38.93	517.01	37.74	1.19	518.20	L
GW-PZ-E3	1/14/2010	555.94	39.90	516.04	ND	ND	ND	L
GW-PZ-E3	3/31/2010	555.94	40.08	515.86	ND	ND	ND	L
GW-PZ-E3	2/1/2011	555.94	40.40	515.54	37.95	2.45	517.99	L
GW-PZ-E3	6/27/2011	555.94	34.01	521.93	33.60	0.41	522.34	L
GW-PZ-E3	12/28/2011	555.94	33.50	522.44	33.11	0.39	522.83	L
9B Companion Well	6/24/2002	486.26	10.60	475.66	10.33	0.27	475.93	L
9B Companion Well	7/1/2002	486.26	10.60	475.66	10.30	0.30	475.96	L
9B Companion Well	7/8/2002	486.26	10.25	476.01	10.18	0.07	476.08	L
9B Companion Well	7/15/2002	486.26	10.45	475.81	10.20	0.25	476.06	L
9B Companion Well	7/22/2002	486.26	9.30	476.96	9.15	0.15	477.11	L
9B Companion Well	7/29/2002	486.26	9.70	476.56	9.50	0.20	476.76	L
9B Companion Well	8/1/2002	486.26	9.15	477.11	9.00	0.15	477.26	L
9B Companion Well	8/5/2002	486.26	9.15	477.11	9.00	0.15	477.26	L
9B Companion Well	8/12/2002	486.26	9.20	477.06	9.15	0.05	477.11	L
9B Companion Well	8/19/2002	486.26	9.30	476.96	9.17	0.13	477.09	L
9B Companion Well	8/26/2002	486.26	8.75	477.51	8.70	0.05	477.56	L
9B Companion Well	9/4/2002	486.26	9.00	477.26	8.90	0.10	477.36	L
9B Companion Well	9/9/2002	486.26	8.75	477.51	8.70	0.05	477.56	L
9B Companion Well	9/17/2002	486.26	8.90	477.36	8.80	0.10	477.46	L
9B Companion Well	9/23/2002	486.26	8.64	477.62	8.60	0.04	477.66	L
9B Companion Well	9/30/2002	486.26	8.75	477.51	8.70	0.05	477.56	L
9B Companion Well	10/7/2002	486.26	9.80	476.46	9.75	0.05	476.51	L
9B Companion Well	10/14/2002	486.26	9.20	477.06	9.17	0.03	477.09	L
9B Companion Well	10/21/2002	486.26	10.80	475.46	10.75	0.05	475.51	L
9B Companion Well	10/28/2002	486.26	11.00	475.26	10.55	0.45	475.71	L
9B Companion Well	11/5/2002	486.26	10.10	476.16	10.00	0.10	476.26	L
9B Companion Well	11/11/2002	486.26	8.95	477.31	8.85	0.10	477.41	L
9B Companion Well	11/18/2002	486.26	9.00	477.26	8.95	0.05	477.31	L

Table A3-1. NAPL Elevations
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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
9B Companion Well	11/25/2002	486.26	9.70	476.56	9.45	0.25	476.81	L
9B Companion Well	12/2/2002	486.26	9.30	476.96	9.25	0.05	477.01	L
9B Companion Well	12/9/2002	486.26	9.25	477.01	9.20	0.05	477.06	L
9B Companion Well	12/18/2002	486.26	9.90	476.36	9.85	0.05	476.41	L
9B Companion Well	12/23/2002	486.26	8.90	477.36	ND	ND	ND	L
9B Companion Well	12/30/2002	486.26	7.75	478.51	ND	ND	ND	L
9B Companion Well	1/6/2003	486.26	7.80	478.46	ND	ND	ND	L
9B Companion Well	1/13/2003	486.26	7.75	478.51	ND	ND	ND	L
9B Companion Well	1/20/2003	486.26	8.05	478.21	ND	ND	ND	L
9B Companion Well	1/27/2003	486.26	10.00	476.26	ND	ND	ND	L
9B Companion Well	2/3/2003	486.26	10.40	475.86	ND	ND	ND	L
9B Companion Well	2/10/2003	486.26	9.10	477.16	ND	ND	ND	L
9B Companion Well	2/17/2003	486.26	9.10	477.16	9.08	0.02	477.18	L
9B Companion Well	2/24/2003	486.26	8.55	477.71	ND	ND	ND	L
9B Companion Well	3/3/2003	486.26	8.38	477.88	ND	ND	ND	L
9B Companion Well	3/10/2003	486.26	8.72	477.54	ND	ND	ND	L
9B Companion Well	3/17/2003	486.26	7.90	478.36	ND	ND	ND	L
9B Companion Well	3/24/2003	486.26	6.60	479.66	ND	ND	ND	L
9B Companion Well	3/31/2003	486.26	9.90	476.36	ND	ND	ND	L
9B Companion Well	4/7/2003	486.26	9.70	476.56	ND	ND	ND	L
9B Companion Well	4/14/2003	486.26	11.70	474.56	ND	ND	ND	L
9B Companion Well	4/21/2003	486.26	10.80	475.46	ND	ND	ND	L
9B Companion Well	4/28/2003	486.26	10.45	475.81	ND	ND	ND	L
9B Companion Well	5/5/2003	486.26	10.50	475.76	ND	ND	ND	L
9B Companion Well	5/12/2003	486.26	9.45	476.81	ND	ND	ND	L
9B Companion Well	5/19/2003	486.26	5.72	480.54	ND	ND	ND	L
9B Companion Well	5/28/2003	486.26	15.46	470.80	15.43	0.03	470.83	L
9B Companion Well	6/2/2003	486.26	14.50	471.76	14.48	0.02	471.78	L
9B Companion Well	6/9/2003	486.26	18.90	467.36	18.83	0.07	467.43	L
9B Companion Well	6/16/2003	486.26	15.65	470.61	15.60	0.05	470.66	L
9B Companion Well	6/23/2003	486.26	18.92	467.34	18.87	0.05	467.39	L
9B Companion Well	6/30/2003	486.26	16.20	470.06	16.15	0.05	470.11	L
9B Companion Well	7/7/2003	486.26	16.65	469.61	16.60	0.05	469.66	L
9B Companion Well	7/14/2003	486.26	18.00	468.26	17.90	0.10	468.36	L
9B Companion Well	7/21/2003	486.26	17.20	469.06	17.10	0.10	469.16	L
9B Companion Well	7/28/2003	486.26	16.80	469.46	16.70	0.10	469.56	L
9B Companion Well	8/4/2003	486.26	19.30	466.96	19.10	0.20	467.16	L
9B Companion Well	8/11/2003	486.26	21.35	464.91	21.30	0.05	464.96	L
9B Companion Well	8/18/2003	486.26	19.75	466.51	19.50	0.25	466.76	L
9B Companion Well	8/25/2003	486.26	20.70	465.56	20.50	0.20	465.76	L
9B Companion Well	9/2/2003	486.26	20.20	466.06	19.95	0.25	466.31	L
9B Companion Well	9/8/2003	486.26	21.60	464.66	21.35	0.25	464.91	L
9B Companion Well	9/15/2003	486.26	21.40	464.86	21.15	0.25	465.11	L
9B Companion Well	9/22/2003	486.26	19.75	466.51	19.45	0.30	466.81	L
9B Companion Well	9/29/2003	486.26	20.45	465.81	20.08	0.37	466.18	L
9B Companion Well	10/6/2003	486.26	20.20	466.06	19.92	0.28	466.34	L
9B Companion Well	10/13/2003	486.26	19.90	466.36	19.60	0.30	466.66	L
9B Companion Well	10/20/2003	486.26	19.40	466.86	19.10	0.30	467.16	L
9B Companion Well	10/27/2003	486.26	20.15	466.11	19.80	0.35	466.46	L
9B Companion Well	11/3/2003	486.26	19.70	466.56	19.30	0.40	466.96	L
9B Companion Well	11/10/2003	486.26	18.50	467.76	18.25	0.25	468.01	L
9B Companion Well	11/17/2003	486.26	20.95	465.31	20.50	0.45	465.76	L
9B Companion Well	11/24/2003	486.26	20.22	466.04	19.85	0.37	466.41	L
9B Companion Well	12/1/2003	486.26	19.70	466.56	19.35	0.35	466.91	L
9B Companion Well	12/8/2003	486.26	20.10	466.16	19.64	0.46	466.62	L
9B Companion Well	12/15/2003	486.26	20.10	466.16	19.70	0.40	466.56	L
9B Companion Well	12/22/2003	486.26	20.15	466.11	19.83	0.32	466.43	L
9B Companion Well	12/29/2003	486.26	21.30	464.96	20.40	0.90	465.86	L
9B Companion Well	1/6/2004	486.26	21.30	464.96	20.70	0.60	465.56	L
9B Companion Well	1/12/2004	486.26	21.80	464.46	21.05	0.75	465.21	L
9B Companion Well	1/19/2004	486.26	21.35	464.91	20.75	0.60	465.51	L
9B Companion Well	1/26/2004	486.26	18.90	467.36	18.35	0.55	467.91	L
9B Companion Well	2/2/2004	486.26	20.93	465.33	20.30	0.63	465.96	L

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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
9B Companion Well	2/9/2004	486.26	21.00	465.26	20.40	0.60	465.86	L
9B Companion Well	2/16/2004	486.26	20.90	465.36	20.30	0.60	465.96	L
9B Companion Well	2/23/2004	486.26	21.35	464.91	20.65	0.70	465.61	L
9B Companion Well	3/1/2004	486.26	21.15	465.11	20.50	0.65	465.76	L
9B Companion Well	3/8/2004	486.26	21.65	464.61	20.95	0.70	465.31	L
9B Companion Well	3/15/2004	486.26	22.00	464.26	21.25	0.75	465.01	L
9B Companion Well	3/22/2004	486.26	22.10	464.16	21.45	0.65	464.81	L
9B Companion Well	3/29/2004	486.26	22.00	464.26	21.25	0.75	465.01	L
9B Companion Well	4/5/2004	486.26	20.40	465.86	19.65	0.75	466.61	L
9B Companion Well	4/12/2004	486.26	21.20	465.06	20.50	0.70	465.76	L
9B Companion Well	4/19/2004	486.26	21.40	464.86	20.50	0.90	465.76	L
9B Companion Well	4/26/2004	486.26	21.70	464.56	20.70	1.00	465.56	L
9B Companion Well	5/3/2004	486.26	24.50	461.76	22.20	2.30	464.06	L
9B Companion Well	5/12/2004	486.26	22.80	463.46	20.70	2.10	465.56	L
9B Companion Well	5/17/2004	486.26	21.90	464.36	19.65	2.25	466.61	L
9B Companion Well	5/24/2004	486.26	22.15	464.11	19.90	2.25	466.36	L
9B Companion Well	6/2/2004	486.26	21.95	464.31	19.70	2.25	466.56	L
9B Companion Well	6/7/2004	486.26	22.00	464.26	19.70	2.30	466.56	L
9B Companion Well	6/14/2004	486.26	22.20	464.06	19.90	2.30	466.36	L
9B Companion Well	6/21/2004	486.26	22.70	463.56	20.30	2.40	465.96	L
9B Companion Well	6/28/2004	486.26	22.00	464.26	19.60	2.40	466.66	L
9B Companion Well	7/6/2004	486.26	21.60	464.66	19.30	2.30	466.96	L
9B Companion Well	7/12/2004	486.26	21.60	464.66	19.30	2.30	466.96	L
9B Companion Well	7/19/2004	486.26	23.90	462.36	21.60	2.30	464.66	L
9B Companion Well	7/26/2004	486.26	NA	NA	NA	NA	NA	L
9B Companion Well	8/2/2004	486.26	21.90	464.36	19.48	2.42	466.78	L
9B Companion Well	8/9/2004	486.26	22.80	463.46	20.46	2.34	465.80	L
9B Companion Well	8/16/2004	486.26	23.25	463.01	20.90	2.35	465.36	L
9B Companion Well	8/23/2004	486.26	23.72	462.54	21.25	2.47	465.01	L
9B Companion Well	8/30/2004	486.26	24.00	462.26	22.60	1.40	463.66	L
9B Companion Well	9/7/2004	486.26	24.10	462.16	21.60	2.50	464.66	L
9B Companion Well	9/13/2004	486.26	24.10	462.16	21.57	2.53	464.69	L
9B Companion Well	9/20/2004	486.26	23.70	462.56	21.13	2.57	465.13	L
9B Companion Well	9/27/2004	486.26	24.20	462.06	21.64	2.56	464.62	L
9B Companion Well	10/4/2004	486.26	23.90	462.36	21.35	2.55	464.91	L
9B Companion Well	10/11/2004	486.26	23.38	462.88	20.75	2.63	465.51	L
9B Companion Well	10/21/2004	486.26	23.00	463.26	20.35	2.65	465.91	L
9B Companion Well	10/25/2004	486.26	22.40	463.86	19.50	2.90	466.76	L
9B Companion Well	11/1/2004	486.26	24.20	462.06	21.57	2.63	464.69	L
9B Companion Well	11/9/2004	486.26	23.70	462.56	20.70	3.00	465.56	L
9B Companion Well	11/15/2004	486.26	18.20	468.06	15.10	3.10	471.16	L
9B Companion Well	11/22/2004	486.26	23.10	463.16	20.20	2.90	466.06	L
9B Companion Well	11/29/2004	486.26	23.73	462.53	21.42	2.31	464.84	L
9B Companion Well	12/6/2004	486.26	23.38	462.88	21.13	2.25	465.13	L
9B Companion Well	12/14/2004	486.26	22.40	463.86	20.12	2.28	466.14	L
9B Companion Well	12/20/2004	486.26	23.30	462.96	21.04	2.26	465.22	L
9B Companion Well	12/31/2004	486.26	20.85	465.41	18.35	2.50	467.91	L
9B Companion Well	1/4/2005	486.26	24.18	462.08	21.70	2.48	464.56	L
9B Companion Well	1/14/2005	486.26	23.02	463.24	20.44	2.58	465.82	L
9B Companion Well	1/18/2005	486.26	23.60	462.66	20.60	3.00	465.66	L
9B Companion Well	1/24/2005	486.26	23.40	462.86	20.40	3.00	465.86	L
9B Companion Well	2/1/2005	486.26	22.70	463.56	20.15	2.55	466.11	L
9B Companion Well	2/7/2005	486.26	24.58	461.68	22.04	2.54	464.22	L
9B Companion Well	2/15/2005	486.26	23.35	462.91	20.05	3.30	466.21	L
9B Companion Well	2/24/2005	486.26	23.65	462.61	21.10	2.55	465.16	L
9B Companion Well	3/1/2005	486.26	23.15	463.11	20.40	2.75	465.86	L
9B Companion Well	3/7/2005	486.26	24.35	461.91	21.85	2.50	464.41	L
9B Companion Well	3/16/2005	486.26	23.90	462.36	21.30	2.60	464.96	L
9B Companion Well	3/24/2005	486.26	22.03	464.23	19.40	2.63	466.86	L
9B Companion Well	3/28/2005	486.26	22.90	463.36	20.25	2.65	466.01	L
9B Companion Well	4/9/2005	486.26	23.65	462.61	20.95	2.70	465.31	L
9B Companion Well	4/14/2005	486.26	23.55	462.71	21.00	2.55	465.26	L
9B Companion Well	4/22/2005	486.26	23.80	462.46	21.33	2.47	464.93	L

