FINAL
Data Gap Analysis

North Hollywood Operable Unit
Second Interim Remedy
Groundwater Remediation System Design

Revision 1

March 14, 2012

AMEC Project Number: 4088115718

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Client:	Honeywell International, Inc. Lockheed Martin Corporation	Data Gap Analysis	amec
Project:	NHOU Second Interim Remedy Groundwater Remediation Design	Project Rev. 1	4088115718 2100.1

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March 14, 2012

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ACRONYMS AND ABBREVIATIONS LIST

>	greater than
µg/L	micrograms per liter
AF	acre-feet
AF/Y	acre-feet per year
AMEC	AMEC Environment & Infrastructure, Inc.
AOC	Agreement and Order on Consent
AOP	Advanced Oxidation Process
bgs	below ground surface
BOU	Burbank Operable Unit
CAO	Cleanup and Abatement Order
CDPH	California Department of Public Health
cfm	cubic feet per minute
cDCE	cis-1,2-dichloroethene
COC	constituents of concern
CSM	conceptual site model
CW	cluster wells
1,1-DCE	1,1-dichloroethene
1,2-DCE	1,2-dichloroethene
1,2-DCP	1,2-dichloropropane
DHS	California Department of Health Services
DTSC	California Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
FFS	Focused Feasibility Study
ft/d	feet per day
ft^2/d	square feet per day
ft/ft	feet per foot
GAC	Granular Activated Carbon
gpd/ft	gallon(s) per day per foot
gpm	gallon(s) per minute
gpm/ft	gallon(s) per minute per foot
GOU	Glendale Operable Unit
GQMP	Groundwater Quality Management Plan
GSIS	Groundwater System Improvement Study
Honeywell	Honeywell International, Inc.
ICIAP	Institutional Control Implementation and Assurance Plan
JMM	J.M. Montgomery, Inc.
K	hydraulic conductivity
LACDPW	Los Angeles County Department of Public Works
LADWP	Los Angeles Department of Water and Power
Lockheed Martin	Lockheed Martin Corporation
LPGAC	Liquid Phase Granular Activated Carbon
MACTEC	MACTEC Engineering and Consulting, Inc.
MCL	maximum contaminant level
MSL	mean sea level
MWH	MWH Americas, Inc.

NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NDMA	n-nitrosodimethylamine
NGVD29	National Geodetic Vertical Datum of 1929
NH-C	cluster monitoring well
NH-east	eastern North Hollywood
NH-west	western North Hollywood
NHE	North Hollywood extraction well
NHOU	North Hollywood Operable Unit
NPL	National Priorities List
OUFS	operable unit feasibility study
PCE	tetrachloroethene
PHG	Public Health Goal
PRPs	potentially responsible parties
RAO(S)	Remedial Action Objectives
RD	Remedial Design
RI	remedial investigation
ROD	Record of Decision
RWQCB-LA	Regional Water Quality Control Board, Los Angeles Region
SD	standard deviation
SFB	San Fernando Basin
SFBFS model	revised SFVRI model for feasibility study
SFV	San Fernando Valley
SFVRI model	SFV-wide remedial investigation model
SOW	Scope of Work
SVOCs	semi-volatile organic compounds
1,1,1-TCA	1,1,1-trichloroethane
T	transmissivity
TCE	trichloroethene
1,2,3-TCP	1,2,3-trichloropropane
ULARA	Upper Los Angeles River Area
VOC(s)	volatile organic compound
VPB	vertical profile boring
VPGAC	vapor-phase granular activated carbon

EXECUTIVE SUMMARY

AMEC Environment & Infrastructure (AMEC) has been contracted by Honeywell International, Inc. (Honeywell) and Lockheed Martin Corporation (Lockheed Martin) to design the Second Interim Remedy for groundwater remediation at the North Hollywood Operable Unit (NHOU) in compliance with the U.S. Environmental Protection Agency's (EPA) Interim Action Record of Decision (ROD) dated September 30, 2009. Specific scope items are also included in the Administrative Settlement Agreement and Order on Consent for Remedial Design (RD), dated February 21, 2011 (AOC) that was executed between the United States, Honeywell, and Lockheed Martin to conduct pre-design data acquisition and RD activities associated with the ROD (EPA, 2011b). The Second Interim Remedy is intended to upgrade and expand the existing NHOU groundwater remediation system to improve containment, protect water supply production well fields, and address emerging contaminants.

ES.1 Background

The NHOU was proposed by the EPA in 1984 in response to the discovery in the late 1970s of trichloroethene (TCE) and tetrachloroethene (PCE) in groundwater from production wells in the San Gabriel basin and throughout much of the eastern portion of the SFB. The NHOU treatment system was designed to remove PCE and TCE from groundwater following an Operable Unit Feasibility Study (OUFS) in 1986. This approach allowed remediation action to occur before the remediation investigation (RI) began.

The NHOU system, which was constructed between 1987 and 1989, consists of eight extraction wells (designated as NHE-1 through NHE-8), a collector line, and a central treatment system consisting of an air-stripper tower, two vapor-phase granular activated carbon (VPGAC) units, and a chlorination system. Treated water is discharged to the North Hollywood Complex where it is blended into the Los Angeles Department of Water and Power (LADWP) water distribution system. As of June 2011, six of the eight extraction wells remain in service. NHE-1 has never operated as part of the NHOU system and NHE-5 has not operated since 2008.

Throughout the 1980s and 1990s, chemicals of concern (COCs) in groundwater quality assessments primarily included volatile organic compounds (VOCs), specifically TCE and PCE. In 1995, the EPA's SFB RI monitoring program analyte list was expanded to include hexavalent chromium because this metal was widely distributed in the eastern portion of the SFB. In 1996, 1,4-dioxane was added to the monitoring program analyte list and was subsequently detected in groundwater. Other emerging chemicals (e.g., 1,2,3-trichloropropane [1,2,3-TCP], n-nitrosodimethalymine [NDMA], perchlorate) were later added to the RI monitoring program analyte list. Groundwater samples have been collected either quarterly, semiannually, or annually since this monitoring program began in 1993.

The NHOU treatment system was originally designed to operate at a nominal flow rate of about 2,000 gallons per minute (gpm) and the extraction wells at a nominal discharge rate of approximately 300 gpm each; however, some of the extraction wells have been unable to sustain their anticipated flow rate and the actual treatment system flow rate has typically been less than 1,500 gpm and often below 1,000 gpm. Several performance assessments conducted between 1991 and 2008 concluded that design modifications were necessary to achieve the original remedial action objectives (RAOs), including containing the extent of the COC plumes in groundwater. Chromium detections at NHE-2 and the presence of 1,2,3-TCP and 1,4-dioxane in monitoring wells upgradient and near the NHOU extraction wells specifically led to the development of a Focused Feasibility Study (FFS) in 2008 because the NHOU system is not capable of treating groundwater for these constituents.

ES.2 Second Interim Remedy Objectives

The objective of the Second Interim Remedy is to specify and implement the upgrade and expansion of the existing NHOU groundwater remediation system to improve containment of chemicals of concern (COCs), protecting water supply production well fields, and address emerging contaminants. The Second Interim Remedy remedial action objectives (RAOs) were defined in the ROD as follows:

- Prevent exposure to contaminated groundwater above acceptable risk levels;
- Contain areas of contaminated groundwater that exceed the maximum contaminant levels (MCLs) and notification levels to the maximum extent practicable;
- Prevent further degradation of water quality at the Rinaldi-Toluca and North Hollywood (west) production wells by preventing the migration toward these well fields of the more highly contaminated areas of the volatile organic compound (VOC) plume to the east/southeast;
- Achieve improved hydraulic containment to inhibit horizontal and vertical contaminant migration in groundwater from the more highly contaminated areas and depths of the aquifer to the less contaminated areas and depths of the aquifer, including the southeast portion of the NHOU near the Erwin and Whitnall production well fields; and,
- Remove contaminant mass from the aquifer.

Because surrounding large-capacity production well fields capture portions of the VOC plume and will continue to operate to meet municipal water demand, it will not be possible to hydraulically capture all contaminated groundwater. Rather, the RAOs intent is directed at containment of high concentration portions of the plume and other portions of the plume (where concentrations are above regulatory limits) to the extent practicable so that no further groundwater quality degradation occurs near the Rinaldi-Toluca and North Hollywood (west) production well fields. Specific work scope items defined in the AOC are intended to achieve the RAOs and include the following:

- Groundwater Monitoring
- Replace Existing Extraction Well NHE-1
- Replace or Repair and Modify Existing Extraction Wells NHE-2, NHE-3, NHE-4, and NHE-5
- Wellhead Chromium Treatment at NHE-2
- Wellhead 1,4-Dioxane Treatment at NHE-2
- Construct New Extraction Wells
- Treatment of VOCs in Extracted Groundwater
- Ex Situ Chromium Treatment for Wells NHE-1, and recommended new wells NEW-2, and NEW-3
- Delivery of Treated Groundwater to LADWP

Groundwater flow modeling conducted for the FFS indicated that up to three new wells would be required northwest of the existing treatment system. The ROD states that new extraction wells are necessary to further limit contaminant migration to nearby well fields and to improve mass removal and that "further evaluation of specific pumping rates and extraction well locations will be performed during RD to ensure that implementation of the Second Interim Remedy will not cause additional degradation of the aquifer". The ROD also states that "if new data collected prior to or during RD indicates that a different configuration of extraction wells is more effective and cost effective than the configuration described in the Proposed Plan, then that different configuration will be considered for implementation as part of the Second Interim Remedy". The AOC states that "a plan for optimizing the pumping rates of the new NHOU extraction well system shall be developed as part of the [Second Interim Remedy] design".

ES.3 Refined NHOU Conceptual Site Model

Available data have been critically reviewed to refine the NHOU conceptual site model (CSM) as part of assessing Second Interim Remedy objectives.

- Two hydrogeologic units have been identified that pertain to the Second Interim Remedy, the A-Zone and B-Zone. These units are based on geologic and geophysical properties rather than on model layer boundaries and production well perforation zones that supported the use of "depth regions". Most of the COC mass resides within the A-Zone, which consists primarily of fine sand and silt sediments. The B-Zone is typically described as containing coarse sand and gravel and underlies the A-Zone unconformably.
- Vadose zone sediments typically include poorly- to well-sorted sand, silt or silty sand, and interbedded zones of gravel that are difficult to spatially correlate due to variable drillers' logs and limited geophysical data. Depths to groundwater typically exceed 200 feet below grade throughout the NHOU area.
- Recharge to the NHOU area within the SFB includes infiltration from seasonal precipitation events, but primarily consists of storm water infiltration at regional recharge facilities, including spreading grounds to the north, northeast, and northwest (e.g., Branford, Hansen, Lopez, and Pacoima Spreading Grounds).
- Groundwater elevations strongly correlate with groundwater extraction primarily from municipal production wells located throughout the eastern portion of the SFB. Groundwater extraction and recharge operations are closely monitored by the ULARA Watermaster in compliance with the SFB adjudication judgment. The City of Los Angeles typically extracts approximately 50,000 AF of native groundwater annually from the SFB; additional extraction includes withdrawal of imported water. Discrepancies exist between municipal pumping rates projected in the FFS and current municipal projections as described in the 2007 Stipulated Agreement and subsequent Watermaster reports. ULARA Watermaster modeling simulations based on the latter suggest that groundwater elevations may rise approximately 50 feet in the NHOU area, rather than continue to decline as indicated in the FFS groundwater modeling simulations.
- Comprehensive data collected during December 2010 monitoring event indicate that, north of Sherman Way, groundwater flows to the southwest from northern landfills toward the Rinaldi-Toluca well field, whereas flow beneath the Hewitt Pit, former Bendix facility, and former Lockheed Martin facilities (i.e., south of Sherman Way) is to the southeast. Other monitoring events, consisting of fewer groundwater elevation measurements, typically indicate a simpler pattern of groundwater flow toward the south and/or southeast, consistent with the inferred regional flow pattern. Pumping from the Rinaldi-Toluca well field appears to have induced a local northeast gradient beneath the Hewitt Pit area before pumping from southernmost production wells in this area ceased circa 1990.

- Analytical data indicate that the primary COCs include PCE, TCE, hexavalent chromium, and 1,4-dioxane. Many known and potential source areas throughout the NHOU area have not been sufficiently characterized and source area investigations are ongoing (LADWP, 1983; RWQCB-LA, 2002; EPA, 2011a, 2012). Chemical signatures support the conclusion that COCs emanating from sources at or near northern landfills have impacted Rinaldi-Toluca production wells. Insufficient data exist to delineate the lateral and vertical distribution of COCs to their respective regulatory limits within the A-Zone.

ES.4 Data Gap Analysis Results

Data gaps identified herein are associated with each AOC scope item and have been categorized as manageable, significant, or critical. Failure to address and resolve critical data gaps before proceeding with remediation design activities will jeopardize the successful operation of the Second Interim Remedy. Critical data gaps are summarized below:

1. Recent analytical data are insufficient to delineate the lateral and vertical distribution of COC mass (and temporal variability) in the A-Zone and B-Zone and to define the necessary target capture area required to achieve Second Interim Remedy RAOs. This data gap applies both to areas throughout the NHOU study area and to areas near the existing NHOU extraction wells.
2. Groundwater elevation data have not been measured from a sufficient number of wells surveyed to a common elevation datum (e.g., North American Vertical Datum of 1988 [NAVD88]) to verify and clarify groundwater flow directions, particularly north of Sherman Way.
3. Aquifer test results are insufficient to estimate hydraulic parameters specific to the A-Zone or B-Zone; these estimates are needed to accurately simulate groundwater flow directions, NHE hydraulic capture areas, and influent pumping rates to the new treatment system.
4. The present monitoring well network is insufficient to characterize vadose zone and groundwater conditions beneath known and potential source areas to further delineate the lateral and vertical distribution of COC mass within the NHOU source area to achieve Second Interim Remedy RAOs.
5. The EPA's SFB RI groundwater monitoring network is inadequate to achieve Second Interim Remedy RAOs. Recently installed wells in the NHOU have not yet been incorporated into this program. Sampling methods need to be revised such that groundwater samples are collected from depths that specifically relate to either the A-Zone or the B-Zone. Not all wells used for measuring groundwater elevation have been surveyed to the same vertical datum, while reference elevations on old wells may have undergone change (e.g., settlement, grade changes, wellhead maintenance).
6. Objective projections of pumping and recharge rates, including beyond year 2015, are not yet available; this prevents meaningful simulation of future groundwater flow conditions and elevations pertinent to the Second Interim Remedy design.
7. Performance monitoring wells have not been installed and monitored to demonstrate the size and shape of the existing NHOU extraction well capture area. Similarly, drawdown measurements at each extraction well have not been recorded for calculating well efficiency changes over time to support the need for well rehabilitation.

8. The existing numerical groundwater flow model is not sufficiently structured or discretized vertically to evaluate hydraulic capture specifically within the A-Zone and potentially the B-Zone.
9. Available analytical data are insufficient to assess A-Zone source water to the new NHOU treatment system to meet CDPH 97-005 requirements.
10. Vertical conduits throughout the NHOU study area have not been sufficiently evaluated to quantify the volume of groundwater and COC mass that is induced to depths below the A-Zone in response to various municipal pumping patterns or scenarios.

ES.5 Data Gap Implications to the Second Interim Remedy

Critical data gaps identified above suggest several significant implications with respect to implementing the Second Interim Remedy, as follows:

1. Analytical data from recently installed monitoring wells indicate that the extent of COC concentrations exceeding their respective regulatory limits (or ten times these limits) cannot yet be determined. Similarly, these data suggest that most COC mass resides in the A-Zone; however, several wells have not been sampled discretely (vertically) to evaluate groundwater quality in the B-Zone. Consequently, the target capture area in the A-Zone cannot yet be defined. If additional data confirm that the bulk of COC mass resides in the A-Zone, the Second Interim Remedy should be designed to improve hydraulic capture within the A-Zone and prevent COC mass migration into the B-Zone or deeper hydrogeologic units (consistent with the AOC).
2. Analysis of NHOU hydrostratigraphy and groundwater quality indicates that the current SFB groundwater flow model was not constructed to be consistent with the A-Zone and B-Zone hydrostratigraphic units. Similarly, monitoring wells have typically not been constructed or sampled discretely with respect to either the A-Zone or the B-Zone. The EPA database also does not account for sample depths, which hinders assignment of groundwater analytical data to either the A-Zone or the B-Zone that would facilitate future performance monitoring. The A-Zone target capture zone thus cannot yet be defined and the model cannot be used to evaluate various simulated pumping scenarios to optimally achieve the target capture zone.
3. Known and potential source areas throughout the NHOU study area as identified via several separate investigations (LADWP, 1983; RWQCB-LA, 2002; MWH, 2010b; EPA, 2011a) remain uncharacterized in the subsurface, yet many appear to have contributed mass that will define the target capture zone. Several sources appear to be responsible for impacting production wells that are intended to be protected by additional NHOU extraction wells to meet specific RAOs. The revised CSM suggests that several AOC scope items may need to be revised, as discussed in Section 5.
4. Recent model simulations of current pumping and recharge projections (ULARA Watermaster, 2011c) indicate groundwater elevations may rise 50 feet by Fall 2015, not continue to decline in response to increased pumping as simulated in the FFS (EPA, 2009a). These contradictory projections prevent meaningful simulation of future groundwater flow conditions and groundwater elevations pertinent to the Second Interim Remedy design. As a result, the design of extraction wells, their flow rates, and treatment system sizing to address the potential range in groundwater elevations is impractical. Rather, specific and reasonable minimum/maximum groundwater elevations should be specified in the Final Groundwater Management Plan that will be subsequently incorporated into the Second Interim Remedy design to achieve the RAOs.

Failure to address these critical data gaps would mean that the designed remedy will prevent the Second Interim Remedy from achieving its RAOs. For example, without further delineation of the horizontal and vertical distribution of COCs, the Second Interim Remedy may cause contaminant migration in groundwater from the more highly contaminated areas to the less contaminated areas and deeper in the aquifer.

ES.6 Recommendations

Recent data have altered the existing CSM that was the basis for the 2009 FFS. Critical data gaps that have been identified during the data review require resolution prior to design of the Second Interim Remedy. The resolution of these critical data gaps will reduce the uncertainty associated with the Second Interim Remedy groundwater treatment system design and allow achievement of the RAOs.

Details associated with most of the following recommendations will be described in detail in a Phase 1 Pre-Design Investigation Work Plan, consistent with AOC, Appendix A, Section 4. Whether a second phase of the Pre-Design Investigation is needed to meet RAOs and to comply with CDPH 97-0005 requirements will be assessed following completion of Phase 1 (see Section 6.1.3). If needed, Phase 2 activities will be described in a subseqent Work Plan, revised project schedule, and addendums to the SAP and QAPP as needed.

1. Additional groundwater sample collection:
    a. Collect at least two semiannual depth-discrete A-Zone and B-Zone groundwater samples from 4909C, 4909F, 4918A, 4928A, 4919D, GW-18B, GW-19B, NH-C01-450, NH-C10-360, NH-C12-360, NH-C14-250, NH-C13-385, NH-C16-390, NH-C17-339, NH-C18-270 and -365, NH-C19-290 and -360, NH-C20-380, NH-C21-260 and -340, NH-C23-400, and NH-C24-305 (as illustrated on Figure 6-1) to further delineate the lateral and vertical distribution and temporal variability of COCs.
    b. Collect depth-discrete groundwater quality samples from NHE-1 and NH-10 to further evaluate the lateral and vertical distribution of COC mass in the A-Zone and B-Zone in this area.
    c. Collect a continuous vertical profile of groundwater quality samples (i.e., no larger than 10-foot intervals) from monitoring wells NH-C19 and NH-C23 to evaluate the vertical distribution of COCs within these screen intervals with high resolution.
    d. Measure groundwater elevations quarterly for at least one year at cluster wells NH-C07 through NH-C25, in addition to RI monitoring wells (surveyed to a common vertical elevation datum), independent from collecting groundwater samples (i.e., within the same day if possible) to better estimate groundwater flow directions and gradients.
    e. Perform vertical flow logging (e.g., heat-pulse, spinner logs, etc.) at wells NH-C05, NH-C10, NH-C16, NH-C19, and NH-C23 at seasonal extremes (i.e., April and October) to evaluate the magnitude and direction of vertical flow through long-screened monitoring wells in response to seasonal pumping patterns.
    f. Identify wells in the NHOU study area used for groundwater elevations in the NHOU study area that have been surveyed to NGVD29 and survey the reference point to NAVD88 to more accurately depict groundwater flow directions and

calculated gradients. Additionally, wells not surveyed within the past 10 years should be surveyed again to account for incidental damage that may have altered the measurement reference point elevation.

2. Aquifer testing:
   a. Perform slug tests at monitoring wells NH-C07-300, NH-C09-310, NH-C10-280, NH-C12-280, NH-C13-385, NH-C14-250, NH-C17-255, NH-C19-290, and NH-C23-310 to estimate A-Zone hydraulic parameters. These data will be used to verify hydraulic conductivity values as simulated in the current SFBFS model to define the NHOU extraction well capture zone.
   b. Perform pneumatic slug tests at wells screened primarily in the B-Zone, potentially including NH-C01-450, NH-C02-325, NH-C03-380, NH-C04-240, NH-C22-460, and NH-C24-410 to estimate B-Zone hydraulic parameters.
   c. Perform aquifer tests at NHE-3, NHE-5, and NHE-7 and utilize the new piezometer couplets (see recommendation #3a) as depth-discrete observation points.
      i. Each of these extraction wells should be inspected with a video camera and, if deemed necessary, redeveloped to potentially improve their capacity prior to performing each aquifer test. Rehabilitation waste discharge will be contained and disposed of properly at an off-site location.
      ii. Discharge from each aquifer test will be conveyed to the existing NHOU treatment system. Results from these tests will be used to calibrate the groundwater flow model and verify the capture area associated from NHOU extraction wells under various configurations and pumping scenarios.
3. Piezometer and monitoring well installation:
   a. Phase 1: Prior to developing the Pre-Design Groundwater Modeling Memorandum, install piezometer couplets (i.e., two collocated, hydraulically isolated piezometers to monitor groundwater conditions at different depths) within tens of feet of NHE-3, NHE-5, and NHE-7 (see Figure 6-1). Depth-discrete groundwater samples from these locations will be used to delineate the lateral and vertical distribution of COCs within the A-Zone, differentiate groundwater quality in the B-Zone, and to support the aquifer tests mentioned in recommendation #2c.
   b. Phase 2 **(**tentative)**:** Should additional data be needed following the completion of Phase 1, consider the need to install monitoring well couplets at locations A through E (as illustrated on Figure 6-1) and collect depth-discrete groundwater samples to delineate the lateral and vertical distribution of COCs within the A-Zone and B-Zone throughout the NHOU study area. These locations were selected, in part, with respect to kriged COC concentration contours and kriged standard deviations on Figures 4-7a/b through 4-10a/b; however, their final locations (if necessary) should be evaluated once other recommendations herein have been implemented and augmented data reassessed.

4. Initiate discussions with LADWP regarding the feasibility of modifying NH-east production wells regarding the following possible actions:

    a. Collection of depth-discrete groundwater samples and of vertical flow measurements to further characterize groundwater flow and quality conditions within the NHOU study area, as potentially affected by inactive production wells. Because this recommendation would directly address a critical data gap and could affect the Second Interim Remedy design, this discussion should occur during Phase 1 Pre-Design Investigation activities. The following recommendations represent potential actions independent of the Second Interim Remedy.

    b. Conversion of NH-east wells NH-10, NH-2, and NH-14A into remediation wells to potentially take advantage of existing infrastructure that could facilitate the design and construction of an improved Second Interim Remedy and achieve RAOs.

    c. Conversion of select production wells into multi-screen monitoring wells to mitigate flow through vertical conduits and also take advantage of existing infrastructure to enhance the current monitoring well network.

    d. Installation of temporary packers at select production wells to mitigate flow through vertical conduits.

Each recommended action listed above (Section ES.6) are intended to resolve critical data gaps so that the Second Interim Remedy design process can continue with greater certainty toward achieving RAOs. As requested by the EPA, the NHOU project schedule has been revised (dated March 14, 2012) to include performing the Pre-Design Investigation to implement these recommendations (Appendix H). This revised project schedule is intended to update and replace the schedule included in the RD Work Plan (AMEC, 2011) and in the AOC scope of work.

Given the strong influence municipal pumping has on groundwater elevations and flow direction, it remains imperative that the Groundwater Management Plan be developed before the Preliminary Design Report has been completed. This Plan will provide consensus regarding future pumping and recharge operations that will be used as a basis to successfully design and implement the Second Interim Remedy.

1 INTRODUCTION

AMEC Environment & Infrastructure (AMEC) has been contracted by Honeywell International, Inc. (Honeywell) and Lockheed Martin Corporation (Lockheed Martin) to design the Second Interim Remedy for groundwater remediation at the North Hollywood Operable Unit (NHOU). Note that as of July 5, 2011, MACTEC Engineering and Consulting, Inc. (MACTEC) changed its name to AMEC.

The U.S. Environmental Protection Agency (EPA established an Interim Action Record of Decision (ROD) on September 30, 2009 (EPA, 2009b), referred to as the Second Interim Remedy, intended to upgrade and expand the existing NHOU groundwater remediation system to improve containment, protect water supply production well fields, and address emerging contaminants. An Administrative Settlement Agreement and Order on Consent for Remedial Design (RD), dated February 21, 2011 (AOC; Appendix G), was executed between the United States, Honeywell, and Lockheed Martin to conduct pre-design data acquisition and RD activities associated with the ROD (EPA, 2011b).

This Data Gap Analysis has been prepared to be consistent with the RD Work Plan (AMEC, 2011) and in compliance with the AOC Appendix A (scope of work; SOW) Section 5.1 and Attachment 2 (EPA, 2011b).

1.1 Data Gap Analysis Objectives

Objectives of this Data Gap Analysis are as follows:

1. Evaluate the basis of design for the existing NHOU system and review its historical performance;
2. Develop a refined NHOU conceptual site model (CSM), including but not limited to the following steps:
   a. Evaluate data sources used to monitor groundwater conditions in the NHOU area;
   b. Review geologic, geophysical, and hydrogeologic data and historical groundwater elevations;
   c. Evaluate historical and recent groundwater quality data and chemical of concern (COC) distribution, including COCs unknown at the time of the original NHOU system design;
   d. Review historical groundwater pumping patterns and regional storage changes and evaluate anticipated conditions such that the design will be compatible with future conditions;
3. Identify data gaps of critical importance to the Second Interim Remedy design; and
4. Propose recommendations and a schedule to fill critical data gaps.

1.2 Data Gap Analysis Report Organization

This Report is organized consistent with the RD Work Plan and includes the following components:

ES *Executive Summary*

1.0 *Introduction* – Describe regulatory basis of this report and the objective of this Data Gap Analysis;

2.0 *NHOU Remediation Objectives* – Defines the NHOU study area and reviews the Second Interim Remedy remedial action objectives (RAOs) and AOC work scope items;

3.0 *Data Summary* – Summarizes data associated with previous basin-scale investigations and hydrogeologic conditions within the NHOU study area, including the original basis of existing NHOU design and construction, groundwater elevation and analytical data, and production well field operations;

4.0 *Data Evaluation and Discussion* – Presents the refined hydrogeologic and remedial CSM based on findings on geologic, geophysical, and groundwater quality data, and previous investigations, historical analytical data and COC plume migration patterns; provides an assessment of groundwater flow and gradients and a review of historical NHOU operations records;

5.0 *Data Gap Analysis* – Presents data gaps associated with RAOs, AOC scope items, and critical path project documents (e.g., Treatment Options Memorandum and Groundwater Model Memorandum) and recommends actions to resolve critical data gaps in order to proceed with the Preliminary RD process;

6.0 *Recommendations* - Discusses recommendations to resolve critical data gaps; and

7.0 *References*.

Additional information is contained in appendixes as follows:

A. NHOU Extraction Wells Assessment

B. Previous NHOU Performance Evaluations

C. Depth Regions 1 and 2 COC Concentration Contour Maps

D. COC Concentration Variograms

E. Groundwater Quality Depth Profiles

F. Time Concentration Profiles

G. Agreement and Order on Consent for Remedial Design

H. March 14, 2012 Revised NHOU Project Scheule and Responses to EPA Comments on the *Draft Data Gap Analysis, North Hollywood Operable Unit Second Interim Remedy, Groundwater Remediation System Design* (dated February, 21, 2012).

2 NHOU REMEDIATION OBJECTIVES

This Section describes the NHOU remediation objectives with respect to RD objectives and the AOC work scope items specific to the Second Interim Remedy. These objectives and work scope items form the basis of the critical data gap analysis discussed in detail in Section 5.

2.1 Study Area

The NHOU study area has been defined differently as additional data have become available during ongoing investigations and remediation efforts:

- The EPA initially divided the San Fernando Valley (SFV) into four areas as part of their proposal to add SFV to the National Priorities List (NPL) in 1984. Area 1 included the North Hollywood area and formed the basis of the 1987 ROD (EPA, 1987) which, on its completion, established the first of several Operable Units in the SFV. The Burbank Operable Unit (BOU) was defined in 1996 and is also within SFV Area 1.
- Monitoring wells installed in the 1990s as part of the SFV Basin (SFB) remedial investigation (RI) program originally associated with the "North Hollywood area" subsequently became associated with areas beyond what is now recognized as the NHOU study area. For example, cluster well NH-C04 is within Area 3 and is associated with the Glendale Operable Unit (GOU) (North).
- The Second Partial Consent Decree (EPA, 1996) defined the "NHOU Site" as comprising "the areal extent of hazardous substance groundwater contamination that is presently located near the North Hollywood Well Field and includes any areas to which and from which such hazardous substance groundwater contamination migrates."
- As defined in the Second Interim Remedy ROD, the NHOU Site "…comprises approximately 4 square miles of contaminated groundwater underlying an area of mixed industrial, commercial, and residential land use in the community of North Hollywood." As stated further in the AOC, the NHOU "…includes any areas to which and from which such hazardous substance groundwater contamination migrates."
- Monitoring wells installed in 2009 and 2010, constructed to fill data needs identified in the Focused Feasibility Study (FFS; EPA, 2009a) were placed in an area covering approximately 10 square miles centered on the NHOU area (MWH Americas, Inc. [MWH], 2010).

The area depicted on Figure 2-1 is used throughout this report to focus the data gap analysis on information directly pertinent to designing the Second Interim Remedy. Data from this area (to a depth of approximately 500 feet below ground surface [bgs]) includes most of the recent 2009/10 characterization efforts and other wells throughout the area that are collectively reviewed herein to evaluate and identify data gaps critical to the Second Interim Remedy design.

2.2 Remedial Action Objectives

As stated in Section 2.8 of the ROD, the Second Interim Remedy for the NHOU is intended to achieve the following RAOs:

- Prevent exposure to contaminated groundwater above acceptable risk levels;
- Contain areas of contaminated groundwater that exceed the maximum contaminant levels (MCLs) and notification levels to the maximum extent practicable;

- Prevent further degradation of water quality at the Rinaldi-Toluca and North Hollywood (west) production wells by preventing the migration toward these well fields of the more highly contaminated areas of the volatile organic compound (VOC) plume to the east/southeast;
- Achieve improved hydraulic containment to inhibit horizontal and vertical contaminant migration in groundwater from the more highly contaminated areas and depths of the aquifer to the less contaminated areas and depths of the aquifer, including the southeast portion of the NHOU near the Erwin and Whitnall production well fields; and,
- Remove contaminant mass from the aquifer.

Because surrounding large-capacity production well fields (Figure 2-1) capture portions of the VOC plume (as defined by concentrations greater than 5 micrograms per liter [µg/L]) and will continue to operate to meet municipal water demand, it will not be possible to hydraulically capture all contaminated groundwater. Rather, the NHOU Second Interim Remedy is intended to establish a target capture zone that contains high concentration portions of the plume (and other portions above regulatory limits to the extent practicable) and operates to prevent further groundwater quality degradation occurs at or near the Rinaldi-Toluca and North Hollywood (west) production well fields. For the purposes of the RD, high concentration portions of the plume can be defined as ten times the applicable drinking water criteria, as implied in the FFS (EPA, 2009a) and ROD, and as defined in California Department of Public Health (CDPH) 97-005 guidelines for compounds posing chronic health effects.

To achieve RAOs and capture high concentration portions of the plume, the approach to the RD focuses on five major steps:

- Update the current CSM and the SFB numerical groundwater flow model, considering recently obtained groundwater elevation and analytical data, and identify data gaps and evaluate how these gaps may affect the RD;
- Refine and re-run the SFB groundwater flow model to develop a remedial well field configuration basis (including the number of wells, their locations, depths, peak and average flow rates) that results in hydraulic capture of groundwater with higher concentrations (i.e., the target capture area) and, to the maximum extent practicable, hydraulic control of groundwater with constituent concentrations greater than the applicable current drinking water quality criteria, with consideration for future LADWP drinking water supply needs;
- Account for current projections of future spreading and municipal pumping plans;
- Evaluate available groundwater quality data and anticipated groundwater extraction rates to establish influent water quality to the NHOU system; and,
- Design and implement a groundwater treatment system to increase the mass of COCs that is withdrawn at optimal flow rates via the remediation well field configuration.

2.3 AOC Work Scope

This Data Gap Analysis will, in part, consider whether sufficient data exist to complete the work scope as required by the AOC. The current CSM and numerical groundwater flow model, existing well designs, ongoing data collection plans, groundwater elevation values, analytical results, and hydraulic test results are reviewed with respect to supporting the Second Interim Remedy. If sufficient data exist, the refined CSM and numerical model will be used to evaluate the following items as stated in the AOC:

- **Additional Groundwater Monitoring**

  Additional monitoring wells have already been installed and samples collected (MWH, 2010b). Data from these monitoring wells and recent NHOU-wide groundwater sampling events will be evaluated to refine the hydrostratigraphy and distribution of COCs in NHOU groundwater. This Data Gap Analysis will consider whether incorporation of data from these wells has filled previously recognized data gaps or additional groundwater flow and quality characterization is necessary.

- **Replacement of Existing Extraction Wells and Installation of New Extraction Wells**
  The ROD specifies the replacement or modification of existing extraction wells and the installation of up to three new extraction wells, as follows:

  - **Replacement of Existing Extraction Well NHE-1**

    The ROD states that a deeper well of similar construction is necessary to achieve the required hydraulic containment.

  - **Replace or Repair and Modify Extraction Wells NHE-2, NHE-4, and NHE-5**

    The ROD states that replacement of wells NHE-2, NHE-4, and NHE-5 with deeper wells of similar construction or possibly new adjacent wells will likely be necessary to achieve the required hydraulic containment of the contaminated groundwater plume.

  - **Construction of New Extraction Wells**

    The ROD states that new extraction wells are necessary to further limit contaminant migration and to improve mass removal. Previous modeling conducted for the FFS indicated that up to three new wells would be required northwest of the existing treatment system. A plan for optimizing the pumping rates of the new NHOU extraction well system shall be developed as part of the design. During pre-design data acquisition and design, existing data and data gathered as part of this SOW will be used to verify the need for and determine the optimal location, depth, and pumping rate of these three wells.

- **Wellhead Treatment at NHE-2**

  Based on EPA's selected alternative, wellhead treatment for hexavalent chromium and 1,4-dioxane was required at NHE-2. Honeywell has been developing an approach to treatment and disposal of water extracted from NHE-2 pursuant to a Cleanup and Abatement Order (CAO) issued by the Regional Water Quality Control Board - Los Angeles Region (RWQCB-LA). Subsequent discussions among Honeywell, the EPA, and the RWQCB-LA resulted in their agreeing to rescind the NHE-2 portion of the CAO and cede oversight of RD and remedial action of NHE-2 to the EPA under a separate AOC with Honeywell. Because Honeywell is addressing ROD requirements regarding NHE-2 under a separate AOC, the NHE-2 wellhead treatment component of the ROD was not included in the scope of the RD Work Plan.

  Honeywell has selected MWH as the lead designers for the NHE-2 remedy. Because NHE-2 is an integral part of the NHOU, AMEC will collaborate closely with MWH during the Preliminary Design Phase of this project to achieve the hydraulic containment of the groundwater plume required by the ROD and to ensure that the NHE-2 alternative selected is consistent with the RAOs for the Second Interim Remedy.

- **Treatment of VOCs in Extracted Groundwater**

  The ROD states that expansion of VOC treatment capacity at the NHOU will be necessary to treat the volume of groundwater produced by existing and proposed new extraction wells. The degree of expansion required will be evaluated during the RD phase.

- **Ex Situ Treatment for Hexavalent Chromium**

  Information developed for the FFS and the ROD indicated that treatment for hexavalent chromium would be required for some of the existing and new groundwater extraction wells.

- **Delivery of Treated Groundwater to LADWP**

  The RD work for the Second Interim Remedy will provide for the delivery of treated groundwater to LADWP for use in its municipal supply system. For purposes of the RD and Remedial Action, the point of compliance for all performance standards shall be the discharge point of the treatment facility, after passing through the "double barrier" treatment system, just upstream of the LADWP header line. LADWP, as the water utility, will have to prepare, submit, and comply with CDPH's Policy Memorandum 97-005. To the extent that CDPH 97-005 guidance applies to the NHOU, it will be considered throughout the RD process. Once the extraction well locations, depths, pumping rates, and capture zones have been determined, AMEC will support LADWP in the assembly of information necessary for the CDPH 97-005 process.

The AOC accounts for flexibility within the ROD, which acknowledges that "further evaluation of specific pumping rates and extraction well locations will be performed during RD to ensure that implementation of the Second Interim Remedy will not cause additional degradation of the aquifer". Additionally, the ROD states that "if new data collected prior to or during RD indicates that a different configuration of extraction wells is more effective and cost effective than the configuration described in the Proposed Plan, then that different configuration will be considered for implementation as part of the Second Interim Remedy".

The ROD also states that "if an offsite drinking water requirement changes, the treatment system must meet whichever standard – the performance standard selected in the ROD or the off-site requirement – is lower". Since the ROD was promulgated, the notification level for 1,4-dioxane was lowered from 3 µg/L to 1 µg/L. To maintain compliance with CDPH requirements, this change will likely result in design changes to the treatment system described in the Proposed Plan.

Considering the lower 1,4-dioxane notification level and additional data generated at recently installed monitoring wells, this Data Gap Analysis examines whether sufficient data exist to modify locations, depths, and pumping rates of the existing NHOU extraction (NHE) wells or to install new NHE wells, or whether sufficient data exist to conclude that the Proposed Plan will be effective relative to long-term water management plans within the SFB.

3 DATA SUMMARY

This section summarizes data that formed the original basis of the original NHOU treatment system design and subsequent data generated since operations began in 1989, and forms the basis of evaluation of previous data (Section 4) and identification of data gaps (Section 5) that need to be filled to complete the Interim Remedy Design.

3.1 San Fernando Valley Groundwater Basin

The San Fernando Valley groundwater basin (SFB) is one of several basins in the Upper Los Angeles River Area (ULARA) within the Los Angeles River Watershed in the County of Los Angeles. The Verdugo, Sylmar, and Eagle Rock basins are hydraulically distinct from the SFB and not discussed herein. The SFB area is approximately 145,000 acres (226 square miles), including the SFV proper, the Tujunga Valley, Browns Canyon, and the alluvial areas surrounding the Verdugo Mountains near La Crescenta and Eagle Rock. The basin is bounded on the north and northwest by the Santa Susana Mountains, on the north and northeast by the San Gabriel Mountains, on the east by the San Rafael Hills, on the south by the Santa Monica Mountains and Chalk Hills, and on the west by the Simi Hills. Geologically recent channels within the NHOU study area are associated with the Tujunga Wash and are apparent on the Preliminary Geologic Map of the Los Angeles Quadrangle (Figure 3-1). The valley is drained by the Los Angeles River and its tributaries. Annual precipitation typically ranges from 15 to 23 inches throughout the SFV and has averaged 18 inches in the North Hollywood area since 1949 (California Department of Water Resources , 2003; LACDPW, 2011[1]).

The following sections briefly describe the history of groundwater production and adjudication, geology and hydrostratigraphy, and groundwater remediation history of the SFV.

3.1.1 Groundwater Management

During the 1930s, most land in the SFV was occupied by farms, orchards, and ranches. By 1949, nearly all the land in Burbank and North Hollywood was occupied by housing developments, industrial facilities, retail establishments, and the Burbank Airport. Accompanying these land use changes in the 1940s was a substantial increase in population and groundwater withdrawals from the SFB. Beginning as early as 1924, the North Hollywood, Erwin, Whitnall, and Verdugo Well Fields were constructed by the LADWP in the North Hollywood area to meet the increasing demand for potable water.

3.1.1.1 Adjudication

In 1968, water rights in the ULARA were established, and groundwater withdrawals from the SFV were reduced to achieve “safe yield” from the basin (approximately 104,040 acre-feet per year [AF/Y]). Final judgment in 1979 further restricted groundwater withdrawals, included provisions regarding water rights and storage, and established a ULARA Watermaster to track groundwater elevation and analytical data; water usage, storage, and disposal; and water imports to the SFV groundwater basin (ULARA Watermaster, 2011a).

3.1.1.2 Groundwater Extractions

Significant groundwater extraction occurs from the SFB to support water demands by the Cities of Los Angeles, Burbank, and Glendale. In the NHOU area, production well fields are operated by the LADWP and include two North Hollywood well fields (west and east), the Tujunga, the

[1] Total monthly precipitation data from North Hollywood gauge 13B (North Hollywood - Blix) and 13C (North Hollywood - Lakeside). Data from 1949 through 1983 are from gauge 13B, which was replaced by gauge 13C.

Rinaldi-Toluca, the Erwin, and the Whitnall well fields (Figure 3-2). Several privately owned production wells supply relatively minor amounts of groundwater to various other industrial and commercial entities within the SFB. Average groundwater extraction since 1968 is approximately 100,834 acre-feet (ULARA Watermaster, 2011a).

Cumulative annual extraction from these wells is monitored by the ULARA Watermaster; approximate values for the municipal SFB well fields during water year 2009/2010 are summarized on Table 3-1 and are illustrated on Figure 3-2. Relative volumes of extracted groundwater since 1989 are illustrated on Figure 3-3.

Table 3-1. Summary of Cumulative Well Field Production for Water Year 2009/10

Well Field Name	Rated Capacity (AF) (ULARA Watermaster, 2011c)	Extracted Volume (AF) (ULARA Watermaster, 2011a)
City of Burbank (including BOU)	17,755	10,048
City of Glendale (including North GOU and South GOU)	8,393	7,935
City of Los Angeles well fields:	229,940	59,959
NHOU	1,738	1,177
Erwin	4,419	1,234
North Hollywood (west)	50,422*	12,434
North Hollywood (east)		0
Pollock	4,274	3,120
Rinaldi-Toluca	81,863	20,224
Tujunga	71,140	16,547
Verdugo	5,360	1,926
Whitnall	10,722	3,297
Total		**77,942**

* North Hollywood well field rated capacity is not differentiated between east and west wells

Allowable pumping from the SFB is the calculated total of the native safe yield credit, import return credit, and the available stored water credit; in water year 2010/11, the total allowable pumping is 234,044 acre-feet (ULARA Watermaster, 2011a). Because significant pumping from these well fields (as limited by water rights allocations and the 2007 Stipulated Agreement) influences groundwater elevations and flow directions, well fields within the NHOU study area are discussed in detail in Section 3.2.4.

3.1.1.3 Groundwater Sources and Recharge Facilities

Recharge to the SFB includes infiltration from seasonal rainfall (typically between November and April); infiltration beneath streams from surrounding mountains; runoff from impervious surfaces; reclaimed wastewater from the Tillman, Burbank, and Los Angeles-Glendale Water Reclamation Plants; industrial discharges; storm water percolation through the Branford, Hansen, Lopez, and Pacoima Spreading Grounds; and imported water via the Los Angeles Aqueduct and Metropolitan Water District (ULARA Watermaster, 2011a).

Precipitation within the SFV floor area averages (100-year record) 16.48 inches annually; the surrounding hill and mountain area receives approximately 21.79 inches on average (ULARA Watermaster, 2011a). Precipitation records from local gauges indicate an annual average of 18 inches since the 1949/50 water year (Los Angeles County Department of Public Works [LACDPW], 2011); annual precipitation totals and differences from the annual average are summarized in Table 3-2. Much of the potential recharge associated with this precipitation is routed to the Los Angeles River as runoff via impervious surfaces and lined drainage channels.

Imported waters originate from the Los Angeles Aqueduct, including sources in the Eastern Sierra Nevada and Owens Valley, and from the Metropolitan Water District, including the State Water Project and from the Colorado River Aqueduct. The net volume of imported water in water year 2009/10 was 469,010 AF (ULARA Watermaster, 2011a).

Significant groundwater recharge occurs at five spreading grounds, flood control structures in the northern portion of the basin, and percolation of ambient precipitation, the last of which is less significant because of runoff from impervious surfaces associated with urban development and discharge into the Los Angeles River. The Branford, Hansen, Lopez, and Pacoima spreading grounds are managed by the LACDPW and the Tujunga spreading grounds are operated with cooperation between LACDPW and the City of Los Angeles (ULARA Watermaster, 2011a). None of these spreading grounds is within the NHOU study area; however, associated recharge from each facility affects storage throughout the SFB. Recharge volumes at each spreading ground for Water Year 2009/10 are summarized in Table 3-3. By comparison, annual recharge at these facilities has averaged 32,000 AF since 1968 (ULARA Watermaster, 2011a).

Table 3-3. Summary of Cumulative Spreading Grounds Recharge for Water Year 2009/10

Spreading Facility	Recharge Volume (acre-feet)
Branford	535
Hansen	16,766
Lopez	274
Pacoima	9,080
Tujunga (LACDPW)	12,849
Tujunga (City of Los Angeles)	7,509
Total	**47,047**

The Strathern Pit, which is within the NHOU study area, has been proposed to be converted into a stormwater retention and recharge facility (ULARA Watermaster, 2011c). These plans are part of the Sun Valley Management Plan that includes additional storm water retention and recharge projects, including a parking lot infiltration project on Sherman Way between the former Bendix facility and the Burbank Airport (LACDWP, 2004a and 2004b).

3.1.1.4 SFB Management

In 2007, the ULARA Watermaster produced a White Paper (*Is the San Fernando Groundwater Basin Undergoing a Long-Term Decline in Storage?*) to reiterate conclusions made in previous

Annual Watermaster Reports that SFB storage has, in fact, been declining despite the "safe yield" status of basin operations since 1968. Previously observed increases in storage are portrayed as the result of additional water imports to the SFB rather than actual storage recovery following the safe yield operations mandated by the 1979 Judgement. Another significant issue discussed in the White Paper is the matter of water credits that have accrued since production wells' operations declined in the 1980s in response to the discovery of widespread groundwater contamination. When imported water volumes and stored water credits were accounted for, SFB storage was approximately 259,138 AF below the 1968 level (when implementation of safe yield operations was required).

Recommendations by the ULARA Watermaster to reverse the downward trend in SFB storage included:

- Re-evaluate the SFB safe yield;
- Perform a hydrologic study in the Narrows area to more accurately calculate (rather than estimate) the amount of groundwater draining from the SFB;
- Restore the Tujunga Spreading Grounds to their full capacity and implement use of additional spreading grounds whenever possible to maximize recharge;
- Modernize and upgrade spreading grounds facilities and operations to increase recharge;
- Construct projects associated with the Los Angeles River Revitalization Master Plan to increase recharge; and
- Fully account for pumping that occurs in the hill and mountain areas and permanent or temporary dewatering operations.

The ULARA Watermaster reports and these recommendations led to the *Interim Agreement for the Preservation of the San Fernando Basin Water Supply* (Stipulated Agreement; California Superior Court, 2007) wherein the Cities of Burbank, Glendale, and Los Angeles and the Crescenta Valley Water District implemented a 10-year plan (effective September 2007) with three key provisions:

1. Segregate total stored water credits into “available credits” (the amount of stored water credits above the 1968 storage level) and “reserved credits” (the amount of stored water credits below the 1968 storage level. Reserved credits are not supported by the actual groundwater storage in the SFB and may not be pumped until SFB storage recovers to allow their safe use.
2. Restore and enhance artificial recharge of storm water runoff within the SFB.
3. As of October 1, 2007, debit the estimated volume of the loss from the SFB due to rising groundwater (i.e., the groundwater rising to ground surface and discharging to the Los Angeles River) and underflow from each stakeholder's stored water credits to restore balance between stakeholder water rights and SFB hydrology.

Groundwater extraction projections for 2010-2015 (ULARA Watermaster, 2011c) from municipalities in the SFB are lower than those included in the FFS, which were based on projections available before development of the Stipulated Agreement. Simulation of additional recharge activities combined with lower projected pumping rates, particularly at LADWP production wells, indicates that groundwater elevations could rise by approximately 50 feet in the NHOU area by Fall 2015. If achieved, groundwater elevations would resemble those measured between 1944 and 1958 (California State Water Rights Board [now known as the State Water Resources Control Board], 1962, Plates 29 and 30). Significant differences in municipal pumping rate projections between those included in the FFS (EPA, 2009a) and those reported by the Watermaster (ULARA Watermaster, 2011c) presents a critical data gap with respect to developing the Second Interim Remedy design, as discussed in Section 5.

3.1.1.5 LADWP Groundwater System Improvement Study

The LADWP initiated a six-year *Groundwater System Improvement Study (GSIS)* in 2009 that is intended to provide additional information to support ongoing water resources projects (LADWP, 2010e). Activities comprising the GSIS include the following:

- Identification, characterization, and evaluation of emerging chemicals in the SFB;
- Expert evaluation of the LADWP groundwater facilities and current operational strategies regarding treatment, regulations, and production well refurbishment;
- Installation of approximately 40 monitoring wells to further characterize the SFB;
- Development of a research monitoring program to characterize the nature and extent of constituents of concern that may pose a risk to LADWP’s ability to maximize its use of the SFB as a water supply; and
- Provide recommendations regarding short- and long-term capital improvement projects to satisfy regulatory requirements.

The outcome of this study is intended to support the development and installation of Groundwater Treatment Facilities near the North Hollywood, Rinaldi-Toluca, and Tujunga well fields, with construction potentially starting by 2016. The Groundwater Treatment Facilities are anticipated to allow LADWP to further benefit from its efforts to enhance recharge to the SFB. Because these plans will directly affect the performance of the Second Interim Remedy, the GSIS includes the development of a Groundwater Management Plan that will be developed through an Institutional Control Implementation and Assurance Plan (ICIAP) with the EPA and the LADWP. The Groundwater Management Plan is intended to ensure that LADWP plans do not adversely affect ongoing cleanup operations overseen by the EPA.

Additionally, LADWP has deployed pressure transducers/data loggers in 115 monitoring wells throughout the SFB as part of ongoing efforts to quantify groundwater storage changes. Measurements from several wells associated with the NHOU area (including NH-C01 through NH-C06 and vertical profile boring [VPB] NH-VPB-01, -02, and -06) are anticipated to be available by fourth quarter 2011; data from additional wells in the NHOU area (including NH-VPB-03, -05, and -08) are anticipated to be available thereafter (ULARA Watermaster, 2011b). Wells included in this program that are within the NHOU study area are shown on Figures 3-4a through 3-4d.

3.1.2 Previous Basin-Scale Hydrogeologic Investigations

Groundwater extracted from the SFB by the LADWP accounts for approximately 11 to 15 percent of the Los Angeles drinking water supply (LADWP, 1983; EPA, 2008b). Since 2005, the SFB provides 79 percent of the local groundwater supply to the City of Los Angeles (LADWP, 2010e). Until widespread contamination was discovered in the early 1980s, the understanding of SFV geology and hydrogeology was primarily based on drillers' logs, groundwater elevations, and groundwater quality obtained from production wells. These data were used to formulate the CSM described in the Report of Referee (California State Water Rights Board, 1962), a significant compendium of findings produced as part of litigation initiated in 1958 that led to the SFB adjudication of water rights.

The 1992 SFV RI was conducted, in part, in response to the need to improve the geologic and hydrogeologic CSM of the SFB. Development of the groundwater model and other investigations in the SFV (e.g., the BOU), however, have resulted in multiple geologic and hydrogeologic terms that complicate correlation between investigation areas. Figure 3-5 illustrates the nomenclature used in various investigations, groundwater model development, and geologic units defined by the ULARA Watermaster to facilitate development of the refined CSM as described in Section 4.

3.1.2.1 Report of Referee (1962)

The Report of Referee (California State Water Rights Board, 1962) was prepared in response to an Order by the Superior Court of California to, among other things, investigate and report on physical facts regarding the geographic and hydrologic boundaries of the Los Angeles River and its tributaries; describe the geology to the extent that it affects the occurrence and movement of groundwater; define the geographic and hydrologic boundaries for all watersheds supplying the Los Angeles River; and quantify water supply needs of, and sources to, the plaintiff and defendants.

The Report of Referee was extensively cited in subsequent geologic and groundwater papers regarding the SFB and provided the basis for the basin-wide CSM until the early 1980s. The SFB was described in terms of an alluvial basin depositional model (i.e., stream deposits) resulting in three water-bearing units: Recent Alluvium, Older Alluvium, and the Saugus Formation. Sediments were described as lenticular deposits oriented roughly parallel to the stream course; clay deposits were described, in part, as the result of subsurface weathering regulated by a fluctuating water table (essentially consistent with paleosol development).

Basin-scale geologic cross-sections G-G' and M-M' of the report pass through the NHOU area, but no details were provided concerning specific depth contacts between the Recent and Older Alluvium or the Saugus Formation. In general, it was reiterated, from findings of previous investigations and establishment of large pumping centers, that the eastern portion of the SFB basin contains coarser sediments than the western portion (i.e., west of the Pacoima Wash).

Groundwater was described as generally flowing to the southeast toward the Los Angeles Narrows (near Glendale) based on measurements recorded at various production wells throughout the SFB. Measurements between 1931 and 1958 indicated that groundwater elevations in the western portion of SFB, where limited groundwater withdrawal occurs, had generally increased, while water table elevations in the eastern portion (generally east of the Pacoima Wash and the 405/San Diego Freeway) had declined by up to 100 feet near Burbank and over 50 feet in the North Hollywood area. These findings, in part, formed the basis of adjudicating the SFB with the intent to implement a “safe yield” management strategy and to reverse overdraft conditions. Analytical data describe major cations and anions reflecting general groundwater quality.

3.1.2.2 SFB Groundwater Contamination Investigation (1979 – 1989)

Commensurate with increasing groundwater production was the use of chlorinated solvents and metals solutions associated with a rapidly growing heavy industry in the SFV. Trichloroethene (TCE) and tetrachloroethene (PCE) were widely used in the SFV starting in the 1940s for degreasing machinery and dry cleaning. Industrial waste disposal was not well regulated at that time (sanitary sewerage volume was monitored throughout the study area by the 1950s (California State Water Rights Board, 1962), but quality was not considered until this investigation), and releases from many facilities were known or suspected to have occurred throughout the eastern SFV (LADWP, 1983). In 1979, TCE and PCE were detected in groundwater in the San Gabriel Valley (to the east of the SFV), prompting the CDPH (formerly the California Department of Health Services [DHS]) to request that all major water providers in the region, including those in the SFV, sample and analyze groundwater for potential industrial contaminants.

The discovery of VOCs in San Fernando and San Gabriel area production wells led to the initiation by the Southern California Association of Governments and LADWP of a two-year study that began in July 1981 to determine the extent and severity of the contamination and to develop strategies to control the problem. The resulting Groundwater Quality Management Plan (GQMP; LADWP, 1983) summarized analytical results from groundwater samples collected from 135 production and monitoring wells and included eight recommendations. The first six recommendations focused on prevention of future contamination by improvement of management, handling, storage, and disposal of hazardous materials at facilities throughout the area. The last two recommendations addressed remedial actions for the current contamination (as then known) and included engineering strategies to restore use of groundwater for potable use.

Based on the known extent of groundwater contamination in the SFV and the impact of that contamination on numerous municipal water supply wells, EPA proposed four SFV Sites to the NPL in 1984 and defined them as areas of regional groundwater contamination. Three of the four Sites (Areas 1, 2 and 4) are contiguous areas within which are several well fields that serve the water supply systems for the cities of Los Angeles, Burbank and Glendale. The fourth Site, Area 3, lies in the Verdugo basin, a geographically separate area of the eastern SFV (see AOC Figure 1).

SFV Area 1, a portion of contaminated groundwater upgradient of the LADWP's North Hollywood well field, was selected as the site for implementation of the initial interim remedy – the existing NHOU Extraction and Treatment System. Remedial actions were given fast-track status because of the potential for contamination to spread to other well fields and areas of uncontaminated groundwater. The design basis and development of the NHOU is discussed in Section 3.2.

EPA listed the SFV Sites as "groundwater only" (i.e., only the regional groundwater contamination was intended to be addressed by EPA's Superfund program) with the intent to focus on addressing the regional groundwater contamination, with an agreement with the state agencies to address known and potential source areas (see Section 3.14). From the late 1980s to late 1990s, EPA provided funds to the RWQCB-LA to assess facilities in the SFV to determine the extent of solvent usage and to assess past and current chemical handling, storage, and disposal practices. These investigations were conducted pursuant to the RWQCB-LA's Well Investigation Program and resulted in source remediation activities under RWQCB-LA oversight at several facilities within the SFV. Source investigations and remediation activities are in progress under the lead of the RWQCB-LA and the California Department of Toxic Substances Control (DTSC), as discussed in Section 3.3.6.

Results of these regulatory-driven efforts culminated with RODs and the establishment of Operable Units for the North Hollywood, Burbank, and Glendale (north and south) areas in 1987, 1989, and 1993, respectively.

3.1.2.3 Remedial Investigation (1992)

The SFV RI was conducted by J. M. Montgomery, Inc., (JMM) for the LADWP under cooperative agreement with the EPA; the RI report was issued in 1992. The RI was intentionally designed to address regional groundwater flow and quality and did not specifically focus on individual operable units (including the NHOU). The RI report relied on various drillers' logs from throughout the SFB and documented RI-related activities including: drilling; geologic and geophysical logging; well installation; soil, soil vapor, and groundwater testing; and aquifer testing performed between 1987 and 1992 (JMM, 1990, 1992).

Findings from the RI were combined with pre-existing information (i.e., drillers' logs) to formulate a basin-wide geologic and hydrogeologic CSM (RI CSM). JMM recognized four major depositional events and indicated that correlating strata (called the Upper, Middle, Lower, and Deep Zones) exhibited similar characteristics. The RI CSM formed the basis for the basin-wide numerical groundwater flow model (SFBRI model), which was subsequently refined by CH2M Hill on behalf of the EPA. The SFBRI model, updated annually, continues to be used by the LADWP with output (e.g., simulated groundwater elevation contour figures) included in the annual ULARA Watermaster reports.

The four major strata are described as follows:

- The Upper Zone was described as comprising fine sand and gravel interbedded with silt; the top of this unit was defined by the water table (40 to 200 feet bgs) and was noted as unsaturated northwest of the North Hollywood area with saturated thickness increasing toward the Crystal Springs area (up to 210 feet). Hydraulic conductivity values for this zone were estimated to range from 32 to 306 feet per day (ft/d) in the North Hollywood area, approximately 100 ft/d in the Crystal Springs area, and approximately 361 ft/d in the Pollock area.
- The Middle Zone was described as a less permeable unit representative of off-channel deposits consisting of clay, silt, and fine sand units that generally extend between 200 and 250 feet bgs throughout the SFB. However, noted discontinuities led to the conclusion that understanding local scale geologic and hydraulic properties and the thickness and lateral continuity of this Zone would require additional geologic and geophysical logging at additional boreholes and the collection of depth-discrete groundwater elevation and analytical data. Hydraulic conductivity values for this Zone were not estimated other than as less than those of the Upper and Lower Zones.
- The Lower Zone was described as including coarse sand, gravel, and cobble sediments that immediately underlie the Middle Zone with a saturated thickness of 200 to 250 feet. Most production wells are screened at least in part within this zone. The full extent of the Lower Zone's saturated thickness had not been determined for lack of sufficient wells installed to depths correlating with the underlying Deep Zone. The hydraulic conductivity of this zone was estimated to range from 237 to 627 ft/d in the North Hollywood area and from 189 to 864 ft/d in the Crystal Springs area.
- The Deep Zone was described as potentially including portions of the Saugus Formation and had elevated calcium and sulphur concentrations, apparently resulting from poor groundwater circulation. Hydraulic conductivity values for this zone were not estimated due to an insufficient number of boreholes and lack of hydraulic test results.

Monitoring wells installed as part of this effort included vertical profile borings (wells named with a “NH-VPB” prefix), most of which were screened in the Upper Zone, and cluster monitoring wells (wells named with a “NH-C” prefix), most of which were screened at various depths within the Lower Zone. Wells within the NHOU study area are discussed in more detail in Section 3.2.2.

Groundwater elevations in the Upper and Lower Zones were measured from surveyed reference points (National Geodetic Vertical Datum of 1929 [NGVD29]) throughout the SFB. Measurements were recorded in September 1990 and August 1991 to represent groundwater flow conditions during periods of high pumping conditions and in January 1991 to represent periods of low pumping conditions. Interpreted elevation contours indicated that pumping from the Lower and Deep Zones created a groundwater depression in the Upper Zone near the Rinaldi-Toluca and North Hollywood well fields. The Upper Zone depression as illustrated in the RI (JMM, 1992 Figures 5-19 and 5-23) extended over an area that included NHOU extraction wells NHE-1 through NHE-6. This depression was not observed in the January 1991 measurements when pumping rates had declined, consistent with seasonal demand. The RI concluded that SFB groundwater elevations in the Upper and Lower Zones are both significantly controlled by seasonal groundwater extraction operations and that precipitation events influence groundwater elevations in only the uppermost saturated units.

Soil gas samples were collected from depths of 6 to 7 feet bgs in the Pollock, Verdugo, Crystal Springs, and North Hollywood study areas; however, initial findings suggested that the applicability of this method in the North Hollywood area was unsatisfactory and subsequent soil gas sampling activities did not include this area (JMM, 1992).

Groundwater samples collected from vertical profile boring wells and cluster monitoring wells were initially analyzed for VOCs, base-neutral and acid extractable organic compounds (BNAs), chlorinated pesticides, polychlorinated biphenyls (PCBs), metals, inorganics, and radionuclides. Samples were not analyzed for BNAs, chlorinated pesticides, radionuclides, and PCBs in subsequent sampling events because they were not detected or only few detections were noted in the initial sampling events. TCE and PCE were the most prevalent COCs detected at concentrations above MCLs.

3.1.2.4 Groundwater Model Development

Throughout the recent history of the SFB, numerical groundwater modeling has been employed to investigate groundwater flow within the SFB. Objectives of the modeling have been to better understand the short- and long-term flow conditions and to evaluate potential measures to remediate and contain contaminant plumes. Some local models have been developed, but the principal model used for these purposes has a domain that covers nearly the entire SFV area. Incorporating data gathered over several investigations, the SFVRI model was initially developed with the 1992 remedial investigation by JMM for LADWP in cooperation with the EPA.

The SFVRI model domain included approximately 163 square miles with a perimeter coincident with the boundary between the SFV floor and surrounding highlands (JMM, 1992). A variable-sized grid was used to allow higher resolution in the eastern half of the SFB, including the RI study area and most significant pumping centers. The model was constructed with four layers:

- Layer 1: represented the Upper and Middle Zones;
- Layer 2: represented the upper portion of the Lower Zone;
- Layer 3: represented the lower portion of the Lower Zone; and
- Layer 4: represented the Deep Zone.

Layer 1 included both the Upper Zone and the upper portion of the Middle Zone because of significant fluctuations in the water table elevation and because these units are difficult to distinguish from one another, suggesting a gradational contact. Each layer covered a progressively smaller area, consistent with the constricted nature of alluvial sediments with depth and the geometry of the basin bedrock floor. The LADWP continues to use the SFVRI model.

CH2M Hill modified and refined the SFVRI model to support the basin-wide Feasibility Study conducted by the EPA in 1994 (CH2M Hill, 1994). Combined with simulated groundwater flow pathlines, the revised SFBFS model for the Feasibility Study (SFBFS model) was developed with the intent to evaluate (1) the effectiveness of the NHOU, BOU, and GOU; (2) potential impacts to human health under current conditions; and (3) potential options for additional basin-wide remediation.

The SFBFS model has undergone several modifications since 1992. The selected model code has progressed from MODFLOW88 and MODFLOW-P to MODFLOW-SURFACT to better handle extreme conditions in the model, primarily the drying up of model cells during simulations of lowered water table conditions in Depth Region 1. Other modifications include refinement of the model grid spacing in the NHOU area (to a 50-by-50 foot spacing), boundary condition effects (such as deletion of fault effects), and addition to and modification of zones of hydraulic conductivity in the model. Distributions of hydraulic conductivity in the model have changed in response to added data from pumping tests, geologic description assessments, and recalibration of the model as the database of available water level readings from a large array of monitoring wells expanded over time.

The SFBFS model layer geometry was initially based on production well screen intervals and included four “depth regions” that roughly corresponded with the four layers comprising the SFVRI model. Depth Region 1 consists of about 200 feet of vadose zone and about 100 feet or less of saturated thickness, Depth Region 2 ranges from about 100 to 150 feet thick. Depth Region 3 is between 200 and 300 feet thick, and Depth Region 4 is 200 to 600 feet thick (CH2M Hill, 1994).

The original JMM model utilized some specified lateral anisotropy in assigning zones of horizontal hydraulic conductivity in an attempt to improve calibration, but this is not present in the current SFBFS model. All models have included vertical anisotropy, mainly on the order of 100:1 (lateral hydraulic conductivity to vertical) to represent effects of finer grained material to moderate vertical flow within the model. For the 2009 FFS, CH2M Hill indicated that they increased the horizontal hydraulic conductivity by 50 percent uniformly and in all layers and stated that this resulted in a better overall fit with observed data. The hydraulic conductivity in the model throughout the NHOU area is currently approximately 150 to 165 ft/d in model layer 1, approximately 340 ft/d in model layer 2, approximately 150 ft/d in model layer 3, and approximately 52 ft/d in model layer 4.

The model as revised in 2006/07 by CH2M Hill (CH2M Hill, 2009a) was used to support the evaluation of proposed alternatives for the EPA’s FFS and Proposed Plan for the Second Interim Remedy for the NHOU area. In conjunction with the model revisions and recalibration to observed conditions through 2006 by CH2M Hill, the ULARA Watermaster provided municipal projections of potential basin-wide conditions through 2017 under considered average conditions and for a similar period that included drought-like years and maximum anticipated water supply demands. These projections were incorporated into the model for a series of model simulations of then current NHOU remedial system pumping conditions (the no further action scenarios) and simulations of the NHOU system which included consideration of modifications to, or replacement of, existing wells with possible deepening of some wells to achieve the design pumping capacity of the system. In addition, new extraction wells were proposed as potentially needed to protect the southerly Rinaldi-Toluca well field wells when those wells were returned to full service.

The effectiveness of the model alternatives was judged by the ability of the NHOU pumping wells to collect interpreted extents of groundwater contaminants through particle tracking, i.e., particles were placed in the model corresponding to the interpreted extents of the contaminant plumes and tracked forward to extraction or production well locations. The proposed system as detailed in the FFS and ROD contained most, but not all, interpreted extents of VOC and chromium plumes.

3.1.2.5 Area 1 (Burbank Operable Unit) Investigations

SFB Area 1 includes both the North Hollywood and Burbank operable units. This section summarizes geologic units as defined in the BOU area. Data specific to the NHOU area are discussed in Section 3.2.

The eastern portion of the SFB Area 1, east of the NHOU, includes groundwater impacted by contaminants associated with the BOU. BOU-related groundwater investigations have defined Older and Younger Alluvium units, with the latter including sediments above approximately 300 feet mean sea level (MSL; correlating to depths of up to 300 to 350 feet bgs).

The Younger Alluvium includes the Upper and Middle Zones identified in the SFB RI (JMM, 1992). The Younger Alluvium is thus approximately equivalent to Depth Region 1 and has been subdivided into five hydrostratigraphic units, including the A'-, X-, A-, Y-, and B-units (from shallower to deeper); the X- and Y- units include relatively fine-grained sediments that behave as aquitards and at least partially confine the underlying A and B aquifers (Oberlander et al., 1993; EPA, 2004; CH2M Hill, 2011b).

These units uniformly dip to the southeast at a greater angle than the water table. Therefore, each unit becomes progressively less saturated in the northwest direction. The entire A'-unit lies above the water table in the NHOU and BOU areas and becomes saturated only in the southeast portion of the SFB. The A'-unit aquifer becomes less defined in the western portion of the BOU area, and its continuity into the NHOU area is unclear.

3.1.2.6 ULARA Watermaster Units

Attempts to further correlate the complex distribution of SFB sediments, including within and between the NHOU and BOU areas, are ongoing, most notably by the current ULARA Watermaster. Geologic and geophysical logs of boreholes throughout the SFB have been and continue to be correlated with the objective to construct a comprehensive database of subsurface geology (ULARA Watermaster, 2011a). Upon request, the Watermaster provided AMEC with an interpretation of geophysical data (including natural gamma and resistivity logs) for Well RT-01 concerning e-log contacts between units in the basin. These were identified on the log for RT-01 as follows:

- Unit A – Between 0 and approximately 160 feet bgs. Identified as Holocene alluvium, and classified on the log as sand, gravel, and rocks
- Unit L – Between approximately 160 and 220 feet bgs, and classified as gravel on the log
- Units K and J - Between approximately 220 and 260 feet bgs

- I group – Between approximately 260 and 300 feet bgs and classified as sand and brown clay on the log
- AA Group - Between approximately 300 and 340 feet bgs and classified as sand and gravel
- BB Group - Between approximately 340 and 420 feet bgs. The top of this group is interpreted as the top of the Saugus formation and was classified as sand, gravel, and rocks on the log
- Unit E – Between approximately 420 and 510 feet bgs, and classified as clay and gravel
- M Group – Between approximately 510 and 570 feet bgs, and classified as sand and gravel
- Blue Star marker bed – Between approximately 570 and 610 feet bgs
- Q Group – Between approximately 610 and 760 feet bgs, and classified as brown clay, gravel, rock on the log
- Unit between approximately 760 and 860 feet bgs, and classified as sandy clay and gravel; fine gravel and clay
- Upper Pico Formation – Below 860 feet bgs, and classified on the log as gravel, clay and sand, clay and gravel, clay and rocks

Correlation of these units with those described in the SFV RI and BOU Investigations is discussed in Section 4.1 and have been incorporated into the refined NHOU CSM.

3.1.3 EPA's RI Monitoring Program

Since its inception in 1991, the EPA's RI Monitoring Program has included approximately 80 monitoring wells throughout the SFB, including 25 wells in Area 1 that were associated with the NHOU area, as defined in the 1992 RI (CH2M Hill, 2011a). As indicated in Section 1.1, several of these 25 RI wells (including VPB and cluster monitoring wells) are in areas now associated with the BOU or GOU. RI wells associated with the current NHOU study area are discussed further in Section 3.2.3.

The current Sampling and Analysis Plan (Addendum #3) and Quality Assurance Program Plan (Addendum #2) were published in November 1999 (E2 Consulting Engineers, 1999a and 1999b, respectively). Groundwater elevations are measured from wells in the RI monitoring program at the time samples are collected (either quarterly or annually) and from all RI monitoring wells during the annual sampling event. The size of the RI monitoring network has remained relatively unchanged since its inception, with 42 to 52 wells sampled quarterly and approximately 63 to 74 wells sampled annually (CH2M Hill, 2011a).

Based on review of the 2007 Annual Groundwater Monitoring Report (CH2M Hill, 2009), groundwater samples are collected from RI wells by purging three to five casing volumes using a dedicated electrical pump. Table C-1 of CH2M Hill (2009) provides pump setting depths for RI monitoring wells; pump settings at recently installed monitoring wells are discussed in MWH (2010).

The analyte list has been modified almost annually since 1989, when greater emphasis was placed on VOCs, semivolatile organic compounds (SVOCs), and nitrate. Hexavalent chromium was added in 1995, 1,4-dioxane was added in 1996, methyl tertiary butyl ether was added in 1997, and perchlorate was added in 1998. Additional emerging chemicals include 1,2,3-

trichloropropane (1,2,3-TCP; added in 2002) and n-nitrosodimethylamine (NDMA; added in 2006) (CH2M Hill, 2011a).

Data from the RI wells form the basis of information used by the EPA, state agencies, potentially responsible parties (PRPs), counties, municipalities, and other stakeholders to prepare depth-specific, basin-wide contour maps of TCE, PCE, chromium (total and hexavalent), and nitrate concentrations (CH2M Hill, 2011a). Historically, quarterly sampling events were conducted in March, June, and September of each year, and the annual sampling event was conducted in December of each year. A comprehensive groundwater monitoring event (including measuring groundwater levels and collecting groundwater samples) was performed by the EPA in December 2010. As of April 2011, groundwater sampling will occur semiannually with events occurring between April 1-15 and October 1-15 each year. The April event will include a more comprehensive list of wells.

Groundwater elevations will continue to be monitored annually at each RI well at the time of sampling and from all RI wells as part of the April sampling event (CH2M Hill, 2011a; EPA, 2011c). Groundwater elevation contours have typically been generated using the SFBRI or SFBFS groundwater models rather than by contouring observed data (e.g., EPA, 2009a; ULARA Watermaster, 2011a). Rather, quarterly groundwater elevations have been illustrated as hydrographs to evaluate changes over time at each location. Groundwater elevations have been measured at the time of sampling such that values span approximately a 1- to 2-week interval. Measurements from the December 2010 and April 2011 monitoring events, which were concerted events meant to collect more data within a shorter period, are summarized in Section 3.2.5 and discussed in Section 4.3.

3.1.4 Groundwater Quality

Groundwater quality data presentation has been based on samples collected as part of the EPA's SFV RI monitoring program and augmented by data gathered from various facility investigations and ongoing active monitoring programs (including production wells) throughout the SFB (CH2M Hill, 2009). Until 2008, COCs data were evaluated and illustrated in annual reports, specifically the distribution of TCE, PCE, chromium, and 1,4-dioxane (CH2M Hill, 1996b, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007a, 2007b, 2009); as of 2008, only regional-scale illustrations of constituent plumes have been produced. Concentration contours produced in these annual reports were based on the most recent historical concentrations at each well; thus, contoured data sets on each figure may include analytical results spanning many years.

Primary COCs in the SFB include TCE, PCE, chromium (total and hexavalent), and nitrate (the last of which is not targeted for remediation), and concentrations have been hand-contoured as part of RI groundwater monitoring reports with respect to Shallow (within 50 feet of the water table) and Deeper Zones (greater than 50 feet below the water table). Emerging chemicals of interest include 1,4-dioxane, 1,2,3-TCP, perchlorate, and NDMA; however, concentration contours have not been prepared as part of the RI monitoring program. Interpretive concentration contours of 1,4-dioxane were included in the FFS (EPA, 2009a). The notification level for 1,4-dioxane was lowered from 3 µg/L to 1 µg/L in November 2010 (i.e., since the FFS was produced and since the Second Interim Remedy ROD was promulgated).

COC concentrations are typically higher and more widely distributed in the Shallow Zone than the Deeper Zone. Chromium concentration contours have not been produced for the Deeper Zone in RI groundwater monitoring reports. Analytical data (including 1,4-dioxane) specific to the NHOU area are summarized in the Section 3.2.5 and their lateral and vertical distribution is discussed in Section 4.5.

Groundwater quality of the San Fernando and San Gabriel Basins was also evaluated by the U.S. Geological Survey as part of their California Groundwater Ambient Monitoring and Assessment (GAMA) Program in 2005 (USGS, 2008). Groundwater samples were analyzed for VOCs, pesticides and pesticide degradates, NDMA, 1,2,3-TCP, 1,4-dioxane, nutrients, major and minor ions, trace elements, radioactive constituents, and microbial indicators. Stable isotopes of hydrogen, oxygen, and carbon; activities of tritium and carbon-14; and noble gases were also measured. PCE, TCE, carbon tetrachloride, and nitrate were detected at concentrations above established MCLs.

3.2 NHOU Study Area

This section summarizes data specific to the NHOU study area, including the monitoring well network, geology, hydrogeology, groundwater elevations, and analytical data from groundwater samples. These data are discussed in detail in Section 4.

3.2.1 NHOU Area Monitoring Wells

This section describes monitoring wells within the NHOU study area as defined in Section 1.1. Well construction details are summarized in Table 3-4. Table 3-5 includes pseudonyms for monitoring wells within or near the NHOU study area. NH-C prefixed wells are “cluster” monitoring wells screened in multiple depth regions, whereas VPB-prefixed wells are screened in the uppermost water-bearing unit. Additional wells have also been variously installed at individual sites within the NHOU study area.

3.2.1.1 Remedial Investigation (1992)

Monitoring wells in the NHOU area were installed as part of the SFB RI project, approximately two years following start-up of the NHE extraction wells. These wells included VPB wells screened in the Upper Zone and cluster monitoring wells screened at various depths within the Lower Zone. Before the installation of these wells, data used to describe local geology, groundwater flow, and groundwater quality conditions primarily originated from production wells' records.

The RI program was designed with the goal of characterizing SFB geology and groundwater quality on a regional scale. Of the 43 VPB wells and 44 cluster monitoring wells (at 15 locations) installed as part of this basin-wide scale effort, six VPB wells and five cluster wells (at three locations) were installed within the NHOU study area, i.e., 11 of a total of 87 wells, including:

- Upper Zone/Depth Region 1:
  - Cluster wells NH-C02-220 and NH-C05-320
  - Vertical profile borings NH-VPB-02, -03, -05, -06, -07, and -08
- Lower Zone/Depth Region 2:
  - Cluster wells NH-C02-325, NH-C03-380, NH-C05-460

The remaining VPB and cluster wells were located upgradient of the NHOU area, cross-gradient of the NHOU area (now associated with the BOU), or downgradient of the NHOU area in the Crystal Springs area (now associated with the GOU) or in the Pollock and Verdugo areas (now associated with Areas 3 and 4, respectively). Although not specified in the SFB RI (JMM, 1992), top of casing reference elevations were typically surveyed at this time to NGVD29. The EPA database cites North American Datum 1983 (NAD83) as the datum for these and other wells; however, this refers to the horizontal datum rather than the vertical datum.

No recommendations for further work were included in the 1992 RI and additional monitoring wells targeting the NHOU were not installed in the North Hollywood area until 2009 (Section 3.2.1.3). As discussed in Section 3.1.3, these VPB and cluster monitoring wells were monitored at various sampling frequencies and analyzed for various constituents as part of the EPA RI monitoring program.

3.2.1.2 Site Investigation Wells

Additional monitoring wells have been installed within and beyond the NHOU study area as part of site-specific investigations, including landfills and industrial sites. The following is a summary of sites overseen by the RWQCB-LA within the NHOU study area with associated monitoring wells. Site locations are illustrated on Figure 2-1 and monitoring wells are listed in Tables 3-4 and 3-5. Note that other known or potential source areas exist within the study area (as discussed in Section 3.2.6) but are not specifically associated with NHOU monitoring wells. Wells at the former Bendix facility have been surveyed to the NAVD88; the vertical reference datum for wells associated with other facilities throughout the NHOU study area (including Lockheed Martin wells in the BOU area) is not known (either NGVD29 or NAVD88) and the EPA database is incomplete concerning this information.

3.2.1.3 Second Interim ROD Monitoring Wells (2009-2010)

To address data needs identified in the FFS and Second Interim ROD, Honeywell installed 31 additional monitoring wells (NH-C07 through NH-C25) at 19 locations in the NHOU area between June 2009 and August 2010 "to better characterize the lateral and vertical extent of contaminated groundwater in relation to known and potential source areas for the purpose of supporting decision-making during design of the Second Interim Remedy" (MHW, 2010). Monitoring wells were constructed with well screens correlating with Depth Regions 1 (18 wells), 2 (12 wells), and 3 (1 well). It was concluded that well screens NH-C09-310, NH-C11-295, NH-C17-339, and NH-C21-340 penetrate both Depth Regions 1 and 2. Locations of these wells are illustrated on Figures 3-4a through 3-4d. Top of casing reference elevation at these wells were surveyed with respect to NAVD88 (MWH, 2011).

Geologic and geophysical logging was conducted for the 31 boreholes before their completion as monitoring wells. Each borehole was advanced using mud rotary drilling techniques and completed with monitoring wells with depths ranging from 240 to 660 feet. Geologic logs produced at each location were based on field observations from a field geologist. The deepest borehole at each location was also geophysically logged before well construction. Geophysical logs included natural gamma, resistivity logs, and sonic logs. Sediments below the water table to an approximate depth of 350 feet were often described as sand or silty sand with or without clay and were typically underlain by unit composed of coarse sand and/or gravel.

Construction details and geologic associations are summarized on Table 3-4. Screen interval lengths ranged from 50 to 70 feet in an attempt to penetrate most of the associated depth regions. Screen intervals were, in part, selected based on chemical analysis of depth-discrete groundwater samples collected from each borehole before well construction. Groundwater quality depth profiles are presented in Appendix C. These and other findings are discussed in Section 4 because they contribute to the refined CSM of the NHOU study area.