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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
9B Companion Well	4/28/2005	486.26	23.98	462.28	22.16	1.82	464.10	L
9B Companion Well	5/2/2005	486.26	24.20	462.06	22.72	1.48	463.54	L
9B Companion Well	5/13/2005	486.26	20.40	465.86	18.80	1.60	467.46	L
9B Companion Well	5/19/2005	486.26	22.30	463.96	21.11	1.19	465.15	L
9B Companion Well	5/30/2005	486.26	23.65	462.61	23.19	0.46	463.07	L
9B Companion Well	6/8/2005	486.26	21.26	465.00	20.46	0.80	465.80	L
9B Companion Well	6/15/2005	486.26	21.13	465.13	20.32	0.81	465.94	L
9B Companion Well	6/24/2005	486.26	20.62	465.64	19.80	0.82	466.46	L
9B Companion Well	7/13/2005	486.26	18.25	468.01	17.44	0.81	468.82	L
9B Companion Well	8/31/2005	486.26	19.80	466.46	19.14	0.66	467.12	L
9B Companion Well	9/12/2005	486.26	18.40	467.86	17.69	0.71	468.57	L
9B Companion Well	10/20/2005	486.26	20.95	465.31	20.26	0.69	466.00	L
9B Companion Well	11/10/2005	486.26	20.95	465.31	20.20	0.75	466.06	L
9B Companion Well	12/27/2005	486.26	20.75	465.51	20.49	0.26	465.77	L
9B Companion Well	1/18/2006	486.26	20.20	466.06	19.84	0.36	466.42	L
9B Companion Well	2/14/2006	486.26	21.75	464.51	21.30	0.45	464.96	L
9B Companion Well	3/3/2006	486.26	21.00	465.26	20.75	0.25	465.51	L
9B Companion Well	4/18/2006	486.26	17.34	468.92	17.05	0.29	469.21	L
9B Companion Well	6/26/2006	486.26	20.72	465.54	20.35	0.37	465.91	L
9B Companion Well	9/20/2006	486.26	19.81	466.45	19.27	0.54	466.99	L
9B Companion Well	12/11/2006	486.26	18.92	467.34	18.15	0.77	468.11	L
9B Companion Well	3/14/2007	486.26	19.30	466.96	18.63	0.67	467.63	L
9B Companion Well	6/28/2007	486.26	20.14	466.12	19.60	0.54	466.66	L
9B Companion Well	9/20/2007	486.26	20.55	465.71	19.72	0.83	466.54	L
9B Companion Well	12/27/2007	486.26	19.30	466.96	18.40	0.90	467.86	L
9B Companion Well	3/25/2008	486.26	21.30	464.96	18.40	2.90	467.86	L
9B Companion Well	6/30/2008	486.26	16.04	470.22	15.80	0.24	470.46	L
9B Companion Well	9/10/2008	486.26	9.90	476.36	9.60	0.30	476.66	L
9B Companion Well	12/16/2008	486.26	12.75	473.51	12.45	0.30	473.81	L
9B Companion Well	3/31/2009	486.26	12.88	473.38	12.60	0.28	473.66	L
9B Companion Well	1/14/2010	486.26	23.05	463.21	21.50	1.55	464.76	L
9B Companion Well	3/31/2010	486.26	22.71	463.55	21.19	1.52	465.07	L
9B Companion Well	2/1/2011	486.26	5.10	481.16	5.05	0.05	481.21	L
9B Companion Well	6/27/2011	486.26	5.14	481.12	5.07	0.07	481.19	L
9B Companion Well	12/28/2011	486.26	0.81	485.45	0.80	0.01	485.46	L

Table A3-1. NAPL Elevations
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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
9B-PZ-B	6/3/2002	484.42	ND	ND	8.23	7.78	476.19	L
9B-PZ-B	6/10/2002	484.42	ND	ND	8.38	7.72	476.04	L
9B-PZ-B	6/17/2002	484.42	ND	ND	8.88	7.20	475.54	L
9B-PZ-B	6/24/2002	484.42	15.90	468.52	9.64	6.26	474.78	L
9B-PZ-B	7/1/2002	484.42	15.90	468.52	9.65	6.25	474.77	L
9B-PZ-B	7/8/2002	484.42	15.92	468.50	9.45	6.47	474.97	L
9B-PZ-B	7/15/2002	484.42	15.90	468.52	9.60	6.30	474.82	L
9B-PZ-B	7/22/2002	484.42	15.91	468.51	9.75	6.16	474.67	L
9B-PZ-B	7/29/2002	484.42	15.90	468.52	9.50	6.40	474.92	L
9B-PZ-B	8/1/2002	484.42	15.90	468.52	9.65	6.25	474.77	L
9B-PZ-B	8/5/2002	484.42	15.90	468.52	9.52	6.38	474.90	L
9B-PZ-B	8/12/2002	484.42	15.25	469.17	9.15	6.10	475.27	L
9B-PZ-B	8/19/2002	484.42	15.90	468.52	9.70	6.20	474.72	L
9B-PZ-B	8/26/2002	484.42	15.95	468.47	9.41	6.54	475.01	L
9B-PZ-B	9/4/2002	484.42	15.90	468.52	9.55	6.35	474.87	L
9B-PZ-B	9/9/2002	484.42	15.90	468.52	9.43	6.47	474.99	L
9B-PZ-B	9/17/2002	484.42	15.92	468.50	9.30	6.62	475.12	L
9B-PZ-B	9/23/2002	484.42	15.90	468.52	9.40	6.50	475.02	L
9B-PZ-B	9/30/2002	484.42	15.96	468.46	9.50	6.46	474.92	L
9B-PZ-B	10/7/2002	484.42	15.92	468.50	9.48	6.44	474.94	L
9B-PZ-B	10/14/2002	484.42	15.95	468.47	9.55	6.40	474.87	L
9B-PZ-B	10/21/2002	484.42	15.95	468.47	9.55	6.40	474.87	L
9B-PZ-B	10/28/2002	484.42	15.92	468.50	9.75	6.17	474.67	L
9B-PZ-B	11/5/2002	484.42	15.95	468.47	9.80	6.15	474.62	L
9B-PZ-B	11/11/2002	484.42	15.93	468.49	9.90	6.03	474.52	L
9B-PZ-B	11/18/2002	484.42	15.92	468.50	9.60	6.32	474.82	L
9B-PZ-B	11/25/2002	484.42	15.95	468.47	9.20	6.75	475.22	L
9B-PZ-B	12/2/2002	484.42	15.93	468.49	9.40	6.53	475.02	L
9B-PZ-B	12/9/2002	484.42	15.92	468.50	9.52	6.40	474.90	L
9B-PZ-B	12/18/2002	484.42	15.92	468.50	9.62	6.30	474.80	L
9B-PZ-B	12/23/2002	484.42	15.93	468.49	9.50	6.43	474.92	L
9B-PZ-B	12/30/2002	484.42	15.95	468.47	9.40	6.55	475.02	L
9B-PZ-B	1/6/2003	484.42	15.95	468.47	8.80	7.15	475.62	L
9B-PZ-B	1/13/2003	484.42	15.95	468.47	8.80	7.15	475.62	L
9B-PZ-B	1/20/2003	484.42	15.92	468.50	8.60	7.32	475.82	L
9B-PZ-B	1/27/2003	484.42	15.95	468.47	8.60	7.35	475.82	L
9B-PZ-B	2/3/2003	484.42	15.92	468.50	8.90	7.02	475.52	L
9B-PZ-B	2/10/2003	484.42	15.92	468.50	9.25	6.67	475.17	L
9B-PZ-B	2/17/2003	484.42	15.94	468.48	9.35	6.59	475.07	L
9B-PZ-B	2/24/2003	484.42	15.94	468.48	8.94	7.00	475.48	L
9B-PZ-B	3/3/2003	484.42	15.95	468.47	9.17	6.78	475.25	L
9B-PZ-B	3/10/2003	484.42	15.97	468.45	9.30	6.67	475.12	L
9B-PZ-B	3/17/2003	484.42	15.95	468.47	8.86	7.09	475.56	L
9B-PZ-B	3/24/2003	484.42	15.97	468.45	8.80	7.17	475.62	L
9B-PZ-B	3/31/2003	484.42	15.97	468.45	8.90	7.07	475.52	L
9B-PZ-B	4/7/2003	484.42	15.95	468.47	8.80	7.15	475.62	L
9B-PZ-B	4/14/2003	484.42	15.95	468.47	9.00	6.95	475.42	L
9B-PZ-B	4/21/2003	484.42	15.97	468.45	9.10	6.87	475.32	L
9B-PZ-B	4/28/2003	484.42	15.97	468.45	9.30	6.67	475.12	L
9B-PZ-B	5/5/2003	484.42	15.95	468.47	9.30	6.65	475.12	L
9B-PZ-B	5/12/2003	484.42	15.97	468.45	9.45	6.52	474.97	L
9B-PZ-B	5/19/2003	484.42	15.97	468.45	9.20	6.77	475.22	L
9B-PZ-B	5/28/2003	484.42	15.25	469.17	8.98	6.27	475.44	L
9B-PZ-B	6/2/2003	484.42	15.97	468.45	9.05	6.92	475.37	L
9B-PZ-B	6/9/2003	484.42	15.12	469.30	9.50	5.62	474.92	L
9B-PZ-B	6/16/2003	484.42	15.40	469.02	9.98	5.42	474.44	L
9B-PZ-B	6/23/2003	484.42	15.11	469.31	10.12	4.99	474.30	L
9B-PZ-B	6/30/2003	484.42	15.25	469.17	10.30	4.95	474.12	L
9B-PZ-B	7/7/2003	484.42	15.12	469.30	10.47	4.65	473.95	L
9B-PZ-B	7/14/2003	484.42	15.11	469.31	10.70	4.41	473.72	L
9B-PZ-B	7/28/2003	484.42	15.12	469.30	10.85	4.27	473.57	L
9B-PZ-B	8/4/2003	484.42	15.12	469.30	10.96	4.16	473.46	L
9B-PZ-B	8/11/2003	484.42	15.22	469.20	10.90	4.32	473.52	L

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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
9B-PZ-B	8/18/2003	484.42	15.21	469.21	11.20	4.01	473.22	L
9B-PZ-B	8/25/2003	484.42	15.23	469.19	11.31	3.92	473.11	L
9B-PZ-B	9/2/2003	484.42	15.28	469.14	11.30	3.98	473.12	L
9B-PZ-B	9/8/2003	484.42	15.30	469.12	11.32	3.98	473.10	L
9B-PZ-B	9/15/2003	484.42	15.18	469.24	11.40	3.78	473.02	L
9B-PZ-B	9/22/2003	484.42	15.20	469.22	11.32	3.88	473.10	L
9B-PZ-B	9/29/2003	484.42	15.31	469.11	11.57	3.74	472.85	L
9B-PZ-B	10/6/2003	484.42	15.10	469.32	11.50	3.60	472.92	L
9B-PZ-B	10/13/2003	484.42	15.30	469.12	11.70	3.60	472.72	L
9B-PZ-B	10/20/2003	484.42	15.30	469.12	11.82	3.48	472.60	L
9B-PZ-B	10/27/2003	484.42	15.33	469.09	11.85	3.48	472.57	L
9B-PZ-B	11/3/2003	484.42	15.35	469.07	12.00	3.35	472.42	L
9B-PZ-B	11/10/2003	484.42	15.35	469.07	12.10	3.25	472.32	L
9B-PZ-B	11/17/2003	484.42	15.30	469.12	12.10	3.20	472.32	L
9B-PZ-B	11/24/2003	484.42	15.30	469.12	12.04	3.26	472.38	L
9B-PZ-B	12/1/2003	484.42	15.30	469.12	12.05	3.25	472.37	L
9B-PZ-B	12/8/2003	484.42	15.38	469.04	12.20	3.18	472.22	L
9B-PZ-B	12/15/2003	484.42	15.37	469.05	12.30	3.07	472.12	L
9B-PZ-B	12/22/2003	484.42	15.38	469.04	12.40	2.98	472.02	L
9B-PZ-B	12/29/2003	484.42	15.38	469.04	12.20	3.18	472.22	L
9B-PZ-B	1/6/2004	484.42	15.38	469.04	12.10	3.28	472.32	L
9B-PZ-B	1/12/2004	484.42	15.37	469.05	12.20	3.17	472.22	L
9B-PZ-B	1/19/2004	484.42	15.38	469.04	12.05	3.33	472.37	L
9B-PZ-B	1/26/2004	484.42	15.38	469.04	12.15	3.23	472.27	L
9B-PZ-B	2/2/2004	484.42	15.38	469.04	12.20	3.18	472.22	L
9B-PZ-B	2/9/2004	484.42	15.37	469.05	12.20	3.17	472.22	L
9B-PZ-B	2/16/2004	484.42	15.38	469.04	12.20	3.18	472.22	L
9B-PZ-B	2/23/2004	484.42	15.37	469.05	12.70	2.67	471.72	L
9B-PZ-B	3/1/2004	484.42	15.38	469.04	12.00	3.38	472.42	L
9B-PZ-B	3/8/2004	484.42	15.37	469.05	11.74	3.63	472.68	L
9B-PZ-B	3/15/2004	484.42	14.80	469.62	11.40	3.40	473.02	L
9B-PZ-B	3/22/2004	484.42	14.80	469.62	11.40	3.40	473.02	L
9B-PZ-B	3/29/2004	484.42	14.50	469.92	11.10	3.40	473.32	L
9B-PZ-B	4/5/2004	484.42	14.20	470.22	10.55	3.65	473.87	L
9B-PZ-B	4/12/2004	484.42	14.20	470.22	10.70	3.50	473.72	L
9B-PZ-B	4/19/2004	484.42	14.30	470.12	10.80	3.50	473.62	L
9B-PZ-B	4/26/2004	484.42	14.30	470.12	10.70	3.60	473.72	L
9B-PZ-B	5/3/2004	484.42	14.10	470.32	10.50	3.60	473.92	L
9B-PZ-B	5/12/2004	484.42	14.20	470.22	10.60	3.60	473.82	L
9B-PZ-B	5/17/2004	484.42	14.35	470.07	10.70	3.65	473.72	L
9B-PZ-B	5/24/2004	484.42	14.30	470.12	10.80	3.50	473.62	L
9B-PZ-B	6/2/2004	484.42	14.30	470.12	10.80	3.50	473.62	L
9B-PZ-B	6/7/2004	484.42	14.00	470.42	10.50	3.50	473.92	L
9B-PZ-B	6/14/2004	484.42	14.00	470.42	10.50	3.50	473.92	L
9B-PZ-B	6/21/2004	484.42	14.05	470.37	10.65	3.40	473.77	L
9B-PZ-B	6/28/2004	484.42	14.10	470.32	10.80	3.30	473.62	L
9B-PZ-B	7/6/2004	484.42	14.30	470.12	10.90	3.40	473.52	L
9B-PZ-B	7/12/2004	484.42	14.25	470.17	10.90	3.35	473.52	L
9B-PZ-B	7/19/2004	484.42	14.20	470.22	10.95	3.25	473.47	L
9B-PZ-B	7/26/2004	484.42	14.40	470.02	10.90	3.50	473.52	L
9B-PZ-B	8/2/2004	484.42	14.35	470.07	11.00	3.35	473.42	L
9B-PZ-B	8/9/2004	484.42	14.40	470.02	11.10	3.30	473.32	L
9B-PZ-B	8/16/2004	484.42	14.52	469.90	11.17	3.35	473.25	L
9B-PZ-B	8/23/2004	484.42	14.50	469.92	10.10	4.40	474.32	L
9B-PZ-B	8/30/2004	484.42	14.40	470.02	10.93	3.47	473.49	L
9B-PZ-B	9/7/2004	484.42	14.40	470.02	11.00	3.40	473.42	L
9B-PZ-B	9/13/2004	484.42	14.50	469.92	10.95	3.55	473.47	L
9B-PZ-B	9/20/2004	484.42	14.66	469.76	11.10	3.56	473.32	L
9B-PZ-B	9/27/2004	484.42	14.65	469.77	11.15	3.50	473.27	L
9B-PZ-B	10/4/2004	484.42	14.70	469.72	11.22	3.48	473.20	L
9B-PZ-B	10/11/2004	484.42	14.60	469.82	10.90	3.70	473.52	L
9B-PZ-B	10/21/2004	484.42	14.48	469.94	10.98	3.50	473.44	L
9B-PZ-B	10/25/2004	484.42	14.60	469.82	11.10	3.50	473.32	L

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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
9B-PZ-B	11/1/2004	484.42	14.85	469.57	11.60	3.25	472.82	L
9B-PZ-B	11/9/2004	484.42	14.30	470.12	11.10	3.20	473.32	L
9B-PZ-B	11/15/2004	484.42	14.40	470.02	11.20	3.20	473.22	L
9B-PZ-B	11/22/2004	484.42	14.30	470.12	11.20	3.10	473.22	L
9B-PZ-B	11/29/2004	484.42	14.35	470.07	11.30	3.05	473.12	L
9B-PZ-B	12/6/2004	484.42	14.51	469.91	11.44	3.07	472.98	L
9B-PZ-B	12/14/2004	484.42	14.42	470.00	11.43	2.99	472.99	L
9B-PZ-B	12/20/2004	484.42	12.70	471.72	11.85	0.85	472.57	L
9B-PZ-B	12/31/2004	484.42	11.95	472.47	11.12	0.83	473.30	L
9B-PZ-B	1/4/2005	484.42	11.85	472.57	11.00	0.85	473.42	L
9B-PZ-B	1/14/2005	484.42	5.60	478.82	4.15	1.45	480.27	L
9B-PZ-B	1/18/2005	484.42	7.60	476.82	6.20	1.40	478.22	L
9B-PZ-B	1/24/2005	484.42	5.80	478.62	4.28	1.52	480.14	L
9B-PZ-B	2/1/2005	484.42	5.60	478.82	4.10	1.50	480.32	L
9B-PZ-B	2/7/2005	484.42	5.70	478.72	4.30	1.40	480.12	L
9B-PZ-B	2/15/2005	484.42	6.40	478.02	4.95	1.45	479.47	L
9B-PZ-B	2/24/2005	484.42	7.05	477.37	5.25	1.80	479.17	L
9B-PZ-B	3/1/2005	484.42	6.20	478.22	4.78	1.42	479.64	L
9B-PZ-B	3/7/2005	484.42	5.43	478.99	4.15	1.28	480.27	L
9B-PZ-B	3/16/2005	484.42	5.00	479.42	3.70	1.30	480.72	L
9B-PZ-B	3/24/2005	484.42	5.05	479.37	3.80	1.25	480.62	L
9B-PZ-B	3/28/2005	484.42	5.02	479.40	3.85	1.17	480.57	L
9B-PZ-B	4/9/2005	484.42	5.05	479.37	3.90	1.15	480.52	L
9B-PZ-B	4/14/2005	484.42	5.83	478.59	4.50	1.33	479.92	L
9B-PZ-B	4/22/2005	484.42	6.52	477.90	5.20	1.32	479.22	L
9B-PZ-B	4/28/2005	484.42	6.66	477.76	5.36	1.30	479.06	L
9B-PZ-B	5/2/2005	484.42	6.80	477.62	5.55	1.25	478.87	L
9B-PZ-B	5/13/2005	484.42	7.42	477.00	6.35	1.07	478.07	L
9B-PZ-B	5/19/2005	484.42	8.43	475.99	6.86	1.57	477.56	L
9B-PZ-B	5/30/2005	484.42	8.48	475.94	7.28	1.20	477.14	L
9B-PZ-B	6/8/2005	484.42	8.82	475.60	7.67	1.15	476.75	L
9B-PZ-B	6/15/2005	484.42	9.30	475.12	7.91	1.39	476.51	L
9B-PZ-B	6/24/2005	484.42	9.15	475.27	8.26	0.89	476.16	L
9B-PZ-B	7/13/2005	484.42	9.82	474.60	8.61	1.21	475.81	L
9B-PZ-B	8/31/2005	484.42	9.89	474.53	8.81	1.08	475.61	L
9B-PZ-B	9/12/2005	484.42	10.00	474.42	8.98	1.02	475.44	L
9B-PZ-B	10/20/2005	484.42	10.05	474.37	9.06	0.99	475.36	L
9B-PZ-B	11/10/2005	484.42	9.98	474.44	9.08	0.90	475.34	L
9B-PZ-B	12/27/2005	484.42	9.62	474.80	9.54	0.08	474.88	L
9B-PZ-B	1/18/2006	484.42	7.45	476.97	6.64	0.81	477.78	L
9B-PZ-B	2/14/2006	484.42	7.56	476.86	6.60	0.96	477.82	L
9B-PZ-B	3/3/2006	484.42	7.48	476.94	6.80	0.68	477.62	L
9B-PZ-B	4/18/2006	484.42	7.03	477.39	6.20	0.83	478.22	L
9B-PZ-B	6/26/2006	484.42	7.49	476.93	6.71	0.78	477.71	L
9B-PZ-B	9/20/2006	484.42	9.11	475.31	8.62	0.49	475.80	L
9B-PZ-B	12/11/2006	484.42	9.83	474.59	9.83	0.00	474.59	L
9B-PZ-B	3/14/2007	484.42	11.08	473.34	11.04	0.04	473.38	L
9B-PZ-B	6/28/2007	484.42	12.20	472.22	11.15	1.05	473.27	L
9B-PZ-B	9/20/2007	484.42	12.60	471.82	11.35	1.25	473.07	L
9B-PZ-B	12/27/2007	484.42	13.40	471.02	ND	ND	ND	L
9B-PZ-B	3/25/2008	484.42	8.20	476.22	6.00	2.20	478.42	L
9B-PZ-B	6/30/2008	484.42	6.53	477.89	6.34	0.19	478.08	L
9B-PZ-B	9/10/2008	484.42	10.10	474.32	10.05	0.05	474.37	L
9B-PZ-B	12/16/2008	484.42	9.97	474.45	9.83	0.14	474.59	L
9B-PZ-B	3/31/2009	484.42	9.45	474.97	9.30	0.15	475.12	L
9B-PZ-B	1/14/2010	484.42	12.89	471.53	11.93	0.96	472.49	L
9B-PZ-B	3/31/2010	484.42	11.29	473.13	10.34	0.95	474.08	L
9B-PZ-B	2/1/2011	484.42	2.90	481.52	2.60	0.30	481.82	L
9B-PZ-B	6/27/2011	484.42	2.89	481.53	2.58	0.31	481.84	L
9B-PZ-B	12/28/2011	484.42	5.98	478.44	5.34	0.64	479.08	L
9B-PZ-C	6/9/2003	488.80	14.00	474.80	13.80	0.20	475.00	L
9B-PZ-C	6/16/2003	488.80	13.21	475.59	13.11	0.10	475.69	L
9B-PZ-C	6/23/2003	488.80	14.65	474.15	14.42	0.23	474.38	L

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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
9B-PZ-C	6/30/2003	488.80	13.90	474.90	13.80	0.10	475.00	L
9B-PZ-C	7/7/2003	488.80	14.12	474.68	14.00	0.12	474.80	L
9B-PZ-C	7/14/2003	488.80	14.45	474.35	14.30	0.15	474.50	L
9B-PZ-C	7/21/2003	488.80	14.22	474.58	14.10	0.12	474.70	L
9B-PZ-C	7/28/2003	488.80	13.70	475.10	13.60	0.10	475.20	L
9B-PZ-C	8/4/2003	488.80	14.97	473.83	14.85	0.12	473.95	L
9B-PZ-C	8/11/2003	488.80	15.40	473.40	15.20	0.20	473.60	L
9B-PZ-C	8/18/2003	488.80	15.43	473.37	15.30	0.13	473.50	L
9B-PZ-C	8/25/2003	488.80	15.60	473.20	15.46	0.14	473.34	L
9B-PZ-C	9/2/2003	488.80	15.45	473.35	15.30	0.15	473.50	L
9B-PZ-C	9/8/2003	488.80	15.80	473.00	15.65	0.15	473.15	L
9B-PZ-C	9/15/2003	488.80	15.90	472.90	15.75	0.15	473.05	L
9B-PZ-C	9/22/2003	488.80	15.90	472.90	15.75	0.15	473.05	L
9B-PZ-C	9/29/2003	488.80	15.92	472.88	15.83	0.09	472.97	L
9B-PZ-C	10/6/2003	488.80	16.00	472.80	15.80	0.20	473.00	L
9B-PZ-C	10/13/2003	488.80	16.10	472.70	15.90	0.20	472.90	L
9B-PZ-C	10/20/2003	488.80	15.98	472.82	15.80	0.18	473.00	L
9B-PZ-C	10/27/2003	488.80	16.02	472.78	15.80	0.22	473.00	L
9B-PZ-C	11/3/2003	488.80	16.10	472.70	15.90	0.20	472.90	L
9B-PZ-C	11/10/2003	488.80	15.90	472.90	15.60	0.30	473.20	L
9B-PZ-C	11/17/2003	488.80	16.30	472.50	16.00	0.30	472.80	L
9B-PZ-C	11/24/2003	488.80	16.25	472.55	16.00	0.25	472.80	L
9B-PZ-C	12/1/2003	488.80	16.20	472.60	15.95	0.25	472.85	L
9B-PZ-C	12/8/2003	488.80	16.15	472.65	15.92	0.23	472.88	L
9B-PZ-C	12/15/2003	488.80	16.25	472.55	16.00	0.25	472.80	L
9B-PZ-C	12/22/2003	488.80	16.20	472.60	16.00	0.20	472.80	L
9B-PZ-C	12/29/2003	488.80	16.05	472.75	15.76	0.29	473.04	L
9B-PZ-C	1/6/2004	488.80	16.10	472.70	15.90	0.20	472.90	L
9B-PZ-C	1/12/2004	488.80	16.10	472.70	15.80	0.30	473.00	L
9B-PZ-C	1/19/2004	488.80	16.05	472.75	15.75	0.30	473.05	L
9B-PZ-C	1/26/2004	488.80	16.00	472.80	15.55	0.45	473.25	L
9B-PZ-C	2/2/2004	488.80	16.15	472.65	15.70	0.45	473.10	L
9B-PZ-C	2/9/2004	488.80	16.00	472.80	15.60	0.40	473.20	L
9B-PZ-C	2/16/2004	488.80	16.20	472.60	15.80	0.40	473.00	L
9B-PZ-C	2/23/2004	488.80	16.20	472.60	15.85	0.35	472.95	L
9B-PZ-C	3/1/2004	488.80	15.70	473.10	15.20	0.50	473.60	L
9B-PZ-C	3/8/2004	488.80	15.50	473.30	15.10	0.40	473.70	L
9B-PZ-C	3/15/2004	488.80	16.10	472.70	15.80	0.30	473.00	L
9B-PZ-C	3/22/2004	488.80	15.45	473.35	14.90	0.55	473.90	L
9B-PZ-C	3/29/2004	488.80	15.70	473.10	15.50	0.20	473.30	L
9B-PZ-C	4/5/2004	488.80	15.70	473.10	15.20	0.50	473.60	L
9B-PZ-C	4/12/2004	488.80	16.10	472.70	15.50	0.60	473.30	L
9B-PZ-C	4/19/2004	488.80	16.10	472.70	15.50	0.60	473.30	L
9B-PZ-C	4/26/2004	488.80	15.95	472.85	15.40	0.55	473.40	L
9B-PZ-C	5/3/2004	488.80	16.20	472.60	15.50	0.70	473.30	L
9B-PZ-C	5/12/2004	488.80	16.30	472.50	15.60	0.70	473.20	L
9B-PZ-C	5/17/2004	488.80	16.10	472.70	15.40	0.70	473.40	L
9B-PZ-C	5/24/2004	488.80	16.20	472.60	15.60	0.60	473.20	L
9B-PZ-C	6/2/2004	488.80	16.20	472.60	15.60	0.60	473.20	L
9B-PZ-C	6/7/2004	488.80	15.95	472.85	15.40	0.55	473.40	L
9B-PZ-C	6/14/2004	488.80	15.90	472.90	15.30	0.60	473.50	L
9B-PZ-C	6/21/2004	488.80	15.90	472.90	15.50	0.40	473.30	L
9B-PZ-C	6/28/2004	488.80	15.90	472.90	15.50	0.40	473.30	L
9B-PZ-C	7/6/2004	488.80	15.60	473.20	15.30	0.30	473.50	L
9B-PZ-C	7/12/2004	488.80	15.83	472.97	15.32	0.51	473.48	L
9B-PZ-C	7/19/2004	488.80	15.90	472.90	15.50	0.40	473.30	L
9B-PZ-C	7/26/2004	488.80	16.00	472.80	15.60	0.40	473.20	L
9B-PZ-C	8/2/2004	488.80	16.00	472.80	15.55	0.45	473.25	L
9B-PZ-C	8/9/2004	488.80	16.00	472.80	15.62	0.38	473.18	L
9B-PZ-C	8/16/2004	488.80	16.00	472.80	15.50	0.50	473.30	L
9B-PZ-C	8/23/2004	488.80	16.02	472.78	15.55	0.47	473.25	L
9B-PZ-C	8/30/2004	488.80	16.50	472.30	15.80	0.70	473.00	L
9B-PZ-C	9/7/2004	488.80	16.10	472.70	15.55	0.55	473.25	L