3.2.2 Hydraulic Properties

The purpose of this subsection is to present hydrogeologic parameter data for the SFB, in particular for the North Hollywood and Burbank areas. Evaluations of aquifer hydraulic properties through slug tests, determination of specific capacity, and pumping tests have been conducted and documented by: Oberlander, et al. (1993); JMM for LADWP (1986; 1992); LADWP (1981; 1989; 1991a); CH2M Hill (1994; 2011b); and MWH (2010). Aquifer property values have also been determined relative to the definition of the stratigraphy as understood at the time. Thus, some results interpreted for more generalized stratigraphic interpretation may span several units of a more detailed interpretation, and some well screen lengths may also span one or more units. Estimated ranges of hydrogeologic unit properties for transmissivity (T), hydraulic conductivity (K), storativity, porosity, and specific yield are presented below.

In the Burbank area, Oberlander, et al., related T and K values to the upper Younger Alluvium as opposed to the deeper Older Alluvium. K and T for the younger Alluvium ranged widely from 3 to 2,000 ft/d and 151,000 to 537,000 square feet per day (ft^2/d), respectively, while K ranged from 2 to 1,000 ft/d in the Older Alluvium. In a more recent pumping test, CH2M Hill evaluated aquifer properties in the BOU extraction system well area (VO-1 through VO-8) and determined that the K and T for zones corresponding to the SFBFS model layer 1 were 153 ft/d and 24,600 ft^2/d (relative to 15 ft/d and 1,800 ft^2/d in the model). In model layer 2 the pumping test derived values were 153 ft/d and 17,700 ft^2/d (compared to 15 and 82 ft/d in two separately assigned K zones and 1,500 and 8,200 ft^2/d in two T zones in the model). Resulting K and T values were much higher than simulated values in current models and corresponded more closely to other prior test results in the area. The specific yield was determined as 0.086 (compared to 0.1 in the BOU model), and storativity estimates in the confined units ranged from 4E-6 to 6.8E-6 as compared to 2.5E-6 in the BOU model (CH2M Hill, 2011b).

In the NHOU area, pumping tests have been performed on some production wells (e.g., NH-5, NH-28, NH-29, and NH-32) and NHOU aeration system extraction wells (NHE-2 through NHE-8). Results for NH-5 pumping tests indicated a T of 20,000 gallons per day per foot (gpd/ft; 2,674 ft^2/d). For pre-design modeling, JMM reviewed results for 103 driller's logs and 39 specific conductance tests and estimated a Shallow Zone K of 214 ft/d with a specific yield of 0.05, a deep K of 160 ft/d, and a confined storage coefficient of 0.0005. In model calibration, the K values were lowered slightly to 160 and 134 ft/d, respectively. The LADWP conducted step pumping tests in NHE-2 through NHE-8, and JMM later summarized these tests and estimated K values from the test-derived T values in the 1992 RI. For specific NHE wells, the estimated T and K values were: NHE-2 (7,219 ft^2/d; 99 ft/d); NHE-3 (8,556 ft^2/d; 136 ft/d); NHE-4 (4,946 ft^2/d; 79 ft/d); NHE-5 (2,674 ft^2/d; 102 ft/d); NHE-6 (4,813 ft^2/d; no estimated K); NHE-7 (12,032 ft^2/d; 172 ft/d); and NHE-8 (26,604 ft^2/d; 306 ft/d). JMM averaged available data in the 1992 RI, providing estimates of average K values in the NHOU area of 150 ft/d in the Upper Zone and 400 ft/d in the Lower Zone. In 2010, MWH compared the 1992 JMM reported data for some NHOU production wells with typically lower values cited in CH2M Hill (1994), and obtained a broader range of estimated K values from 100 to 810 ft/d. LADWP also performed some limited duration drawdown tests at several production wells. In the NHOU area, the Ks corresponding to NH-32 and NH-29 were approximately 420 ft/d for NH-32 and 454 ft/d for NH-29.

In FFS model construction, some literature values for effective porosity and specific yield have been assigned in addition to SFB-specific data. In SFBS the model, effective porosity values generally range from 0.15 to 0.25, while specific yield values range from 0.02 to 0.18.

3.2.3 Production Well Fields

As mentioned in Section 2.1, production well fields within the NHOU study area include the Rinaldi-Toluca, North Hollywood (west and east), Whitnall, and Erwin well fields. Well field locations and total volume of groundwater extracted during water year 2009/10 are illustrated on Figure 3-2. Annual volumes contributed by each well field since 1989 are illustrated on Figure

3-3. Rated capacities and production volumes for Water Years 2009/10 at each well field are summarized in Table 3-1.

3.2.3.1 Rinaldi-Toluca

The Rinaldi-Toluca well field consists of 15 production wells (RT-1 through RT-15) generally situated along a northwest/southeast transect northwest of the NHOU extraction well field. These wells were installed between 1985 and 1988 using reverse rotary wash drilling techniques with 20-inch diameter casings (three Rinaldi-Toluca wells have 36-inch diameter casings to a depth of 100 feet). All wells of this well field penetrate Depth Regions 2 and 3; however, gravel packs installed at each well hydraulically extend vertical conduits at these wells from Depth Region 1 to lower regions.

As of 2010, all Rinaldi-Toluca production wells were active (Table 3-6); however, production wells closest to the NHOU area, including RT-1, RT-3, RT-10, RT-11, RT-13, RT-14, and RT-15, were limited relative to the other wells. During water year 2009/10, the Rinaldi-Toluca Well field produced approximately 20,225 AF of water (Table 3-1).

3.2.3.2 North Hollywood (West)

Production wells of the North Hollywood well field are divided informally into the west well field (NH-west) comprising 16 wells and the east well field (NH-east) comprising 20 wells. NH-west well field production wells lie west of the NHOU extraction well field and are south (downgradient) of the former Hewitt Pit (former landfill). These production wells were installed between 1924 and 1984 using the cable tool drilling method; thus, none of these wells were constructed with a gravel pack. Perforation zones variously include Depth Regions 1, 2, and 3 at many of these production wells.

As of 2010, all NH-west production wells were active except for NH-24 (Table 3-6); however, production from NH-23, NH-33, and NH-37, was limited relative to the other wells. During water year 2009/10, the NH-west well field produced approximately 12,400 AF of water (Section 3.1.1.3; Table 3-1).

Production wells NH-3, NH-8, and NH-15 were destroyed; well NH-9 was capped, not destroyed.

3.2.3.3 North Hollywood (East)

NH-east production wells were installed between 1924 and 1970 using the cable tool drilling method. The NH-east well field includes a larger area than the NH-west well field. The NHOU extraction wells are collocated with NH-east production wells (Figure 3-2). NH-east wells are screened throughout all four depth regions (Table 3-4).

Most of the NH-east production wells were relegated to inactive status by approximately 1990 in response to the discovery of elevated TCE and PCE concentrations in these and other production wells in the early 1980s. Water production was replaced by the Rinaldi-Toluca well field.

Production wells NH-5 and NH-31 were destroyed; Well NH-10 was capped, not destroyed.

3.2.3.4 Whitnall

Whitnall production wells were installed between 1951 and 1975 via the cable tool drilling technique with 20-inch diameter casings. Perforated zones correlate with Depth Regions 2 and 3. The well field consists of 11 production wells southeast of the NHOU extraction well field oriented along a northwest-southeast transect coincident with a regional power line right-of-way.

The four active production wells in 2010 (Table 3-6) produced approximately 3,300 acre-feet in water year 2009/10 (Section 3.1.1.3; Table 3-1).

3.2.3.5 Erwin

Erwin production wells were installed between 1953 and 1980 using the cable tool drilling method with 20-inch diameter casings. Perforated zones at individual wells correlate with all four depth regions. This well field has consisted of up to ten production wells, two of which were active in water year 2009/10 and produced approximately 1,250 acre-feet. The two active production wells are collocated with the Whitnall well field, south of the NHOU extraction well field.

3.2.3.6 Tujunga

The Tujunga production wells are in the northwest portion of Area 1, beyond the NHOU study area and northwest of the Rinaldi-Toluca well field, near the Tujunga spreading grounds. These wells were installed between 1988 and 1991 using a reverse rotary wash drilling technique and were constructed with 20-inch diameter casings. All wells include stainless steel wire-wrap screens to depths correlating with Depth Regions 2 and 3; gravel packs extend into Depth Region 1.

All wells were active as of 2010 (Table 3-6); however, production from T-2, T-4, T-5, T-8, T-10, and T-11 was significantly less than other wells because of ongoing water quality issues. The Tujunga well field produced a total of approximately 16,500 acre-feet during water year 2009/10. The source of groundwater quality impacts is being investigated (including collection of soil, soil vapor, and groundwater samples) by the LADWP as part of the Tujunga Discovery Project (ULARA Watermaster, 2011c). Approximately 7,500 gallons per minute (gpm) of pumping capacity was restored in November 2009 with the installation of a liquid-phase granular activated carbon groundwater treatment system at this well field; delivery to the LADWP distribution system began in May 2010 (ULARA Watermaster, 2011c).

3.2.4 EPA's SFV RI Monitoring Program (NHOU Area)

As discussed previously, the NHOU area within the RI context includes a much larger area than the area comprising this Data Gap Analysis. NHOU wells comprising the RI monitoring program that lie within the study area as defined in Section 1.1 included the wells listed on Table 3-7. These wells were recommended by CH2M Hill for future monitoring as indicated in the following table (CH2M Hill, 2011a). Wells listed on Table 3-7 are illustrated on Figures 3-4a through 3-4d.

Table 3-7. RI Monitoring Program Sampling Frequency

Well Name	Sampling Frequency as of 2010	EPA Future Recommended Sampling Frequency	
		VOCs	Hex. Chromium
NH-C02-220	Quarterly	Semiannual	Semiannual
NH-C02-325	Quarterly	Annual	Annual
NH-C02-520	Quarterly	Annual	Biennial
NH-C02-681	Annual	Exclude	Exclude
NH-C03-380	Annual	Annual	Annual
NH-C03-580	Annual	Annual	Annual
NH-C03-680	Annual	Biennial	Biennial
NH-C03-800	Annual	Exclude	Exclude
NH-C05-320	Suspended (pump replacement needed)	Annual	Annual
NH-C05-460	Annual	Semiannual	Annual
NH-VPB-02	Quarterly	Semiannual	Annual
NH-VPB-03	Suspended (pump replacement needed)	Annual	Annual
NH-VPB-05	Quarterly	Semiannual	Semiannual
NH-VPB-06	Quarterly	Semiannual	Semiannual
NH-VPB-07	Annual	Annual	Annual
NH-VPB-08	Quarterly	Annual	Annual

None of the recently installed cluster monitoring wells (NH-C07 through NH-C25) have yet been incorporated into the program and were last sampled by Honeywell in December 2010.

3.2.5 Groundwater Elevations

Groundwater levels are measured as part of each sampling event. Historically, quarterly sampling events were conducted in March, June, and September of each year, and the annual sampling event was conducted in December of each year. Simulated potentiometric maps are prepared on a semiannual basis by the Watermaster using the SFBRI model. A comprehensive round of groundwater levels was collected by the EPA in December 2010 and April 2011.

As discussed in Section 3.2.1, wells within the NHOU area have been installed over at least two decades, during which time survey reference datums have changed. As a result, older wells were surveyed to NGVD29, and more recently installed wells were surveyed to NAVD88. As an example, a top of casing elevation of 746.93 feet MSL (NGVD29) was reported for NH-VPB-06 in the SFB RI report; however, recent survey data indicate an elevation of 749.85 feet MSL (NAVD88) requiring a vertical correction of 2.92 feet (MWH, 2011). When corrected for this factor, groundwater elevations at NH-VPB-06 are consistent (within 0.5 feet) with measurements at nearby NH-C20-380. The vertical difference between inconsistently surveyed monitoring well referent points significantly affects groundwater elevations, calculated gradients, and flow directions. To account for this surveying discrepancy, groundwater elevations from all wells installed as part of the SFB RI field program (including VPB wells, other than NH-VPB-06, cluster wells NH-C01 through NH-C06, and the LC1 well cluster) have been modified by adding an approximate correction factor of approximately 2.6 feet +/- 0.2 feet (as transformed from NGVD29 to NAVD88) to the top of casing elevation to be consistent with the NAVD88 datum. This approach is intended to prepare consistent groundwater elevation contours and does not resolve additional elevation correction(s) that would be addressed by surveying these or other wells with respect to the NAVD88 datum.

Potentiometric surface contours based on the December 2010 and April 2011 groundwater elevations (Figures 3-7a and 3-7b, respectively) illustrate groundwater elevation contours based on shallowest data at each location (deeper collocated data were excluded from contouring). The contours were generated using the nearest neighbor contouring algorithm. Groundwater elevations vary from approximately 475 to 520 feet MSL in December 2010 and from approximately 480 to 520 feet MSL in April 2011. These data represent seasonally low pumping conditions; groundwater elevations reflecting high pumping conditions are anticipated to be observed in data collected during October events.

More wells were measured as part of the December 2010 event and groundwater elevations illustrate that southwest flowing groundwater in the northeast portion of the NHOU study area transitions toward the southeast along the axial center of the SFB. This bi-directional pattern is also apparent in April 2011 despite fewer measurements than in December 2010. Groundwater beneath the northern landfills area (including Penrose, Newberry, and Strathern landfills and the Tujunga Pit) flows toward the Rinaldi-Toluca production well field with gradients ranging from approximately 0.003 to 0.006, and transitions toward the southeast beneath the former Bendix facility with gradients ranging from approximately 0.0006 (near the Rinaldi-Toluca well field) to 0.002 (downgradient). It cannot be determined if the flow direction transition and flatter gradient near the Rinaldi-Toluca well field results from pumping patterns or is a result of hydrogeologic conditions.

3.2.6 Contamination Sources

Potential sources of contaminants found in groundwater beneath the North Hollywood community have been identified since the early 1980s (LADWP, 1983). Previous activities are summarized concerning the following documents.

3.2.6.1 Groundwater Quality Management Plan (1983)

The hazardous waste sources investigation conducted as part of the original SFB Groundwater Quality Management Plan (LADWP, 1983) included an assessment of 301 industrial locations, accidental spills and unintentional releases, dry weather urban drainage, landfills, and industrial and commercial wastewater disposal practices. It was estimated that approximately 6 million gallons of liquid chemicals and 1.1 million pounds of solid chemicals were used by industry in the area each year.

Liquid chemicals used by local industries included gasoline (52.4%), chromium solutions (31.4%), alcohols (9.2%), petroleum products (1.8%), aliphatic solvents (1.7%), and cutting oils (1.2%). Of the chemicals comprising the remaining 2.3%, PCE accounted for 11.1%. Solid chemicals used were categorized as petroleum distillates (94.8%), zinc compounds (3.2%), lead compounds (0.9%), and others (1.1%), which included antimony compounds (33.8%), cyanides (30.8%), chromium compounds (17.3%), and nickel compounds (10.2%).

Industrial wastes were also assessed, and liquid wastes primarily included chromium solutions (57.1%) followed by heavy metals, zinc solutions, photographic chemicals, etc. Of the 0.4% minor chemical categories, non-halogenated and halogenated solvents comprised 24.8% and 12.4% of liquid wastes, respectively. The annual volume of halogenated compounds in industrial waste was estimated at 56,000 gallons (including 360 gallons per year of 1,1,1-trichloroethane [1,1,1-TCA] and 110 gallons per year of PCE). At the time of this assessment, most industrial solvents were either recycled, refined and resold, or removed from the property by a third party waste hauler. A "small fraction" was noted as disposed of with conventional refuse, to the sanitary sewer, or to the ground.

At that time that it was not possible to identify specific sources of TCE and PCE detected in SFB production wells, but a clear correlation between groundwater contamination and commercial/industrial development was observed. It was further concluded that most releases likely occurred in the 1950s and 1960s; however, insufficient data existed to evaluate long-term concentration trends.

3.2.6.2 Chromium Investigations

Several investigations were performed to further delineate the extent of chromium, particularly hexavalent chromium, in the SFV (RWQCB-LA, 2002; ULARA Watermaster, 2003; CH2M Hill, 2006).

- RWQCB-LA, 2002 – This investigation included 255 facilities (40 of which lie within the NHOU area) and concluded that 105 facilities (13 of which are within the NHOU study area) require further assessment. Most of these sites were former plating shops affiliated with the aerospace industry. A background chromium concentration was identified as a future challenge, among others. Lysimeters or monitoring wells did not exist at most of these sites and groundwater samples were not collected as part of this investigation to characterize the subsurface distribution of chromium in groundwater at each site. Existing monitoring wells were typically installed to evaluate groundwater quality regarding COCs other than hexavalent chromium.
- CH2M Hill, 2006 – This investigation was performed on behalf of the EPA to evaluate historical and recent detections of dissolved chromium and emergent chemicals within the NHOU area. Significant temporal and spatial dataset limitations were noted but it was concluded that concentrations were generally stable under then-current conditions. CH2M Hill recommended continued monitoring for chromium at NHOU area wells, installation of additional monitoring wells or conversion of existing inactive production in the NHOU area to monitoring wells, collect spring and fall groundwater elevation measurements, and coordination with multiple agencies to collect samples from multiple sites in the NHOU area.

3.2.6.3 Groundwater Characterization Report, NHOU (2010)

The report (MWH, 2010b) summarized facilities within the NHOU study area with either known or potential sources of COCs (including PCE, TCE, 1,1,1-TCA, hexavalent chromium, and 1,4-dioxane) to soil and/or groundwater based on public records review. A total of 38 facilities were identified as known release sites, and 281 facilities were identified as potential release sites, 75 of which were considered to have a higher potential of having had a release (Tier 2 site).

Of the 13 facilities identified by the RWQCB-LA (2002), 10 are included in the list of known releases and 2 are associated with a low potential for release (Tier 1 sites).

3.2.6.4 EPA Source Assessment

EPA states that the agency has been conducting PRP search efforts in the NHOU for many years. EPA indicated in a January 6, 2011, meeting that it has developed a Comprehensive List of approximately 800 parties associated with the 400 facilities in the NHOU. Criteria used by EPA to add facilities to the Comprehensive List included:

- History of PCE, TCE, and/or chromium use at the location;
- Evidence that hazardous substances had been disposed at the location; and
- History of business operations at the location generally associated with use of PCE, TCE, and/or chromium.

In the January 2011 meeting, EPA indicated that the information sources used to compile the Comprehensive List included:

- Responses to approximately 250 CERCLA §104(e) information requests;
- Records kept by EPA's Superfund Record Center that have been compiled throughout the history of the SFV groundwater cleanup;
- Records kept by seven state and local agencies with jurisdiction over environmental, health, and waste issues;
- Records included facility-specific reports and more broadly focused investigations and reports;
- GeoTracker and Envirostor databases maintained by DTSC and RWQCB;
- Subscription and public database searches, e.g. Westlaw®, Accurint®, Google®, etc., primarily to locate corporate information; and,
- Environmental Data Resources, Inc. (EDR) reports.

EPA stated that it has evaluated or is evaluating approximately 300 of the 400 facilities on the Comprehensive List. EPA indicated it has made decisions regarding approximately 253 facilities. These decisions are summarized as follows:

- 10 facilities were sources of TCE, PCE, and/or hexavalent chromium contamination in NHOU groundwater.
    - o EPA sent the 21 parties associated with these 10 facilities special notice letters on July 1, 2010.
- 243 facilities were not likely to have contributed to PCE, TCE, and/or hexavalent chromium contamination in NHOU groundwater.

During a July 20, 2010, PRP meeting, EPA indicated that it had identified 16 additional (new) potential source facilities that it was still evaluating. In the January 6, 2011, meeting, EPA indicated that the number of additional potential source areas increased to 22 as a result of ongoing EPA PRP search efforts and information provided by the PRPs (discussed further below). In November and December 2010, EPA sent 45 104(e) information requests to parties associated with the 22 additional potential source areas.

Additionally, PRPs in attendance identified 35 additional facilities that may have contributed to soil and groundwater contamination. The EPA noted that 13 of these facilities were included in their list of 22 facilities and subsequently concluded that 9 of the remaining facilities had not likely contributed to soil or groundwater contamination (no investigation had been conducted). The EPA agreed to further investigate the remaining 13 facilities as potential sources in addition to the 22 facilities that they had identified as potential sources.

In a PRP meeting held on March 8, 2012, the EPA presented a revised list of 23 potential source properties, in addition to the 10 known source properties (EPA, 2012). Potential source properties include those where the most recent list of known and potential source properties is summarized in Table 3-8 and illustrated on Figure 3-8.

3.2.7 Groundwater Quality

Table 3-9 summarizes all compounds detected in groundwater samples from the NHOU study area, as listed in the EPA's SFB database. Minimum and maximum concentrations are summarized for each constituent with the number of unique detections at individual wells. These results are compared to regulatory limits or other guidelines for reference. Appendix F provides time-concentration plots for NHOU monitoring wells for identified COCs.

Comparison of maximum concentrations to regulatory limits and frequency of detections confirms that the COCs—PCE, TCE, 1,4-dioxane, and hexavalent chromium—have been consistently detected above regulatory limits in groundwater at the following maximum concentrations:

- PCE – 6,100 micrograms per liter (μg/L)
- TCE – 17,000 μg/L
- 1,4-dioxane – 320 μg/L
- Hexavalent chromium – 140,000 μg/L

Wells with maximum TCE, 1,4-dioxane, and hexavalent chromium concentrations are hydraulically contained by former Bendix facility onsite extraction wells and NHE-2; the maximum PCE concentration was observed at a well east of the Burbank Airport. Eighty-six other chemicals were detected at concentrations exceeding regulatory limits. Contaminants detected above regulatory levels in more than 30 wells included, but are not limited to, 1,1-dichloroethane, 1,1-dichloroethene, 1,2,3-trichloropropane, 1,2-dichloroethane, carbon tetrachloride, cis-1,2-dichloroethene (cDCE), methylene chloride, nitrate (as NO_3), radium-226, and radium-228. Figure 3-6 illustrates the most recent year(s) that groundwater samples were collected from wells within the NHOU study area.

3.3 NHOU Well Field and Treatment System

3.3.1 Origins and Basis of the Current NHOU Design

As mentioned in Section 3.1.2.2, the original GQMP included eight recommendations to address groundwater contamination in the SFB (LADWP, 1983). The eighth recommendation (Aquifer Management and Groundwater Treatment Program) proposed treating groundwater from existing production wells NH-5, NH-11, NH-13, NH-21, NH-28, NH-29, NH-31, and NH-40 using a central packed aeration tower (see Figures 2-1 and 3-2). After the GQMP, LADWP retained JMM to perform design and construction services for the installation of the 'aeration facility.' This effort eventually included a review of the LADWP proposal to install and operate eight shallow aquifer extraction wells[2] in the North Hollywood area to supply a central aeration tower and meet remedial objectives. Therefore, the design of the existing NHOU system (originally called the "aeration system") was based on the distribution of TCE and PCE and hydrogeologic characteristics as understood in 1982 (i.e., before the RI program) (JMM, 1986).

[2]Although the treatment option was retained, LADWP plans apparently were modified to include the installation of eight groundwater extraction wells screened in the shallow aquifer zone. This decision likely arose from packer test results at NH-24 that demonstrated the shallow nature of groundwater contamination at that time.

The anticipated groundwater flow direction and gradient at that time was based on groundwater elevations measured at production wells in the area. Few, if any, depth-discrete monitoring wells existed in the North Hollywood area at the time, and groundwater elevation contour maps produced were based on measurements collected at production wells with perforation zones spanning multiple depth intervals. Available hydraulic parameters included production well packer/pump test results (including wells NH-5, NH-24, NH-43, and NH-44) and grain size analysis of the Upper Zone (based on driller's logs). Thus, the original NHOU conceptual design was not based on groundwater flow conditions specific to what would come to be called the Upper Zone, from which remedial groundwater extraction was intended.

The 1986 evaluation of what would become the NHOU extraction well field recognized these data limitations and the uncertainties regarding hydraulic parameters, and thus developed an "idealized" model (i.e., not a calibrated model). The model structure included three layers representing an unconfined zone of variable thickness, a 100-foot thick confined intermediate zone, and a 500-foot thick confined deep aquifer zone, with a vertical conductance array between the intermediate and deep aquifer zones that represented a regional aquitard. Extraction from production wells near the NHOU area was assumed to occur only from the intermediate and deep aquifer zones.

The idealized local model was used to simulate contaminant capture and likely drawdown that would result from operating the eight extraction wells proposed by LADWP and by alternative extraction well configurations. Uncertainty regarding the transmissivity of the Shallow Zone (estimated to range from 20,000 to 120,000 gpd/ft, equivalent to 2,670 to 16,040 ft^2/d) was addressed by recommending two additional extraction wells because it was noted that "the proposed [extraction] well locations…will allow significant portions of both the western and center plumes to escape the extraction under high shallow aquifer transmissivity conditions." The transmissivity incorporated into the model (20,000 gpd/ft) is equivalent to a hydraulic conductivity of approximately 50 to 100 ft/d, based on an Upper Zone saturated thickness of 50 to 75 feet. It was concluded that even the operation of ten extraction wells "…while allowing portions of the center plume to escape, will capture most of the western plume under the same aquifer conditions." The resulting recommended well locations included the phased installation of ten NHOU extraction wells with discharge rates between 50 and 400 gpm each to supply a total treatment system flow capacity of 2,000 gpm. It was acknowledged, however, that the 8-well configuration proposed by LADWP was significantly advantageous in that the extraction wells would be located on City-owned property.

While it was evaluating its preliminary RD, the LADWP requested in July 1985 that EPA determine whether sufficient data existed to justify a fast-track action for the "North Hollywood subbasin". In January 1986, the EPA agreed that sufficient data existed to proceed with a fast-track approach and proposed an operable unit feasibility study (OUFS) mechanism to accelerate remedial action. As defined therein (EPA, 1986), an OUFS represents a "…response action that can be implemented to achieve source control and/or management of migration of contaminants prior to the selection of the appropriate final remedial measures."

The final OUFS (November 1986) recommended the installation of eight shallow extraction wells (each approximately 300 feet deep) hydraulically connected to a central air stripper tower (12-foot diameter, 48-foot height) with vapor-phase granular activated carbon (VPGAC) treatment capable of reducing VOC concentrations in treated groundwater to CDPH (then DHS) action levels (5 µg/L TCE and 4 µg/L PCE) without blending. Each extraction well was to be completed within a pilot borehole approximately 400 feet deep; final screen intervals were to be determined on review of the geologic and geophysical logs. Pumps were anticipated to be capable of providing 300 gpm against a 420-foot head. Final specifications were to be based on pumping tests performed after the completion of each extraction well. The treatment system was designed with a total capacity of 2,000 gpm and to be capable of reducing TCE and PCE from influent concentrations of up to 650 and 100 µg/L, respectively, to concentrations meeting or below state action levels (5 and 4 µg/L, respectively). Groundwater remediation would occur via aeration tower and VPGAC units (JMM, 1986).

3.3.2 NHOU Construction

The EPA approved the LADWP design in March 1987 and signed a three-party agreement (including EPA, CDPH [then DHS], and LADWP) in June 1987. This agreement specified responsibilities, cost shares, and other applicable provisions for operating and financing the NHOU system, but did not stipulate required operational performance objectives. Construction activities began in December 1987 with the installation of the collector line, followed by extraction well installations in 1988 and 1989. NHOU groundwater treatment operations began in December 1989.

The influent conveyance line comprises approximately 2,660 feet of 8-inch ductile iron pipe (between NHE-8 and NHE-7) and 8,980 feet of 12-inch ductile iron pipe and appurtenances connecting each extraction well to the central aeration tower (at 11845 Vose Street[3]) (LADWP, 1989; 1991b). Extraction wells comprising the NHOU system are discussed in detail in Appendix A.

The NHOU treatment system (illustrated schematically on Figure 3-9) includes:

- A 45-foot tall, 12-foot diameter, steel air stripping tower constructed with a 500 to 2,200 gpm hydraulic capacity, packed with polypropylene plastic 1-inch "saddles";
- A 8,020-cubic feet per minute (cfm) capacity blower with a 15-horse power, 480 volts, 3-phase motor;
- Electrical measurement equipment and controls for pumps, fans, and instruments;
- Instruments for determining equipment efficiencies;
- A chemical feed system (sodium hexametaphosphate, an anti-scaling solution);
- A chlorination system;
- An air heating system; and
- Two air-phase granular activated carbon contacting units (each with a 4,000 cfm capacity).

Effluent conveyance comprises approximately 450 feet of 16-inch ductile iron pipeline and appurtenances that extend from the NHOU treatment facility to the NH Complex, where LADWP blends water from the North Hollywood well field and other sources to LADWP's potable water distribution system. The blend ratio of other water supplies to the NHOU treated groundwater at the NH Complex is a minimum 35 to 1 (LADWP, 2003).

3.3.3 NHOU Treatment System Operations Performance

The NHOU treatment system has been evaluated several times since operations began in 1989 (LADWP, 1991a and 2003; CH2M Hill, 1996a; EPA, 1993, 1998, 2003, and 2008b). Findings from these reviews are summarized below and discussed in detail in Appendix B.

[3] The aeration tower was originally proposed to be located at the North Hollywood Pumping Station at 11803 Vanowen Street but was relocated due to concerns over placing a 45-foot tall aeration tower within a largely residential area.

NHOU facility operations began in December 1989, with NHE-2 through NHE-8 discontinuously operated, and have since been maintained by the LADWP. Well NHE-1 has not operated due to limited saturated thickness and low yield. The system operated with a run-time efficiency of approximately 80 percent (LADWP, 2003). As of September 2009, the NHOU system had removed over 7,000 pounds of VOCs from groundwater with an average rate of approximately 300 pounds removed annually, as illustrated on Figure 3-10. Figure 3-11 illustrates quarterly groundwater extraction rates from active NHE wells for the period of record. Most significant periods of non-operation occurred when the water table was low or resulted from external issues related to the LADWP water distribution system (e.g., maintenance and/or repairs to trunk lines and to the NH Complex).

A shutdown occurred in 2007 when chromium concentrations increased at NHE-2 such that water quality no longer complied with California drinking water standards. The system was reconfigured to exclude influent from NHE-2, and operations resumed in September 2008. Well NHE-2 was reconfigured with wellhead treatment for VOCs and discharge to the sewer system. Wellhead treatment has ceased because VOC concentrations declined to below the limits identified in the sewer discharge permit (ULARA Watermaster, 2011).

The existing NHOU system was originally sized based on the ability to treat collected water from eight approximately 300-foot deep wells with a pumping capacity of 300 gpm per well. System capability was based on the reduction of VOCs by 95 percent with the minimum goal to discharge water with concentrations of listed VOC below the MCLs at that time. VOCs known to be present included TCE, PCE, 1,1-dichloroethene (1,1-DCE), 1,2-dichloroethene (1-2 DCE), 1,1,1-TCA, chloroform, benzene, methylene chloride, and trichlorofluoromethane, ranging in influent low concentrations of 0.58 µg/L of benzene to a high of 650 µg/L of TCE.

Maximum VOC concentrations in NHOU treatment system influent water samples detected since 2004 (as available from the EPA's SFB database) are summarized in Table 3-10. NHOU treatment system influent and effluent samples have not been analyzed for 1,4-dioxane; however, samples from individual extraction wells have. System effluent and individual extraction well samples are analyzed for hexavalent chromium.

Treatment of approximately 1,000 gpm (versus the system rating of 2,000 gpm) has occurred because the operational issues related to the active pumping wells. The lower flow rate has been due to several factors associated with the capacity of the extraction wells, including lowered water table and saturated aquifer thickness, lower aquifer hydraulic conductivity than originally estimated, and maintenance issues. Bacterial growth in the aeration tower, once a problem, has been resolved. Hardness and scale build-up in the aeration tower packing continue to cause issues with operations and maintenance, as related to the sodium hexametaphosphate injection system. Reduction of VOCs to below standards has been consistently achieved; however, the size and shape of the NHOU extraction well field capture area cannot be verified because performance monitoring wells have not been installed sufficiently close to active extraction wells to observe drawdown over time. Because drawdown within each extraction well has not been measured, pumping efficiencies cannot be estimated nor can it be determined that rehabilitation efforts are necessary (or could be effective).

The system is designed to initially treat bacteria through chlorination, followed by hardness reduction through dosing with sodium hexametaphosphate, VOC stripping through aeration in a packed tower wet scrubber, moisture control for the aeration gas stream through a mist eliminator, air stream temperature control through an in-line duct burner, VOC reduction and/or polishing from the air stream through two dual bed activated carbon adsorption units before discharge of the air to atmosphere. The treated water from the aeration tower is chlorinated again before it is directed to the LADWP groundwater basin conveyance line for blending.

Additional details regarding the historical performance of the NHOU system, including previous evaluation assessments and conclusions and recommendations included in the four five-year reviews completed to date are presented in Appendix B.

4 REFINED NHOU CONCEPTUAL SITE MODEL

This section discusses data presented in the previous section and includes a refined CSM of the NHOU area that describes the geology, hydrogeology, groundwater flow conditions, and groundwater quality as it pertains to designing the Second Interim Remedy.

4.1 Geology/Hydrostratigraphy

Geologic cross-sections have been prepared to incorporate geologic and geophysical data summarized in Section 3.2. Cross-section locations are shown on Figure 4-1, and sections A-A' through F-F' are included on Figures 4-2a through 4-2f, respectively. The cross-sections illustrate geologic, geophysical, hydrostratigraphic, and ULARA Watermaster units.

4.1.1 Correlation of Geologic Units

As discussed in Section3.1.2.3, JMM relied on drillers' logs and geologic data generated as part of the SFB RI to subdivide the alluvium in the eastern portion of the SFV into four lithologic zones – the Upper, Middle, Lower, and Deep Zones and CH2M Hill subdivided alluvial units into four depth regions. As shown on Figure 3-5, Depth Region 1 correlates to the Upper Zone and upper portion of the Middle Zone; Depth Region 2 to the lower portion of the Middle Zone and the Lower Zone; and Depth Regions 3 and 4 to the Deep Zone identified by JMM. Depth Region descriptions by MWH (2010) vary slightly from those listed above, but MWH model layer surface structure contour maps (2010) are the same as those prepared by CH2M Hill (1994), other than the contour interval.

The Younger Alluvium identified by Oberlander (1933) includes the Upper and Middle Zones identified in the SFB RI (JMM, 1992). The Oberlander Younger Alluvium is thus approximately equivalent to Depth Region 1. The A'-, X-, A-, Y-, and B-units units that compose the Oberlander Younger Alluvium uniformly dip to the southeast at a greater angle than the water table. Therefore, each unit becomes progressively less saturated in the northwest direction. The entire Oberlander A'-unit aquifer lies above the water table in the NHOU and BOU areas and becomes saturated only in the southeast portion of the SFB. The Oberlander A'-unit aquifer becomes less defined in the western portion of the BOU area, and its continuity into the NHOU area is unclear.

Based on the hydrostratigraphic dip defined in the BOU area (approximately 0.0056 ft/ft) and assuming these units are laterally continuous with little folding or tectonic distortion, the Oberlander X-unit aquitard would be expected to be encountered beneath the NHOU area at depths of approximately 197 feet bgs (at NH-C24) and 187 feet bgs (at NH-C20). Geologic contacts based on low-resistivity values (e-log data) at 215 and 205 feet bgs, respectively, suggest that this unit extends below the NHOU area. This correlation suggests that the dip decreases to approximately 0.0045 ft/ft west of the BOU area, which is approximately consistent with the change in topographic grade.

These findings suggest that the upper portion of the NHE well screens may be completed within an equivalent of the Oberlander X-unit aquitard; however, the water table is consistently below this interval, and fine-grained materials screened at this interval do not influence groundwater production or flow directions. Most groundwater pumped by the NHOU extraction wells originates from the Upper Zone, which is equivalent to the Oberlander A-unit aquifer.

Based on depths and geophysical logs, the Upper Zone identified in the 1992 RI appears to be equivalent to the ULARA Watermaster's A, J, and K groups, and the Middle Zone appears to correlate with the ULARA Watermaster AA group. The underlying ULARA Watermaster BB and

E groups appear to be equivalent to the Lower Zone. The top of the BB group has been interpreted by the current ULARA Watermaster as the top of the Saugus formation. The Deeper Zone correlates to the ULARA Watermaster M group and underlying units.

As discussed in the following sections, recent geophysical data and depth-discrete groundwater quality data indicate that the ULARA Watermaster AA group is distinctly significant with respect to implementing the Second Interim Remedy. Yet the AA group is bisected by the Depth Regions 1 and 2 contact and, thus, the SFBFS groundwater flow model cannot adequately simulate groundwater flow conditions in this interval. Critical data gaps resulting from how the AA group has been characterized and not explicitly simulated by the SFBFS model are discussed in Section 5.

4.1.2 Geophysical Units

The ULARA Watermaster units are particularly informative because they are based on available geophysical data rather than drillers' logs, geologic logs, or well screen intervals. Geologic observations and logs are critically important to interpreting geophysical data. Down-hole geophysical logs represent high-resolution and relatively objective records of geologic conditions that often greatly facilitate correlating individual geologic units over large areas. This is particularly useful in the SFB because, as has been noted for many years (California State Water Rights Board, 1962), SFB sediments are geologically similar, and differentiating very old sediments from relatively recent deposits is often difficult.

Available geophysical logs and lithologic logs for wells within the NHOU were reviewed concerning geophysical signatures and lithologic units identified by the ULARA Watermaster. As aptly noted by JMM (1992), correlation based on e-log values should be performed with caution because variability occurs due to the different resistivity tools used to measure formation properties.

Comparison of many e-logs show a distinct pattern from the water table to the top of the Watermaster BB group as a closing of separation between the resistivity curves indicative of less mud invasion with depth in this interval (i.e., sediments grade from coarse to finer or cemented sediments) (Figures 4-2a through 4-2f). This zone is recognized herein as the AA group. A decrease in sonic travel time is noted in many of the recently obtained geophysical logs from wells NH-C07 through NHC-25 (MWH, 2010b) that appears to correlate to the top of the AA group. The decrease in sonic travel time (i.e., increase in P-wave velocity) indicates that the sediments below this contact are more compacted (or cemented) than those above it. Based on the observed sediments types during drilling and the geophysical signature (e-logs and sonic combined), the AA group represents a lower permeability hydrostratigraphic unit (because of the presence of silt and fine sand) compared to the underlying BB group (predominantly coarse sand and gravel). These geophysical data indicate that the currently defined boundary between Depth Regions 1 and 2 bisects the AA group.

Directly beneath the AA group, a relative increase in resistivity is observed on e-logs and is the most correlatable geophysical signature from SFV well logs. This geophysical signature matches the top of the Watermaster BB group or JMM Lower Zone. The relatively higher resistivity values measured within the BB group are indicative of greater resistivity formation fluids (i.e., fresher water) and reflect a larger volume of interconnected porosity (i.e., the coarse-grained nature of the BB group). The constant degree of separation between the resistivity curves indicates that the unit is relatively uniform with regarding sediment type.

Many monitoring wells in the NHOU do not extend below the base of the BB group and, therefore, there is less information to correlate contacts between Depth Regions 2 and 3 (JMM

Lower and Deeper Zones). However, available deep e-logs indicate a correlatable decrease in resistivity, suggesting an increase in formation water conductivity (i.e., increased salinity).

The geologic log for RT-01 appears to include two units within Depth Region 2 and four within Depth Region 3. The geophysical signature designating the Blue Star Marker Bed is apparent on several well logs that extend into Depth Region 3. Although potentially important for water resources purposes, marker beds at these depths are less relevant to the Second Interim Remedy, which focuses on sediments comprising Depth Regions 1 and perhaps 2 (particularly the AA group, as discussed further below).

4.1.3 Hydrostratigraphic Units

Despite the complex distribution of fine- and coarse-grained sediments composing the SFB as discussed above, hydrostratigraphic units are defined by hydraulic characteristics (e.g., pressure responses, head differences, groundwater quality) in addition to geologic characteristics. Thus, differentiation of the Upper Zone from the Lower Zone, for example, as hydrostratigraphic units should be based on distinct differences in hydrogeologic conditions.

The fact that groundwater elevations and seasonal fluctuations are generally consistent regardless of depth suggests that the SFB does not contain competent or laterally extensive aquitard units. This is supported by findings from a 1991 aquifer test performed at NH-28 where a similar magnitude and rate of drawdown was observed at NH-C03 wells regardless of depth (CH2M Hill, 1991; EG&G, 1991). Lack of a significant aquitard(s) is also suggested by the relatively small vertical head gradient in the SFB. For instance, less than 10 feet of head difference is typically observed between NH-C03-380 and NH-C03-800, despite over 400 feet of vertical separation. Furthermore, geologic observations typically describe finer-grained units (e.g., the Middle Zone) as a fine-grained sand with or without silt; relatively few geologic logs indicate a significant presence of clay, which would likely comprise a competent aquitard unit.

Based solely on available vertical head differences and pumping responses, it could appear that the SFB behaves essentially as a single hydrostratigraphic unit; however, complex patterns of groundwater flow and analytical variations exist at various depths within the SFB due in large part to the operation of large-capacity municipal well fields throughout the area. Furthermore (as discussed in Section 4.5), groundwater quality is not uniform throughout the SFB and the highest COC concentrations are typically found in shallower units.

When well screen intervals are superimposed on the NHOU stratigraphic sequence, the NHOU extraction wells appear to penetrate approximately the upper half of the AA group; as an exception, the NHE-6 well screen penetrates the AA group and extends through the underlying BB group (such that it slightly penetrates Depth Region 3). Previous interpretations have described these wells as screened above the Middle Zone. Recognizing in fact that the extraction wells are screened within the AA group is important, because extraction well operations are thus not only susceptible to reduced saturated thickness in response to declining groundwater elevations (e.g., in response to drought conditions or significant regional pumping), but also to lower hydraulic conductivity values in sediments penetrated by the deeper portions of each extraction well screen).

Stratified groundwater quality is suggestive of multiple hydrostratigraphic units, however hydraulically similar they may be otherwise. With respect to groundwater remediation, recognizing these units is critical to implementing the Second Interim Remedy and successfully achieving RAOs. The lack of depth-discrete monitoring wells is a significant hindrance to preparing a high-resolution vertical profile of groundwater quality throughout the NHOU area. Note also that the EPA's practice of contouring COC concentrations with respect to "Shallow" or

"Deeper" intervals (i.e., either within or beyond 50 feet of the water table), as illustrated in their annual RI Groundwater Monitoring Reports, precludes correlation with geologic and hydrostratigraphic units.

The AA and BB groups are geologically and geophysically distinct and correlatable units that extend throughout the NHOU study area and more clearly reflect soils conditions pertinent to the Second Interim Remedy than previously defined units. Accordingly, for the purpose of the developing the refined NHOU CSM herein, soils extending from the water table to the base of the AA group are hereafter referred to as the "A-Zone" and soils in the BB group are hereafter referred to as the "B-Zone". The A-Zone thus includes units identified by JMM as the Shallow and Middle Zone and extends approximately 20 to 80 feet deeper than the base of Depth Region 1. The B-Zone generally correlates with the Upper Zone and excludes the uppermost portion of Depth Region 2 (the upper portion of which includes the lower half of the Middle Zone). Figure 3-5 illustrates how the A-Zone and B-Zone correlate with other hydrostratigraphic units developed by previous investigators.

Structural elevation contours illustrating the base of the A-Zone are shown on Figure 4-6. This figure also illustrates monitoring wells that are known to have been constructed with screen intervals that penetrate the A-Zone and the elevation used for contouring purposes.

4.2 Hydraulic Properties

SFB hydraulic conductivity values are lower west of the Pacoima Wash (approximately Highway 170); east of this demarcation are sediments with higher hydraulic conductivity values resulting from the high-energy depositional environment associated with the Tujunga Wash. Within the eastern half of the SFB, the current CSM (which forms the basis of the regional-scale numerical groundwater models) holds that hydraulic conductivity values are higher in the central portions and are lower along the mountain margins of the basin. Zones of hydraulic conductivity in the SFBFS model are largely oriented symmetrically about the axis of the basin, with typically lower hydraulic conductivity in the western portion of the basin.

It is this type of distribution that serves as a higher permeable pathway along the axis of the basin and, with the no-flow boundaries representing the impermeable surrounding mountains, that provides a south-easterly groundwater flow direction, albeit moderated by local pumping and recharge areas. The only way for groundwater to leave the model other than through pumping stresses is discharge into the Los Angeles River and passage as subsurface flow through the Los Angeles Narrows; these are typically relatively small components of the total basin water balance, given the relatively large production and extraction well pumping rates.

The FFS indicated a uniform 50 percent increase in hydraulic conductivity in all model layers as resulting in a better model fit. This degree of modification suggests the model is insensitive to moderate variations in hydraulic conductivity. However, the relatively few depth-discrete observation points available for calibration purposes limit the ability to fully evaluate model sensitivity to any single hydraulic parameter.

It has been AMEC's experience that calibration of a model simulating high hydraulic conductivity conditions and high pumping stresses is difficult and that the model tends to be somewhat insensitive to hydraulic conductivity. However, excessively high hydraulic conductivity values may result in an overly conservative estimate of pumping rates needed to achieve specific capture zones.

4.3 Groundwater Flow Patterns

This subsection describes the potential for groundwater to flow with respect to horizontal direction, responses to sources and sinks (vertical), and over time (temporal).

4.3.1 Horizontal Groundwater Flow

Depths to groundwater were measured in December 2010 and April 2011 as part of comprehensive monitoring events intended by the EPA to evaluate groundwater conditions beneath the NHOU study area more completely than has been possible in previous monitoring events. Groundwater elevation contours for these two monitoring events are illustrated on Figures 3-7a and 3-7b. Top of casing elevations reported for monitoring wells installed in the late 1980s and early 1990s were transformed from the NGVD29 datum to the NAVD88 datum to normalize groundwater elevation data.

Highest groundwater elevations in the NHOU area are observed in the north and northeast and are likely related to SFB structure, including the Verdugo Fault, in addition to engineered recharge operations farther north (i.e., Hansen spreading grounds). Based on measurements collected in December 2010, groundwater beneath northern landfills (including the Penrose, Strathern, Newberry and Tujunga Pit) flows to the southwest toward the southern portion of the Rinaldi-Toluca production well field (Figure 3-7a). During the April 2011 monitoring event, groundwater appears to flow southward; however, these results are based on data from fewer wells than in the previous monitoring event (Figure 3-7b). Groundwater flow beneath the Hewitt Pit, the former Bendix facility, and former Lockheed Martin facilities is toward the southeast as indicated by data from both monitoring events.

Gradients associated with southwest groundwater flow vary from approximately 0.003 ft/ft to 0.006 ft/ft, with the steeper gradient being supported by data from NH-VPB-09. The southwest flow directly, however, is supported by data from several monitoring wells. Gradients associated with southeast groundwater flow vary from approximately 0.0006 ft/ft (near the Rinaldi-Toluca well field) to 0.002 ft/ft. Insufficient data exist to determine if the flatter gradient near the Rinaldi-Toluca production well field is caused by pumping or is a result of hydrogeologic conditions; however, Rinaldi-Toluca wells south of RT-2 have not been operated in recent years due to water quality concerns. Therefore, it appears that the south/southwest gradient observed in December 2010 and April 2011 represents SFB recharge or structural characteristics.

Relative to historical data, groundwater elevations measured in December 2010 and April 2011 are similar to those measured in late 1980s and late 1990s. As illustrated with hydrographs presented on Figures 4-4 and 4-5, groundwater elevations fluctuated approximately 30 feet higher from current levels in the early- to mid-1990s and approximately 15 feet lower in the early 1990s and early 2000s.

Groundwater elevations are measured at too few monitoring wells during specific sampling events (as available from the EPA's SFB database) to develop historical groundwater elevation contours within the NHOU study area. This is consistent with the reliance upon the SFBRI and SFBFS groundwater flow models to simulate regional-scale groundwater elevation contours (e.g., CH2M Hill, 1994, 1996a; ULARA Watermaster, 2011a). Recent simulated groundwater elevation contours associated with Fall (September) 2010 (ULARA Watermaster, 2011c) do not reflect the southwest groundwater flow component observed in December 2010.

4.3.2 Responses to Sources and Sinks

Hydrographs from select wells near and distant from major pumping well fields illustrate how A-Zone groundwater elevations fluctuate in response to pumping from deeper zones (e.g., Depth Regions 3 and 4). Specifically, the NH-VPB-06 hydrograph is of particular interest because of its close proximity to the Rinaldi-Toluca well field (Figure 4-4). This hydrograph indicates that groundwater elevations have been consistently higher at NH-VPB-06 than at other wells more distant from the well field (to the southeast), other than before 1991. During that time, groundwater elevations at NH-VPB-06 appeared slightly lower than other wells (e.g., NH-VPB-02, NH-C02-220, NH-C03-380, and NH-VPB-08), suggesting that pumping at the well field was sufficient to depress A-Zone groundwater elevations at that time. Rinaldi-Toluca well field operations began in 1988 and cumulative flow rates were the highest on record until 1992. The apparent groundwater depression during that period was illustrated in the 1992 RI. Subsequent pumping from this well field has been less and groundwater elevations have remained higher at NH-VPB-06 with no indication of northward groundwater flow toward the Rinaldi-Toluca well field.

Assuming this is a repeatable pumping-induced pattern, this response suggests that fine-grained sediments within the A-Zone do not represent a hydraulically competent aquitard. Rather, groundwater heads above and below this zone can equilibrate with one another. The lack of competent aquitards in the SFB is further reflected by relatively small vertical gradients throughout the SFB, even to significant depths below the B-Zone. As discussed in the following subsection, seasonal vertical gradient changes (upward during winter months, downward during summer months) reflect some degree of vertical anisotropy, as does the fact that most contaminant mass remains above or within the A-Zone. Thus, this unit appears to effectively mitigate mass migration and provides some protection of deeper units. Furthermore, seasonal pumping-induced groundwater gradient reversals toward a production well field do not necessarily result in long-term directional changes in COCs migration. For example, an evaluation of pumping conditions between 1982 and 2006 (which include significant pumping from the Rinaldi-Toluca wells) indicate no significant net groundwater movement (i.e., flow reversal) toward either the Rinaldi-Toluca or NH-west production wells from areas south of Sherman Way and east of Lankershim Boulevard (MWH, 2010b).

4.3.3 Temporal Groundwater Flow Patterns

Shallow groundwater elevation hydrographs at NH-C02, NH-C03, NH-VPB-02, NH-VPB-06, and NH-VPB-08 are illustrated on Figure 4-4 along with annual precipitation. Precipitation values are illustrated with respect to the annual average amount of 18 inches (LACDPW, 2011). Groundwater elevations appear to correlate with significant precipitation events with an approximately one year lag. However, significant pumping patterns (which strongly influence groundwater elevations) are also related to precipitation events.

Groundwater elevation changes at well NH-VPB-02 (Figure 4-4) have been used by the LADWP as representative of conditions near the NHE wells; groundwater elevations are not monitored at individual NHE wells (LADWP, 2011). This well is located approximately 4,700 feet west of NHE-4 and appears to be located cross-gradient to the NHOU extraction well field.

Shallow and deep hydrographs from NH-C02 and NH-C03 are illustrated on Figure 4-5. These wells are within the NHOU study area and together represent conditions in all four depth regions. It is evident from these hydrographs that, since at least 1991, groundwater elevations have changed in approximate unison, despite significant distances between each well screen. Groundwater elevations measured at deeper wells (e.g., NH-C02-681 and NH-C03-800) are higher than those at shallower wells (e.g., NH-C02-220 and NH-C03-380) during winter months (upward vertical gradient) and vice versa during summer months (downward vertical gradient). As is also apparent on Figure 4-5, groundwater elevation changes at these NHOU wells correlate closely with SFB storage changes calculated for the entire SFB (ULARA Watermaster, 2010a, Plate 13). This correlation suggests that basin-scale changes influence groundwater elevation fluctuations in response to and in addition to those induced by individual production well field operations.

The relatively slight vertical head difference present within the SFB suggests a high degree of vertical communication throughout the basin fill. SFB sediments appear not to include extensive clay deposits and the lack of a substantial vertical gradient thus likely indicates the absence of highly competent and/or laterally extensive aquitard units.

Regardless of the competency of fine-grained sediments within the A-Zone as an aquitard, many production wells have served as vertical conduits through the A-Zone since before the 1960s (when most were installed). Vertical conduits include any feature that results in a preferred pathway for vertical groundwater movement. In this case, many of the production wells in the NH well field were constructed with perforation intervals hydraulically connecting the A-Zone to deeper units (Figure 4-3). Although no longer active, most of these wells have not been abandoned or fitted with packers that would limit or prevent vertical groundwater flow through the well casing. As groundwater elevations drop in response to seasonal pumping from other nearby well fields, including the NH-west and Rinaldi-Toluca well fields, preferential groundwater flow likely occurs through the inactive NH-east wells. Additional data are needed to estimate the magnitude of this potential flow, particularly because many of these vertical conduits provide direct hydraulic communication between the A-Zone (where most COC mass resides) and deeper hydrostratigraphic units.

Cluster well NH-C03 was intentionally installed next to NH-28 with the four individual wells constructed such that each screen interval correlates with perforation intervals of this production well (except for the A-Zone perforation interval), in part for aquifer testing purposes (LADWP, 1992). Because the four perforation zones of NH-28 provide cross-communication between Depth Regions 1, 2, 3, and 4, groundwater elevation and analytical data from cluster well NH-C03 may be influenced by vertical flow through NH-28 or other nearby production wells with multiple perforation intervals.

Given the strong influence municipal pumping has on groundwater elevations and flow directions, it is imperative that the Groundwater Management Plan developed through the ICIAP account for the likely impact that reactivating production wells within the NHOU study area would have on successfully implementing the Second Interim Remedy.

4.4 Production Well Fields and Spreading Grounds Operations

This section discusses previous and current projections of municipal pumping from LADWP production wells and implications to designing the Second Interim Remedy. Discussions are based on simulated groundwater elevations in response to various pumping scenarios previously incorporated in the FFS (EPA, 2009a) and current municipal pumping projections reported by the ULARA Watermaster (2011c).

4.4.1 Groundwater Model Use in the Focused Feasibility Study (FFS)

The USEPA proposed plan for the NHOU Second Interim Remedy, as promulgated in the 2009 ROD, was largely based on the simulation of alternatives using the SFBFS-B groundwater flow model in transient mode under the assumptions for projected water use for the years 2006-

2017. Two such projections were made: the first under "average year" flows for groundwater extraction and recharge, and the second with interspersed "dry years" (that included increased pumping demand and decreased recharge at spreading basins) and “normal” years. These two assumed annual projections were prepared in concert with the LADWP and the ULARA Watermaster (EPA, 2009a).

Under the "average years" scenario, the recharge minus the pumping rate (production and extraction wells) deficit was approximately 12,628 AF/Y. Simulated water levels in response to the "average years" scenario declined by approximately 30 to 40 feet. For the “dry years" scenario, the recharge to pumping deficit averaged about 37,323 AF/Y, which lowered the simulated water table in the NHOU area by approximately 100 feet. In both scenarios, portions (for average scenarios), or nearly all (for dry scenarios) of model layer 1 (e.g., the A-Zone) in the NHOU area became dewatered. This result, in part, led the EPA to conclude in the FFS that existing NHOU extraction wells would need to be deepened and that additional extraction wells would be needed to protect southerly Rinaldi-Toluca production wells that would otherwise be in jeopardy of being impacted by COCs contamination.

These simulations were run for approximately 10 years (2007-2017). Had projected uses and deficits been simulated for a longer time, the simulated water table would likely continued to decline over time, potentially to below the bottom of screens assumed in the simulations and for the general well construction specifications presented in the FFS and ROD. This suggests that pumping projections included in the FFS are not realistic or would not be supported by the ULARA Watermaster.

4.4.2 SFB Water Management

Projected pumping scenarios were prepared circa 2005 and were based on the potential for parties of the 1979 Adjudication to withdraw as much of their respective allocations as their rights permitted. By 2007, the ULARA Watermaster had concluded that the previous calculation of a safe yield for the basin was likely in error (overestimated) and made recommendations for restoring SFB storage to 1968 levels. The stipulated agreement was reached in 2007 between the Cities of Los Angeles, Burbank, and Glendale to reduce groundwater extraction and increase recharge via water conservation, recycling, improved and expanded spreading grounds use, extraction and treatment of contaminated groundwater returned for blending with public supplies, and green initiatives for reduced water consumption. Expanded recharge operations potentially include converting the Strathern Pit into a spreading ground and installation of storm water retention and recharge projects, including a parking lot infiltration project located on Sherman Way between the former Bendix facility and the Burbank Airport (LACDWP, 2004a and 2004b).

Each party to the Agreement produces a five-year projection of the proposed pumping and spreading operations annually. The Watermaster compiles and summarizes these projections into an annual Groundwater Pumping and Spreading Plan for the Upper Los Angeles River Area, typically released each July (i.e., ULARA Watermaster 2011c includes Water Years 2010 through 2015). In addition, the LADWP has produced a 2010 Urban Water Management Report (LADWP, 2010e) that outlines water management programs in general terms and projects some goals or anticipated water use as far out as fiscal year 2034/35.

As reported by the ULARA Watermaster (2011c), water use from the SFB is anticipated to remain at low levels through 2015, partly due to concerns for contaminants in groundwater. The Urban Water management Plan indicates that production may remain low until about 2020/21 when treatment facility improvements and water management initiatives are expected to be in place and operating. Should these projections be realized, by 2015 the water table within the

NJOU area is expected to have risen by approximately 50 to 60 feet (ULARA Watermaster, 2011c). As the report also notes, the estimated change in storage over the years 2010 to 2015 is projected to increase by approximately 310,913 AF. Maximum annual projected water use in the SFB once restored is expected to drop by about 33 percent less than dry year projections assumed for the FFS future use scenarios (e.g., about 92,000 AF/Y versus about 137,000 AF/Y in the FFS model). Average withdrawals would be expected to follow a similar pattern with no long-term deficit operation within the basin. Following further data collection, an independent consultant is anticipated to be employed to conduct a more detailed and definitive re-evaluation of the safe yield of the SFB (ULARA Watermaster, 2011c). Goals will be to maintain that level of storage within the basin.

4.4.3 Implications for the Second Interim Remedy

Whereas the FFS projections gave rise to concerns for a continuing lowered water table relative to the ability of the existing wells to operate at design rates and probable migration of contaminants from the A-Zone into the B-Zone, current pumping projections present an entirely opposite problem that, in many ways, offers greater challenges than those in the previous (FFS) scenarios.

- While the rising water table may provide existing wells with sufficient saturated thickness to pump at the original design specifications (250 gpm average and 300 gpm peak), water levels may become sufficiently high to increase transmissivity to where even greater pumping rates would be needed to maintain control of capture zones. Higher rated pumps might be installed, but sufficient capacity would have to be allowed for the treatment plant and for sizing of conveyance. This might lead to increased initial capital costs associated with an over-designed facility.
- The rising water table also means that lower portions of the present vadose zone would become saturated and “stranded” contaminants retained within the unsaturated soils beneath known and potential source areas would be mobilized. Although this would alter the COCs distribution within the A-Zone, the current monitoring well network is not likely sufficient to observe this change and the new and/or expanded NHOU extraction well field may not be appropriately configured. Well locations based on the current understanding of contaminants, particularly those associated with the A-Zone, may be ineffectively placed both vertically and horizontally to maximize containment and mass removal.
- Conversion of the Strathern Pit to a spreading ground could mobilize COCs suspended in the vadose zone and/or saturated zone beneath or near this area and facilitate COC migration toward active production well fields. Subsurface conditions should be fully characterized at each site being considered for active recharge prior to implementing recharge operations.
- The 2010 Urban Water Management Plan (LADWP, 2010e) suggests that treatment facilities may not be in place until circa 2020. Therefore, an appropriate simulation period analogous to the simulation period of about ten years in the FFS may be best targeted for the water years 2020/11 to 2030/31. This suggests an even longer projected use estimate, and one with a greater degree of uncertainty in knowing not only what water demands will be, but estimating influent concentrations for satisfying CDHP 97-005 requirements. During this time, existing concentrations of some contaminants may fall below target cleanup criteria and not require collection or treatment. Where some plumes are known to be stable or shrinking, required capture zones (and in a 3-

dimensional sense) may be much smaller by then; however, new areas of groundwater contamination may develop.

- If the water levels rise as much as anticipated in the NHOU area, contaminants mobilized from the vadose zone will require that NHE wells be constructed to target multiple contaminated vertical zones. Nested extraction wells may be needed if contaminant masses remain collocated in both shallow and deeper portions of the saturated interval.

Significant uncertainty about future municipal pumping scenarios, groundwater elevations, and recharge operations in this dynamic groundwater basin presents a critical data gap regarding designing the Second Interim Remedy, as discussed further in Section 5. Regardless of future pumping rates, because surrounding large-capacity production well fields capture portions of the VOC plume and will continue to operate to meet municipal water demand, it will not be possible to hydraulically capture all contaminated groundwater. Rather, the objective of the Second Interim Remedy is to contain high concentration portions of the plume and other portions above regulatory limits to the extent practicable so that no further groundwater quality degradation occurs, particularly near the Rinaldi-Toluca and North Hollywood (west) production well fields.

4.5 Groundwater Quality

This section evaluates groundwater quality concerning the distribution of COCs identified in the Second Interim ROD (PCE, TCE, chromium, and 1,4-dioxane) plus several emerging chemicals (i.e., 1,2,3-TCP, NDMA, and perchlorate). The lateral, vertical, and temporal distributions of these contaminants described in this section have been evaluated to quantify the degree of uncertainty associated with each COC data set and to identify critical data gaps that pertain to the Second Interim Remedy design.

Analytical data from monitoring wells installed in 2009 and 2010 and historical data from VPB and cluster monitoring wells within the NHOU study area consistently indicate that highest COC concentrations near the NHE well field occur in what has previously been referred to as Depth Region 1. Elevated COC concentrations were also observed, however inconsistently, at wells previously associated with Depth Region 2. When screen intervals and sample depths are considered with respect to ULARA Watermaster geologic units, it is clear that higher concentrations are associated with the A-Zone (whether previously associated with Depth Region 1 or 2).

For instance, NH-C19-360 (the deeper of two screens at this location) penetrates 40 feet of the A-Zone and 20 feet of the B-Zone. Sample depth information confirm that analytical data are representative of the A-Zone and these data are consistent with depth-discrete Simulprobe® data at this location (MWH, 2010b). Similar patterns are observed at NH-C18 and NH-C21. Therefore it is appropriate to associate samples collected to date from wells NH-C13-385, NH-C15-330, NH-C-16-390, NH-C17-339, NH-C18-365, NH-C19-360, NH-C20-380, NH-C21-340, and NH-C23-400 with the A-Zone.

Historical groundwater quality data have been carefully considered; however, COC concentration maps discussed herein are based solely on recent data (since 2007) and only from purpose-built monitoring wells. Among other objectives, the resulting data set has been used to evaluate the adequacy and representativeness of the NHOU performance monitoring well network (as represented by available wells within the NHOU study area and available recent analytical data, as a proxy for future data, contained in the EPA's SFB database). If recent collected data cannot reasonably describe existing conditions, then future data collected similarly at existing monitoring wells cannot be used to assess future remedial actions. Historical

CSMs (particularly regarding SFB geologic descriptions) are discussed to underscore what changes are considered necessary to proceed with implementing the Second Interim Remedy.

4.5.1 Lateral Distribution of COCs

Achieving Second Interim Remedy RAOs will depend upon the degree of characterization of COCs within the A-Zone and B-Zone. Figures 4-7a/b through 4-10a/b illustrate the interpreted distribution of maximum COC concentrations in groundwater based on samples collected since 2007. These figures have been developed for the purposes of determining data adequacy to identify statistical uncertainty and data gaps critical to the Second Interim Remedy design. For comparison purposes, COC isoconcentration maps were also prepared with respect to Depth Zones 1 and 2 and are presented in Appendix C.

Contaminant delineation maps presented in previous reports have included isoconcentration contours based on most recent historical concentrations with respect to Depth Regions (EPA, 1993, 1998, 2003, 2008; MWH, 2010b) or depths relative to the water table (CH2M Hill, 2009) and have combined analytical results from samples collected over several years. For example, NH-east production wells were last sampled in 1988 but were included in contaminant concentration contour maps through at least 2007 (CH2M Hill, 2009). Given that these and other production wells are perforated across multiple zones and considering results from packer testing conducted at NH-24, the combined use of non-depth-discrete data with relatively depth-discrete data from surrounding monitoring wells likely results in an inaccurate plume delineation and may also make plumes appear to be more stable over time than they actually are.

Interpreted COC isoconcentration contours presented herein are based on the maximum concentration detected at each NHOU area monitoring well sampled since 2007, as available from the EPA's SFV database. The highest concentration value was contoured where collocated samples within a given depth interval occur, as in monitoring wells with multiple samples collected within the A-Zone. Because of their completion in multiple depth regions, data from production wells were excluded from COC concentration contour maps. Samples collected from depths below the B-Zone were not considered for contouring because these depths lie beyond (beneath) the NHOU study area. Data used to develop the isoconcentration contours are provided in Table 4-1.

COC isoconcentration contours illustrated on Figures 4-7a/b through 4-10a/b were generated using a kriging contouring algorithm; extraneous contours have been cropped as indicated on each figure. The resulting COC distribution maps thus do not represent "plume maps" because they are mathematical constructs meant to account for data values and locations rather than interpret COC patterns based on groundwater flow and source considerations. The method does not account for groundwater flow directions, pumping patterns, or uncharacterized known or potential source areas.

Kriging is an appropriate method because of its flexibility and ability to provide consistent interpolation over a large range of sample sizes and to quantify uncertainties in the interpolated results (kriging variance). “Simple kriging” requires an overall mean value of 0.0 and no trends. Ordinary kriging is very similar to simple kriging but allows for a non-zero average value across the data set; this is much more practical when dealing with concentrations. Universal kriging is an advanced method that de-trends data before processing and requires additional data and professional interpretation of the causes of trends to be effective. Contours were developed via the ordinary kriging method of interpolation.

Kriging assumes that concentrations vary continuously in space; “nearby” points have similar values to each other while more distant points may vary greatly. “Nearby” is dependent on the data set and their distribution in space. The associated distance is short in areas with high gradients (e.g., plume edges) and, conversely, may include large areas with relatively constant values (e.g., background areas). Ordinary kriging of the COC data involves fitting a model variogram to differences in points scattered across the data set. The variogram describes how strongly points are correlated with distance apart.

Variograms are modeled by plotting the absolute differences between points' concentration over a range of distances between the known data points in a dataset. A model variogram is a mathematical function that is fitted to these points. Commonly used functions include spherical, Gaussian, logarithmic, and exponential, and were chosen according to the best fit for each dataset. The nugget effect, which describes the variance at zero distance due to variability in sample collection and measurement, was also considered in fitting the model variogram to each dataset. To achieve an acceptable fit, it was necessary to use the log10-transformed value of each concentration. Non-detect values for a given COC were set to a value of one-half the detection limit for contouring purposes. Variograms for each data set and a more detailed description of the kriging process are presented and discussed in Appendix D.

Kriged COC concentration contours – and more importantly, the kriging variance – are useful tools for identifying areas of critical values and/or unacceptably high uncertainty based on available data (data gap analysis).This approach was specifically taken to identify potential data gaps based on available data. Other contouring algorithms (e.g., nearest neighbor, inverse-distance weighted) do not produce measures of estimation uncertainty. Variance values associated with the kriging method have been converted to standard deviation values associated with each COC by taking their square root:

$$Kriging\ standard\ deviation = \sqrt{Kriging\ variance}$$

When juxtaposed with kriged COC concentration contours, areas of greater uncertainty (as exemplified by higher standard deviation values away from measured values) with respect to the COC distribution (based on available recent data) become apparent and may represent significant data gaps. By considering both the estimated value and the kriging standard deviation (SD), an approximate confidence interval can be estimated. By assuming kriging errors are normally distributed – a reasonable first approximation for errors in general - upper and lower 95% confidence values for the estimate can be calculated by:

$$95\%\ confidence\ interval = Kriging\ estimate\ \pm 1.96 * Kriging\ standard\ deviation$$

Because this is a numerical construct, it is possible for the lower confidence limit to be computed to be less than zero – a physically-impossible negative concentration. For interpretation purposes, a negative confidence limit can be considered to be a concentration of zero.

Kriged SD values contoured on Figure 4-7a/b through 4-10a/b are intended to graphically convey where extrapolated known data are least certain. For instance, a kriged SD value of 4 µg/L crossing an area where kriged TCE concentrations range from 10 to 25 µg/L indicates a 95 percent probability that TCE concentrations vary from 2 to 33 µg/L along the SD contour line. Similarly, the same kriged contour area where crossed by a SD contour line of 10 µg/L indicates that TCE concentrations vary (with a 95% probability) from 0 to 45 µg/L. TCE concentrations in this example cannot be determined below 50 µg/L area with a 95% probability in areas beyond the 10 µg/L SD contour line.

The degree of confidence (as illustrated by the kriged SD contour lines) is important for identifying data gaps (e.g., decisions relative to the MCL). Poorly characterized known and potential source areas in low-confidence COC concentration areas may be associated with more critical data gaps than source areas in high-confidence COC concentration areas. Areas of unsampled known or potential source areas also are associated with a higher uncertainty than the kriged prediction because pertinent local concentrations (higher than predicted values from non-source areas) are not used in the estimate.

4.5.1.1 TCE

A-Zone: TCE concentrations contours for the A-Zone (Figure 4-7a) show four target areas where TCE is present in groundwater at concentrations exceeding 10 times the MCL (greater than 50 µg/L). These areas are located: 1) south (downgradient) of the Hewitt Pit, 2) south (downgradient) of the former Bendix facility, 3) southwest and south (cross-gradient and down-gradient) of the former Lockheed Martin facilities), and 4) southwest to south (downgradient) of the former Lockheed Martin facilities. Insufficient data exist to delineate the lateral extent of TCE to the MCL, as indicated by the kriged contours that extend beyond the standard deviation contours (Figure 4-7a). The approximate 95% confidence intervals for this figure range from ± 8 µg/L (4*1.96) to ± 20 µg/L (10*1.96) for SD = 4 and SD=10 respectively.

Target Area 1: In the area south/southeast (downgradient) of the Hewitt Pit, TCE has been detected at concentrations up to 100 µg/L at NH-C09-310. Recent groundwater quality data north, west, and east of this area are insufficient to indicate a boundary for the 50 µg/L contour and to assess whether the TCE observed at NH-C09-310 is contiguous with elevated TCE concentrations farther east (Area 2). In fact, no monitoring wells are present west of this area to delineate the lateral extent of TCE to the MCL or lower concentrations[4]. Several known and potential sources exist in this area in addition to the Hewitt Pit.

Target Area 2: In the area south of the former Bendix facility, concentrations of TCE range up to 1,300 µg/L (at NHE-2 and GW-7). With respect to the former Bendix facility, the area of kriged TCE concentrations greater than 50 µg/L extends west (cross-gradient), southeast (downgradient), and south (cross-gradient and opposite the NHOU extraction well field).

- Elevated concentrations beneath the former Bendix facility appear to be captured by NHOU extraction wells NHE-2 (primarily) and NHE-3, although insufficient data exist to verify the size and shape of the capture zones associated with these wells.
- Elevated concentrations at NH-C19-360, NH-C18-365, and NH-C21-340 represent the lower portion of the A-Zone. Groundwater elevation data suggest that NH-C19-360 is cross- or up-gradient from the former Bendix facility, but also proximate to or downgradient of other known or potential sources. Insufficient data exist to determine whether elevated concentrations at this well are contiguous with Target Area 1. Additional uncertainty exists because insufficient depth-discrete groundwater quality data from the A-Zone exist to determine whether contamination from the former Bendix facility extends to NH-C18-365 and NH-C21-340 (as illustrated on Figure 4-7a). At least eight known and potential source areas exist within and upgradient (northeast) of this area.
- Elevated concentrations at NHE-4 and NH-C10-280 appear discontinuous from higher concentrations closer to the former Bendix facility. Multiple sources exist near these wells and, because of historical pumping by NHE wells, differentiating one source from another is not likely possible without evaluating soil vapor analytical data in this area.

[4] The EPA released its final health assessment for TCE on September 28, 2011 (EPA, 2011d). The assessment concludes that the weight of evidence supports a mutagenic mode of action for TCE kidney carcinogenicity. Consequently, the TCE MCL will likely be lowered from its current level of 5 µg/L.

Target Area 3: In the area southwest and south of the former Lockheed Martin facilities, concentrations of TCE range up to 1,240 µg/L at well LC1-CW06 and 400 µg/L at well 3830S. Recent groundwater data to the northwest are insufficient to delineate the 50 µg/L contour boundary and also insufficient to identify the source of this contamination. Figure 4-7a shows six known and potential source areas upgradient of this area. Groundwater elevation data suggest that TCE detected at LC1-CW06 originates from source(s) to the north or northwest.

TCE concentrations greater than 50 µg/L extend to the southeast beyond NHOU extraction wells NHE-7 and NHE-8 and may commingle with Target Area 4. The lateral extension of elevated TCE concentrations, including greater than 100 µg/L concentrations at well 3831Q (approximately 3,000 feet downgradient of NHE-7 and NHE-8), suggests either that this extraction well has not prevented the downgradient migration of TCE in this area or that TCE had already migrated downgradient of NHE-7 and NHE-8 and that sufficient mass remains in the vadose zone to sustain elevated concentrations in groundwater. Elevated TCE concentrations at well 3831Q appear to extend downward into the B-Zone at concentrations below 50 µg/L, as discussed below.

Target Area 4: In the area east to southeast of the former Lockheed Martin facilities, TCE concentrations range up to 1,720 µg/L at LA1-CW07. Recent groundwater data are insufficient to characterize the extent of TCE at 50 µg/L to the northeast and south. This area is contiguous with the BOU.

Analytical results for wells screened in the A-Zone north of the former Bendix facility and northwest of the former Lockheed Martin facilities indicate that TCE is present at concentrations above the MCL of 5 µg/L in areas upgradient and cross gradient of the two sites. Given the southwest groundwater flow directions near the Penrose Landfill, Newberry Landfill, Strathern Inert Landfill, and Tujunga Pit, elevated TCE concentrations (between the MCL and 50 µg/L) observed at NH-C05, NH-C16, and NH-C22 likely originate from one or more sources in this area. The distribution illustrated on Figure 4-7a suggests that TCE is being captured by the Rinaldi-Toluca well field and that, southeast of this well field, TCE continues to migrate toward the southeast (downgradient) consistent with groundwater elevation contours illustrated on Figure 3-7a.

B-Zone: Review of TCE concentration contours for the B-Zone (Figure 4-7b) indicates that elevated TCE concentrations greater than 50 µg/L were detected only at NH-C05-460. Contours are based on few data points; recent groundwater data are insufficient to characterize the extent of the area where TCE exceeds 50 µg/L or the MCL. The approximate 95% confidence intervals for this figure range from ± 8 µg/L (4*1.96) to ± 20 µg/L (10*1.96) for SD = 4 and SD=10 respectively.

Recent groundwater monitoring data shows that TCE ranges up to 120 µg/L (NH-C05-460). The point (or points) of origin responsible for TCE observed at NH-C05-460 is not known at this time; however, given the southwest direction of groundwater flow (Figure 3-7a) and distribution of TCE in the A-Zone throughout this area, the Penrose Landfill, Newberry Landfill, Strathern Inert Landfill, and Tujunga Pit are sources at or near these detections. Whether this TCE is captured by one or more of the Rinaldi-Toluca production wells cannot be confirmed without additional depth-discrete data from the B-Zone.

The isoconcentration contours also indicate that there is a separate area of elevated TCE concentrations in the B-Zone beneath the former Bendix facility (Target Area 2) and south of the former Lockheed Martin facilities that underlie Target Areas 3 and 4. These B-Zone TCE concentrations are below 50 µg/L. Insufficient data exist to delineate the lateral extent of TCE to the MCL in the B-Zone south of the former Lockheed Martin facilities; however, data from other wells beneath the former Bendix facility suggest that the elevated TCE concentrations as indicated by data from GW-16-347 are not laterally extensive.

It should be noted that the distribution of the wells shown on Figure 4-7b illustrate that there are insufficient recent groundwater monitoring data from the B-Zone to characterize the extent of TCE above the MCL at the depths represented by the B-Zone. Several monitoring wells that penetrate this zone from which groundwater depth-discrete samples could be collected are recommended to be sampled as discussed in Section 6.

4.5.1.2 PCE

A-Zone: PCE isoconcentration contours prepared for the A-Zone (Figure 4-8a) show three areas where PCE concentrations exceed 10 times the MCL of 5 µg/L. These areas loosely correspond with Target Areas 2, 3, and 4 as discussed in the previous section. The maximum concentration of PCE of 1,120 µg/L was detected in LA1-CW07, east of the former Lockheed Martin facilities (i.e., beneath Target Area 4). Contamination to the east of the former Lockheed Martin facilities is contiguous with the BOU. The approximate 95% confidence intervals for this figure range from ± 4 µg/L (2*1.96) to ± 10 µg/L (5*1.96) for SD = 2 and SD=5, respectively.

In the area beneath the former Bendix facility, PCE was detected at concentrations up to 130 µg/L (at GW-10 and GW-15, which are on-site and within the capture zone of the Bendix site remediation system). Figure 4-8a illustrates six known and potential source areas upgradient of this area. In the area southeast of the former Bendix facility, PCE was detected at concentrations up to 92 µg/L at NH-C10-280. There are over 11 known and potential source areas within and upgradient of this area.

PCE has also been detected at concentrations above 50 µg/L at locations north (upgradient) of the former Bendix facility (e.g., NH-C01-325 at 58 µg/L); however, too few surrounding data points exist to support kriged contours above this threshold. This area is downgradient of the Penrose, Newberry, and Strathern landfills and Tujunga Pit. The potential relationship with TCE detected in this area is discussed in Section 4.5.2.

There are insufficient recent groundwater quality data from the A-Zone to characterize the extent of PCE concentrations exceeding the MCL; specifically in the areas west of the former Bendix facility (e.g., west of NH-C09-310), north of former Bendix facility (e.g., near NH-C01-325), and north of the former Lockheed Martin facilities. NH-C09-310 is located downgradient of the Hewitt Pit and NH-C01 is downgradient from the Penrose Landfill, Newberry Landfill, Strathern Inert Landfill, and Tujunga Pit; PCE detections at or near these wells could be associated with one or more of those sites.

B-Zone: PCE isoconcentration contours as illustrated on Figure 4-8b indicate that the MCL is exceeded more than ten-fold south of the former Lockheed Martin facilities. The approximate 95% confidence intervals for this figure range from ± 4 µg/L (2*1.96) to ± 10 µg/L (5*1.96) for SD = 2 and SD=5 respectively. Recent groundwater samples are insufficient to delineate the extent of PCE to the MCL in the B-Zone.

4.5.1.3 1,4-Dioxane

A-Zone: Review of 1,4-dioxane data from the A-Zone (Figure 4-9a) indicate a widespread area where 1,4-dioxane was detected above the 1 µg/L notification level. The approximate 95% confidence intervals for this figure range from ± 2 µg/L (1*1.96) to ± 18 µg/L (9*1.96) for SD = 1 and SD=9 respectively. This area extends upgradient, cross-gradient, and downgradient of the former Bendix facility. Concentrations exceeded 10 µg/L in samples from several monitoring wells at the former Bendix facility (up to 320 µg/L at GW-2, which is hydraulically contained by the onsite treatment system), immediately south of the former Bendix facility (27 µg/L at GW-17-282 and 24 µg/L at NH-C07-300), at NH-C10-280 (18 µg/L), and at NHC09-310 (13 µg/L) south of the Hewitt Pit.

One Simulprobe® sample collected from the NH-C23 boring indicated a 1,4-dioxane concentration of 30 µg/L at a depth of 291 feet bgs; however, similar elevated concentrations were not observed in samples from NH-C23-310 or NH-C23-400. Given the depth to water of approximately 250 feet at the time of sampling, these data suggest additional 1,4-dioxane mass may reside within the A-Zone above the sampling depth associated with NH-C23-310 (screened from 250 to 310 feet bgs). Several wells with lower concentrations separate this location from the former Bendix facility, where other elevated concentrations have been observed. Several known and potential sources exist northwest and west of this area (upgradient) and depth-discrete samples have not yet been collected within the A-Zone (i.e., 4909C and 4909F). Additional depth-discrete groundwater quality data from these wells may be helpful in delineating the extent of 1,4-dioxane in this area and, potentially, in identifying the associated source or sources.

1,4-dioxane concentrations greater than the notification level extends upgradient of the former Bendix facility (5.18 µg/L at well 4918B, 3.1 µg/L at NH-C16-390, and 3.0 µg/L at NH-C05-320) that suggest a source exists near or north of the Penrose Landfill. Concentrations at NHOU extraction wells range from 1.6 µg/L at NHE-8 to 7 µg/L at NHE-2. There are no 1,4-dioxane data available from NH-C16-320, NH-C19-290, NH-C21-260, or NH-C23-400. Otherwise, recent groundwater quality data are insufficient to constrain the areal extent of 1,4-dioxane concentrations in the A-Zone exceeding 10 µg/L (or the notification level) in the NHOU study area and, as shown on Figure 4-9a, multiple known and potential sources are in this area.