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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
9B-PZ-C	9/13/2004	488.80	16.10	472.70	15.50	0.60	473.30	L
9B-PZ-C	9/20/2004	488.80	16.20	472.60	15.66	0.54	473.14	L
9B-PZ-C	9/27/2004	488.80	16.15	472.65	15.60	0.55	473.20	L
9B-PZ-C	10/4/2004	488.80	16.11	472.69	15.55	0.56	473.25	L
9B-PZ-C	10/11/2004	488.80	16.20	472.60	15.60	0.60	473.20	L
9B-PZ-C	10/21/2004	488.80	16.12	472.68	15.55	0.57	473.25	L
9B-PZ-C	10/25/2004	488.80	15.98	472.82	15.40	0.58	473.40	L
9B-PZ-C	11/1/2004	488.80	16.20	472.60	15.60	0.60	473.20	L
9B-PZ-C	11/9/2004	488.80	16.25	472.55	15.65	0.60	473.15	L
9B-PZ-C	11/15/2004	488.80	15.05	473.75	14.22	0.83	474.58	L
9B-PZ-C	11/22/2004	488.80	15.34	473.46	14.55	0.79	474.25	L
9B-PZ-C	11/29/2004	488.80	16.10	472.70	15.54	0.56	473.26	L
9B-PZ-C	12/6/2004	488.80	16.30	472.50	15.61	0.69	473.19	L
9B-PZ-C	12/14/2004	488.80	16.30	472.50	15.70	0.60	473.10	L
9B-PZ-C	12/20/2004	488.80	16.35	472.45	15.65	0.70	473.15	L
9B-PZ-C	12/31/2004	488.80	16.20	472.60	15.40	0.80	473.40	L
9B-PZ-C	1/4/2005	488.80	15.10	473.70	14.10	1.00	474.70	L
9B-PZ-C	1/14/2005	488.80	9.70	479.10	8.76	0.94	480.04	L
9B-PZ-C	1/18/2005	488.80	9.30	479.50	8.35	0.95	480.45	L
9B-PZ-C	1/24/2005	488.80	9.35	479.45	8.37	0.98	480.43	L
9B-PZ-C	2/1/2005	488.80	10.45	478.35	9.40	1.05	479.40	L
9B-PZ-C	2/7/2005	488.80	10.90	477.90	10.00	0.90	478.80	L
9B-PZ-C	2/15/2005	488.80	11.10	477.70	10.20	0.90	478.60	L
9B-PZ-C	2/24/2005	488.80	10.82	477.98	9.87	0.95	478.93	L
9B-PZ-C	3/1/2005	488.80	10.33	478.47	9.50	0.83	479.30	L
9B-PZ-C	3/7/2005	488.80	10.18	478.62	9.35	0.83	479.45	L
9B-PZ-C	3/16/2005	488.80	10.56	478.24	9.30	1.26	479.50	L
9B-PZ-C	3/24/2005	488.80	9.50	479.30	8.71	0.79	480.09	L
9B-PZ-C	3/28/2005	488.80	10.10	478.70	9.32	0.78	479.48	L
9B-PZ-C	4/9/2005	488.80	11.40	477.40	10.58	0.82	478.22	L
9B-PZ-C	4/14/2005	488.80	11.70	477.10	10.95	0.75	477.85	L
9B-PZ-C	4/22/2005	488.80	12.60	476.20	11.60	1.00	477.20	L
9B-PZ-C	4/28/2005	488.80	12.42	476.38	12.10	0.32	476.70	L
9B-PZ-C	5/2/2005	488.80	13.24	475.56	12.45	0.79	476.35	L
9B-PZ-C	5/13/2005	488.80	12.04	476.76	11.35	0.69	477.45	L
9B-PZ-C	5/19/2005	488.80	13.90	474.90	13.05	0.85	475.75	L
9B-PZ-C	5/30/2005	488.80	14.41	474.39	13.60	0.81	475.20	L
9B-PZ-C	6/8/2005	488.80	14.64	474.16	13.91	0.73	474.89	L
9B-PZ-C	6/15/2005	488.80	15.05	473.75	14.32	0.73	474.48	L
9B-PZ-C	6/24/2005	488.80	15.25	473.55	14.52	0.73	474.28	L
9B-PZ-C	7/13/2005	488.80	14.30	474.50	13.92	0.38	474.88	L
9B-PZ-C	8/31/2005	488.80	15.92	472.88	15.35	0.57	473.45	L
9B-PZ-C	9/12/2005	488.80	14.98	473.82	14.52	0.46	474.28	L
9B-PZ-C	10/20/2005	488.80	15.79	473.01	15.65	0.14	473.15	L
9B-PZ-C	11/10/2005	488.80	16.58	472.22	15.90	0.68	472.90	L
9B-PZ-C	12/27/2005	488.80	16.05	472.75	15.80	0.25	473.00	L
9B-PZ-C	1/18/2006	488.80	12.80	476.00	7.45	5.35	481.35	L
9B-PZ-C	2/14/2006	488.80	13.70	475.10	7.56	6.14	481.24	L
9B-PZ-C	3/3/2006	488.80	13.88	474.92	7.48	6.40	481.32	L
9B-PZ-C	4/18/2006	488.80	9.59	479.21	9.00	0.59	479.80	L
9B-PZ-C	6/26/2006	488.80	11.87	476.93	11.29	0.58	477.51	L
9B-PZ-C	9/20/2006	488.80	13.80	475.00	13.02	0.78	475.78	L
9B-PZ-C	12/11/2006	488.80	13.80	475.00	13.31	0.49	475.49	L
9B-PZ-C	3/14/2007	488.80	14.50	474.30	13.50	1.00	475.30	L
9B-PZ-C	6/28/2007	488.80	15.40	473.40	14.67	0.73	474.13	L
9B-PZ-C	9/20/2007	488.80	15.68	473.12	15.12	0.56	473.68	L
9B-PZ-C	12/27/2007	488.80	15.65	473.15	11.00	4.65	477.80	L
9B-PZ-C	3/25/2008	488.80	11.10	477.70	ND	ND	ND	L
9B-PZ-C	6/30/2008	488.80	10.92	477.88	10.87	0.05	477.93	L
9B-PZ-C	9/10/2008	488.80	9.08	479.72	8.92	0.16	479.88	L
9B-PZ-C	12/16/2008	488.80	11.58	477.22	11.50	0.08	477.30	L
9B-PZ-C	3/31/2009	488.80	11.01	477.79	10.95	0.06	477.85	L
9B-PZ-C	1/14/2010	488.80	14.78	474.02	14.70	0.08	474.10	L

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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
9B-PZ-C	3/31/2010	488.80	14.70	474.10	14.52	0.18	474.28	L
9B-PZ-C	2/1/2011	488.80	3.81	484.99	2.64	1.17	486.16	L
9B-PZ-C	6/27/2011	488.80	3.79	485.01	2.61	1.18	486.19	L
9B-PZ-C	12/28/2011	488.80	3.46	485.34	3.45	0.01	485.35	L
RG-3B	7/24/2002	468.35	9.22	459.13	9.21	0.01	459.14	L
RG-3B	8/22/2002	468.35	9.00	459.35	8.96	0.04	459.39	L
RG-3B	9/20/2002	468.35	9.12	459.23	9.10	0.02	459.25	L
RG-3B	10/16/2002	468.35	9.15	459.20	9.11	0.04	459.24	L
RG-3B	11/27/2002	468.35	9.06	459.29	9.00	0.06	459.35	L
RG-3B	12/6/2002	468.35	9.21	459.14	9.16	0.05	459.19	L
RG-3B	1/21/2003	468.35	8.18	460.17	8.15	0.03	460.20	L
RG-3B	2/24/2003	468.35	8.77	459.58	8.75	0.02	459.60	L
RG-3B	3/13/2003	468.35	8.57	459.78	8.55	0.02	459.80	L
RG-3B	4/30/2003	468.35	9.30	459.05	9.28	0.02	459.07	L
RG-3B	6/26/2003	468.35	9.37	458.98	9.35	0.02	459.00	L
RG-3B	7/31/2003	468.35	10.83	457.52	10.79	0.04	457.56	L
RG-3B	8/29/2003	468.35	10.11	458.24	10.09	0.02	458.26	L
RG-3B	9/26/2003	468.35	10.38	457.97	10.37	0.01	457.98	L
RG-3B	11/19/2003	468.35	10.70	457.65	10.65	0.05	457.70	L
RG-3B	12/30/2003	468.35	10.36	457.99	10.34	0.02	458.01	L
RG-3B	1/31/2011	468.35	5.40	462.95	5.20	0.20	463.15	L
RG-3B	6/27/2011	468.35	5.29	463.06	5.08	0.21	463.27	L
RG-3B	12/28/2011	468.35	9.04	459.31	7.87	1.17	460.48	L
RGPZ-5B	6/30/2008	514.08	21.95	492.13	21.95	0.00	492.13	L
RGPZ-5B	9/24/2008	514.08	22.37	491.71	22.35	0.02	491.73	L
RGPZ-5B	12/22/2008	514.08	22.70	491.38	22.67	0.03	491.41	L
RGPZ-5B	3/30/2009	514.08	22.42	491.66	22.40	0.02	491.68	L
RGPZ-5B	1/14/2010	514.08	31.50	482.58	25.05	6.45	489.03	L
RGPZ-5B	3/31/2010	514.08	30.17	483.91	24.65	4.89	489.43	L
RGPZ-5B	1/31/2011	514.08	31.15	482.93	16.10	15.05	497.98	L
RGPZ-5B	6/27/2011	514.08	30.22	483.86	16.03	14.19	498.05	L
RGPZ-5B	12/28/2011	514.08	33.98	480.10	21.30	12.68	492.78	L
RIMW-3	9/25/2008	482.50	17.19	465.31	17.10	0.09	465.40	L
RIMW-3	12/22/2008	482.50	17.07	465.43	16.89	0.18	465.61	L
RIMW-3	3/30/2009	482.50	17.59	464.91	17.50	0.09	465.00	L
RIMW-3	1/14/2010	482.50	21.80	460.70	18.20	3.60	464.30	L
RIMW-3	3/31/2010	482.50	20.67	461.83	17.33	3.34	465.17	L
RIMW-3	1/31/2011	482.50	6.30	476.20	5.80	0.50	476.70	L
RIMW-3	6/27/2011	482.50	12.60	469.90	11.90	0.70	470.60	L
RIMW-3	12/28/2011	482.50	15.94	466.56	14.62	1.32	467.88	L
RIPZ-8	6/30/2008	531.35	24.77	506.58	23.51	1.26	507.84	L
RIPZ-8	9/25/2008	531.35	22.04	509.31	21.85	0.19	509.50	L
RIPZ-8	12/17/2008	531.35	22.48	508.87	22.10	0.38	509.25	L
RIPZ-8	3/31/2009	531.35	22.15	509.20	22.00	0.15	509.35	L
RIPZ-8	1/14/2010	531.35	30.15	501.20	23.40	6.75	507.95	L
RIPZ-8	3/31/2010	531.35	30.00	501.35	23.08	6.92	508.27	L
RIPZ-8	2/1/2011	531.35	15.30	516.05	ND	ND	ND	L
RIPZ-8	6/27/2011	531.35	13.29	518.06	ND	ND	ND	L
RIPZ-8	12/28/2011	531.35	20.67	510.68	19.60	1.07	511.75	L
RIPZ-13	9/14/2007	595.48	80.52	514.96	74.21	6.31	521.27	L
RIPZ-13	9/17/2007	595.48	80.60	514.88	74.17	6.43	521.31	L
RIPZ-13	9/18/2007	595.48	80.82	514.66	74.09	6.73	521.39	L
RIPZ-13	9/19/2007	595.48	80.90	514.58	73.97	6.93	521.51	L
RIPZ-13	9/20/2007	595.48	80.75	514.73	73.87	6.88	521.61	L
RIPZ-13	9/27/2007	595.48	80.92	514.56	73.94	6.98	521.54	L
RIPZ-13	10/4/2007	595.48	80.81	514.67	74.00	6.81	521.48	L
RIPZ-13	10/11/2007	595.48	80.98	514.50	74.07	6.91	521.41	L
RIPZ-13	10/18/2007	595.48	81.10	514.38	74.23	6.87	521.25	L
RIPZ-13	11/15/2007	595.48	80.90	514.58	74.65	6.25	520.83	L
RIPZ-13	12/13/2007	595.48	81.54	513.94	74.98	6.56	520.50	L
RIPZ-13	1/17/2008	595.48	81.10	514.38	75.30	5.80	520.18	L
RIPZ-13	2/13/2008	595.48	81.42	514.06	75.38	6.04	520.10	L
RIPZ-13	3/13/2008	595.48	82.25	513.23	75.62	6.63	519.86	L

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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
RIPZ-13	4/17/2008	595.48	81.14	514.34	75.42	5.72	520.06	L
RIPZ-13	5/22/2008	595.48	81.17	514.31	75.50	5.67	519.98	L
RIPZ-13	6/19/2008	595.48	81.26	514.22	75.60	5.66	519.88	L
RIPZ-13	7/17/2008	595.48	81.30	514.18	75.61	5.69	519.87	L
RIPZ-13	8/20/2008	595.48	81.38	514.10	75.44	5.94	520.04	L
RIPZ-13	9/17/2008	595.48	81.28	514.20	75.52	5.76	519.96	L
RIPZ-13	12/6/2008	595.48	81.26	514.22	75.70	5.56	519.78	L
RIPZ-13	3/23/2009	595.48	81.50	513.98	76.29	5.21	519.19	L
RIPZ-13	3/24/2009	595.48	81.50	513.98	76.29	5.21	519.19	L
RIPZ-13	3/25/2009	595.48	81.55	513.93	76.34	5.21	519.14	L
RIPZ-13	3/26/2009	595.48	81.74	513.74	76.25	5.49	519.23	L
RIPZ-13	3/27/2009	595.48	81.78	513.70	76.34	5.44	519.14	L
RIPZ-13	3/30/2009	595.48	81.73	513.75	76.38	5.35	519.10	L
RIPZ-13	3/31/2009	595.48	81.41	514.07	76.40	5.01	519.08	L
RIPZ-13	4/1/2009	595.48	82.18	513.30	76.32	5.86	519.16	L
RIPZ-13	4/2/2009	595.48	82.09	513.39	76.36	5.73	519.12	L
RIPZ-13	4/3/2009	595.48	82.52	512.96	76.35	6.17	519.13	L
RIPZ-13	4/6/2009	595.48	82.30	513.18	76.39	5.91	519.09	L
RIPZ-13	4/7/2009	595.48	81.54	513.94	76.37	5.17	519.11	L
RIPZ-13	4/8/2009	595.48	81.46	514.02	76.46	5.00	519.02	L
RIPZ-13	4/9/2009	595.48	81.43	514.05	76.42	5.01	519.06	L
RIPZ-13	4/10/2009	595.48	81.57	513.91	76.30	5.27	519.18	L
RIPZ-13	4/13/2009	595.48	81.51	513.97	76.40	5.11	519.08	L
RIPZ-13	4/14/2009	595.48	81.48	514.00	76.38	5.10	519.10	L
RIPZ-13	4/15/2009	595.48	81.31	514.17	76.52	4.79	518.96	L
RIPZ-13	4/16/2009	595.48	81.30	514.18	76.58	4.72	518.90	L
RIPZ-13	4/20/2009	595.48	81.53	513.95	76.44	5.09	519.04	L
RIPZ-13	4/27/2009	595.48	81.52	513.96	76.45	5.07	519.03	L
RIPZ-13	5/4/2009	595.48	81.38	514.10	76.49	4.89	518.99	L
RIPZ-13	5/11/2009	595.48	81.49	513.99	76.56	4.93	518.92	L
RIPZ-13	5/18/2009	595.48	81.48	514.00	76.63	4.85	518.85	L
RIPZ-13	6/1/2009	595.48	81.46	514.02	76.66	4.80	518.82	L
RIPZ-13	6/22/2009	595.48	82.49	512.99	77.61	4.88	517.87	L
RIPZ-13	9/22/2009	595.48	81.38	514.10	77.29	4.09	518.19	L
RIPZ-13	12/21/2009	595.48	81.38	514.10	77.61	3.77	517.87	L
RIPZ-13	3/9/2010	595.48	81.36	514.12	77.77	3.59	517.71	L
RIPZ-13	12/16/2010	595.48	81.25	514.23	76.25	5.00	519.23	L
RIPZ-13	6/27/2011	595.48	81.30	514.18	75.44	5.86	520.04	L
RIPZ-13	10/31/2011	595.48	80.55	514.93	71.26	9.29	524.22	L
RIPZ-13	12/28/2011	595.48	80.66	514.82	71.70	8.96	523.78	L
RIPZ-14	6/30/2008	708.66	133.60	575.06	133.60	0.00	575.06	L
RIPZ-14	9/10/2008	708.66	128.69	579.97	128.50	0.19	580.16	L
RIPZ-14	12/16/2008	708.66	129.31	579.35	128.98	0.33	579.68	L
RIPZ-14	3/31/2009	708.66	130.42	578.24	130.18	0.24	578.48	L
RIPZ-14	1/14/2010	708.66	130.95	577.71	126.97	3.98	581.69	L
RIPZ-14	3/14/2010	708.66	134.90	573.76	130.95	3.95	577.71	L
RIPZ-14	2/1/2011	708.66	132.00	576.66	128.42	3.58	580.24	L
RIPZ-14	6/27/2011	708.66	128.86	579.80	125.10	3.76	583.56	L
RIPZ-14	10/31/2011	708.66	121.63	587.03	117.48	4.15	591.18	L
RIPZ-14	12/28/2011	708.66	125.69	582.97	120.59	5.10	588.07	L
RIPZ-23	12/5/2004	560.38	40.50	519.88	40.46	0.04	519.92	L
RIPZ-23	12/6/2004	560.38	41.50	518.88	40.96	0.54	519.42	L
RIPZ-23	12/7/2004	560.38	41.75	518.63	40.96	0.79	519.42	L
RIPZ-23	12/8/2004	560.38	42.05	518.33	41.08	0.97	519.30	L
RIPZ-23	12/9/2004	560.38	42.20	518.18	41.18	1.02	519.20	L
RIPZ-23	12/10/2004	560.38	42.42	517.96	41.00	1.42	519.38	L
RIPZ-23	12/14/2004	560.38	43.35	517.03	41.00	2.35	519.38	L
RIPZ-23	12/20/2004	560.38	44.40	515.98	40.20	4.20	520.18	L
RIPZ-23	12/22/2004	560.38	47.20	513.18	40.45	6.75	519.93	L
RIPZ-23	12/31/2004	560.38	47.20	513.18	40.45	6.75	519.93	L
RIPZ-23	1/4/2005	560.38	47.75	512.63	40.40	7.35	519.98	L
RIPZ-23	1/13/2005	560.38	50.07	510.31	40.67	9.40	519.71	L
RIPZ-23	1/19/2005	560.38	49.97	510.41	40.56	9.41	519.82	L

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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
RIPZ-23	1/24/2005	560.38	49.78	510.60	40.39	9.39	519.99	L
RIPZ-23	2/1/2005	560.38	49.88	510.50	40.26	9.62	520.12	L
RIPZ-23	2/7/2005	560.38	49.98	510.40	40.33	9.65	520.05	L
RIPZ-23	2/15/2005	560.38	49.90	510.48	40.30	9.60	520.08	L
RIPZ-23	2/24/2005	560.38	49.50	510.88	40.30	9.20	520.08	L
RIPZ-23	3/1/2005	560.38	49.70	510.68	40.30	9.40	520.08	L
RIPZ-23	3/7/2005	560.38	49.86	510.52	40.21	9.65	520.17	L
RIPZ-23	3/16/2005	560.38	49.88	510.50	40.10	9.78	520.28	L
RIPZ-23	3/24/2005	560.38	50.00	510.38	39.92	10.08	520.46	L
RIPZ-23	3/28/2005	560.38	49.74	510.64	39.82	9.92	520.56	L
RIPZ-23	4/9/2005	560.38	49.74	510.64	39.58	10.16	520.80	L
RIPZ-23	4/14/2005	560.38	49.98	510.40	39.50	10.48	520.88	L
RIPZ-23	4/22/2005	560.38	50.10	510.28	39.25	10.85	521.13	L
RIPZ-23	4/28/2005	560.38	50.10	510.28	39.09	11.01	521.29	L
RIPZ-23	5/2/2005	560.38	50.10	510.28	39.00	11.10	521.38	L
RIPZ-23	5/10/2005	560.38	50.30	510.08	38.65	11.65	521.73	L
RIPZ-23	5/13/2005	560.38	50.15	510.23	38.80	11.35	521.58	L
RIPZ-23	5/19/2005	560.38	50.05	510.33	38.42	11.63	521.96	L
RIPZ-23	5/30/2005	560.38	50.20	510.18	38.11	12.09	522.27	L
RIPZ-23	6/8/2005	560.38	50.00	510.38	37.90	12.10	522.48	L
RIPZ-23	6/15/2005	560.38	49.99	510.39	37.61	12.38	522.77	L
RIPZ-23	6/24/2005	560.38	50.09	510.29	37.45	12.64	522.93	L
RIPZ-23	7/13/2005	560.38	51.17	509.21	37.13	14.04	523.25	L
RIPZ-23	8/31/2005	560.38	51.26	509.12	36.25	15.01	524.13	L
RIPZ-23	9/12/2005	560.38	50.97	509.41	36.38	14.59	524.00	L
RIPZ-23	10/20/2005	560.38	51.65	508.73	36.17	15.48	524.21	L
RIPZ-23	11/10/2005	560.38	50.39	509.99	36.36	14.03	524.02	L
RIPZ-23	12/27/2005	560.38	50.99	509.39	36.68	14.31	523.70	L
RIPZ-23	1/18/2006	560.38	38.95	521.43	37.32	1.63	523.06	L
RIPZ-23	2/14/2006	560.38	39.98	520.40	37.28	2.70	523.10	L
RIPZ-23	3/27/2006	560.38	41.72	518.66	37.52	4.20	522.86	L
RIPZ-23	4/18/2006	560.38	42.53	517.85	37.50	5.03	522.88	L
RIPZ-23	6/26/2006	560.38	44.90	515.48	37.34	7.56	523.04	L
RIPZ-23	9/20/2006	560.38	45.94	514.44	37.06	8.88	523.32	L
RIPZ-23	12/11/2006	560.38	49.35	511.03	38.05	11.30	522.33	L
RIPZ-23	2/9/2007	560.38	50.20	510.18	38.45	11.75	521.93	L
RIPZ-23	6/28/2007	560.38	50.38	510.00	39.55	10.83	520.83	L
RIPZ-23	9/20/2007	560.38	50.65	509.73	39.75	10.90	520.63	L
RIPZ-23	12/27/2007	560.38	46.68	513.70	41.05	5.63	519.33	L
RIPZ-23	3/25/2008	560.38	45.11	515.27	41.00	4.11	519.38	L
RIPZ-23	6/30/2008	560.38	42.05	518.33	41.63	0.42	518.75	L
RIPZ-23	9/10/2008	560.38	42.10	518.28	41.68	0.42	518.70	L
RIPZ-23	12/16/2008	560.38	42.21	518.17	41.14	1.07	519.24	L
RIPZ-23	3/31/2009	560.38	42.53	517.85	42.10	0.43	518.28	L
RIPZ-23	1/14/2010	560.38	50.13	510.25	48.40	1.73	511.98	L
RIPZ-23	3/31/2010	560.38	51.69	508.69	43.77	7.92	516.61	L
RIPZ-23	2/1/2011	560.38	51.88	508.50	42.55	9.33	517.83	L
RIPZ-23	6/27/2011	560.38	49.90	510.48	38.11	11.79	522.27	L
RIPZ-23	12/28/2011	560.38	51.50	508.88	37.30	14.20	523.08	L
RIPZ-24	1/4/2005	557.24	39.30	517.94	39.25	0.05	517.99	L
RIPZ-24	1/13/2005	557.24	39.70	517.54	39.40	0.30	517.84	L
RIPZ-24	1/19/2005	557.24	39.68	517.56	39.40	0.28	517.84	L
RIPZ-24	1/24/2005	557.24	39.15	518.09	38.88	0.27	518.36	L
RIPZ-24	2/1/2005	557.24	39.15	518.09	38.88	0.27	518.36	L
RIPZ-24	2/7/2005	557.24	39.14	518.10	39.12	0.02	518.12	L
RIPZ-24	2/15/2005	557.24	39.20	518.04	39.03	0.17	518.21	L
RIPZ-24	2/24/2005	557.24	39.40	517.84	38.93	0.47	518.31	L
RIPZ-24	3/1/2005	557.24	39.55	517.69	38.90	0.65	518.34	L
RIPZ-24	3/7/2005	557.24	39.50	517.74	38.84	0.66	518.40	L
RIPZ-24	3/16/2005	557.24	39.20	518.04	38.74	0.46	518.50	L
RIPZ-24	3/24/2005	557.24	39.08	518.16	38.66	0.42	518.58	L
RIPZ-24	3/28/2005	557.24	38.85	518.39	38.54	0.31	518.70	L
RIPZ-24	4/9/2005	557.24	38.73	518.51	38.32	0.41	518.92	L