<u>B-Zone:</u> Review of 1,4-dioxane concentration contours for samples collected from wells screened in the B-Zone (Figure 4-9b) show three areas where 1,4-dioxane was detected above the 1 µg/L notification level. The extent of 1,4-dioxane in these areas is not well characterized because there are few recent groundwater samples collected from the B-Zone. The approximate 95% confidence intervals for this figure range from ± 4 µg/L (2*1.96) to ± 10 µg/L (5*1.96) for SD = 2 and SD=5 respectively. The maximum detected 1,4-dioxane concentration in the B-Zone was 5.2 µg/L from GW-11-352.

No 1,4-dioxane data exist in the EPA's SFB database at LADWP production wells, except for TJ-07 and TJ-08 (both in the Tujunga well field). While not useful for contouring purposes (data associated with production wells have been excluded from Figures 4-9a/b), this information could be useful to evaluate the potential for this compound to migrate toward and impact active production wells in the NHOU area.

4.5.1.4 Hexavalent Chromium

As stated in the AOC, LADWP has voluntarily implemented a 5 µg/L cleanup level because an MCL does not yet exist for this COC. In July 2011, the CDPH proceeded toward the eventual promulgation of an MCL with the revision of their draft Public Health Goal [PHG] (0.02 µg/L). Because PHGs are not enforceable regulatory limits, the Second Interim Remedy will continue to evaluate hexavalent chromium with respect to the 5 µg/L cleanup level until further notified by the EPA. Nonetheless, concentration contours shown on Figures 4-10a/b extend to 1 µg/L to evaluate the extent of this COC above its detection limit.

<u>A-Zone:</u> Review of hexavalent chromium concentration contours for the A-Zone (Figure 4-10a) indicate that highest concentrations are observed beneath and south of the former Bendix

facility with concentrations ranging up to 140,000 µg/L (GW-14A). Elevated concentrations in the western portion of the former Bendix facility are captured by the on-site treatment system. Off-site exceedances appear to be captured by NHE-2, discharge from which is planned to be conveyed to the on-site treatment system. The approximate 95% confidence intervals for this figure range from ± 8 µg/L (4*1.96) to ± 20 µg/L (10*1.96) for SD = 4 and SD= 10, respectively.

As illustrated on Figure 4-10a, the spatial distribution of hexavalent chromium in recent groundwater samples appears to be sufficient to characterize its extent in groundwater relative to 5 µg/L in this area with some exceptions. As also shown on Figure 4-10a, there are at least three known and potential source areas upgradient of this area where little (if any) characterization has occurred. Elevated hexavalent chromium concentrations at NH-C18-365 and NH-C21-260 are hydraulically cross-gradient from the former Bendix facility and opposite the NHOU extraction well field, but downgradient from several known or potential source areas. Note that hexavalent chromium data are not available from NH-C19-360, NH-C21-340, or NH-C23-400 (lower A-Zone).

Two isolated locations also have hexavalent chromium concentrations above the 5 µg/L cleanup level: south of the former Lockheed Martin facilities (well 3830S at 10.8 µg/L) and west of the Hewitt Pit (NH-C11-295 at 7 µg/L). Thus, insufficient data exist to determine the lateral extent of this COC regarding the 5 µg/L cleanup level and the known and potential sources in the NHOU study area.

The ROD requirement of installing up to three new extraction wells northwest of the current NHOU extraction well field was based, in part, on concerns that hexavalent chromium would be (or may have already been) drawn into this area in response to pumping from the Rinaldi-Toluca wells. Wells NH-C19, NH-C20, and NH-C-23 were installed in this area in part to verify these concerns, and results indicate that the groundwater is not impacted with hexavalent chromium in this area. Furthermore, groundwater elevations measured in December 2010 indicate a southeast gradient beneath the Hewitt Pit and former Bendix facility, consistent with regional flow directions, that does not suggest potential migration toward the Rinaldi-Toluca well field under pumping conditions at that time.

B-Zone: Review of hexavalent chromium concentration data for samples collected from the B-Zone (Figure 4-10b) indicate that hexavalent chromium has impacted groundwater in a small portion of the B-Zone beneath the former Bendix facility, suggesting some downward migration of this COC from the A Zone. Concentrations in this area are lower than were detected in the A-Zone; the maximum detected concentration in B-Zone samples is 23 µg/L (GW-17A). The approximate 95% confidence intervals for this figure range from ± 8 µg/L (4*1.96) to ± 20 µg/L (10*1.96) for SD = 4 and SD= 10 respectively. The extent of impacted groundwater appears to be limited in extent; however, recent data from the B-Zone are limited, because only one well was sampled downgradient of GW-17A.

4.5.2 Groundwater Chemical Signatures

Additional information regarding groundwater flow directions, groundwater quality, and potential source conditions was ascertained by evaluating groundwater chemical signatures, specifically regarding chlorinated ethenes. Pie chart diagrams of chlorinated VOC generated for samples collected each year since 2007 at wells in the NHOU study area are shown on Figures 4-11 through 4-15. Proportional concentrations of PCE, TCE, cDCE, and vinyl chloride compose each pie chart; diameters indicate the total VOC concentrations on a logarithmic scale. December 2010 groundwater elevation contours are included on each figure to relate chemical signatures to groundwater flow directions.

Chemical signatures prepared in this fashion convey information regarding spatially distinct chemical processes (i.e., fate) and, possibly, unique contaminant sources. Results suggest at least three areas with specific chemical signatures:

1. A TCE-rich chemical signature in the western portion of the NHOU study area (including the northern Rinaldi-Toluca well field),
2. A TCE/cDCE chemical signature in the central portion of the NHOU study area, and
3. A PCE-rich chemical signature in the eastern portion of the NHOU study area.

The TCE/cDCE chemical signature is particularly significant because the presence of cDCE suggests that degradation processes are present in these wells that are not present in the western or eastern portions of the NHOU study area. This signature is dominant in NH-C16, which is downgradient from landfills in the northern portion of the study area, and characterizes samples from wells farther downgradient in and near Target Areas 1 and 2 (see Section 4.5.1.1), including production wells in the southern portion of the Rinaldi-Toluca well field, monitoring wells at the former Bendix facility, and monitoring wells downgradient of the Hewitt Pit and former Bendix facility. Wells in Target Area 3 have TCE/cDCE-rich chemical signature, although with less cDCE than in Target Area 2. Wells in Target Area 4 have a PCE-rich chemical signature and suggest a different source.

Assuming geologic conditions are similar throughout the NHOU study area, the presence of cDCE in the central portion is indicative of additional biodegradation that may be driven by electron acceptors occurring at higher concentrations than elsewhere. Common electron acceptors, including nitrate, iron, sulphate, or carbon dioxide, are typically associated with landfill leachate. Insufficient data are available to thoroughly assess the biodegradation potential in the NHOU area. The EPA's SFB database indicates that ORP values range from below -100 to above 100 millivolts at individual wells over time (suggesting an inconsistent potential for reduction or oxidation to occur) and that dissolved oxygen values range from below zero to above 12 mg/L (suggesting an extreme variability and/or suspect measurements). Parameters measured at recently installed monitoring wells indicate that ORP values range from 50 to 150 millivolts and that dissolved oxygen concentrations typically are greater than 4 mg/L (MWH, 2010b). These values indicate oxidizing conditions that are not conducive to reductive dechlorination of TCE to cDCE; however, relatively low dissolved oxygen concentrations were measured at NH-C16-390 (below 1.5 mg/L) are indicative of biological activity and may explain the presence of cDCE and trans-1,2-DCE. This suggests that cDCE may be generated primarily near the source(s) and persist downgradient in the A-Zone. Occasional vinyl chloride detections at wells throughout the NHOU study area (i.e., not clustered) suggest additional reductive dechlorination processed may be occurring.

When compared to groundwater elevation contours, chemical signatures illustrated on Figures 4-11 through 4-15 suggest that a source or sources at or near the northern landfills has contributed COCs to groundwater and has altered groundwater chemistry to enhance biodegradation and generate cDCE. This signature extends downgradient toward the southern Rinaldi-Toluca production wells and continues downgradient (southeast) of the former Bendix facility. The northern extent of the TCE/cDEC-rich signature strongly suggests that a northern source or sources is at least partially responsible for water quality degradation occurring at the Rinaldi-Toluca well field. This finding is significant because it suggests that the new extraction wells proposed in the FFS and stipulated in the ROD will not limit additional groundwater quality degradation near the Rinaldi-Toluca well field, which is one of the Second Interim Remedy RAOs.

4.5.3 Emerging Chemicals

Emerging chemicals discussed in this section include 1,1,1-TCA, 1,2,3-TCP, 1,2-dichloropropane (1,2-DCP), NDMA, and perchlorate; additional analytes are included in the EPA's RI monitoring program and will continue to be evaluated as additional data become available. The presence of one or more of these compounds is relevant to the Second Interim Remedy design only if sufficient mass exists within the anticipated capture area to be present in the treatment system influent at concentrations sufficiently high to require treatment prior to delivery to the LADWP distribution system. As stated in the Second Interim Remedy ROD, the point of compliance shall be the combined effluent from the NHOU treatment facility, just prior to its delivery to the end use, the LADWP drinking water system.

4.5.3.1 1,1,1-TCA

Review of historical groundwater monitoring data from the NHOU area indicates that 1,1,1-TCA concentrations exceeded the California MCL of 200 µg/L in only one sample. This sample was collected from well 4917B in 2007 (250 µg/L), which is at the Tuxford Landfill north of the Penrose Landfill. It is notable that this elevated 1,1,1-TCA concentration appears to be consistent with elevated 1,4-dioxane concentrations detected at 4918B, NH-C22, and NH-C23 (1,4-dioxane is commonly associated with the use of 1,1,1-TCA).

Because 1,1,1-TCA was only detected above the MCL in one sample, the Second Interim Remedy treatment system will not likely need to remove this compound from groundwater; however, this compound will continue to be monitored as part of the RI monitoring program and will be considered with respect to CDPH 97-005 requirements.

4.5.3.2 1,2,3-TCP

Historical monitoring data indicate that 1,2,3-TCP is present in groundwater throughout the NHOU area but generally at concentrations below the CDPH notification level of 0.005 µg/L. This compound has been detected at concentrations exceeding the CDPH notification level in a small percentage of samples collected from groundwater monitoring wells, extraction wells, and production wells. Maximum detected concentrations are summarized below:

- Honeywell Monitoring Wells (the former Bendix facility) - maximum detected concentration of 0.017 µg/L (July 2007 in GW-12A-319 [A-Zone]); the most recent detection above the action level was at 0.006 µg/L in December 2010.
- Lockheed Martin Monitoring Wells - maximum detected concentration of 63.6 µg/L (June 2009 in LB5-CW02 [B-Zone]); the most recent detection above the action level was 1.7 µg/L in November 2010
- Other wells (including RI monitoring wells) - maximum detected concentration of 5 µg/L (February 2011 in 4909F [multiple screens, unknown sample depth]).
- Rinaldi-Toluca Well Field – maximum detected concentration of 11.5 µg/L (November 2010)
- North Hollywood Well Field – maximum detected concentration of 10 µg/L (January 2011)
- Extraction wells - maximum detected concentration of 10 µg/L (January 2011)

1,2,3-TCP was not detected in samples collected from the LADWP production wells prior to 2010. Detected concentrations of 1,2,3-TCP in samples collected in 2010 and 2011 are suspect because they are three orders of magnitude above the notification level and are not consistent with previously detected concentrations.

Based on the detection of 1,2,3-TCP at concentrations above the notification level, the RD will evaluate this compound as part of the influent stream. Additional monitoring is ongoing to further assess its distribution in groundwater at NHOU.

4.5.3.3 1,2-Dichloropropane (1,2-DCP)

Historical data indicate that 1,2-DCP has generally been detected in groundwater in the NHOU study area at concentrations below the MCL of 5 µg/L, and less than five percent of the samples contained concentrations exceeding the MCL. Maximum detected concentrations in monitoring wells, extraction wells, and production wells are as follows:

- Lockheed Martin Monitoring Wells – maximum detected concentrations of 7.96 µg/L (June 2008 in LB5-CW02)
- Other wells – maximum concentration of 8.6 µg/L (January 1995 at 3830Q)
- Rinaldi-Toluca Well Field – maximum concentration of 11.6 µg/L (August 2010)
- North Hollywood (west) Well Field – maximum concentration of 10.3 µg/L (January 2010)

As with 1,2,3-TCP results, 1,2-DCP was not detected in samples collected from LADWP production wells before 2010 and the data from 2010 and 2011 are suspect because reported concentrations were higher than previously reported.

Because 1,2-DCP has not been widely detected at concentrations above the MCL within the NHOU study area, the Second Interim Remedy will not likely require consideration of this constituent in the design process. However, its presence at wells surrounding the NHOU area will continue to be monitored as part of the RI monitoring program and will be considered to comply with CDPH 97-005 requirements.

4.5.3.4 NDMA

NDMA has been typically detected in groundwater in the NHOU study area at concentrations below the CDPH notification level of 0.01 µg/L. There have been sporadic detections above the cleanup level in samples collected in 2003 and 2006 in monitoring wells and extraction wells as indicated below:

- Honeywell Monitoring Wells - maximum detected concentration of 0.043 µg/L (September 2003 in GW-2)
- Lockheed Martin Monitoring Wells - maximum detected concentration of 0.12 µg/L (March 2006 in LB5-CW02)
- Other monitoring wells – maximum detected concentration of 0.095 µg/L (March 2006 in 3830S)
- Extraction wells – NDMA exceeded the notification level in one sample from NHE-6 (0.024 µg/L) and one sample from NHE-8 (0.04 µg/L).

Because NDMA has not been widely detected at concentrations above the notification level in the NHOU study area, the Second Interim Remedy will not likely require treatment of this constituent. However, its presence at wells surrounding the NHOU area will continue to be monitored as part of the RI monitoring program and will be considered to comply with CDPH 97-005 requirements.

4.5.3.5 Perchlorate

Perchlorate is typically observed in groundwater in the NHOU study area at concentrations below the MCL (6 µg/L). Concentrations up to 74 µg/L have been observed within a hydraulically contained portion of the former Bendix facility, and perchlorate was detected in a depth-discrete sample collected during the installation of NH-C24 (near the Hawker-Pacific site) at a concentration of 750 µg/L. Historical maximum concentrations include one detection at RT-07 greater than the MCL (at 6.9 µg/L in 2005); however, concentrations have otherwise not exceeded the MCL at the Rinaldi-Toluca wells since 2008. Higher concentrations have been measured in the Tujunga well field (11 µg/L and 13 µg/L at TJ-12 and TJ-11, respectively, in 2004); however, similar to the Rinaldi-Toluca well field, concentrations have declined such that the MCL was exceeded only at TJ-11 since 2008 (up to 9.11 µg/L). Nonetheless, the data suggest that at least one perchlorate source is in the northern portion of Area 1 upgradient of the NHOU study area.

Groundwater samples from monitoring wells indicated the presence of perchlorate at low concentrations (below the MCL) throughout the NHOU, with slightly higher concentrations at NH-C02 and NH-C04, which are in the eastern portion of the NHOU area. Notably, perchlorate was not detected in samples from NH-C24-305 despite the detections in depth-discrete samples collected during the installation of this monitoring well.

Because perchlorate has not been widely detected at concentrations above the MCL at wells within the NHOU study area, the Second Interim Remedy will not likely require treatment of this constituent. However, its presence at wells surrounding the NHOU area will continue to be monitored as part of the RI monitoring program, and the potential for its migration into the NHOU capture area will be further evaluated to comply with CDPH 97-005 requirements.

4.5.4 Vertical Distribution of COCs

Vertical distributions of COCs throughout the NHOU study area include mass “stranded” in the vadose zone in addition to mass residing in saturated hydrogeologic units. COC mass presence and distribution within the vadose zone throughout the NHOU study area is poorly understood, particularly due to the many known and potential source areas in the area and the limited amount of soil gas data (if any) associated with each. The distribution of COCs within the saturated zone as based on available depth-discrete groundwater quality data, are discussed below. Depth-discrete analytical data from Simulprobe® samples are compared with groundwater samples collected from monitoring wells, screen intervals, and A-Zone and B-Zone intervals in Appendix E.

As discussed in Section 4.5, COC concentrations are highest in the A-Zone and are generally lower in the B-Zone. Conceptually, decreasing concentrations with depth are consistent with ongoing mass migration from the vadose zone and progressively lower concentrations with depth below the water table as a result of various attenuation processes. Fine-grained sediments in the A-Zone appear to have sufficient capacity to retard the vertical migration of COCs, as indicated by analytical results from samples collected via Simulprobe® (Appendix E) that indicate the highest concentrations are found at depths consistent with this hydrogeologic unit.

Because the NHE wells currently extract from the A-Zone (which includes the AA group), this finding suggests that deepening the NHOU extraction well field to pump from the B-Zone is not necessary and could induce migration to degrade zones of higher groundwater quality. However, additional capture does appear to be needed (both deeper and over a larger area than is apparently capable by the existing NHOU extraction well field), but specifically within the A-Zone. The SFBFS model is not vertically discretized with sufficient resolution to account for this distinction.

Analytical results of groundwater samples collected at collocated monitoring wells east of the NHOU extraction well field (e.g., NH-C10, NH-C12, and NH-C17; Appendix E) indicate an opposite vertical distribution from those observed at NH-C18 and NH-C19, for example. The results also suggest that significant migration through the A-Zone has not yet occurred in this area, although these wells are downgradient of the NHOU area with respect to the regional groundwater flow direction.

Notwithstanding concerns over low-resolution plume delineation and discrepancies between depth regions and hydrostratigraphic units, the vertical extent of COCs within the A-Zone southwest of the NHOU well field could be explained by one or more of the following mechanisms:

- Multiple contaminant sources west of the NHE well field
- Higher vertical (downward) gradients and westward lateral gradients induced by active western North Hollywood production wells
- Change in lateral and/or vertical hydraulic conductivity values of the A-Zone in this area.
- Variation in the amount of organic carbon or other parameters that would affect rates of COC migration through the AA group.

Understanding which of these mechanisms (or combination thereof) is responsible will be critical to designing the Second Interim Remedy. Without this information, it will not be possible to identify the target capture zone or to design the Second Interim Remedy to establish the target capture zone and extract COC mass to the maximum extent practicable with optimal flow rates.

Understanding past vertical migration pathways and potential future pathways is complicated by the large number of production wells in the NHOU study area, specifically because of their construction. Many production wells in the North Hollywood area were constructed with perforation intervals and/or filter packs that penetrate the A-Zone as well as deeper hydrogeologic units (Table 3-4; Figure 4-3). Downward vertical gradients occur seasonally in response to substantial pumping from production well fields throughout the area (Figure 4-5). Elevated COC concentrations observed in the A-Zone are thus potentially able to rapidly migrate downward through these vertical conduits and, subsequently, laterally through the B-Zone in response to local pumping stresses. This is a particular concern with respect to the production wells comprising the NH-east well field given their proximity to elevated COC concentrations in the A-Zone.

Vertical conduit production wells comprising the NH-west well field are active whereas those comprising the NH-east well field are inactive. This means that the NH-west and NH-east wells should be considered 'active' and 'passive' vertical conduits, respectively. Destroyed wells (e.g., NH-5, NH-15, and NH-31) represent historically 'active' vertical conduits. Vertical conduits represented by filter packs include NH-39 and the 15 production wells comprising the Rinaldi-Toluca well field. Only two Rinaldi-Toluca wells, RT-1 and RT-2, were installed with a conductor casing surrounding the gravel pack, and these only extend to a depth of 100 feet bgs.

4.5.5 Temporal COCs Distribution

This section discusses historical VOC migration and changes in COC concentrations and distribution over time, including a statistical trend analysis of COC concentrations at RI monitoring wells. Time-concentration plots are presented in Appendix F.

4.5.5.1 Historical VOC Migration

The 1987 ROD and other documents cite a plume migration rate of approximately 1,100 feet between 1981 and 1985 (approximately 300 feet/year) based on the progressive detections of VOCs at production wells. Although the Groundwater Management Plan (LADWP, 1983) included a recommendation to calculate retardation rates, particularly near the North Hollywood production well field, the ROD states that the apparent migration rate approximated the regional groundwater velocity.

The perceived rapid migration rate at that time was based on VOC detections at various production wells in the North Hollywood area. The number of production wells where TCE concentrations exceeded the MCL [5 µg/L] increased from 11 wells in 1980, to 22 wells in 1983, to 27 wells in 1985, and an additional 5 to 10 wells were projected to be impacted by 1987. In hindsight, production well operations in the North Hollywood area likely induced the plume to migrate into the B-Zone and deeper due to their construction as vertical conduits, as described previously. The apparent rapid lateral plume migration rate (equivalent to groundwater velocities) in the 1980s reflects a two-dimensional perspective, although actual migration must have followed a more complex three-dimensional pathway. Contaminants would have migrated vertically through the vadose zone beneath each source area and then migrated laterally through the A-Zone upon encountering saturated conditions.

Given the number of active NH production wells pumping from the A-Zone at the time, it is likely that contamination from many sources in the area was captured by these wells; however, when not active (i.e., since 1990), these same wells may have facilitated rapid vertical migration of COCs to deeper zones in response to pumping from other well fields. VOC concentrations observed below the B-Zone at NH-C03-580 (Appendix F, Figure F-M-6) appear to correspond with aggregate municipal pumping (Figure 3-3), which is consistent with expected groundwater quality impacts in response to shallow COC mass migrating downward through one or more vertical conduits (e.g., NH-28) as induced by pumping from deep hydrogeologic units.

It cannot be determined when elevated VOC concentration first impacted production wells in the North Hollywood area for several reasons. Multiple known, potential, and unknown sources of VOC contamination exist and have existed throughout the area since the 1940s, and exact release dates cannot be known with certainty. Although significant pumping from production wells throughout the SFB complicate local groundwater flow conditions, many of these production wells (particularly those in the NH well field) penetrate the A-Zone in addition to deeper units. Insufficient data exist to differentiate mass directly extracted by production wells partially penetrating the A-Zone from mass induced to migrate toward production wells penetrating deeper groundwater zones.

Continued production well operations and seasonal groundwater elevation fluctuations eventually led to COC migration into and perhaps through the A-Zone (in addition to migration through vertical conduits represented by wells penetrating multiple zones), followed by complex lateral migration paths between active production wells within the B-Zone and possibly deeper zones. Although NH-east production well operations were mostly terminated by 1990, these wells continue to provide vertical conduits through the A-Zone today.

4.5.5.2 Temporal Concentration Changes

Temporal concentration changes at monitoring wells and NHOU extraction wells have been evaluated regarding groundwater elevations, pumping cycles, and precipitation patterns, to the extent that data are available. The intent of this comparison is to evaluate the stability of the plume over time and to determine how the NHOU system has performed over time. Time concentration plots of wells throughout the NHOU study area are presented in Appendix F.

As discussed further in Appendix A, historical groundwater quality and operational data from various NHE wells appear to correlate inversely, meaning that VOC concentrations tend to increase when pumping stops. The EPA described this phenomenon in their Third 5-Year Review (EPA, 2003) as an indication of the arrival of a contaminant pulse. However, considering that groundwater elevations have fluctuated significantly (+/- 20 feet) since NHOU operations began, an equally likely explanation is that contaminants have been alternately suspended within the vadose zone and remobilized when groundwater elevations rebound during periods of low pumping. Historical reliance on groundwater quality as determined from samples collected from pumping wells rather than monitoring wells introduces additional uncertainty that limit their potential interpretation.

Statistical trends in COC concentrations over time were calculated for RI monitoring wells as part of an attempt to optimize the RI monitoring program (CH2M Hill, 2011a). Of the RI monitoring wells in the NHOU study area, data from NH-C03-380 (B-Zone) are perhaps most informative for the Second Interim Remedy. Concentrations have decreased with time such that VOCs are below their respective MCLs and hexavalent chromium concentrations are below 2 µg/L. Relatively low COC concentrations are observed throughout the NHOU study area based on recent analytical data from numerous monitoring wells. Pending results from depth-discrete samples at B-Zone wells not yet collected, these analytical results suggest that B-Zone groundwater quality is higher than groundwater quality within the A-Zone and that this trend has not reversed itself over time. This suggests that deepening NHOU extraction wells to below the A-Zone is not necessary. However, as discussed above and in Sections 5 and 6, expanded hydraulic capture within the A-Zone and over a larger area than currently possible is warranted.

4.6 NHOU Operations

This section discusses NHOU operations since their initiation in 1989. Detailed discussions of NHOU extraction wells and previous evaluations of the NHOU system are provided in Appendices A and B. The performance of the NHOU system has not met design expectations in part because of declining or variable groundwater elevations (largely as a result of significant pumping and limited recharge) and in part because of an incomplete and inadequate CSM when the original system was designed. An accurate CSM is of critical importance for any treatment system to meet RAOs, as acknowledged by the EPA (2010).

4.6.1 Pumping Capacity

Of the NHE wells that have remained active since 1989, NHE-4 and NHE-5 have performed poorly and less reliably than the other wells. NHE-1 has never been operated as part of the NHOU system, and NHE-5 has been mostly inoperable since 2008. Although previous investigations have concluded that several factors have contributed to the low NHE production rates the primary reason has been fluctuating groundwater elevations that occasionally drop to near or below submersible pump depths. Causes for these fluctuations include seasonally higher production well field activities in summer and fall, drought conditions, and limited or variable amounts of recharge to the SFB, in part because of climatic changes. All NHE wells are screened within the A-Zone which includes geologic units that generally dip gently to the southeast. The relatively flat water table in this area results in a smaller saturated thickness toward the northwest; well NHE-1 is apparently very close to the hydraulic extent of this hydrostratigraphic unit.

Specific capacity and step-drawdown results from tests performed in 1987 and 1988 suggest that hydraulic conductivity values of the A-Zone range from 86 to 115 ft/d between NHE-2 and NHE-3 (farthest west), from 41 to 67 ft/d near NHE-4 and NHE-5, and from 148 to 271 ft/d near NHE-7 and NHE-8 (farthest east). Hydraulic conductivity values specific to the A-Zone cannot be derived from tests performed at NHE-6, because this well is screened in both the A- and B-Zones (and slightly below the B-Zone); however, the composite estimate of 26 ft/d suggests that values generally decline southward. The combination of lower hydraulic conductivity and limited saturated thickness appears to explain the unreliable performance at NHE-4 and NHE-5.

Although the presence of north-south trending alluvial channels throughout the eastern SFB have long been recognized (as part of the Tujunga Wash), how the lateral distribution of horizontal hydraulic conductivity within the A-Zone or B-Zone may correlate with channels, or whether contiguous channel-filled sediments (typically coarse-grained) are present, has not yet been evaluated. Insufficient data exist to assess whether hydraulic conductivity progressively increases from west to east, as suggested by tests performed at the NHE wells, or whether the NHE wells were unknowingly installed within or among multiple north-south trending channels. The lateral and vertical distribution of permeable units (i.e., preferential pathways) is an important feature to understand the potential for COCs to migrate under various groundwater flow conditions.

Monitoring wells recently installed as part of the Second Interim Remedy characterization, including those west of the NHOU extraction well field (e.g., NH-C09, NH-C19, NH-C18, NH-C15, and NH-C21), have not been hydraulically tested. Insufficient data exist to assess whether the low specific capacity measured at NHE-1, for instance, is indicative of similar or lower values within the A-Zone farther west, or whether NHE-1 is screened across floodplain sediments (i.e., between channels) and that sediments of higher specific capacities would be encountered farther west due to permeable sediments associated with other channels. North-south anisotropy that may result from these paleo-channels could influence local groundwater flow direction and, consequently, contaminant distribution from the many known and potential sources throughout the region. Furthermore, heterogeneity within geologic units composing the A-Zone will necessarily affect the extent and shape of the NHOU capture zone.

The elevation gradient of both the ground surface and the base of the A-Zone decline to the east at a gradient of approximately 0.01 ft/ft; however, A-Zone groundwater has an eastward gradient of approximately 0.004 ft/ft. This means that groundwater extracted by NHE-7 and NHE-8 originates from shallower sediments than at extraction wells NHE-2 and NHE-3. Geophysical data suggest that horizontal conductivity values decline with depth within the A-Zone and, thus, NHE well capacities likely decline due to lower permeability as groundwater elevations decline (in addition to less saturated thickness).

This feature, if present, has important implications for each NHOU extraction well capture zone. Hydraulic capture widths are directly proportional to hydraulic conductivity for a given discharge rate. If hydraulic conductivity values increase to the southeast, the capture zones associated with NHE-7 and NHE-8 should be narrower than those associated with other NHOU extraction wells for a given discharge rate. Because insufficient data exist to estimate the spatial distribution of A-Zone hydraulic conductivity and because a performance monitoring well network does not yet exist, the appropriate discharge rate for each NHOU extraction well to capture COC mass cannot be estimated with reasonable certainty.

Additional capacity to be implemented by the Second Interim Design will be addressed in the Groundwater Modeling Memorandum and the Preliminary Design Report. The additional and deeper extraction wells called for in the preferred remedy are intended to increase overall capacity and, consequently, the NHOU capture zone area. Data gaps associated with implementing this design are discussed in detail in Section 5.

4.6.2 Groundwater Quality

Extraction wells NHE-2 through NHE-8 have been discontinuously operated since December 1989. As of September 2009, the NHOU system has removed approximately 7,000 pounds of VOCs from groundwater with an average rate of approximately 300 pounds removed annually as shown on Figure 3-10. Note that NHE wells' analytical data in the EPA database extend from 1990 (NHE-4) and from 1992 for other wells (except NHE-1) to the present; pre-1992 data are thus extrapolated and total mass removed by the NHOU systems over time may be underestimated.

Groundwater quality as indicated by analytical results from the NHE wells over time suggest at least three water quality domains among the existing extraction wells that may be illustrative for designing the Second Interim Remedy:

1. VOCs (greater than [>] 50 µg/L) and hexavalent chromium (>5 µg/L): NHE-3 and NHE-5
2. VOCs (>50 µg/L), hexavalent chromium (>5 µg/L), and 1,4-dioxane (>1 µg/L): NHE-2 and NHE-4
3. VOCs (>50 µg/L): NHE-7 and NHE-8.

VOCs, hexavalent chromium, and 1,4-dioxane are below each of the concentrations defining these domains at NHE-6; therefore, its operation provides additional hydraulic capture and dilutes concentrations in groundwater extracted by other NHE wells. NHE-2 is distinct due to the relatively high hexavalent chromium concentrations. For this reason, NHE-2 has been separated from the other NHE well scope and will be routed to the former Bendix facility treatment system for treatment and injection there. How these water quality domains will relate to the Second Interim Remedy extraction well configuration is unknown, as is discussed with respect to data gaps in Section 5.

Nonetheless, historical data from the existing NHE wells are illustrative, although the period of record for 1,4-dioxane and chromium concentrations is shorter than that of VOCs. Using VOC data as a proxy, the bulk of the mass removed by the NHOU originates from NHE-7, NHE-2, and NHE-8 (in that order) (Figure 3-10). VOC mass captured by NHE-2, NHE-3, NHE-4, and (historically) NHE-5 likely originates from several sources in the North Hollywood area (see Section 3.2.6). Contribution from known and potential source areas cannot be accurately identified without improving the resolution of plume delineation by installing additional monitoring wells in this area (as discussed in Section 6). VOC mass extracted at NHE-7 and NHE-8 originate from the plume or plumes associated with the BOU. The larger VOC mass removed by NHE-7, relative to NHE-2, is consistent with the higher discharge rate sustained at NHE-7. Higher VOC concentrations are observed at NHE-2 than at NHE-7.

Implications based on the chemical signatures and concentration trends at the NHE wells must be tempered by the fact that very few monitoring wells exist in their immediate vicinity and, therefore, local plume delineation changes that may have occurred in this area since operations began in 1989 cannot be fully assessed.

In the event that a lower TCE MCL is promulgated in response to the EPA's recent conclusion regarding its carcinogenicity (EPA, 2011d), the Second Interim Remedy ROD states that "ARARs are frozen at the time the ROD is signed, but off-site requirements, including requirements applicable to treated water delivered to the drinking water supply, must be met in order to comply with the Second Interim Remedy's selected end use regardless of whether those requirements change over time. As a result, if an offsite drinking water requirement changes, the treatment system must meet whichever standard – the performance standard selected in the ROD or the off-site requirement – is lower."

4.7 Conceptual Site Model Summary

This section summarizes the refined NHOU CSM based on AMEC's review of existing data and previous CSMs summarized and discussed in Sections 3 and 4. This refined CSM specifically focuses on AMEC's understanding of the geology, hydrogeology, distribution of contaminants (including source areas), the current NHOU treatment system, and the past and projected operation of active municipal production wells as they pertain to design of the Second Interim Remedy.

4.7.1 Hydrostratigraphic Units

The SFB is an alluvial-filled basin consisting of fine- to coarse-grained sediments in the western portion and coarse-grained sediments (e.g., consisting largely of sand, gravel, and cobbles) in the eastern portion that primarily derived from the San Gabriel Mountains. Various subunits have been identified within the SFB based on geophysical signatures and lithology, but in general, many of the identified units are difficult to correlate across the SFB without use of down-hole geophysical data. Within the NHOU study area, however, these units appear to correlate well and suggest relatively flat orientations with little structural dip. Aquifer hydraulic parameters of most units in the SFB suggest relatively high-transmissivity conditions, consistent with a granitic source area and a high-energy depositional environment, also consistent with the mountainous topography surrounding the SFB. Fine-grained units have previously been associated with in situ weathering of granitic feldspar to clay particles and are thus more prevalent with older, deeper sediments (JMM, 1992).

Currently used Depth Regions 1 through 4 are primarily based on production well perforation zones, but these do not necessarily correspond with geologic or hydrostratigraphic units. An important refinement to the previous CSM is the recognition that Depth Regions 1 and 2, specifically, bisect a finer-grained unit within which most COC mass occurs. This unit has been recognized previously and has been referred to as the Middle Zone (JMM, 1992) and, in part, the "AA Group" by the ULARA Watermaster; however, neither approach encapsulates the importance of this unit with regarding the NHOU design. This refined CSM defines the "A-Zone" as saturated sediments including the AA group and shallower sediment units throughout the NHOU study area. The base of the A-Zone (approximately 350 feet bgs) extends 20 to 80 feet below the base of Depth Region 1 and encapsulates the majority of sediments within which most COC mass remains that requires remedial action. Because the top of the A-Zone is defined by the water table, this denomination also includes the relatively thin Shallow Zone as referred to in the 1992 RI report (JMM, 1992).

The A-Zone overlies a coarse-grained unit referred to by the ULARA Watermaster as the BB Group and is included in Depth Region 2. The refined CSM refers to this unit as the B-Zone, the base of which is consistent with the base of Depth Region 2. COC concentrations are much lower in the B-Zone, potentially due to dilution; however, relatively few depth-discrete B-Zone groundwater samples have been collected to date. Several monitoring wells have been constructed with screen intervals penetrating this zone and collecting depth-discrete samples is a readily achievable option.

The A-Zone and B-Zone are key components of the refined CSM because the vertical distribution of COCs strongly correlates with these hydrostratigraphic units. When the groundwater flow model is revised such that layers 1 and 2 correlate with these zones, the Second Interim Remedy for the NHOU groundwater remediation design can be appropriately simulated regarding optimally capturing remaining COC mass.

Monitoring wells in the NHOU study area were not constructed with screen intervals specifically placed in the A-Zone or B-Zone. Several recently installed collocated monitoring wells (e.g., NH-C18, NH-C19, and NH-C21) were installed such that the lower of the two well screens penetrates both the A-Zone and the B-Zone. As discussed below, it is critically important to understand the implications of these well construction details when considering groundwater elevation data or analytical data collected at these and other wells. For instance, all three of the deeper screens associated with these wells have been associated with Depth Region 2; however, low-flow samples collected to date were from the A-Zone, not the B-Zone. Confusion persists at other wells, particularly where sample depth information is not available from the EPA's SFB database. Accurately associating groundwater sample depth information with either the A-Zone or B-Zone (or deeper) will be critical to design the Second Interim Remedy.

Recognizing the significance of the A-Zone concerning COC distribution is also important to understanding potential mass migration pathways through vertical conduits at active and formerly active production wells. Many production wells in the North Hollywood area were constructed with multiple perforation zones that allow COCs to rapidly migrate from the A-Zone to deeper units in response to seasonal or pumping-induced vertical gradients. These pathways need to be blocked to allow the NHOU treatment system to protect surrounding active production well fields from continued COC mass migration.

4.7.2 Groundwater Flow Conditions

Groundwater flow within the NHOU study area is to the southwest between northern landfills and the Rinaldi-Toluca well field and to the southeast beneath the Hewitt Pit, former Bendix facility, and former Lockheed Martin facilities. Gradients flatten near the Rinaldi-Toluca well field. It cannot be determined if this is due to pumping operations or results from hydrogeologic conditions, but production wells south of RT-2 have not operated in recent years due to water quality concerns. Thus, it appears likely that the south-southwest gradient north of Sherman Way is a natural characteristic of the SFB. Historic operation of the Rinaldi-Toluca well field at maximum capacity in the late 1980s and 1990s may have resulted in local groundwater capture from the southeast; however, there is no indication that groundwater flow directions beneath the former Bendix facility have reversed since that time.

Groundwater elevations are not measured from depth-discrete monitoring wells so high-resolution vertical head profiles cannot be developed. It appears that the SFB is characterized by slight vertical gradients with groundwater elevation values typically differing by less than 10 feet even over several hundred feet of vertical separation. This suggests a high degree of hydraulic communication between hydrostratigraphic units, which is consistent with a basin composed of coarse-grained sediments, but cross-communication via the many vertical conduits throughout the NHOU study area and long monitoring well screens may obscure true vertical gradients in this area.

Temporal groundwater flow patterns are difficult to illustrate in plan view (i.e., event-specific groundwater elevation contours) because groundwater elevations are measured at relatively few monitoring wells in the NHOU study area at the same time. Measurements from individual wells shown on long-term hydrographs, however, indicate that groundwater elevations change throughout the SFB in relative unison. As with the slight vertical gradients, this pattern suggests a high degree of hydraulic communication and is consistent with highly transmissive sediments. Rapid response time over large distances is also indicative of low storativity values; however, insufficient data exist to differentiate these hydraulic parameters in discrete hydrostratigraphic units within the NHOU study area.

Pumping from sediments with high transmissivity values, as appears to be the case in the SFB, typically results in a shallow, broad cone of depression around the pumping well (for a given pumping rate). This means that an observation well would need to be closer to a pumping well to observe the cone of depression than for sediments of lower transmissivity (all else being equal). Monitoring wells in the NHOU study area have been installed primarily to characterize the lateral extent of COCs in groundwater and, as a result, are distant from the NHOU extraction wells. Therefore, an NHOU performance monitoring well network effectively does not yet exist and groundwater flow directions near the NHOU extraction wells cannot be verified.

Similarly, insufficient data exist to characterize three-dimensional groundwater flow patterns in the A-Zone. Regional-scale monitoring indicates seasonally variable (upward/downward) vertical gradients between shallow and deep sediments. However, data are not sufficient to quantify vertical gradients within the A-Zone or assess how these gradients may change over time, particularly in response to pumping patterns. Gradients in the A-Zone may be more complex near inactive production wells where vertical conduits provide a hydraulic connection to active production wells pumping from deeper units. As mentioned in Section 4.5.5.1, this behavior may explain the occurrence of VOCs at cluster well NH-C03-580. Increasing vertical downward gradients in the A-Zone by pumping from deepened NHOU extraction wells will exacerbate downward migration and increase the likelihood of impacting the B-Zone.

Few wells are known to have been constructed with a screen interval that solely penetrates the B-Zone and groundwater flow directions and gradients specific to the B-Zone thus cannot be verified. However, flow directions are not expected to differ dramatically from those in the A-Zone, gradients are expected to differ because of the (presumably) higher hydraulic conductivity of the B-Zone.

4.7.3 Contaminant Distribution and Source Areas

Multiple known and potential source areas complicate delineating each COC but more problematic are the unknown sample depths associated with groundwater samples collected from the A-Zone. Available data, as contoured using the kriging algorithm, suggest that insufficient data exist to delineate most of the COCs to the MCL (or notification limit) and even to ten times these limits. Delineation of the lateral and vertical extent of each area is of critical importance when designing the new NHOU extraction well field to ensure Second Interim Remedy RAOs are met (particularly those regarding protecting nearby production well fields).

In addition, many production wells throughout the NHOU area were constructed with perforation zones that penetrate the A-Zone and deeper intervals that could facilitate vertical COC mass migration and complicate NHOU remediation activities. The degree of mass migration through idle and active vertical conduits at these production wells has not yet been assessed, and insufficient data exist to perform such an assessment.

4.7.3.1 Vadose Zone

Very little information regarding COCs distribution within the vadose zone exists in the NHOU study area, in part because the applicability of soil gas testing conducted as part of the SFB RI was concluded as unsatisfactory and subsequent testing excluded the North Hollywood area. VOCs in particular are expected to remain in vapor-phase and, possibly, in aqueous phase suspended in soil moisture within the vadose zone beneath historical and active source areas. Hexavalent chromium would not be present in vapor-phase and is not likely to adsorb significantly to soil particles; however, soil moisture or perched water zones in the vadose zone beneath historical and active source area would likely remain active subsurface source areas, as was the case at the former Bendix facility. Hexavalent chromium sources at other known or potential sites could continue to leach to groundwater over potentially long periods. Delineation of hexavalent chromium in the vadose zone would require analysis of these waters, most likely using of lysimeters or other negative pressure systems capable of collecting sufficient vadose zone soil moisture for chemical analysis.

Soil vapor investigations and use of lysimeters, etc. have not been conducted in the NHOU area, except at the former Bendix facility. Available data are thus inadequate to evaluate COCs distribution with respect to the known and potential source areas throughout the NHOU study area.

This data gap is potentially of critical significance given recent municipal pumping projections (ULARA Watermaster, 2011c) that suggest groundwater elevations in the NHOU area could rise by 50 feet by Fall 2015. This condition would result from adherence to a stipulated agreement between the Cities of Los Angeles, Burbank, and Glendale with the goal to increase SFB storage by reducing pumping and increasing recharge. Should this goal be realized, COC mass stranded within the vadose zone would be mobilized in the (thicker) A-Zone and able to migrate laterally, potentially without being observed by existing monitoring wells (which may be screened too deep). Although increased storage would likely facilitate operation of the NHOU extraction wells, it would also likely require additional monitoring wells and extraction wells screened to shallower intervals than are currently available.

4.7.3.2 A-Zone

Delineating the lateral and vertical extent of COCs in the A-Zone is difficult because most monitoring wells have been sampled from a single depth (i.e., no vertical profiles within the A-Zone) and the sample depth is not always recorded in the EPA's SFB database. Additionally, most wells were not constructed with screen intervals discretely placed within the A-Zone. As a result, available data tend to support a plan-view perspective of COC distributions and limit the ability to evaluate the three dimensional distribution of COCs in this unit.

This is a critical data gap because available depth-discrete data (e.g., Simulprobe® data at select cluster monitoring wells) suggest that most COC mass remains within the A-Zone. Insufficient data exist to determine whether mass is absorbed to A-Zone sediments (e.g., organic carbon) or whether groundwater flux is sufficiently high in the underlying B-Zone to dilute COC concentrations that are migrating downward from the A-Zone. In either case, depth-discrete data are needed to design the new NHOU extraction well field to prevent additional COC mass migration from the A-Zone that could further impair groundwater quality at production well fields within the NHOU study area.

Wells where multiple depth-discrete groundwater samples have been collected (i.e., NH-C19, NH-C18, and NH-C21) suggest that COC concentrations are higher in the lower portion of the A-Zone. No data exist near the NHOU extraction wells to verify how COC mass has been distributed in response to approximately 20 years of pumping from these wells (all of which are screened in the upper portion of the A-Zone, except for NHE-6 which is also screened in the B-Zone and extends slightly below the B-Zone). A summary of the primary COCs follows:

- TCE is the most widely distributed COC in the NHOU area and at least four major areas of elevated TCE concentrations appear to exist in the A-Zone. Recent data are insufficient to delineate this COC to the MCL (5 µg/L) or, in several areas, to ten times the TCE MCL. Therefore, whether these four areas are contiguous or distinct from one another cannot be determined with reasonable certainty.
- PCE concentrations are highest over the largest area to the east, as associated with the BOU; however, singular hot-spots (i.e., greater than ten times the MCL of 5 µg/L, as at NH-C10) suggest that additional data are needed to delineate the lateral and vertical extent of this COC in the NHOU study area.
- The distribution of 1,4-dioxane suggests one or more sources northeast (upgradient) and west of the former Bendix facility. Its presence at NH-C09 at 13 µg/L is particularly noteworthy, given the relatively isolated nature of this detection and the relatively few known or potential source areas to the northwest (other than the Hewitt Pit). No concentration data for this COC are associated with the LADWP production wells (including the NHOU treatment system) as available from the EPA's SFB database. The CDPH notification level for this COC is 1 µg/L and thus its detection often indicates an exceedance of this level. The absence of these data prevents assessing how this COC has impacted drinking water quality in the area or how effective the existing NHOU extraction well configuration has been in capturing it.
- Although the CDPH recently promulgated a draft PHG of 0.02 µg/L for hexavalent chromium, no MCL exists for this COC and the LADWP has enacted a voluntary cleanup level of 5 µg/L (as indicated in the AOC). This COC is known to be associated with the former Bendix facility; however, many other known and potential source areas exist within the NHOU study area where (as mentioned above) little, if any, subsurface information exists. Additional data from at several recently installed monitoring wells (e.g., NH-C18 and NH-C21) suggest that one or more sources other than the former Bendix facility, is responsible for the distribution of hexavalent chromium in A-Zone groundwater.

4.7.3.3 B-Zone

As noted above, few monitoring wells were constructed with screen intervals that discretely penetrate the B-Zone. Wells that partially penetrate the B-Zone, but that have not yet been sampled in this interval, are indicated on Figures 4-7a/b through 4-10a/b. Available data suggest that COC concentrations generally are much lower in the B-Zone than in the A-Zone. Whether this results from mass migration from the vadose zone and soil properties that are sufficient to retain most COCs within the A-Zone or from a groundwater flow (flux) that is sufficiently high in the B-Zone to dilute continued mass migration out of the A-Zone cannot yet be determined.

Of the four areas with elevated TCE concentrations in the A-Zone, only the westernmost area may also significantly (i.e., greater than ten times the MCL) impact groundwater quality in the B-Zone. Additional wells must be sampled to further delineate the lateral extent of TCE at this depth.

B-Zone PCE concentrations generally do not exceed ten times the MCL, but insufficient data exist to delineate the lateral extent of PCE to the MCL. Concentrations generally mimic those in the A-Zone, particularly to the east beneath the BOU area (where data from LB5-CW02 indicate concentrations greater than 50 µg/L). Highest concentrations to the west exist beneath the Hewitt Pit and the former Bendix facility. Multiple sources exist throughout the NHOU that may have contributed to this distribution.

The distribution of 1,4-dioxane suggests that concentrations exceeding the notification level occur between the Hewitt Pit and former Bendix facility. However, many monitoring wells screened across the B-Zone have not yet been sampled and additional data from this location could greatly improve delineation of this COC within this zone. An additional exceedance is observed to the east at LC1-C02, upgradient of or collocated with the former Lockheed Martin facilities.

Hexavalent chromium concentrations in the B-Zone are typically below 5 µg/L except for data from GW-17A (south of the former Bendix facility). Additional data from existing monitoring wells screened in this zone are needed to further assess the presence and distribution of this COC.

4.7.3.4 Source Areas

At least 33 known or potential source areas exist in the NHOU study area as identified by the EPA or by PRPs with EPA concurrence. The EPA has identified 10 facilities associated with known source properties and 23 potential source properties (EPA, 2012). General location information associated with these properties are summarized on Table 3-8 and illustrated on Figure 3-8.

At least an additional 75 suspected sources also are within the NHOU area that may require additional characterization, including recipients of EPA's general and special notification letters (EPA, 1998a) and others (MWH, 2010b). Subsurface conditions (vadose zone or below the water table) with respect to COCs distribution has not been characterized at most of these sites. These unknowns present critical data gaps relevant to designing the Second Interim Remedy because the target capture zones may not be able to prevent ongoing and future groundwater quality impacts to productions wells as specified by the AOC, depending on where active sources remain.

The apparent rapid lateral plume migration rate (equivalent to groundwater velocities) as depicted in the 1980s reflects a two-dimensional perspective, although actual migration must have followed a more complex three-dimensional pathway. Contaminants would have migrated vertically through the vadose zone beneath each source area and then would have migrated laterally and vertically through the A-Zone upon encountering saturated conditions. Contaminants have been retained by finer-grained sediments within the A-Zone and may have slowly migrated through those sediments into the B-Zone. Migration into the B-Zone may be accelerated by flow through vertical conduits created by production wells. Given the number of active NH production wells pumping from the A-Zone at the time, it is likely that contamination from many sources in the area were captured by these wells; however, when not active, these same wells may have facilitated rapid vertical migration to deeper zones in response to pumping from other well fields.

The distribution of COCs and chemical signatures in groundwater throughout the NHOU study area suggest that one or more sources at or near the northern landfills are impacting groundwater quality at the Rinaldi-Toluca production well field. This source(s) is upgradient to the former Bendix facility and does not preclude contribution from many other known or potential sources. The new NHOU treatment system will not achieve RAOs if the lateral and vertical extent of COCs is not delineated first.

4.7.4 NHOU Extraction Wells/Treatment System Effectiveness

The NHOU system was designed based on analytical data from sampling production wells rather than depth-discrete monitoring wells; system operations began in 1989. Most of the six active NHE wells primarily capture groundwater from the A-Zone; NHE-6 captures groundwater from the B-Zone and from slightly below the B-Zone. The lateral and vertical extent of capture by each NHOU extraction well cannot, however, be illustrated because monitoring wells installed as part of the SFB RI near the NHE extraction wells were screened below the A-Zone (or equivalent). In lieu of empirical data, the collective NHOU capture area has been estimated using basin-scale groundwater flow models.

Of the eight extraction wells, NHE-1 has not been capable of sustaining flow and thus this well has not been incorporated into the NHOU system. Sustaining flow at other wells, particularly NHE-4 and NHE-5, has also been problematic. The underlying cause has been variable groundwater elevations in the relatively thin saturated depth interval from which pumping at these wells occurs. LADWP has maintained these wells by occasionally using a wire brush to remove debris, scale, etc. from the well screen; however, this does not appear to have improved long-term performance. NHOU operations improved after the LADWP implemented its Preventative Maintenance Plan in 2002, including the decision to terminate operations when influent hexavalent chromium concentrations exceeded 5 µg/L, rather than to terminate pumping from individual wells when concentrations exceeded 50 µg/L.

NHOU extraction well performance is limited to analytical data from groundwater samples collected at each of the active extraction wells; additional discussion is provided in Appendix A. The absence of an NHOU performance monitoring network (including individual monitoring wells or piezometers in the NHOU extraction well field) has significantly prevented verifying the size and extent of the NHE capture zones. The absence of depth-discrete data within the A-Zone near active NHOU extraction wells prevents evaluating the effectiveness of the NHOU treatment system to assess the vertical extent of actual capture relative to the appropriate target capture zone. The basin-scale groundwater flow model is structured such that model layers 1 and 2 (equivalent to Depth Regions 1 and 2) bisect the A-Zone and prevent simulation of capture specifically regarding this hydrostratigraphic unit, further complicating evaluation of the NHOU treatment system.

The refined CSM (i.e., differentiating the A- and B-Zones from Depth Regions 1 and 2) is significant with respect to attaining RAOs stated in the Second Interim Remedy. Scope items specify that several NHOU extraction wells need to be deepened to capture COCs (if only in response to future conditions) from in Depth Region 2. Because COC mass resides within the A-Zone, however, deepening extraction well screens such that they capture groundwater from in the B-Zone would induce deeper COC mass migration where groundwater quality is generally high.

However, additional capture appears to be needed (both deeper and over a larger area than is capable by the existing NHOU extraction well field), but more specifically within the A-Zone. The SFBFS model is not vertically discretized with sufficient resolution to account for this distinction.

4.7.5 SFB Management

The Cities of Los Angeles, Burbank, and Glendale entered into a 10-year Stipulated Agreement in 2007 to limit groundwater extraction and increase recharge in an attempt to restore SFB storage to pre-1968 conditions. Recent simulations by the ULARA Watermaster based on current municipal pumping and recharge projections suggest that groundwater elevations may rise 50 feet in the NHOU area by Fall 2015. These projections directly contradict those included in the EPA's FFS (EPA, 2009a), which anticipated declining groundwater elevations in response to increased pumping over time.

The consequence of these inconsistent and contradictory pumping conditions is critically significant concerning the Second Interim Remedy. Increased SFB storage and an associated rise in the water table would likely resolve many operational problems that have thwarted sustained operation of several NHE wells (e.g., NHE-1 and NHE-5) and could likely allow the collective NHOU extraction rate to meet the original design capacity of 2,000 gpm. However, significantly raising the water table would also mobilize COCs suspected to be stranded within the vadose zone. The capture width of each NHOU extraction well would also be reduced proportionate to the increased A-Zone transmissivity. Thus, the need for additional extraction wells as stipulated in the AOC (to additionally protect nearby production well fields) could be replaced by the need for additional extraction wells to maintain capture of an enlarged target capture area.

5 DATA GAP ANALYSIS

As stated in the AOC, the means to address data gaps deemed critical to support the Second Interim Remedy design will be provided in the Groundwater Monitoring Plan. Data gaps discussed in this section are organized with respect to the Second Interim RAOs, AOC Work Scope Items, and critical path documents. Identifying which data gaps are critical is thus a key objective of this Data Gap Analysis. To that end, Table 5-1 organizes identified data gaps into one of three categories: manageable, significant, and critical. The priority of which each data gap should be addressed is also indicated on Table 5-1 and relates to the recommended actions as listed in Table 5-1 and discussed in Section 6.

5.1 Previous Data Gap Analysis (2009)

The FFS (EPA, 2009a) included a summary of data needs and recommended the installation of 37 monitoring wells to address each identified data need, as follows:

1. Adequately characterize the lateral and vertical distribution of contaminant plumes and known hotspot areas and their relationship to known source areas;
2. Provide sufficient data to measure the progress of future remedial actions in reducing contaminant concentrations over time in areas targeted for remediation;
3. Provide data to estimate the extent of hydraulic capture provided by the remedy extraction well network;
4. Provide information to assess the potential for chromium, emerging chemicals, or both to impact groundwater treatment plant performance and efficiency; and,
5. Develop a monitoring/sentinel well network to detect the migration of known COCs and emerging chemicals from known plume and hot spot areas.

These data needs were assimilated into the Second Interim Remedy as the first AOC work scope item "Groundwater Monitoring"; persistent or new data gaps surrounding the NHOU monitoring well network are discussed in Section 5.3.

The FFS also included recommended technologies for treating the identified constituents of VOC's, hexavalent chromium, and 1,4-dioxane. Appendix C of the FFS includes assumptions, theoretical calculations and computer modeling based on published literature. While VOC treatment has been in operation at the NHOU treatment system for many years, no testing, either bench- or pilot-scale, has been done regarding hexavalent chromium, 1,4-dioxane, or the use of VPGAC's on the NHOU extracted groundwater. Rather, assumptions and theoretical calculations included in the FFS were used to develop cost estimates associated with the selection of alternatives.

5.2 Second Interim ROD Remedial Action Objectives

Second Interim Remedy RAOs presented in the ROD (EPA, 2009b) represent overarching goals anticipated to be met by implementing the preferred remedy. This section contains an evaluation of existing data gaps for each of the five RAOs introduced in Section 1.2.

5.2.1 Prevent Exposure to Contaminated Groundwater

Groundwater in the SFB remains vitally important to the municipal water supplies of Los Angeles, Burbank, and Glendale. Thus, this objective pertains to limiting exposure to contaminated groundwater on a regional scale via several well fields, including those downgradient of the NHOU area. Data gaps specific to this RAO are discussed in the next section.

5.2.2 Contain Contaminated Groundwater with Contaminants Greater than MCLs

Hydraulically containing groundwater with contaminants greater than their respective MCLs first requires that the lateral and vertical distribution of contaminants above those thresholds be defined. By extension, defining the three-dimensional distribution of COCs requires a monitoring network capable of providing sufficiently high-resolution characterization of groundwater flow and quality conditions. The existing RI monitoring network has included approximately 80 wells throughout the entire SFB, of which 16 are in the NHOU study area (12 in the A-Zone and 4 in the B-Zone) and none are near the NHOU extraction wells. As discussed in Section 3.2.4 this network is not sufficient to characterize groundwater flow and quality conditions in the NHOU area. Data from the recently installed 31 monitoring wells have improved the CSM substantially, but these wells have not been incorporated into the RI program and have been sampled only twice since their installation.

Although RI monitoring wells have been sampled for almost 20 years, their sparse distribution provides a limited data set that has left the NHOU area substantially under-characterized regarding the delineation of lateral and vertical distribution of COCs to respective MCLs. This data gap is compounded when potentially lower MCLs (e.g., TCE) or new MCLs (e.g., hexavalent chromium) are considered. The uncertainty regarding the extent of COCs in the NHOU study area is underscored by detections to the west (e.g., NH-C09-310, NH-C18-365, and NH-C19-365), to the south (e.g., NH-C17-289 and NH-C21-340), and to the north (e.g., NH-C05-460). Further uncertainty results because many known or potential sources exist throughout the NHOU area that have likely contributed to the COC distribution in groundwater, but have little if any groundwater characterization data. Fully defining the three-dimensional extent of the areas where COC concentrations exceed current MCLs or notification levels may not be practical given the large extent of the contamination, the variable flow directions, influences of well fields on distribution, and the uncertainties associated with uncharacterized source areas. However, some obvious and critical data gaps exist that affect the basis of design and must be resolved in order to proceed with designing the Second Interim Remedy.

These uncertainties have been inherently accepted as part of the Second Interim Remedy and thus the ROD acknowledges that the selected remedy, increasing the extraction rate and deepening the wells, is not expected to capture all groundwater with COC concentrations greater than their respective MCLs. Nonetheless, it cannot be assumed that effectively deepening the existing NHOU extraction wells to increase pumping rates and the capture area will improve groundwater quality, as intended by the Second Interim Remedy, because insufficient data exist to delineate the lateral distribution of COCs and source areas remain uncharacterized. Attempts to capture elevated COC concentrations to the west (e.g., as indicated at NH-C09) by pumping more from existing (albeit deeper) NHE wells would likely draw contamination from one or more uncharacterized source areas to the west or northwest. As a result, the existing NHOU extraction well field may need to be fundamentally reconfigured rather than simply deepened at select current locations.

Regarding the uncertainty of each COC distribution in the NHOU area:

- As illustrated on Figures 4-7a/b, insufficient data exists to delineate the lateral extent of TCE to the MCL in either the A-Zone or the B-Zone throughout much of the NHOU area and particularly west of the NHOU extraction well field. TCE concentrations greater than ten times the MCL are present downgradient of NHE-7 and NHE-8 and cross-gradient to NH-2, NH-3, and NHE-4. Recent data are insufficient to verify whether COC mass has by-passed NHOU capture (from upgradient sources) or originate from downgradient sources.

- PCE concentrations are generally lower, but, as with TCE and illustrated on Figure 4-8a/b, insufficient data exist to delineate this COC to the MCL.
- Hexavalent chromium concentrations (Figures 4-10a/b) above the 5 µg/L cleanup level (as specified in the AOC) are relatively limited in lateral extent; however, elevated concentrations at NH-C19 and NH-C21 (cross-gradient from the former Bendix facility) appear to represent impacts to groundwater from one or several known or potential sources to the northwest (upgradient).
- Insufficient data exist to delineate the distribution of 1,4-dioxane to the notification level; however, it appears to be widely distributed in the NHOU study area. Water quality extracted by active LADWP production wells cannot be assessed regarding this COC because no analytical data exist from these wells or the NHOU treatment system in the EPA's SFB database. Available data from NHOU extraction wells suggest concentrations range from 1 to 3 µg/L, with most 1,4-dioxane contribution occurring at NHE-2.

As discussed in Section 5.3 with respect to various AOC scope items, too few samples have been collected from the new monitoring wells to assess temporal variability of COC. Similarly, too few depth-discrete groundwater samples have been collected to assess the vertical extent of COCs, particularly in the B-Zone. Preliminary data suggest that groundwater samples from additional locations, including the A-Zone, are needed to further delineate the lateral and vertical distribution of COCs exceeding their respective MCLs.

5.2.3 Prevent Further Impacts to Rinaldi-Toluca and North Hollywood (West) Well Fields

This RAO is fundamentally a specific extension of the previous RAO in that it addresses the reasonable concern that pumping at higher rates from the Rinaldi-Toluca and NH-west well fields will induce a stronger (albeit seasonal) gradient from the NHOU area and result in additional groundwater quality degradation. This RAO is directly addressed by AOC Scope Items that call for either deepening well NHE-1 and/or installing up to three new extraction wells northwest of the NHE-1 area. The goal of the new and modified extraction wells is to provide a hydraulic barrier that will intercept COC plumes in response to increased pumping from these two production well fields in particular.

Effectively, a deeper NHE-1 and up to three new extraction wells are intended to compete with much larger-capacity production wells, as is supported by modeling presented in the FFS. Much of the preferred remedy relies heavily on the ability of the SFBFS model to accurately depict responses to production well field operations, yet little data exist to calibrate this model at a site-specific scale appropriate to the NHOU area, particularly concerning vertical discretization. As discussed in Section 4.4, significant uncertainty surrounds the project pumping scenarios in the FFS and, without additional data, the need for the proposed new extraction wells cannot be verified, or optimally located, if needed.

Site-specific data are insufficient to account for COC sources currently impacting production well water quality. This data gap further underscores the uncertainty associated with the preferred plan that assumes COC mass will migrate northwest upon greater pumping stress from Rinaldi-Toluca wells. Groundwater elevations suggest a southeast gradient in this area that contradicts previous speculation that elevated COC concentrations may have resulted from north-westward migration (EPA, 2003). Rather, groundwater flow direction, analytical data, and chemical signatures suggest that the Rinaldi-Toluca production well field is being impacted by one or more sources beneath or near the landfills in the northern portion of the NHOU study area. Known and potential source areas east, west, and north of the NHOU well field need to be sufficiently characterized to assess the potential benefit or limitations of pumping from additional extraction wells.

Analytical data from NH-C19, NH-C20, and NH-C23 (all installed near the proposed new extraction wells) indicate that TCE, PCE, and 1,4-dioxane concentrations are below ten times their respective MCLs and notification levels; hexavalent chromium concentrations were below the AOC cleanup level. Several known and potential source areas exist near these production well fields that could contribute to TCE, PCE, and 1,4-dioxane detected at these monitoring wells, given the measured groundwater flow gradient toward the southeast.

Implementing the preferred plan with insufficient groundwater flow and quality characterization could result in unanticipated changes in groundwater quality, particularly in response to projected municipal pumping rates and recharge volumes, as discussed in Section 4.4. Additional data are needed to delineate the lateral and vertical distribution of COCs and assess seasonal groundwater flow directions to attain this RAO. Based on available data, installing the proposed new extraction wells and deepening existing extraction wells would likely not prevent further impacts to water quality at the Rinaldi-Toluca or North Hollywood (west) production wells.

5.2.4 Achieve Improved Hydraulic Containment

This RAO refers to inhibiting horizontal and vertical contaminant migration of groundwater with elevated COC concentration to groundwater with low COC concentrations. It applies to the entire NHOU study area, but specifically refers to the southeast area in the vicinity of the Erwin and Whitnall production well fields. This objective may be achievable in several ways, including: more consistent and reliable operation of the NHOU extraction wells; improved extraction well performance, possibly by a more aggressive maintenance program; installing a performance monitoring network to identify optimal pumping rates needed to sustain hydraulic capture; and/or, assessing the significance of many existing vertical conduits in the NHOU study area.

As discussed in Section 5.2.2, recent data downgradient of NHE-7 and NHE-8 (including near inactive production wells EW-1 and EW-5) suggest that concentrations of TCE greater than ten times the MCL are not being captured by the NHOU. A-Zone TCE and 1,4-dioxane concentrations exceed the current MCL and notification level, respectively, near Whitnall production wells W-1 through W-3 (inactive) and W-4 and W-5 (active) and Erwin production well E-4 (inactive). This distribution suggests that the NHOU capture zone needs to be expanded to include this area; however, no recent data exist to assess whether groundwater quality has been impacted at these production wells. Groundwater samples should be collected specifically from the B-Zone at well NH-C17-339 to further evaluate the vertical distribution of COCs in this area.

5.2.5 Remove Contaminant Mass from Aquifer

This RAO appropriately specifies the removal of mass from the aquifer, rather than simply increasing groundwater extraction in an attempt to expand hydraulic containment of an as yet undelineated mass of COCs. As discussed above, a performance monitoring network, from which the ability of the existing system to remove mass from the aquifer could be assessed, has not been established for the NHOU extraction well field. Furthermore, the lateral and vertical distribution of COCs exceeding their respective MCLs remains undelineated, even after incorporating analytical data from recently installed monitoring wells and from a comprehensive sampling effort by the EPA in December 2010. Lastly, few monitoring wells were constructed to specifically penetrate either the A-Zone or B-Zone and many wells have not been sampled using depth-discrete techniques such that groundwater quality in one or both of these zones can be assessed. Although available data suggest that most COC mass resides in the A-Zone, insufficient data exist to delineate the vertical extent of COCs in the A-Zone to determine the optimal depth required to deepen NHE wells as specified in the AOC scope to avoid capturing higher quality water from the B-Zone.

To comply with State Resolution 68-16, contaminant mass from the aquifer must be removed without degrading existing high quality groundwater. Installing new extraction wells and deepening existing ones in the absence of an adequate source and extent characterization will likely result in spreading the contamination and could induce vertical migration from the A-Zone into the B-Zone, which would result in less mass removal per gallon of water extracted. It would also result in an inefficient remedy that may ultimately not achieve other RAOs, such as protecting existing production wells, and would not be consistent with the EPA *Greener Cleanups Policy* (2009c).

Specific data gaps crucial to attaining this RAO and proceeding with the Second Interim Design are discussed in the following section.

5.3 AOC Scope Items

Work scope items identified in the AOC (EPA, 2011b) are intended to address specific items associated with implementing the Second Interim Remedy. Data gaps associating with completing the scope items are described below.

5.3.1 Groundwater Monitoring

This scope item acknowledged that, 31 of the 37 monitoring wells recommended from the FFS have already been installed by Honeywell. Additional geologic, geophysical, groundwater elevation, and groundwater quality data associated with these monitoring wells (NH-C07 through NH-C25) have allowed a significantly more complete CSM. However, as of April 2011, these wells had been sampled only twice and none had been incorporated into the RI monitoring program. Additionally, groundwater quality data from several wells has significantly altered the previously understood distribution of COCs. In particular, analytical data from new cluster wells suggests that TCE concentrations above the MCL extend significantly to the west of the NHOU area, beyond the NHOU extraction well field capture area as described in the FFS.

Analytical data from samples collected at these locations suggest a COC distribution that differs from that understood when the FFS was prepared. Specifically, wells NH-C09, NH-C11, NH-C13, NH-C19, NH-C-20, and NH-C23 were installed to address FFS well installations in areas A, F, and G (EPA, 2009a). Initial analytical results from samples collected at these wells suggest that a VOC plume exists west of the NHOU area, near the Hewitt Pit and other known and potential sources. However, most groundwater samples collected from these wells are associated with the A-Zone, despite their association with Depth Region 2 (MWH, 2010b). As a result, many wells, particularly west of the NHOU extraction well field, have not been sampled in the B-Zone and significant uncertainty exists concerning COC distributions in this area. Cluster wells NH-C07 through NH-C25 have not yet been incorporated into the RI monitoring program.

The EPA's SFB RI database does not include sample depth information or sampling method information. This information, associated with RI monitoring wells (i.e., sampling pump setting), was presented in annual groundwater monitoring reports (most recently in 2007); however, depths of groundwater samples collected from facility wells are not known and thus their association of these samples with either the A-Zone, B-Zone, or deeper units cannot be determined. Known construction details and sample depths have been used to identify wells that are screened within the A-Zone or B-Zone but where depth-discrete samples have not yet been collected, as illustrated on Figures 4-7a/b through 4-10a/b.

Correlating COC distributions with depth intervals is further confounded by assigning analytical data to either Shallow and Deeper units as defined by the sample depth in relation to the water table, as has been conducted in the EPA's groundwater monitoring reports. This approach obscures correlation between COC distribution and hydrostratigraphic unit and suggests that the interpreted lateral distribution of each COC expands or contracts in response to water level changes over time.

VOC concentrations (particularly TCE) in samples collected from wells installed immediately next to (south of) the Rinaldi-Toluca well field exceed the MCL and range up to 34 µg/L in the A-Zone. Insufficient data exist to assess B-Zone groundwater quality in this area; however, elevated concentrations east (NH-C05-460) and west (4909F) suggest that additional characterization is required to delineate COCs in this zone. Depth-discrete Simulprobe® sample results associated with these wells indicate that the highest TCE concentrations at NH-C20 (south of the Rinaldi-Toluca well field) occur between approximately 300 and 350 feet bgs (i.e., within the A-Zone), whereas at NH-C22 (east of the Rinaldi-Toluca well field and upgradient of NH-C05) they occur at depths below 400 feet bgs.

Groundwater elevations are calculated by subtracting measured depths to water from surveyed reference points, typically at the monitoring well top of casing. Unfortunately, monitoring wells installed in the 1980s were surveyed to NGVD29 and wells installed more recently were surveyed to NAVD88. This inconsistency results in vertical head differences of approximately 2.6 +/- 0.2 feet, which significantly influences calculated gradients and groundwater flow directions. Monitoring wells used for measuring groundwater elevations must be surveyed to the same vertical datum to allow for meaningful evaluation of groundwater flow directions and gradients. As also recommended in Section 6, wells surveyed over 10 years ago should be surveyed again to account for changes (e.g., incidental damage, natural settlement, etc.) that may have altered the measurement reference point elevation.

Also, groundwater elevations measured as part of the RI monitoring program are recorded at the time each well is sampled. This approach means that measurements may be recorded over many days (15 days for the December 2010 event and 8 days for the April 2011 event) that may not depict a 'snap-shot' of groundwater flow conditions if recorded over a shorter period.

These and other data that have become available since publication of the FFS significantly change the CSM and thus the preferred remedy defined in the FFS should be reconsidered to achieve the RAOs associated with the Second Interim Remedy.

5.3.2 Replace Existing Extraction Well NHE-1

The presumed need for a deeper NHE-1, as stated in the AOC, was to prevent additional mass migration toward the Rinaldi-Toluca and possibly the NH-west production well fields. This presumption was based on numerical simulations of advective groundwater flow in response to forecasted municipal pumping conditions rather than empirical historical data that do not support these patterns.

Additional data from recent characterization activities suggest that the COC distribution extends beyond the simulated NHOU extraction well field capture zone. For example, data from NH-C05, NH-C16, and NH-C22 suggest that elevated PCE, TCE, and cDCE concentrations are migrating from one or more sources at or near the northern landfills, and that at least a portion of this COC-contaminated groundwater has been captured by the southern portion of the Rinaldi-Toluca well field. Additionally, groundwater elevations measured in December 2010 at NH-C19, NH-C20, and NH-C23 suggest a south-eastward gradient near the southern extent of the Rinaldi-Toluca well field, suggesting that contamination beneath the former Bendix facility not captured either onsite or by NHE-2 is migrating away from the Rinaldi-Toluca well field.

Deepening NHE-1 would thus not likely prevent further water quality degradation at Rinaldi-Toluca production wells and could induce COC mass to migrate upgradient from the former Bendix facility. That said, additional data are necessary to further delineate the lateral and vertical distribution of COCs, particularly in the A-Zone, to determine the appropriate need for expanding the NHOU capture zone into this area. Before NHE-1 is deepened, depth-discrete samples should be collected from NHE-1 and nearby production well NH-10, and additional monitoring wells should be installed in the area to further delineate the lateral and vertical distribution of COCs (particularly in the A-Zone).

5.3.3 Replace or Repair and Modify Existing Extraction Wells NHE-2, NHE-4, and NHE-5

The ROD states that replacement of wells NHE-2, NHE-4, and NHE-5 with deeper wells of similar construction or possibly new adjacent wells will likely be necessary to achieve the required hydraulic containment of the contaminated groundwater plume. The need to deepen wells near NHE-4 should be further assessed given that TCE, PCE, 1,4-dioxane, and chromium concentrations at nearby NH-C03-380 (B-Zone) are below regulatory limits. Difficulty in maintaining pumping at wells NHE-4 and NHE-5 since approximately 2007, despite higher groundwater elevations, suggests that these well screens may need to be re-developed or that electrical or mechanical modifications to the submersible pumps or controllers may be necessary.

Limited groundwater quality data from the B-Zone near the NHOU extraction well field indicates that COC concentrations are not sufficiently elevated to warrant hydraulic capture at this depth. Additional data are required to confirm this observation; however, assuming available data are representative, purposefully constructing NHOU extraction wells screened in the B-Zone would likely further induce COCs to migrate downward into groundwater units not currently impacted. Furthermore, inducing COC mass to migrate further throughout the A-Zone may result in sorption onto fine-grained materials that would severely reduce the mass removal rate and cause a long tailing effect that could substantially increase the time needed to reduce concentrations within the NHOU to acceptable levels.

Insufficient data exist near these extraction wells to verify the vertical distribution of COC mass in the A-Zone relative to the existing extraction well screen intervals. Care must be taken not to extend extraction wells into the B-Zone unless a COC mass is confirmed at that depth interval. Otherwise, extracting groundwater from the B-Zone would induce low quality groundwater to migrate into higher quality groundwater and result in less mass removed per gallon of groundwater extracted. Installation of well couplets (i.e., two collocated, hydraulically isolated monitoring wells to monitor groundwater conditions from different depths) is recommended next to these and other NHOU extraction wells to further delineate the vertical distribution of COCs within the A-Zone, observe drawdown in response to NHE pumping, and estimate A-Zone hydraulic parameters.

5.3.4 Wellhead Chromium and 1,4-Dioxane Treatment at NHE-2

As previously discussed, Honeywell is addressing ROD requirements regarding NHE-2 under a separate AOC; therefore, the NHE-2 wellhead treatment component of the ROD was not included in the scope of the RD Work Plan. Should the EPA not approve of the separate AOC prior to our submittal of the Preliminary Design Report, NHE-2 will be included in the Second Interim Remedy.

Assuming that the EPA will approve the separate AOC, and because NHE-2 is an integral part of the NHOU, AMEC will collaborate closely with the NHE-2 design firm during the Preliminary Design Phase of this project to achieve the hydraulic containment of the groundwater plume required by the ROD and to ensure that the NHE-2 alternative selected is consistent with the RAOs for the Second Interim Remedy. Part of the Second Interim Remedy will be to determine the NHE-2 flow rate required for capture. Once the flow rate is determined, the NHE-2 design firm can evaluate the ability of the existing former Bendix facility treatment system to treat and reinject the additional water and what, if any, system upgrades are necessary to support the required hydraulic flow rate from NHE-2. The NHE-2 flow rate necessary to attain hydraulic capture will be determined as part of the pre-design activities and will be reported in the Groundwater Model Memorandum.

1,4-dioxane detections at NHE-2 indicate concentrations have ranged from 2.4 to 7 µg/L since 2005. Honeywell has agreed under a separate AOC to augment the former Bendix facility treatment system with an advanced oxidation process (AOP) system to remove 1,4-dioxane from water received from NHE-2.

5.3.5 Construct New Extraction Wells

The ROD states that new extraction wells are necessary to further limit contaminant migration and to improve mass removal. Previous FFS modeling indicated that up to three new wells would be required northwest of the existing treatment system.

As discussed in Section 5.2.3, the need for these extraction wells was based on numerical simulations with the assumption that COC mass from the NHOU extraction well field area would migrate (or has already migrated) westward toward the Rinaldi-Toluca well field upon resumption of pumping from the southernmost wells. Groundwater flow directions, analytical data, and chemical signatures suggest that water quality extracted by this well field is being impacted by one or more sources beneath or near the landfills in the northern portion of the NHOU study area. Additionally, analytical data from NH-C19, NH-C20, and NH-C23, both near the proposed new extraction wells, suggest that TCE, PCE, and 1,4-dioxane concentrations are elevated throughout this area (although less than ten times the respective MCL and notification limit), but that chromium concentrations are below the cleanup level.

Given the significant uncertainty regarding projected pumping from municipal wells (as discussed in Section 3.1.1.4), including the Rinaldi-Toluca well field, it is difficult to assess the potential for COCs to migrate westward if full-scale pumping were to resume at the southern Rinaldi-Toluca wells. Regardless, based on our revised conceptual model of the NHOU area, the proposed wells NEW-1, -2, and -3 would not capture COC mass that apparently originates from upgradient (northeast) that is impacting Rinaldi-Toluca water quality. As such, operation of these wells would not meet RAOs at the locations and/or depths indicated in the FFS and are thus considered unnecessary. However, data from NH-C09 suggest elevated TCE and 1,4-dioxane concentrations that warrant additional investigation (including identifying potential sources). Should a greater hydraulic capture extent be warranted, additional extraction wells will likely be needed, but at locations that are consistent with groundwater flow directions, projected pumping rates, and COC distributions.

5.3.6 Treatment of VOCs in Extracted Groundwater

The ROD states that expansion of VOC treatment capacity at the NHOU will be necessary to treat the volume of groundwater produced by existing and proposed new extraction wells. The degree of expansion required will be evaluated during the RD phase. Insufficient data exist to estimate VOC concentrations that will compose influent water quality to the new NHOU treatment system. Recent data suggest that PCE, TCE, and carbon tetrachloride concentrations influent to the NHOU treatment system (which excludes contribution from NHE-2) are approximately 1.5, 8, and 3 times their respective MCLs. Other VOCs, including 1,1-DCE and cis-1,2-DCE, have been detected at concentrations below their respective MCL; an MCL does not yet exist for chloroform, but concentrations are below the environmental screening level. Refining this chemical signature will require delineation of the lateral and vertical distribution of VOCs, definition of the target capture zone, and reasonable estimation of pumping rates from existing and proposed extraction wells.

5.3.7 Ex Situ Chromium Treatment for Wells NHE-1, NEW-2, and NEW-3

Information developed for the FFS and the ROD indicated that ex situ treatment for chromium (total and hexavalent) should be implemented for the combined flow from at least three new and existing NHOU extraction wells. The distribution of chromium impacted groundwater near the new extraction well locations requires further evaluation, specifically because data from wells nearest NHE-1 (including production well RT-15) indicated that chromium concentrations are below regulatory limits (as of April 2011). Further, monthly analyses over 2009 and 2010 of the effluent from the NHOU treatment system indicated that without NHE-2 in the system the average concentration of hexavalent chromium was about 3.5 µg/L, less than the current treatment goal of 5 µg/L. Hence, under these conditions, augmenting the central treatment system with the capability to remove hexavalent chromium would not be necessary. The additional evaluation of existing and new data will be used to assess the lateral and vertical distribution of chromium above the cleanup level and the need for additional hydraulic capture.

5.3.8 Delivery of Treated Groundwater to LADWP

The RD work for the Second Interim Remedy will provide for the delivery of treated groundwater to LADWP for use in its municipal supply system. For purposes of the RD and Remedial Action, the point of compliance for all performance standards will be the discharge point of the treatment facility, after passing through the "double barrier" treatment system, just upstream of the LADWP header line. LADWP, as the water utility, will have to prepare, submit, and comply with CDPH’s Policy Memorandum 97-005. To the extent that CDPH 97-005 guidance applies to the NHOU, it will be considered throughout the RD process. The following items will be evaluated regarding delivery of treated groundwater to the LADWP:

- Source water assessment
- Full characterization of raw water quality
- Source protection
- Effective monitoring and treatment
- Human health risks associated with failure of the proposed treatment system
- Identification of alternatives to the use of the extremely impaired source

- Completion of the CEQA review

Roles and responsibilities associated with each of these elements are stipulated in the Final Remedial Draft Work Plan (AMEC, 2011). The source water assessment will require additional analytical results from groundwater samples representative of the A-Zone capture zone associated with the new NHOU treatment system.

5.4 Treatment Options Memorandum Data Gaps

As stated in the AOC, groundwater treatment options will be evaluated considering the target zones, pumping well locations, depths, flow rates, and influent concentrations estimated as part of numerical groundwater flow modeling. To achieve the RAOs involving containment of high concentration areas of the plume, and to prevent further degradation of groundwater quality near the production well fields, potential groundwater extraction and treatment scenarios will need to consider extraction well locations, depths, and pumping rates; the efficiency and cost-effectiveness of separate treatment areas that target distinct plumes; the use of wellhead treatment versus centralized treatment; and, the need for additional groundwater investigation to adequately assess the risk contaminants pose to well fields.

As described in Section 3.3, the NHOU system design was based on the groundwater quality data available from production wells in 1980 and 1981. Early evaluations of the NHOU system performance (LADWP, 1991a) concluded that additional extraction wells were needed to provide operational flexibility and that additional monitoring and testing were needed to better understand the distribution of contamination, verify the capture zone area, and quantify Upper Zone hydraulic properties. Despite the acknowledged need for additional data at that time, NHOU operations continued with no changes to the original design, and a local-scale investigation did not begin until in response to the Second Interim Remedy ROD.