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Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
RIPZ-24	4/14/2005	557.24	38.70	518.54	38.25	0.45	518.99	L
RIPZ-24	4/22/2005	557.24	38.31	518.93	37.05	1.26	520.19	L
RIPZ-24	4/28/2005	557.24	38.34	518.90	37.73	0.61	519.51	L
RIPZ-24	5/2/2005	557.24	38.15	519.09	37.63	0.52	519.61	L
RIPZ-24	5/10/2005	557.24	37.72	519.52	37.32	0.40	519.92	L
RIPZ-24	5/13/2005	557.24	37.90	519.34	37.23	0.67	520.01	L
RIPZ-24	5/19/2005	557.24	37.75	519.49	37.23	0.52	520.01	L
RIPZ-24	5/30/2005	557.24	37.16	520.08	36.89	0.27	520.35	L
RIPZ-24	6/8/2005	557.24	36.75	520.49	36.58	0.17	520.66	L
RIPZ-24	6/15/2005	557.24	36.75	520.49	36.40	0.35	520.84	L
RIPZ-24	6/24/2005	557.24	36.62	520.62	36.22	0.40	521.02	L
RIPZ-24	7/13/2005	557.24	35.57	521.67	35.56	0.01	521.68	L
RIPZ-24	8/31/2005	557.24	35.60	521.64	35.45	0.15	521.79	L
RIPZ-24	9/12/2005	557.24	35.41	521.83	35.36	0.05	521.88	L
RIPZ-24	10/20/2005	557.24	35.35	521.89	ND	ND	ND	L
RIPZ-24	11/10/2005	557.24	35.39	521.85	ND	ND	ND	L
RIPZ-24	12/27/2005	557.24	36.20	521.04	ND	ND	ND	L
RIPZ-24	1/18/2006	557.24	35.78	521.46	35.70	0.08	521.54	L
RIPZ-24	2/14/2006	557.24	35.92	521.32	35.80	0.12	521.44	L
RIPZ-24	3/27/2006	557.24	36.20	521.04	36.20	NA	521.04	L
RIPZ-24	4/18/2006	557.24	36.36	520.88	36.20	0.16	521.04	L
RIPZ-24	6/26/2006	557.24	36.35	520.89	36.11	0.24	521.13	L
RIPZ-24	9/20/2006	557.24	36.40	520.84	36.09	0.31	521.15	L
RIPZ-24	12/11/2006	557.24	37.85	519.39	37.15	0.70	520.09	L
RIPZ-24	2/9/2007	557.24	38.30	518.94	37.60	0.70	519.64	L
RIPZ-24	6/28/2007	557.24	39.05	518.19	38.50	0.55	518.74	L
RIPZ-24	9/20/2007	557.24	39.10	518.14	38.20	0.90	519.04	L
RIPZ-24	12/27/2007	557.24	39.60	517.64	39.25	0.35	517.99	L
RIPZ-24	3/25/2008	557.24	40.05	517.19	39.60	0.45	517.64	L
RIPZ-24	6/30/2008	557.24	39.62	517.62	39.58	0.04	517.66	L
RIPZ-24	9/10/2008	557.24	39.35	517.89	39.30	0.05	517.94	L
RIPZ-24	12/16/2008	557.24	39.50	517.74	39.40	0.10	517.84	L
RIPZ-24	3/31/2009	557.24	39.64	517.60	39.60	0.04	517.64	L
RIPZ-24	1/14/2010	557.24	43.80	513.44	41.68	2.12	515.56	L
RIPZ-24	3/31/2010	557.24	45.60	511.64	41.50	4.10	515.74	L
RIPZ-24	2/1/2011	557.24	45.70	511.54	40.15	5.55	517.09	L
RIPZ-24	6/27/2011	557.24	37.50	519.74	36.25	1.25	520.99	L
RIPZ-24	12/28/2011	557.24	38.57	518.67	35.84	2.73	521.40	L
RIPZ-25	12/3/2004	485.34	12.70	472.64	12.45	0.25	472.89	L
RIPZ-25	12/4/2004	485.34	12.47	472.87	12.35	0.12	472.99	L
RIPZ-25	12/5/2004	485.34	12.38	472.96	12.22	0.16	473.12	L
RIPZ-25	12/6/2004	485.34	13.35	471.99	12.60	0.75	472.74	L
RIPZ-25	12/7/2004	485.34	12.80	472.54	12.58	0.22	472.76	L
RIPZ-25	12/8/2004	485.34	12.87	472.47	12.69	0.18	472.65	L
RIPZ-25	12/9/2004	485.34	13.00	472.34	12.75	0.25	472.59	L
RIPZ-25	12/10/2004	485.34	12.80	472.54	12.64	0.16	472.70	L
RIPZ-25	12/14/2004	485.34	13.00	472.34	12.75	0.25	472.59	L
RIPZ-25	12/20/2004	485.34	12.91	472.43	12.60	0.31	472.74	L
RIPZ-25	12/22/2004	485.34	12.92	472.42	12.34	0.58	473.00	L
RIPZ-25	12/31/2004	485.34	12.92	472.42	12.34	0.58	473.00	L
RIPZ-25	1/4/2005	485.34	12.26	473.08	12.04	0.22	473.30	L
RIPZ-25	1/13/2005	485.34	8.45	476.89	8.30	0.15	477.04	L
RIPZ-25	1/19/2005	485.34	7.40	477.94	7.06	0.34	478.28	L
RIPZ-25	1/24/2005	485.34	6.40	478.94	6.32	0.08	479.02	L
RIPZ-25	2/1/2005	485.34	8.05	477.29	7.07	0.98	478.27	L
RIPZ-25	2/7/2005	485.34	8.55	476.79	7.72	0.83	477.62	L
RIPZ-25	2/15/2005	485.34	8.15	477.19	7.95	0.20	477.39	L
RIPZ-25	2/24/2005	485.34	7.65	477.69	7.39	0.26	477.95	L
RIPZ-25	3/1/2005	485.34	7.50	477.84	7.25	0.25	478.09	L
RIPZ-25	3/7/2005	485.34	6.83	478.51	6.68	0.15	478.66	L
RIPZ-25	3/16/2005	485.34	6.75	478.59	6.58	0.17	478.76	L
RIPZ-25	3/24/2005	485.34	6.17	479.17	6.00	0.17	479.34	L
RIPZ-25	3/28/2005	485.34	6.55	478.79	6.40	0.15	478.94	L

Table A3-1. NAPL Elevations
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
RIPZ-25	4/9/2005	485.34	7.67	477.67	7.51	0.16	477.83	L
RIPZ-25	4/14/2005	485.34	8.15	477.19	7.97	0.18	477.37	L
RIPZ-25	4/22/2005	485.34	8.80	476.54	8.64	0.16	476.70	L
RIPZ-25	4/28/2005	485.34	9.44	475.90	9.12	0.32	476.22	L
RIPZ-25	5/2/2005	485.34	9.95	475.39	9.33	0.62	476.01	L
RIPZ-25	5/10/2005	485.34	9.83	475.51	9.75	0.08	475.59	L
RIPZ-25	5/13/2005	485.34	9.00	476.34	8.85	0.15	476.49	L
RIPZ-25	5/19/2005	485.34	10.24	475.10	10.00	0.24	475.34	L
RIPZ-25	5/30/2005	485.34	10.80	474.54	10.41	0.39	474.93	L
RIPZ-25	6/8/2005	485.34	10.79	474.55	10.69	0.10	474.65	L
RIPZ-25	6/15/2005	485.34	11.05	474.29	10.95	0.10	474.39	L
RIPZ-25	6/24/2005	485.34	11.47	473.87	11.07	0.40	474.27	L
RIPZ-25	7/13/2005	485.34	11.40	473.94	11.10	0.30	474.24	L
RIPZ-25	8/31/2005	485.34	11.85	473.49	11.56	0.29	473.78	L
RIPZ-25	9/12/2005	485.34	11.89	473.45	11.60	0.29	473.74	L
RIPZ-25	10/20/2005	485.34	12.00	473.34	11.77	0.23	473.57	L
RIPZ-25	11/10/2005	485.34	12.26	473.08	11.85	0.41	473.49	L
RIPZ-25	12/27/2005	485.34	12.05	473.29	11.87	0.18	473.47	L
RIPZ-25	1/18/2006	485.34	10.08	475.26	9.85	0.23	475.49	L
RIPZ-25	2/14/2006	485.34	10.60	474.74	10.03	0.57	475.31	L
RIPZ-25	3/27/2006	485.34	10.05	475.29	9.81	0.24	475.53	L
RIPZ-25	4/18/2006	485.34	6.88	478.46	6.85	0.03	478.49	L
RIPZ-25	6/26/2006	485.34	9.15	476.19	8.78	0.37	476.56	L
RIPZ-25	9/20/2006	485.34	10.70	474.64	10.48	0.22	474.86	L
RIPZ-25	12/11/2006	485.34	16.68	468.66	10.85	5.83	474.49	L
RIPZ-25	6/28/2007	485.34	16.62	468.72	11.75	4.87	473.59	L
RIPZ-25	9/20/2007	485.34	15.25	470.09	12.30	2.95	473.04	L
RIPZ-25	12/27/2007	485.34	15.10	470.24	12.60	2.50	472.74	L
RIPZ-25	3/25/2008	485.34	11.45	473.89	8.55	2.90	476.79	L
RIPZ-25	6/30/2008	485.34	10.17	475.17	9.81	0.36	475.53	L
RIPZ-25	9/10/2008	485.34	8.18	477.16	8.05	0.13	477.29	L
RIPZ-25	12/16/2008	485.34	8.95	476.39	8.80	0.15	476.54	L
RIPZ-25	3/31/2009	485.34	8.55	476.79	8.10	0.45	477.24	L
RIPZ-25	1/14/2010	485.34	13.50	471.84	10.55	2.95	474.79	L
RIPZ-25	3/31/2010	485.34	13.11	472.23	10.20	2.91	475.14	L
RIPZ-25	1/31/2011	485.34	8.11	477.23	6.58	1.53	478.76	L
RIPZ-25	6/27/2011	485.34	8.01	477.33	6.10	1.91	479.24	L
RIPZ-25	12/28/2011	485.34	1.40	483.94	1.39	0.01	483.95	L
RIPZ-27	11/15/2007	559.13	40.80	518.33	40.79	0.01	518.34	L
RIPZ-27	12/13/2007	559.13	41.26	517.87	41.25	0.01	517.88	L
RIPZ-27	12/21/2009	559.13	58.56	500.57	43.25	15.31	515.88	L
RIPZ-27	3/9/2010	559.13	62.67	496.46	43.20	19.47	515.93	L
RIPZ-27	12/16/2010	559.13	61.74	497.39	41.53	20.21	517.60	L
RIPZ-27	6/27/2011	559.13	61.62	497.51	41.29	20.33	517.84	L
RIPZ-27	10/31/2011	559.13	60.29	498.84	40.17	20.12	518.96	L
RIPZ-27	12/28/2011	559.13	58.62	500.51	37.50	21.12	521.63	L
RIPZ-31	10/25/2006	484.55	11.21	473.34	9.63	1.58	474.92	L
RIPZ-31	11/22/2006	484.55	11.65	472.90	9.70	1.95	474.85	L
RIPZ-31	12/28/2006	484.55	8.96	475.59	7.69	1.27	476.86	L
RIPZ-31	1/31/2007	484.55	14.30	470.25	7.80	6.50	476.75	L
RIPZ-31	2/18/2007	484.55	9.30	475.25	7.70	1.60	476.85	L
RIPZ-31	3/28/2007	484.55	11.00	473.55	9.31	1.69	475.24	L
RIPZ-31	4/27/2007	484.55	10.75	473.80	9.79	0.96	474.76	L
RIPZ-31	5/29/2007	484.55	12.16	472.39	11.20	0.96	473.35	L
RIPZ-31	6/28/2007	484.55	17.88	466.67	10.19	7.69	474.36	L
RIPZ-31	7/11/2007	484.55	19.05	465.50	11.14	7.91	473.41	L
RIPZ-31	8/7/2007	484.55	19.45	465.10	11.24	8.21	473.31	L
RIPZ-31	9/20/2007	484.55	10.30	474.25	ND	ND	ND	L
RIPZ-31	10/29/2007	484.55	12.90	471.65	10.97	1.93	473.58	L
RIPZ-31	11/28/2007	484.55	11.52	473.03	11.20	0.32	473.35	L
RIPZ-31	12/27/2007	484.55	11.85	472.70	9.60	2.25	474.95	L
RIPZ-31	1/31/2008	484.55	9.25	475.30	NR	NR	NR	L
RIPZ-31	2/28/2008	484.55	8.61	475.94	7.35	1.26	477.20	L

Table A3-1. NAPL Elevations
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