As indicated in Section 2.3, work scope items intended to be addressed with respect to the Second Interim Remedy design specifically include:

- Contaminant Treatment
- Ex-situ chromium treatment at wells NHE-1, and proposed NEW-2 and NEW-3,
- Treatment of VOCs in extracted groundwater,
- Mass contaminant removal from the aquifer,
- Delivery of treated groundwater to LADWP that meets or exceeds state and federal drinking water quality requirements.
- Develop a treatment system design that meets the requirements of the State of CDPH Policy Memo 97-005 Policy Guidance for Direct Domestic Use of Extremely Impaired Sources.

The City of Glendale has been conducting groundwater pilot tests for hexavalent chromium treatment near the NHOU area. Information provided to AMEC during a site walk indicates that there are still operational issues associated with these pilot units, and optimization is being worked out.

Additionally, treatment alternatives (i.e., reduction/coagulation/filtration, liquid phase granular activated carbon, membrane treatment, ion exchange) were not validated as part of the FFS or ROD. Detailed raw water quality and treatment goals negotiated with CDPH are critical data gaps.

The recommended 1,4-dioxane treatment alternative AOP was also not validated as part of the FFS or ROD. The following information, which is needed as part of the design, was not evaluated in the referenced documents and poses a critical data gap.

- Hydrogen peroxide dosages per volume and concentration,
- Ultra violet residence times per volume and concentration
- Other parameters that may interfere with successful operation (e.g., high loading of iron or calcium)
- Vendor-supplied equipment testing specific to NHOU groundwater.

The FFS and ROD did not indicate the optimal order of treatment units. As an example, an AOP system would also treat VOCs (if performed first), but would have a greater energy and hydrogen peroxide demand (versus secondary treatment). AOP may be better suited as the last unit operation, but the treatment train order (from an effectiveness, additive usage, and cost standpoint) was not evaluated in the FFS or ROD and is a critical data gap. AOP placed after other VOC treatment would also serve as a second barrier for contaminant removal as required by CDPH in the 97-005 treatment criteria.

Liquid Phase Granular Activated Carbon Units (LPGAC) are not currently used as part of the NHOU groundwater treatment system, but is one option that could be used as secondary treatment (double barrier) for VOC's in accordance with CDPH 97-005 requirements.

5.5 Groundwater Flow Model Memorandum Data Gaps

The SFBFS model is based on relatively few data from the NHOU because the model, developed as part of the SFV RI, has been and continues to be developed to provide a regional perspective despite finer gridding in the NHOU model area for the FFS. Hence, local conditions in the NHOU are not adequately portrayed in the model, and the contaminant distribution on which the particle tracking and capture zone analysis depend, in part, on relatively old data with limited data density and historical maximums for the interpretation of contaminant distributions.

As discussed in the FFS (EPA, 2009a), the SFBFS model was used to conclude that additional, deeper extraction wells were required to increase the NHOU capture area and its capacity for COC mass removal from groundwater. Particle pathlines were generated to illustrate potential groundwater flow paths in response to various pumping scenarios, both from NHOU extraction wells and from large-capacity production wells in the NHOU vicinity.

Potentially significant limitations to the SFBFS model regarding the design include:

1. The coarse vertical discretization of the SFBFS model (four layers) does not adhere to known geologic units, including the relatively fine-grained sediments in the A-Zone where highest COC concentrations have been observed. These layers may be of significant importance in evaluating the potential for mass migration and long-term remedy operations. Revising the model to adhere to identified geologic units may more realistically simulate groundwater movement between the A- and B-Zone that could lead to better understanding of capture in these two zones as a function of screened interval and water table elevation.

2. The model has exhibited relatively large residuals (differences between model-computed and observed water level measurements) in the NHOU area, suggesting the calibration in this area could be improved
3. Simulations of future conditions lead to large dewatered areas of model layer 1 (including the A-Zone), which would bias design decisions. Projected municipal pumping from the SFB needs to be incorporated in the model to reflect current implemented water management plans
4. The SFBFS model needs to be updated with the four years of additional data that have become available since the FS modeling was performed
5. Recent pumping tests in the Burbank area have suggested that the hydraulic conductivity assigned to this portion of the model is too low
6. Assignment of uniform hydraulic conductivity in model layers in the NHOU area is not consistent with estimates of transmissivity as determined by pumping tests in the NHOU area (JMM, 1992); additional standardized aquifer tests would improve hydraulic characterization
7. The general application of a 50 percent increase to all zones of hydraulic conductivity to improve calibration as indicated in Appendix B of the FFS may not be appropriate, especially for model calibration near the NHOU where some locations exhibit relatively large residuals. Preliminary sensitivity analyses have suggested that the model calibration may not be very sensitive to reasonable variations in the assigned hydraulic conductivity values in the NHOU area. However, better local calibration (to lower residuals in this area) should provide better indications of model response and determinations of capture zone extent and interaction with existing well fields for applied stresses (i.e., better estimates of extraction well location, pumping rates, and screened intervals).
8. The use of a relatively high vertical anisotropy (primarily 100:1 lateral to vertical hydraulic conductivity) in the model may not adequately represent the effects of fine-grained units within the A-Zone
9. The particle tracking evaluation of capture zones in the FS may be limited by the specification of effective porosity and vertical seeding of particles, especially for the variable scenarios of dry conditions and maximum pumping
10. The modeling did not include the planned extraction of groundwater at NHE-2 with subsequent delivery to and treatment and injection at the former Bendix facility site
11. Many of the screened intervals assigned to production and extraction wells simulated in the SFBFS model do not agree with perforated intervals indicated in the EPA SFB database. Proper representation of production and extraction well screens and discharge from the model domain will more likely represent actual pumping rates and resultant capture associated with these wells, which will increase the likelihood of properly designing the Second Interim Remedy
12. The current SFBFS model does not include the influence of fault zones, the primary one in the SFV being the Verdugo Fault. Potential effects of including the fault in the model on groundwater flow and capture should be evaluated.

An updated projection for evaluation of alternative well arrays was assumed for the basis of evaluation of alternatives in the FFS. Those projections started in about 2006 and extended to 2017. However, even the less conservative of the two projections, i.e., based on “average” conditions, resulted in a decline of over 30 feet in the water table through the NHOU over this 11-year period. This, if potentially accurate, would have severe implications for the design of any NHOU pump-and-treat system, particularly the placement, operating rates, and depths of wells. However, runs of the calibrated FFS model updated to include data from the annual ULARA Watermaster reports through water year 2009/10 suggested that no decline has occurred over those four years as opposed to the projection simulations. Current municipal projections suggest that NHOU-area groundwater elevations will rise approximately 50 to 60 feet by fall 2015.

Considering the evolving water management practices in the basin, and the concern for safe yield and storage levels in the basin, the projections made for the FFS simulations no longer appear appropriate. New projections, beyond the 2010-2015 projections made as part of the 2007 Stipulated Agreement, with bounding conditions on pumping (high and low groundwater elevations) need to be established and known, in conjunction with the LADWP, the EPA, and the ULARA Watermaster, before the design can proceed.

Representation of past pumping test results do not appear to be honored locally in the basin-wide perspective of the model. Results from limited pumping tests at each NHE well indicate a significant variation in transmissivity across the wells with much higher transmissivities in some of the more southern and eastern wells than in NHE-1. Current values of hydraulic conductivity throughout the NHOU and Depth Region 1 are relatively constant in the model in contrast with these pumping test results. Similarly, more recent pumping tests in the BOU indicate that values of hydraulic conductivity may be much too low in that area of the model. Whether this affects decisions in the NHOU modeling remains to be evaluated. Reasonably accurate representation of hydraulic conductivity variability (as indicated by several pumping tests) will likely increase the accuracy of the pumping response and the capture zone extent associated with each of these and potentially other extraction well locations.

Revision and recalibration of the model is likely needed in light of more current investigations to support the Second Interim Remedy design. Fine-grained soils in the A-Zone are not explicitly accounted for in the SFBFS model, and their representation may be an important factor in providing an effective design for the Second Interim Remedy. Development of a refined model, incorporating the revised interpretation of hydrostratigraphy, will continue. As data gaps are closed, this information will be used as a basis for an improve recalibration of the model, leading to a more accurate depiction of current and projected conditions in the NHOU. Simulations of design alternatives to arrive at improved extraction system well locations with the engineering design components will aid in narrowing the system components and specifications. The model development and refinement, including simulation outcomes and evaluation (including further modifications of the model to accommodate representation of target capture zones, horizontal location, and vertical components of the design alternatives), will be documented in the Groundwater Modeling Memorandum. The memorandum will also include a detailed review of the existing SFBFS model as a basis for the anticipated model refinements.

5.6 Data Gap Summary

Not all data gaps described in the previous sections need to be addressed or addressed completely to proceed with designing the Second Interim Remedy. Some degree of uncertainty will remain regardless of the number of data points or length of monitoring period and, therefore, the design will accommodate, within reasonable limits, a range of parameters to account for operational changes and provide some flexibility in response to influent water quality fluctuations, etc.

As stated in the AOC, the means to address data gaps deemed critical to support the Second Interim Remedy design will be provided in the Groundwater Monitoring Plan. Identifying which data gaps are critical is thus a key objective of this Data Gap Analysis. To that end, Table 5-1 organizes identified data gaps into one of three categories: manageable, significant, and critical.

"Manageable" data gaps include those that can likely be addressed once the Second Interim Remedy becomes operational. For instance, specific issues such as the influent flow rate will not be critical to the design as long as the cumulative groundwater extraction rate necessary to capture the target contamination zone and the projected influent constituent concentrations are within the treatment system capacity.

"Significant" data gaps include those that could result in significant operational problems should specific issues arise but that should not preclude proceeding with the Second Interim Remedy design. For instance, known or potential source areas that have not yet been characterized may continue to impact groundwater quality and could extend the necessary remediation duration; however, remediation activities have and will continue to proceed in the meantime.

"Critical" data gaps are those that represent issues that jeopardize the successful operation of the Second Interim Remedy if not first addressed and resolved. For instance, designing the NHOU capture zone without knowing the lateral and vertical distribution of COCs precludes the ability to achieve capture under various production well operational configurations.

Failure to address and resolve the following critical data gaps before proceeding with remediation design activities will jeopardize the successful operation of the Second Interim Remedy:

1. Recent analytical data are insufficient to delineate the lateral and vertical distribution of COC mass (and temporal variability) in the A-Zone and B-Zone and to define the necessary target capture area required to achieve Second Interim Remedy RAOs. This data gap applies both to areas throughout the NHOU study area and to areas near the existing NHOU extraction wells;
2. Groundwater elevation data have not been measured from a sufficient number of wells surveyed to a common elevation datum (e.g., North American Vertical Datum of 1988 [NAVD88]) to verify and clarify groundwater flow directions, particularly north of Sherman Way;
3. Aquifer test results are insufficient to estimate hydraulic parameters specific to the A-Zone or B-Zone, which are needed to accurately simulate groundwater flow directions, NHE hydraulic capture areas, and influent pumping rates to the new treatment system;
4. The monitoring well network is insufficient to characterize vadose zone and groundwater conditions beneath known and potential source areas to further delineate the lateral and vertical distribution of COC mass within the NHOU source area to achieve Second Interim Remedy RAOs;
5. Objective projections of pumping and recharge volumes, including beyond year 2015, are not yet available, which prevents meaningful simulation of future groundwater flow conditions and elevations pertinent to the Second Interim Remedy design;
6. Performance monitoring wells have not been installed and monitored, which are needed to demonstrate the size and shape of the existing NHOU extraction well capture area. Similarly, drawdown measurements at each extraction well have not been recorded for calculating well efficiency changes over time to support the need for well rehabilitation;

7. The existing numerical groundwater flow model is not sufficiently structured or discretized vertically to evaluate hydraulic capture specifically within the A-Zone and potentially the B-Zone;
8. Available analytical data are insufficient to evaluate A-Zone and, potentially, B-Zone groundwater quality within the future NHOU capture zone to meet CDPH 97-005 requirements (specifically, the source water assessment component); and
9. Vertical conduits throughout the NHOU study area have not been sufficiently evaluated to quantify the volume of groundwater and COC mass that is induced to depths below the A-Zone in response to various pumping patterns or scenarios.

Not resolving each critical data gap before designing the Second Interim Remedy will cause a system failure with respect to achieving the RAOs. For instance, although the existing NHOU treatment system has removed mass and established a local capture zone since operations began in 1989, the size and extent of the NHOU capture area cannot be verified and remediation objectives have not been met largely because critical data gaps were not addressed as part of the original design and construction activities.

Moving forward, AMEC strongly recommends that critical data gaps identified herein be addressed before proceeding with treatment system design activities. Not doing so will prevent completion of an appropriate design that will attain RAOs and optimally achieve the target capture zone.

6 RECOMMENDATIONS

This section discusses recommendations associated with critical data gaps as identified in the previous section and listed on Table 5-1. Data gaps described as "manageable" or "significant" will be assessed throughout the project to limit the number of assumptions associated with the Second Interim Remedy design.

Failure to resolve these critical data gaps as proposed before the preliminary design phase of the Second Interim Remedy will result in a treatment system that will not achieve the RAOs set forth in the ROD. In particular, an improved understanding of the lateral and vertical distribution of COCs within the A-Zone is expected to result in a significantly improved conceptual model that will directly benefit the Second Interim Remedy effectiveness regarding hydraulically capturing COC mass and preventing further degradation of groundwater quality at production wells in the NHOU study area.

Details associated with most of the following recommendations will be described in detail in a Phase 1 Pre-Design Investigation Work Plan, consistent with AOC, Appendix A, Section 4. Whether a second phase of the Pre-Design Investigation is needed to meet RAOs and to comply with CDPH 97-0005 requirements will be assessed following completion of Phase 1 (see Section 6.1.3). If needed, Phase 2 activities will be described in a subseqent Work Plan, revised project schedule, and addendums to the SAP and QAPP as necessary. Proposed sampling, testing, piezometers, and tentative (Phase 2) monitoring well locations are shown on Figure 6-1.

6.1.1 Groundwater Sample Collection and Flow Monitoring

The following groundwater sampling activities are recommended to further delineate the lateral and vertical distribution of COCs in the NHOU study area:

1. Collect depth discrete samples from at least the following monitoring wells, specifically in the A-Zone and B-Zone, at least twice (seasonal extremes) to represent seasonal conditions and further delineate COC distributions in each zone.
    a. A-Zone samples: NH-C14-250, NH-C18-270 and -365, NH-C19-290 and -360, NH-C21-260 and -340, NH-C24-305, 4909C, 4909F, PST-MW1P, PST-MW2P, and 4919D to further delineate the lateral and vertical distribution and temporal variability of COCs in the A-Zone
    b. B-Zone samples: NH-C01-450, NH-C10-360, NH-C12-360, NH-C13-385, NH-C16-390, NH-C17-339, NH-C18-365, NH-C19-360, NH-C20-380, NH-C21-340, NH-C23-400, GW-18B, GW-19B, 4909C, 4909F, 4918A, and 4928A to further delineate the lateral and vertical distribution of COCs in the B-Zone
    c. Two semiannual groundwater samples should be collected from each well using a depth-discrete method, taking care to ensure vertical stratification conditions that may be present are not disturbed, to further evaluate the temporal variability of COCs in the A-Zone and B-Zone.
    d. Groundwater samples will be analyzed for VOCs, 1,4-dioxane, hexavalent and total chromium, and major ions. All analytical data will be validated by a third party pursuant to AOC requirements stated in Appendix A, Sections 4.1 and 4.2.

2. Obtain additional A-Zone and B-Zone groundwater quality samples near the NHE-1 extraction well from existing infrastructure to further evaluate the lateral and vertical distribution of COCs that may be present in this area.
   a. Remove the NHE-1 wellhead, measure groundwater elevations, and collect at least one set of depth-discrete groundwater samples for COCs analysis to further evaluate the potential utilization of this well as part of the Second Interim Remedy.
   b. Access production well NH-10 and collect at least one set of depth-discrete groundwater samples from the upper perforation zones to evaluate the vertical distribution of COCs in the A-Zone and B-Zone.
   c. Groundwater samples will be analyzed for VOCs, 1,4-dioxane, hexavalent and total chromium, and major ions. All analytical data will be validated by a third party pursuant to AOC requirements stated in Appendix A, Sections 4.1 and 4.2.
3. Collect a continuous vertical profile of groundwater quality samples (i.e., no more than 10-foot intervals) from cluster monitoring wells NH-C19 and NH-C23 to evaluate the vertical distribution of COCs in these intervals with high resolution.
4. Measure groundwater elevations quarterly for at least one year at cluster wells NH-C07 through NH-C25, in addition to RI monitoring wells (surveyed to a common vertical elevation datum), independent from collecting groundwater samples (i.e., within the same day if possible) to better estimate groundwater flow directions and gradients. To the extent possible, these data should be evaluated in relation to production well pumping rates during the preceding month to better understand potential influences on local gradients.
5. As part of collecting groundwater samples, vertical flow logs (e.g., heat-pulse, spinner logs, etc.) should be generated at wells NH-C05, NH-C10, NH-C16, NH-C19, and NH-C23 at seasonal extremes (i.e., April and October) to evaluate the magnitude and direction of vertical flow through long-screened monitoring wells in response to seasonal pumping patterns.
6. Ensure that reference points at monitoring wells in the NHOU study area used for groundwater elevation monitoring are surveyed to a common elevation datum (e.g., NAVD88) to more accurately depict groundwater flow directions and calculated gradients. Specifically, NH-VPB wells and cluster wells NH-C01 through NH-C07 were all surveyed to NGVD29. Recent survey data at NH-VPB-06 suggest a +2.92-foot difference in elevation between NAVD88 and NVGD29. If properly constructed and surveyed, depth to groundwater measurements at select facility monitoring wells (e.g., at Hewitt Pit and northern landfills) may refine groundwater gradients and flow directions. Additionally, wells surveyed over 10 years ago should be surveyed again to account for changes (e.g., from incidental damage, settlement, etc.) that may have altered the measurement reference point elevation.

6.1.2 Aquifer Testing

1. Perform pneumatic slug tests at monitoring wells NH-C07-300, NH-C09-310, NH-C10-280, NH-C12-280, NH-C13-385, NH-C14-250, NH-C17-255, NH-C19-290, and NH-C23-310 to estimate A-Zone hydraulic parameters. These data will be used to verify hydraulic

conductivity values as simulated in the current SFBFS model to define the NHOU extraction well capture zone.

2. Perform pneumatic slug tests at wells screened primarily in the B-Zone, potentially including NH-C01-450, NH-C02-325, NH-C03-380, NH-C04-240, NH-C22-460, and NH-C24-410 to estimate B-Zone hydraulic parameters.

3. Perform aquifer testing at three NHE wells.

   a. Each of these extraction wells should be inspected with a video camera and, if deemed necessary, redeveloped to potentially improve their capacity prior to performing each aquifer test. Rehabilitation waste discharge will be contained and disposed of properly at an off-site location. This task will require that the existing pump be temporarily removed from each extraction well. Results from this step will be used to consider potential benefits to rehabilitating other NHOU extraction wells.

   b. Subsequent to the installation, development, and initial sampling of the piezometer well couplets (described in Section 6.1.3), aquifer tests should be performed at NHE-3, NHE-5, and NHE-7. Upon completion of the rehabilitation task, each pump will be reinstalled and operated for at least 72 hours (uninterrupted) at a constant discharge rate. Drawdown will be observed continuously at each extraction well and the adjacent piezometers. A temporary pump will likely need to be installed at NHE-5 because the existing pump is not operational. Discharge from each aquifer test will be conveyed to the NHOU treatment system via the existing discharge pipeline.

   c. Drawdown data observed during each test will be used to estimate A-Zone hydraulic parameters, including hydraulic conductivity and storativity, and delineate the lateral and vertical radius of influence from each tested extraction well. These data, in turn, will be used to calibrate the groundwater flow model and verify the capture area associated from NHOU extraction wells under various configurations and pumping scenarios.

6.1.3 Well Installation

Additional monitoring wells are required to further assess groundwater quality conditions adjacent to and beneath existing NHOU extraction wells and to verify the size and shape of the NHOU extraction wells' capture area.

1. Phase 1: Prior to developing the Groundwater Modeling Memorandum, install piezometer couplets (i.e., two collocated, hydraulically isolated piezometers to monitor groundwater conditions at different depths) adjacent to NHE-3, NHE-5, and NHE-7 and collect depth-discrete groundwater samples to delineate the vertical extent of COCs within the A-Zone and differentiate groundwater quality in the B-Zone. Locations of and construction details associated with these piezometers will be further considered once analytical results from additional groundwater samples (Section 6.1.1) have been evaluated. Discrete soil samples will be collected from the A-Zone and B-Zone to assess characteristics that may result in or limit COC attenuation within the A-Zone. Each piezometer couplet will be installed within tens of feet from the associated NHOU extraction well to facilitate drawdown monitoring associated with aquifer testing (described in Section 6.1.2). The shallower piezometer screen would be consistent with

the associated NHE screen interval; the deeper piezometer screen would target the A-Zone beneath the associated NHE screen interval.

2. Phase 2 (tentative): Should additional data be deemed necessary following completion of the Phase 1 Pre-Design Investigation, consider the need to install monitoring well couplets throughout the NHOU study area to further delineate the lateral and vertical extent of COCs where significant uncertainty exists. Tentative locations are illustrated on Figure 6-1; however, their need and final locations should be assessed with respect to data following the completion of other recommendations described herein. Based on existing data, the rationale for each tentatively proposed monitoring well couplet includes the following:
   a. Well A is intended to refine groundwater flow directions and further delineate COC distribution southwest (downgradient) of landfills in the northern portion of the NHOU study area suspected to be responsible for chemical constituents observed at NH-C05, NH-C16, and NH-C22.
   b. Well B is intended to further delineate COCs northeast of the Rinaldi-Toluca well field and upgradient of the former Bendix facility.
   c. Well C is intended to evaluate the continuity of COCs between the area south of the former Bendix facility and NH-C09 and the vertical distribution of COCs within the A-Zone.
   d. Well D is intended to delineate the western extent of COCs near the North Hollywood (west) production well field and the vertical distribution of COCs within the A-Zone.
   e. Well E is intended to delineate the eastern extent of COCs southeast of the former Bendix facility and the vertical distribution of COCs within the A-Zone.

6.1.4 Collaboration with LADWP

Initiate collaborative meetings with LADWP to discuss the feasibility of modifying NH-east production wells regarding the following actions:

1. Collection of depth-discrete groundwater samples and vertical flow measurements to further characterize groundwater flow and quality conditions within the NHOU study area, as potentially affected by inactive production wells. Because this recommendation would directly address a critical data gap and could affect the Second Interim Remedy design, this discussion should occur during Phase 1 Pre-Design Investigation activities. The following recommendations represent potential actions independent of the Second Interim Remedy.

2. Use of packers to convert NH-east wells NH-10, NH-2, and NH-14A to remediation wells to meet Second Interim Remedy RAOs to potentially take advantage of existing infrastructure that could facilitate the design and construction of an improved Second Interim Remedy.

3. Conversion of select production wells into multi-screen monitoring wells to mitigate flow through vertical conduits and also take advantage of existing infrastructure to enhance the current monitoring well network.

4. Installation of temporary packers at select inactive (NH-east) production wells to mitigate flow through vertical conduits.

Because recent model simulations (ULARA Watermaster, 2011c) suggest that groundwater elevations may rise 50 feet by Fall 2015, rather than continue to decline in response to increased pumping as simulated in the FFS (EPA, 2009a), it is not yet possible to appropriately design the Second Interim Remedy. The Final Groundwater Management Plan, to be developed as part of the ICIAP between the EPA and cities of Los Angeles, Burbank, and Glendale, should specify reasonable minimum/maximum groundwater elevations and establish consensus regarding future pumping and recharge rates that will be necessary to successfully design and implement the Second Interim Remedy and achieve RAOs.

A Pre-Design Investigation, including a field program and data evaluation consistent with Section 4 of the AOC scope of work, is proposed to resolve critical data gaps before the preliminary design phase of the Second Interim Remedy. The Pre-Design Investigation will proceed concurrently with other AOC scope items (i.e., RD QAPP, Building Conditions Assessment) that are either not dependent upon findings from the Pre-Design Investigation or can be adjusted as needed in subsequent AOC scope item deliverables (e.g., Preliminary Design Report). The Pre-Design Groundwater Modeling Memorandum and Treatment Options Memorandum will be initiated during the Pre-Design Investigation and completed based on collected data. The revised NHOU project schedule is presented in Appendix H (Attachment A).

7 REFERENCES

AMEC, 2011. Final Remedial Draft Work Plan. October 5.

California Department of Water Resources, 2003. California's Groundwater, Bulletin 118 – Update 2003.

California State Water Rights Board, 1962. Report of Referee, City of Los Angeles vs. City of San Fernando: In the Superior Court of the State of California in and for the County of Los Angeles, No. 650079. July

California Superior Court, 2007. Interim Agreement for the Preservation of the San Fernando Basin Water Supply. September.

CDPH, 1997. Memorandum – Policy Memo 97-005 Policy Guidance for Direct Domestic Use of Extremely Impaired Sources. November 5.

CH2M Hill, 1991. Letter: Cluster Well Aquifer Test Analysis, San Fernando Valley. March 18.

_____, 1994. San Fernando Basin Groundwater Model Documentation, San Fernando Valley Superfund Site, Los Angeles County, California. October.

_____, 1996a. Evaluation of Past and Potential Performance of the North Hollywood Operable Unit Facility, San Fernando Valley Superfund Site, Los Angeles County, California. January.

_____, 1996b. Report for Third and Fourth Quarter 1995 Sampling, San Fernando Valley, Los Angeles, California. August.

_____, 1997. Report for 1996 RI Monitor Well Sampling, San Fernando Valley, Los Angeles, California. June.

_____, 1998. Report for 1997 RI Monitor Well Sampling, San Fernando Valley, Los Angeles, California. June.

_____, 1999. Report for 1998 RI Monitor Well Sampling, San Fernando Valley, Los Angeles, California. February.

_____, 2000. Report, 1999 RI Monitoring Well Sampling, San Fernando Valley, Los Angeles, California. September.

_____, 2001. Report, 2000 RI Monitoring Well Sampling, San Fernando Valley, Los Angeles, California. November.

_____, 2002. Report, 2001 RI Monitoring Well Sampling, San Fernando Valley, Los Angeles, California. July.

_____, 2003. Report, 2002 RI Monitoring Well Sampling, San Fernando Valley, Los Angeles, California. August.

_____, 2004. 2003 Report, San Fernando Valley Superfund Sites, Groundwater Monitoring Program, San Fernando Valley, Los Angeles, California. July.

_____, 2005. 2004 Report, San Fernando Valley Superfund Sites, Groundwater Monitoring Program, San Fernando Valley, Los Angeles, California. July.

_____, 2006. North Hollywood Operable Unit, Chromium Evaluation. January.

_____, 2007a. 2005 Report, San Fernando Valley Superfund Sites, Groundwater Monitoring Program, San Fernando Valley, Los Angeles, California. January.

_____, 2007b. 2006 Report, San Fernando Valley Basin, Groundwater Monitoring Program, San Fernando Valley, Los Angeles, California. December.

_____, 2009. 2007 Report, San Fernando Valley Superfund Sites, Groundwater Monitoring Program, San Fernando Valley, Los Angeles County, California. July.

_____, 2011a. Basinwide Groundwater Monitoring Program Optimization Evaluation for the San Fernando Valley Superfund Sites, Los Angeles County, California. February 25.

_____, 2011b. Summer 2010, Burbank Operable Unit Aquifer Test and Analysis. Presented as an EPA webinar on May 24.

DWR, 2003. California's Groundwater, Bulletin 118 – Update 2003.

E2 Consulting Engineers, 1999a. Addendum No. 3 to the Revised Sampling and Analysis Plan for San Fernando Groundwater Monitoring Program, San Fernando Valley Basin, Burbank, Glendale, North Hollywood, and Los Angeles, California. November.

_____1999b. Addendum No. 2 to the Quality Assurance Project Plan for San Fernando Groundwater Monitoring Program, San Fernando Valley Basin, Burbank, Glendale, North Hollywood, and Los Angeles, California. November.

EG&G, 1991. Letter: Review of San Fernando Pumping Test Analyses. June 5.

EPA, 1986. Letter: Addressed to Mr. Duane L. Georgeson, Assistant General Manager – Water, Department of Water & Power. January 27.

_____, 1987. Record of Decision for a Remedial Action for Area 1 of the San Fernando Valley Superfund Sites. September 23.

_____, 1993. Five-Year Review of North Hollywood Operable Unit, San Fernando Valley Superfund Site. July 8.

_____, 1996. Partial Consent Decree, Civil No. 93-6490-MRP (Tx).

_____, 1998a. General and Special Notice Letter Recipients, http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/webdisplay/oid-91548cdb0dca97bb88256e2b007b9d56?OpenDocument. May 14.

_____, 1998b. Five-Year Review Report, North Hollywood Operable Unit Facility, San Fernando Valley Superfund Site – Area 1, Los Angeles County, California. July.

_____, 2003. Third NHOU Five-Year Review for North Hollywood Operable Unit, San Fernando Valley (Area 1) Superfund, Los Angeles County, California. September.

_____, 2004. Five-Year Review Report for Burbank Operable Unit, San Fernando Valley (Area I) Superfund, Los Angeles County, California. September.

_____, 2008a. A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems. EPA 600/R-08/003. January.

_____, 2008b. NHOU Five-Year Review Report for San Fernando Valley (Area 1) Superfund Site, Los Angeles County, California. September.

_____, 2009a. Focused Feasibility Study, North Hollywood Operable Unit, San Fernando Valley Area 1 Superfund Site, Los Angeles County, California. July.

_____. 2009b. EPA Superfund Interim Action Record of Decision, North Hollywood Operable Unit, San Fernando Valley (Area 1) Superfund Site, Los Angeles County, California. EPA ID: CAD980894893. September 30.

_____, 2009c. Greener Cleanups Policy – EPA/Region 9. September 14.

_____, 2011a. Presentation slides: North Hollywood Operable Unit of the San Fernando Valley, Area 1 - Update on EPA PRP Search Activities. January 6.

_____, 2011b. Administrative Settlement Agreement and Order on Consent for Remedial Design, CERCLA Docket No. 2011-01, in the matter of North Hollywood Operable Unit, San Fernando Valley (Area I), Superfund Site, Los Angeles, California. February 21.

_____, 2011c. Letter: Request for ongoing biannual sampling coordination and 2011 changes to EPA Basinwide Remedial Investigation sampling frequency. February 25.

_____, 2011d. EPA Press Release: EPA Releases Final Health Assessment for TCE. September 28.

_____, 2012. EPA PRP Meeting Presentation, March 8.

J. M. Montgomery, Inc., 1986. Well Siting North Hollywood-Burbank Aeration Facility. Prepared for: The City of Los Angeles Department of Water and Power. June.

_____, 1990. Section 3.1.2.3 Pg 3-6.

_____, 1992. Remedial Investigation of Groundwater Contamination in the San Fernando Valley. Submitted to: City of Los Angeles Department of Water and Power under Cooperative Agreement with the United States Environmental Protection Agency. December.

LACDPP, 2004a. Final Sun Valley Watershed Management Plan. May.

_____, 2004b. Final Project Environmental Impact Report, Sun Valley Management Plan

_____, 2011. Rainfall stations 13B (North Hollywood-Blix) and 13C (North Hollywood-Lakeside).

LADWP, 1981. Report on Groundwater Flow Patterns/Water Levels and Groundwater Usage (Subtasks I-A-1 and I-A-2) San Fernando Basin Groundwater Management Plan. October.

_____, 1983. Groundwater Quality Management Plan, San Fernando Valley Basin. July 1.

_____, 1987. Memorandum: Geological Monitoring of North Hollywood Aeration Facility Extraction Well Pilot Holes. December 2.

_____, 1988. Operable Unit Feasibility Study for the North Hollywood Well Field Area of the North Hollywood-Burbank NPL Site. September.

_____, 1989. Aeration Well Pumping Test, December 21, 1987 – March 28, 1988.

_____, 1991a. Evaluation of the North Hollywood Operable Unit Well Extraction System. April.

_____, 1991b. North Hollywood – Burbank Aeration Facility, As-Built Construction Drawings, July 8.

_____, 1992. Technical Memorandum: Spinner Logging and Depth Sampling with Related Aquifer Test Results in the San Fernando Basin (SFB). January.

_____, 1994. North Hollywood Aeration Well Construction Data 1987. February 7.

_____, 2002. Draft Evaluation of the North Hollywood Operable Unit and Options to Enhance Its Effectiveness.

_____, 2003. Final Evaluation of the North Hollywood Operable Unit and Options to Enhance Its Effectiveness.

_____, 2004. San Fernando Valley Remedial Investigation, North Hollywood Operable Unit, Quarterly Report. May 10.

_____, 2005. San Fernando Valley Remedial Investigation, North Hollywood Operable Unit, Quarterly Report. February 10.

_____, 2005. San Fernando Valley Remedial Investigation, North Hollywood Operable Unit, Quarterly Report, Corrected Table B. February 18.

_____, 2005. San Fernando Valley Remedial Investigation, North Hollywood Operable Unit, Quarterly Report. August 10.

_____, 2006. San Fernando Valley Remedial Investigation, North Hollywood Operable Unit, Quarterly Report. November 10.

_____, 2007. San Fernando Valley Remedial Investigation, North Hollywood Operable Unit, North Hollywood Groundwater Treatment Facility, Eighty-first Quarterly Report, April-June 2007. August 23.

_____, 2007. San Fernando Valley Remedial Investigation, North Hollywood Operable Unit, Quarterly Report. November 14.

_____, 2008. San Fernando Valley Remedial Investigation, North Hollywood Operable Unit, Quarterly Report. May 29.

_____, 2008. San Fernando Valley Remedial Investigation, North Hollywood Operable Unit, Quarterly Report. October 21.

_____, 2009a. San Fernando Valley Remedial Investigation, North Hollywood Operable Unit, Quarterly Report. August 14.

_____, 2009b. North Hollywood Operable Unit, Quarterly Report. November 12.

_____, 2010a. San Fernando Valley Remedial Investigation, North Hollywood Operable Unit, Quarterly Report. February 8.

_____, 2010b. San Fernando Valley Remedial Investigation, North Hollywood Operable Unit, Quarterly Report. May 3.

_____, 2010c. San Fernando Valley Remedial Investigation, North Hollywood Operable Unit, Quarterly Report. August 9.

_____, 2010d. San Fernando Valley Remedial Investigation, North Hollywood Operable Unit, Quarterly Report. November 3.

_____, 2010e. Final 2010 Urban Water Management Plan.

_____, 2011. Personal communicatiosn with Mr. Vahe Dabbaghian. June 29, July 1, and July 19.

MWH, 2010a. Long-Term Treatment Plan, North Hollywood Operable Unit Well NHE-2, 11617 Dehougne Street, North Hollywood, CA. March 1.

_____, 2010b. Draft Groundwater Characterization Report North Hollywood Operable Unit, prepared for Honeywell International Inc. April 7.

_____, 2011. Personal communication with MWH staff. August 26 and September 19.

Oberlander, P., T. Panian, J. Phillips, and T. Blackman, 1993. "A Case History (In Progress), 12,000 gpm of Pump and Treat in Burbank, California". Proceedings of the Eighth National Outdoor Action Conference and Exposition, Minneapolis, Minnesota, May 23-25.

RWQCB-LA, 2002. San Fernando Valley Cooperative Agreement – Final Chromium VI Investigation Report, San Fernando Valley, California. August 28.

_____, 2008. Presentation: Chromium in the San Fernando Valley Groundwater Basin (Panel Discussion) – Location and Extent of Chromium Contamination. Chromium Workshop, Glendale Civic Auditorium. March 10.

ULARA Watermaster, 2003. Watermaster Special Report Concerning the History and Occurrence of Hexavalent Chromium Contamination in the San Fernando Basin and Watermaster Conclusions and Recommendations.

_____, 2007. White Paper: Is the San Fernando Groundwater Basin Undergoing a Long-Term Decline in Storage? March.

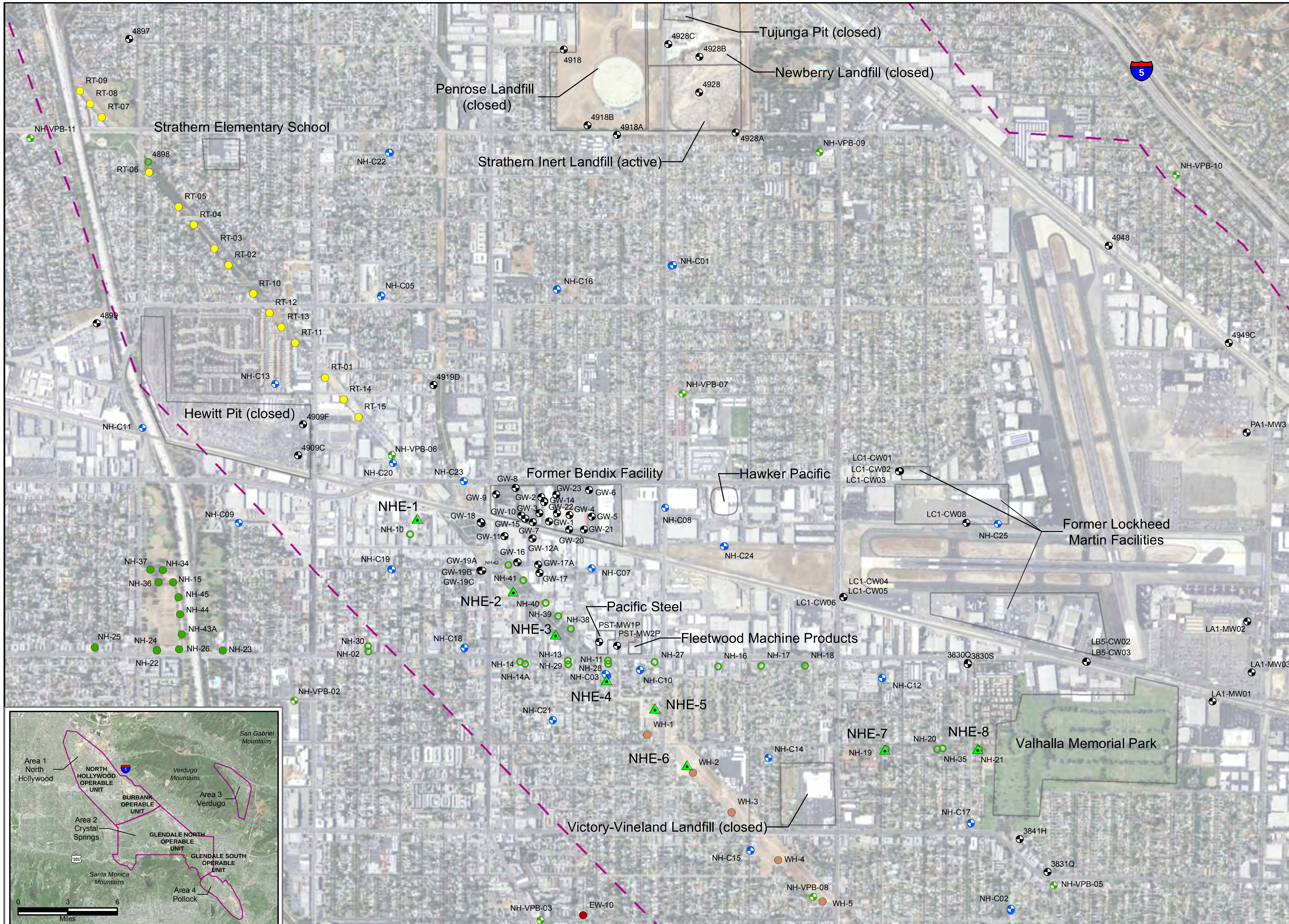
_____, 2011a. Annual Report, Upper Los Angeles River Area Watermaster, 2009-10 Water Year (October 1, 2009 – September 30, 2010). May.

_____, 2011b. Personal communication with Mr. Anthony Hicke. June.

_____, 2011c. Annual Report, Upper Los Angeles River Area Watermaster, Groundwater Pumping and Spreading Plan for the Upper Los Angeles River Area, 2010-2015 Water Years. July.

USGS, 2008. Ground-Water Quality Data in the San Fernando-San Gabriel Study Unit, 2005 – Results from the California GAMA Program. Prepared in cooperation with the California State Water Resources Control Board. Data Series 356.

FIGURES



EXPLANATION

NHOU Extraction Well

PRODUCTION WELLS

- Erwin Well Field
- North Hollywood Well Field (West)
- North Hollywood Well Field (East)
- Rinaldi-Toluca Well Field
- Whitnall Well Field

MONITORING WELLS

- NHOU Monitoring Well
- North Hollywood Vertical Profile Boring Monitoring Well
- Facility Monitoring Wells

Study Area Features

Approximate Boundary San Fernando Valley Investigation Area 1

N

0 1,500 3,000
Feet

Aerial Photograph: DigitalGlobe, June 2009

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DATE: 10/2011	DATE: 10/2011

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Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

NHOU Study Area

FIGURE
2-1

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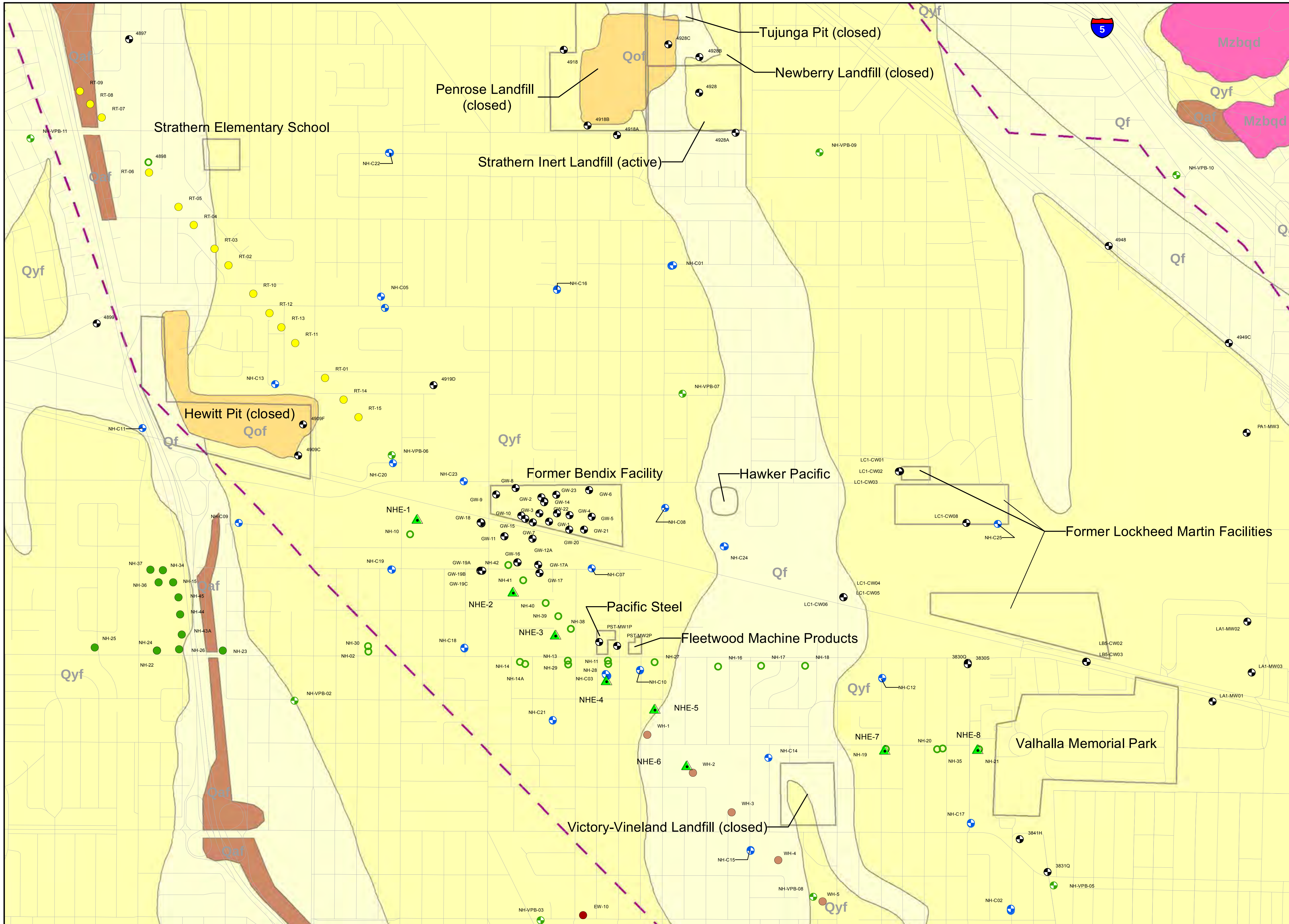

EXPLANATION

Geologic Units

- Mzbqd — Biotite-quartz diorite (Mesozoic?)
- Qaf — Artificial fill (late Holocene)
- Qf — Alluvial fan deposits (Holocene)
- Qof — Old alluvial fan deposits, undivided (late to middle Pleistocene)
- Qyf — Young alluvium, undivided (Holocene and late Pleistocene)

NHOU Extraction Well

PRODUCTION WELLS

- Erwin Well Field
- North Hollywood Well Field (West)
- North Hollywood Well Field (East)
- Rinaldi-Toluca Well Field
- Whitnall Well Field

MONITORING WELLS

- NHOU Monitoring Well
- North Hollywood Vertical Profile Boring Monitoring Well
- Facility Monitoring Wells

Approximate Boundary San Fernando Valley Investigation Area 1

N

0 1,500 3,000
Feet

Map source: Preliminary Geologic Map of the Los Angeles 30' x 60' Quadrangle, Southern California, USGS, 2005

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Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

NHOU Study Area
Geologic Map

FIGURE
3-1

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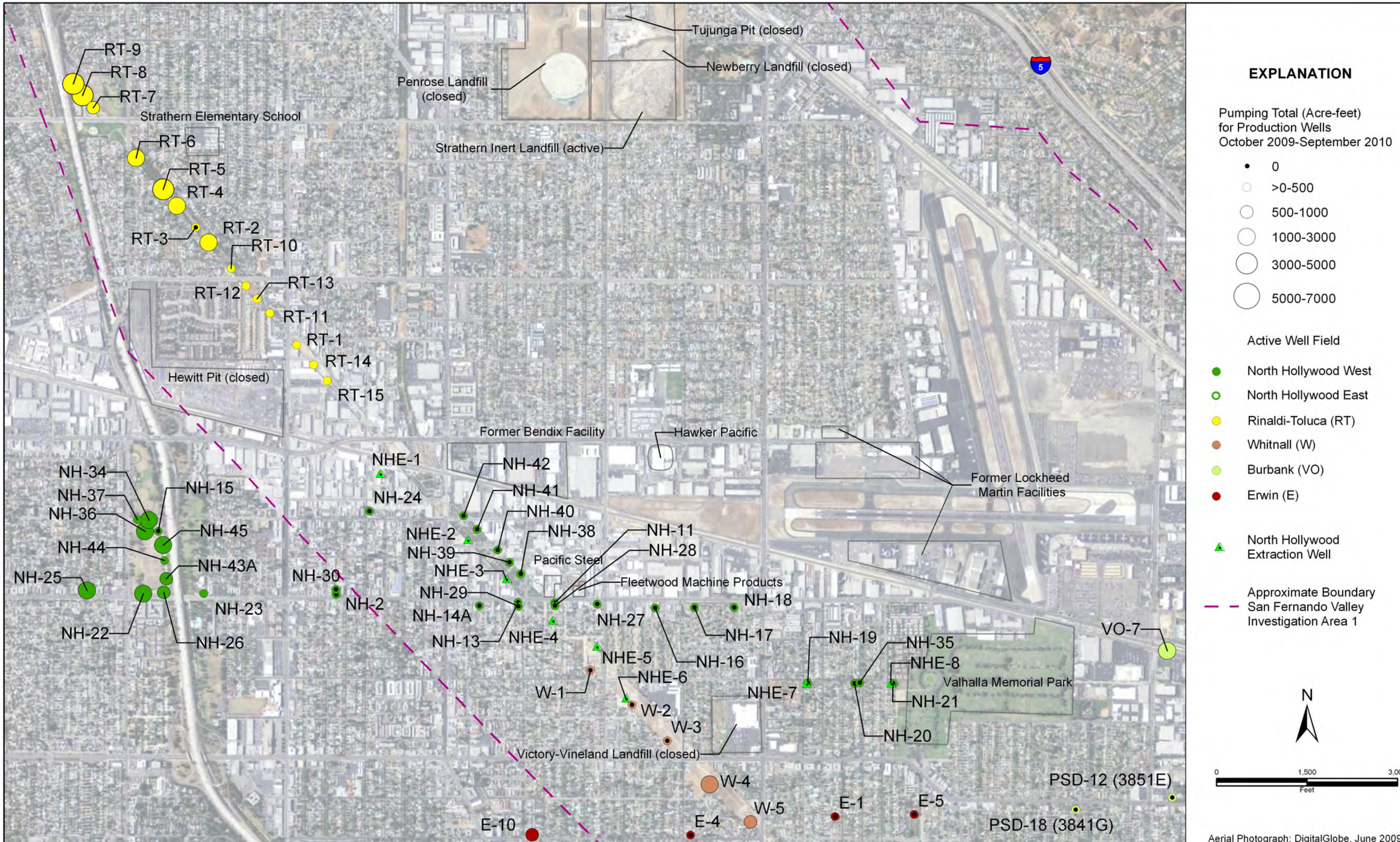

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Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

North Hollywood Area
Production Well Fields

FIGURE
3-2

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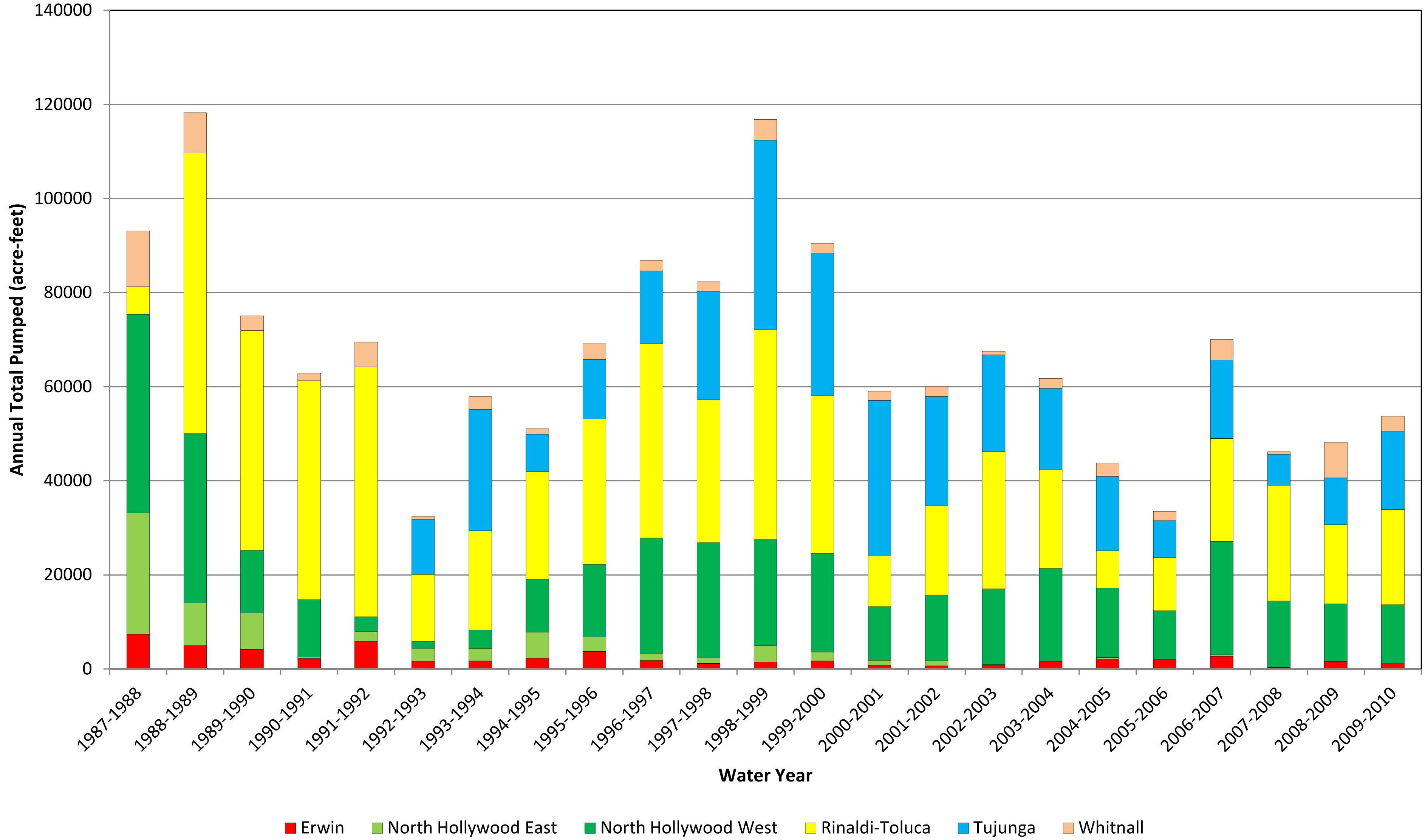

North Hollywood Area Production Well Fields
Contribution Over Time
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **3-3**

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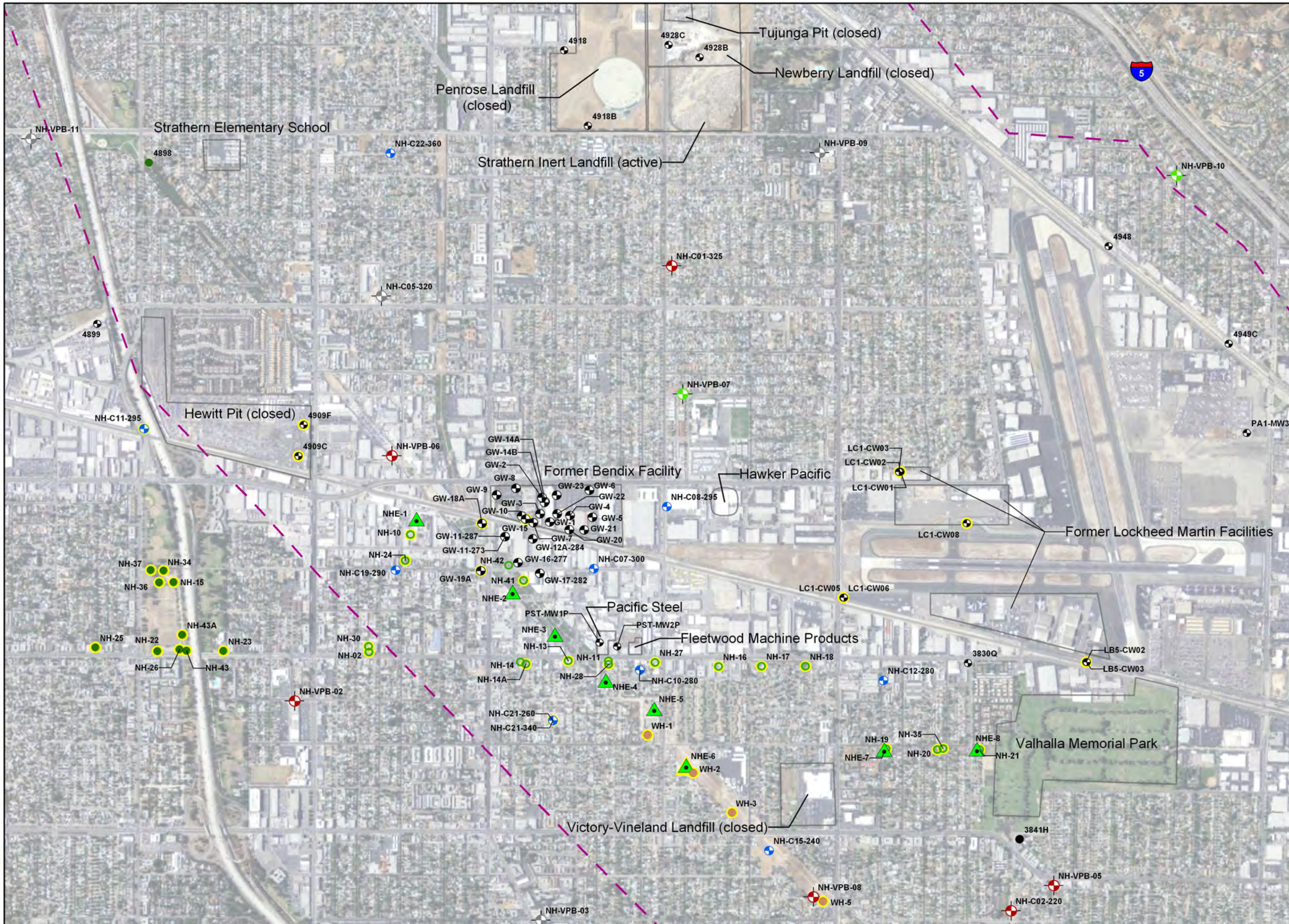

EXPLANATION

- NHOU Monitoring Well
- NHOU Extraction Well
- Facility/RI Monitoring Well

PRODUCTION WELLS

- North Hollywood Well Field - West
- North Hollywood Well Field - East
- Erwin Well Field
- Tujunga Well Field
- Whitnall Well Field
- Other Well Field

RI Well with Sampling Frequency

- Quarterly
- Annual
- Not Sampled

- ULARA Watermaster Well with Transducer

Wells with yellow highlight are screened in mulitple depth regions

- Approximate Boundary San Fernando Valley Investigation Area 1

N

0 1,500 3,000
Feet

Aerial Photograph: DigitalGlobe, June 2009

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Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

NHOU Area Monitoring Wells
Depth Region 1

FIGURE
3-4a

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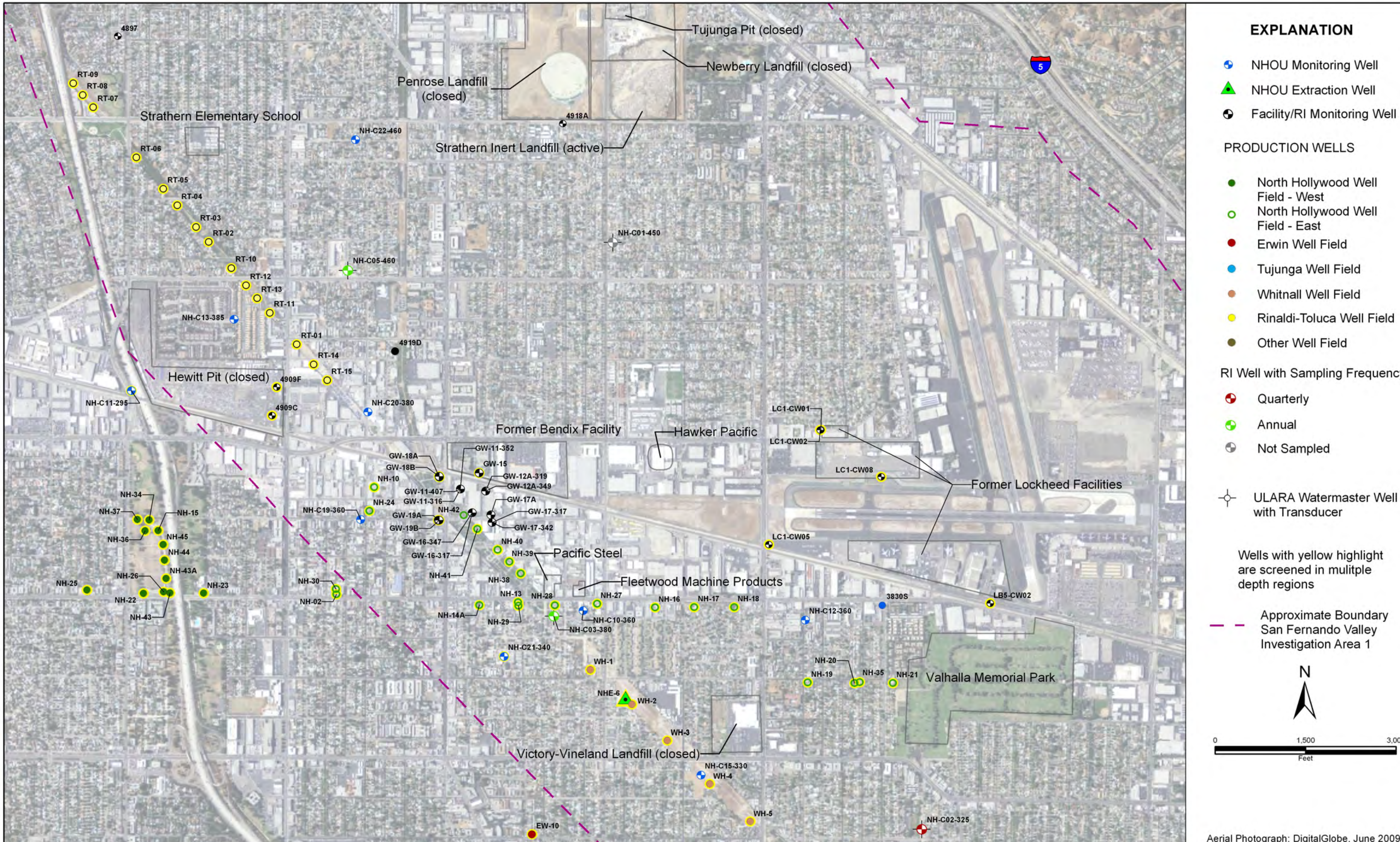

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Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

NHOU Area Monitoring Wells
Depth Region 2

FIGURE
3-4b

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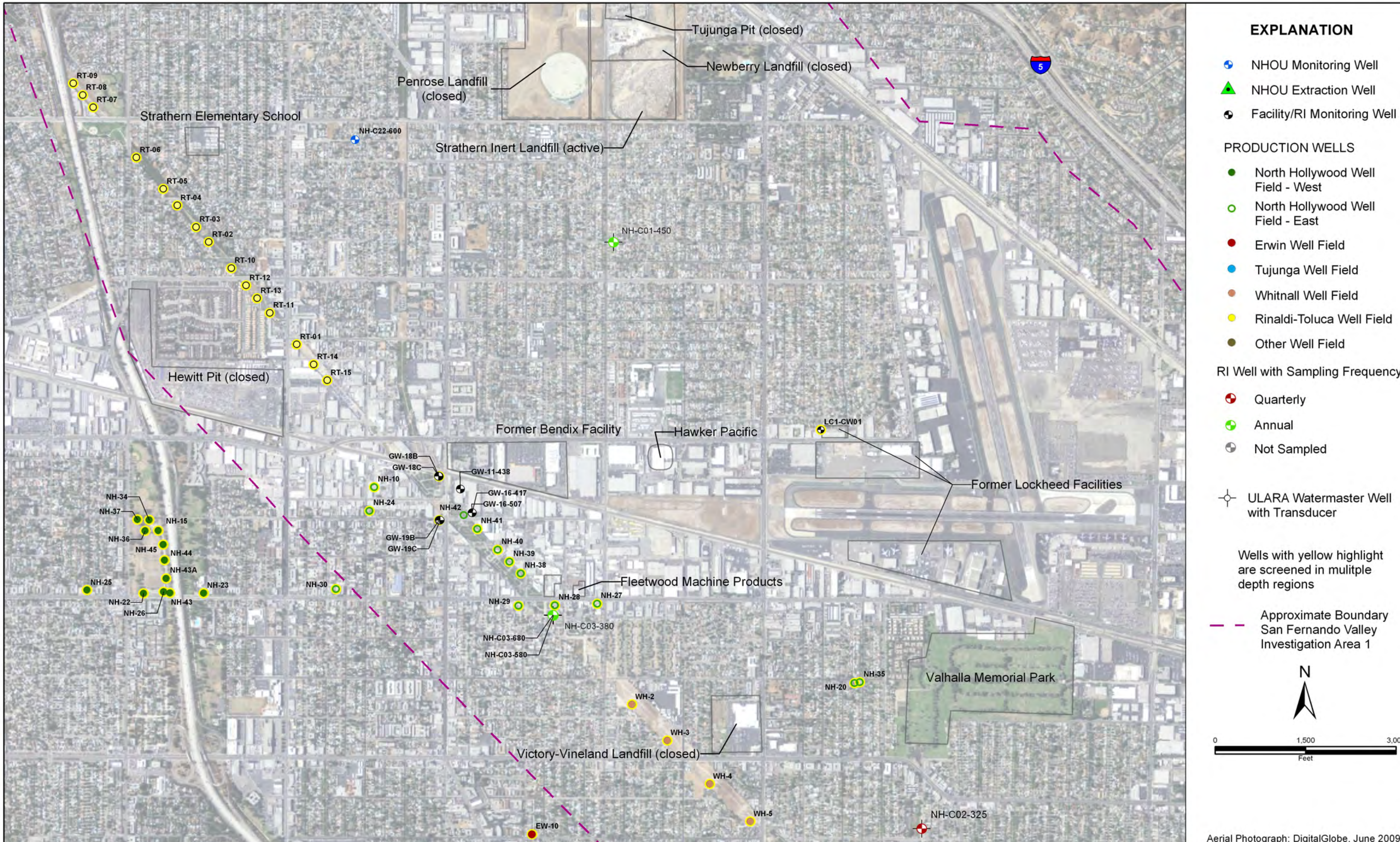

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Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

NHOU Area Monitoring Wells
Depth Region 3

FIGURE
3-4c

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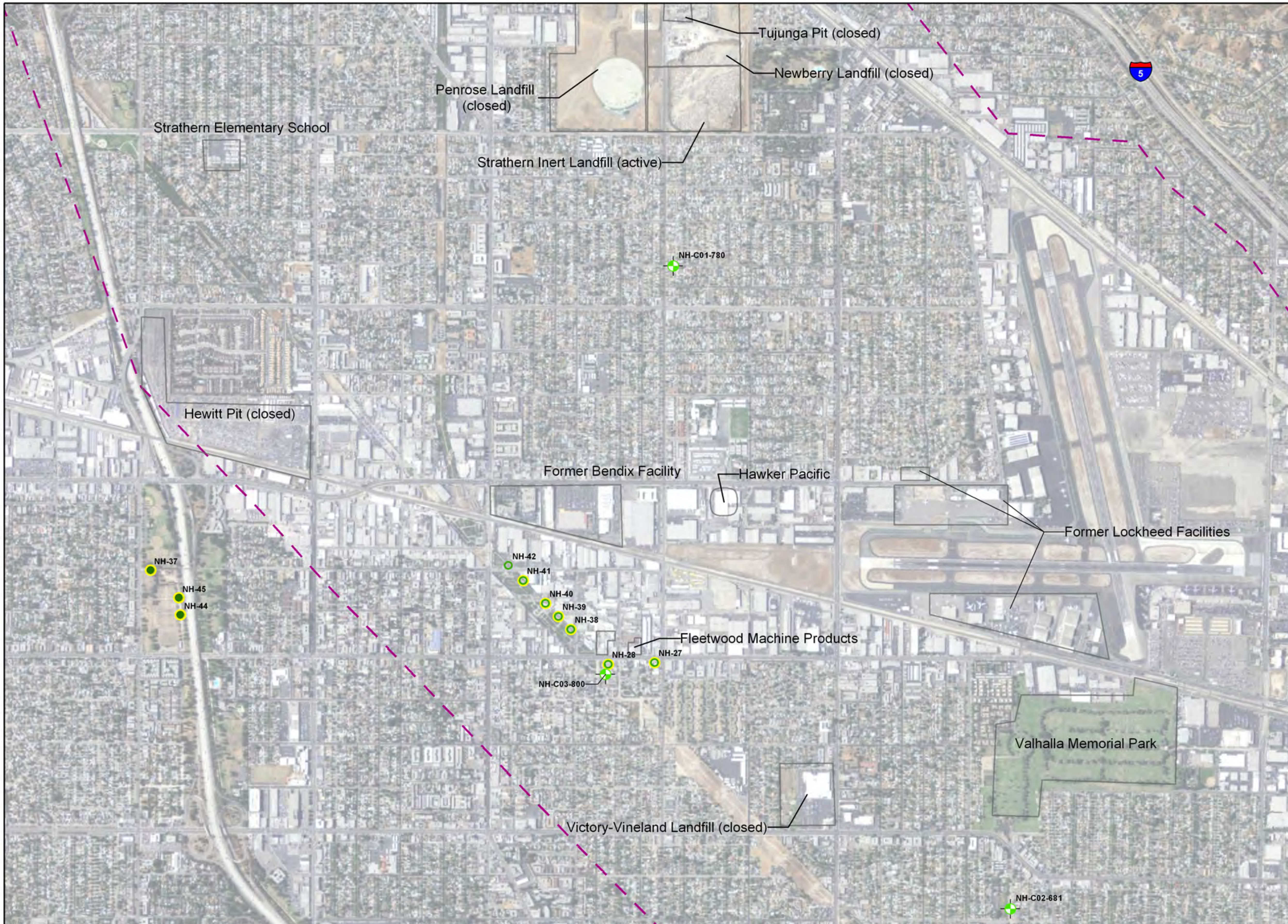

EXPLANATION

- NHOU Monitoring Well
- NHOU Extraction Well
- Facility/RI Monitoring Well

PRODUCTION WELLS

- North Hollywood Well Field - West
- North Hollywood Well Field - East
- Erwin Well Field
- Tujunga Well Field
- Whitnall Well Field
- Rinaldi-Toluca Well Field
- Other Well Field

RI Well with Sampling Frequency

- Quarterly
- Annual
- Not Sampled

- ULARA Watermaster Well with Transducer

Wells with yellow highlight are screened in mulitple depth regions

Approximate Boundary San Fernando Valley Investigation Area 1

N

0 1,500 3,000 Feet

Aerial Photograph: DigitalGlobe, June 2009

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Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

NHOU Area Monitoring Wells
Depth Region 4

FIGURE **3-4d**

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Approx. Depth (feet)	Geologic Age	JMM (1992) Zone Designation	ULARA Watermaster Units	Oberlander, et al. (1993) units	Depth Region	NHOU Hydrostratigraphic Units[1]
100	Holocene	Upper	**A** - aluvial sand, gravel, and rocks		1	A Zone
200	Pleistocene		**L** - gravel			
			K, J - fine grained	A' - coarse sands, gravel, cobbles		
300		Middle	**I** - sand and brown clay	X - sand, silty sand, sandy silt, silty clay		
			AA - sand and gravel	A - coarse sands, gravel, cobbles		
400		Lower	**BB** - sand, gravel, rocks	Y - sand, silty sand, sandy silt, silty clay B - coarse sand, gravel, cobbles	2	B Zone
500			**E** - clay and gravel, very hard clay		3	Deeper Units
			M - sand and gravel			
600			**Blue Star** - marker bed			
700			**Q** - brown clay, gravel, rocks			
800			Deeper Units		4	
900	Upper Pliocene					
1000						

[1] NHOU Hydrostratigraphic units described in Section 4.0

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Stratigraphic Correlation Diagram
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

3-5

DRAWN	JOB NUMBER	CHECKED	DATE
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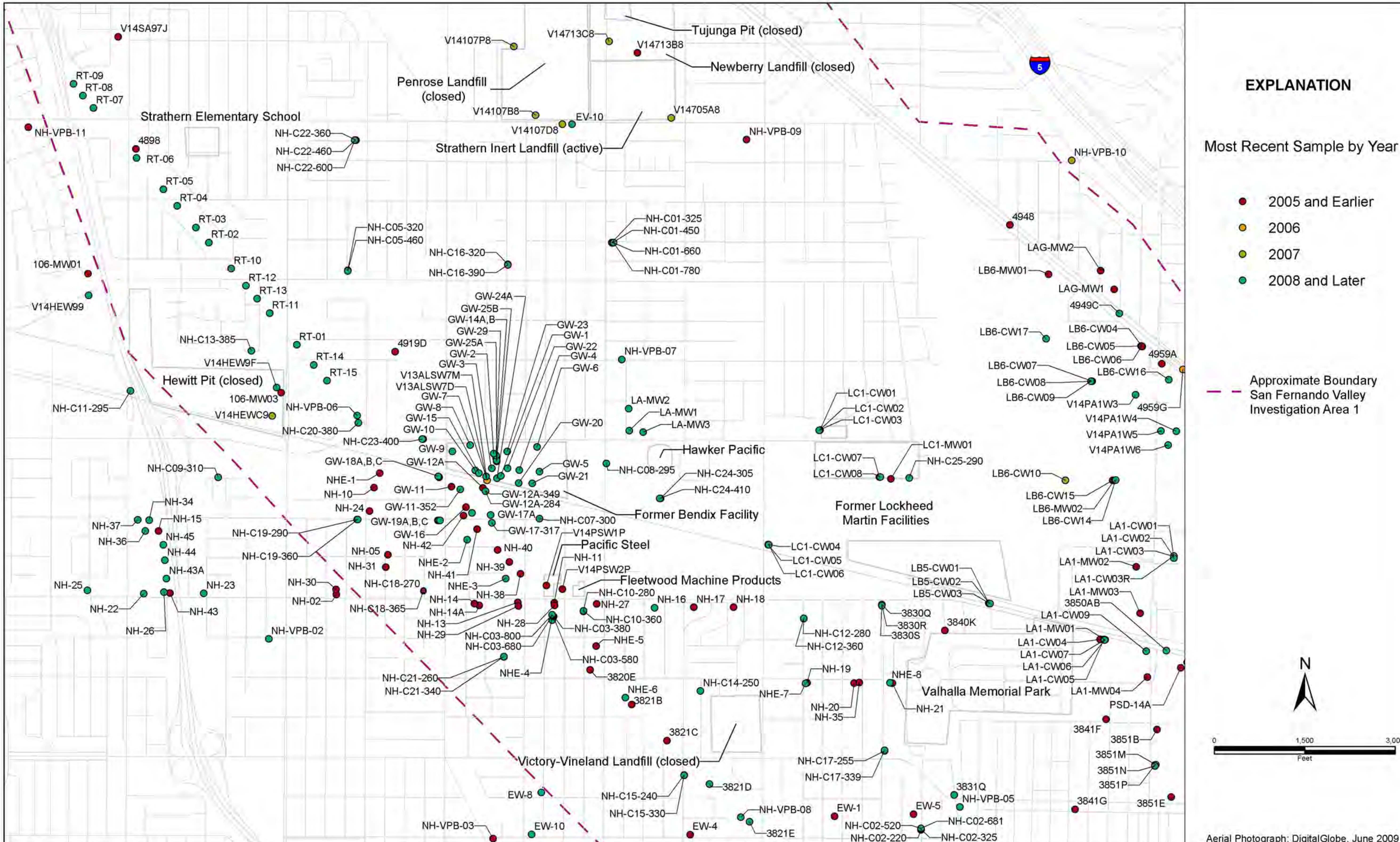

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Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Groundwater Sampling Locations with Most Recent Sample Year

FIGURE 3-6

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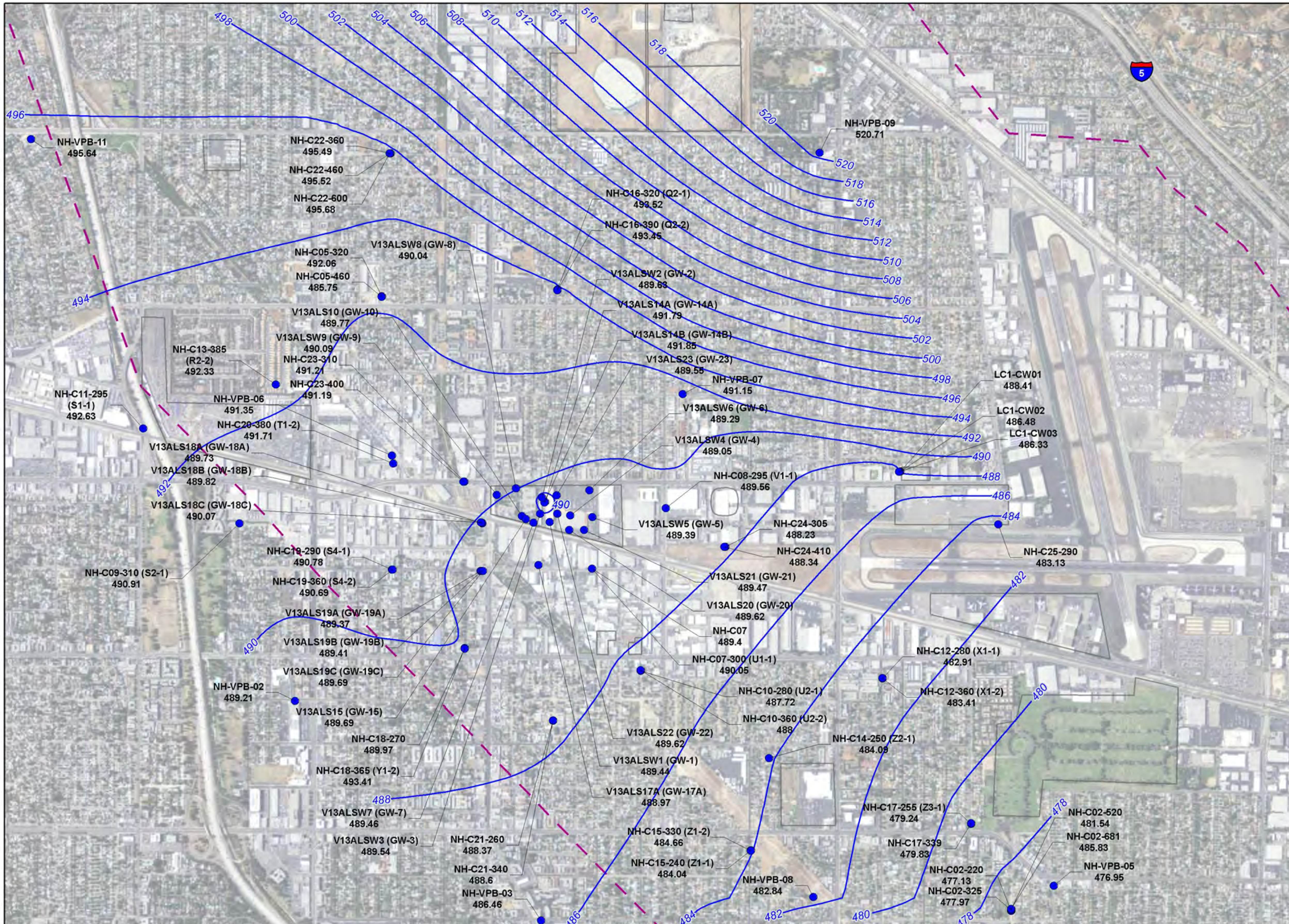

EXPLANATION

- Well with Groundwater Elevation
- Groundwater Elevation Contour (ft. above NAVD88 MSL)
- Approximate Boundary San Fernando Valley Investigation Area 1

NOTE:
- Shallow well groundwater elevation used for contouring at nested well locations.

N

0 1,500 3,000 Feet

Aerial Photograph: DigitalGlobe, June 2009

DRAWN: RJP	PROJECT NO: 4088115718
REV: 00	SCALE: AS SHOWN
CHECKED: MJH	APPROVED: MDT
DATE: 10/2011	DATE: 10/2011

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Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

December 2010 Potentiometric Map

FIGURE 3-7a

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EXPLANATION

- Well with Groundwater Elevation
- Groundwater Elevation Contour (ft. above NAVD88 MSL)
- Approximate Boundary San Fernando Valley Investigation Area 1

* Groundwater elevation not used for contouring

NOTE:
- Shallow well groundwater elevation used for contouring at nested well locations.

N

0 1,500 3,000
Feet

Aerial Photograph: DigitalGlobe, June 2009

DRAWN:	RJP	PROJECT NO:	4088115718
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DATE:	10/2011	DATE:	10/2011

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Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

April 2011 Potentiometric Map

FIGURE
3-7b

Friday, October 28, 2011 10:05:03 AM
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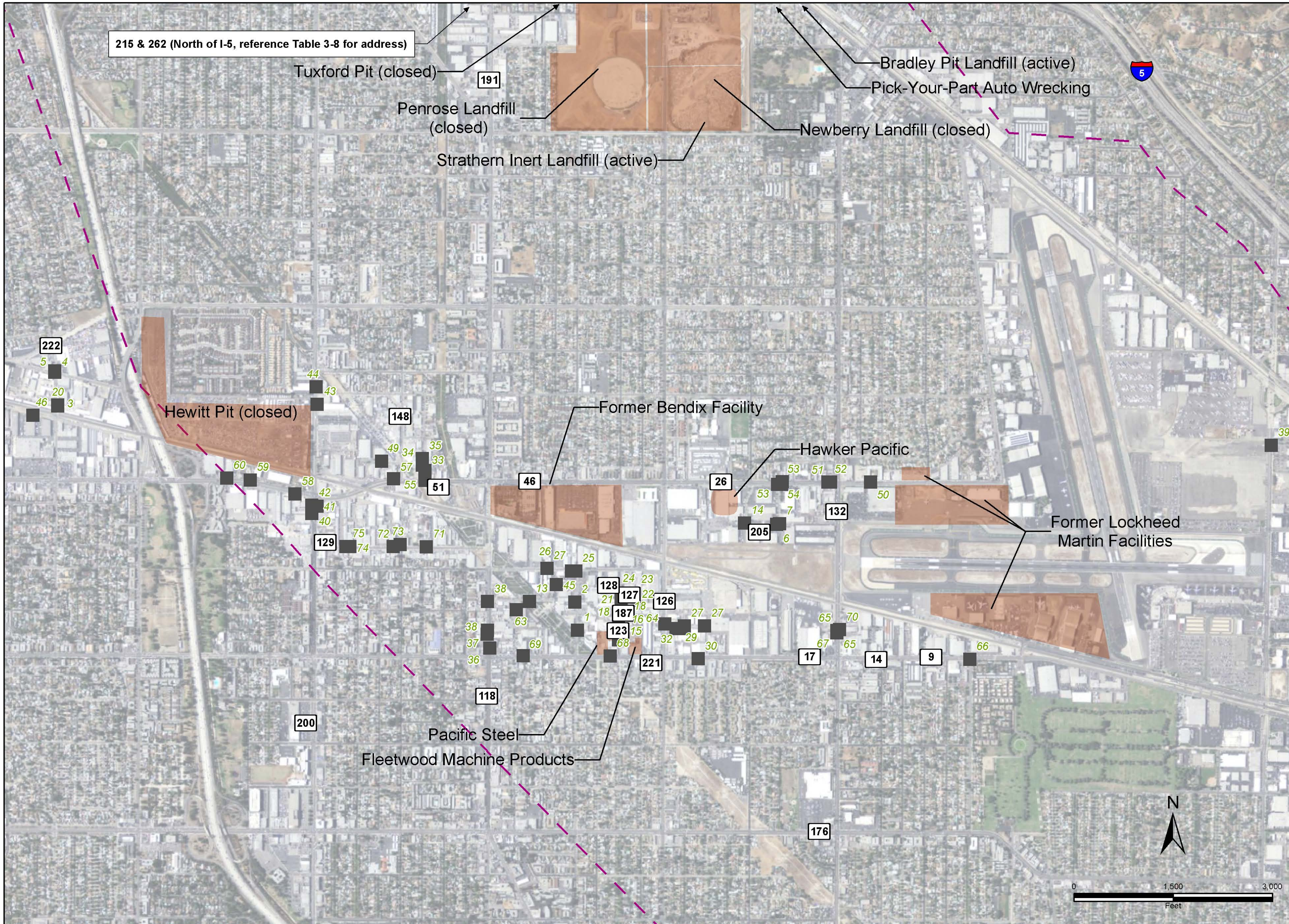

EXPLANATION

- 4 — EPA Potential Source Properties with EPA Site ID Number
- Potential Release Site (Table 5-2, Tier 2, MWH, 2010)
- EPA Known Source Properties
- 39 — Indicates reference to record in Table 5-2, MWH, 2010

Known and potential source property addresses are summarized on Table 3-8.

- Approximate Boundary San Fernando Valley Investigation Area 1

Aerial Photograph: DigitalGlobe, June 2009

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Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Known and Potential Source Properties

FIGURE 3-8

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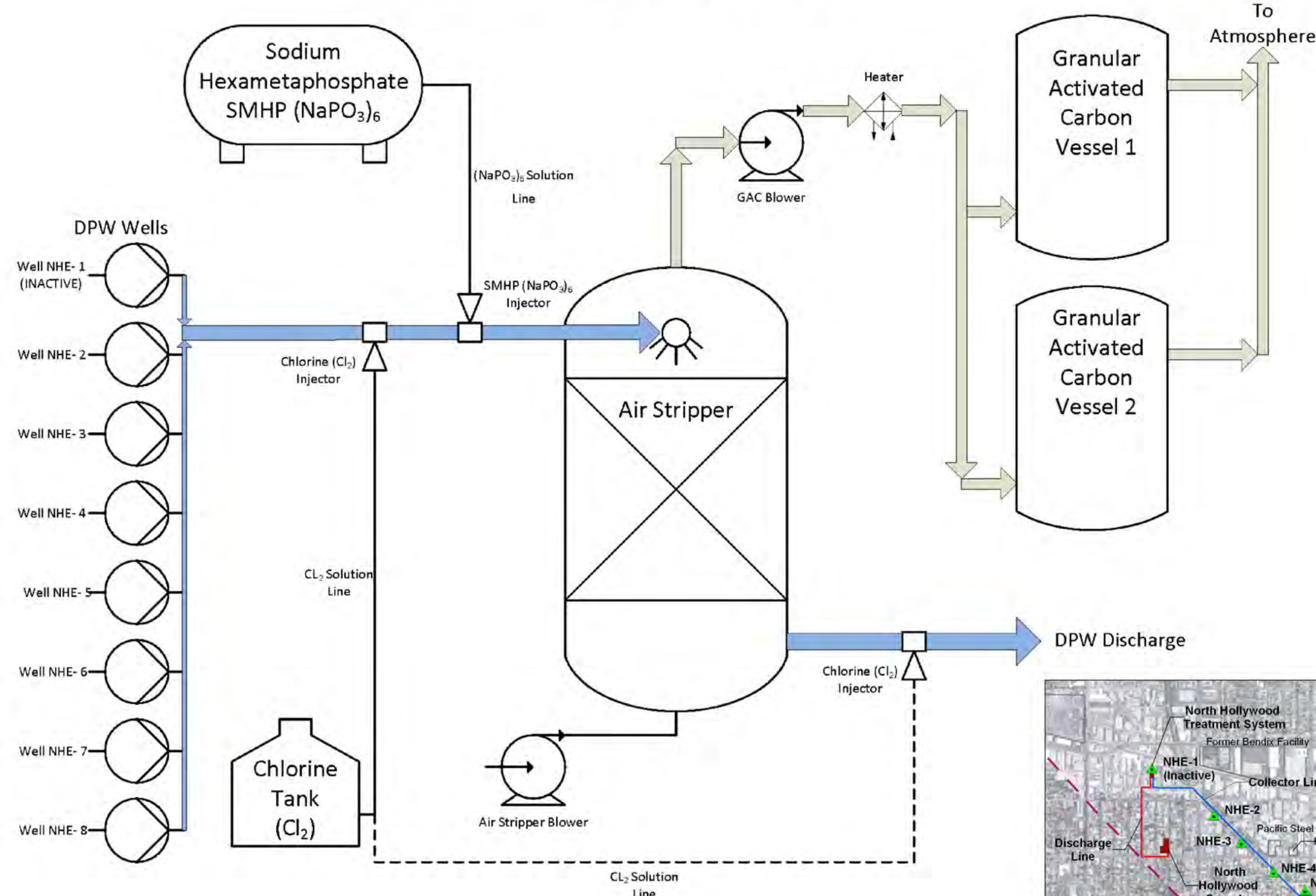
NORTH HOLLYWOOD TREATMENT SYSTEM
WATER AERATION FLOW DIAGRAM



EXPLANATION

▲ DPW Extraction Wells

— — Approximate Boundary San Fernando Valley Investigation Area 1

LOCATION MAP

N

Aerial Photograph: DigitalGlobe, June 2009

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REV: 00	SCALE: AS SHOWN		FIGURE 3-9
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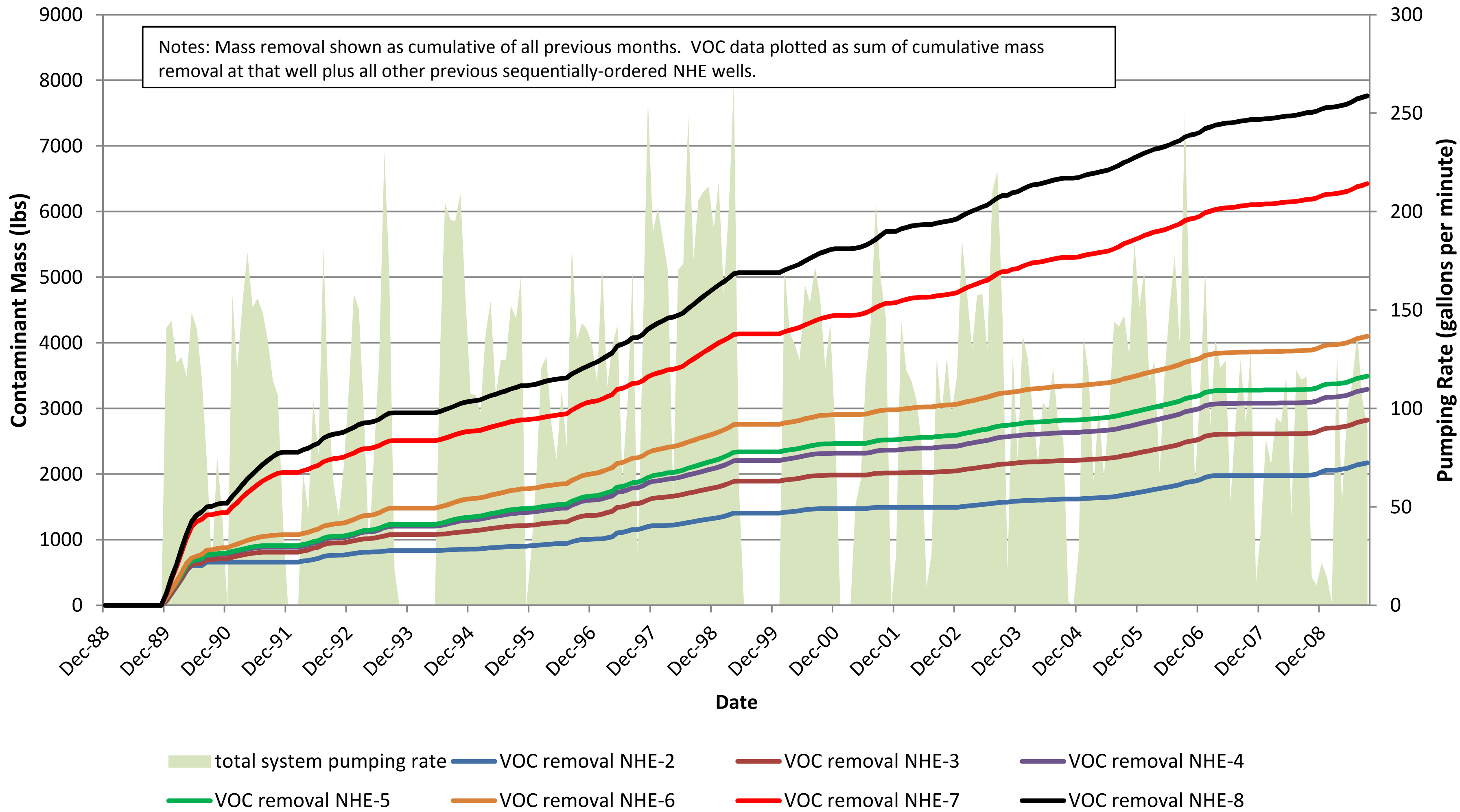

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Cumulative Mass Removal from NHOU Treatment System
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **3-10**

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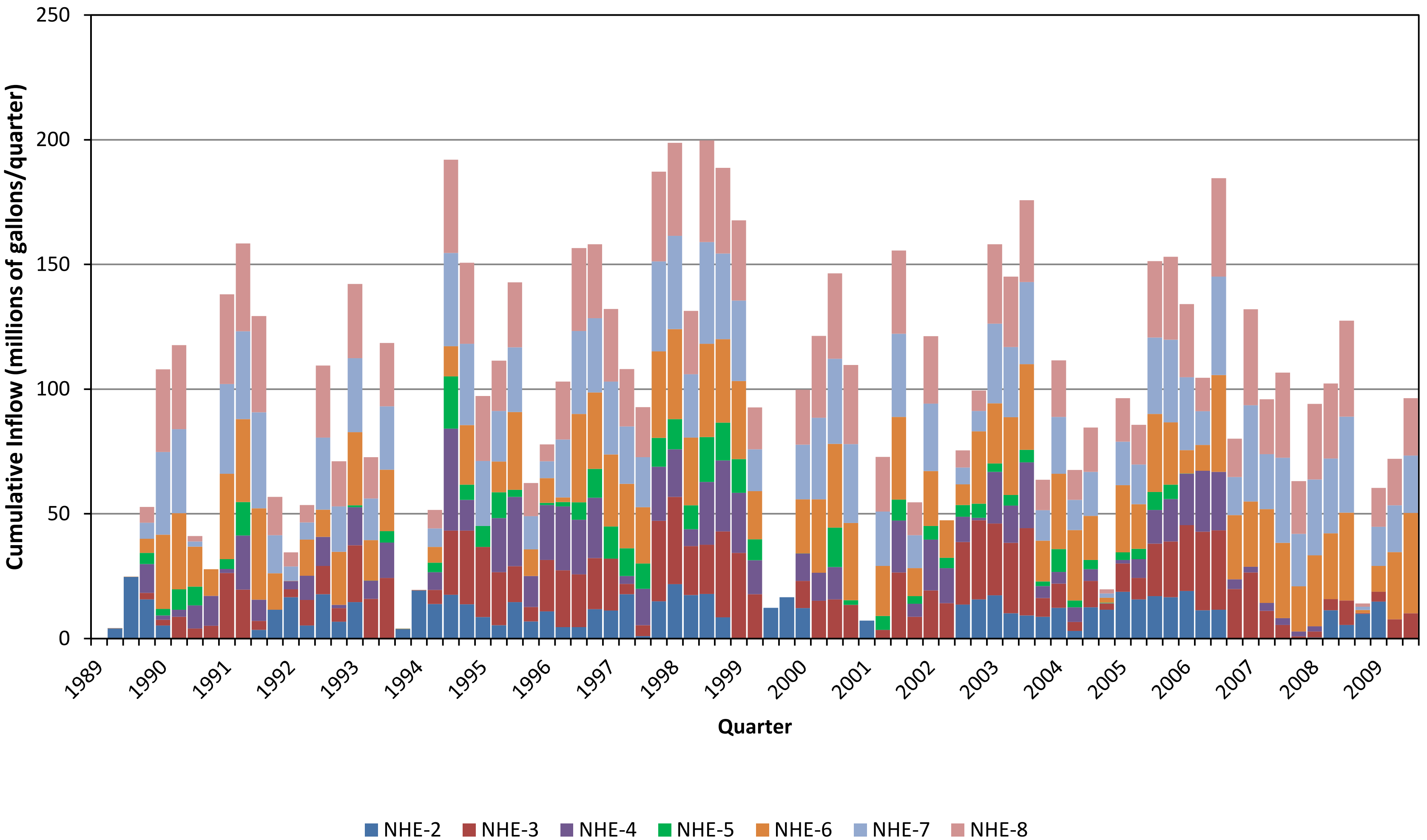

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Historical Production from NHOU
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **3-11**

DRAWN	JOB NUMBER	CHECKED	DATE
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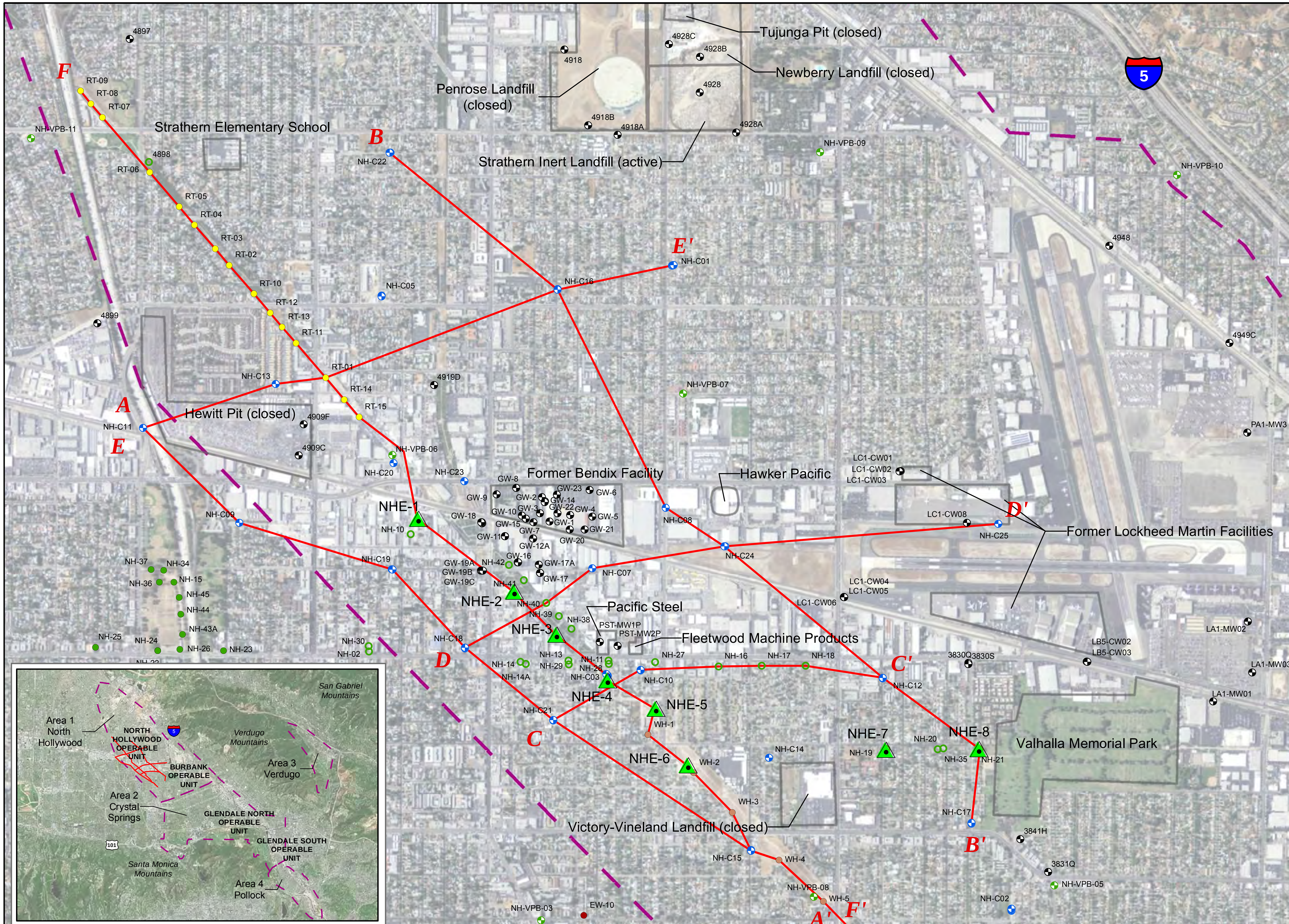

EXPLANATION

- NHOU Extraction Well

PRODUCTION WELLS

- Erwin Well Field
- North Hollywood Well Field (West)
- North Hollywood Well Field (East)
- Rinaldi-Toluca Well Field
- Whitnall Well Field

MONITORING WELLS

- NHOU Monitoring Well
- North Hollywood Vertical Profile Boring Monitoring Well
- Facility Monitoring Wells

- Approximate Boundary San Fernando Valley Investigation Area 1
- Cross-Section Line

N

0 1,500 3,000 Feet

Aerial Photograph: DigitalGlobe, June 2009

DRAWN: PCB	PROJECT NO: 4088115718
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CHECKED:	APPROVED:
DATE: 8/2011	DATE:

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Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Geologic Cross Section
Location Map

FIGURE
4-1

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DATE: 10/11	DATE: 10/11		

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Data Gap Analysis

North Hollywood Operable Unit
Los Angeles County, California

Geologic Cross Section A-A'

FIGURE: **4-2a**

DRAWN: PCB	PROJECT NO: 4088115718		
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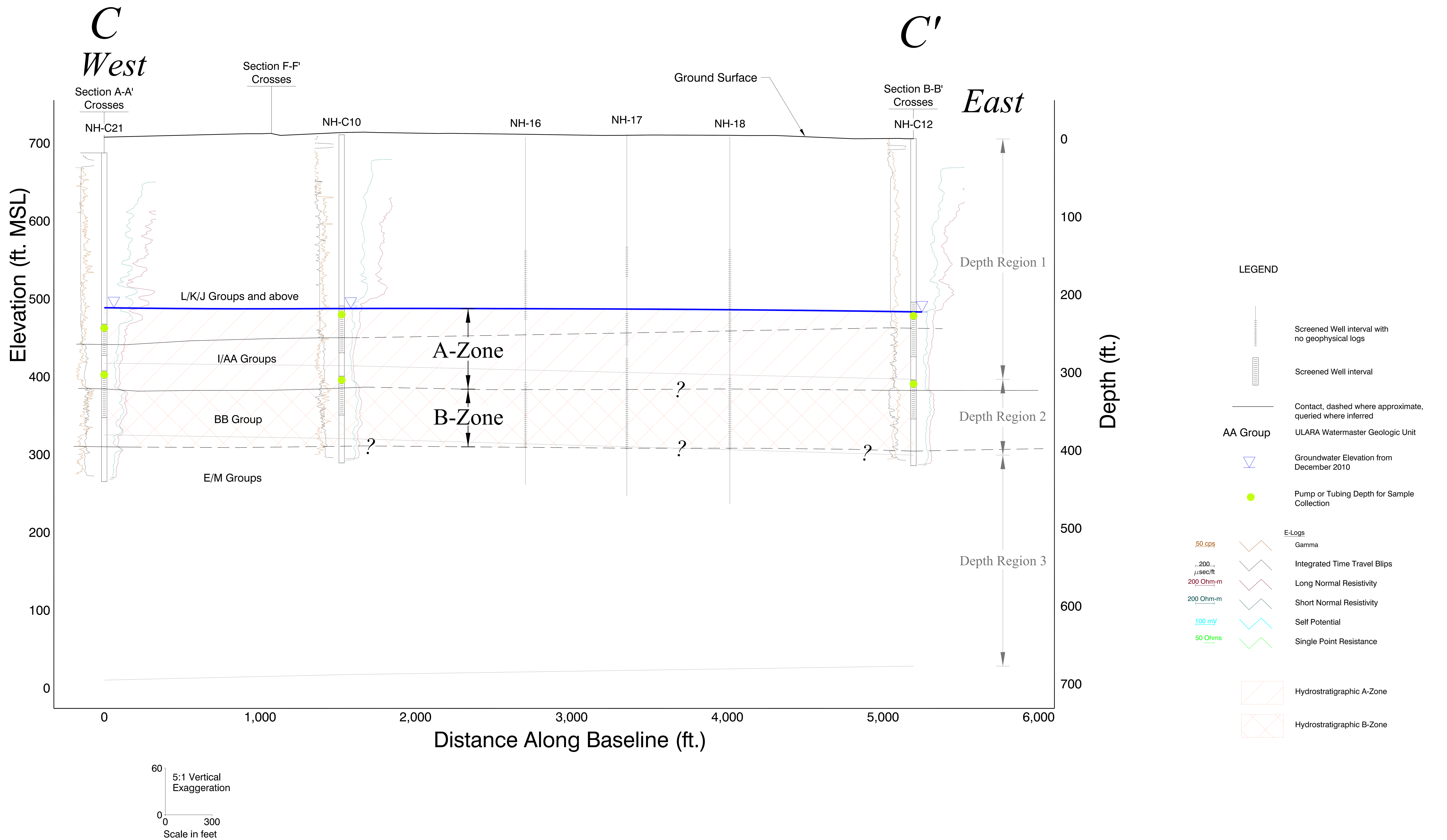
Data Gap Analysis

North Hollywood Operable Unit
Los Angeles County, California

Geologic Cross Section B-B'

FIGURE: **4-2b**



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DATE: 10/11	DATE: 10/11		

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Data Gap Analysis

North Hollywood Operable Unit
Los Angeles County, California

Geologic Cross Section C-C'

FIGURE:
4-2c

DRAWN: PCB	PROJECT NO: 4088115718		
REV: 00	SCALE: AS SHOWN		
CHECKED: MJH	APPROVED: MDT		
DATE: 9/11	DATE: 9/11		

amec

Data Gap Analysis

North Hollywood Operable Unit
Los Angeles County, California

Geologic Cross Section D-D'

FIGURE:
4-2d

DRAWN: PCB	PROJECT NO: 4088115718		
REV: 00	SCALE: AS SHOWN		
CHECKED: MJH	APPROVED: MDT		
DATE: 10/11	DATE: 10/11		

amec

Data Gap Analysis

North Hollywood Operable Unit
Los Angeles County, California

Geologic Cross Section E-E'

FIGURE: **4-2e**

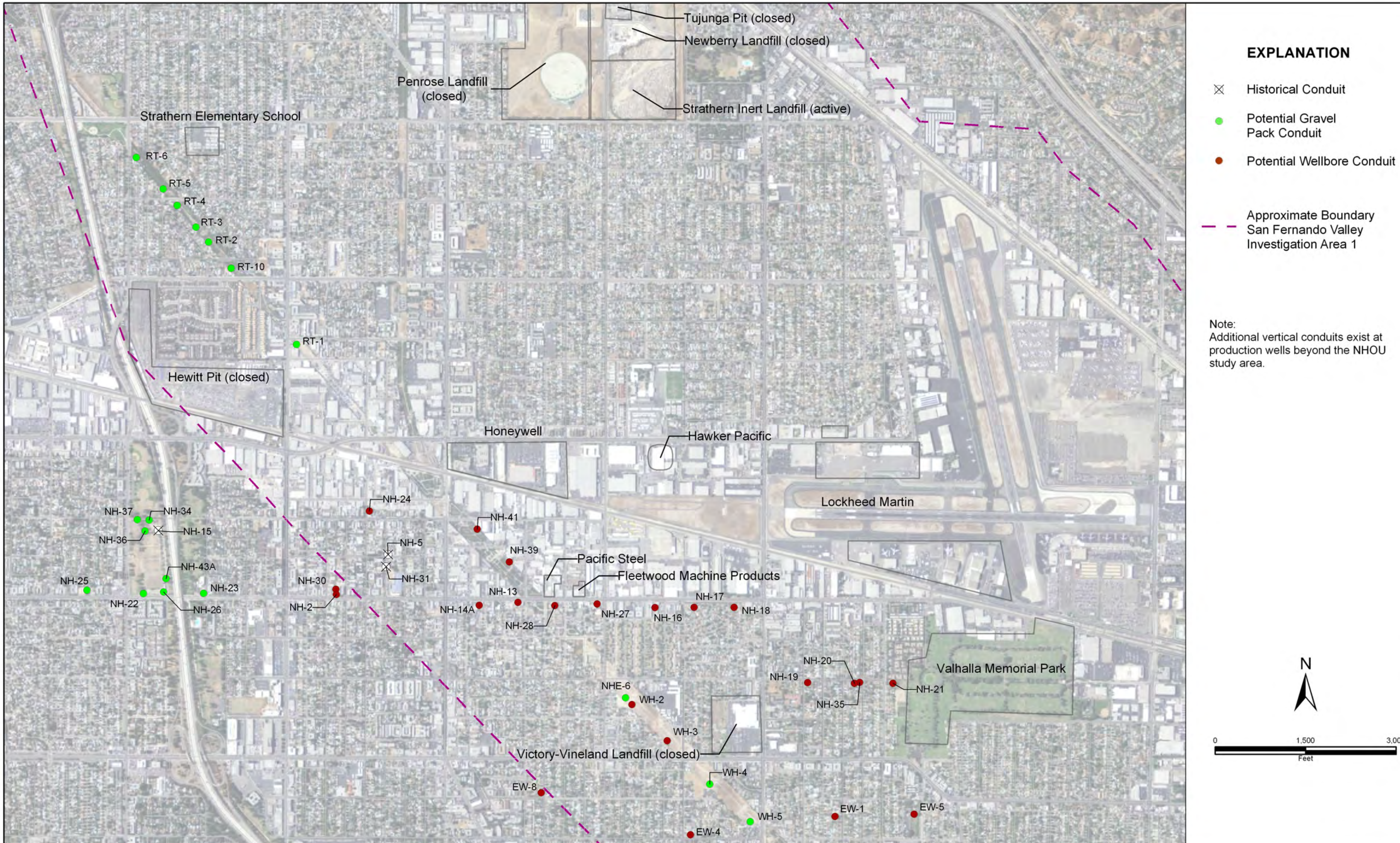
DRAWN:	PCB	PROJECT NO:	4088115718
REV:	00	SCALE:	AS SHOWN
CHECKED:	MJH	APPROVED:	MDT
DATE:	10/11	DATE:	10/11

Data Gap Analysis

North Hollywood Operable Unit
Los Angeles County, California

Geologic Cross Section F-F'

FIGURE:
4-2f



DRAWN: TJH	PROJECT NO: 4088115718	Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	Known Vertical Conduits
REV: 00	SCALE: AS SHOWN		FIGURE 4-3
CHECKED: MJH	APPROVED: MDT		
DATE: 9/2011	DATE: 9/2011		

amec

October 26, 2011 4:28:42 PM
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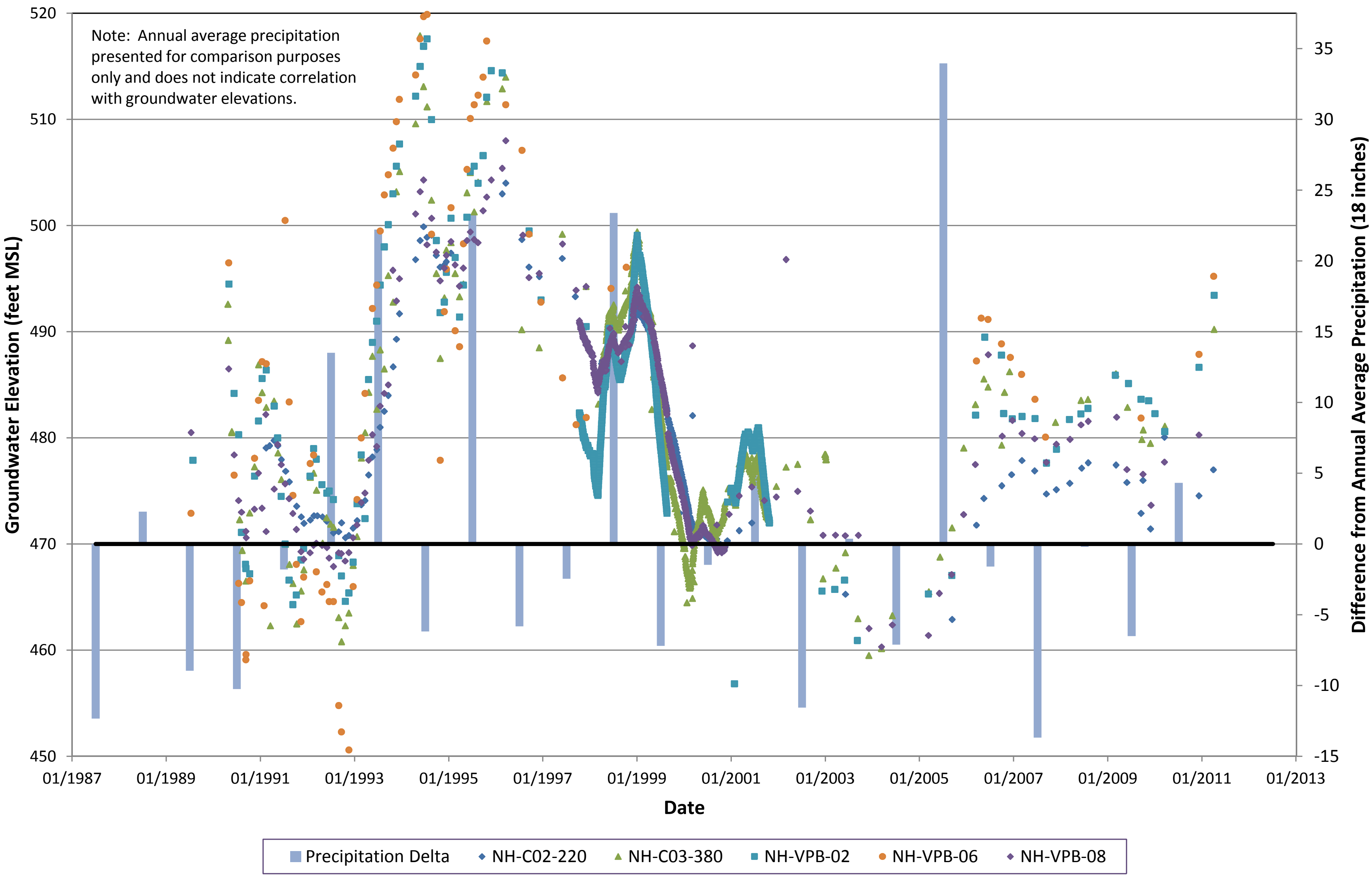

amec

Shallow Groundwater Elevation Hydrographs and Annual Precipitation
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **4-4**

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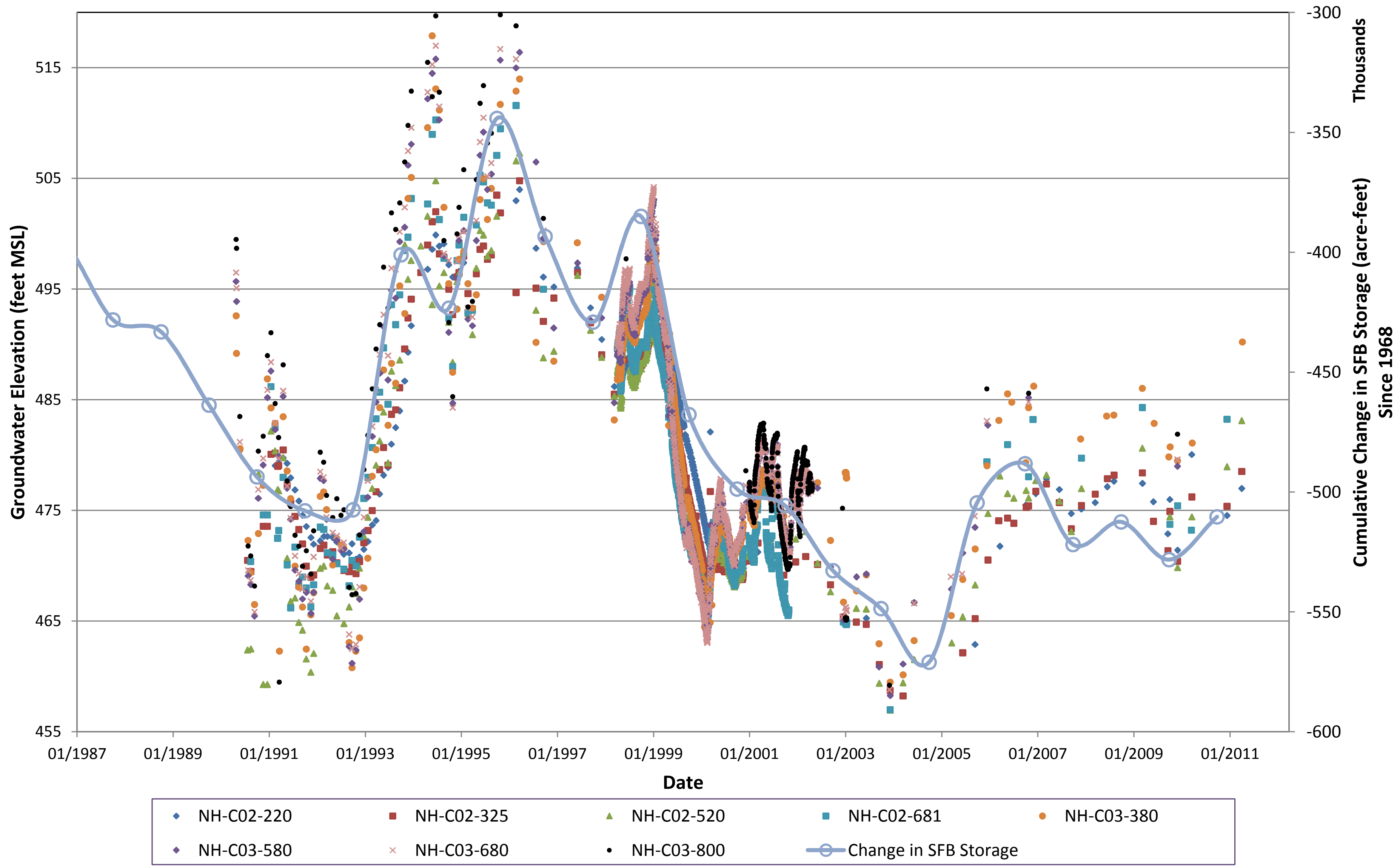

amec

Shallow and Deep Groundwater Elevation Hydrographs and SFB Storage
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **4-5**

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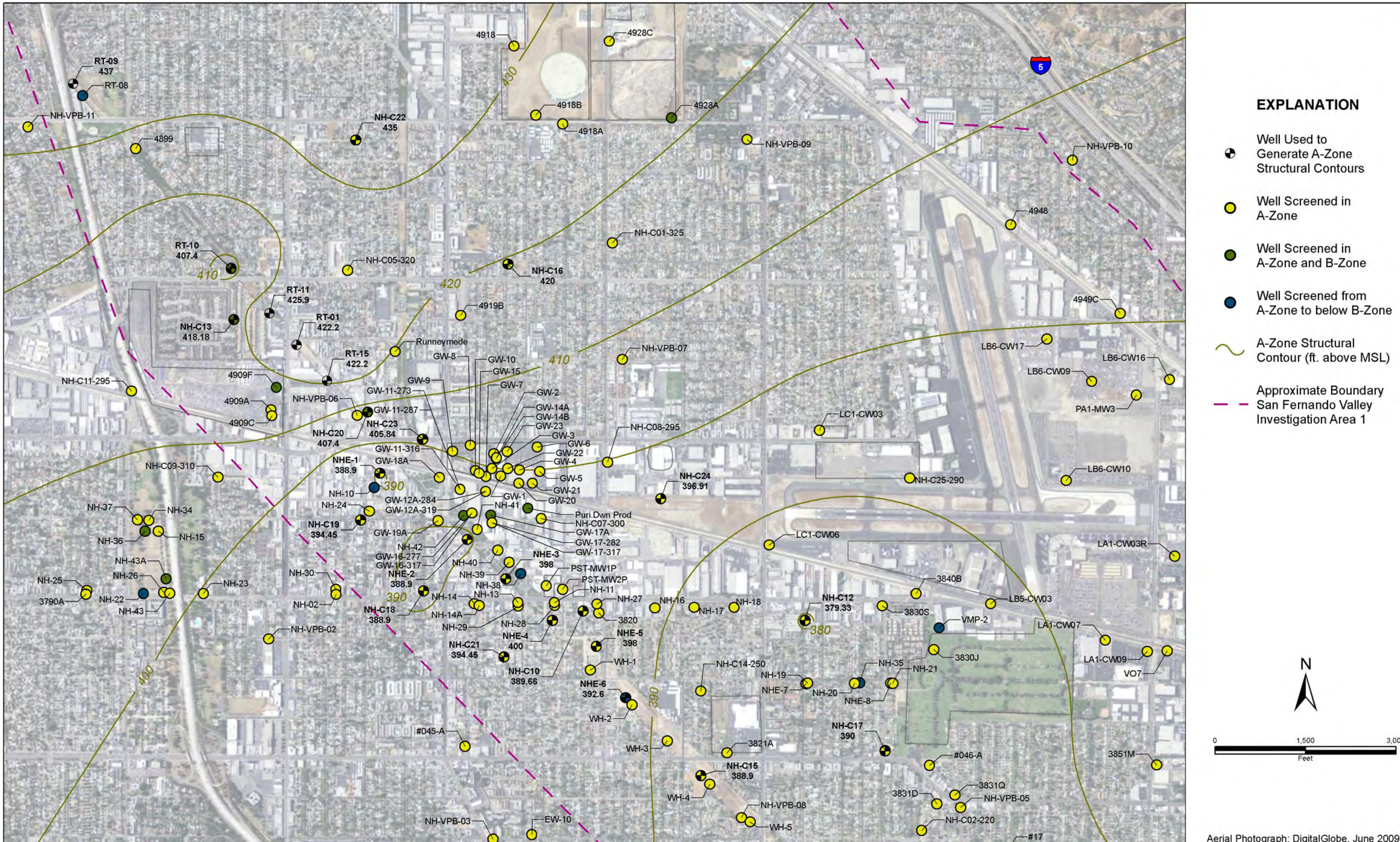
NAM	4088115718	SLC	10/2011



DRAWN: RJP	PROJECT NO: 4088115718
REV: 00	SCALE: AS SHOWN
CHECKED: MJH	APPROVED: MDT
DATE: 10/2011	DATE: 10/2011

amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Structural Contour Map
Base of the A-Zone

FIGURE
4-6

Tuesday, October 11, 2011 3:35:30 PM
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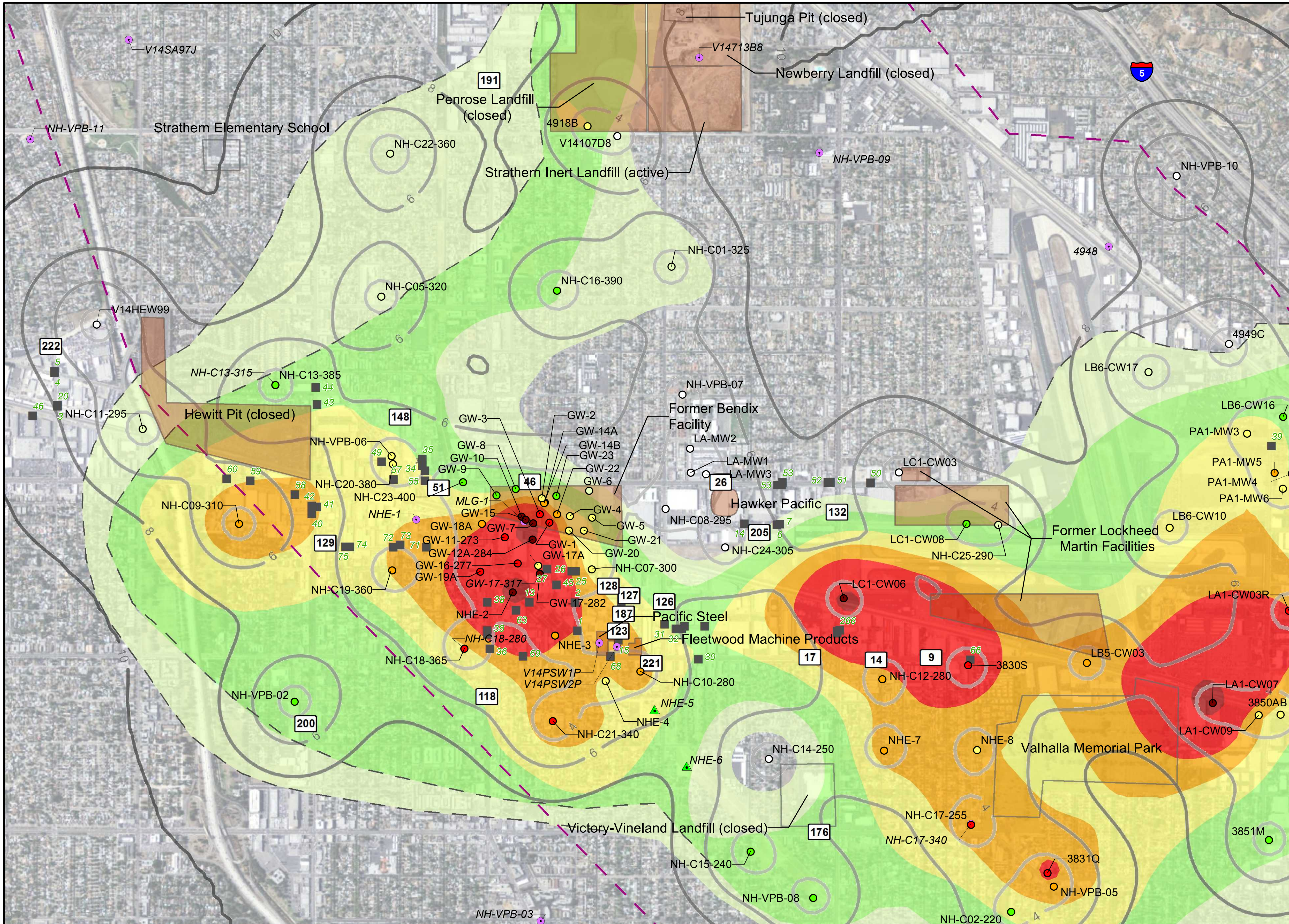

EXPLANATION

Well with Concentration (ug/L)

- <5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- 100 - 500
- >500

4948 Well without Sample Data Representative of A-Zone (Based on available data since 2007)

NHOU Extraction Well

Concentration Contours (ug/L)

- 5-10
- 10-25
- 25-50
- 50-100
- 100-500
- >500

Estimated Projected Contour Extent

Standard Deviation Contours (ug/L)

Approximate Boundary San Fernando Valley Investigation Area 1

Known and potential source properties are explained on Figure 3-8.

N

0 1,500 3,000 Feet

Aerial Photograph: DigitalGlobe, June 2009

DRAWN: TJH	PROJECT NO: 4088115718
REV: 00	SCALE: AS SHOWN
CHECKED: MJH	APPROVED: MDT
DATE: 10/2011	DATE: 10/2011

amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

TCE Distribution and Uncertainty
A-Zone
(Maximum Concentrations, 2007-2011)

FIGURE **4-7a**

October 6, 2011 10:31:10 AM
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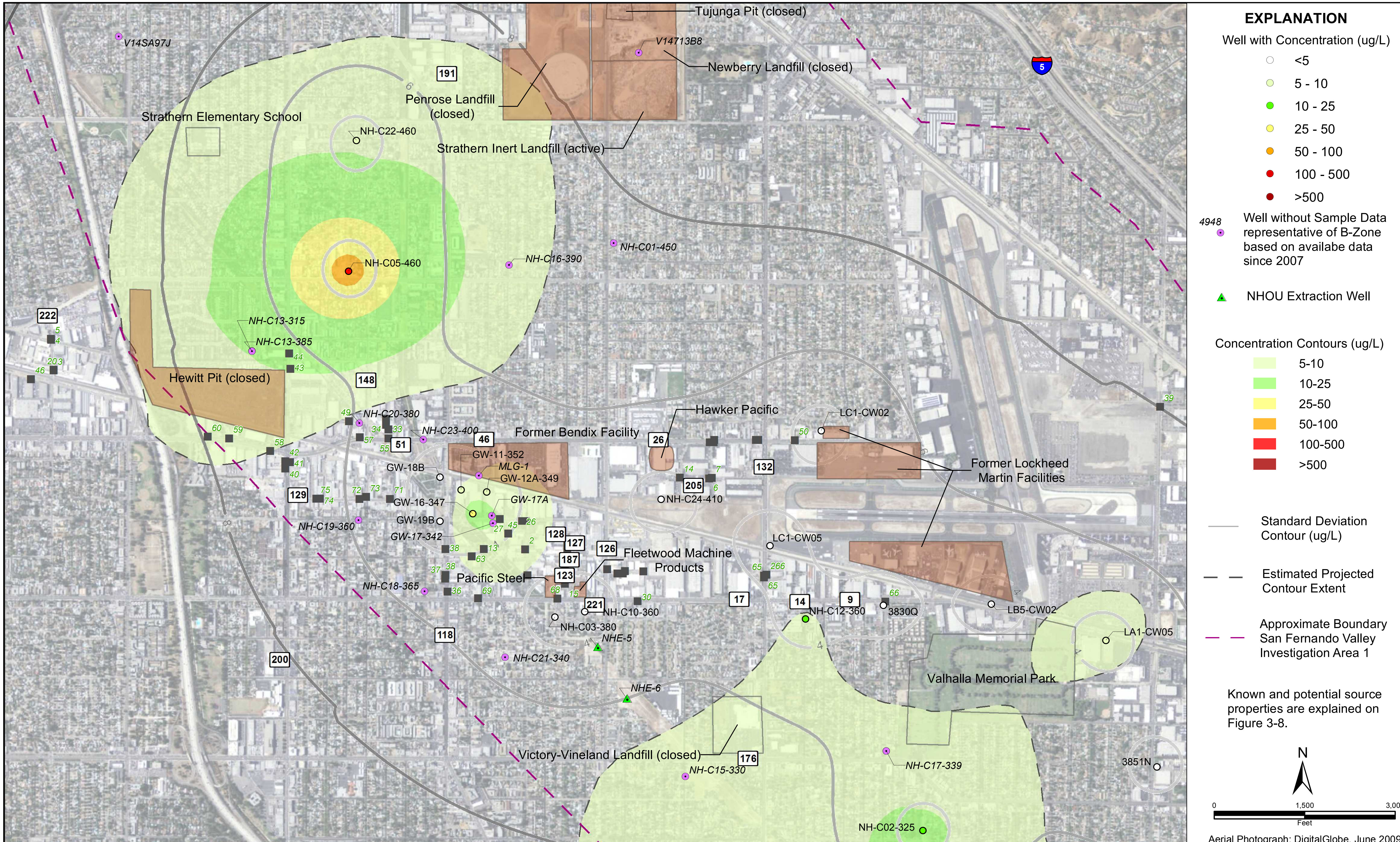


DRAWN: TJH	PROJECT NO: 4088115718
REV: 00	SCALE: AS SHOWN
CHECKED: MJH	APPROVED: MDT
DATE: 10/2011	DATE: 10/2011

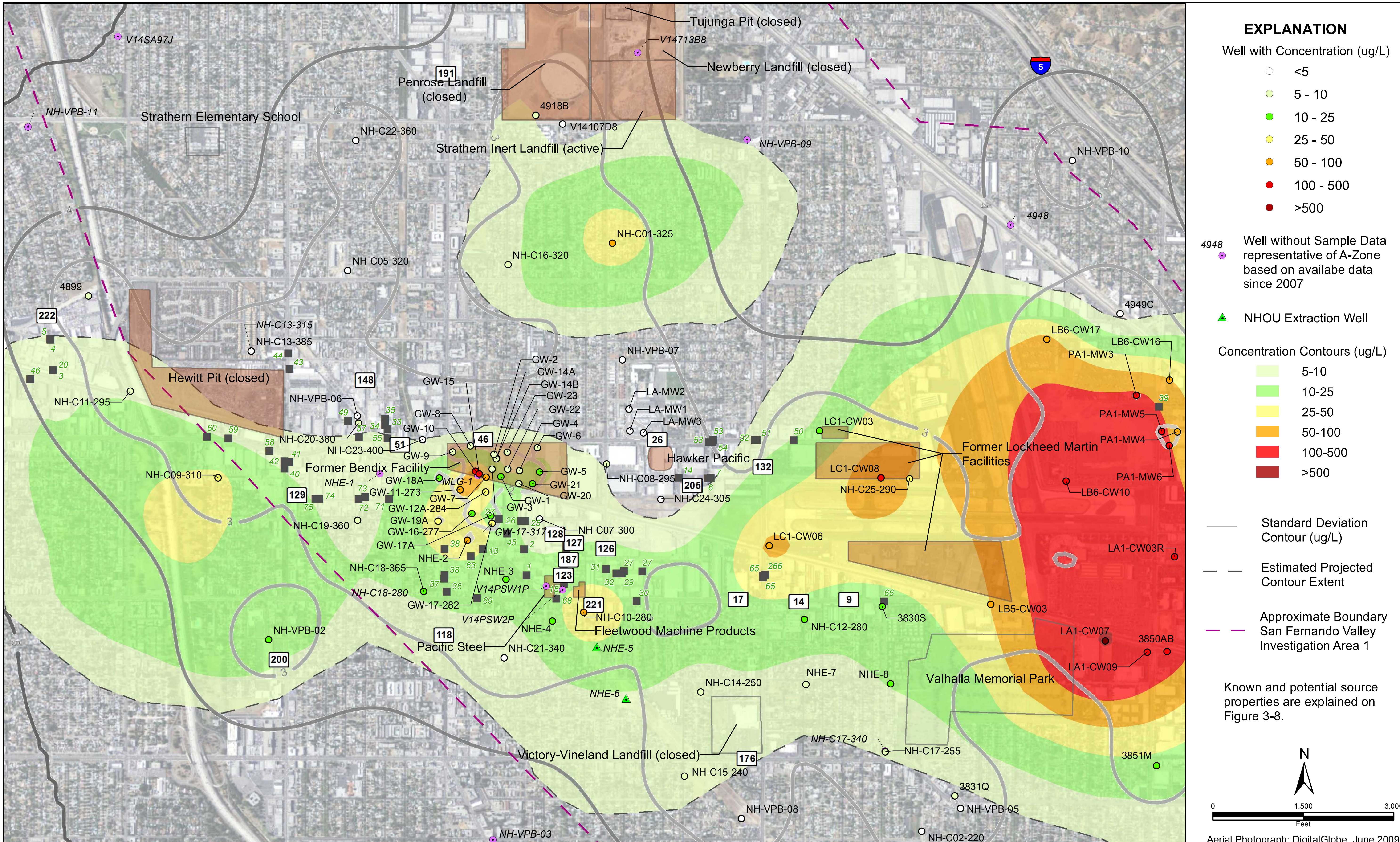
amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

TCE Distribution and Uncertainty
B-Zone
(Maximum Concentrations, 2007-2011)

FIGURE
4-7b

Wednesday, March 14, 2012 11:08:55 AM
P:\4088115718_NHOU\GIS\Projects\DataGapsAnalysis\Figure4-7b-TCE-B.mxd



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REV: 00	SCALE: AS SHOWN
CHECKED: MJH	APPROVED: MDT
DATE: 10/2011	DATE: 10/2011

amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

PCE Distribution and Uncertainty
A-Zone
(Maximum Concentrations, 2007-2011)

FIGURE
4-8a

Wednesday, March 14, 2012 11:18:40 AM
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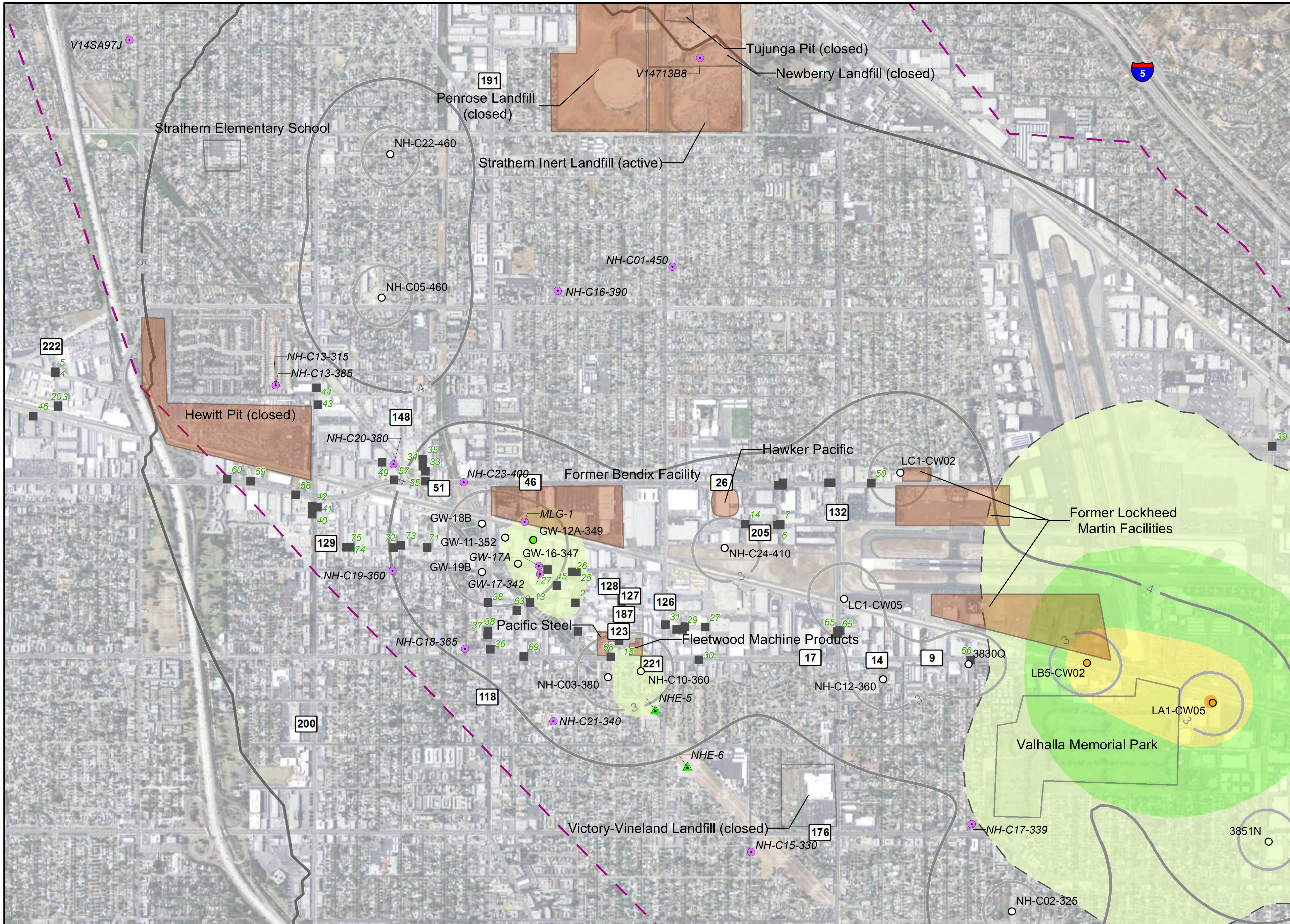

EXPLANATION

Well with Concentration (ug/L)

- <5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- 100 - 500
- >500

4948 Well without Sample Data Representative of B-Zone (Based on available data since 2007)

NHOU Extraction Well

Concentration Contours (ug/L)

- 5-10
- 10-25
- 25-50
- 50-100
- 100-500
- >500

Standard Deviation Contours (ug/L)

Estimated Projected Contour Extent

Approximate Boundary San Fernando Valley Investigation Area 1

Known and potential source properties are explained on Figure 3-8.

N

0 1,500 3,000 Feet

Aerial Photograph: DigitalGlobe, June 2009

DRAWN: TJH	PROJECT NO: 4088115718
ENGINEER:	SCALE: AS SHOWN
CHECKED:	APPROVED:
DATE: 10/2011	DATE:

amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

PCE Distribution and Uncertainty
B-Zone
(Maximum Concentrations, 2007-2011)

FIGURE **4-8b**

Wednesday, March 14, 2012 11:26:59 AM
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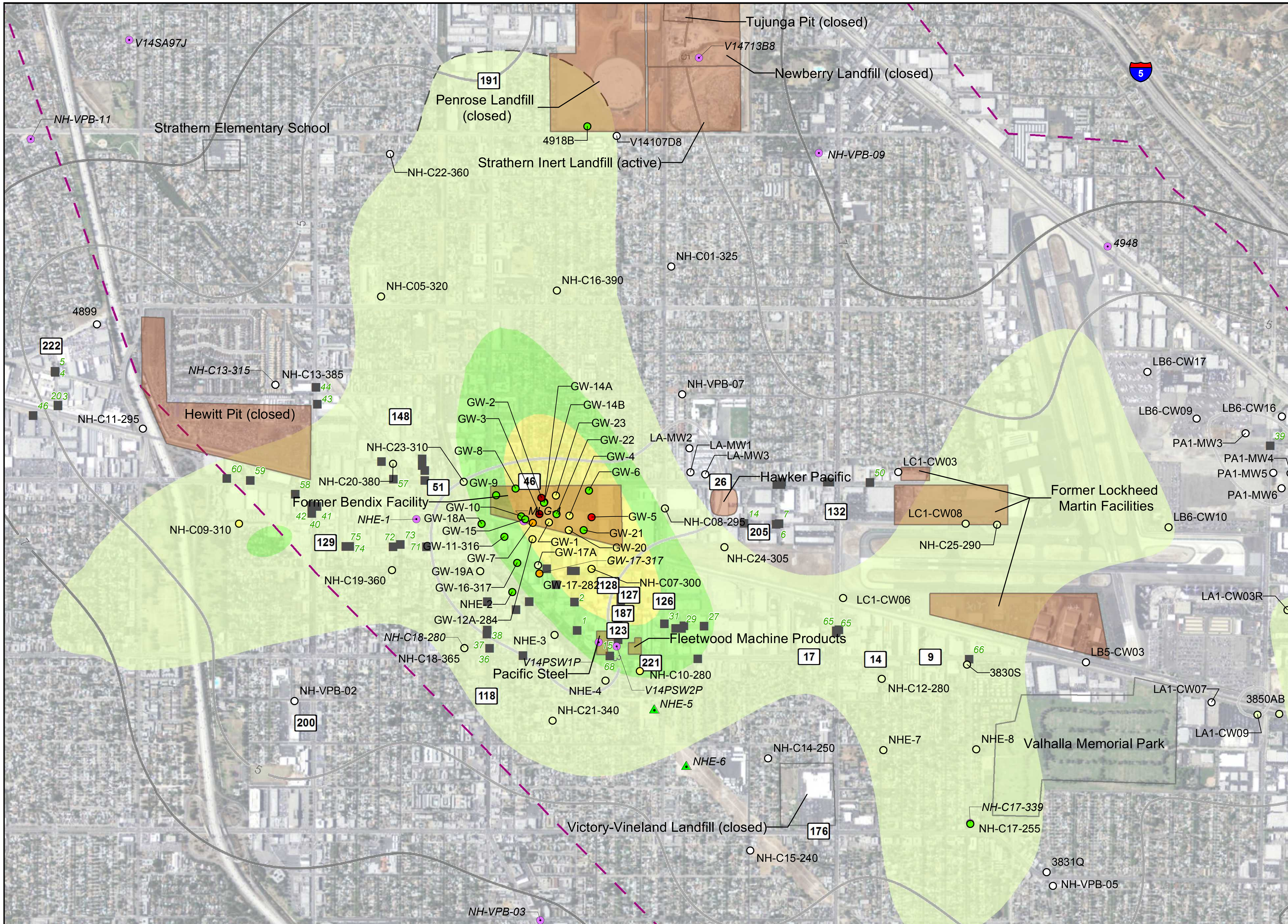

EXPLANATION

Well with Concentration (ug/L)

- <1
- 1 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- > 100

4948 — Well without Sample Data Representative of A-Zone (Based on available data since 2007)

NHOU Extraction Well

Concentration Contours (ug/L)

- 1-5
- 5-10
- 10-25
- 25-50

Standard Deviation Contour (ug/L)

Estimated Projected Contour Extent

Approximate Boundary San Fernando Valley Investigation Area 1

Known and potential source properties are explained on Figure 3-8.

N

0 1,500 3,000 Feet

Aerial Photograph: DigitalGlobe, June 2009

DRAWN: TJH	PROJECT NO: 4088115718
ENGINEER:	SCALE: AS SHOWN
CHECKED:	APPROVED:
DATE: 10/2011	DATE:

amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

1,4-Dioxane Distribution and Uncertainty , A-Zone (Maximum Concentrations, 2007-2011)

FIGURE 4-9a

Wednesday, March 14, 2012 11:28:21 AM
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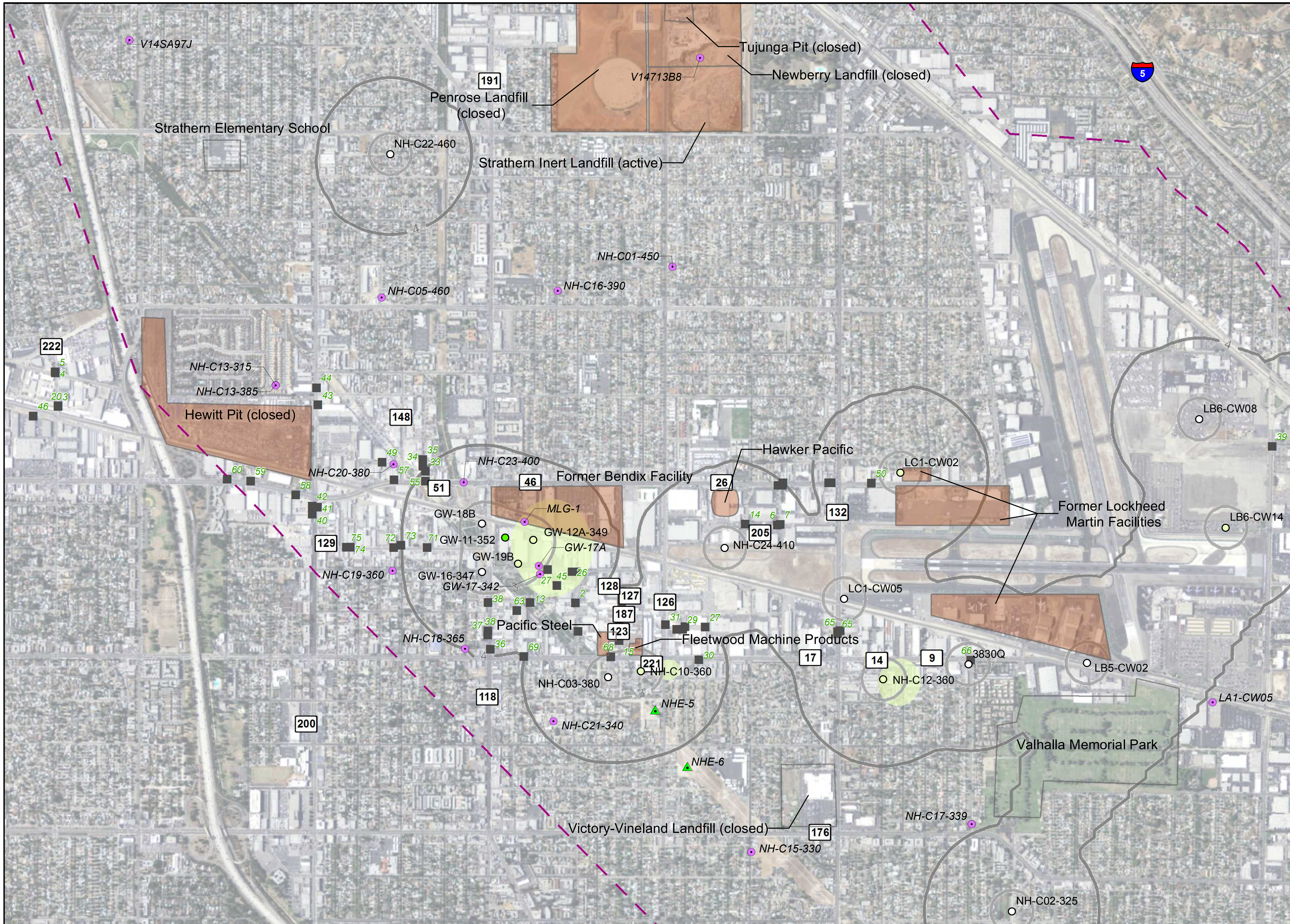

EXPLANATION

Well with Concentration (ug/L)

- <1
- 1 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- > 100

4948 Well without Sample Data Representative of B-Zone (Based on available data since 2007)

NHOU Extraction Well

Concentration Contours (ug/L)

- 1-5
- 5-10
- 10-25
- 25-50

Standard Deviation Contour (ug/L)

Approximate Boundary San Fernando Valley Investigation Area 1

Known and potential source properties are explained on Figure 3-8.

N

0 1,500 3,000 Feet

Aerial Photograph: DigitalGlobe, June 2009

DRAWN: TJH	PROJECT NO: 4088115718
ENGINEER:	SCALE: AS SHOWN
CHECKED:	APPROVED:
DATE: 8/2011	DATE:

amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

1,4-Dioxane Distribution and Uncertainty, B-Zone (Maximum Concentrations, 2007-2011)

FIGURE **4-9b**

Wednesday, March 14, 2012 11:30:45 AM
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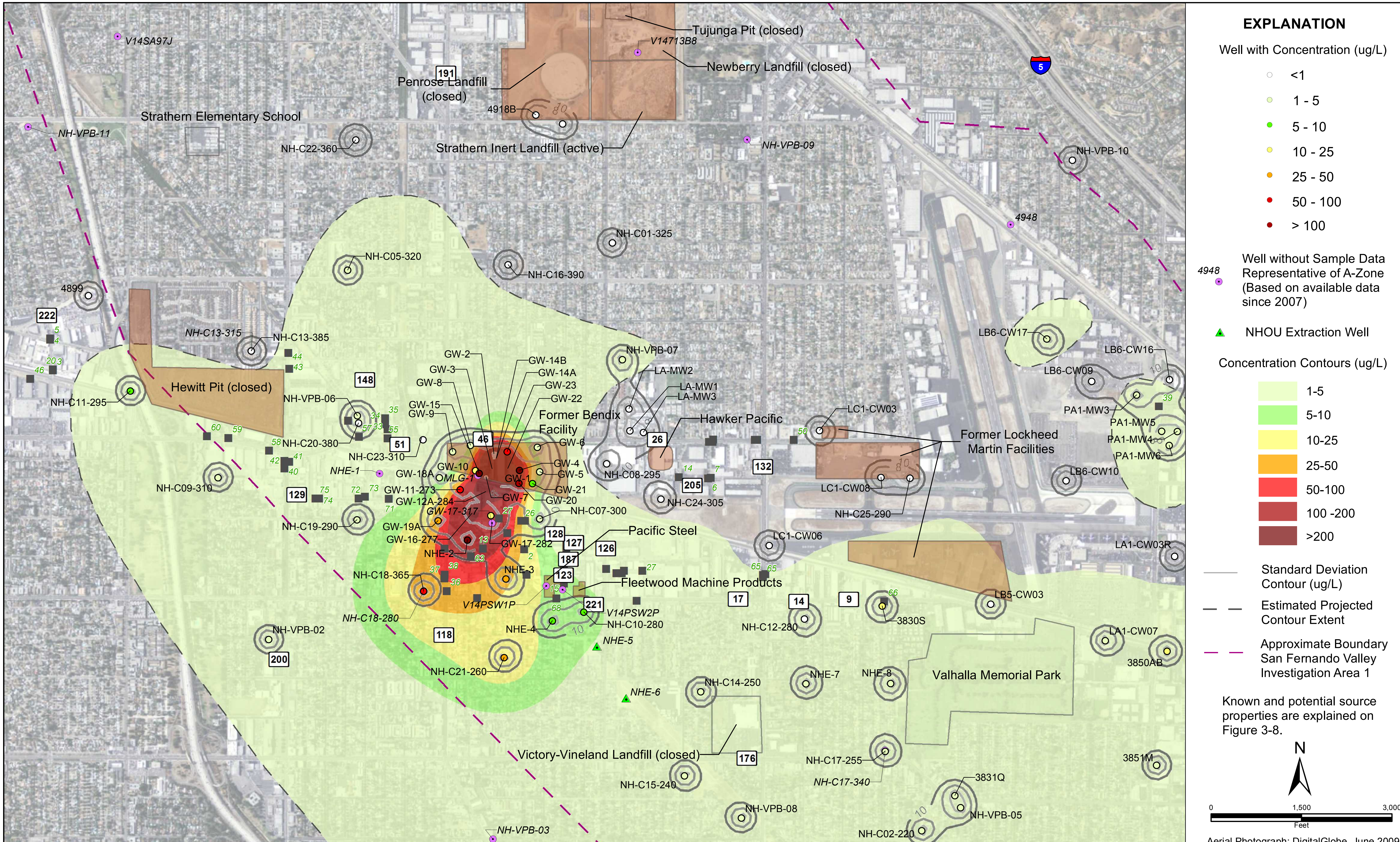

DRAWN: TJH	PROJECT NO: 4088115718		
ENGINEER:	SCALE: AS SHOWN		
CHECKED:	APPROVED:		
DATE: 10/2011	DATE:		

amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Hexavalent Chromium
Distribution and Uncertainty, A-Zone
(Maximum Concentrations, 2007-2011)

FIGURE
4-10a

Wednesday, March 14, 2012 11:32:10 AM
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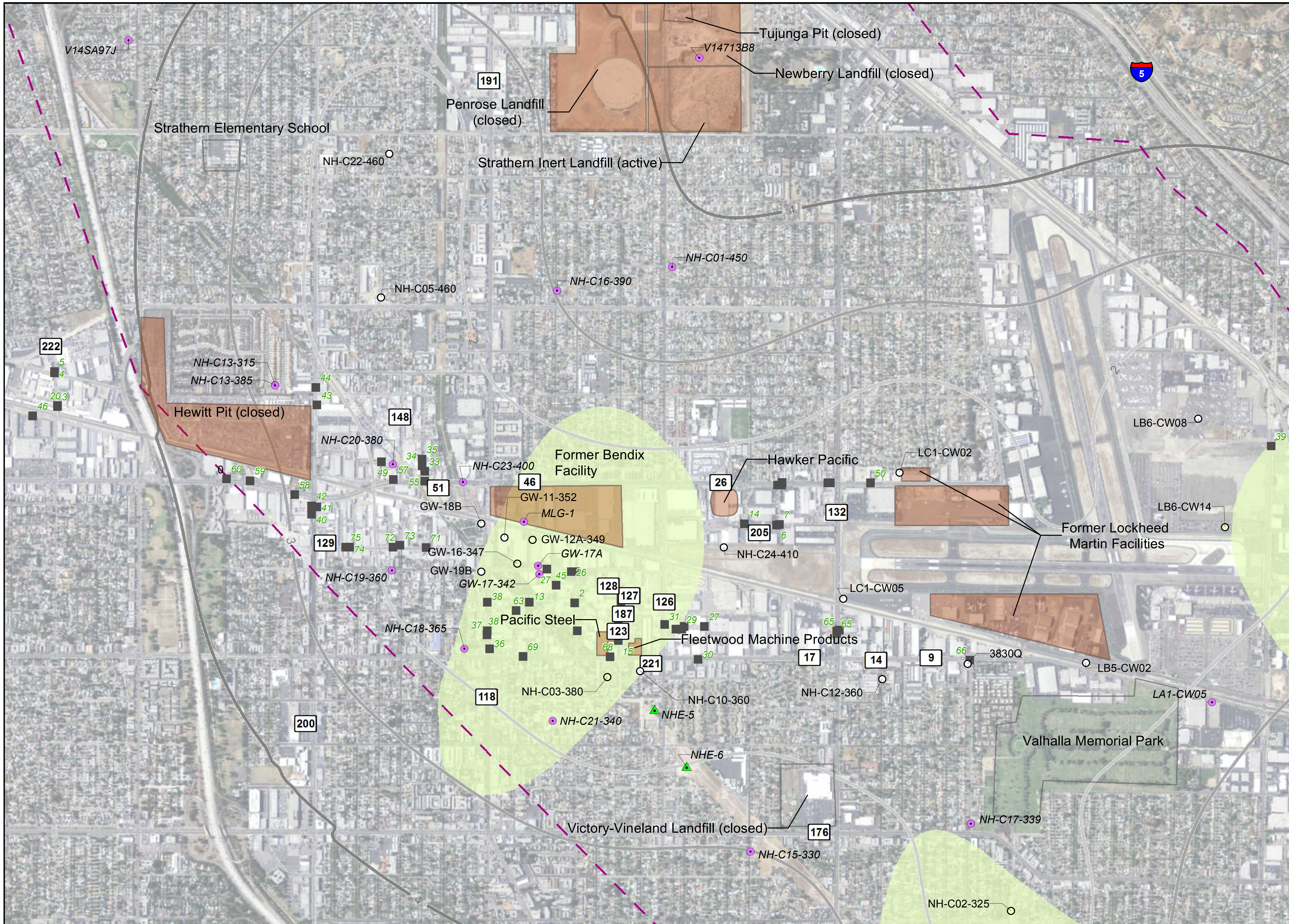

EXPLANATION

Well with Concentration (ug/L)

- <1
- 1 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- > 100

4948 Well without Sample Data Representative of B-Zone (Based on available data since 2007)

NHOU Extraction Well

Concentration Contours (ug/L)

- 1-5
- 5-10
- 10-25
- 25-50
- 50-100
- 100 -200
- >200

Standard Deviation Contour (ug/L)

Approximate Boundary San Fernando Valley Investigation Area 1

Known and potential source properties are explained on Figure 3-8.