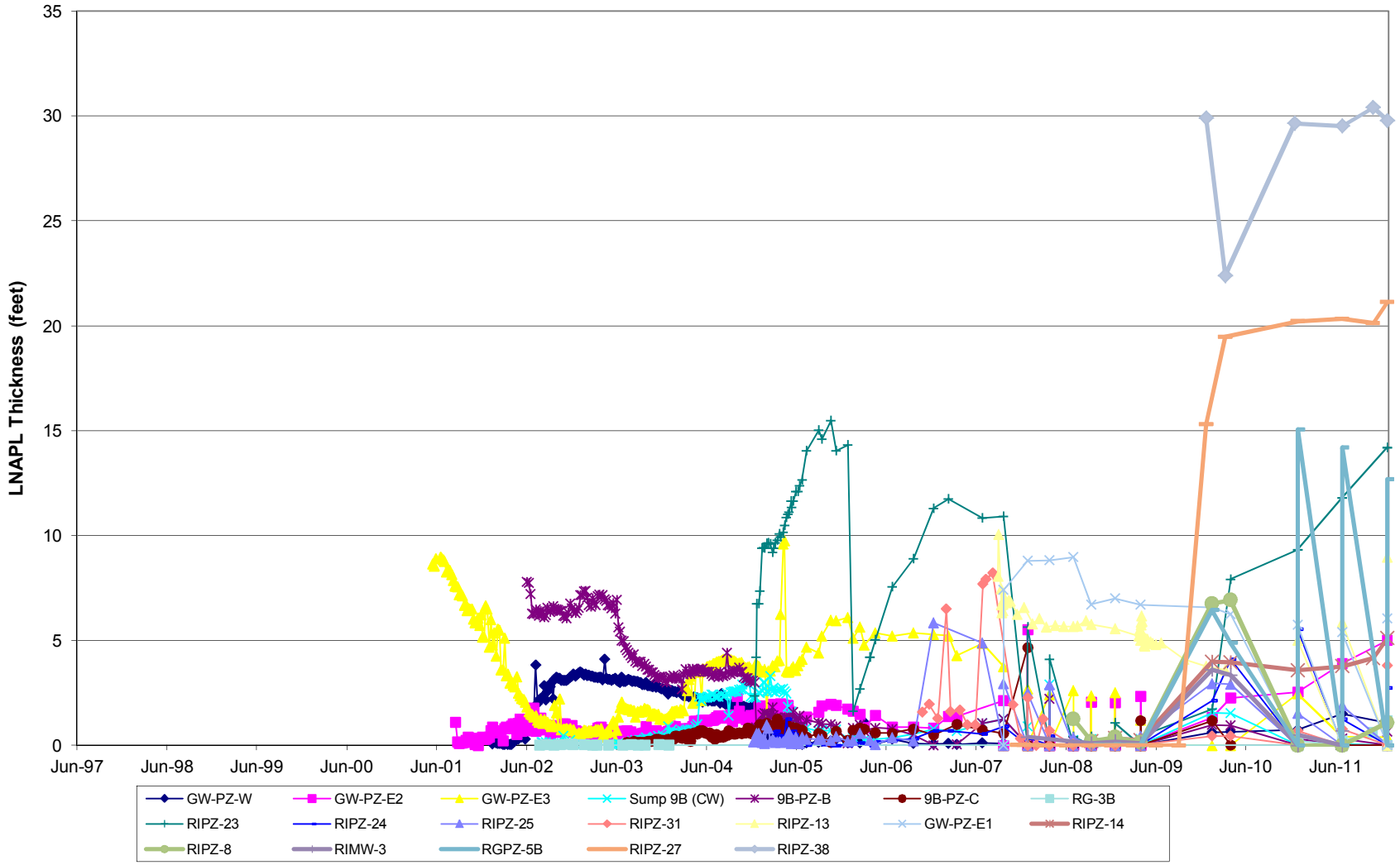
Station	Date	TOC (ft MSL)	DTW (ft BTOC)	WLE (ft MSL)	Depth to NAPL (ft BTOC)	Thickness NAPL (ft)	NAPL Elev. (ft MSL)	NAPL TYPE (D,L)
RIPZ-31	3/25/2008	484.55	7.40	477.15	6.70	0.70	477.85	L
RIPZ-31	6/30/2008	484.55	6.76	477.79	6.70	0.06	477.85	L
RIPZ-31	9/10/2008	484.55	8.26	476.29	8.20	0.06	476.35	L
RIPZ-31	12/16/2008	484.55	6.52	478.03	6.45	0.07	478.10	L
RIPZ-31	3/31/2009	484.55	8.19	476.36	8.15	0.04	476.40	L
RIPZ-31	1/14/2010	484.55	8.10	476.45	7.65	0.45	484.10	L
RIPZ-31	3/31/2010	484.55	7.69	476.86	7.24	0.45	484.10	L
RIPZ-31	2/1/2011	484.55	3.30	481.25	2.60	0.70	481.95	L
RIPZ-31	6/27/2011	484.55	3.27	481.28	2.51	0.76	482.04	L
RIPZ-31	10/28/2011	484.55	6.41	478.14	5.78	0.63	478.77	L
RIPZ-31	12/28/2011	484.55	6.10	478.45	2.31	3.79	482.24	L
RIPZ-38	12/21/2009	562.64	75.90	486.74	46.00	29.90	516.64	L
RIPZ-38	3/9/2010	562.64	68.40	494.24	46.01	22.39	516.63	L
RIPZ-38	12/16/2010	562.64	73.86	488.78	44.22	29.64	518.42	L
RIPZ-38	6/27/2011	562.64	73.64	489.00	44.12	29.52	518.52	L
RIPZ-38	10/31/2011	562.64	70.09	492.55	39.69	30.40	522.95	L
RIPZ-38	12/28/2011	562.64	69.84	492.80	40.06	29.78	522.58	L
RIPZ-39	9/20/2007	634.94	108.71	526.23	108.70	0.01	526.24	L
RIPZ-39	9/27/2007	634.94	108.92	526.02	ND	ND	ND	L
RIPZ-39	10/4/2007	634.94	108.95	525.99	ND	ND	ND	L
RIPZ-39	10/11/2007	634.94	109.10	525.84	ND	ND	ND	L
RIPZ-39	11/15/2007	634.94	109.41	525.53	ND	ND	ND	L
RIPZ-39	12/13/2007	634.94	109.78	525.16	109.78	NA	525.16	L
RIPZ-39	1/17/2008	634.94	109.95	524.99	ND	ND	ND	L
RIPZ-39	2/13/2008	634.94	109.90	525.04	ND	ND	ND	L
RIPZ-39	3/13/2008	634.94	110.20	524.74	ND	ND	ND	L
RIPZ-39	4/17/2008	634.94	110.39	524.55	110.19	0.20	524.75	L
RIPZ-39	5/22/2008	634.94	109.62	525.32	109.60	0.02	525.34	L
RIPZ-39	6/19/2008	634.94	109.88	525.06	ND	ND	ND	L
RIPZ-39	7/17/2008	634.94	109.90	525.04	ND	ND	ND	L
RIPZ-39	8/20/2008	634.94	109.93	525.01	ND	ND	ND	L
RIPZ-39	9/17/2008	634.94	110.03	524.91	ND	ND	ND	L
RIPZ-39	12/16/2008	634.94	110.66	524.28	ND	ND	ND	L
RIPZ-39	3/23/2009	634.94	111.05	523.89	ND	ND	ND	L
RIPZ-39	6/22/2009	634.94	111.62	523.32	ND	ND	ND	L
RIPZ-39	9/22/2009	634.94	111.31	523.63	ND	ND	ND	L
RIPZ-39	12/21/2009	634.94	112.08	522.86	ND	ND	ND	L
RIPZ-39	3/9/2010	634.94	112.20	522.74	111.60	0.60	523.34	L
RIPZ-39	12/28/2011	634.94	108.13	526.81	106.68	1.45	528.26	L

Notes:
TOC = Top of casing
MSL = Mean sea level
WLE = Water level elevation
DNAPL = Dense non-aqueous phase liquid
LNAPL = Light non-aqueous phase liquid
DTP = Depth to product

BTOC = Below top of casing
ND = None detected
NA = No data available

(1) = Data from Gallery Well recovery test; pump turned off and levels allowed to recover. Levels recorded after 8 hours are shown.

Checked: NAM
Approved: WBC

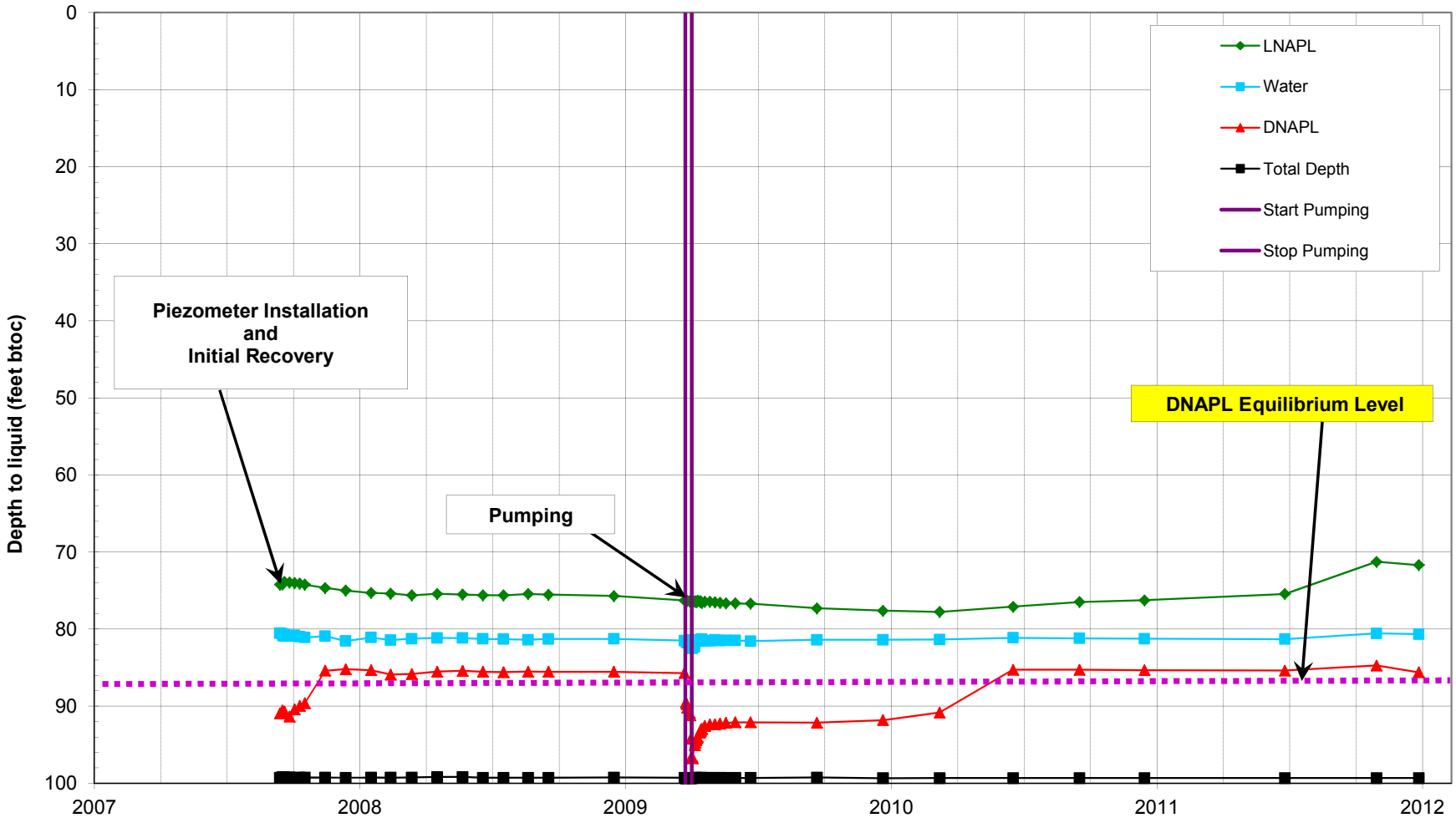


LNAPL Thickness Over Time
December 1997 - December 2011
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Figure

A3-1

DRAWN	JOB NUMBER	APPROVED	DATE
WJF	4088097619	WBC	AUGUST 2014

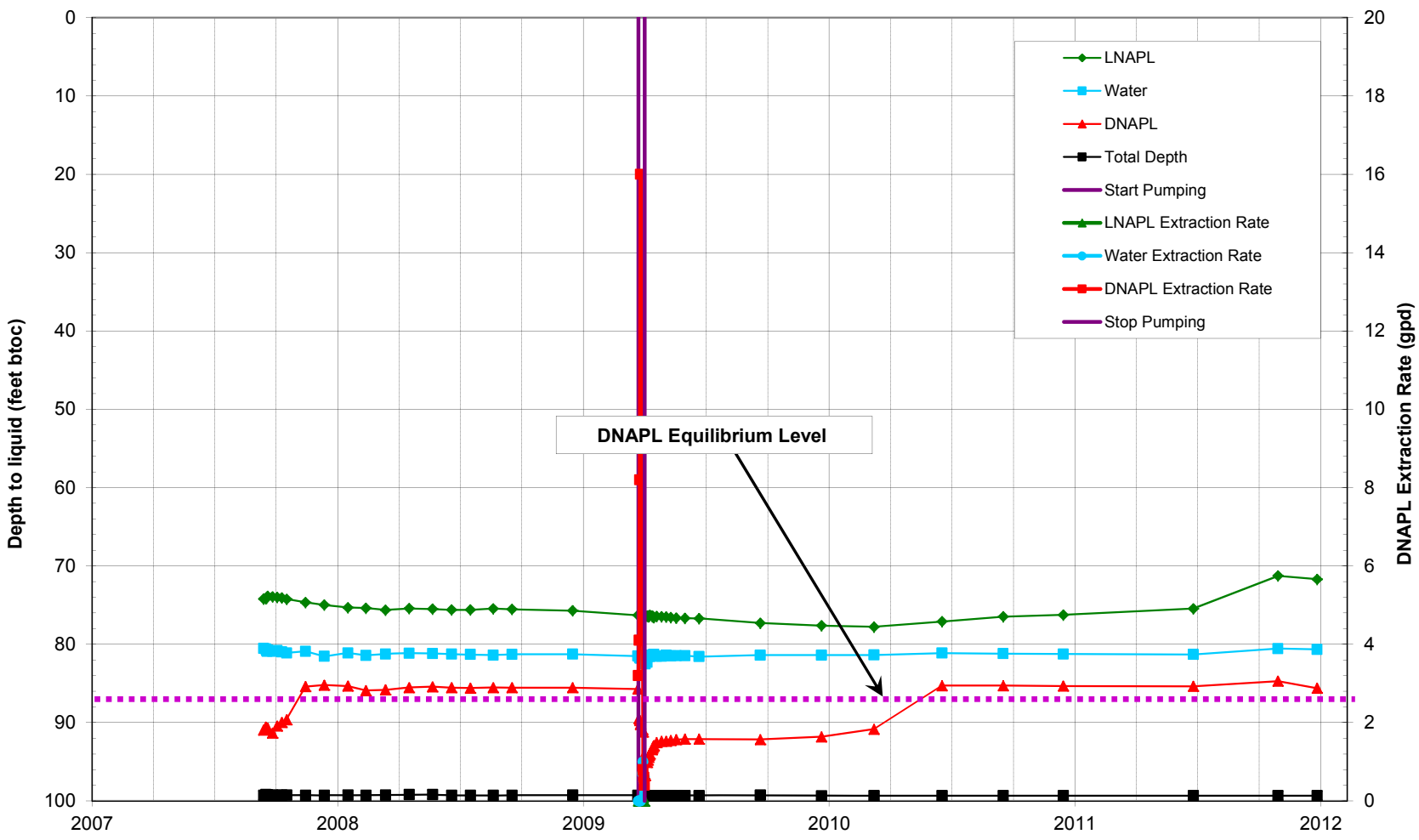


RIPZ-13 DNAPL Long Term Monitoring Hydrograph
August 2007 - December 2011
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Figure