N

0 1,500 3,000 Feet

Aerial Photograph: DigitalGlobe, June 2009

DRAWN: TJH	PROJECT NO: 4088115718
ENGINEER:	SCALE: AS SHOWN
CHECKED:	APPROVED:
DATE: 10/2011	DATE:

amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Hexavalent Chromium
Distribution and Uncertainty , B-Zone
(Maximum Concentrations, 2007-2011)

FIGURE
4-10b

Wednesday, March 14, 2012 11:42:52 AM
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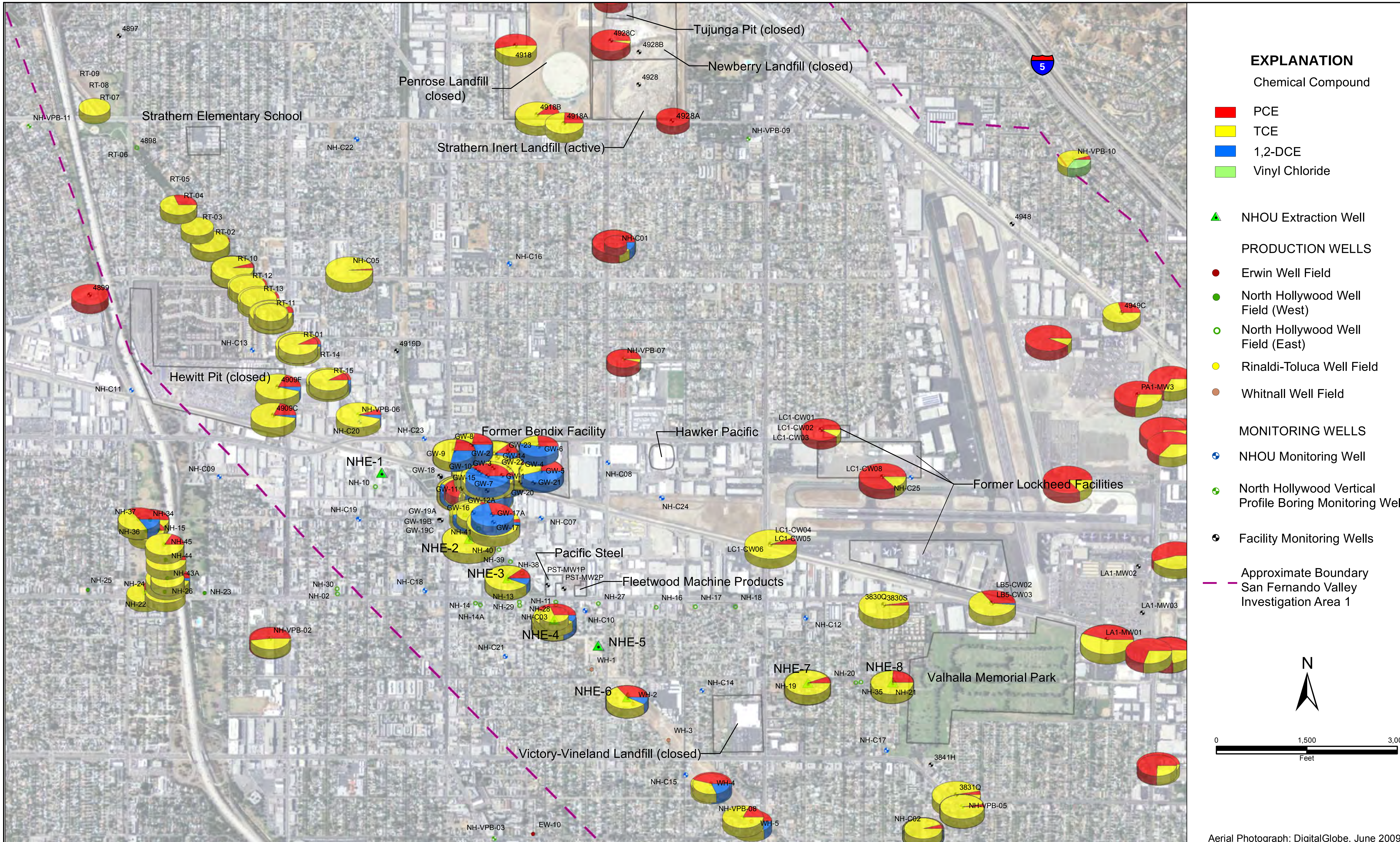

DRAWN: TJH	PROJECT NO: 4088115707		
ENGINEER:	SCALE: AS SHOWN		
CHECKED:	APPROVED:		
DATE: 10/2011	DATE:		

amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Groundwater Chemical Signatures
2007

FIGURE
4-11

October 11, 2011 4:00:54 PM
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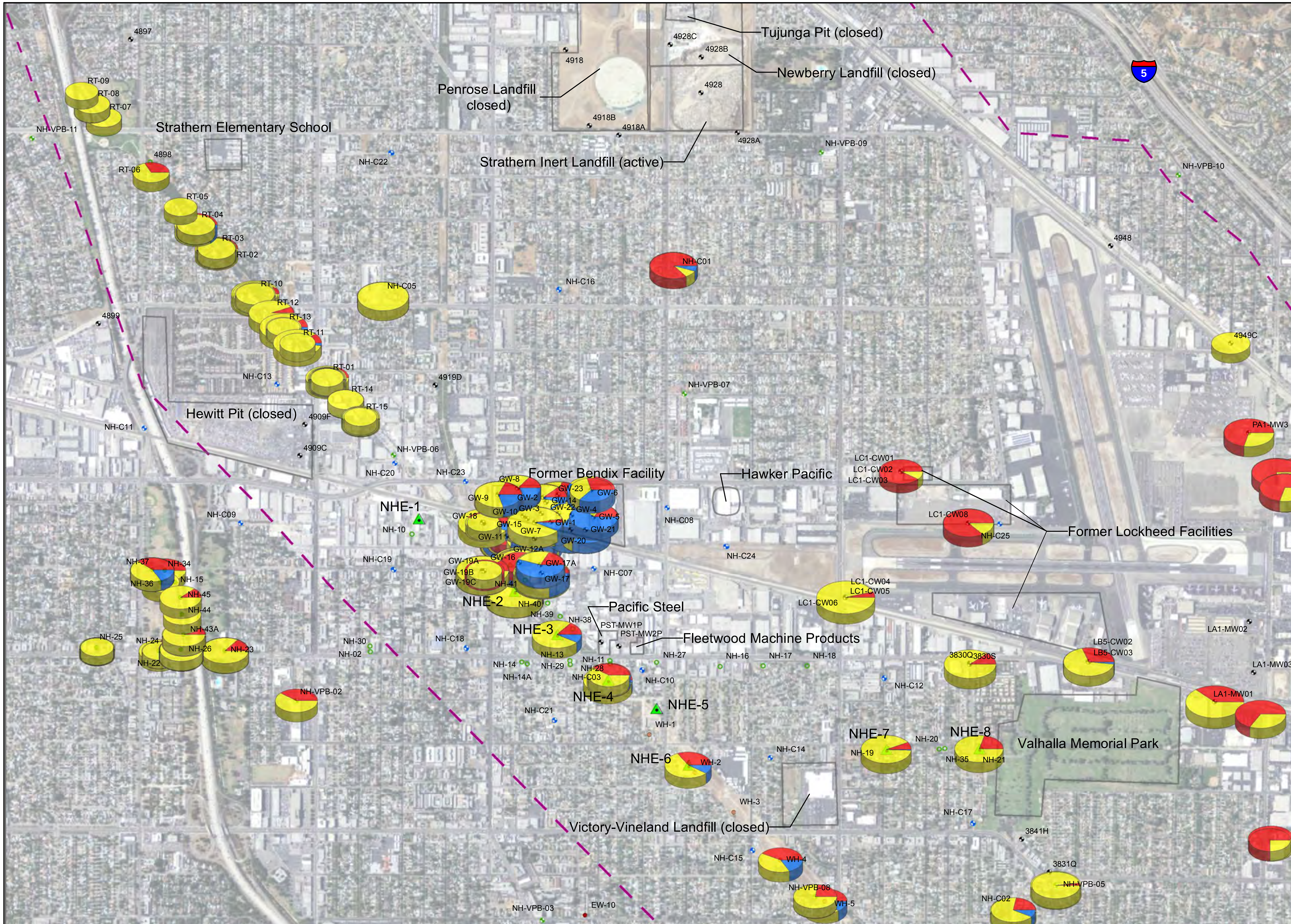

EXPLANATION

Chemical Compound

- PCE
- TCE
- 1,2-DCE
- Vinyl Chloride

NHOU Extraction Well

PRODUCTION WELLS

- Erwin Well Field
- North Hollywood Well Field (West)
- North Hollywood Well Field (East)
- Rinaldi-Toluca Well Field
- Whitnall Well Field

MONITORING WELLS

- NHOU Monitoring Well
- North Hollywood Vertical Profile Boring Monitoring Well
- Facility Monitoring Wells

Approximate Boundary San Fernando Valley Investigation Area 1

N

0 1,500 3,000 Feet

Aerial Photograph: DigitalGlobe, June 2009

DRAWN: TJH	PROJECT NO: 4088115707	amec	Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	Groundwater Chemical Signatures 2008	FIGURE 4-12
ENGINEER:	SCALE: AS SHOWN				
CHECKED:	APPROVED:				
DATE: 10/2011	DATE:				

October 28, 2011 3:50:17 PM
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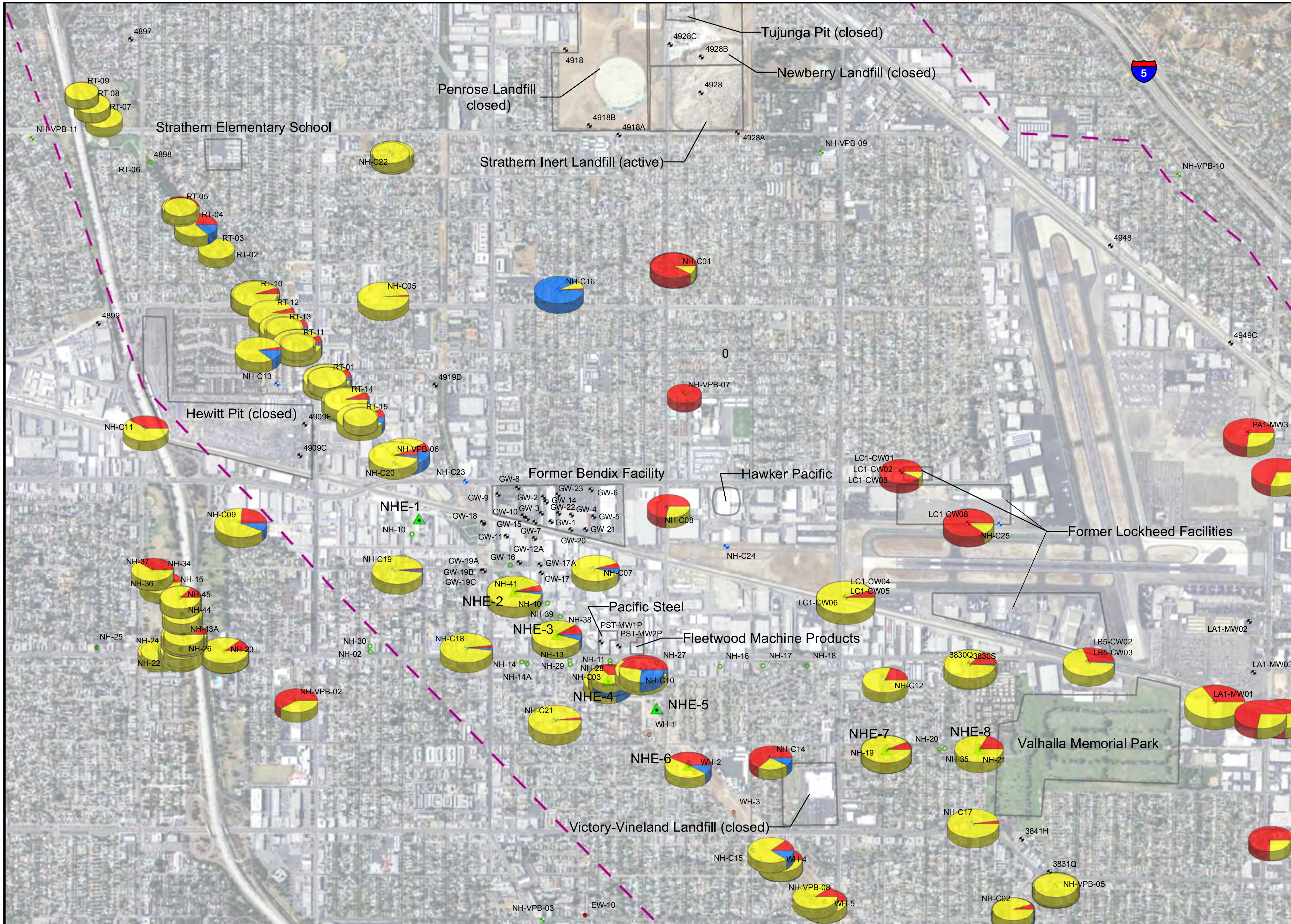

EXPLANATION

Chemical Compound

- PCE
- TCE
- 1,2-DCE
- Vinyl Chloride

- NHOU Extraction Well

PRODUCTION WELLS

- Erwin Well Field
- North Hollywood Well Field (West)
- North Hollywood Well Field (East)
- Rinaldi-Toluca Well Field
- Whitnall Well Field

MONITORING WELLS

- NHOU Monitoring Well
- North Hollywood Vertical Profile Boring Monitoring Well
- Facility Monitoring Wells

- Approximate Boundary San Fernando Valley Investigation Area 1

N

0 1,500 3,000
Feet

Aerial Photograph: DigitalGlobe, June 2009

DRAWN: TJH	PROJECT NO: 4088115707
ENGINEER:	SCALE: AS SHOWN
CHECKED:	APPROVED:
DATE: 10/2011	DATE:

amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Groundwater Chemical Signatures
2009

FIGURE
4-13

October 11, 2011 4:06:12 PM
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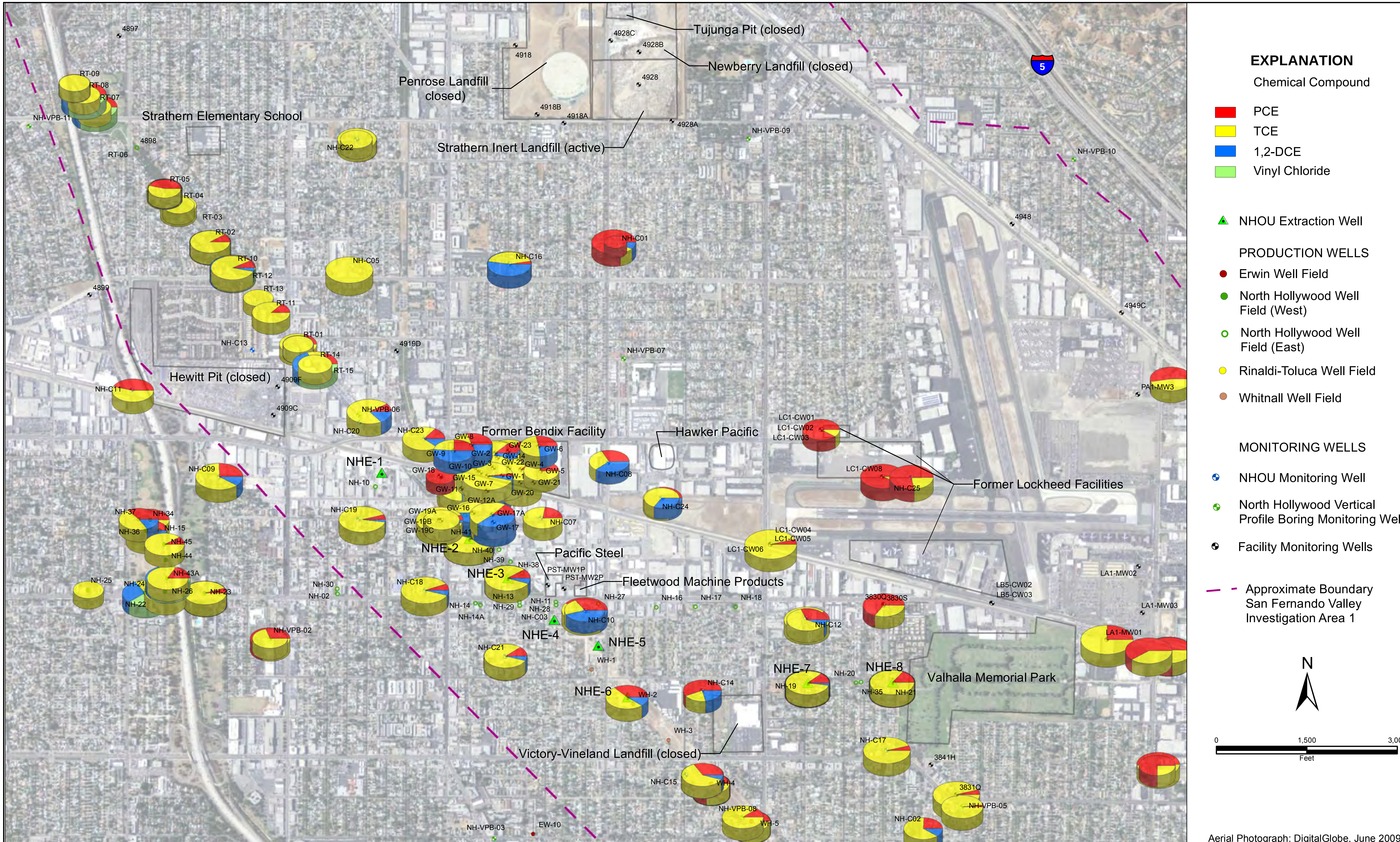

DRAWN: TJH	PROJECT NO: 4088115707	
ENGINEER:	SCALE: AS SHOWN	
CHECKED:	APPROVED:	
DATE: 10/2011	DATE:	

amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Groundwater Chemical Signatures
2010

FIGURE
4-14

October 11, 2011 4:08:30 PM
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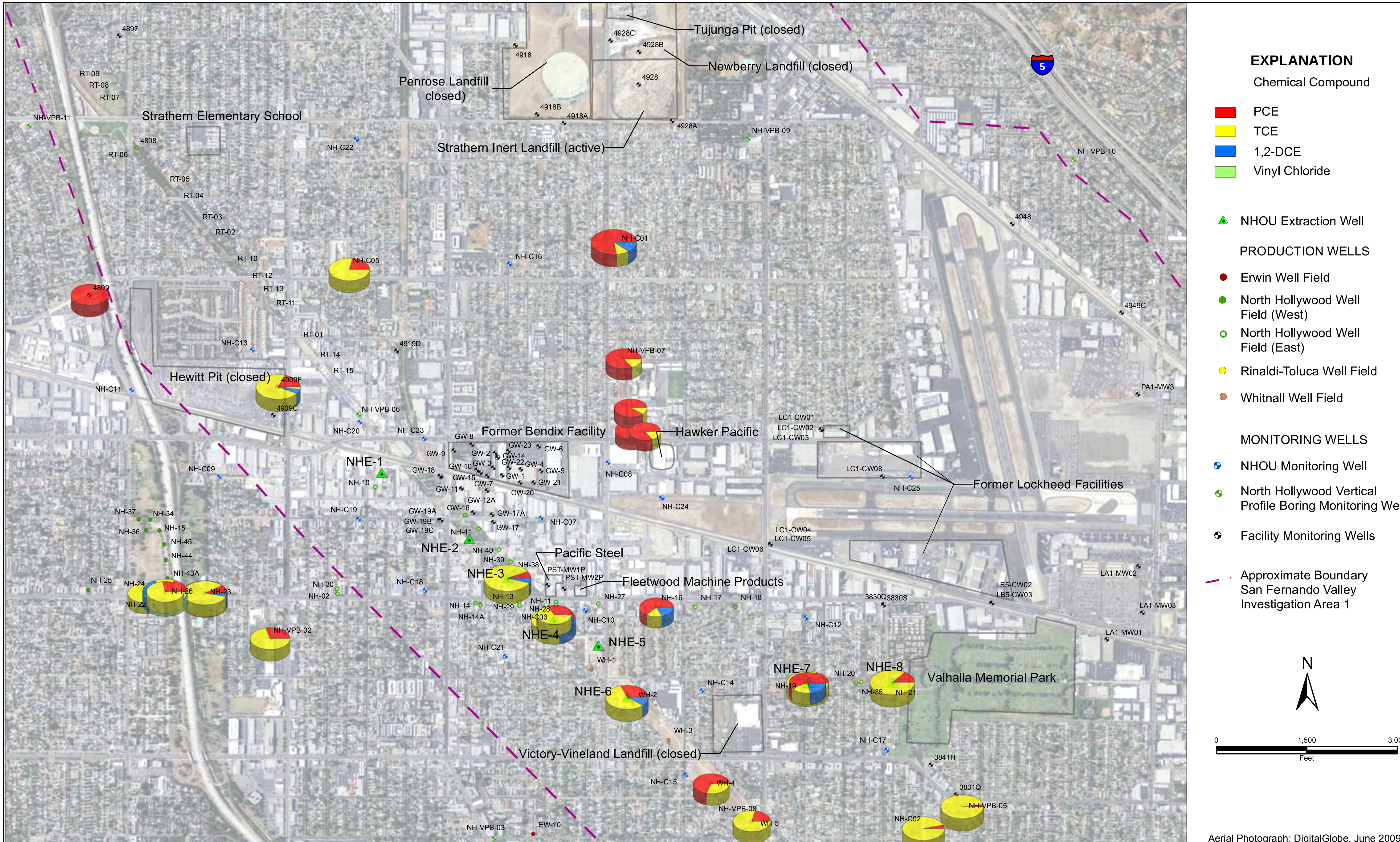

DRAWN: TJH	PROJECT NO: 4088115707	Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	Groundwater Chemical Signatures 2011
ENGINEER:	SCALE: AS SHOWN		
CHECKED:	APPROVED:		FIGURE 4-15
DATE: 10/2011	DATE:		

amec

October 11, 2011 4:11:04 PM
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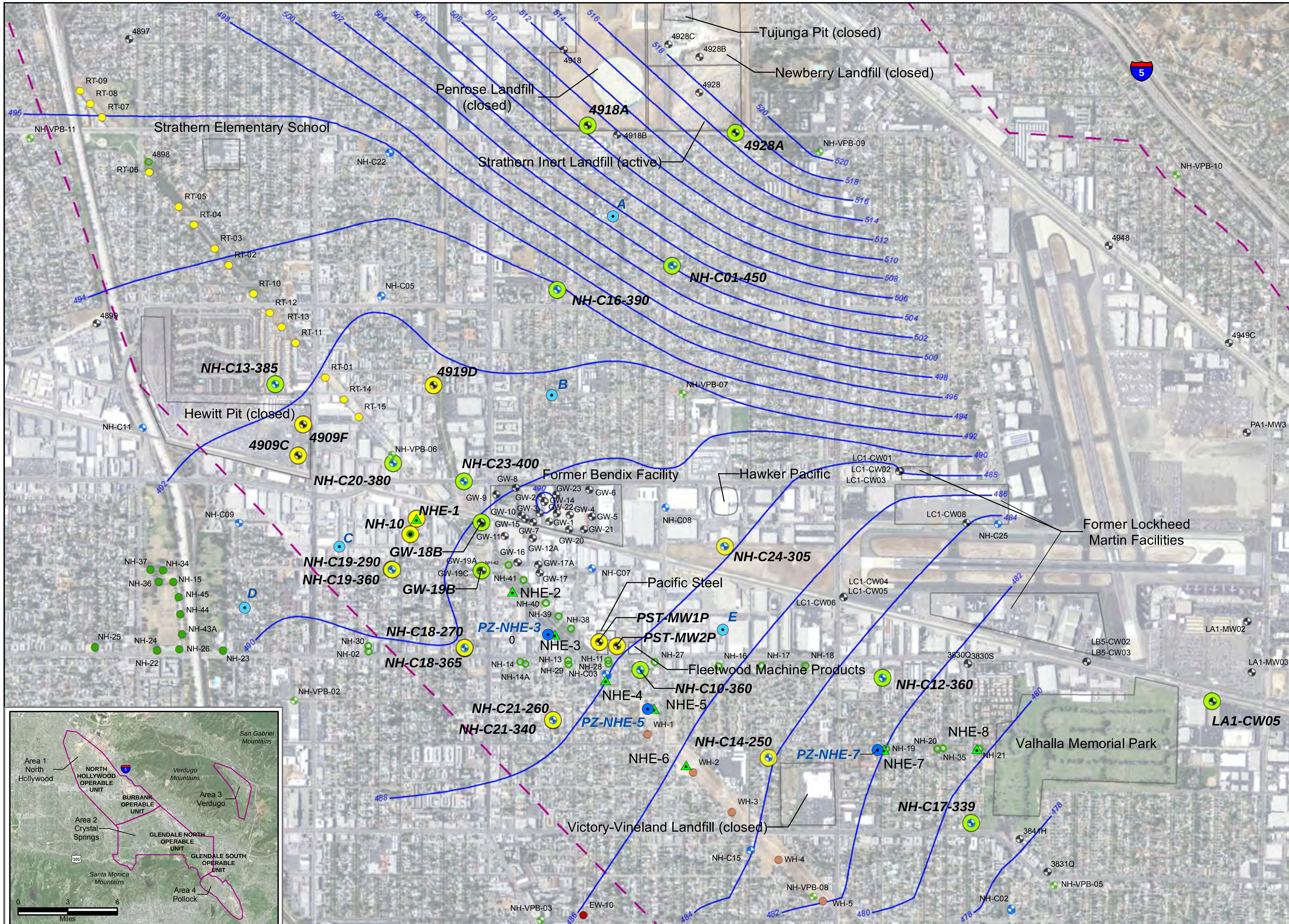

EXPLANATION

- Proposed Piezometer Couplet and Aquifer Test Location (Phase 1)
- A — Tentative Monitoring Well Couplet Location (Phase 2)

Depth-Discrete Sampling Locations

- A-Zone Well
- B-Zone Well
- NHOU Extraction Well

PRODUCTION WELLS

- Erwin Well Field
- North Hollywood Well Field (East)
- North Hollywood Well Field (West)
- Rinaldi-Toluca Well Field
- Whitnall Well Field

MONITORING WELLS

- NHOU Monitoring Well
- North Hollywood Vertical Profile Boring Monitoring Well
- Facility Monitoring Wells
- December 2010 Groundwater Elevation Contour, Ft. MSL
- Approximate Boundary San Fernando Valley Investigation Area 1

N

0 1,500 3,000 Feet

Aerial Photograph: DigitalGlobe, June 2009

DRAWN:	TJH	PROJECT NO:	4088115718
REV:	00	SCALE:	AS SHOWN
CHECKED:	MJH	APPROVED:	MDT
DATE:	3/2012	DATE:	3/2012

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Recommended Sampling and Well Installation Locations

FIGURE 6-1

Thursday, March 8, 2012 2:21:55 PM
P:\4088115718_NHOU\GIS\Projects\DataGapsAnalysis\Figure6-1-ProposedWells.mxd

TABLES

Table 3-2 Summary of Annual Precipitation in NHOU Area
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Water Year	Annual Total [a] (inches)	Delta Average [b] (inches)
1949/50	10.00	-8.00
1950/51	8.44	-9.56
1951/52	32.51	14.51
1952/53	10.28	-7.72
1953/54	13.14	-4.86
1954/55	14.14	-3.86
1955/56	16.21	-1.79
1956/57	12.83	-5.17
1957/58	23.81	5.81
1958/59	9.74	-8.26
1959/60	8.92	-9.08
1960/61	7.31	-10.69
1961/62	23.94	5.94
1962/63	11.16	-6.84
1963/64	8.93	-9.07
1964/65	13.74	-4.26
1965/66	22.96	4.96
1966/67	24.05	6.05
1967/68	16.67	-1.33
1968/69	30.68	12.68
1969/70	9.40	-8.60
1970/71	15.57	-2.43
1971/72	8.27	-9.73
1972/73	21.78	3.78
1973/74	17.48	-0.52
1974/75	14.73	-3.27
1975/76	10.53	-7.47
1976/77	15.32	-2.68
1977/78	38.22	20.22
1978/79	20.79	2.79
1979/80	31.28	13.28
1980/81	11.48	-6.52
1981/82	17.51	-0.49
1982/83	39.66	21.66
1983/84	9.31	-8.69
1984/85	12.11	-5.89
1985/86	22.21	4.21
1986/87	5.66	-12.34
1987/88	20.28	2.28
1988/89	9.05	-8.95
1989/90	7.76	-10.24
1990/91	16.21	-1.79
1991/92	31.51	13.51
1992/93	40.22	22.22
1993/94	11.83	-6.17
1994/95	41.31	23.31

Table 3-2 Summary of Annual Precipitation in NHOU Area
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Water Year	Annual Total [a] (inches)	Delta Average [b] (inches)
1995/96	12.19	-5.81
1996/97	15.54	-2.46
1997/98	41.40	23.40
1998/99	10.81	-7.19
1999/00	16.53	-1.47
2000/01	22.86	4.86
2001/02	6.44	-11.56
2002/03	18.38	0.38
2003/04	10.89	-7.11
2004/05	51.97	33.97
2005/06	16.41	-1.59
2006/07	4.32	-13.68
2007/08	17.81	-0.19
2008/09	11.49	-6.51
2009/10	22.32	4.32
Average Annual Precipitation [c]	18.00	

Footnotes:

[a] Annual precipitation measured from October 1 through September 30 and obtained from Los Angeles County Department of Public Works Rainfall stations 13B (North Hollywood-Blix) and 13C (North Hollywood-Lakeside).

[b] Delta average is the difference of the average annual precipitation from the annual precipitation.

[c] The average annual precipitation is the average annual precipitation from water years 1949/50 to 2009/10.

References:

Los Angeles County Department of Public Works, 2011. Rainfall stations 13B (North Hollywood -Blix) and 13C (North Hollywood-Lakeside).

Table 3-4 NHOU Study Area Well Construction Details
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Well Name	Year Completed	Top of Well Screen (feet bgs)	Bottom of Well Screen (feet bgs)	Assumed Representative Depth Region[1] Single Depth Region 1	2	3	4	Multiple Depth Regions 1,2	2,3	1,2,3	1,2,3,4	2,3,4	3,4	Assumed Representative Screen Zone A-Zone	B-Zone	Below B-Zone	ULARA Watermaster Geologic Unit L/J/K and Shallower	I	AA	BB	E/M	Blue Star	Q and Deeper
Clustered Monitoring Wells																							
NH-C01-325	1990	275	325	X										X			X	X					
NH-C01-450	1990	400	450		X									X	X			X		X			
NH-C01-660	1990	630	660			X										X						?	?
NH-C01-780	1990	740	780				X									X							X
NH-C02-220	1990	170	220	X										X			X	X					
NH-C02-325	1990	275	325		X										X					X			
NH-C02-520	1990	470	520			X										X						?	?
NH-C02-681	1990	641	681				X									X							X
NH-C03-380	1990	340	380		X										X					X			
NH-C03-580	1990	540	580			X										X						?	?
NH-C03-680	1990	640	680			X										X							X
NH-C03-800	1990	760	800				X									X							X
NH-C05-320	1990	270	320	X										X			X	X					
NH-C05-460	1990	390	460		X										X					X			
NH-C07-300	2009	240	300	X										X			X	X					
NH-C08-295	2009	245	295	X										X			X	X					
NH-C09-310	2009	250	310		X									X				X	X				
NH-C10-280	2009	220	280	X										X			X	X					
NH-C10-360	2009	310	360		X									X	X			X		X			
NH-C11-295	2009	235	295	X										X						X			
NH-C12-280	2009	210	280	X										X			X	X					
NH-C12-360	2009	310	360		X									X	X			X		X			
NH-C13-315	--	--	--	X										X			?	?	?	?	?	?	?
NH-C13-385	2009	335	385					X						X	X			X		?			
NH-C14-250	2009	200	250	X										X				X					
NH-C15-240	2009	180	240	X										X			?	?	?				
NH-C15-330	2009	270	330					X						X	X			?	?	?			
NH-C16-320	2009	250	300		X									X			X	X					
NH-C16-390	2009	340	390		X									X	X			X		X			
NH-C17-255	2009	185	255	X										X			X	X					
NH-C17-340	2009	280	340					X						X	X			X		X			
NH-C18-280	2009	220	280		X									X			X	X					
NH-C18-365	2009	305	365		X									X	X			X		X			
NH-C19-290	2009	230	290	X										X			X	X	X				
NH-C19-360	2009	300	360					X						X	X				X	X			
NH-C20-380	2009	320	380					X						X	X				X	X			
NH-C21-260	2009	210	260	X										X			X	X					
NH-C21-340	2009	280	340					X						X	X			X		X			
NH-C22-360	2009	300	360	X										X			X	X					
NH-C22-460	2009	390	460		X										X					X			
NH-C22-600	2009	550	600			X										X					X		
NH-C23-310	2009	250	310		X									X			X	X	X				
NH-C23-400	2009	340	400		X									X	X				X	X			
NH-C24-305	2009	245	305	X										X				?	?				
NH-C24-410	2009	360	410		X										X					?			
NH-C25-290	2009	240	290	X										X			?	?	?				
North Hollywood Vertical Profile Boring Monitoring Wells																							
NH-VPB-02	1989	242	262	X										X				?	?				
NH-VPB-03	1989	200	220	X										X			?	?	?				
NH-VPB-05	1989	185	205	X										X				X					
NH-VPB-06	1989	287	308	X										X					X				
NH-VPB-07	1989	271	291	X										X				X					
NH-VPB-08	1989	205	226	X										X			?	?	?				
NH-VPB-09	1989	271	291	X										X			?	?	?				
NH-VPB-10	1989	305	326	X										X			?	?	?				
NH-VPB-11	1989	301	321	X										X				X	X				

Table 3-4 NHOU Study Area Well Construction Details
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North Hollywood Operable Unit
Los Angeles County, California

Well Name	Year Completed	Top of Well Screen (feet bgs)	Bottom of Well Screen (feet bgs)	Assumed Representative Depth Region[1]										Assumed Representative Screen Zone			ULARA Watermaster Geologic Unit						
				Single Depth Region				Multiple Depth Regions															
				1	2	3	4	1,2	2,3	1,2,3	1,2,3,4	2,3,4	3,4	A-Zone	B-Zone	Below B-Zone	L/J/K and Shallower	I	AA	BB	E/M	Blue Star	Q and Deeper
North Hollywood Operable Unit Extraction Wells																							
NHE-1	1987	190	276	X										X			X	X					
NHE-2	1987	190	300	X										X			X	X					
NHE-3	1987	190	286	X										X			X	X					
NHE-4	1987	180	280	X										X			X	X					
NHE-5	1988	180	266	X										X			X	X					
NHE-6	1988	180	378							X				X	X	X	X	X		?	?		
NHE-7	1988	180	270	X										X			X	X					
NHE-8	1988	180	280	X										X			X	X					
Honeywell Monitoring Wells																							
GW-1	1991	245	305	X										X			?	?	?				
GW-2	1991	241	301	X										X			?	?	?				
GW-3	1991	245	305	X										X			?	?	?				
GW-4	1991	245	305	X										X			?	?	?				
GW-5	1991	248	308	X										X			?	?	?				
GW-6	1991	245	305	X										X			?	?	?				
GW-7	1993	230	310	X										X			?	?	?				
GW-8	1993	225	305	X										X			?	?	?				
GW-9	1993	223	303	X										X			?	?	?				
GW-10	1993	230	310	X										X			?	?	?				
GW-11-273	2005	273	279	X										X			?	?	?				
GW-11-287	2005	287	293	X										X			?	?	?				
GW-11-316	2005	316	322	X										X			?	?	?				
GW-11-352	2005	352	358		X										X					?			
GW-11-407	2005	407	713									X			X	X				?	?	?	?
GW-11-438	2005	438	444			X										X					?	?	?
GW-12A-284	2004	284	287	X										X			?	?	?				
GW-12A-319	2004	319	322	X										X			?	?	?				
GW-12A-349	2004	349	352		X										X					?			
GW-14A	--	255	285	X										X			?	?	?				
GW-14B	--	285	312	X										X			?	?	?				
GW-15	--	245	330					X						X			?	?	?				
GW-16-277	2005	277	283	X										X			?	?	?				
GW-16-317	2005	317	323					X						X			?	?	?				
GW-16-347	2005	347	353		X										X					?			
GW-16-417	2005	417	423						X							X					?	?	?
GW-16-507	2005	507	513			X										X					?	?	?
GW-16-558	2005	558	560			X										X					?	?	?
GW-17	2005	269.5	289.5	X										X			?	?	?	?	?	?	?
		309.5	329.5	X										X			?	?	?	?	?	?	?
		339.5	349.5	X										X			?	?	?	?	?	?	?
GW-17-282	2005	282	288	X										X			?	?	?				
GW-17-317	2005	317	323	X										X			?	?	?				
GW-17-342	2005	342	348		X										X					?			
GW-17A	2007	320	350					X						X	X		?	?	?	?			
GW-18A	2008	230	330					X						X			?	?	?				
GW-18B	2008	400	450						X						X	X				?	?	?	?
GW-18C	2008	480	500			X										X					?	?	?
GW-19A	2007	230	330					X						X			?	?	?				
GW-19B	2007	400	450						X						X	X				?	?	?	?
GW-19C	2007	480	500			X										X					?	?	?
GW-20	2008	245	315	X										X			?	?	?				
GW-21	2008	245	315	X										X			?	?	?				
GW-22	2008	245	315	X										X			?	?	?				
GW-23	2008	245	315	X										X			?	?	?				
MLG-1	--	--	--	X										X			?	?	?	?	?	?	?
Lockheed Martin Monitoring Wells																							
3830Q	--	--	--	X										X			?	?	?				
3830S	1992	218	258	X										X			?	?	?				
3831Q	--	--	--	X										X			?	?	?				

Table 3-4 NHOU Study Area Well Construction Details
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North Hollywood Operable Unit
Los Angeles County, California

Well Name	Year Completed	Top of Well Screen (feet bgs)	Bottom of Well Screen (feet bgs)	Assumed Representative Depth Region[1] Single Depth Region				Multiple Depth Regions						Assumed Representative Screen Zone			ULARA Watermaster Geologic Unit						
				1	2	3	4	1,2	2,3	1,2,3	1,2,3,4	2,3,4	3,4	A-Zone	B-Zone	Below B-Zone	L/J/K and Shallower	I	AA	BB	E/M	Blue Star	Q and Deeper
3851M	1990	165	215	X										X			?	?	?				
3851N	1991	305	325		X										X					?			
3851Q	--	--	--	X										X			?	?	?	?	?	?	?
3851X	--	--	--	X										X			?	?	?	?	?	?	?
3856T	--	--	--	X										X			?	?	?	?	?	?	?
4948	1989	0	247	X										X			?	?	?				
		247	297	X										X			?	?	?				
		297	302	X										X			?	?	?				
4949C	1989	222	272	X										X			?	?	?				
LA1-CW01	1988	540	605			X										X					?	?	?
LA1-CW03R	1990	--	--	X										X			?	?	?				
LA1-CW4A	--	--	--	X										X			?	?	?	?	?	?	?
LA1-CW05(A1-CW05)	1989	336	376		X										X	X				?	?	?	?
LA1-CW07(A1-CW07)	1989	174	224	X										X			?	?	?				
LA1-CW09(A1-CW09)	1992	187	227	X										X			?	?	?				
LB1-CW07	--	--	--	X										X			?	?	?	?	?	?	?
LB5-CW02	1988	340	350		X										X					?			
LB5-CW03	1988	211	231	X										X			?	?	?				
LB6-CW08	1988	361	374					X							X					?			
LB6-CW09	1988	242	263	X										X			?	?	?				
LB6-CW10	1989	204	259	X										X			?	?	?				
LB6-CW14	1989	325	370					X							X					?			
LB6-CW16	1991	210	260	X										X			?	?	?				
LB6-CW17	--	--	--	X										X			?	?	?				
LC1-CW01(C1-CW01)	1988	481	575			X										X					?	?	?
LC1-CW02(C1-CW02)	1988	382	392		X										X					?			
LC1-CW03(C1-CW03)	1988	259	280	X										X			?	?	?				
LC1-CW04(C1-CW04)	1988	652	665			X										X					?	?	?
LC1-CW05(C1-CW05)	1988	376	391		X										X					?			
LC1-CW06(C1-CW06)	1988	232	252	X										X			?	?	?				
LC1-CW08(C1-CW08)	--	--	--	X										X			?	?	?				
MW-V06	--	--	--	X										X			?	?	?	?	?	?	?
OW-V06	--	--	--	X										X			?	?	?	?	?	?	?
OW-V07	--	--	--	X										X			?	?	?	?	?	?	?
Erwin Production Well Field																							
EW-10	1953	204	214	X										X			?	?	?				
		270	303		X									X	X		?	?	?	?			
		355	380			X									X	X				?	?	?	?
		425	446			X										X					?	?	?
		477	491			X										X					?	?	?
		522	542			X										X					?	?	?
		555	600			X										X					?	?	?
North Hollywood Production Well Field																							
NH-02	1924	105	135	X										X			?	?	?				
		172	276	X										X			?	?	?				
		282	309					X						X			?	?	?				
		318	374		X										X					?			
NH-10	1924	160	535							X				X	X	X	?	?	?	?	?	?	?
NH-11	1925	108	261	X										X			?	?	?				
		303	396					X						X	X	X	?	?	?	?	?	?	?
NH-13	1925	110	225	X										X			?	?	?				
		245	302	X										X			?	?	?				
		327	392		X										X					?			
NH-14	1925	110	149	X										X			?	?	?				
NH-14A	1947	120	149	X										X			?	?	?				
		155	181	X										X			?	?	?				
		185	214	X										X			?	?	?				
		220	265	X										X			?	?	?				
		320	387		X									X	X		?	?	?	?			

Table 3-4 NHOU Study Area Well Construction Details
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Los Angeles County, California

Well Name	Year Completed	Top of Well Screen (feet bgs)	Bottom of Well Screen (feet bgs)	Assumed Representative Depth Region[1]										Assumed Representative Screen Zone			ULARA Watermaster Geologic Unit						
				Single Depth Region				Multiple Depth Regions						A-Zone	B-Zone	Below B-Zone	L/J/K and Shallower	I	AA	BB	E/M	Blue Star	Q and Deeper
				1	2	3	4	1,2	2,3	1,2,3	1,2,3,4	2,3,4	3,4										
NH-15	1926	126	136	X										X			?	?	?				
		210	267	X										X			?	?	?				
		284	306	X										X			?	?	?				
		315	368		X									X	X		?	?	?	?			
		434	460			X										X					?	?	?
NH-16	1929	144	168	X										X			?	?	?				
		168	236	X										X			?	?	?				
		315	400						X						X	X				?	?	?	?
NH-17	1929	145	185	X										X			?	?	?				
		230	273	X										X			?	?	?				
		287	406							X				X	X	X	?	?	?	?	?	?	?
NH-18	1929	145	197	X										X			?	?	?				
		197	265	X										X			?	?	?				
		308	401						X					X	X	X	?	?	?	?	?	?	?
NH-19	1930	145	268	X										X			?	?	?				
		308	388		X										X	X				?	?	?	?
NH-20	1930	146	241	X										X			?	?	?				
		252	270	X										X			?	?	?				
		308	408						X						X	X				?	?	?	?
NH-21	1930	149	173	X										X			?	?	?				
		197	280	X										X			?	?	?				
		311	394		X										X	X				?	?	?	?
NH-22	1948	166	460							X				X	X	X	?	?	?	?	?	?	?
NH-23	1951	222	298	X										X			?	?	?				
		298	267					X						X	X		?	?	?	?			
		432	460			X										X					?	?	?
NH-24	1954	206	246	X										X			?	?	?				
		260	283	X										X			?	?	?				
		318	338					X						X			?	?	?				
		338	410		X									X	X	X	?	?	?	?	?	?	?
		464	508			X										X					?	?	?
		514	534			X										X					?	?	?
NH-25	1958	160	187	X										X			?	?	?				
		198	340					X						X	X		?	?	?	?			
		348	376		X										X					?			
		412	445			X										X					?	?	?
		465	540			X										X					?	?	?
NH-26	1959	220	262	X										X			?	?	?				
		275	370					X						X	X		?	?	?	?			
		418	452			X										X					?	?	?
		507	555			X										X					?	?	?
NH-27	1959	210	220	X										X			?	?	?				
		240	250	X										X			?	?	?				
		252	262	X										X			?	?	?				
		312	334		X									X	X		?	?	?	?			
		334	340		X										X					?			
		360	378		X										X					?			
		460	466			X										X					?	?	?
		483	490			X										X					?	?	?
		518	560			X										X					?	?	?
		595	608			X										X					?	?	?
		608	560			X										X					?	?	?
		696	708				X									X					?	?	?
		712	742				X									X					?	?	?
NH-28	1962	250	258	X										X			?	?	?				
		292	392					X						X	X	X	?	?	?	?	?	?	?
		535	607			X										X					?	?	?
		631	660			X										X					?	?	?
		710	760				X									X					?	?	?

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North Hollywood Operable Unit
Los Angeles County, California

Well Name	Year Completed	Top of Well Screen (feet bgs)	Bottom of Well Screen (feet bgs)	Assumed Representative Depth Region[1]										Assumed Representative Screen Zone			ULARA Watermaster Geologic Unit						
				Single Depth Region				Multiple Depth Regions						A-Zone	B-Zone	Below B-Zone	L/J/K and Shallower	I	AA	BB	E/M	Blue Star	Q and Deeper
				1	2	3	4	1,2	2,3	1,2,3	1,2,3,4	2,3,4	3,4										
NH-29	1962	215	254	X										X			?	?	?				
		315	371		X									X	X		?	?	?	?			
		415	434			X										X					?	?	?
		490	502			X										X					?	?	?
		562	622			X										X					?	?	?
		655	664			X										X					?	?	?
NH-30	1962	255	275	X										X			?	?	?				
		318	390		X									X	X		?	?	?	?			
		573	583			X										X					?	?	?
		645	676										X			X					?	?	?
NH-34	1964	202	263	X										X			?	?	?				
		280	290	X										X			?	?	?				
		308	398					X						X	X		?	?	?	?			
		430	462			X										X					?	?	?
		494	505			X										X					?	?	?
		510	561			X										X					?	?	?
		563	574			X										X					?	?	?
		608	642			X										X					?	?	?
		675	720				X									X					?	?	?
NH-35	1967	260	400					X						X	X	X	?	?	?	?	?	?	?
		573	600			X										X					?	?	?
		660	695										X			X					?	?	?
NH-36	1967	265	370					X						X	X		?	?	?	?			
		432	462			X										X					?	?	?
		502	648										X			X					?	?	?
		700	720				X									X					?	?	?
NH-37	1968	230	260	X										X			?	?	?				
		278	390					X						X	X		?	?	?	?			
		430	460			X										X					?	?	?
		505	550			X										X					?	?	?
		620	640			X										X					?	?	?
		700	720				X									X					?	?	?
		850	860				X									X					?	?	?
		875	910				X									X					?	?	?
NH-38	1968	300	426							X				X	X	X	?	?	?	?	?	?	?
		473	510			X										X					?	?	?
		565	625			X										X					?	?	?
		650	692										X			X					?	?	?
		736	798				X									X					?	?	?
NH-39	1969	300	305	X										X			?	?	?				
		333	395		X										X					?			
		423	484			X										X					?	?	?
		490	515			X										X					?	?	?
		550	620			X										X					?	?	?
		670	700										X			X					?	?	?
		762	804				X									X					?	?	?
		810	830				X									X					?	?	?
NH-40	1970	308	323					X						X			?	?	?				
		328	407						X						X					?			
		418	425			X										X					?	?	?
		435	448			X										X					?	?	?
		514	575			X										X					?	?	?
		575	613			X										X					?	?	?
		617	625			X										X					?	?	?
		652	705										X			X					?	?	?
		742	844				X									X					?	?	?
NH-41	1970	248	276	X										X			?	?	?				
		280	346					X						X	X		?	?	?	?			
		358	400		X										X					?			
		420	454			X										X					?	?	?

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Los Angeles County, California

Well Name	Year Completed	Top of Well Screen (feet bgs)	Bottom of Well Screen (feet bgs)	Assumed Representative Depth Region[1]										Assumed Representative Screen Zone			ULARA Watermaster Geologic Unit						
				Single Depth Region				Multiple Depth Regions															
				1	2	3	4	1,2	2,3	1,2,3	1,2,3,4	2,3,4	3,4	A-Zone	B-Zone	Below B-Zone	L/J/K and Shallower	I	AA	BB	E/M	Blue Star	Q and Deeper
		480	520			X										X					?	?	?
		550	570			X										X					?	?	?
		590	610			X										X					?	?	?
NH-42	1970	280	406					X						X	X		?	?	?	?			
		448	460			X										X					?	?	?
		494	497			X										X					?	?	?
		503	522			X										X					?	?	?
		533	538			X										X					?	?	?
		558	568			X										X					?	?	?
		608	634			X										X					?	?	?
		698	712				X									X					?	?	?
NH-43	1924	103	234	X										X			?	?	?				
		234	366					X						X	X		?	?	?	?			
NH-43A	1982	280	370					X						X	X		?	?	?	?			
		380	390		X										X					?			
		420	460			X										X					?	?	?
		475	496			X										X					?	?	?
		506	565			X										X					?	?	?
		590	630			X										X					?	?	?
NH-44	1984	340	780									X			X	X				?	?	?	?
NH-45	1984	340	780									X			X	X				?	?	?	?
Rinaldi-Toluca Production Well Field																							
RT-01	1985	360	780									X			X	X				?	?	?	?
RT-02	1986	370	600						X						X	X				?	?	?	?
		640	780				X									X					?	?	?
RT-03	--	370	600						X						X	X				?	?	?	?
		630	670										X			X					?	?	?
		700	770				X									X					?	?	?
RT-04	1986	370	600						X						X	X				?	?	?	?
		630	670										X			X					?	?	?
		700	770				X									X					?	?	?
RT-05	1986	370	600						X						X	X				?	?	?	?
		620	670										X			X					?	?	?
		700	770				X									X					?	?	?
RT-06	1986	370	770									X			X	X				?	?	?	?
RT-07	1987	370	590						X						X	X				?	?	?	?
		640	780				X									X					?	?	?
RT-08	1988	360	620						X					X	X	X	?	?	?	?	?	?	?
		645	665				X									X					?	?	?
		680	780				X									X					?	?	?
RT-09	1988	370	580						X						X	X				?	?	?	?
		640	665				X									X					?	?	?
		680	780				X									X					?	?	?
RT-10	1987	360	460		X									X	X		?	?	?	?			
		480	660										X			X					?	?	?
RT-11	1987	370	590						X						X	X				?	?	?	?
		620	640			X										X					?	?	?
		670	770				X									X					?	?	?
RT-12	1988	370	470						X						X	X				?	?	?	?
		490	510			X										X					?	?	?
		530	590			X										X					?	?	?
		640	789										X			X					?	?	?
RT-13	1987	370	590						X						X	X				?	?	?	?
		630	780										X			X					?	?	?
RT-14	1988	360	540						X						X	X				?	?	?	?
		550	670										X			X					?	?	?
		700	770				X									X					?	?	?
RT-15	1988	360	600						X						X	X				?	?	?	?
		610	750										X			X					?	?	?

Table 3-4 NHOU Study Area Well Construction Details
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Well Name	Year Completed	Top of Well Screen (feet bgs)	Bottom of Well Screen (feet bgs)	Assumed Representative Depth Region[1]										Assumed Representative Screen Zone			ULARA Watermaster Geologic Unit						
				Single Depth Region				Multiple Depth Regions						A-Zone	B-Zone	Below B-Zone	L/J/K and Shallower	I	AA	BB	E/M	Blue Star	Q and Deeper
				1	2	3	4	1,2	2,3	1,2,3	1,2,3,4	2,3,4	3,4										
Whitnall Production Well Field																							
WH-01	1951	150	175	X										X			?	?	?				
		185	204	X										X			?	?	?				
		232	274	X										X			?	?	?				
		294	369		X									X	X		?	?	?	?			
		501	509			X										X					?	?	?
WH-02	1951	162	203	X										X			?	?	?				
		232	252	X										X			?	?	?				
		312	371		X										X					?			
		442	455			X										X					?	?	?
WH-03	1951	170	189	X										X			?	?	?				
		212	244	X										X			?	?	?				
		286	349		X									X	X		?	?	?	?			
		429	442			X										X					?	?	?
WH-04	1951	150	175	X										X			?	?	?				
		285	330		X										X					?			
		385	390			X										X					?	?	?
		412	430			X										X					?	?	?
		440	460			X										X					?	?	?
		478	504			X										X					?	?	?
WH-05	1952	150	170	X										X			?	?	?				
		193	208	X										X			?	?	?				
		229	234	X										X			?	?	?				
		284	316		X										X					?			
		377	388			X										X					?	?	?
		402	414			X										X					?	?	?
		434	459			X										X					?	?	?
		465	492			X										X					?	?	?
Other Monitoring Wells																							
107-MW05	--	--	--	X										X			?	?	?	?	?	?	?
3780	--	--	--	X										X			?	?	?	?	?	?	?
3780B	--	--	--	X										X			?	?	?	?	?	?	?
3782G	--	154	165	X										X			?	?	?				
3790A	--	80	295	X										X			?	?	?				
		295	340					X						X	X		?	?	?	?			
		349	529						X						X	X				?	?	?	?
3791	--	--	--	X										X			?	?	?	?	?	?	?
3791A	1925	79	95	X										X			?	?	?	?	?	?	?
		130	169	X										X			?	?	?	?	?	?	?
		200	211	X										X			?	?	?	?	?	?	?
		220	283	X											X					?			
		289	298		X										X					?			
		307	380		X										X	X				?	?	?	?
		397	429			X										X					?	?	?
3791B	--	--	--	X										X			?	?	?	?	?	?	?
3791C	--	--	--	X										X			?	?	?	?	?	?	?
3791D	--	--	--	X										X			?	?	?	?	?	?	?
3792	--	--	--	X										X			?	?	?	?	?	?	?
3800B	--	--	--	X										X			?	?	?	?	?	?	?
3801	--	--	--	X										X			?	?	?	?	?	?	?
3801A	1927	--	--	X										X			?	?	?	?	?	?	?
3810D	1947	--	--	X										X			?	?	?	?	?	?	?
3810E	--	--	--	X										X			?	?	?	?	?	?	?
3810F	--	--	--	X										X			?	?	?	?	?	?	?
3810G	1953	--	--	X										X			?	?	?	?	?	?	?
3810H	1953	130	350					X						X	X		?	?	?	?			
3810J	--	80	150	X										X			?	?	?	?	?	?	?
3811	1916	--	--	X										X			?	?	?	?	?	?	?
3811A	--	--	--	X										X			?	?	?	?	?	?	?
3811B	--	--	--	X										X			?	?	?	?	?	?	?

Table 3-4 NHOU Study Area Well Construction Details
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Well Name	Year Completed	Top of Well Screen (feet bgs)	Bottom of Well Screen (feet bgs)	Assumed Representative Depth Region[1]										Assumed Representative Screen Zone			ULARA Watermaster Geologic Unit						
				Single Depth Region				Multiple Depth Regions						A-Zone	B-Zone	Below B-Zone	L/J/K and Shallower	I	AA	BB	E/M	Blue Star	Q and Deeper
				1	2	3	4	1,2	2,3	1,2,3	1,2,3,4	2,3,4	3,4										
3811C	--	--	--	X										X			?	?	?	?	?	?	?
3811D	--	--	--	X										X			?	?	?	?	?	?	?
3811E	1949	110	147	X										X			?	?	?				
		168	178	X										X			?	?	?				
		182	226	X										X			?	?	?				
3820	1925	87	218	X										X			?	?	?				
		309	379		X									X	X		?	?	?	?			
3820A	1915	--	--	X										X			?	?	?	?	?	?	?
3820G	--	--	--	X										X			?	?	?	?	?	?	?
3821	1915	--	--	X										X			?	?	?	?	?	?	?
3821A	1927	100	110	X										X			?	?	?				
		122	152	X										X			?	?	?				
		191	215	X										X			?	?	?				
3822	--	--	--	X										X			?	?	?	?	?	?	?
3830	--	--	--	X										X			?	?	?	?	?	?	?
3830A	1925	--	--	X										X			?	?	?	?	?	?	?
3830E	--	--	--	X										X			?	?	?	?	?	?	?
3830F	--	--	--	X										X			?	?	?	?	?	?	?
3830G	--	--	--	X										X			?	?	?	?	?	?	?
3830H	--	290	756								X			X	X	X	?	?	?	?	?	?	?
3830J	1930	175	293	X										X			?	?	?				
		316	358					X							X					?			
3830K	--	--	--	X										X			?	?	?	?	?	?	?
3830M	--	--	--	X										X			?	?	?	?	?	?	?
3831	--	--	--	X										X			?	?	?	?	?	?	?
3831A	--	--	--	X										X			?	?	?	?	?	?	?
3831B	--	--	--	X										X			?	?	?	?	?	?	?
3831C	--	--	--	X										X			?	?	?	?	?	?	?
3831D	1951	144	154	X										X			?	?	?				
		210	220	X										X			?	?	?				
		238	238	X										X			?	?	?				
3840	--	--	--	X										X			?	?	?	?	?	?	?
3840B	1928	155	270	X										X			?	?	?				
3840D	--	--	--	X										X			?	?	?	?	?	?	?
3840E	1932	--	--	X										X			?	?	?	?	?	?	?
3840F	1925	--	--	X										X			?	?	?	?	?	?	?
3840G	--	--	--	X										X			?	?	?	?	?	?	?
3840H	--	--	--	X										X			?	?	?	?	?	?	?
3840J	--	--	--	X										X			?	?	?	?	?	?	?
3840L	--	--	--	X										X			?	?	?	?	?	?	?
3840M	--	--	--	X										X			?	?	?	?	?	?	?
3841	--	--	--	X										X			?	?	?	?	?	?	?
3841A	--	--	--	X										X			?	?	?	?	?	?	?
3841B	--	--	--	X										X			?	?	?	?	?	?	?
3841E	--	230	254	X										X			?	?	?				
		274	282		X										X					?			
		320	342		X										X	X				?	?	?	?
		395	405			X										X					?	?	?
		459	462			X										X					?	?	?
		504	512			X										X					?	?	?
		536	562			X										X					?	?	?
		700	718				X									X					?	?	?
		737	750				X									X					?	?	?
3841H		144	154	X										X			?	?	?				
		210	220	X										X			?	?	?				
3841J	--	383	397			X										X					?	?	?
		410	417			X										X					?	?	?
		435	521			X										X					?	?	?
		538	545			X										X					?	?	?
		567	633										X			X					?	?	?

Table 3-4 NHOU Study Area Well Construction Details
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Well Name	Year Completed	Top of Well Screen (feet bgs)	Bottom of Well Screen (feet bgs)	Assumed Representative Depth Region[1]										Assumed Representative Screen Zone			ULARA Watermaster Geologic Unit						
				Single Depth Region				Multiple Depth Regions						A-Zone	B-Zone	Below B-Zone	L/J/K and Shallower	I	AA	BB	E/M	Blue Star	Q and Deeper
				1	2	3	4	1,2	2,3	1,2,3	1,2,3,4	2,3,4	3,4										
		647	661				X									X					?	?	?
		692	709				X									X					?	?	?
		719	729				X									X					?	?	?
		739	749				X									X					?	?	?
		767	793				X									X					?	?	?
		843	857				X									X					?	?	?
3850A	--	--	--	X										X			?	?	?	?	?	?	?
3850AB	1993	125	225	X										X			?	?	?				
		235	285	X										X	X		?	?	?	?			
		325	355		X										X	X				?	?	?	?
3850B	--	--	--	X										X			?	?	?	?	?	?	?
3850C	--	--	--	X										X			?	?	?	?	?	?	?
3850D	--	--	--	X										X			?	?	?	?	?	?	?
3850E	1940	215	308	X										X	X		?	?	?	?			
		546	568			X										X					?	?	?
		589	603			X										X					?	?	?
		623	638			X										X					?	?	?
		654	689				X									X					?	?	?
		719	724				X									X					?	?	?
		729	736				X									X					?	?	?
3850F		180	250	X										X			?	?	?	?	?	?	?
		270	288	X										X			?	?	?	?	?	?	?
3850G	--	--	--	X										X			?	?	?	?	?	?	?
3850H	--	--	--	X										X			?	?	?	?	?	?	?
3851	1941	--	--	X										X			?	?	?	?	?	?	?
3851D	1942	140	275					X						X	X		?	?	?	?			
		302	330		X										X	X				?	?	?	?
		376	386						X							X					?	?	?
		426	437			X										X					?	?	?
		488	490			X										X					?	?	?
		542	547			X										X					?	?	?
3851G	--	--	--	X										X			?	?	?	?	?	?	?
3851H	--	--	--	X										X			?	?	?	?	?	?	?
3851L	--	21	24	X										X			?	?	?				
4889	1916	--	--	X										X			?	?	?	?	?	?	?
4897	1932	190	192	X										X			?	?	?				
		217	255	X										X			?	?	?				
		275	435					X						X	X		?	?	?	?			
4898	1974	250	330	X										X			?	?	?				
4899	1984	120	286	X										X			?	?	?				
4909	--	--	--	X										X			?	?	?	?	?	?	?
4909A	1924	112	136	X										X			?	?	?				
		220	247	X										X			?	?	?				
4909B	1952	230	270	X										X			?	?	?	?	?	?	?
		300	314	X										X			?	?	?	?	?	?	?
4909C	1985	230	240	X										X			?	?	?		?	?	?
		290	300	X										X			?	?	?				
		390	400		X										X					?			
		480	490			X										X					?	?	?
4909F	--	138	348					X						X	X		?	?	?	?			
4918	1984	164	365	X										X			?	?	?				
4918A	1985	230	240	X										X			?	?	?				
		300	320	X										X			?	?	?				
		390	400	X										X			?	?	?				
		480	490		X										X					?			
4918B	1988	160	369	X										X			?	?	?				
4919	--	--	--	X										X			?	?	?	?	?	?	?
4919A	--	--	--	X										X			?	?	?	?	?	?	?
4919B		140	154	X										X			?	?	?				

Table 3-4 NHOU Study Area Well Construction Details
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Well Name	Year Completed	Top of Well Screen (feet bgs)	Bottom of Well Screen (feet bgs)	Assumed Representative Depth Region[1]										Assumed Representative Screen Zone			ULARA Watermaster Geologic Unit						
				Single Depth Region				Multiple Depth Regions															
				1	2	3	4	1,2	2,3	1,2,3	1,2,3,4	2,3,4	3,4	A-Zone	B-Zone	Below B-Zone	L/J/K and Shallower	I	AA	BB	E/M	Blue Star	Q and Deeper
4919D	1984	230	240	X										X			?	?	?				
		290	300	X										X			?	?	?				
		390	400		X										X					?			
		480	490			X										X					?	?	?
4928	--	--	--	X										X			?	?	?				
4928A	1984	225	433					X						X	X		?	?	?	?			
4928B	1984	161	362	X										X			?	?	?	?			
4928C	1988	160	375	X										X			?	?	?				
4929	1953	200	214	X										X			?	?	?				
		264	271	X										X			?	?	?				
		350	473						X						X	X				?	?	?	?
		487	502			X										X					?	?	?
		564	572			X										X					?	?	?
		586	638			X										X					?	?	?
		658	714			X										X					?	?	?
4939	--	--	--	X										X			?	?	?	?	?	?	?
4939A	--	--	--	X										X			?	?	?	?	?	?	?
4939B	1929	164	250	X										X			?	?	?	?	?	?	?
4949	--	--	--	X										X			?	?	?	?	?	?	?
4949A	--	--	--	X										X			?	?	?	?	?	?	?
4949B	--	--	--	X										X			?	?	?	?	?	?	?
4959B	--	--	--	X										X			?	?	?	?	?	?	?
4959I	--	--	--	X										X			?	?	?	?	?	?	?
713-MW08	--	--	--	X										X			?	?	?	?	?	?	?
LA-MW1	1986	--	--	X										X			?	?	?				
LA-MW2	1987	--	--	X										X			?	?	?				
LA-MW3	1986	--	--	X										X			?	?	?				
PA1-MW1	1987	180	240	X										X			?	?	?	?	?	?	?
PA1-MW2	1987	180	240	X										X			?	?	?	?	?	?	?
PA1-MW3	1991	220	280	X										X			?	?	?				
PA1-MW4	1991	200	260	X										X			?	?	?				
PA1-MW5	1991	205	265	X										X			?	?	?				
PA1-MW6	1991	200	260	X										X			?	?	?				
PST-MW1P	1992	207	287	X										X			?	?	?				
PST-MW2P	1993	204	284	X										X			?	?	?				
SVJ-BW1	--	--	--	X										X			?	?	?	?	?	?	?
SVJ-BW2	--	--	--	X										X			?	?	?	?	?	?	?

Note: Where no well screen available, the A-Zone assumed.

Footnotes:
[1] Geologic units assigned to screened intervals based on interpretation of available geophysical logs and Watermaster interpretation of well log RT-01.

Abbreviations:
bgs = Below ground surface.
? = Denotes projected or questionable unit association.
-- = Not available.

Table 3-5 Well Name Pseudonyms
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Well Name	Names in the San Fernando Valley Database				
	Primary Well	**Alternate Well**	**Second Alternate Well**	**Well Owner**	**Well Location Description**
3780	3780				
3791	3791				
3792	3792				
3801	3801				
3811	3811				
3820	3820				
3821	3821				
3822	3822				
3830	3830				
3831	3831				
3840	3840				
3841	3841				
3851	3851				
4889	4889	MCBRIDE WELL			
4897	V14SA97J	4897		SHELDON-ARLETA SANITARY	JANSS WELL
4898	4898	4899		LADWP	MCBRIDE WELL
4899	V14HEW99	4899		HEWITT LANDFILL	HEWITT LANDFILL
4909	4909				
4917	4917				
4918	V14107P8	4918		LABP Penrose	PENROSE / NEWBERRY LF / STRATHERN PIT
4919	4919				
4927	V14713W7	4927		NEWBERRY LANDFILL	PENROSE / NEWBERRY LF / STRATHERN PIT
4928	V1471328	4928		NEWBERRY LANDFILL	PENROSE / NEWBERRY LF / STRATHERN PIT
4929	4929	Tujunga #2		LADWP	TUJUNGA WELL #2
4939	4939				
4948	4948			Lockheed	
4949	4949				
107-MW05	107-MW05	PENROSE-5		OTHER	
3780B	3780B				
3782G	3782G				
3790A	3790A				
3791A	3791A				
3791B	3791B				
3791C	3791C				
3791D	3791D				
3800B	3800B			LADWP	
3801A	3801A				
3810D	3810D				
3810E	3810E				
3810F	3810F				
3810G	3810G				
3810H	3810H	Puri.Dwn Prod		LADWP	PURIFIED DOWNS
3810J	3810J				
3811A	3811A				
3811B	3811B				

Table 3-5 Well Name Pseudonyms
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Well Name	Names in the San Fernando Valley Database				
	Primary Well	**Alternate Well**	**Second Alternate Well**	**Well Owner**	**Well Location Description**
3811C	3811C				
3811D	3811D				
3811E	3811E	#045-A		LADWP	Victry/Trst 045A
3820A	3820A				
3820G	3820G				
3821A	3821A				
3830A	3830A				
3830E	3830E				
3830F	3830F				
3830G	3830G				
3830H	3830H	VMP-2			
3830J	3830J				
3830K	3830K				
3830M	3830M	2			
3830Q	3830Q			Lockheed	
3830S	3830S			Lockheed	
3831A	3831A				
3831B	3831B				
3831C	3831C	B175-E1			
3831D	3831D				
3831Q	3831Q			Lockheed	
3840B	3840B			LADWP	
3840D	3840D				
3840E	3840E				
3840F	3840F				
3840G	3840G				
3840H	3840H				
3840J	3840J				
3840L	3840L				
3840M	3840M				
3841A	3841A				
3841B	3841B				
3841E	3841E	#17			
3841H	3841H	#046-A		LADWP	Victry/Aklnd 46A
3841J	3841J	6A			
3850A	3850A				
3850AB	3850AB	VO7		CITY OF BURBANK	Burbank Operable Unit{3850AB}{VO-7}
3850B	3850B				
3850C	3850C				
3850D	3850D				
3850E	3850E				
3850F	3850F	VEGA			
3850G	3850G				
3850H	3850H				
3851D	3851D	PSD-11			

Table 3-5 Well Name Pseudonyms
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Well Name	Names in the San Fernando Valley Database				
	Primary Well	Alternate Well	Second Alternate Well	Well Owner	Well Location Description
3851G	3851G				
3851H	3851H				
3851L	3851L				
3851M	3851M			Lockheed	
3851N	3851N			Lockheed	
3851Q	3851Q			LOCKHEED AERONAUTICS	
3851X	3851X			LOCKHEED AERONAUTICS	
3852F	3852F			Lockheed	
3856T	3856T			LOCKHEED AERONAUTICS	
4909A	4909A				
4909C	V14HEWC9	4909C		HEWITT LANDFILL	HEWITT LANDFILL
4909F	V14HEW9F	4909F		HEWITT LANDFILL	HEWITT LANDFILL
4917A	V14TUX06	4917A		TUXFORD LANDFILL	TUXFORD LANDFILL
4917B	V14TUX07	4917B		TUXFORD LANDFILL	TUXFORD LANDFILL
4918A	V14107D8	4918A	EV-10	LADWP	PENROSE / NEWBERRY LF / STRATHERN PIT
4918B	V14107B8	4918B		PENROSE LANDFILL	PENROSE / NEWBERRY LF / STRATHERN PIT
4919A	4919A				
4919B	4919B				
4919D	4919D	Runneymede		LADWP (Runnymede)	RUNNYMEDE WELL
4928A	V14705A8	4928A		STRATHERN PIT	PENROSE / NEWBERRY LF / STRATHERN PIT
4928B	V14713B8	4928B		NEWBERRY LANDFILL	PENROSE / NEWBERRY LF / STRATHERN PIT
4928C	V14713C8	4928C		NEWBERRY LANDFILL	PENROSE / NEWBERRY LF / STRATHERN PIT
4939A	4939A				
4939B	4939B				
4949A	4949A				
4949B	4949B				
4949C	4949C			Lockheed	
4959B	4959B				
4959I	4959I				
713-MW08	713-MW08	NEWBERRY-8		OTHER	
EW-10	3811F	EW-10	ER010	CITY OF LOS ANGELES (ERWIN WF)	Erwin (E){3811F}{E-10}
GW-1	V13ALSW1	GW-1	GW-01	ALLIED SIGNAL-BENDIX (HONEYWELL)	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-2	V13ALSW2	GW-2	GW-02	ALLIED SIGNAL-BENDIX (HONEYWELL)	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-3	V13ALSW3	GW-3	GW-03	ALLIED SIGNAL-BENDIX (HONEYWELL)	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-4	V13ALSW4	GW-4	GW-04	ALLIED SIGNAL-BENDIX (HONEYWELL)	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-5	V13ALSW5	GW-5	GW-05	ALLIED SIGNAL-BENDIX (HONEYWELL)	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-6	V13ALSW6	GW-6	GW-06	ALLIED SIGNAL-BENDIX (HONEYWELL)	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-7	V13ALSW7	GW-7	GW-07	ALLIED SIGNAL-BENDIX (HONEYWELL)	Groundwater Monitoring Well, Honeywell North Hollywood Site

Table 3-5 Well Name Pseudonyms
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Well Name	Names in the San Fernando Valley Database				
	Primary Well	Alternate Well	Second Alternate Well	Well Owner	Well Location Description
GW-8	V13ALSW8	GW-8	GW-08	ALLIED SIGNAL-BENDIX (HONEYWELL)	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-9	V13ALSW9	GW-9	GW-09	ALLIED SIGNAL-BENDIX (HONEYWELL)	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-10	V13ALS10	GW-10		ALLIED SIGNAL HONEYWELL	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-11-273	V13ALS11-273	GW-11-273		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-11 at depth of 273
GW-11-287	V13ALS11-287	GW-11-287		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-11 at depth of 287
GW-11-316	V13ALS11-316	GW-11-316		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-11 at depth of 316
GW-11-352	V13ALS11-352	GW-11-352		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-11 at depth of 352
GW-11-407	V13ALS11-407	GW-11-407		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-11 at depth of 407
GW-11-438	V13ALS11-438	GW-11-438		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-11 at depth of 438
GW-12A-284	V13ALS12A-284	GW-12A-284		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-12A at depth of 284
GW-12A-319	V13ALS12A-319	GW-12A-319		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-12A at depth of 319
GW-12A-349	V13ALS12A-349	GW-12A-349		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-12A at depth of 349
GW-14A	V13ALS14A	GW-14A		ALLIED SIGNAL HONEYWELL	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-14B	V13ALS14B	GW-14B		ALLIED SIGNAL HONEYWELL	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-15	V13ALS15	GW-15		ALLIED SIGNAL HONEYWELL	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-16-277	V13ALS16-277	GW-16-277		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-16 at depth of 277
GW-16-317	V13ALS16-317	GW-16-317		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-16 at depth of 317
GW-16-347	V13ALS16-347	GW-16-347		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-16 at depth of 347
GW-16-417	V13ALS16-417	GW-16-417		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-16 at depth of 417
GW-16-507	V13ALS16-507	GW-16-507		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-16 at depth of 507
GW-16-558	V13ALS16-558	GW-16-558		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-16 at depth of 558
GW-17	V13ALS17	GW-17		ALLIED SIGNAL HONEYWELL	Groundwater Monitoring Well, Honeywell North Hollywood Site

Table 3-5 Well Name Pseudonyms
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Well Name	Names in the San Fernando Valley Database				
	Primary Well	Alternate Well	Second Alternate Well	Well Owner	Well Location Description
GW-17-282	V13ALS17-282	GW-17-282		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-17 at depth of 282
GW-17-317	V13ALS17-317	GW-17-317		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-17 at depth of 317
GW-17-342	V13ALS17-342	GW-17-342		ALLIED SIGNAL HONEYWELL	Barcad Samplers, Honeywell North Hollywood Site, GW-17 at depth of 342
GW-17A	V13ALS17A	GW-17A		ALLIED SIGNAL HONEYWELL	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-18A	V13ALS18A	GW-18A		ALLIED SIGNAL HONEYWELL	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-18B	V13ALS18B	GW-18B		ALLIED SIGNAL HONEYWELL	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-18C	V13ALS18C	GW-18C		ALLIED SIGNAL HONEYWELL	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-19A	V13ALS19A	GW-19A		ALLIED SIGNAL HONEYWELL	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-19B	V13ALS19B	GW-19B		ALLIED SIGNAL HONEYWELL	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-19C	V13ALS19C	GW-19C		ALLIED SIGNAL HONEYWELL	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-20	V13ALS20	GW-20		ALLIED SIGNAL HONEYWELL	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-21	V13ALS21	GW-21		ALLIED SIGNAL HONEYWELL	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-22	V13ALS22	GW-22		ALLIED SIGNAL HONEYWELL	Groundwater Monitoring Well, Honeywell North Hollywood Site
GW-23	V13ALS23	GW-23		ALLIED SIGNAL HONEYWELL	Groundwater Monitoring Well, Honeywell North Hollywood Site
LA1-CW01	LA1-CW01			LOCKHEED AERONAUTICS	
LA1-CW03R	LA1-CW03R			Lockheed	
LA1-CW05(A1-CW05)	LA1-CW05	A1-CW05		Lockheed	
LA1-CW07(A1-CW07)	LA1-CW07	A1-CW07		Lockheed	
LA1-CW09(A1-CW09)	LA1-CW09	A1-CW09		Lockheed	
LA1-CW4A	LA1-CW4A	A1CW-4-A		LOCKHEED AERONAUTICS	
LA-MW1	V14LAMW1	LA-MW1		L. A. UNIFIED SCHOOL DISTRICT	
LA-MW2	V14LAMW2	LA-MW2		L. A. UNIFIED SCHOOL DISTRICT	
LA-MW3	V14LAMW3	LA-MW3		L. A. UNIFIED SCHOOL DISTRICT	
LB1-CW07	LB1-CW07	B-1-CW7		LOCKHEED AERONAUTICS	
LB5-CW02	LB5-CW02			Lockheed	
LB5-CW03	LB5-CW03			Lockheed	
LB6-CW08	LB6-CW08			Lockheed	
LB6-CW09	LB6-CW09			Lockheed	
LB6-CW10	LB6-CW10			Lockheed	
LB6-CW14	LB6-CW14			Lockheed	
LB6-CW16	LB6-CW16			Lockheed	

Table 3-5 Well Name Pseudonyms
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Well Name	Names in the San Fernando Valley Database				
	Primary Well	Alternate Well	Second Alternate Well	Well Owner	Well Location Description
LB6-CW17	LB6-CW17			Lockheed	
LC1-CW01(C1-CW01)	LC1-CW01	C1-CW01	C-1-CW01	Lockheed	
LC1-CW02(C1-CW02)	LC1-CW02	C1-CW02	C-1-CW02	Lockheed	
LC1-CW03(C1-CW03)	LC1-CW03	C1-CW03	C-1-CW03	Lockheed	
LC1-CW04(C1-CW04)	LC1-CW04	C1-CW04	C-1-CW04	LOCKHEED AERONAUTICS	
LC1-CW05(C1-CW05)	LC1-CW05	C1-CW05	C-1-CW05	LOCKHEED AERONAUTICS	
LC1-CW06(C1-CW06)	LC1-CW06	C1-CW06	C-1-CW05		
LC1-CW08(C1-CW08)	LC1-CW08	C1-CW08	C-1-CW08	Lockheed	
MLG-1	V13ALSMLG1	MLG-1		ALLIED SIGNAL HONEYWELL	Honeywell North Hollywood Site, came in with Survey data 13 Aug 2007
MW-V06	MW-V06			LOCKHEED AERONAUTICS	
NH-02	3800	NH-02		LADWP	North Hollywood (NH){3800}{NH-2}
NH-10	3800A	NH-10		LADWP	
NH-11	3810	NH-11		LADWP	North Hollywood (NH){3810}{NH-11}
NH-13	3810A	NH-13		LADWP	North Hollywood (NH){3810A}{NH-13}
NH-14	3810C	NH-14		LADWP	
NH-14A	3810B	NH-14A		LADWP	North Hollywood (NH){3810B}{NH-14A}
NH-15	3790B	NH-15		CITY OF LOS ANGELES (NH WF)	
NH-16	3820D	NH-16		LADWP	North Hollywood (NH){3820D}{NH-16}
NH-17	3820C	NH-17		LADWP	North Hollywood (NH){3820C}{NH-17}
NH-18	3820B	NH-18		LADWP	North Hollywood (NH){3820B}{NH-18}
NH-19	3830D	NH-19		LADWP	North Hollywood (NH){3830D}{NH-19}
NH-20	3830C	NH-20		LADWP	North Hollywood (NH){3830C}{NH-20}
NH-21	3830B	NH-21		LADWP	North Hollywood (NH){3830B}{NH-21}
NH-22	3790C	NH-22	NH022	CITY OF LOS ANGELES (NH WF)	North Hollywood (NH){3790C}{NH-22}
NH-23	3790D	NH-23	NH023	CITY OF LOS ANGELES (NH WF)	North Hollywood (NH){3790D}{NH-23}
NH-24	3800C	NH-24		LADWP	North Hollywood (NH){3800C}{NH-24}
NH-25	3790F	NH-25	NH025	CITY OF LOS ANGELES (NH WF)	North Hollywood (NH){3790F}{NH-25}
NH-26	3790E	NH-26	NH026	CITY OF LOS ANGELES (NH WF)	North Hollywood (NH){3790E}{NH-26}
NH-27	3820F	NH-27		LADWP	North Hollywood (NH){3820F}{NH-27}
NH-28	3810K	NH-28		LADWP	North Hollywood (NH){3810K}{NH-28}
NH-29	3810L	NH-29		LADWP	North Hollywood (NH){3810L}{NH-29}
NH-30	3800D	NH-30		LADWP	North Hollywood (NH){3800D}{NH-30}
NH-34	3790G	NH-34	NH034	CITY OF LOS ANGELES (NH WF)	North Hollywood (NH){3790G}{NH-34}
NH-35	3830N	NH-35		LADWP	North Hollywood (NH){3830N}{NH-35}
NH-36	3790H	NH-36	NH036	CITY OF LOS ANGELES (NH WF)	North Hollywood (NH){3790H}{NH-36}
NH-37	3790J	NH-37	NH037	CITY OF LOS ANGELES (NH WF)	North Hollywood (NH){3790J}{NH-37}
NH-38	3810M	NH-38		LADWP	North Hollywood (NH){3810M}{NH-38}
NH-39	3810N	NH-39		LADWP	North Hollywood (NH){3810N}{NH-39}
NH-40	3810P	NH-40		LADWP	North Hollywood (NH){3810P}{NH-40}
NH-41	3810Q	NH-41		LADWP	North Hollywood (NH){3810Q}{NH-41}
NH-42	3810R	NH-42		CITY OF LOS ANGELES (NH WF)	North Hollywood (NH){3810R}{NH-42}
NH-43	3790	NH-43		LADWP	
NH-43A	3790K	NH-43A	NH043A	CITY OF LOS ANGELES (NH WF)	North Hollywood (NH){3790K}{NH-43A}
NH-44	3790L	NH-44	NH044	CITY OF LOS ANGELES (NH WF)	North Hollywood (NH){3790L}{NH-44}

Table 3-5 Well Name Pseudonyms
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Well Name	Names in the San Fernando Valley Database				
	Primary Well	Alternate Well	Second Alternate Well	Well Owner	Well Location Description
NH-45	3790M	NH-45	NH045	CITY OF LOS ANGELES (NH WF)	North Hollywood (NH){3790M}{NH-45}
NH-C01-325	NH-C01-325			EPA	KESWICK
NH-C01-450	NH-C01-450			EPA	KESWICK
NH-C01-660	NH-C01-660			EPA	KESWICK
NH-C01-780	NH-C01-780			EPA	KESWICK
NH-C02-220	NH-C02-220			EPA	FOUR WELLS SOUTHERNMOST
NH-C02-325	NH-C02-325			EPA	FOUR WELLS 3RD FROM NORTH
NH-C02-520	NH-C02-520			EPA	FOUR WELLS 2ND FROM NORTH
NH-C02-681	NH-C02-681			EPA	FOUR WELLS NORTH
NH-C03-380	NH-C03-380			EPA	PROP LOT
NH-C03-580	NH-C03-580			EPA	PROP LOT
NH-C03-680	NH-C03-680			EPA	PROP LOT
NH-C03-800	NH-C03-800			EPA	PROP LOT
NH-C04-240	NH-C04-240	NH-CO4-240		EPA	BURBANK POWER TOWER
NH-C04-375	NH-C04-375	NH-CO4-375		EPA	BURBANK POWER TOWER
NH-C04-560	NH-C04-560	NH-CO4-560		EPA	BURBANK POWER TOWER
NH-C05-320	NH-C05-320			EPA	GENTRY
NH-C05-460	NH-C05-460			EPA	GENTRY
NH-C06-160	NH-C06-160			EPA	ROSE
NH-C06-285	NH-C06-285			EPA	ROSE
NH-C06-425	NH-C06-425			EPA	ROSE
NH-C07-300	NH-C07-300	U1-1		EPA	NHOU FFS J1-1
NH-C08-295	NH-C08-295	V1-1		EPA	
NH-C09-310	NH-C09-310	S2-1		EPA	NHOU FFS F1-1
NH-C10-280	NH-C10-280	U2-1		EPA	NHOU FFS J2-1
NH-C10-360	NH-C10-360	U2-2		EPA	NHOU FFS J2-2
NH-C11-295	NH-C11-295	S1-1		EPA	NHOU FFS G1-1
NH-C12-280	NH-C12-280	X1-1		EPA	NHOU FFS C1-1
NH-C12-360	NH-C12-360	X1-2		EPA	NHOU FFS C1-2
NH-C13-315	NH-C13-315	R2-1		EPA	NHOU FFS G2-1
NH-C13-385	NH-C13-385	R2-2		EPA	NHOU FFS G2-2
NH-C14-250	NH-C14-250	Z2-1		EPA	NHOU FFS D1-1
NH-C15-240	NH-C15-240	Z1-1		EPA	
NH-C15-330	NH-C15-330	Z1-2		EPA	
NH-C16-320	NH-C16-320	Q2-1		EPA	NHOU FFS H1-1
NH-C16-390	NH-C16-390	Q2-2		EPA	NHOU FFS H1-2
NH-C17-255	NH-C17-255	Z3-1		EPA	NHOU FFS E1-1
NH-C17-340	NH-C17-340	Z3-2		EPA	NHOU FFS E1-2
NH-C18-280	NH-C18-280	Y1-1		EPA	NHOU FFS L1-1
NH-C18-365	NH-C18-365	Y1-2		EPA	NHOU FFS L1-2
NH-C19-290	NH-C19-290	S4-1		EPA	NHOU FFS F3-1
NH-C19-360	NH-C19-360	S4-2		EPA	NHOU FFS F3-2
NH-C20-380	NH-C20-380	T1-2		EPA	NHOU FFS A1-2
NH-C21-260	NH-C21-260			LADWP	
NH-C21-340	NH-C21-340			LADWP	

Table 3-5 Well Name Pseudonyms
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Well Name	Names in the San Fernando Valley Database				
	Primary Well	**Alternate Well**	**Second Alternate Well**	**Well Owner**	**Well Location Description**
NH-C22-360	NH-C22-360			LADWP	
NH-C22-460	NH-C22-460			LADWP	
NH-C22-600	NH-C22-600			LADWP	
NH-C23-310	NH-C23-310				
NH-C23-400	NH-C23-400				
NH-C24-305	NH-C24-305				
NH-C24-410	NH-C24-410				
NH-C25-290	NH-C25-290				
NHE-1	3800E	NHE-1	AT001	LADWP	Aeration (A){3800E}{A-1}
NHE-2	3810U	NHE-2	AT002	LADWP	Aeration (A){3810U}{A-2}
NHE-3	3810V	NHE-3	AT003	LADWP	Aeration (A){3810V}{A-3}
NHE-4	3810W	NHE-4	AT004	LADWP	Aeration (A){3810W}{A-4}
NHE-5	3820H	NHE-5	AT005	LADWP	Aeration (A){3820H}{A-5}
NHE-6	3821J	NHE-6	AT006	LADWP	Aeration (A){3821J}{A-6}
NHE-7	3830P	NHE-7	AT007	LADWP	Aeration (A){3830P}{A-7}
NHE-8	3831K	NHE-8	AT008	LADWP	Aeration (A){3831K}{A-8}
NH-VPB-01	NH-VPB-01			EPA	CLARKE
NH-VPB-02	NH-VPB-02			EPA	ARCHWOOD
NH-VPB-03	NH-VPB-03			EPA	ERWIN & LANKERSHIM
NH-VPB-04	NH-VPB-04			EPA	COLLINS
NH-VPB-05	NH-VPB-05			EPA	VICTORY & CLYBORNE
NH-VPB-06	NH-VPB-06			EPA	SHERMAN WELL
NH-VPB-07	NH-VPB-07			EPA	VALERIO & TUJUNGA
NH-VPB-08	NH-VPB-08			EPA	
NH-VPB-09	NH-VPB-09			EPA	ARMINTA LIBRARY
NH-VPB-10	NH-VPB-10			EPA	ARMINTA & DE GARMO
NH-VPB-11	NH-VPB-11			EPA	BEEMAN WELL
NH-VPB-12	NH-VPB-12			EPA	GRINNEL
NH-VPB-13	NH-VPB-13			EPA	VENN STREET
NH-VPB-14	NH-VPB-14			EPA	
OW-V06	OW-V06			LOCKHEED AERONAUTICS	
OW-V07	OW-V07			LOCKHEED AERONAUTICS	
PA1-MW1	V14PA1W1	PA1-MW1		PACIFIC AIRMOTIVE CORP.	
PA1-MW2	V14PA1W2	PA1-MW2		PACIFIC AIRMOTIVE CORP.	
PA1-MW3	V14PA1W3	PA1-MW3	PA-W3	PACIFIC AIRMOTIVE CORP.	
PA1-MW4	V14PA1W4	PA1-MW4	PA-W4	PACIFIC AIRMOTIVE CORP.	
PA1-MW5	V14PA1W5	PA1-MW5	PA-W5	PACIFIC AIRMOTIVE CORP.	
PA1-MW6	V14PA1W6	PA1-MW6	PA-W6	PACIFIC AIRMOTIVE CORP.	
PST-MW1P	V14PSW1P	PST-MW1P		PACIFIC STEEL TREATING CO. INC	
PST-MW2P	V14PSW2P	PST-MW2P		PACIFIC STEEL TREATING CO. INC	
RT-01	4909E	RT-01	RT001	CITY OF LOS ANGELES (RINALDI TOLUCA WF	Rinaldi-Toluca (RT){4909E}{RT-1}
RT-02	4898A	RT-02		CITY OF LOS ANGELES (RINALDI TOLUCA WF	Rinaldi-Toluca (RT){4898A}{RT-2}
RT-03	4898B	RT-03		CITY OF LOS ANGELES (RINALDI TOLUCA WF	Rinaldi-Toluca (RT){4898B}{RT-3}
RT-04	4898C	RT-04	RT004	CITY OF LOS ANGELES (RINALDI TOLUCA WF	Rinaldi-Toluca (RT){4898C}{RT-4}
RT-05	4898D	RT-05	RT005	CITY OF LOS ANGELES (RINALDI TOLUCA WF)	Rinaldi-Toluca (RT){4898D}{RT-5}

Table 3-5 Well Name Pseudonyms
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Well Name	**Names in the San Fernando Valley Database**				
	Primary Well	**Alternate Well**	**Second Alternate Well**	**Well Owner**	**Well Location Description**
RT-06	4898E	RT-06	RT006	CITY OF LOS ANGELES (RINALDI TOLUCA WF)	Rinaldi-Toluca (RT){4898E}{RT-6}
RT-07	4898F	RT-07	RT007	CITY OF LOS ANGELES (RINALDI TOLUCA WF	Rinaldi-Toluca (RT){4898F}{RT-7}
RT-08	4898G	RT-08	RT008	CITY OF LOS ANGELES (RINALDI TOLUCA WF	Rinaldi-Toluca (RT){4898G}{RT-8}
RT-09	4898H	RT-09		CITY OF LOS ANGELES (RINALDI TOLUCA WF	Rinaldi-Toluca (RT){4898H}{RT-9}
RT-10	4909G	RT-10	RT010	CITY OF LOS ANGELES (RINALDI TOLUCA WF	Rinaldi-Toluca (RT){4909G}{RT-10}
RT-11	4909K	RT-11	RT011	CITY OF LOS ANGELES (RINALDI TOLUCA WF	Rinaldi-Toluca (RT){4909K}{RT-11}
RT-12	4909H	RT-12	RT012	CITY OF LOS ANGELES (RINALDI TOLUCA WF	Rinaldi-Toluca (RT){4909H}{RT-12}
RT-13	4909J	RT-13	RT013	CITY OF LOS ANGELES (RINALDI TOLUCA WF	Rinaldi-Toluca (RT){4909J}{RT-13}
RT-14	4909L	RT-14	RT014	CITY OF LOS ANGELES (RINALDI TOLUCA WF	Rinaldi-Toluca (RT){4909L}{RT-14}
RT-15	4909M	RT-15	RT015	CITY OF LOS ANGELES (RINALDI TOLUCA WF	Rinaldi-Toluca (RT){4909M}{RT-15}
SVJ-BW1	SVJ-BW1				
SVJ-BW2	SVJ-BW2				
WH-01	3820E	WH-1		CITY OF LOS ANGELES (WHITNALL	Whitnall (W){3820E}{W-1}
WH-02	3821B	WH-2		CITY OF LOS ANGELES (WHITNALL	Whitnall (W){3821B}{W-2}
WH-03	3821C	WH-3		CITY OF LOS ANGELES (WHITNALL	Whitnall (W){3821C}{W-3}
WH-04	3821D	WH-4	WH004	CITY OF LOS ANGELES (WHITNALL	Whitnall (W){3821D}{W-4}
WH-05	3821E	WH-5	WH005	CITY OF LOS ANGELES (WHITNALL	Whitnall (W){3821E}{W-5}
4909B	4909B	HEWITT 1		OTHER	

Table 3-6 Production Well Status
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Well Name (Well ID)	Year Completed	Most Recent Quarter When Well Was Active[1]	Status[2]
Erwin Wells			
EW-1 (3831H)	1955	3Q2008	I
EW-10 (3811F)	1953	3Q2008	A
EW-2 (3821G)	1953	NA	I
EW-2A (3821I)	1980	3Q2008	NA
EW-3 (3831G)	1955	3Q2008	I
EW-4 (3821F)	1953	3Q2008	I
EW-5 (3831F)	1953	3Q2008	I
EW-6 (3821H)	1955	3Q2008	A
EW-8 (3811G)	1953	NA	I
North Hollywood East Wellfield			
NH-10 (3800A)	1924	NA	NA
NH-11 (3810)	1925	3Q2008	S
NH-13 (3810A)	1925	3Q2008	I
NH-14 (3810C)	1925	2Q1974	NA
NH-14A (3810B)	1947	3Q2008	I
NH-16 (3820D)	1929	3Q2008	I
NH-17 (3820C)	1929	3Q2008	I
NH-18 (3820B)	1929	3Q2008	I
NH-19 (3830D)	1930	3Q2008	I
NH-2 (3800)	1924	3Q2008	I
NH-20 (3830C)	1930	3Q2008	I
NH-21 (3830B)	1930	3Q2008	I
NH-27 (3820F)	1959	3Q2008	I
NH-28 (3810K)	1962	3Q2008	S
NH-29 (3810L)	1962	3Q2008	I
NH-30 (3800D)	1962	3Q2008	I
NH-31 (3810T)	1963	3Q2005	D
NH-35 (3830N)	1967	3Q2008	I
NH-38 (3810M)	1968	3Q2008	I
NH-39 (3810N)	1969	3Q2008	I
NH-40 (3810P)	1970	3Q2008	S
NH-41 (3810Q)	1970	3Q2008	I

Table 3-6 Production Well Status
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Well Name (Well ID)	Year Completed	Most Recent Quarter When Well Was Active[1]	Status[2]
NH-42 (3810R)	1970	3Q2008	I
NH-43 (3790)	1924	NA	NA
NH-5 (3810S)	1924	3Q2005	D
North Holywood West Wellfield			
NH-15 (3790B)	1926	3Q2008	D
NH-22 (3790C)	1948	3Q2008	A
NH-23 (3790D)	1951	3Q2008	A
NH-24 (3800C)	1954	3Q2008	I
NH-25 (3790F)	1958	3Q2008	A
NH-26 (3790E)	1959	3Q2008	A
NH-32 (3770C)	1963	3Q2008	A
NH-33 (3780C)	1963	3Q2008	A
NH-34 (3790G)	1964	3Q2008	A
NH-36 (3790H)	1967	3Q2008	A
NH-37 (3790J)	1968	3Q2008	A
NH-4 (3780A)	1924	3Q2008	A
NH-43A (3790K)	1982	3Q2008	A
NH-44 (3790L)	1984	3Q2008	A
NH-45 (3790M)	1984	3Q2008	A
NH-7 (3770)	1924	3Q2008	A
Rinaldi-Toluca Wellfield			
RT-1 (4909E)	1985	3Q2008	A
RT-10 (4909G)	1987	3Q2008	A
RT-11 (4909K)	1987	3Q2008	A
RT-12 (4909H)	1988	3Q2008	A
RT-13 (4909J)	1987	3Q2008	A
RT-14 (4909L)	1988	3Q2008	A
RT-15 (4909M)	1988	3Q2008	A
RT-2 (4898A)	1986	2Q2007	A
RT-3 (4898B)	NA	3Q2008	A
RT-4 (4898C)	1986	3Q2008	A
RT-5 (4898D)	1986	3Q2008	A
RT-6 (4898E)	1986	3Q2008	A

Table 3-6 Production Well Status
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Well Name (Well ID)	Year Completed	Most Recent Quarter When Well Was Active[1]	Status[2]
RT-7 (4898F)	1987	3Q2008	A
RT-8 (4898G)	1988	3Q2008	A
RT-9 (4898H)	1988	3Q2008	A
Tujunga Wellfield			
TJ-01 (4887C)	NA	3Q2008	A
TJ-02 (4887D)	NA	3Q2008	A
TJ-03 (4887E)	1990	3Q2008	A
TJ-04 (4887F)	1990	3Q2008	A
TJ-05 (4887G)	1990	3Q2008	A
TJ-06 (4887H)	1990	3Q2008	A
TJ-07 (4887J)	1990	3Q2008	A
TJ-08 (4887K)	1991	3Q2008	A
TJ-09 (4886B)	1991	3Q2008	A
TJ-10 (4886C)	1991	3Q2008	A
TJ-11 (4886D)	1991	3Q2008	A
TJ-12 (4886E)	1988	3Q2008	A
Whitnall Wellfield			
WH-1 (3820E)	1951	3Q2008	I
WH-10 (3842E)	1951	3Q2008	I
WH-2 (3821B)	1951	3Q2008	I
WH-3 (3821C)	1951	3Q2008	I
WH-4 (3821D)	1951	3Q2008	A
WH-5 (3821E)	1952	3Q2008	A
WH-6 (3831E)	1951	2Q1978	NA
WH-6A (3831J)	1975	3Q2008	A
WH-7 (3832K)	1951	3Q2008	A
WH-8 (3832L)	1951	3Q2008	I
WH-9 (3832M)	1952	3Q2008	I

[1] Pumping data available through third quarter 2008
[2] A = active, I = inactive, S = standby, D = destroyed

NA = Not available

Table 3-8. Known and Potential Source Properties Identified by EPA (2012)
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

EPA Known Source Properties[1]

Site #	Facility Street #	Facility Street Name	City	Zip Code	Company or Entity Name
1	4201-4531	Empire Avenue	Burbank	91605	Lockheed Martin Corporation Plant B-5
	3050	Clybourn Avenue	Burbank	91605	Lockheed Martin Corporation Hangar 22
	10780	Sherman Way	Burbank	91605	Lockheed Martin Corporation Plant C-1
	10811	Sherman Way	Sun Valley	91352	Lockheed Martin Corporation Building 528
2	11600	Sherman Way	North Hollywood	91605	Honeywell International Inc.
3	6829	Farmdale Avenue	North Hollywood	91605	Pacific Steel Treating Pacific Magnetic & Penetrant Co., Pacwest Properties
4	11310 - 11240	Sherman Way	Sun Valley	91352	Hawker Pacific Aerospace
5	11201	Strathern Avenue	Sun Valley	91352	L.A. By-Products, Co.
6	9227	Tujunga Avenue	Sun Valley	91352	Bradley Landfill Waste Mgmt. Recycling & Disposal Services of CA, Inc.
7	11590	Tuxford Street	Sun Valley	91352	California Car Hikers
8	11447	Vanowen Street	North Hollywood	91605	Fleetwood Machine Products NC and NC II Family Partnership
9	9361	Glen Oaks Boulevard	Sun Valley	91352	Pick-Your-Part- Auto Wrecking
10	7245 - 7361	Laurel Canyon Road	North Hollywood	91605	Hewitt Landfill CalMat Company dBA Vulcan Materials Company, Inc.

Table 3-8. Known and Potential Source Properties Identified by EPA (2012)
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

EPA Potential Source Properties[2]

EPA Site ID	Facility Street #	Facility Street Name	City	Zip Code	Company or Entity Name
262	6631	Laurel Canyon Boulevard	North Hollywood	91606	N/A
118	6709	Lankershim Boulevard	North Hollywood	91606	N/A
123	6868	Farmdale Avenue	North Hollywood	91605	N/A
126	6904	Tujunga Avenue	North Hollywood	91605	N/A
187	6910	Farmdale Avenue	North Hollywood	91605	N/A
127	6928, 6938, 6940	Farmdale Avenue	North Hollywood	91605	N/A
128	6945	Farmdale Avenue	North Hollywood	91605	N/A
129	7040	Laurel Canyon Boulevard	North Hollywood	91605	N/A
132	7131	Vineland Avenue	North Hollywood	91605	N/A
148	7351	Radford Avenue	North Hollywood	91605	N/A
191	8101	Lankershim Boulevard	North Hollywood	91605	N/A
9	10777	Vanowen Street	North Hollywood	91605	N/A
14	10903-10917	Vanowen Street	North Hollywood	91605	N/A
17	11041	Vanowen Street	North Hollywood	91605	N/A
176	11051	Victory Boulevard	North Hollywood	91606	N/A
205	11150	Gault Street	North Hollywood	91605	N/A
26	11247	Sherman Way	Sun Valley	91352	N/A
221	11417 - 11423	Vanowen Street	North Hollywood	91605	N/A
200	11630	Tuxford Street	Sun Valley	91352	N/A
46	11637	Sherman Way	North Hollywood	91605	N/A
215	11645	Pendleton Avenue	Sun Valley	91352	N/A
51	11800	Sherman Way	North Hollywood	91605	N/A
222	12600	Saticoy Street	North Hollywood	91605	N/A

[1] 2010 Special Notice Letter Recipient and/or 1996/1997 Consent Decree Signatory
[2] Known and potential source properties as reported by EPA, March 6, 2012

Table 3-9 Groundwater Analytical Detection History and Regulatory Screening Levels
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Analyte Name	Minimum Concentration	Maximum Concentration	Units	Number of Exceedances	Number of Unique Wells with Exceedances	MCL [a]	PHG [b]	PHG Date	Notification Level [c]	ESLs [d]	Comments
1,1,1,2-Tetrachloroethane	1	10.7	µg/L	14	8					1.3	
1,1,1-Trichloroethane (1,1,1-TCA)	0.1	140	µg/L			200	1000	2006		200	
1,1,2,2-Tetrachloroethane	0.22	11.7	µg/L	27	14	1	0.1	2003		1	
1,1,2-Trichloro-1,2,2-trifluoroethane - Freon 113	0.07	46.1	µg/L			1200	4000	2011 revision			
1,1,2-Trichloroethane (1,1,2-TCA)	0.055	88.2	µg/L	59	17	5	0.3	2006		5	
1,1-Dichloroethane (1,1-DCA)	0	60	µg/L	107	31	5	3.0	2003		5	
1,1-Dichloroethene (1,1-DCE)	0.06	86	µg/L	294	45	6	10	1999		6	
1,1-Dichloropropene	1	11	µg/L								
1,2,3-Trichlorobenzene	0	10.5	µg/L								
1,2,3-Trichloropropane (1,2,3-TCP)	0.0011	170	µg/L	373	64		0.0007	2006	0.005		
1,2,3-Trimethylbenzene	4.97	11.4	µg/L								
1,2,4-Trichlorobenzene	0.3	10.6	µg/L	18	10	5	5	1999		5	
1,2,4-Trimethylbenzene	0.39	12.1	µg/L						330		
1,2-Dibromo-3-chloropropane (DBCP)	0.3	10.6	µg/L	29	15	0.2	0.0017	1999		0.2	
1,2-Dibromoethane	0.2	10.9	µg/L	30	16					0.05	
1,2-Dichlorobenzene	0.1	10.5	µg/L			600	600	2009 revision		600	
1,2-Dichloroethane (1,2-DCA)	0.1	107	µg/L	516	65	0.5	0.4	2005 revision		0.5	
1,2-Dichloroethene (total)	0.2	90	µg/L	21	4	6	100	2006		6	MCL, PHG, and ESL are based on cis-1,2-dichloroethene
1,2-Dichloropropane	0.07	11.6	µg/L	31	14	5	0.5	1999		5	
1,3-Dichlorobenzene	0.3	10.5	µg/L							210	
1,3-Dichloropropane	0.48	11.3	µg/L								
1,4-Dichlorobenzene	0.15	10.8	µg/L	21	10	5	6	1997		5	
1,4-Dioxane	0.31	320	µg/L	581	80				1	3	
2,2-Dichloropropane	1	13.1	µg/L								
2,3,4,6-tetrachlorophenol	0.598	2.96	µg/L								
2-Chloroethyl vinyl ether	1	1	µg/L								
2-Chlorotoluene	1	11.7	µg/L						140		
2-Hexanone	2	10	µg/L								
3,3'-Dichlorobenzidine	5	5	µg/L	1	1					0.029	
4,6-dinitro-2-methylphenol	20	76	µg/L								
4-Bromofluorobenzene	9.96	10	µg/L								
4-Chloro-3-methylphenol	1	1	µg/L								
4-Chloroaniline	5	5	µg/L							28	
4-Chlorotoluene	1	11.1	µg/L						140		
4-Nitrophenol	1	1.1	µg/L								
Acetone	0.3	2400	µg/L							6300	
Acidity As CO2	11700	14200000	µg/L								
Aggressive Index	12.08	13	pH units								
Alachlor	1000	1000	µg/L	1	1	2	4	1997			
Alkalinity	110	691	mg/L								
Alkalinity as CaCO3	169	548	mg/L								
Alkalinity as carbonate	1.7	450	mg/L								
Alkalinity bicarbonate	86	774	mg/L								
Alpha Radium	0.0262	0.212	pCi/L								
Aluminum	2.6	367	µg/L			1000	600	2001			
Ammonia	0.051	0.21	mg/L								
Ammonia (Nitrogen)	0.09	7	mg/L								
Anions Sum	5.02	56	meq/L								
Anthracene	5	5	µg/L							2100	
Antimony	0.476	43000	µg/L	41	29	6	0.7	Draft 2009		6	
Arsenic	0.08	83	µg/L	52	20	10	0.004	2004		50	
Asbestos	0.2	0.2	MFL			7	7	2003			
Atrazine	0.12	19	µg/L	10	10	1	0.15	1999			
Barium	0.046	5000	µg/L	1	1	1000	2000	2003		1000	
Benzene	0.1	11.4	µg/L	39	21	1	0.15	2001		1	
Benzo(a)pyrene	5	5	µg/L	1	1	0.2	0.007	2010		0.2	
Benzo(b)fluoranthene	5	5	µg/L	1	1					0.029	

Table 3-9 Groundwater Analytical Detection History and Regulatory Screening Levels
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Analyte Name	Minimum Concentration	Maximum Concentration	Units	Number of Exceedances	Number of Unique Wells with Exceedances	MCL [a]	PHG [b]	PHG Date	Notification Level [c]	ESLs [d]	Comments
Benzo(g,h,i)perylene	5	5	µg/L							210	
Benzo(k)fluoranthene	5	5	µg/L	1	1					0.029	
Benzyl butyl phthalate	0.8	11	µg/L								
Beryllium	0.003	20	µg/L	10	6	4	1	2003		4	
bis(2-Ethylhexyl)phthalate	1	600	µg/L	13	11					4	
Boron	20	950	µg/L						1000	1000	
Bromide	0.05	4.4	mg/L								
Bromobenzene	1	11.2	µg/L								
Bromochloromethane	0.27	10.7	µg/L								
Bromodichloromethane	0.06	11.4	µg/L							100	
Bromoform	0.08	23	µg/L							100	
Bromomethane	0.27	11.7	µg/L	18	11					9.8	
C11-C12 Petroleum Hydrocarbons	15	21	µg/L							210	Based on TPH middle distillates
C13-C14 Petroleum Hydrocarbons	5.6	5.7	µg/L							210	Based on TPH middle distillates
C15-C16 Petroleum Hydrocarbons	5.6	6	µg/L							210	Based on TPH middle distillates
C17-C18 Petroleum Hydrocarbons	0.76	26	µg/L							210	Based on TPH middle distillates
C19-C20 Petroleum Hydrocarbons	2.2	4.5	µg/L							210	Based on TPH middle distillates
C21-C22 Petroleum Hydrocarbons	3.7	8.3	µg/L							210	Based on TPH middle distillates
C23-C24 Petroleum Hydrocarbons	3	4.5	µg/L							210	Based on TPH middle distillates
C25-C28 Petroleum Hydrocarbons	1.8	9.7	µg/L							210	Based on TPH residual fuels
C29-C32 Petroleum Hydrocarbons	6.9	8.8	µg/L							210	Based on TPH residual fuels
C33-C36 Petroleum Hydrocarbons	9.9	11	µg/L							210	Based on TPH residual fuels
C37-C40 Petroleum Hydrocarbons	0.078	0.078	µg/L							210	Based on TPH residual fuels
C9-C10 Petroleum Hydrocarbons	0.59	11	µg/L							210	Based on TPH middle distillates
Cadmium	0.000012	52	µg/L	15	13	5	0.04	2006		5	
Calcium	0.0168	366	mg/L								
Carbon dioxide	0.0123	77.6	mg/L								
Carbon disulfide	0.2	16	µg/L						160		
Carbon tetrachloride	0.05	25.7	µg/L	856	69	0.5	0.1	2000		0.5	
Carbonate	0	338	mg/L								
Cation Sum	5.22	15.84	meq/L								
Chemical oxygen demand	5	20	mg/L								
Chloride	0.00001	0.15	µg/L			250					Secondary CA MCL [e]
Chlorine	0.26	40.6	mg/L								
Chlorobenzene	0.1	10.5	µg/L			70	200	2003		70	
Chloroethane	0.27	11.2	µg/L							12	
Chloroform	0.059	150	µg/L	5	3					70	
Chloromethane	0.08	17	µg/L							180	
Chromium	0.005	149000	µg/L	302	28	50				50	
Chromium(VI)	0.0011	140000	µg/L	557	47		0.02	2011	5	21	Notification level is the voluntary cleanup level established by LADWP
cis-1,2-Dichloroethene	0.07	230	µg/L	481	50	6	100	2006		6	
cis-1,3-Dichloropropene	0.1	10.5	µg/L								
Cobalt	0.033	100	µg/L							140	
Color	1	17	ACU			15					Secondary CA MCL
Copper	0.01	732	µg/L			1300	300	2008		1300	
Cyclohexane	0.15	1.5	µg/L								
Dibenz(a,h)anthracene	5	5	µg/L	1	1					0.0048	
Dibromochloromethane	0.12	20	µg/L							100	
Dibromofluoromethane	5	5	µg/L								
Dibromomethane	1	10.6	µg/L								
Dichlorodifluoromethane (Freon 12)	0.1	54	µg/L						1000		
Di-n-butyl phthalate	5	52	µg/L								
Di-n-octyl phthalate	17	58	µg/L								
Dissolved Oxygen	-0.27	2980	mg/L								
Electrical conductance	0	1393	mS/cm								
Ethanol	100	100	µg/L								
Ethylbenzene	0.1	11.7	µg/L			300	300	1997		300	

Table 3-9 Groundwater Analytical Detection History and Regulatory Screening Levels
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Analyte Name	Minimum Concentration	Maximum Concentration	Units	Number of Exceedances	Number of Unique Wells with Exceedances	MCL [a]	PHG [b]	PHG Date	Notification Level [c]	ESLs [d]	Comments
Ethyl tert-butyl ether	2	21.6	µg/L								
Fecal Coliform	0.5	2.2	CFU/100mL								
flow rate at time of sampling	0	20	GPM								
Fluoride	0.09	7.8	mg/L	1	1	2	1	1997			
Gross Alpha	0.13	120	pCi/L	39	17	15					
Gross Alpha Minimum Detectable Activity at the 95% confidence level	1.21	1.73	pCi/L			15					
Gross Beta	-1.88	140	pCi/L	4	3	50					Equal to 4 millirem/year
Gross Beta Minimum Detectable Activity at the 95% confidence level	2.41	2.95	pCi/L			50					Equal to 4 millirem/year
Hardness	58	706	mg/L								
Hardness (magnesium)	45	260	mg/L								
Hardness Calcium (as CaCO3)	170	400	mg/L								
Heterotrophic Plate Count	1	13000	CFUs/mL								
Hexachlorobenzene	5	5	µg/L	1	1	1	0.03	2003		1	
Hexachlorobutadiene	3.98	10.4	µg/L	24	10					0.45	
Hexachlorocyclopentadiene	5	5	µg/L			50	50	1999			
Hydrogen carbonate	190	459	mg/L								
Hydroxide (OH), H2SO4 titration	0	289	mg/L								
Indeno(1,2,3-c,d)pyrene	5	5	µg/L	1	1					0.048	
Ion Balance	-4.42	3.11	percent								
Iron	0.003	91	mg/L	202	54	0.3					Secondary CA MCL
Isopropyl ether	2	2	µg/L								
Isopropylbenzene	0.1	11.5	µg/L						770		
Langelier Index (AT 25 C) [f]	-0.3	1.2	pH units								
Langelier Index at Field Temp: units are pH units	-0.25	1.2	pH Units								
Lead	0.004	1200	µg/L	45	25	15	0.2	2009		15	
m-xylene	10	10	µg/L			1750	1800	1997		1800	
m,p-Xylene	0.035	25.2	µg/L			1750	1800	1997		1800	
Magnesium	0.0046	63	mg/L								
Manganese	0.0000257	2.1	mg/L	139	38	0.05			0.5		Secondary CA MCL
Mercury	0.015	10	µg/L	1	1	2	1.2	2005 revision		2	
Methyl acetate	0.5	2.1	µg/L								
Methyl cyclohexane	0.5	0.5	µg/L								
Methyl ethyl ketone	1	106	µg/L							4200	
Methyl isobutyl ketone (MIBK)	0.2	57.6	µg/L						120	120	
Methyl tert-butyl ether	0.12	20	µg/L	18	10	13	13	1999		13	
Methylene Blue Acting Substances	50	200	µg/L								
Methylene chloride	0.09	240	µg/L	59	36	5	4	2000		5	
Molybdenum	1.04	200	µg/L	31	11					35	
Naphthalene	0.4	150	µg/L	1	1				17	17	
N-butylbenzene	1	12	µg/L						260		
Nickel	0.06	610	µg/L	6	6	100	12	2001		100	
Nitrate (as Nitrogen)	0.696	9.74	mg/L			45	45	1997			Based on Nitrate (as NO3)
Nitrate (as NO3)	57850	75650	µg/L	3	3	45000	45000	1997			
Nitrate (as NO3)	0.01	329.3	mg/L	779	70	45	45	1997			
Nitrate Nitrite (as Nitrogen)	0.33	13.1	mg/L	2	2	10	10	1997			as N
Nitrite	0.0009	340	mg/L	6	6	1	1	1997			Based on Nitrite (as Nitrogen)
Nitrite (as Nitrogen)	0.0009	20	mg/L	24	17	1	1	1997			as N
N-Nitrosodimethylamine (NDMA)	0	0.17	µg/L	29	22		0.003	2006	0.01		
N-Nitrosodimethylamine (NDMA)	0.59	5.7	ng/L				3	2006	10		
n-Propylbenzene	1	11.6	µg/L						260		
o-Xylene	0.057	11.7	µg/L			1750	1800	1997		1800	
Odor	1	1	TON			3					Secondary CA MCL
Oil & grease, total rec	0.06	20	µg/L								
Oxygen-Reduction Potential	-300.5	349	mV								
Pentachloroethane	5	11.2	µg/L								

Table 3-9 Groundwater Analytical Detection History and Regulatory Screening Levels
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Analyte Name	Minimum Concentration	Maximum Concentration	Units	Number of Exceedances	Number of Unique Wells with Exceedances	MCL [a]	PHG [b]	PHG Date	Notification Level [c]	ESLs [d]	Comments
Perchlorate	0.3	1700	µg/L	28	8	6	1	2011 draft		6	
pH	0	786	pH units								
pH Saturation (25 Deg C)	6.1	7.8	pH Units								
pH Saturation (60 Deg C)	5.6	7.3	pH Units								
Phenanthrene	5	5	µg/L							210	
Phosphate	0.015	0.15	mg/L								
p-Isopropyltoluene	0.05	11.7	µg/L								
Potassium	0.109	81	mg/L								
Radium	0.0454	0.384	pCi/L			5					MCL for Radium 226 + Radium 228
Radium 226 95% CL	0.0616	0.226	pCi/L	18	16		0.05	2006			
Radium 228 95% CL	0.414	0.77	pCi/L	18	16		0.019	2006			
Radium-226	-0.175	2.4	pCi/L	154	60		0.05	2006			
Radium-228	-0.08	2.4	pCi/L	159	57		0.019	2006			
Radon	2.8	853	pCi/L								
Radon-222	339	339	pCi/L								
Ratio U-234/238	1.2	1.2	pCi/L								
sec-Butylbenzene	1	11.6	µg/L						260		
Selenium	0.14	71	µg/L	1	1	50	30	2010		50	
Silica	10	35	mg/L								
Silicon	7.21	14.3	mg/L								
Silver	0.004	18	µg/L			100				35	Secondary CA MCL
Sodium	0.0301	1000	mg/L								
Specific Conductance	0.00099	770	mS/cm	54	22	0.9					
Styrene	0.11	11.9	µg/L			100	0.5	2010		100	
Sulfate	0.02	1200	mg/L	57	19	250					Secondary CA MCL
Sulfide	0.006	5.19	mg/L								
t-Butylbenzene	1	11.3	µg/L						260		
Temperature	0	27	Deg C								
Tert-amyl methyl ether	2	32.9	µg/L								
Tert-butyl alcohol	10	20	µg/L	1	1				12	12	
Tetrachloroethylene	0.02	6100	µg/L	2237	142	5	0.06	2001		5	
Thallium	15	139	µg/L	61	30	2	0.1	2004 revision		2	
Toluene	0	170	µg/L	1	1	150	150	1999		150	
Total C7 Hydrocarbons	12	270	µg/L	2	2					210	Based on TPH gasolines
Total C8 Hydrocarbons	0.72	140	µg/L							210	Based on TPH gasolines
Total Coliform	1	86.2	µS/cm								
Total Coliform	1	155.3	MPN/100mL								
Total Decachlorobiphenyls	93	117	percent								
Total Dissolved Solids	-999	1070	mg/L	366	70	500					Secondary CA MCL
Total Organic Carbon	0.0011	100.7	mg/L								
Total Organic Halides	80	240	µg/L								
Total Petroleum Hydrocarbons	130	4100	µg/L	6	5					210	Based on TPH gasolines, middle distillates, and residual fuels
Total Settlable Solids	2	10	mg/L								
Total Suspended Solids	1	6	mg/L								
Total Trihalomethanes	0.155	35.59	µg/L			80	0.8	2010 Draft			
Total Uranium 95% CL	0.23	0.97	pCi/L								
Total Xylenes	0.05	4.5	µg/L			1750	1800	1997		1800	
TPH Gasoline	51	2100	µg/L	3	3					210	Based on TPH gasolines
TPH Volatiles	27	490	µg/L								
trans-1,2-Dichloroethene	0.079	11.8	µg/L	7	6	10	60	2006		10	
trans-1,3-Dichloropropene	0.1	11.1	µg/L								
Trichloroethylene	0.057	17000	µg/L	4094	167	5	1.7	2009		5	
Trichlorofluoromethane (freon 11)	0.08	11.7	µg/L			150	700	1997			
Turbidity	0	1200	NTU			5					Secondary CA MCL
Uranium	3.7	24.7	µg/L								
Uranium	1.21	21.8	pCi/L	4	1	20	0.43	2001			
Uranium234	10.5	10.5	pCi/L								

Table 3-9 Groundwater Analytical Detection History and Regulatory Screening Levels
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Analyte Name	Minimum Concentration	Maximum Concentration	Units	Number of Exceedances	Number of Unique Wells with Exceedances	MCL [a]	PHG [b]	PHG Date	Notification Level [c]	ESLs [d]	Comments
Uranium235	0.367	0.367	pCi/L								
Uranium238	8.9	8.9	pCi/L								
Uranium (U), ICP/MS	16.2	22.1	µg/L								
Vanadium	0.042	1000	µg/L	13	10				50	15	
Vinyl acetate	3	10	µg/L								
Vinyl chloride	0.19	11.2	µg/L	27	12	0.5	0.05	2000		0.5	
Volume purged at time of sampling	0	1281	GAL								
Xylidine	0.52	0.8	µg/L								
Zinc	0.11	10000	µg/L	1	1	5000				5000	Secondary CA MCL

Note: **Bold** analyte name indicates an exceedanc.

Abbreviations:

MCL = Maximum contaminant levels.
PHG = Public health goals.
ESL = Environmental screening levels.
µg/L = Micrograms per liter.
mg/L = Milligrams per liter.
pCi/L = Picocuries per liter.
MPN/mL = Most probably number per milliliter.
meq/L = milliequivalent per liter.
MFL = Million fibers per liter.
TPH = Total petroleum hydrocarbons.
ACU = Apparent color units.
CA MCL = California maximum contaminant levels.
µS/cm = Microsiemens per centimeter.
mS/cm = Millisiemens per centimeter.
CFU/mL = colony-forming unit per milliliter.
CFU/100mL = colony-forming unit per hundred milliliter.
GPM = Gallons per minute.
N = Nitrogen.
mV = Millivolts.
C = Celsius.
95% CL = Minimum Detectable Activity at the 95% confidence limit.
NTU = Nephelometric turbidity units.
GAL = Gallon.

Footnotes:

[a] Maximum contaminant levels compiled from California Department of Public Health table *MCLs, DLRs, and PHGs for Regulated Drinking Water Contaminants* updated February 24, 2011.

[b] Public health goals compiled from California Department of Public Health table *MCLs, DLRs, and PHGs for Regulated Drinking Water Contaminants* updated February 24, 2011.

[c] Notification levels compiled from California Department of Public Health's *Drinking Water Notification Levels and Response Levels: An Overview* table 1 *CDPH Drinking Water Notification Levels* updated December 14, 2010.

[d] Environmental screening levels compiled from San Francisco Bay Region California Regional Water Quality Control Board's Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater table F-3 Summary of Drinking Water Screening Levels published November 2007 revised May 2008.

[e] Secondary California maximum contaminant levels compiled from California Code of Regulation, Title 22. Division 4. Environmental Health, Chapter 15. Domestic Water Quality and Monitoring Regulations, Article 16. Secondary Water Standards, 64449. Secondary Maximum Contaminant Levels and Compliance tables 64449-A and 64449-B updated May 2, 2006. Secondary CA MCLs address esthetics such as taste and odor.

[f] Approximate indicator of the degree of saturation of calcium carbonate in water, between -1 and 1, units are pH units

Table 3-10 Maximum Influent and Effluent NHOU Treatment System COCs Detections
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

	2004		2005		2006		2007[1]		2008		2009[2]		2010[3]		2011	
Analyte	**Influent**	**Effluent**	**Influent**	**Effluent**	**Influent**	**Effluent**	**Influent**	**Effluent**	**Influent**	**Effluent**	**Influent**	**Effluent**	**Influent**	**Effluent**	**Influent**	**Effluent**
1,1,1-TCA	ND	ND	ND	ND	**0.807**	ND	**0.655**	ND	ND	ND	N/A	N/A	N/S	N/S	ND	ND
1,1-DCA	**0.765**	ND	**0.6**	ND	**0.868**	ND	**0.55**	ND	ND	ND	N/A	N/A	N/S	N/S	ND	ND
1,1-DCE	**1.9**	ND	**1.5**	ND	**1.85**	ND	**1.99**	ND	**1.58**	ND	N/A	N/A	N/S	N/S	**1.45**	ND
1,4-dioxane[4]	*N/S*	*N/S*	*N/S*	*N/S*	*N/S*	*N/S*	*N/S*	*N/S*	*N/S*	*N/S*	*N/S*	*N/S*	N/S	N/S	*N/S*	*N/S*
Bromodichloromethane	**1.39**	ND	**1.58**	ND	**1.1**	ND	ND	ND	ND	ND	N/A	N/A	N/S	N/S	ND	ND
Carbon tetrachloride	**1.3**	ND	**0.958**	ND	**0.82**	ND	**1.1**	ND	**1.22**	ND	N/A	N/A	N/S	N/S	**2.44**	ND
Chloroform	**2.81**	ND	**2.3**	ND	**1.99**	ND	**1.65**	ND	**1.11**	ND	N/A	N/A	N/S	N/S	**1**	ND
Chloromethane	ND	ND	ND	ND	ND	ND	ND	ND	**0.529**	ND	N/A	N/A	N/S	N/S	ND	ND
Chromium (hexavalent)	*N/S*	**6**	*N/S*	**6.99**	*N/S*	**28.5**	*N/S*	**33.7**	*N/S*	**3.16**	*N/S*	**3.9**	N/S	**4.8**	*N/S*	**1.5**
Chromium (total)	*N/S*	**9.11**	*N/S*	**7.34**	*N/S*	**26.9**	*N/S*	**35**	*N/S*	**3.8**	*N/S*	**3.5**	N/S	**5.6**	*N/S*	**2.3**
cis-1,2-DCE	**3.17**	ND	**1.84**	ND	**3.02**	ND	**1.68**	ND	**1.06**	ND	N/A	N/A	N/S	N/S	**0.753**	ND
Dichlorodifluoromethane	**5.78**	ND	**2.17**	ND	**1.93**	ND	**2**	ND	**1.82**	ND	N/A	N/A	N/S	N/S	**1.1**	ND
PCE	**15.4**	ND	**11.4**	ND	**8.93**	ND	**8.39**	ND	**8.75**	ND	**8.65**	ND	**9.77**	ND	**7.82**	ND
TCE	**81.3**	ND	**85**	**1.1**	**96.2**	**1.67**	**108**	**0.607**	**40.2**	ND	**43.8**	ND	**41.2**	ND	**30.5**	ND
Total trihalomethanes	**2.81**	ND	**3.88**	ND	**2.13**	ND	**1.65**	ND	**1.11**	ND	N/A	N/A	N/S	N/S	**1**	ND

Notes:

N/A not available from the EPA's San Fernando Basin database or LADWP quarterly reports
N/S samples not analyzed for this analyte
ND not detected; reported as "0" in the EPA's San Fernando Basin database
1,1,1-TCE 1,1,1-trichloroethane
1,1-DCA 1,1-dichloroethane
1,1-DCE 1,1-dichloroethene
cis-1,2-DCE cis-1,2-dichloroethene
PCE tetrachloroethene
TCE trichloroethene
all concentrations in units of micrograms per liter (µg/L)
detected concentrations shown in bold font

[1] Production from NHE-2 to the NHOU treatment system ceased in February 2007

[2] LADWP's NHOU July-September 2009 and October-December 2009 Quarterly Reports (dated November 12, 2009 and February 8, 2010)

[3] LADWP's NHOU January-March, April-June, and July-September 2010 Quarterly Reports (dated May 3, 2010, August 9, 2010, and November 3, 2010)

[4] LADWP groundwater samples from NHOU extraction wells are analyzed for 1,2,3-TCP, nitrate (as NO3), NDMA, perchlorate, and vanadium in addition to analytes listed above

Influent and effluent water samples are collected upstream and downstream of the air stripper, respectively; LADWP samples air emissions from downstream of the VPGAC units and are analyzed for benzene, TCE, PCE, trichlorofluoromethane, 1,1-DCE, methylene chloride, 1,1-DCA, cis-1,2-DCE, chloroform, 1,1,1-TCE, and carbon tetrachloride

Table 4-1 Chemical of Concern Concentrations Used in Contouring
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Sample Location	Tetrachloroethene	Trichloroethene	1,4-Dioxane	Hexavalent Chromium
	µg/L	µg/L	µg/L	µg/L
A-Zone				
3830Q	2.84	0.68	ND(0.5)	ND(0.1)
3830S	18.1	400	2.2	10.8
3831Q	7.8	180	0.82	3.2
3850AB	230	44	1.5	12
3851M	19.6	13	--	1.3
4899	5.6	ND(0.31)	ND(0.4)	0.22
4909C[a]	13	44	2.7	1.1
4918 [a]	12.3	12.6	1.53	0.15
4918B	8.6	36.6	5.18	ND(0.14)
4928C [a]	10.3	0.26	ND(1)	1.07
4949C	1.77	3.44	--	--
GW-1	12	180	18	53100
GW-2	7.6	45	320	13000
GW-3	10	160	210	33100
GW-4	10	33	11	510
GW-5	19	30	90	4.3
GW-6	10	7.9	9.4	2
GW-7	66	1300	30	13000
GW-8	5.6	13	6.5	1.5
GW-9	7.3	24	5.6	1.7
GW-10	130	510	8.3	15
GW-11-273	99	340	7.3	91
GW-12A-284	38	900	13	2700
GW-14A	9.7	64	60	140000
GW-14B	9.1	63	9.5	8800
GW-15	130	920	8.9	240
GW-16-277	16	340	10	1300
GW-17-282	43	1200	27	1300
GW-18A	17	80	7.2	2.57
GW-19A	42	190	1.7	34
GW-20	8.5	36	17	130
GW-21	13	30	9.7	8.5
GW-22	7	56	7.2	1200
GW-23	9.9	13	11	55
LA1-CW03R	200	130	1.5	ND(0.2)
LA1-CW07	1120	1720	ND(0.5)	2.03
LA1-CW09	111	40	1.4	--
LA-MW1	1.2	0.1	ND(1.9)	0.90
LA-MW2	1.3	0.1	0.47	0.81
LA-MW3	0.85	0.12	ND(2.1)	0.82
LB5-CW03	50.2	77	ND(0.5)	0.938
LB6-CW09	--	--	ND(0.8)	ND(0.04)
LB6-CW10	270	36	1.7	ND(0.2)
LB6-CW16	61.2	22.8	ND(0.8)	0.91
LB6-CW17	99.5	6.1	0.88	1.6
LC1-CW03	10.8	0.8	0.9	0.155
LC1-CW06	91.2	1240	1.1	0.82
LC1-CW08	163	23	2	0.137
NH-C01-325	58	6.5	ND(0.5)	0.34
NH-C02-220	1.2	18	--	4.1
NH-C05-320	3.3	9.8	3	1.4
NH-C07-300	2.3	29	24	2.8

Table 4-1 Chemical of Concern Concentrations Used in Contouring
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Sample Location	Tetrachloroethene µg/L	Trichloroethene µg/L	1,4-Dioxane µg/L	Hexavalent Chromium µg/L
NH-C08-295	6.3	3	1.5	0.69
NH-C09-310	44	100	13	2.2
NH-C10-280	92	100	18	10
NH-C11-295	9.7	9.2	ND(0.4)	7
NH-C12-280	14	56	3.8	0.97
NH-C13-385	0.57	15	ND(0.4)	0.83
NH-C14-250	6.2	2.2	ND(0.4)	1.7
NH-C15-240	8.8	14	ND(0.4)	4.1
NH-C16-320	7.9	--	--	0.73
NH-C16-390	--	16	3.1	0.83
NH-C17-255	6.3	110	5.5	3.7
NH-C18-365	11	160	3.3	51
NH-C19-290	--	--	--	4
NH-C19-360	5.8	95	1.6	--
NH-C20-380	5.2	38	4.9	0.47
NH-C21-260	--	--	--	32
NH-C21-340	4.6	170	1.5	--
NH-C22-360	ND(0.51)	7.9	ND(0.4)	0.63
NH-C23-310	--	--	4	0.88
NH-C23-400	3.9	17	--	--
NH-C24-305	2.5	3.7	1.6	0.78
NH-C25-290	35	7.9	1.7	0.73
NHE-2	55.3	1300	7	440
NHE-3	10.7	97.6	2	31
NHE-4	16	39	3.3	6.77
NHE-6 [a]	10.9	19	0.88	4.11
NHE-7	6.92	97.8	2	1.62
NHE-8	11.1	44	1.6	1.2
NH-VPB-02	15	12	ND(0.5)	3.5
NH-VPB-05	1.3	82	ND(0.5)	5
NH-VPB-06	3.9	48	--	1.8
NH-VPB-07	2.8	0.39	ND(0.5)	1.1
NH-VPB-08	3.1	13	--	3
NH-VPB-10	0.074	0.73	--	ND(0.1)
PA1-MW3	150	45.1	ND(0.5)	1.8
PA1-MW4	66.5	14.8	ND(0.5)	1.6
PA1-MW5	136	52.3	ND(0.5)	2.4
PA1-MW6	105	43.1	ND(0.5)	4.96
B-Zone				
3851N	5.77	1.57	--	--
4909F [a]	14	50	1	1.5
4918A	1.7	4.4	ND(1)	ND(0.2)
4928A [a]	1.5	ND(0.12)	ND(1)	1.2
GW-11-352	10	9.9	5.2	0.65
GW-12A-349	12	5.9	3.3	3.6
GW-16-347	9.8	43	4.4	4.3
GW-17A	12	33	4.7	23
LB5-CW02	61.7	4.8	ND(0.5)	0.089
LB6-CW08	--	--	ND(0.5)	ND(0.1)
LB6-CW14	--	--	1.1	1.07
LC1-CW02	4.19	ND(0.5)	1.2	0.041
LC1-CW05	1.7	ND(0.5)	ND(0.5)	ND(0.1)

Table 4-1 Chemical of Concern Concentrations Used in Contouring
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Sample Location	Tetrachloroethene	Trichloroethene	1,4-Dioxane	Hexavalent Chromium
	µg/L	µg/L	µg/L	µg/L
NH-C02-325	4.1	14	1	1.3
NH-C03-380	4.4	2.7	ND(0.5)	2.1
NH-C05-460	2.2	120	--	0.26
NH-C22-460	ND(0.51)	7.2	ND(0.4)	0.17
NH-C24-410	ND(0.51)	1.6	ND(0.4)	0.7
Depth Region 1				
3830Q	2.84	0.68	ND(0.5)	ND(0.1)
3830S	18.1	400	2.2	10.8
3831Q	7.8	180	0.82	3.2
3851M	19.6	13	--	1.3
4899	5.6	ND(0.31)	ND(0.4)	0.22
4918 [a]	12.3	12.6	1.53	0.15
4918B	8.6	36.6	5.18	ND(0.14)
4928C [a]	10.3	0.26	ND(1)	1.07
4949C	1.77	3.44	--	--
GW-1	12	180	18	53100
GW-2	7.6	45	320	13000
GW-3	10	160	210	33100
GW-4	10	33	11	510
GW-5	19	30	90	4.3
GW-6	10	7.9	9.4	2
GW-7	66	1300	30	13000
GW-8	5.6	13	6.5	1.5
GW-9	7.3	24	5.6	1.7
GW-10	130	510	8.3	15
GW-11-273	99	340	--	91
GW-11-316	--	--	7.3	--
GW-12A-284	38	900	13	2700
GW-14A	9.7	64	60	140000
GW-14B	9.1	63	9.5	8800
GW-16-277	16	340	--	1300
GW-16-317	--	--	10	--
GW-17-282	43	1200	27	1300
GW-20	8.5	36	17	130
GW-21	13	30	9.7	8.5
GW-22	7	56	7.2	1200
GW-23	9.9	13	11	55
LA1-CW03R	200	130	1.5	ND(0.2)
LA1-CW07	1120	1720	ND(0.5)	2.03
LA1-CW09	111	40	1.4	--
LA-MW1	1.2	0.1	ND(1.9)	0.90
LA-MW2	1.3	0.1	0.47	0.81
LA-MW3	0.85	0.12	ND(2.1)	0.82
LB5-CW03	50.2	77	ND(0.5)	0.938
LB6-CW09	--	--	ND(0.8)	ND(0.04)
LB6-CW10	270	36	1.7	ND(0.2)
LB6-CW16	61.2	22.8	ND(0.8)	0.91
LB6-CW17	99.5	6.1	0.88	1.6
LC1-CW03	10.8	0.8	0.9	0.155
LC1-CW06	91.2	1240	1.1	0.82
LC1-CW08	163	23	2	0.137
NH-C01-325	58	6.5	ND(0.5)	0.34

Table 4-1 Chemical of Concern Concentrations Used in Contouring
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Sample Location	Tetrachloroethene	Trichloroethene	1,4-Dioxane	Hexavalent Chromium
	µg/L	µg/L	µg/L	µg/L
NH-C02-220	1.2	18	--	4.1
NH-C05-320	3.3	9.8	3	1.4
NH-C07-300	2.3	29	24	2.8
NH-C08-295	6.3	3	1.5	0.69
NH-C09-310	44	100	13	2.2
NH-C10-280	92	100	18	10
NH-C11-295	9.7	9.2	ND(0.4)	7
NH-C12-280	14	56	3.8	0.97
NH-C14-250	6.2	2.2	ND(0.4)	1.7
NH-C15-240	8.8	14	ND(0.4)	4.1
NH-C16-320	7.9	6.2	--	--
NH-C16-390	--	16	3.1	0.83
NH-C17-255	6.3	110	5.5	3.7
NH-C18-365	11	160	3.3	51
NH-C19-290	--	--	--	4
NH-C19-360	5.8	95	1.6	--
NH-C20-380	5.2	38	4.9	0.47
NH-C21-260	--	--	--	32
NH-C21-340	4.6	170	1.5	--
NH-C22-360	ND(0.51)	7.9	ND(0.4)	0.63
NH-C23-310	3.7	4.5	4	0.88
NH-C24-305	2.5	3.7	1.6	0.78
NH-C25-290	35	7.9	1.7	0.73
NHE-2	55.3	1300	7	440
NHE-3	10.7	97.6	2	31
NHE-4	16	39	3.3	6.77
NHE-7	6.92	97.8	2	1.62
NHE-8	11.1	44	1.6	1.2
NH-VPB-02	15	12	ND(0.5)	3.5
NH-VPB-05	1.3	82	ND(0.5)	5
NH-VPB-06	3.9	48	--	1.8
NH-VPB-07	2.8	0.39	ND(0.5)	1.1
NH-VPB-08	3.1	13	--	3
NH-VPB-10	0.074	0.73	--	ND(0.1)
PA1-MW3	150	45.1	ND(0.5)	1.8
PA1-MW4	66.5	14.8	ND(0.5)	1.6
PA1-MW5	136	52.3	ND(0.5)	2.4
PA1-MW6	105	43.1	ND(0.5)	4.96
Depth Region 2				
3851N	5.77	1.57	--	--
3850AB	230	44	1.5	12
4909F [a]	14	50	1	1.5
4918A	1.7	4.4	ND(1)	ND(0.2)
4928A [a]	1.5	ND(0.12)	ND(1)	1.2
GW-11-352	10	9.9	5.2	0.65
GW-12A-349	12	5.9	3.3	3.6
GW-15	130	920	8.9	240
GW-16-347	9.8	43	4.4	4.3
GW-17A	12	33	4.7	23
GW-18A	17	80	7.2	2.57
GW-19A	42	190	1.7	34
LA1-CW05	76.1	7.1	--	--

Table 4-1 Chemical of Concern Concentrations Used in Contouring
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Sample Location	Tetrachloroethene	Trichloroethene	1,4-Dioxane	Hexavalent Chromium
	µg/L	µg/L	µg/L	µg/L
LB5-CW02	61.7	4.8	ND(0.5)	0.089
LB6-CW08	--	--	ND(0.5)	ND(0.1)
LB6-CW14	--	--	1.1	1.07
LC1-CW02	4.19	ND(0.5)	1.2	0.041
LC1-CW05	1.7	ND(0.5)	ND(0.5)	ND(0.1)
NH-C02-325	4.1	14	1	1.3
NH-C03-380	4.4	2.7	ND(0.5)	2.1
NH-C05-460	2.2	120	--	0.26
NH-C10-360	8.2	3.6	1.6	0.66
NH-C12-360	3.9	12	2	0.46
NH-C13-385	0.57	15	ND(0.4)	0.83
NH-C15-330	6.7	14	ND(0.4)	2
NH-C17-339	3.7	45	1.6	2
NH-C23-400	3.9	17	2.1	0.37
NH-C24-410	ND(0.51)	1.6	ND(0.4)	0.7

Note: Maximum concentration used from 2008 to present used in contouring. Half of the detection limit was used for contouring.

Abbreviations:
µg/L = Micrograms per liter.
-- = Not available.
ND(#) = Not detected above the detection limit.

Footnotes:
[a] Not included in contouring because well is screened through multiple zones and sample depth association considered unreliable.

Table 5-1 Second Interim Remedy Design Data Gaps
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Data Gaps		AOC Scope Item (#) Treatment Options Memo Groundwater Model Memo	Consequence of Not Addressing	Benefit of Addressing	Category (C/S/M)	Recommended Resolution
No.	**Description**					
1a	Recent analytical data are insufficient to delineate the lateral and vertical extent of COC mass (and temporal variability) in the A-Zone and B-Zone throughout the NHOU study area	(1) Groundwater Monitoring	Not delineating the lateral and vertical extent of COCs (particularly in the A-Zone) within the existing NHE well field will prevent proper design of the new, expanded NHE well field.	Additional A-Zone groundwater samples near NHE-1 and B-Zone samples throughout the NHOU study area would facilitate delineating COC concentrations near replacement and/or new well locations and help optimize system design.	CRITICAL	(1) collect two semiannual A-Zone groundwater samples from NH-C14-250, NH-C18-270 and -365, NH-C19-290 and -360, NH-C21-260 and -340, NH-C24-305, 4909C, 4909F, 4919D, PST-MW1P, and PST-MW2P (2) collect two semiannual B-Zone groundwater samples from NH-C01-450, NH-C10-360, NH-C12-360, NH-C13-385, NH-C16-390, NH-C17-339, NH C18-365, NH C19-360, NH-C20-380, NH-C21-340, NH-C23-400, GW-18B, GW-19B, 4909C, 4909F, 4918A, and 4928A (3) Measure semiannual vertical flow (ambient) at wells NH-C05, NH-C10, NH-C16, NH-C19, and NH-C23 at seasonal extremes to evaluate the magnitude and direction of vertical flow through long-screened monitoring wells in response to seasonal pumping patterns (4) Install paired piezometer couplets with screens placed within the shallow and deep A-Zone to further evaluate the lateral and vertical extent of COCs near NHE-3, NHE-5, and NHE-7 (Figure 6-1)
		(2) NHE-1 Replacement	(1) Deepening NHE-1 to the proposed depth without confirming groundwater quality conditions will degrade B-Zone groundwater quality. (2) Not delineating the vertical extent of COCs within the A-Zone will prevent the proper design of the replacement well for NHE-1 (see Step 2, EPA 2008a).	Depth-discrete groundwater samples within the A-Zone near NHE-1 will confirm the need for replacement well(s) in this area and help optimize well location, screen depth, and system design.	CRITICAL	(1) remove NHE-1 well head and collect groundwater samples for COC analysis (2) evaluate retrofitting NH-10 production well with packers to collect depth-discrete groundwater samples within the A-Zone and B-Zone.
		(5) Construct New Wells	(1) Installation of new extraction wells without first confirming groundwater quality will degrade B-Zone groundwater quality upon operation. (2) Not delineating the vertical extent of COCs within the A-Zone will prevent the proper design of new NHE wells (see Step 2, EPA 2008a).	Depth-discrete groundwater samples from within the A-Zone near the 3 proposed new extraction wells will confirm the need for a replacement well(s) in this area and help optimize well location, screen depth, and system design.	CRITICAL	(1) evaluate data from NHE-1 and NH-10 from the sampling efforts described above (2) collect a continuous vertical profile of depth-discrete groundwater samples from NH-C19 and NH-C23 well screens and analyze samples for COCs. (3) following completion of the Preliminary Design Report, consider the need to install collocated monitoring wells (A through E, see Figure 6-1) to delineate the lateral extent of COCs and to modify the Second Interim Remdy per the Intermediate Design Report to meet RAOs and comply with CDPH 97-005 requirements
		Treatment Options Memo	Insufficient data increases the likelihood that the 2nd Interim Remedy design will not be adaptable or expandable to address influent variations and meet RAOs. This is particularly true regarding potential influence from future municipal pumping rates, which is intended to be addressed in the Groundwater Management Plan.	Additional data will allow for the design of a treatment system capable of handling the proper hydraulic range of flows and chemical concentrations. This will provide for more certainty and improved probability of successful performance.	CRITICAL	Resolve critical data gaps as noted above and incorporate Groundwater Management Plan into the Groundwater Modeling Memorandum.
1b	Insufficient groundwater chemistry data exist to characterize the lateral and vertical extent of COCs near existing NHE wells and to define the necessary target area	(1) Groundwater Monitoring	Necessary capture area cannot be determined without first characterizing the lateral extent of COCs to the west near NH-C09, NH-C19, and NH-C18 or to the east near LC1-CW06 (see Step 2, EPA 2008a). The vertical extent of needed hydraulic capture cannot be determined without additional depth-discrete data near NHE wells.	Further refining the plume north and west of the NHOU area will help assess whether detections at NH-C09 are contiguous or emanating from one or more other source areas (important to the CSM and has long-term remedial design implications). Additional depth-discrete data adjacent to existing NHE wells will establish the necessary vertical target capture area	CRITICAL	This data gap is anticipated to be resolved (at least partially) by implementing recommendations associated with data gap 1a and by piezometer couplets recommended below.
		(3) Repair/Replace Wells	(1) Installation of deeper extraction wells into the B-Zone would promote vertical migration from the A-Zone, degrade B-Zone groundwater quality, and reduce mass removal efficiency from each well. (2) Not delineating the vertical extent of COCs within the A-Zone will prevent the proper design of deeper NHE-2, NHE-4, and NHE-5 wells (see Step 2, EPA 2008a).	Depth-discrete groundwater samples from within the A-Zone near NHE-2, NHE-4, and NHE-5 will confirm the need for replacement well(s) and help optimize well location, screen depth, and system design.	CRITICAL	Install A-Zone piezometer couplets adjacent to NHE-3, NHE-5, and NHE-7 following evaluation of additional B-Zone groundwater analytical data to evaluate the vertical extent of COCs at those locations, observe drawdown in response to NHOU pumping, and estimate A-Zone hydraulic parameters.

Table 5-1 Second Interim Remedy Design Data Gaps
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Data Gaps		AOC Scope Item (#) Treatment Options Memo Groundwater Model Memo	Consequence of Not Addressing	Benefit of Addressing	Category (C/S/M)	Recommended Resolution
No.	**Description**					
1b	Insufficient groundwater chemistry data exist to characterize the lateral and vertical extent of COCs near existing NHE wells and to define the necessary target area	(5) Construct New Wells	Improper placement of new extraction wells will induce plume migration and degrade groundwater quality without first knowing the lateral continuity of TCE/PCE at NH-C09, NH-C19, and NH-C18 with NHOU plume (see Step 2, EPA 2008a).	Additional information delineating the lateral and vertical extent of COCs to the north and west of the NHOU area will increase the likelihood of designing an appropriate and effective capture zone and protect RT and NH (west) production wells.	CRITICAL	Reconsider the location of new extraction wells following evaluation of data generated from paired piezometer couplet(s) intended to resolve data gap 1a.
		(6) VOCs Treatment	Not collecting additional data, particularly within the A-Zone near the proposed extraction well locations, will prevent optimal design of the 2nd Interim Remedy because influent concentrations will need to be assumed based on insufficient data. This may lead to over- or under-budgeted capacity and treatment capability (particularly regarding emerging chemicals)	Additional depth-discrete data within the A-Zone at existing and proposed extraction well locations will reduce the number of assumptions regarding influent concentration and facilitate optimizing system design. Delineating the lateral extent and continuity of the plume will reduce the number of assumptions made regarding anticipated influent water quality and will increase the likelihood of preparing an optimal remediation design.	CRITICAL	(1) Analyze depth-discrete samples for hexavalent chromium, VOCs, and emerging chemicals from existing wells that are not part of the current monitoring network (2) Analyze groundwater samples from collocated piezomter couplets next to NHE-3, NHE-5, and NHE-7 following development and aquifer testing at each location (3) collect samples from Rinaldi-Toluca (RT) and North Hollywood (west) production wells and analyze them for 1,4-dioxane and NDMA to allow for comparison to data from NHOU area monitoring wells.
		(8) LADWP Delivery	Insufficient data will prevent the accurate preparation of raw water quality characterization and source water assessment.	Additional data will increase the accuracy of predicted influent water quality and increase confidence in remedy design.	M	Additional data will provide analysis for potential COCs as required for evaluation under CHPH 97-005.
		Groundwater Model Memo	Existing coarse resolution of lateral and vertical data prevents the meaningful revision and calibration of the groundwater flow model.	Higher resolution data would increase the accuracy of simulated flow conditions and improve the ability to calibrate the flow model.	M	The groundwater flow model will be restructured to more accurately account for the A-Zone and B-Zone (at least)
1c	Insufficient data exist to assess the temporal variability of groundwater quality in recently installed monitoring wells	(1) Groundwater Monitoring	Not collecting additional samples from recently installed cluster wells will prevent confirmation of COC concentrations and evaluation of responses to pumping patterns.	Additional samples from recently installed cluster wells (in particular) will provide information needed to assess whether COC concentrations vary seasonally or in response to pumping patterns or are stable (and thus predictable with respect to remedial design).	CRITICAL	Collect depth-discrete samples representing the A-Zone and B-Zone wells describe under AOC Scope Item 1 semiannually for one hydrologic cycle to evaluate temporal changes in groundwater quality with respect to COCs and emerging chemicals
2	Groundwater elevation data have not been measured from a sufficient number of wells surveyed to a common elevation datum (e.g., North American Vertical Datum of 1988 [NAVD88]) to verify and clarify groundwater flow directions, particularly north of Sherman Way	(1) Groundwater Monitoring	Not resolving the fact that SFV RI monitoring wells were surveyed to NGVD29 and recently installed cluster wells were surveyed to NAVD88 prevents meaningful analysis of calculated groundwater elevations throughout the study area without misleading findings.	Surveying all monitoring wells where groundwater elevations are collected to the same vertical datum (e.g., NAVD88) will allow for accurate evaluation of groundwater elevations, flow directions, and gradients.	CRITICAL	(1) Measure groundwater elevations quarterly for at least one year at cluster wells NH-C07 through NH-C25, in addition to RI monitoring wells, independent from collecting groundwater samples (i.e., within the same day if possible) (2) Survey reference points of wells (i.e., monitoring, extraction , etc.) used to measure depths to groundwater within the SFV to a common vertical datum (e.g., NAVD88) with an accuracy and precision consistent with GeoTracker specifications. Wells should be re-surveyed on a 10-year frequency and whenever the top of casing reference point has been modified.
		Groundwater Model Memo	Inconsistent vertical datum with surveyed reference points prevents reliable calibration of the numerical flow model.	Use of a common vertical datum for groundwater elevation measurements ensures that the numerical model is calibrated to an accurate and consistent observation data set.	CRITICAL	

Table 5-1 Second Interim Remedy Design Data Gaps
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Data Gaps No.	Data Gaps Description	AOC Scope Item (#) Treatment Options Memo Groundwater Model Memo	Consequence of Not Addressing	Benefit of Addressing	Category (C/S/M)	Recommended Resolution
3	Aquifer test results are insufficient to estimate hydraulic parameters specific to the A-Zone or B-Zone, which are needed to accurately simulate groundwater flow directions, NHE hydraulic capture areas, and influent pumping rates to the new treatment system	(2) NHE-1 Replacement	Lacking hydraulic parameter data of the A-Zone (in particular) near NHE-1 prevents developing an optimal design for the 2nd Interim Remedy.	Collection of hydraulic parameters of the A-Zone (and potentially B-Zone) near NHE-1 will improve the ability to predict the replacement well flow rate	CRITICAL	(1) Perform pneumatic slug tests at monitoring wells NH-C07-300, NH-C09-310, NH-C10-280, NH-C12-280, NH-C13-385, NH-C14-250, NH-C17-255, NH-C19-290, and NH-C23-310 to estimate A-Zone hydraulic parameters. (2) Perform pneumatic slug tests at wells screened primarily in the B-Zone, potentially including NH-C01-450, NH-C02-325, NH-C03-380, NH-C04-240, NH-C22-460, and NH-C24-410.
		(3) Repair/Replace Wells	Lacking hydraulic parameter data for the A-Zone (in particular) near the proposed three new extraction well locations and at existing NHE wells to be deepened prevents developing an optimal design for the 2nd Interim Remedy.	Collection of hydraulic parameters of the A-Zone (and potentially B-Zone) near proposed and existing NHOU extraction well locations will improve the ability to predict flow rates and the ability to contain and prevent migration to the Rinaldi-Toluca well field	CRITICAL	(1) Perform aquifer tests (potentially including slug or pressure pulse tests) at NHE-3, NHE-5, and NHE-7 with new piezometer couplets (1a) as observation wells to estimate A-Zone hydraulic parameters and to observe drawdowns to estimate lateral and vertical radii of influence of the extraction well. (2) Rehabilitate NHE-3, NHE-5, and NHE-7 and assess the degree of improved performance for consideration of rehabilitating other NHOU extraction wells.
		(5) Construct New Wells				
		(6) VOCs Treatment	Insufficient hydraulic parameter data from proposed new and modified extraction well locations inhibits the prediction of groundwater flow rates and influent COC concentrations, both of which are fundamentally important to designing the 2nd Interim Remedy.	Collection of hydraulic parameter data from proposed new and modified extraction wells will improve the ability to predict the NHOU treatment system capacity and influent water quality.	CRITICAL	Incorporate additional hydraulic data from aquifer testing recommended to resolve other AOC scope items impacted by this data gap.
		Treatment Options Memo	Insufficient A-Zone hydraulic parameter data at proposed new and modified extraction well locations inhibits the prediction of groundwater flow rates and influent COC concentrations, both of which are fundamentally important to designing the 2nd Interim Remedy.	Hydraulic parameters of the A-Zone will directly improve the probability that the 2nd Interim Remedy will meet RAOs.	CRITICAL	Incorporate additional hydraulic data from aquifer testing recommended to resolve other AOC scope items impacted by this data gap.
		Groundwater Model Memo	Lacking hydraulic parameter data of the A-Zone (in particular) at proposed new and modified extraction well locations reinforces the reliance upon groundwater model scenarios that have not been verified with empirical data.	Additional A-Zone hydraulic data will provide greater certainty with respect to delineating the size and extent of NHOU capture zones and improve the likelihood of correctly placing necessary extraction wells.	S	The hydraulic conductivity distribution simulated in the groundwater flow model will be revised to account for additional hydraulic parameter information obtained by resolving critical data gaps described herein
4	The monitoring well network is insufficient to characterize vadose zone and groundwater conditions beneath known and suspected source areas to further delineate the lateral and vertical extent of COC mass within the NHOU source area to achieve Second Interim Remedy RAOs	(1) Groundwater Monitoring	Not characterizing sources of contamination contributing to the NHOU plume(s) will prevent addressing RAOs regarding protection of the NH-west and Rinaldi-Toluca production wells.	As indicated by the EPA (2011), additional sampling performed at 22 suspected source areas and possibly at 13 other suspected source areas will help determine their contribution to the NHOU plumes; an additional 100 (approximately) suspected source areas have not yet been evaluated.	CRITICAL	Either obtain additional soil vapor and A-Zone groundwater quality data from these sites or revise the Second Interim Remedy such that protection of the Rinaldi-Toluca and NH-West production wells are no longer specified in the RAOs.
		(5) Construct New Wells	Incomplete source characterization will prevent designing an optimal and effective NHOU extraction well field.			
5	Objective projections of pumping and recharge volumes, including beyond year 2015, are not yet available, which prevents meaningful simulation of future groundwater flow conditions and elevations pertinent to the Second Interim Remedy design conditions pertinent to the Second Interim Remedy design	Groundwater Model Memo	FFS pumping scenarios (2007-2017) include higher discharge rates than have occurred since 2007 and than are projected until 2016; lacking objective/accurate predictive pumping rates and recharge operations will result in an over- or under-designed 2nd Interim Remedy design, particularly with respect to potential capture by the Rinaldi-Toluca and North Hollywood (west) well fields.	Objective pumping limits from the ULARA Watermaster will provide for a rational basis for predictive simulations and to optimize the 2nd Interim Remedy well field design/optimization.	CRITICAL	Either revise the predictive scenario timeline to comply with available ULARA Watermaster projections (i.e., 5 year projections) or coordinate with pertinent stakeholders to agree to a reasonable and annually updated long-term pumping projection data set for the purposes of designing the 2nd Interim Remedy. Revised pumping rates should be established in the Groundwater Management Plan (AOC Institutional Control).

Table 5-1 Second Interim Remedy Design Data Gaps
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Data Gaps No.	Data Gaps Description	AOC Scope Item (#) Treatment Options Memo Groundwater Model Memo	Consequence of Not Addressing	Benefit of Addressing	Category (C/S/M)	Recommended Resolution
6	Performance monitoring wells have not been installed and monitored, which are needed to demonstrate the size and shape of the existing NHOU extraction well capture area. Similarly, drawdown measurements at each extraction well have not been recorded for calculating well efficiency changes over time to support the need for well rehabilitation	(1) Groundwater Monitoring	Insufficient empirical groundwater elevation data prevent interpretation of actual capture and comparison to the target capture zone (see Step 6 of EPA, 2008a).	Additional monitoring wells placed within the anticipated existing and proposed capture zone will allow for delineating the size and extent of capture zones and comparison to the target capture zone(s).	CRITICAL	(1) Install pressure transducers in paired piezometers/monitoring wells recommended to resolve Data Gap 1a and evaluate pressure responses with respect to NHE well operations (i.e., start-up/shut-down events) and estimate the radius of influence (2) Install piezometer couplets (A-Zone) adjacent to NHE-3, NHE-5, and NHE-7 to observe drawdown associated with each of these extraction wells to estimate the radius of influence of each.
		Groundwater Model Memo	The absence of empirical data has prevented model calibration with respect to the NHE capture area under any given pumping scenario; that undermines confidence in model output and significantly limits confidence in model simulations used to develop the 2nd Interim Remedy design.	Additional monitoring wells placed within the anticipated capture zone will yield valuable groundwater elevation data (transient) that would empirically verify the size and extent of the existing capture zones and an improved basis for future projections.	CRITICAL	Refine the groundwater flow model calibration by incorporating data from new piezometer couplets, pressure transducer data, and updated pumping and spreading data from the ULARA Wastermaster.
7	The existing numerical groundwater flow model is not sufficiently structured or discretized vertically to evaluate hydraulic capture specifically within the A-Zone and potentially the B-Zone	(2) NHE-1 Replacement (3) Repair/Replace Wells (5) Construct New Wells Groundwater Model Memo	Ignoring hydrostratigraphic units within the groundwater model domain/structure prevents the accurate simulation of groundwater capture within the target capture zone, particularly with respect to the A-Zone and B-Zone.	Modifying the groundwater model structure to honor hydrostratigraphic units will allow for the meaningful simulation of hydraulic capture in one or more target capture zone depth intervals.	CRITICAL	Modify the model structure such that Model Layers 1 and 2 correlate with the A-Zone and B-Zone revised stratigraphy, respectively. Further model vertical discretization will likely be needed for calibration and/or simulations.
8	Available analytical data are insufficient to evaluate A-Zone and, potentially, B-Zone groundwater quality within the future NHOU capture zone to meet CDPH 97-005 requirements (specifically, the source water assessment component)	(8) LADWP Delivery	Without additional data, including analysis for emerging chemicals, the proper capture zones and remedy capacity and appropriate treatment train elements and sequencing cannot be designed for sufficient data provided to assure compliance with CDPH 97-005.	Collecting these data will allow for sufficient information to comply with CDPH 97-005 requirements.	CRITICAL	Evaluate data from depth-discrete groundwater quality data from wells as described under Data Gaps 1a, 1b, and 1c.
9	Vertical conduits throughout the NHOU study area have not been sufficiently evaluated to quantify the volume of groundwater and COC mass that is induced to depths below the A-Zone in response to various pumping patterns or scenarios	(5) Construct New Wells	Erroneous conclusions as to the mechanism for migration of COCs from the A-Zone to the B-Zone may lead to improper placement of deep proposed extraction wells and exacerbation of migration which might otherwise be prevented.	Assessment of potential conduits near apparent B-Zone hot spots may lead to simplified or shortened alternative remedies (e.g., seal off perforation zones with packers if well constructions allows).	CRITICAL	(1) perform vertical flow metering (heat pulse or spinner, or equivalent) to identify wells with the A-Zone target plume areas that exhibit significant vertical downward flow (2) collaborate with LADWP to evaluate potential retrofit options of NH-east production wells, including NH-10, NH-2, and NH-14A

Pre-Design Groundwater Modeling Memorandum deliverable

Treatment Options Memorandum deliverable

AOC Scope Items

(1) Groundwater Monitoring
(2) Replace Existing Extraction Well NHE-1
(3) Replace or Repair and Modify Existing Extraction Wells NHE-2, NHE-4, and NHE-5
(4) Wellhead Chromium and 1,4-Dioxane Treatment at NHE-2
(5) Construct New Extraction Wells
(6) Treatment of VOCs in Extracted Groundwater
(7) *Ex Situ* Chromium Treatment for Wells NHE-1, NEW-2, and NEW-3
(8) Delivery of Treated Groundwater to LADWP

APPENDIX A

NHOU EXTRACTION WELLS ASSESSMENT

APPENDIX A - NORTH HOLLYWOOD EXTRACTION WELLS ASSESSMENT

This appendix includes a detailed assessment of the design, construction, testing, and performance for each extraction well associated with the existing North Hollywood Operable Unit (NHOU) remedy. The subsurface of at each NHOU extraction (NHE) well location was initially investigated with a pilot borehole, each of which was geophysically logged (spontaneous potential, point resistivity, and 6-foot lateral resistivity) between September and October 1987 (Los Angeles Department of Water and Power [LADWP], 1987). All NHE wells were installed by March 1988.

A.1 NHE-1

The 20-inch-diameter borehole for this extraction well was advanced to a depth of 415 feet below ground surface (bgs) using the reverse rotary drilling method and was geophysically logged in September 1987. The 10-inch-diameter well screen was installed from 190 to 276 feet bgs with a 10-foot sump (i.e., the total well depth is 286 feet bgs) with an 8×16 gravel pack installed from 286 to 20 feet bgs. A cement grout seal was placed from 20 feet bgs to grade.

Groundwater was initially observed at 224 feet bgs and was measured at 232 feet bgs upon well completion. The well was pumped at 60 gallons per minute (gpm) for 6 hours and a drawdown of 18 feet was recorded, suggesting a specific capacity of 3.3 gpm per foot (gpm/ft). A single-well aquifer test was attempted in December 1987 by pumping NHE-1 at 50 gpm; however, hydraulic parameters were apparently not calculated and results were not included in LADWP records.

As described regarding other NHE wells herein, this specific capacity value is anomalously low and explains why NHE-1 was not brought into service as part of the NHOU system. Few details have been found regarding the operation of this extraction other than the fact 'it dewatered at very low rates of extraction' (CH2M Hill, 1996a). Whether a pumping rate below 50 gpm was attempted is not known. NHE-1 has reportedly never been operated as part of the NHOU system.

Monthly groundwater elevations measured between January 1993 and February 1994 indicate water levels rose from 4 feet/month to 2 feet/month, resembling long-term recovery from previous pumping. These levels correlated to groundwater elevations ranging from 470 feet mean sea level (MSL) in January 1993 to 510 feet MSL in February 1994, which are consistent with groundwater elevations monitored at NH-VPB-02 and other shallow wells. Rising water levels during this period correlate with above-average rainfall seasons and below-average pumping from nearby production wells, particularly at the Rinaldi-Toluca well field.

Groundwater samples were collected from NHE-1 15 times between 1997 and 2001. Results reflect erratic trichloroethene (TCE) concentrations fluctuating from below 50 micrograms per liter (µg/L) to almost 450 µg/L and tetrachloroethene (PCE) concentrations from approximately 4 µg/L to almost 50 µg/L. Samples were apparently not analyzed for other compounds currently of interest. Specifically, no data exist to indicate groundwater quality at this location with respect to hexavalent chromium and 1,4-dioxane.

A.2 NHE-2

The 20-inch-diameter borehole for this extraction well was advanced to a depth of 451 feet bgs using the reverse rotary drilling method and was geophysically logged in September 1987. The

0.050 slot-size 10-inch-diameter well screen was installed from 190 to 300 feet bgs with a 10-foot sump (i.e., total well depth is 310 feet bgs) with an 8×16 gravel pack installed from 310 to 20 feet bgs. A cement grout seal was placed from 20 feet bgs to grade. Extraction well NHE-2 was completed in December 1987.

As noted on the driller's log, groundwater was initially observed at 228.5 feet bgs and was measured at 228 feet bgs upon well completion. The well was pumped at 360 gpm for 4 hours, and a drawdown of 22.5 feet was recorded, suggesting a specific capacity of 16 gpm/ft. By comparison, an initial specific capacity of 26 gpm/ft was reported by the EPA (CH2M Hill, 1996a) at a sustained production rate of 270 gpm. LADWP records from a December 1987 step test (three steps) included specific capacity results varying from 26 to 28 gpm/ft at pumping rates of 347, 421, and 511 gpm; transmissivity was estimated at approximately 7,200 square feet per day (ft^2/d). Given the saturated thickness of 83 feet at the time, this value correlates to a hydraulic conductivity of approximately 86 feet per day (ft/d).

Monthly NHE-2 groundwater extraction rates have varied from below 10 gpm to approximately 150 gpm, with an average flow rate of approximately 60 gpm, since operations began. NHE-2 operations have been suspended more frequently that at other wells due to water quality issues (i.e., hexavalent chromium). Operations continued almost without interruption in water year 2008/09 with an average pumping rate of 80 gpm. The current flow rate (as of March 2010) is 140 gpm (MWH, 2010a).

TCE concentrations at NHE-2 typically exceed 50 µg/L and fluctuated to over 1,000 µg/L in 1997 and in 2007, both times associated with significant rainfall events in the preceding winter season. Concentrations rose above 600 µg/L in 2002, which was also preceded by a wet winter season. TCE concentrations declined to below 300 µg/L as of late 2010. PCE concentrations have remained below 50 µg/L since monitoring began, except for an increase in concentrations in 2007 similar to TCE and other constituents.

Chromium was used in the metal plating and aerospace industry (metal fabrication), and for corrosion inhibition in industrial cooling towers, from the 1940s through the 1980s. Thus, the primary analyte list since 2000 has included chromium (total and hexavalent) at the NHE wells. Highest concentrations were observed at NHE-2 but remained below 50 µg/L until July 2006 when, after a year of high rainfall and rising groundwater levels in the San Fernando Valley (SFV), total chromium concentrations rose above this threshold. Hexavalent chromium concentrations increased to over 400 µg/L in 2007 and caused total chromium concentrations in the combined NHOU treatment system effluent to exceed 30 µg/L (60 percent of the state MCL). As a result, California Department of Public Health (CDPH) advised LADWP to shut down well NHE-2 or divert the water produced by the well to nonpotable use.

NHE-2 remained shut down until September 2008, when the installation of a wellhead treatment unit capable of removing volatile organic compounds (VOC) and modification of the discharge piping were completed, resulting in treated effluent being discharged to the Los Angeles Bureau of Sanitation sewer system. This work was conducted by Honeywell (a corporate successor to Bendix) as an interim measure, pursuant to a Cleanup and Abatement Order (CAO) from the Regional Water Quality Control Board, Los Angeles Region (RWQCB-LA) requiring Honeywell to clean up the chromium contamination and to restore lost water caused by the shut-down of well NHE-2. As shown on Figure A-1, primary COCs removed by NHE-2 in 2008 include chromium and TCE (depicted by molar ratios).

The analyte list has included 1,4-dioxane since 2005 and concentrations have fluctuated from up to 7 µg/L in 2007 to approximately 3 µg/L since 2009 with an average of 3.97 µg/L. Declining 1,4-dioxane concentrations mirror those of chromium and TCE. This trend suggests that groundwater quality strongly correlates with groundwater elevations, which also declined during this period.

An NHE-2 treatment and disposal approach, including treatment for hexavalent chromium and 1,4-dioxane, to meet drinking water standards will be implemented separate from this remedial design (RD) by Honeywell but in coordination with the implementation of the NHOU Second Interim Remedy. Groundwater extracted from NHE-2 will be conveyed to and treated at the former Bendix facility treatment plant and reinjected to the shallow aquifer (MWH, 2010a). As of September 2009, over 2,100 pounds of VOCs had been removed from groundwater by operating NHE-2 since NHOU treatment operations began.

A.3 NHE-3

The 20-inch-diameter borehole for this extraction well was advanced to a depth of 400 feet bgs using the reverse rotary drilling method and was geophysically logged in September 1987. The 0.050 slot-size 10-inch-diameter well screen was installed from 190 to 286 feet bgs with a 10-foot sump (i.e., total well depth is 296 feet bgs) with an 8×16 gravel pack installed from 296 to 20 feet bgs. A cement grout seal was placed from 20 feet bgs to grade. Extraction well NHE-3 was completed in December 1987.