A3-2

DRAWN	JOB NUMBER	APPROVED	DATE
WJF	4088097619	WBC	AUGUST 2014

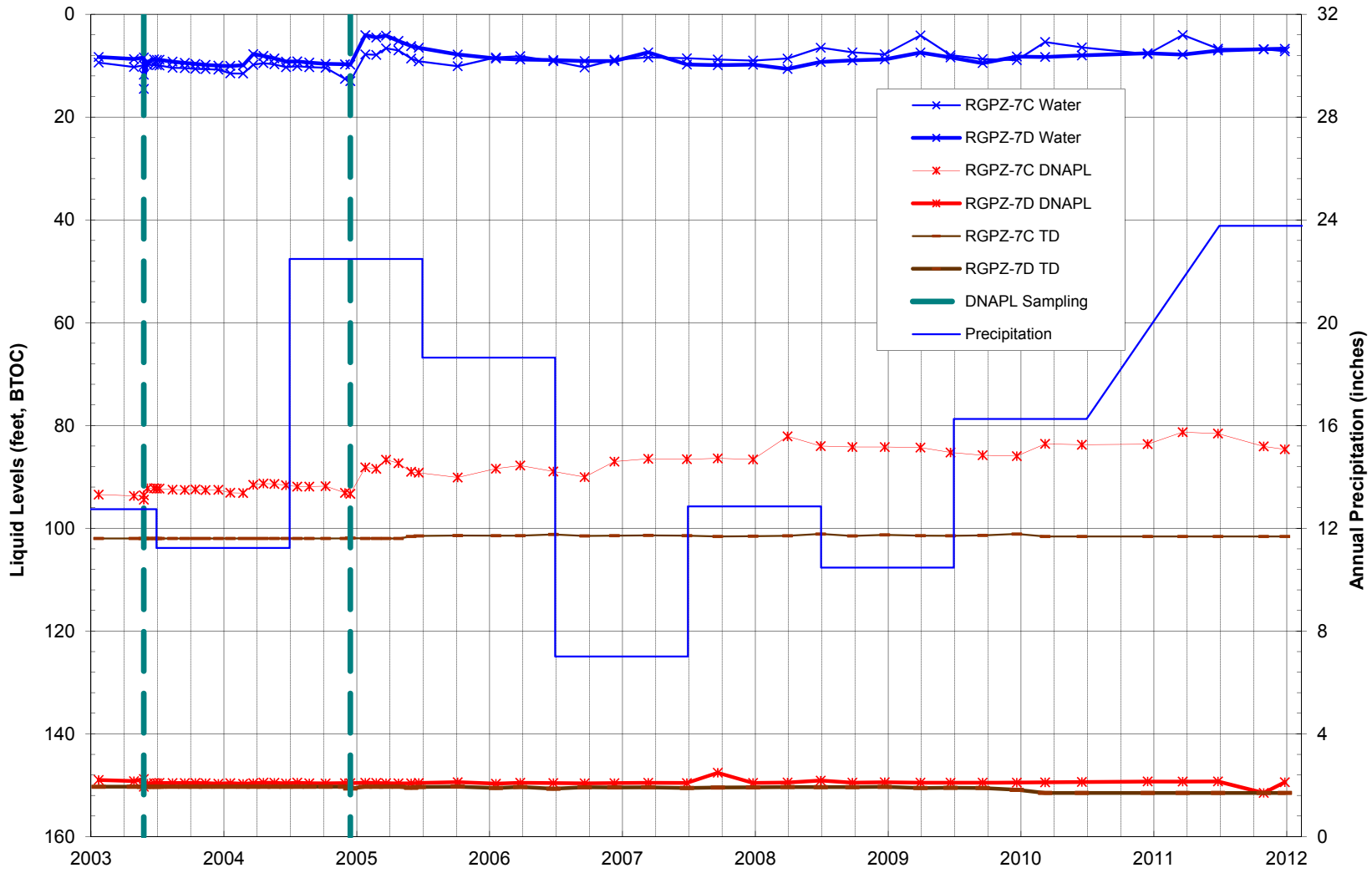


RIPZ-13 DNAPL Recovery Test Hydrograph
March 2009 - December 2011
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Figure

A3-3

DRAWN	JOB NUMBER	APPROVED	DATE
WJF	4088097619	WBC	AUGUST 2014



RGPZ-7C and RGPZ-7D DNAPL Long Term Monitoring Hydrograph
January 2003 - December 2011
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Figure

A3-4

DRAWN	JOB NUMBER	APPROVED	DATE
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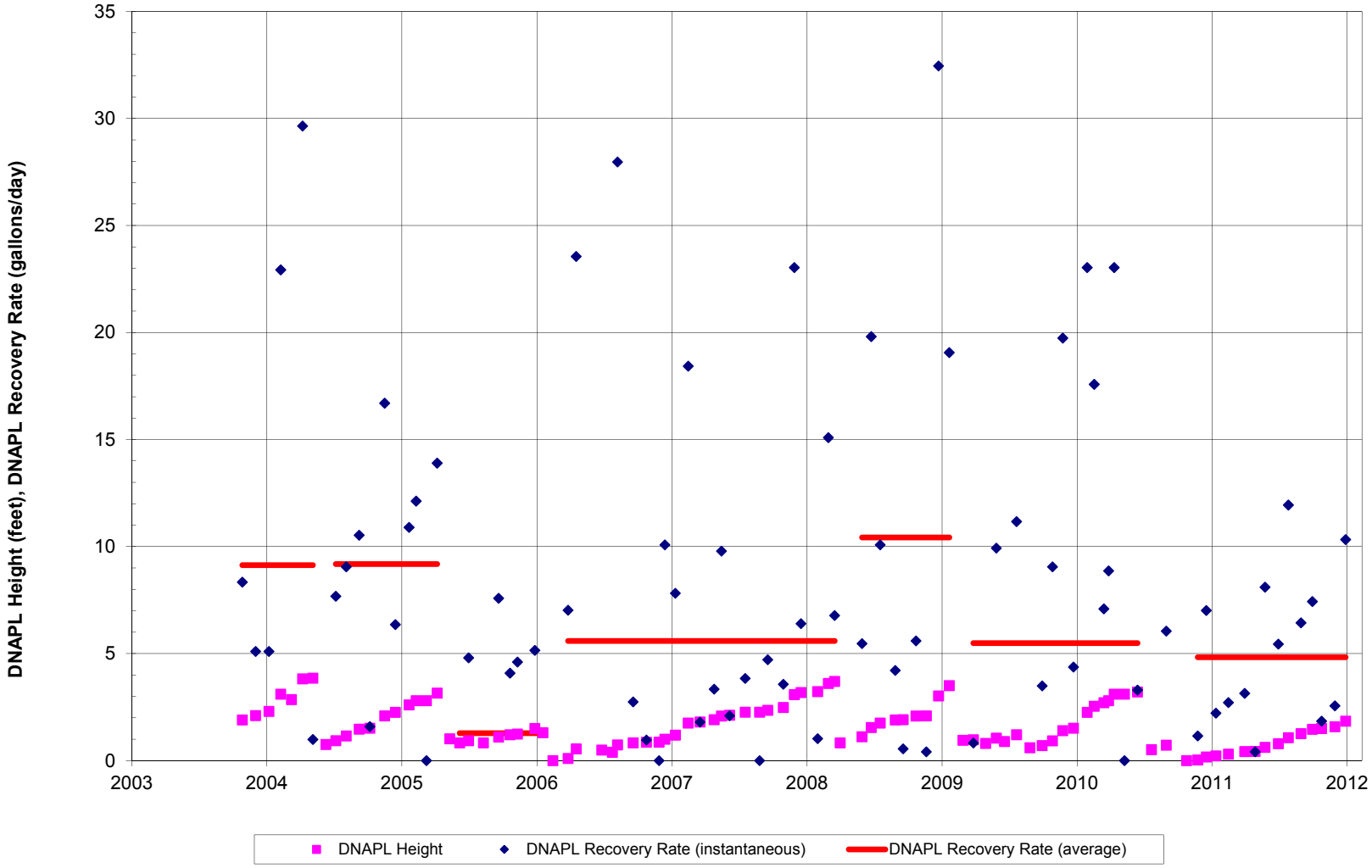
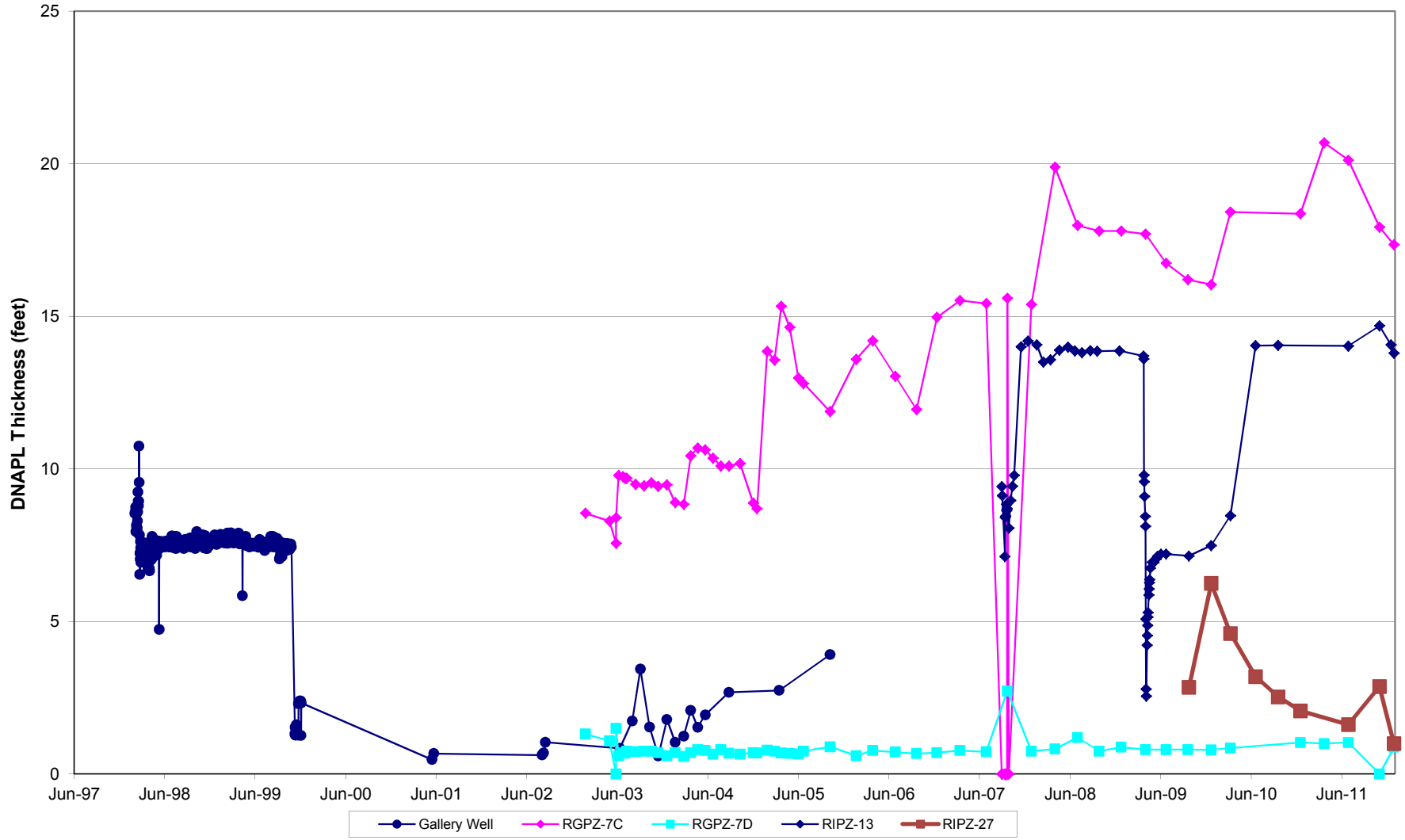


DNAPL Recovery Rates
Tank Accumulations
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Figure

A3-5

DRAWN	JOB NUMBER	APPROVED	DATE
WJF	4088097619	WBC	AUGUST 2014



DNAPL Thickness Over Time
December 1997 - December 2011
Feasibility Study
Casmalia Resources Superfund Site
Casmalia, California

Figure

A3-6

DRAWN	JOB NUMBER	APPROVED	DAT
WJF	4088097619	WBC	AUGUST 2014