Groundwater was measured at 224 feet bgs initially and upon well completion. The well was pumped at 479 gpm for 6 hours, and a drawdown of 33 feet was recorded, suggesting a specific capacity of 14.5 gpm/ft. This result is similar to the initial specific capacity of 18 gpm/ft reported by the EPA (CH2M Hill, 1996a) at a sustained production rate of 130 gpm. LADWP records from a December 1987 step-test (three steps) included specific capacity results varying from 18 to 25 gpm/ft at pumping rates of 219, 294, and 479 gpm; transmissivity was estimated at approximately 8,500 ft^2/d. Given the saturated thickness of 74 feet at the time, this value of transmissivity correlates to a hydraulic conductivity of approximately 115 ft/d.

Monthly NHE-3 groundwater extraction rates have varied from below 10 gpm to approximately 370 gpm, with an average flow rate of approximately 110 gpm, since operations began. Since 2007, pumping rates have remained below 100 gpm, despite rebounding groundwater elevations in the NHOU study area. Insufficient data exist to determine the cause of this below average performance.

COCs removed by NHE-3 in 2008 included, in order of decreasing molar proportion, TCE, chromium, PCE, cis-1,2-dichlorethene (cis-1,2-DCE), and 1,4-dioxane, as illustrated on the pie chart on Figure A-2. TCE concentrations ranged from approximately 130 µg/L in the early 1990s to below 20 µg/L in 2006 to approximately 60 µg/L in 2010 with similar (but muted) temporal fluctuations, as observed at NHE-2. Hexavalent chromium concentrations were consistently observed below 10 µg/L until 2007 and have remained at approximately 15 µg/L following a short-duration spike to approximately 30 µg/L. 1,4-dioxane concentrations have remained below 2 µg/L for the period of record with an average of 1.24 µg/L. As of September 2009, over 600 pounds of VOCs had been removed from groundwater by operating NHE-3.

A.4 NHE-4

The 20-inch-diameter borehole for this extraction well was advanced to a depth of 450 feet bgs using the reverse rotary drilling method and was geophysically logged in September 1987. The

0.050 slot-size 10-inch-diameter well screen was installed from 180 to 280 feet bgs with a 10-foot sump (i.e., total well depth is 290 feet bgs) with an 8×16 gravel pack installed from 280 to 20 feet bgs. A cement grout seal was placed from 20 feet bgs to grade. Extraction well NHE-4 was completed in January 1988.

Groundwater was measured at 232 feet bgs initially and upon well completion. The well was pumped at 390 gpm for 4.5 hours, and a drawdown of 16 feet was recorded, suggesting a specific capacity of 24.4 gpm/ft. By comparison, an initial specific capacity of 17 gpm/ft was reported by the EPA (CH2M Hill, 1996a) at a sustained production rate of 150 gpm. LADWP records from a January 1988 step-test (three steps) included specific capacity results varying from 17 to 22 gpm/ft at pumping rates of 223, 295, and 384 gpm; transmissivity was estimated at approximately 4,900 ft^2/d. Given the saturated thickness of 73 feet at the time, this value correlates to a hydraulic conductivity of approximately 67 ft/d.

Monthly NHE-4 groundwater extraction rates have varied from below 10 gpm to approximately 350 gpm, with an average flow rate of approximately 75 gpm, since operations began. Between late 2006 and 2010, NHE-4 was apparently not operational despite rebounding groundwater elevations in the NHOU study area. Insufficient data exist to determine the cause of this period of non-operation; a new pump was installed on April 4, 2011 (LADWP, 2011).

COCs removed by NHE-4 in 2008 include, in order of decreasing molar proportion, TCE, chromium, PCE, 1,4-dioxane, and cis-1,2-DCE (Figure A-3). TCE concentrations ranged from approximately 200 µg/L in the early 1990s to generally below 75 µg/L since 1995 and had continued to decline to approximately 20 µg/L as of 2009. Hexavalent chromium concentrations declined from 14 µg/L in 2001 to approximately 4 µg/L in 2009. 1,4-dioxane concentrations have generally fluctuated between 2 and 3 µg/L for the period of record and with an average of 1.92 µg/L. As of September 2009, over 450 pounds of VOCs had been removed from groundwater by operating NHE-4.

A.5 NHE-5

The 20-inch-diameter borehole for this extraction well was advanced to a depth of 340 feet bgs using the reverse rotary drilling method and was geophysically logged in September 1987. The 0.050 slot-size 10-inch-diameter well screen was installed from 180 to 266 feet bgs with a 10-foot sump (i.e., total well depth is 290 feet bgs) with an 8×16 gravel pack installed from 276 to 20 feet bgs. A cement grout seal was placed from 20 feet bgs to grade. Extraction well NHE-5 was completed in January 1988.

Groundwater was measured at 211 feet bgs initially and upon well completion. The well was pumped at 380 gpm for 6.5 hours, and a drawdown of 31 feet was recorded, suggesting a specific capacity of 12.3 gpm/ft. An initial specific capacity of 16 gpm/ft was reported by the EPA (CH2M Hill, 1996a) at a sustained production rate of 150 gpm. LADWP records from a January 1988 step-test (three steps) included specific capacity results varying from 16 to 20 gpm/ft at pumping rates of 229, 302, and 391 gpm; transmissivity was estimated at approximately 2,700 ft^2/d. Given the saturated thickness of 66 feet at the time, this value correlates to a hydraulic conductivity of approximately 41 ft/d.

Monthly NHE-5 groundwater extraction rates have varied from below 10 gpm typically to approximately 150 gpm, with an average flow rate of approximately 30 gpm, since operations began. Since early 2006, NHE-5 has not been operational despite rebounding groundwater elevations in the NHOU study area. A maintenance record from Januray 30, 2006 (LADWP,

2011) indicates that the pump had locked up and caused the column to unscrew. Insufficient data exist to determine what caused the original pump to lock up, why the replacement pump apparently also failed, or why the problem(s) has not been corrected.

COCs removed by NHE-5 in 2008 included, in order of decreasing molar proportion, TCE, chromium, PCE, and cis-1,2-DCE (Figure A-4). TCE concentrations have ranged from approximately 80 µg/L in the early 1990s to below 50 µg/L since 2005; PCE concentrations have generally increased during this period to concentrations similar to those of TCE. Hexavalent chromium concentrations had increased from 10 to 15 µg/L between 2001 and 2007. Only one sample has been collected from NHE-5 (December 2004) that was analyzed for 1,4-dioxane, which was not detected; insufficient data thus exist to assess the presence or temporal variability of 1,4-dioxane at this well. As of September 2009, approximately 200 pounds of VOCs had been removed from groundwater by operating NHE-5.

A.6 NHE-6

The 20-inch-diameter borehole for this extraction well was advanced to a depth of 450 feet bgs using the reverse rotary drilling method and was geophysically logged in September 1987. The 0.050 slot-size 10-inch-diameter well screen was installed from 180 to 378 feet bgs with a 10-foot sump (i.e., total well depth is 388 feet bgs) with an 8×16 gravel pack installed from 388 to 20 feet bgs. A cement grout seal was placed from 20 feet bgs to grade. Extraction well NHE-5 was completed in February 1988.

Groundwater was measured at 205 feet bgs initially and upon well completion. The well was pumped at 500 gpm for 5.5 hours, and a drawdown of 18 feet was recorded, suggesting a specific capacity of 27.8 gpm/ft. By comparison, an initial specific capacity of 31 gpm/ft was reported by the EPA (CH2M Hill, 1996a) at a sustained production rate of 300 gpm. LADWP records from a February 1988 step-test (three steps) included specific capacity results varying from 31 to 32 gpm/ft at pumping rates of 218, 289, and 337 gpm; transmissivity was estimated at approximately 4,800 ft^2/d. Given the saturated thickness of 184 feet at the time, this value correlates to a hydraulic conductivity of approximately 26 ft/d.

Given the similar thickness of the upper zone at this location to other NHE well locations, it is not clear what rationale was used to design NHE-6 with a screen interval that penetrates both the upper and lower zones (including Depth Regions 1 and 2 and approximately 10 feet of Depth Region 3), unlike the other NHE wells. The specific capacity measured at this well is only slightly higher than that measured at NHE-2, despite the additional screen interval installed at NHE-6. Although resistivity logs suggest that the lower zone consists of coarser grain-size materials than the upper zone, the specific capacity test results suggest the hydraulic conductivity of the lower zone is similar to that of the upper zone. Depth-discrete aquifer testing has not been performed in the vicinity, and thus is it not possible to confirm this qualitative observation with a quantitative analysis.

Monthly NHE-6 groundwater extraction rates have varied from below 10 gpm to approximately 350 gpm, with an average flow rate of approximately 160 gpm, since operations began. Records indicate no change in yield since 2006 as occurred at NHE-3, NHE-4, and NHE-5.

COCs removed by NHE-6 in 2008 include, in order of decreasing molar proportion, TCE, PCE, chromium, cis-1,2-DCE, and 1,4-dioxane (Figure A-5). TCE concentrations ranged from approximately 100 µg/L in the early 1990s to approximately 10 µg/L since 1997; PCE concentrations have generally risen from approximately 5 µg/L in the early 1990s to approximately 10 μg/L since 2000. Hexavalent chromium concentrations declined from 4 μg/L in 2001 (with the exception of a single detection at 11.4 μg/L) to approximately 3 μg/L since 2009. 1,4-dioxane concentrations remained below 1 μg/L for the period of record with an average of 0.48 μg/L. Collectively, these analytical results indicate that concentrations decrease in the downgradient direction relative to NHE-2. As of September 2009, over 600 pounds of VOCs had been removed from groundwater by operating NHE-6.

A.7 NHE-7

The 20-inch-diameter borehole for this extraction well was advanced to a depth of 420 feet bgs using the reverse rotary drilling method and was geophysically logged in September 1987. The 0.050 slot-size 10-inch-diameter well screen was installed from 180 to 270 feet bgs with a 10-foot sump (i.e., total well depth is 280 feet bgs) with an 8×16 gravel pack installed from 280 to 20 feet bgs. A cement grout seal was placed from 20 feet bgs to grade. Extraction well NHE-7 was completed in March 1988.

Groundwater was measured at 201 feet bgs initially and upon well completion. The well was pumped at 353 gpm for 6.5 hours, and a drawdown of 9 feet was recorded, suggesting a specific capacity of 39 gpm/ft. By comparison, an initial specific capacity of 42 gpm/ft was reported by the EPA (CH2M Hill, 1996a) at a sustained production rate of 320 gpm. The NHE-7 resistivity log suggests fewer and thinner sand units in the shallow zone, relative to NHE wells farther west, which seemingly contradicts the higher specific capacity values at this location. LADWP records from a March 1988 step-test (three steps) included specific capacity results varying from 42 to 45 gpm/ft at pumping rates of approximately 170, 240, and 344 gpm; transmissivity was estimated at approximately 12,000 ft^2/d. Given the saturated thickness of 81 feet at the time, this value correlates to a hydraulic conductivity of approximately 148 ft/d.

Monthly NHE-7 groundwater extraction rates have varied from below 10 gpm to approximately 350 gpm, with an average flow rate of approximately 160 gpm, since operations began. Records indicate no change in yield since 2006 as occurred at NHE-3, NHE-4, and NHE-5.

COCs removed by NHE-7 in 2008 include, in order of decreasing molar proportion, TCE and to a much lesser extent, PCE, chromium, 1,4-dioxane, and cis-1,2-DCE (Figure A-6). TCE concentrations increased from below 50 μg/L to approximately 250 μg/L from the early 1990s to 2003 and have since declined to below 25 μg/L; PCE concentrations have generally remained below 5 μg/L for the period of record. Hexavalent chromium concentrations have generally remained below 2 μg/L since testing began in 2000. 1,4-dioxane concentrations have remained below 2 μg/L for the period of record with an average of 1.26 μg/L. Collectively, these analytical results represent a significantly different chemical signature than observed at other NHE wells. Based on this chemical signature and its distal eastward location (with respect to the North Hollywood area), contaminants in groundwater extracted by NHE-7 are more consistent with the Burbank Operable Unit (BOU) than with the NHOU. As of September 2009, over 2,300 pounds of VOCs had been removed from groundwater by operating NHE-7.

A.8 NHE-8

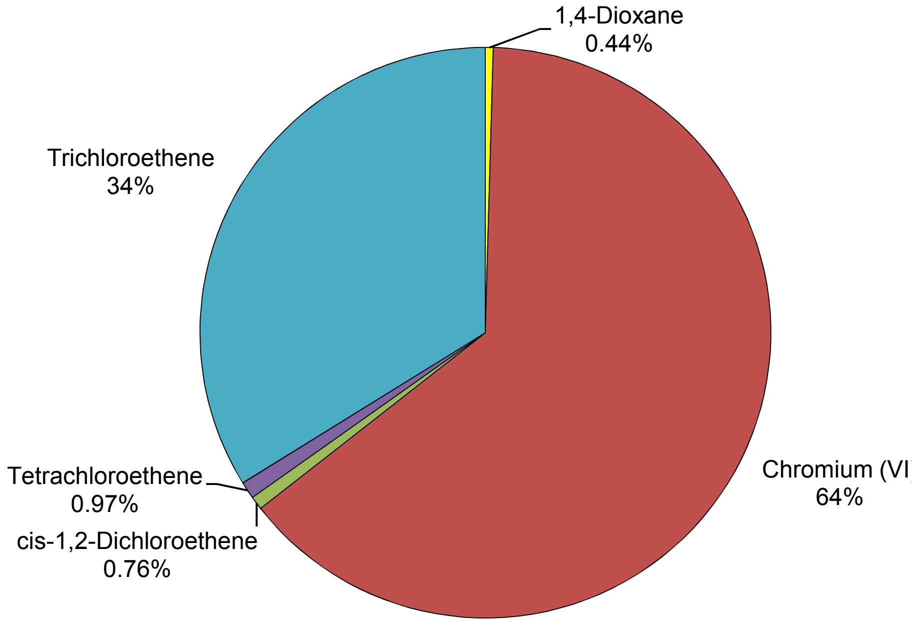
The 20-inch diameter borehole for this extraction well was advanced to a depth of 350 feet bgs using the reverse rotary drilling method and was geophysically logged in October 1987. The 0.050 slot-size 10-inch-diameter well screen was installed from 180 to 280 feet bgs with a 10-foot sump (i.e., total well depth is 290 feet bgs) with an 8×16 gravel pack installed from 290 to

20 feet bgs. A cement grout seal was placed from 20 feet bgs to grade. Extraction well NHE-8 was completed in March 1988.

Groundwater was measured at 194 feet bgs initially and upon well completion. The well was pumped at 464 gpm for 6.5 hours, and a drawdown of 10 feet was recorded, suggesting a specific capacity of 46.4 gpm/ft. By comparison, an initial specific capacity of 48 gpm/ft was reported by the EPA (CH2M Hill, 1996a) at a sustained production rate of 330 gpm. LADWP records from a March 1988 step-test (three steps) include specific capacity results varying from 48 to 54 gpm/ft at pumping rates of approximately 226, 313, and 464 gpm; transmissivity was estimated at approximately 26,600 ft^2/d. Given the saturated thickness of 98 feet at the time, this value correlates to a hydraulic conductivity of approximately 271 ft/d.

Monthly NHE-8 groundwater extraction rates have varied from below 10 gpm to approximately 300 gpm, with an average flow rate of approximately 170 gpm, since operations began. Records indicate that average pumping rates have been declining since 2006 from approximately 200 gpm to below 150 gpm in 2009.

COCs removed by NHE-8 in 2008 included, in order of decreasing molar proportion, TCE and PCE, and to a much lesser extent, chromium and 1,4-dioxane (Figure A-7). Although the overall signature is similar to that of NHE-7, increasing TCE concentrations peaked earlier at NHE-8 at a lower concentration (from below 50 µg/L in the early 1990s to approximately 150 µg/L in 1997) and have since declined to below 50 µg/L; PCE concentrations have declined from approximately 50 µg/L to below 10 µg/L. Hexavalent chromium concentrations have generally remained below 2 µg/L since testing began in 2000. 1,4-dioxane concentrations have remained below 2 µg/L for the period of record with an average of 0.95 µg/L. As mentioned above for NHE-7, the chemical signature at NHE-8 and its distal eastward location support that contaminants in groundwater extracted by NHE-8 originate from the VOC plume associated with the BOU rather than the NOU. As of September 2009, over 1,300 pounds of VOCs had been removed from groundwater by operating NHE-8.



Chemical of Concern	Number of Samples Detected	Number of Samples Analyzed	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	Performance Standards (µg/L)	Number of Samples Exceeding the Performance Standards	Mass Removed in 2008 (lbs)
1,4-Dioxane	28	30	1.9	7	1	28	0.50
Chromium (VI) *	94	94	7.9	440	5	94	42.57
cis-1,2-Dichloroethene	55	56	2.75	23	6	26	0.95
Tetrachloroethene	120	120	1.6	55.3	5	88	2.07
Trichloroethene	120	120	41	1300	5	120	56.86

* Based on discussion with LADWP, it is EPA's understanding that LADWP will continue to use a voluntary cleanup level of 5 µg/L for hexavalent chromium for water it will accept for use in its water supply system. Consequently, under the drinking water end use option, chromium treatment at the NHOU will be needed so that LADWP's voluntary cleanup level of 5 µg/L can be met.

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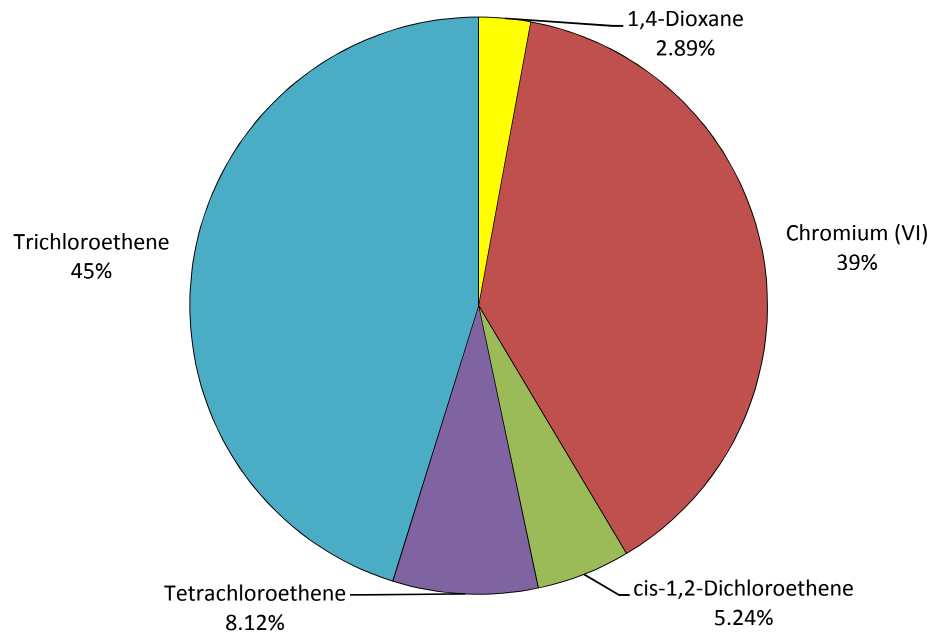
Chemicals of Concern Removed in 2008
North Hollywood Extraction Well NHE-2
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

A-1

DRAWN	Job Number	CHECKED	DATE
NAM	4088115718	SLC	8/2011



Chemical of Concern	Number of Samples Detected	Number of Samples Analyzed	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	Performance Standards (µg/L)	Number of Samples Exceeding the Performance Standards	Mass Removed in 2008 (lbs)
1,4-Dioxane	26	29	0.84	2	1	23	0.23
Chromium (VI) *	64	64	3.82	31	5	63	1.78
cis-1,2-Dichloroethene	60	61	0.647	3.7	6	0	0.45
Tetrachloroethene	129	130	1	15.4	5	94	1.20
Trichloroethene	130	130	7.68	138	5	130	5.29

* Based on discussion with LADWP, it is EPA's understanding that LADWP will continue to use a voluntary cleanup level of 5 µg/L for hexavalent chromium for water it will accept for use in its water supply system. Consequently, under the drinking water end use option, chromium treatment at the NHOU will be needed so that LADWP's voluntary cleanup level of 5 µg/L can be met.

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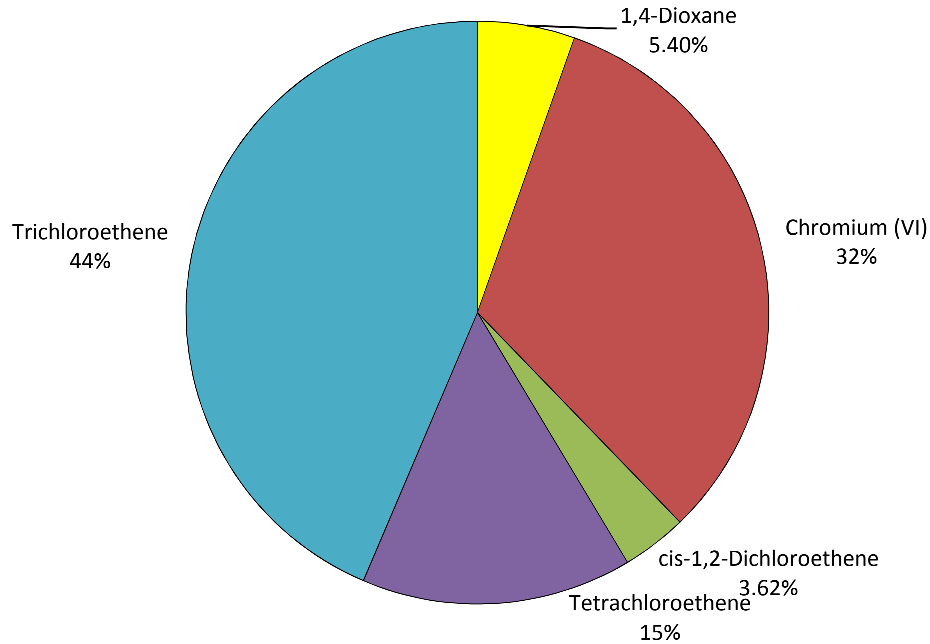
Chemicals of Concern Removed in 2008
North Hollywood Extraction Well NHE-3
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **A-2**

DRAWN	Job Number	CHECKED	DATE
NAM	4088115718	SLC	8/2011



Chemical of Concern	Number of Samples Detected	Number of Samples Analyzed	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	Performance Standards (µg/L)	Number of Samples Exceeding the Performance Standards	Mass Removed in 2008 (lbs)
1,4-Dioxane	12	15	1	3.3	1	11	0.03
Chromium (VI) *	45	46	1.34	14.1	5	19	0.12
cis-1,2-Dichloroethene	38	38	0.698	6.12	6	1	0.03
Tetrachloroethene	103	103	1	80.4	5	84	0.18
Trichloroethene	102	103	1.1	208	5	102	0.41

* Based on discussion with LADWP, it is EPA's understanding that LADWP will continue to use a voluntary cleanup level of 5 µg/L for hexavalent chromium for water it will accept for use in its water supply system. Consequently, under the drinking water end use option, chromium treatment at the NHOU will be needed so that LADWP's voluntary cleanup level of 5 µg/L can be met.

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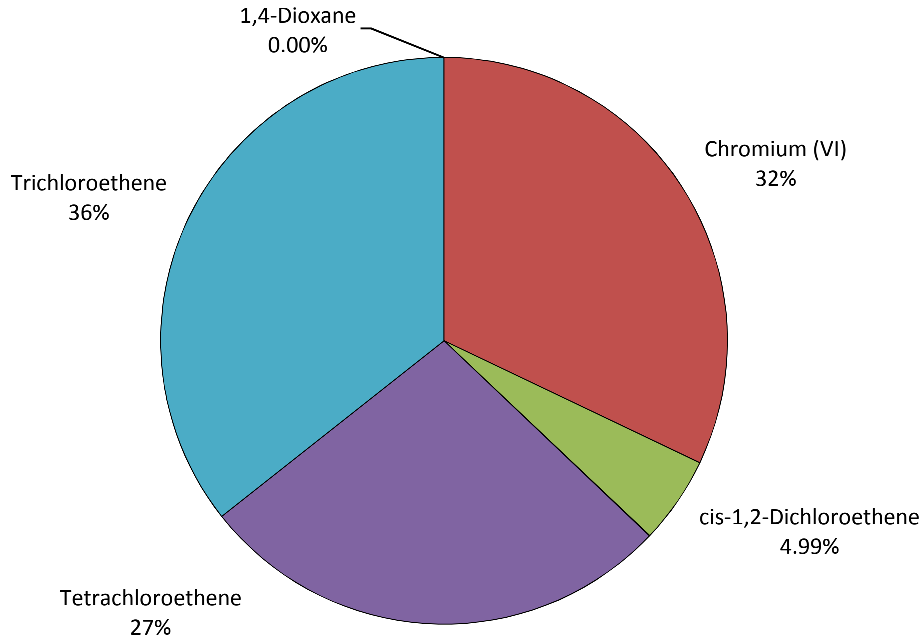
Chemicals of Concern Removed in 2008
North Hollywood Extraction Well NHE-4
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **A-3**

DRAWN	Job Number	CHECKED	DATE
NAM	4088115718	SLC	8/2011



Chemical of Concern	Number of Samples Detected	Number of Samples Analyzed	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	Performance Standards (µg/L)	Number of Samples Exceeding the Performance Standards	Mass Removed in 2008 (lbs)
1,4-Dioxane	0	1	0	0	1	0	0.00
Chromium (VI) *	16	16	4.2	16.3	5	16	2.38
cis-1,2-Dichloroethene	11	11	2.94	4.9	6	0	0.69
Tetrachloroethene	65	66	1.5	62	5	61	6.46
Trichloroethene	66	66	10.7	78	5	66	6.68

* Based on discussion with LADWP, it is EPA's understanding that LADWP will continue to use a voluntary cleanup level of 5 µg/L for hexavalent chromium for water it will accept for use in its water supply system. Consequently, under the drinking water end use option, chromium treatment at the NHOU will be needed so that LADWP's voluntary cleanup level of 5 µg/L can be met.

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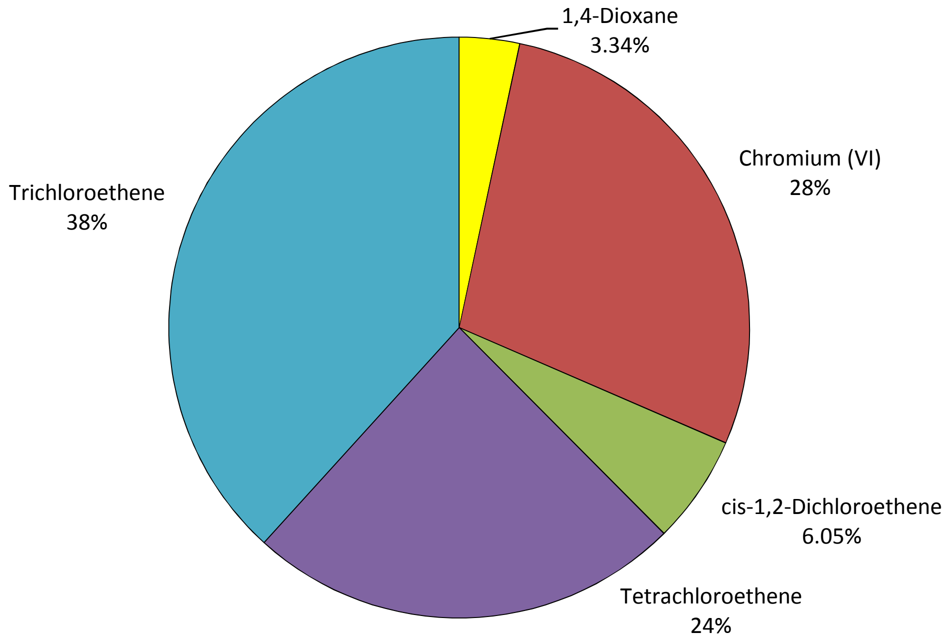
Chemicals of Concern Removed in 2008
North Hollywood Extraction Well NHE-5
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **A-4**

DRAWN	Job Number	CHECKED	DATE
NAM	4088115718	SLC	8/2011



Chemical of Concern	Number of Samples Detected	Number of Samples Analyzed	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	Performance Standards (µg/L)	Number of Samples Exceeding the Performance Standards	Mass Removed in 2008 (lbs)
1,4-Dioxane	21	33	0.57	0.88	1	0	0.44
Chromium (VI) *	58	58	1.4	11.4	5	1	2.19
cis-1,2-Dichloroethene	55	55	0.731	2.8	6	0	0.88
Tetrachloroethene	127	127	3	13	5	117	6.00
Trichloroethene	127	127	3.55	109	5	126	7.52

* Based on discussion with LADWP, it is EPA's understanding that LADWP will continue to use a voluntary cleanup level of 5 µg/L for hexavalent chromium for water it will accept for use in its water supply system. Consequently, under the drinking water end use option, chromium treatment at the NHOU will be needed so that LADWP's voluntary cleanup level of 5 µg/L can be met.

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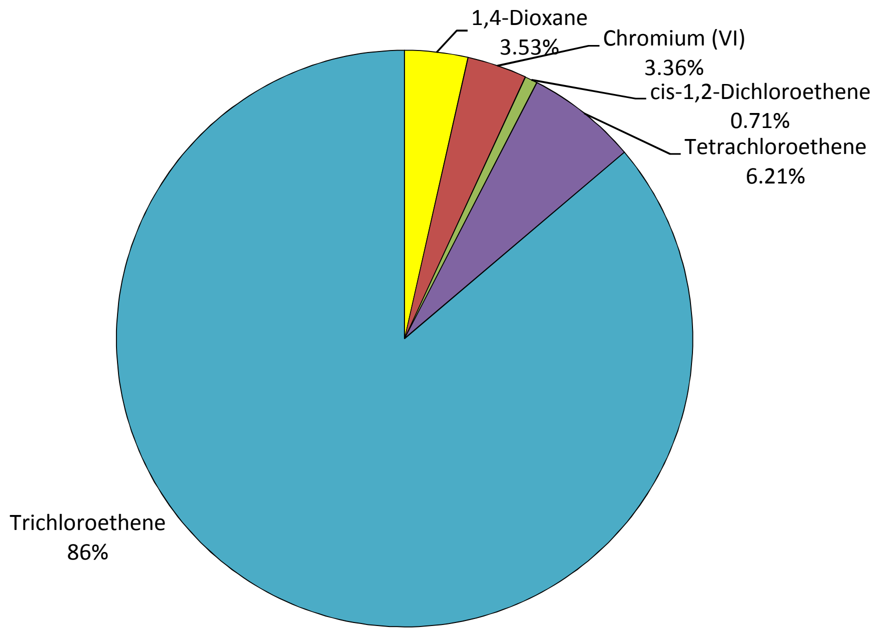
Chemicals of Concern Removed in 2008
North Hollywood Extraction Well NHE-6
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **A-5**

DRAWN	Job Number	CHECKED	DATE
NAM	4088115718	SLC	8/2011



Chemical of Concern	Number of Samples Detected	Number of Samples Analyzed	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	Performance Standards (µg/L)	Number of Samples Exceeding the Performance Standards	Mass Removed in 2008 (lbs)
1,4-Dioxane	26	33	0.97	2	1	24	1.35
Chromium (VI) *	26	64	1	2.87	5	0	0.76
cis-1,2-Dichloroethene	11	60	0.511	0.624	6	0	0.30
Tetrachloroethene	129	130	0.7	20.2	5	81	4.47
Trichloroethene	129	130	0.818	244	5	125	49.20

* Based on discussion with LADWP, it is EPA's understanding that LADWP will continue to use a voluntary cleanup level of 5 µg/L for hexavalent chromium for water it will accept for use in its water supply system. Consequently, under the drinking water end use option, chromium treatment at the NHOU will be needed so that LADWP's voluntary cleanup level of 5 µg/L can be met.

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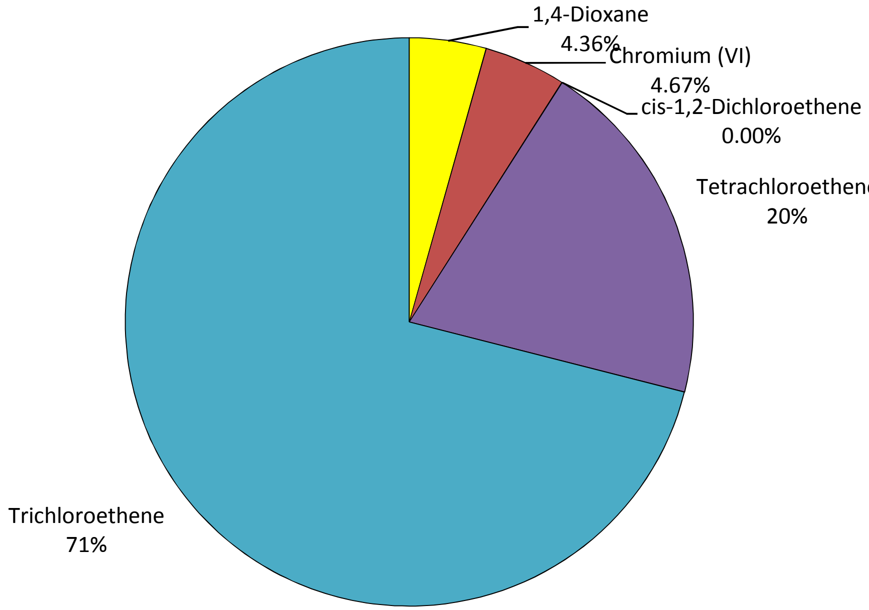
Chemicals of Concern Removed in 2008
North Hollywood Extraction Well NHE-7
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

A-6

DRAWN	Job Number	CHECKED	DATE
NAM	4088115718	SLC	8/2011



Chemical of Concern	Number of Samples Detected	Number of Samples Analyzed	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	Performance Standards (µg/L)	Number of Samples Exceeding the Performance Standards	Mass Removed in 2008 (lbs)
1,4-Dioxane	26	33	0.8	1.6	1	20	0.65
Chromium (VI) *	29	63	1	2.6	5	0	0.41
cis-1,2-Dichloroethene	2	59	4.82	10.2	6	2	0.00
Tetrachloroethene	128	129	4.2	76.7	5	127	5.60
Trichloroethene	128	129	9.19	225	5	128	15.81

* Based on discussion with LADWP, it is EPA's understanding that LADWP will continue to use a voluntary cleanup level of 5 µg/L for hexavalent chromium for water it will accept for use in its water supply system. Consequently, under the drinking water end use option, chromium treatment at the NHOU will be needed so that LADWP's voluntary cleanup level of 5 µg/L can be met.

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Chemicals of Concern Removed in 2008
North Hollywood Extraction Well NHE-8
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **A-7**

DRAWN	Job Number	CHECKED	DATE
NAM	4088115718	SLC	8/2011

APPENDIX B

PREVIOUS NHOU PERFORMANCE EVALUATIONS

APPENDIX B - PREVIOUS NHOU PERFORMANCE EVALUATIONS

Several assessments were conducted by the U.S. Environmental Protection Agency (EPA) to evaluate North Hollywood Operable Unit (NHOU) performance (CH2M Hill, 1996a) and to evaluate options to enhance its effectiveness (Los Angeles Department of Water and Power [LADWP, 2002, 2003]). General findings, concerns, and recommendations are discussed in the following sections.

B.1 Performance Evaluations

B.1.1 Evaluation of the North Hollywood Operable Unit Well Extraction System (LADWP, 1991a)

The NHOU was recognized at this time as not capable of meeting the 2,000 gallons per minute (gpm) design flow rate and the average treatment system flow of approximately 1,000 gpm was considered to low groundwater elevations in the upper zone as a result of an ongoing drought and pumping from nearby production well fields. This report was written to consider four alternatives to increase extraction of contaminated groundwater and meet the NHOU design flow capacity, including (1) installing a new extraction well next to NHE-1; (2) converting production NH-19 into a remediation well with a 1,000 gpm capacity; (3) constructing one shallow-zone extraction well near production wells NH-14, NH-17, or NH-18; and, (4) constructing one extraction shallow-intermediate zone well near production wells NH-14, NH-17, or NH-18.

Groundwater flow model simulations were used to evaluate the seven active NHE wells (NHE-1 could not be operated due to insufficient saturated thickness) in response to various pumping configurations at nearby production well fields and various groundwater elevations (i.e., normal versus drought conditions). The report concluded that the seven NHE wells met the remedial objective of maintaining a capture zone and limiting or halting contaminant migration, but that lacking an eighth NHOU extraction (NHE) well cost the system operational flexibility and impaired the ability to ensure that the hydraulic capture had adequate coverage. Importantly, it was recognized that "…there is no means to actually verify the effectiveness due to the lack of monitoring facilities for the NHOU."

Alternative No. 1 was dropped from further consideration in recognition of the (simulated) sensitivity to groundwater elevation fluctuations near NHE-1 in response to the Rinaldi-Toluca well field operations. In other words, it was determined at that time that upper zone groundwater elevations had already declined too much to sustain groundwater extraction in this area. No rationale was provided to explain why Alternative No. 2 was not recommended. Alternatives Nos. 3 and 4 are identical other than additionally extracting from the "intermediate zone" in the latter (partially equivalent to the B-Zone).

After evaluating these alternatives, LADWP favored Alternative No. 3 and provided the following specific recommendations:

1. Perform an aquifer test by installing a piezometric well near NHE-5 at a depth comparable to the depth of screen for NHE-5.
2. Install a vertical profile borehole (VFB) well near NH-16, NH-17, and NH-18 to determine whether VOC contamination in the upper zone consisted of two separate plumes or one larger plume. If TCE levels in the VPB well were comparable to the high concentrations in the two adjacent plumes, one or more aeration well(s) in this area might be required to develop a contiguous capture zone.

3. Install a cluster well (CW) consisting of a shallow well and a shallow-intermediate well downgradient of NHE-6, NHE-7, and NHE-8 to monitor changes to assess the NHOU effectiveness. This CW would also provide water quality data for the shallow-intermediate zone in this area.
4. Redevelop NHE-2 and others, if it is determined to be successful in improving well efficiency and extractions.
5. Construct one additional NHE well near either NH-14A or NH-17, if high TCE concentrations (100 mg/L) [sic] were found in the new VPB or near NH-18.
6. If high TCE concentrations were found in the shallow-intermediate zone from the new CW, further studies should be conducted to determine the extent of the deeper contaminant plume since the required extractions to contain the deeper plume might exceed the capacity of the NH Groundwater Treatment Facility.

Of these recommendations, cluster well NH-C02 appeared to meet the criteria of the third recommendation; however, this well cluster had already existed for a year when LADWP prepared this review, so it is unclear whether this recommendation was in reference to an additional monitoring well. Regarding the fourth recommendation, various redevelopment activities occurred at the NHE wells over time, apparently without significant improvement in production capacity. Other actions were not implemented with respect to the first, second, fifth, and sixth recommendations.

B.1.2 Evaluation of the Past and Potential Performance (CH2M Hill, 1996)

This evaluation was prepared for the EPA as an update to the 1992 *Draft North Hollywood Operable Unit Performance Evaluation* in response to the availability of four additional years of NHOU performance data and of the North Hollywood local groundwater flow model. The objectives of this review were to:

1. Evaluate the past performance of the NHOU remedial facility regarding the quantity and quality of extracted groundwater and the estimated area of achieved hydraulic control.
2. Evaluate the potential hydraulic control that could have been achieved if the NHOU facility had operated continuously at design rates during water years 1990-1994.
3. Evaluate the potential future hydraulic control that might be achieved assuming the NHOU facility operated continuously at either 50, 75, or 100 percent of design capacity during water years 1995-2010.
4. Evaluate the potential for a monitoring system to confirm the estimates of hydraulic control achieved by the NHOU facility.

This evaluation included operational data collected from December 1989 through September 1995. NHOU operations during this time period were discontinuous because of maintenance issues with well pumps, air and water treatment systems, and distribution systems receiving the treated water. The treatment system design capacity was 3,000 acre-feet per year (AF/Y; 1,857 gpm; based on an anticipated 300 gpm production from all eight aeration wells), NHOU was 36 percent operational during water years 1990-1994. With respect to the long-term capacity of 1,400 gpm, NHOU was 48 percent operational during water years 1990-1994.

Continuous operations were achieved during the second half of water year 1994 through September 1995, potentially as a result of a local rise in groundwater elevations since 1993. Low groundwater elevations were suspected to be the primary cause of lower than expected NHOU well yields.

Maximum trichloroethene (TCE) concentrations declined from approximately 500 micrograms per liter (μg/L) before late 1989 to near or below 100 μg/L, apparently in response to NHOU operations (initiated in December 1989). Tetrachloroethene (PCE) concentrations generally remained below 10 μg/L. Higher PCE concentrations observed at NHE-8 was recognized as indicating that this well was capturing at least a portion of the plume associated with the Burbank Operable Unit (BOU).

At the time, production wells NH-11 and NH-28 were operated in conjunction with what were then called the North Hollywood Advanced Oxidation Process (AOP) plant to remove volatile organic compounds (VOCs) from groundwater with a 3,000 gpm capacity. Operations of this AOP plant began in 1991and continued at a production rate of less than 600 gpm. Higher production rates were thwarted by logistical problems with the treatment facility and maintenance of the NH Complex distribution system. Anticipated TCE concentrations were also not realized and the demonstration plant was subsequently decommissioned. Wells NH-11 and NH-28 are collocated near NHE-4 and NH-C03; these findings suggest that VOC concentrations in Depth Region 2 were not as high as had been anticipated.

The area of hydraulic control achieved by the end of water year 1994 was estimated at 220 acres; had the NHOU operated continuously, hydraulic control could have been about double in terms of area and mass. Hydraulic control estimated for water years 1995-2010 was expected to increase the total capture area to approximately 1,100 acres (i.e., a 5-fold increase over the capture area established by 1994); complete capture of the plume was expected assuming even minimal NHE discharge rates (i.e., 50 percent of design capacity) in combination with the North Hollywood AOP plant. It was concluded that non-operation of the AOP plant might result in a narrow, hydraulically uncontrolled path between wells NHE-6 and NHE-7. All capture zone analysis conclusions were based on groundwater flow model simulation results.

The evaluation of the NHOU monitoring network noted that although NH-C03 was installed within approximately 100 feet of NHE-4, this cluster well was installed without a well screen penetrating the shallow zone (where NHOU groundwater extraction occurs). Thus it was concluded that no dedicated monitoring wells had been installed near the NHOU extraction well field. Perhaps for this reason, recommendations focused on the NHOU monitoring network and suggested the installation of additional monitoring wells within tens of feet of the NHOU extraction wells to confirm expected levels of drawdown in the shallow zone. Specific locations were not provided. Additionally, it was suggested that an additional monitoring well might be justified in the shallow zone between NHE-6 and NHE-7[5].

Also considered, but not included in the recommendations section, was the modification of several production wells near the NHE well field. The following production wells were considered as potential monitoring wells in the NHOU vicinity:

- NH-41 and NH-42 (near NHE-2); both were active production wells with perforations in the shallow zone that would need to be sealed from lower perforation zones
- NH-38 and NH-39 (near NHE-3); neither included perforations in the shallow zone
- WH-1 (between NHE-5 and NHE-6); included perforations in the shallow zone; not active
- NH-19 and NH-21 (near NHE-7 and NHE-8); both were active production wells with perforations in the shallow zone that would need to be sealed from lower perforation zones

Aquifer testing was also recommended during relatively static conditions after NHE wells were inactive for several days and production activity was minimal.

[5] NH-C14-250 was installed in this location in 2009.

B.1.3 Evaluation of the NHOU and Options to Enhance its Effectiveness (LADWP, 2003)

Although not stated explicitly, the impetus of this report appears to have been the detection of elevated hexavalent chromium concentrations (up to approximately 50 µg/L) at NHE-2 that led to the temporary shutdown of this well from September 2000 to June 2001[6]. The objectives of evaluating NHOU effectiveness included increasing NHOU production to fully utilize the 2,000 gpm treatment capacity, enhance the NHOU capture zone to protect upgradient (to the northwest) SFB production wells, and reduce the frequency, severity, and duration of NHOU outages.

Several reasons were stated to explain why NHOU production was lower than the design capacity, including:

- The Upper Zone was most sensitive to fluctuations to groundwater elevations that can decline during periods of low precipitation and recharge.
- NHOU wells were designed based on limited geologic and hydrogeologic data available in the early 1980s.
- Some NHOU wells had been throttled to maintain groundwater extraction at rates below the 300 gpm rated capacity, particularly during periods of drought.
- Too few NHOU wells existed to provide reserve production capacity to compensate for equipment failure or water quality issues that arose at individual wells.

Several potential improvements to the NHOU system were developed to overcome these issues, including:

1. Continue to coordinate with the RWQCB-LA to remediate the former Bendix facility source site and any other source sites that would be discovered within the capture zone of the NHOU (via RWQCB-LA CAO R4-2003-0037).
2. Coordinate with LADWP to perform flow model simulations to evaluate the benefit of up to three additional NHOU wells, each rated with a 300 gpm capacity, to increase NHOU production to at least 2,000 gpm and to restore upgradient containment of contamination.
3. Coordinate with LADWP to select the preferred option for the additional NHOU wells and arrange for their approval, installation, and operations.
4. Identify and evaluate possible treatment processes, including their waste disposal aspects, that can remove chromium and hexavalent chromium that could be potentially pilot-tested with NHOU well supply.
5. Coordinate with LADWP to select the additional groundwater treatment facilities that are determined to be needed to continue the NHOU operation and arrange for their approval, construction, and operations.

Regarding the additional extraction wells, LADWP considered five locations, including four locations within the high-voltage power transmission line right-of-way (north of NHE-2) and one on the Lankershim Yard property, all of which would be relatively near the NHOU collection line.

[6] Note that more significant chromium concentrations increases that occurred in 2007 led to a temporary shutdown of the entire system.

B.2 Five-Year Reviews

In 1993, 1998, 2003, and 2008, EPA conducted Level I five-year reviews (as required by CERCLA) to evaluate the protectiveness of the NHOU interim remedy. General findings, concerns, and recommendations include the following:

B.2.1 First NHOU Five-Year Review (EPA, 1993)

The first five-year review briefly summarized the background of the San Fernando Valley basin (SFB) superfund site and regulatory history leading to the NHOU remedy and concludes that, although the system was operating at lower than planned extraction rates, it was slowing migration of contaminants and was "effectively achieving its objective as stated in the ROD." Further evaluation was recommended with the then anticipated basin wide feasibility study.

EPA promulgated the first record of decision (ROD) in August 1987 with the objective to "slow down or arrest the migration of the contamination plume at the North Hollywood-Burbank Well Field as an interim measure while the San Fernando Valley RI/FS is being performed." Of the treatment methods considered (aeration, granular activated carbon [GAC], and aeration with vapour phase GAC [VPGAC]), the EPA selected aeration with VPGAC as the preferred alternative and acknowledged operable unit feasibility study (OUFS) findings that eight extraction wells would provide sufficient groundwater capture[7]. The statement in the AOC (section IV, paragraph 15) that the 1987 ROD 'called for 15 years of pumping…' seems to have originated from the 1993 Five-Year review. The ROD anticipated a useful life of the facility of 15 years and subsequent use of 15-year annualization for present net worth calculations, but did not otherwise explicitly limit the duration of groundwater extractions and treatment.

B.2.2 Second NHOU Five-Year Review (EPA, 1998b)

This five-year review focused on the distribution and concentration trends of TCE, PCE, and metals. The overall conclusion was that, based on data from 1992 to 1997, the NHOU system was achieving its objectives effectively, even at the reduced operating rates.

EPA noted that the extent of the TCE plume shrank rapidly between 1992 and 1994 and that the NHOU might be "partially responsible" for concentrations declining below 200 µg/L in 1992 and below 100 µg/L in 1994. TCE concentrations were noted as increasing between 1995 to 1997 at NHE-2, and it was concluded that this reversal in trend represented "the arrival of a contaminant pulse that may have originated from ongoing contaminant transport, changes in groundwater flow conditions, changes in contaminant source conditions, or an increase in hydraulic control associated with the recent consistent operation of the NHOU groundwater facility."

PCE concentrations were noted as stable throughout this review, with the highest concentrations consistently being observed at NHE-8. The review concluded that NHE-8 was extracting groundwater contamination that originated from the BOU. Chromium was not included in the metals assessment, and no groundwater quality issues resulting from other metals concentration were identified.

As of December 1997, the NHOU treatment facility had processed approximately 7,500 acre-feet (2.44 billion gallons) of contaminated groundwater and, assuming it had operated continuously since 1989, was estimated to have potentially removed approximately 2,800

[7] The EPA also acknowledged the OUFS conclusion that "…the exact location of each of the eight wells was unimportant as long as they are spaced somewhat evenly across the contaminant area and arranged perpendicular to regional groundwater flow, which is toward the southeast." Given that proposed extraction wells were known to be aligned with a northwest-southeast configuration, the EPA's condition that wells be arranged "perpendicular to regional groundwater flow" presumably was intended to refer to groundwater elevation contours rather than to groundwater flow direction.

pounds of VOCs. No attempt was made to account for the actual operational runtime and calculate the actual mass of VOCs removed.

Further assessment of the NHOU system and capture area was conducted with the use of the groundwater flow model rather than with empirical data. The review recommended that more accurate water-level data from recently installed pressure transducers be used to refine and verify the groundwater flow model results. Additional recommendations included performing an engineering review should NHOU operational runtime become intermittent and for the LADWP to post the facility sign where it would be more visible.

B.2.3 Third NHOU Five-Year Review (EPA, 2003)

EPA reported in this five-year review that the TCE and PCE groundwater plume that the remedy was designed to capture was migrating vertically and laterally beyond the remedy's zone of hydraulic control. This conclusion was based largely on EPA's evaluation of the current NHOU groundwater conditions and LADWP findings in the *Draft Evaluation of the North Hollywood Operable Unit and Options to Enhance Its Effectiveness* (LADWP, 2002). The *Final Evaluation of the North Hollywood Operable Unit and Options to Enhance Its Effectiveness* (LADWP, 2003) also raised concerns regarding detections of total and hexavalent chromium in extraction well NHE-2 of the NHOU interim remedy. Well NHE-2 is a short distance from the former Bendix facility, one of the known VOC sources in the NHOU.

The following is the EPA's concluding protective statement:

> *The interim remedy at the NHOU currently protects human health and the environment because the concentration of TCE and PCE in treated groundwater is less than ROD selected clean-up goals and no other potential COCs currently exceed health-based standards. However, in order for the remedy to be protective of human health and the environment in the long-term, VOC plume containment should be addressed to control potential exposure pathways to ensure continued protectiveness. In addition, there should be ongoing reporting of extraction well concentrations of total chromium, hexavalent chromium, and perchlorate, COCs not previously identified in the ROD. Additional sampling and reporting is recommended. In order to provide continued protectiveness in the long-term, periodic review of emergent chemical concentrations and their associated MCLs or risk-based treatment standards should be made.*
>
> *A protectiveness determination for Area 1 as a whole cannot be made at this time until the five-year review report is complete for the Burbank OU. It is expected that this will be completed during 2004. This site-wide review will address the long-term protectiveness issues noted above.*

With respect to NHOU, as reported in the 2004 five-year review for the BOU:

> *The findings of this review and the NHOU five-year review, which was completed in September 2003, both concluded that VOC plume containment should be evaluated and addressed to ensure continued protectiveness…In the future, protectiveness determinations will be made for Area 1 (BOU and NHOU) together as a whole. The next five-year review for Area 1 will be conducted on or before September 2009.*

B.2.4 Fourth NHOU Five-Year Review (EPA, 2008b)

As indicated above, this five-year review was prepared to collectively address SFV Area 1, including both the BOU and NHOU. Recommendations and issues noted in previous NHOU five-year reviews were summarized and addressed, including reference to the draft Focused

Feasibility Study (released in February 2008), status updates regarding improved coordination within LADWP management since 2003, and more comprehensive reporting of NHOU operations by LADWP.

In addition to acknowledging that NHOU was not designed to remove chromium from groundwater, EPA mentioned other emergent chemicals of concern, including 1,2,3-trichloropropane (1,2,3-TCP; occasionally detected at NHE-2 and NHE-5 at concentrations above the notification level of 0.005 μg/L) and 1,4-dioxane (consistently detected at NHE-2 at concentrations above the notification level, then 3 μg/L). There was no need to augment NHOU treatment for these compounds because their concentrations in the influent water were below notification levels.

EPA concluded that "…the system is considered to be meeting the objective of inhibiting migration of contamination in the North Hollywood area, although it has not yet completely contained all contaminant migration, particularly in the Deep Zone." Although the original NHOU remedial objective was "to slow down or arrest the migration of the contamination plume at the North Hollywood-Burbank well field as an interim measure…", rather than to "completely contain all contaminant migration," several factors were identified as to why complete migration had been inhibited, including:

1. The NHOU extraction well field was designed primarily to contain the high concentration cores of two Shallow Zone VOC plumes. By the time the extraction wells began operation in 1989, some VOC contamination in NHOU groundwater had already migrated laterally or vertically beyond the zone of hydraulic control that the extraction wells were designed to achieve.
2. During and soon after construction of the NHOU extraction wells and treatment system, LADWP completed construction of the Rinaldi-Toluca water-supply well field in North Hollywood and the Tujunga well field immediately to the north, in Pacoima. The production wells in these well fields withdrew groundwater primarily from deeper aquifer zones (below the Shallow Zone). Operation of these two new water-supply well fields contributed to regional groundwater level drawdown that extended to the NHOU extraction wells.
3. The system had experienced operation and maintenance issues that have limited its performance, further diminishing the long-term average pumping rate and the extent of hydraulic containment achieved by the NHOU extraction wells.
4. Detection of high chromium concentrations at extraction well NHE-2 caused this well to be shut down through much of 2007 and 2008. Well NHE-2 is the closest extraction well to the high concentration VOC and chromium plume emanating from the former Bendix facility and, therefore, its operation was important for limiting contaminant migration in the NHOU.

Regarding the NHOU, the EPA identified an issue that "some groundwater migration from areas with high levels of COCs to areas of lower levels or no contamination has occurred" and suggested a follow-up action with a 2009 milestone date to complete the FFS and select a remedy improvement that will achieve more effective plume containment.

The concluding protectiveness statement states:

> *The remedy for the NHOU is protective of human health and the environment in the short-term because there is no exposure to untreated groundwater. The treatment*

system effluent contaminant concentrations are less than their regulatory cleanup goals. There are governmental controls in place that prevent exposure to untreated groundwater. However, to be protective in the long term, the treatment facility needs to be modified to treat chromium and the extraction system needs modifications to improve plume containment. EPA is completing a focused feasibility study to evaluate options for expanding and improving the performance of the NHOU remedy and expects to propose and later select a second interim remedy in 2009 that will enhance plume capture and add chromium treatment.

B.3 Focused Feasibility Study (EPA, 2009a)

As stated in this report, the inability of the existing NHOU system to fully contain the groundwater (VOC) plume combined with the discovery of new contaminants (e.g., chromium, 1,4-dioxane, 1,2,3-TCP) necessitated the selection and implementation of a new NHOU remedy. The planned improved remedy was referred to in this FFS as the Second Interim Remedy, which was intended to address the continued presence of significant VOC contamination in groundwater, the presence of chromium and other emerging chemicals in exceedance of the MCLs or State notification levels, and the need to achieve more complete capture of the VOC plume. It was acknowledged that the Second Interim Remedy was not intended to restore the aquifer, in part because additional data were needed to better define the problem before determining appropriate remedial actions for all AOC areas. Rather, this Second Interim Remedy, similar to the original, was intended to prevent further migration of the known high-concentration contaminant plumes and to collected additional data to evaluate the need for further remedial action.

An FFS data evaluation, primarily focused on TCE, PCE, and chromium, was performed to provide an updated interpretation of NHOU groundwater contamination, delineate target volumes for groundwater remediation, provide updated hydrogeologic data for groundwater modeling, provide a foundation to develop an improved monitoring well network to further define the extent of groundwater contamination, and to assist in the selection of a preferred remedial alternative for the Second Interim Remedy. As acknowledged in this report, "*…the fact that EPA does not have data or has limited data from some facilities is not an indication that a particular facility did not contribute to the contamination. It is possible that additional sources or facilities that have not yet been identified have contributed, or are contributing, to groundwater contamination in the NHOU.*"

The distributions of TCE and PCE were described with respect to Depth Region 1 and Depth Regions 2 through 4, whereas chromium was discussed primarily with respect to Depth Region 1 (noting that elevated chromium concentrations in Depth Region 2 in the NHOU vicinity were limited to the former Bendix facility). Other emerging chemicals evaluated included 1,2,3-TCP, 1,4-dioxane, n-nitrosodimethylamine (NDMA), and perchlorate.

The primary cleanup goal for the Second Interim Remedy was to achieve containment of the most significant concentrations of the VOC- and chromium-contaminated groundwater. RAOs included in the FFS were as follows:

- Contain areas of contaminated groundwater that exceed the MCLs and notification levels to the maximum extent practicable.
- Prevent further degradation of water quality at the Rinaldi-Toluca and North Hollywood west production wells by preventing the migration toward these well fields of the more highly contaminated areas of the VOC plume to the east-southeast.

- Achieve improved hydraulic containment to inhibit horizontal and vertical contaminant migration in groundwater from the more highly contaminated areas and depths of the aquifer to the less contaminated areas and depths of the aquifer, including the southeast portion of the NHOU near the Erwin and Whitnall production well fields.
- Remove contaminant mass from the aquifer.

Remedial alternatives considered as part of the FFS included:

Alternative No. 1. Existing NHOU Extraction and Treatment System (i.e., no further action)

Alternative No. 2. Expand Extraction Well System and Operate Chromium Wellhead Treatment Systems at Extraction Wells NHE-1 and NHE-2

Alternative No. 3. Expand Extraction Well System and Operate Chromium Treatment System for Combined Effluent from Extraction Wells NHE-1 and NHE-2

Alternative No. 4. Expand Extraction Well System and Operate Ex Situ Chromium Treatment System for Multiple Extraction wells

Alternative No. 5. Expand Extraction Well System and Operate Ex Situ Chromium Treatment System for All Extraction Wells

Remedial actions common to each alternative included the following:

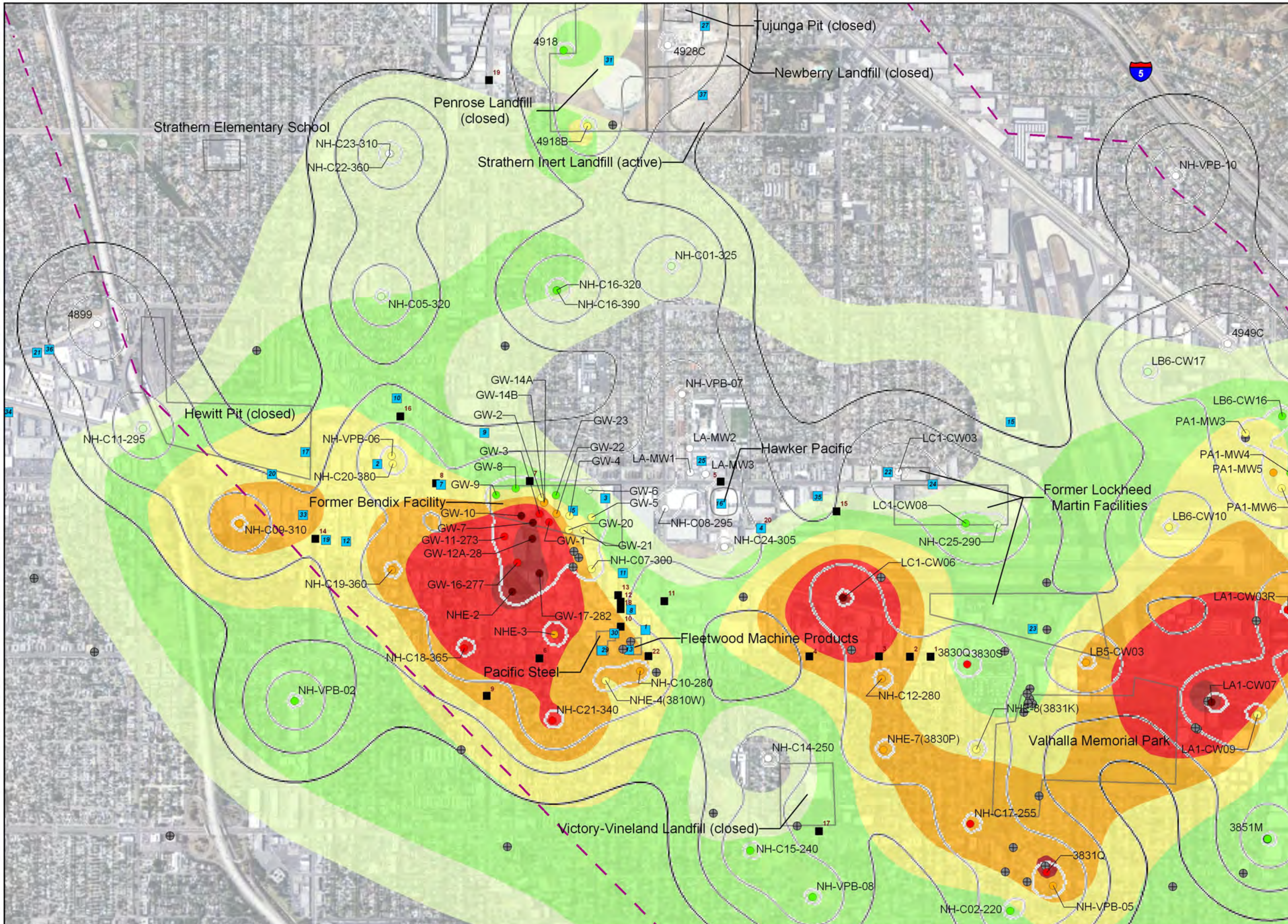
- Institutional controls in the form of a groundwater management plan to mitigate the potential negative impacts to the NHOU system performance that could result from unexpected groundwater withdrawal by LADWP in and near the NHOU.
- Groundwater and treatment system monitoring, including approximately 37 new groundwater monitoring wells.
- Wellhead treatment at extraction well NHE-2 to remove 1,4-dioxane.
- Chromium treatment for groundwater extracted by NHE-2.

Various recommendations were made to implement Alternatives 2 through 5, including repairing and/or deepening extraction wells NHE-1 through NHE-8, constructing up to three new extraction wells northwest of the existing NHOU well field, refurbish the existing air stripper and add a second air stripper, and providing chromium treatment for extraction wells in addition to NHE-2. One set of alternatives (2a, 3a, 4a, and 5a) was prepared to allow for discharge of treated groundwater to the LADWP water supply system. A second set of alternatives (2b, 3b, 4b, and 5b) was prepared to allow for reinjection of treated groundwater to the SFB (requiring the installation of six injection wells and additional monitoring wells). Costs were evaluated comparatively with an assumed O&M duration of 30 years.

EPA selected Alternative 4a as its preferred alternative, which included the installation of three new extraction wells, the modification/rehabilitation of existing extraction wells, expanded VOC treatment, chromium treatment for NHE-1 and NHE-2 and for two of the new extraction wells, and discharge of treated groundwater to the LADWP water supply system. This preferred alternative was subsequently incorporated into the September 2009 Second Interim Action ROD for the NHOU.

APPENDIX C

DEPTH REGIONS 1 AND 2 COC CONCENTRATION CONTOUR MAPS



EXPLANATION

Well with Concentration (ug/L)

- <5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- 100 - 500
- >500

Well without Sample Data (Since 2007)

Concentration Contours (ug/L)

- 5-10
- 10-25
- 25-50
- 50-100
- 100-500
- >500

Standard Deviation (ug/L)

- 10
- 8
- 6
- 4

Approximate Boundary San Fernando Valley Investigation Area 1

Facilities with Known Releases

EPA-Listed Facilities with Potential Releases

Known and suspected release areas are listed on Table 3-7

N

0 1,500 3,000 Feet

Aerial Photograph: DigitalGlobe, June 2009

DRAWN: TJH	PROJECT NO: 4088115718		
ENGINEER:	SCALE: AS SHOWN		
CHECKED:	APPROVED:		
DATE: 8/2011	DATE:		

amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Depth Region 1
TCE Concentration Contours
(Maximum Concentrations, 2008-2011)

FIGURE
C-1a

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EXPLANATION

Well with Concentration (ug/L)

- <5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- 100 - 500
- >500

Well without Sample Data (Since 2007)

Concentration Contours (ug/L)

- 5-10
- 10-25
- 25-50
- 50-100
- 100-500
- >500

Standard Deviation (ug/L)

- 10
- 8
- 6
- 4

Approximate Boundary San Fernando Valley Investigation Area 1

Facilities with Known Releases

EPA-Listed Facilities with Potential Releases

Known and suspected release areas are listed on Table 3-7

N

0 1,500 3,000 Feet

Aerial Photograph: DigitalGlobe, June 2009

DRAWN: TJH	PROJECT NO: 4088115718		
ENGINEER:	SCALE: AS SHOWN		
CHECKED:	APPROVED:		
DATE: 8/2011	DATE:		

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Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Depth Region 2
TCE Concentration Contours
(Maximum Concentrations, 2007-2011)

FIGURE
C-1b

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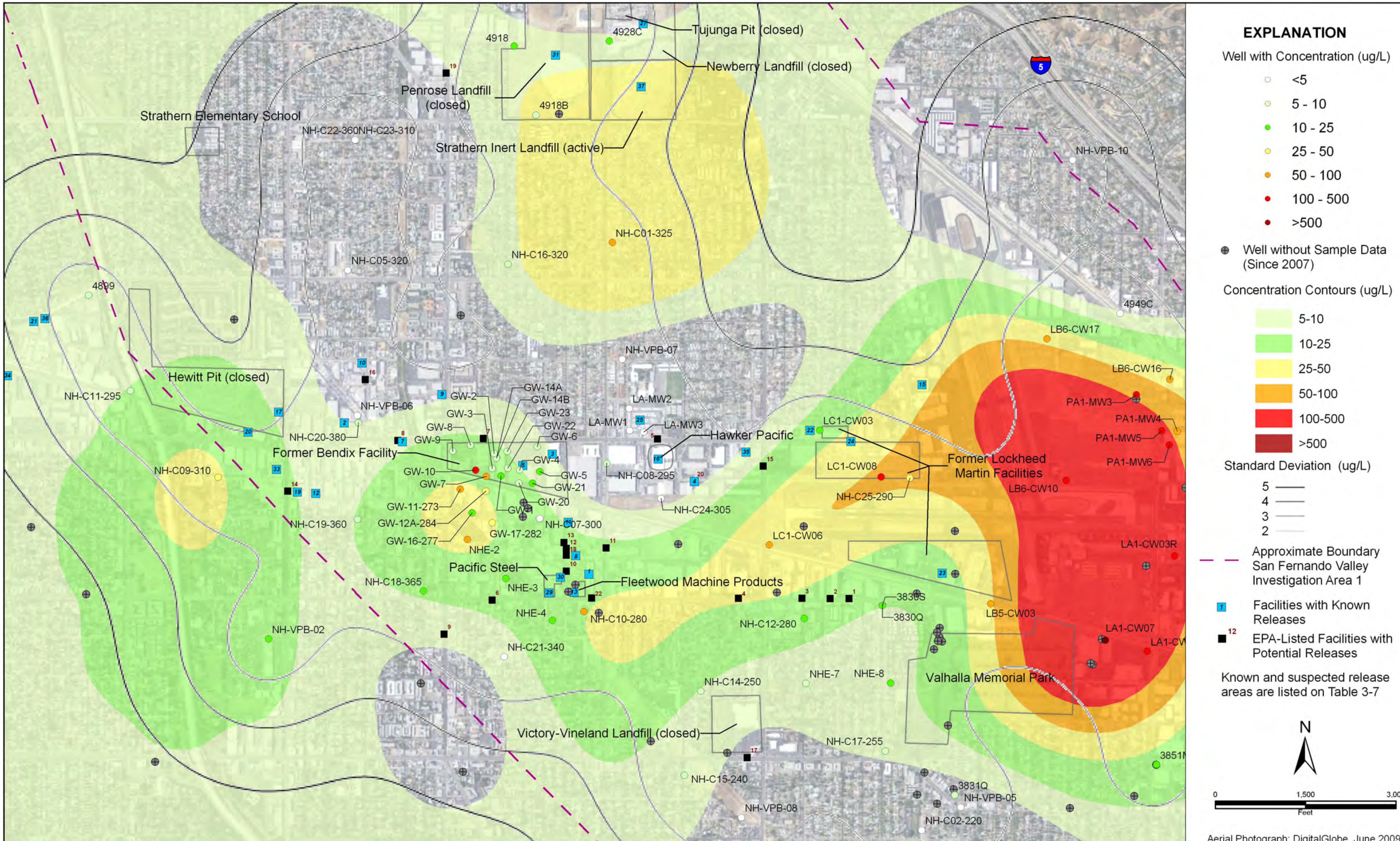

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ENGINEER:	SCALE: AS SHOWN
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DATE: 8/2011	DATE:

amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Depth Region 1
PCE Concentration Contours
(Maximum Concentrations, 2007-2011)

FIGURE
C-2a

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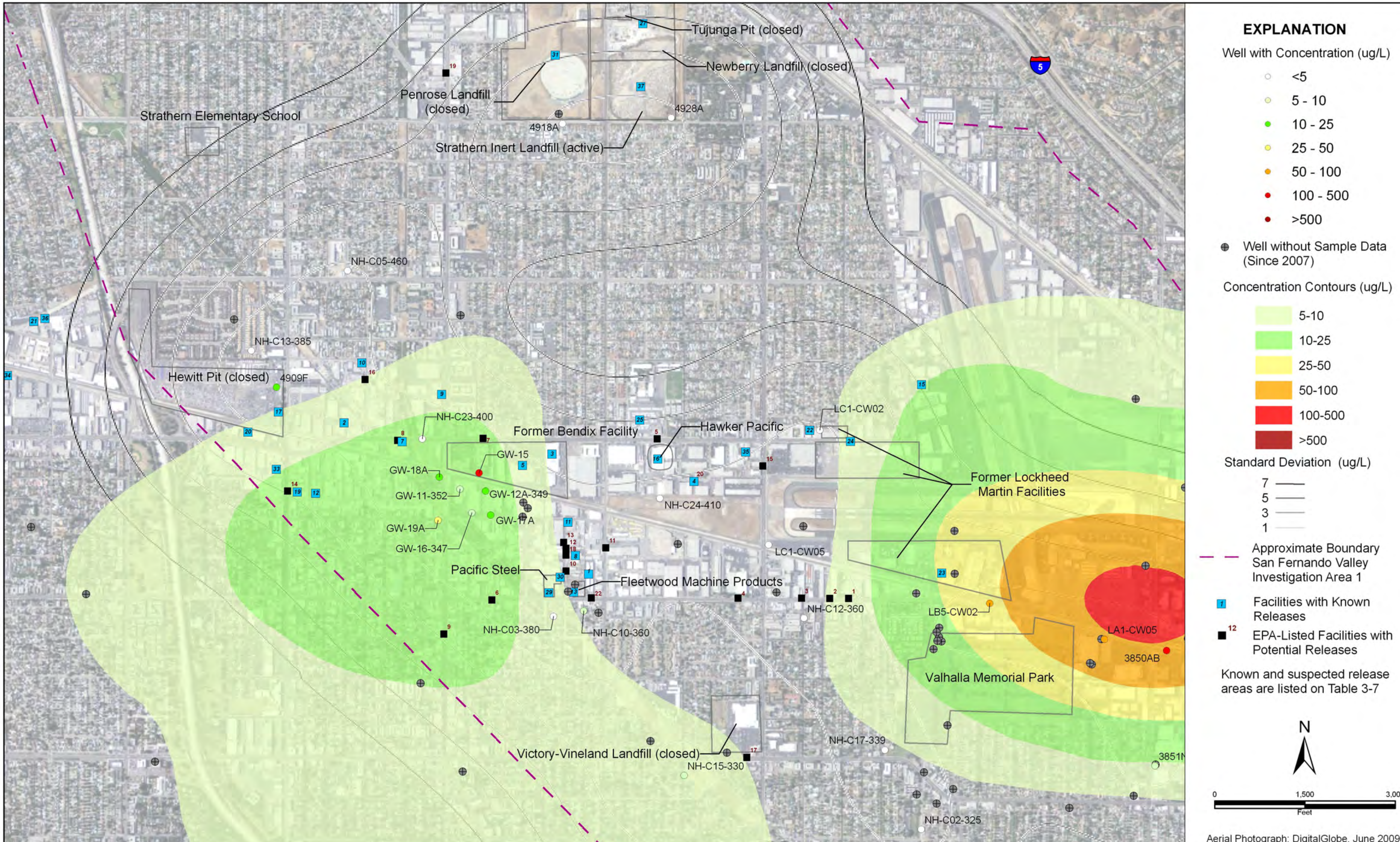

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DATE: 8/2011	DATE:	

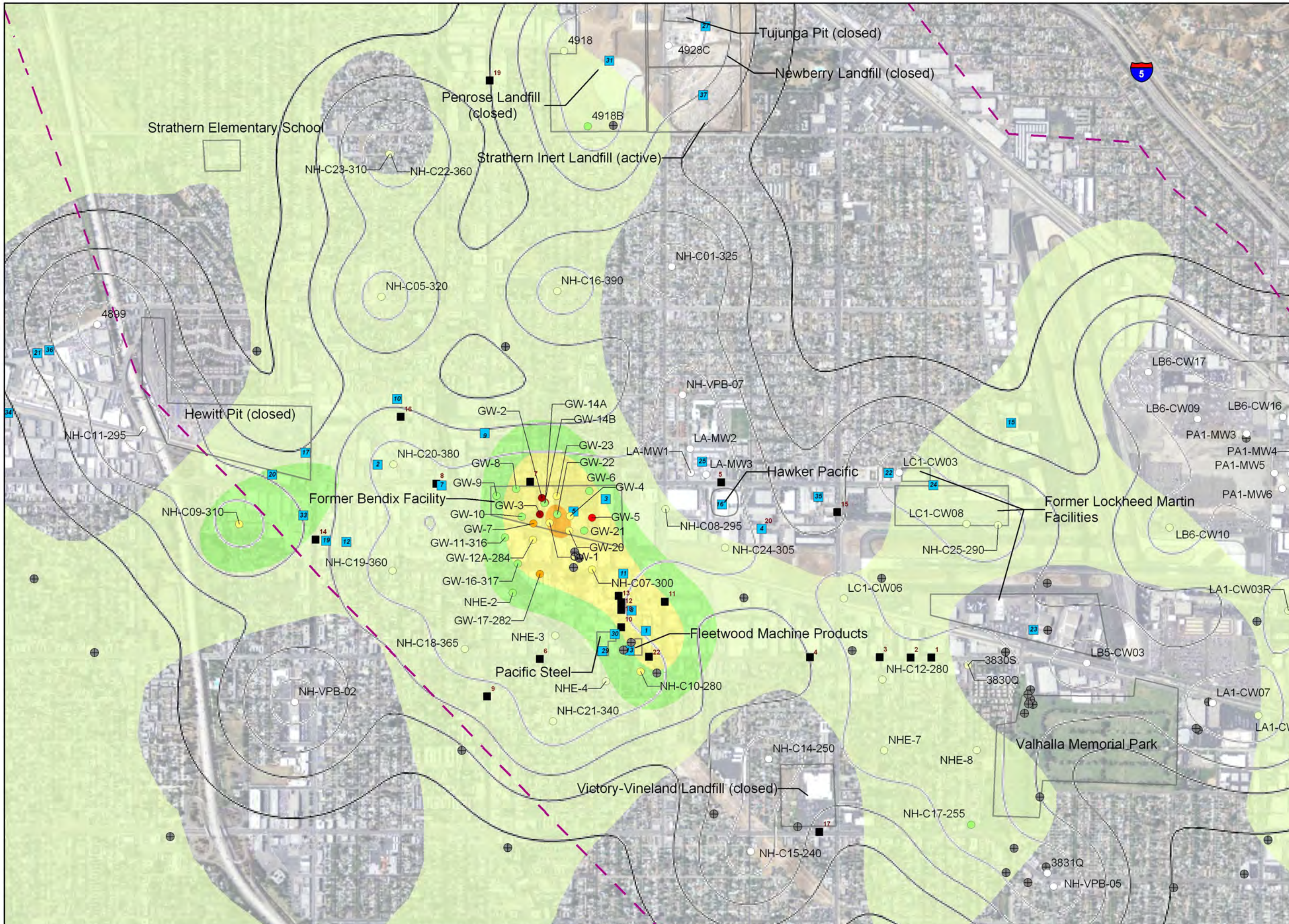
amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Depth Region 2
PCE Concentration Contours
(Maximum Concentrations, 2007-2011)

FIGURE
C-2b

September 1, 2011 5:40:57 PM
P:\4088115718_NHOU\GIS\Projects\DataGapsAnalysis\FigureC-2b-PCE-DR2.mxd



DRAWN: TJH	PROJECT NO: 4088115718
ENGINEER:	SCALE: AS SHOWN
CHECKED:	APPROVED:
DATE: 8/2011	DATE:

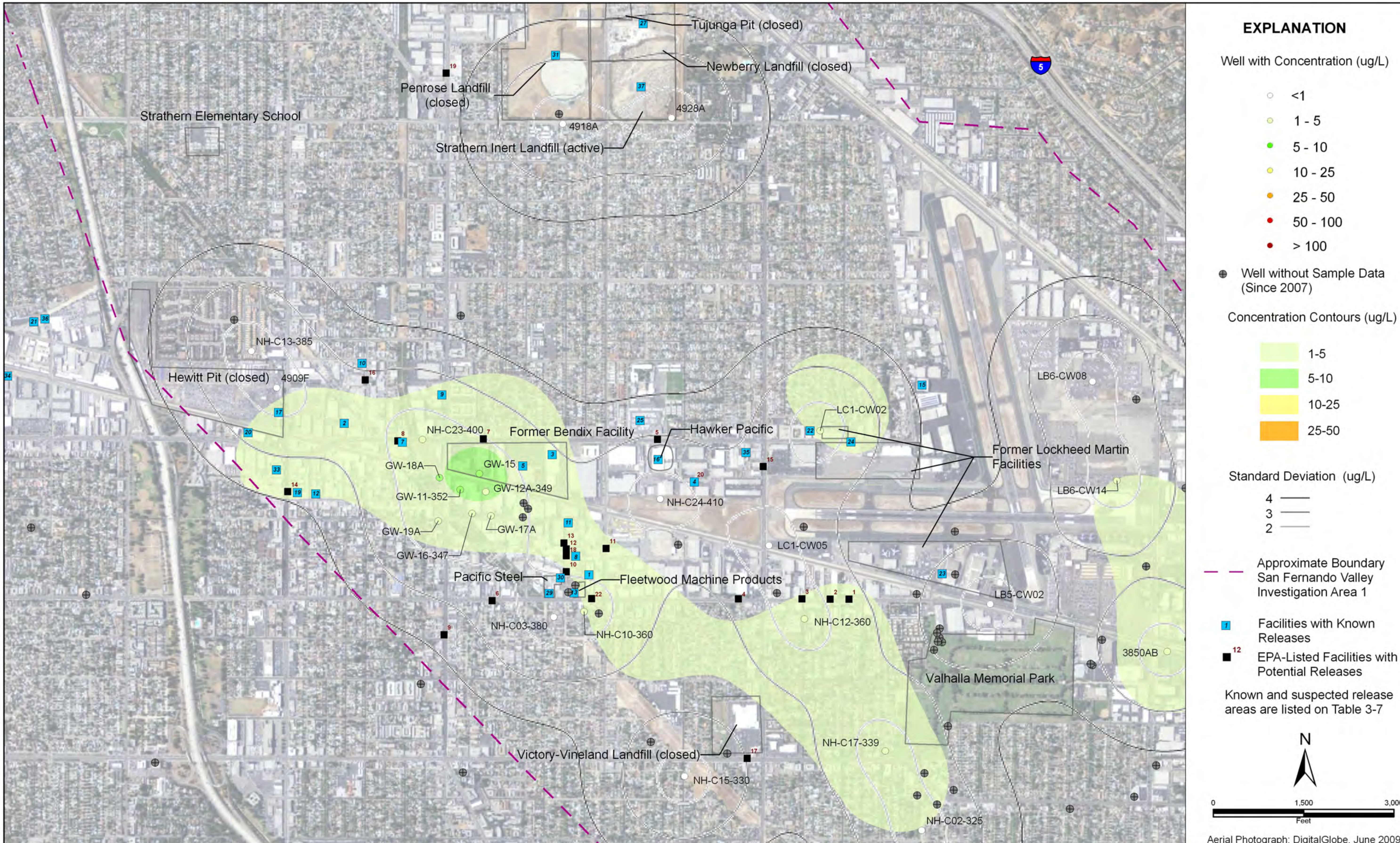
amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Depth Region 1
1,4-Dioxane Concentration Contours
(Maximum Concentrations, 2007-2011)

FIGURE C-3a

September 1, 2011 5:45:09 PM
P:\4088115718_NHOU\GIS\Projects\DataGapsAnalysis\FigureC-3a-Dioxane-DR1.mxd



DRAWN: TJH	PROJECT NO: 4088115718		
ENGINEER:	SCALE: AS SHOWN		
CHECKED:	APPROVED:		
DATE: 8/2011	DATE:		

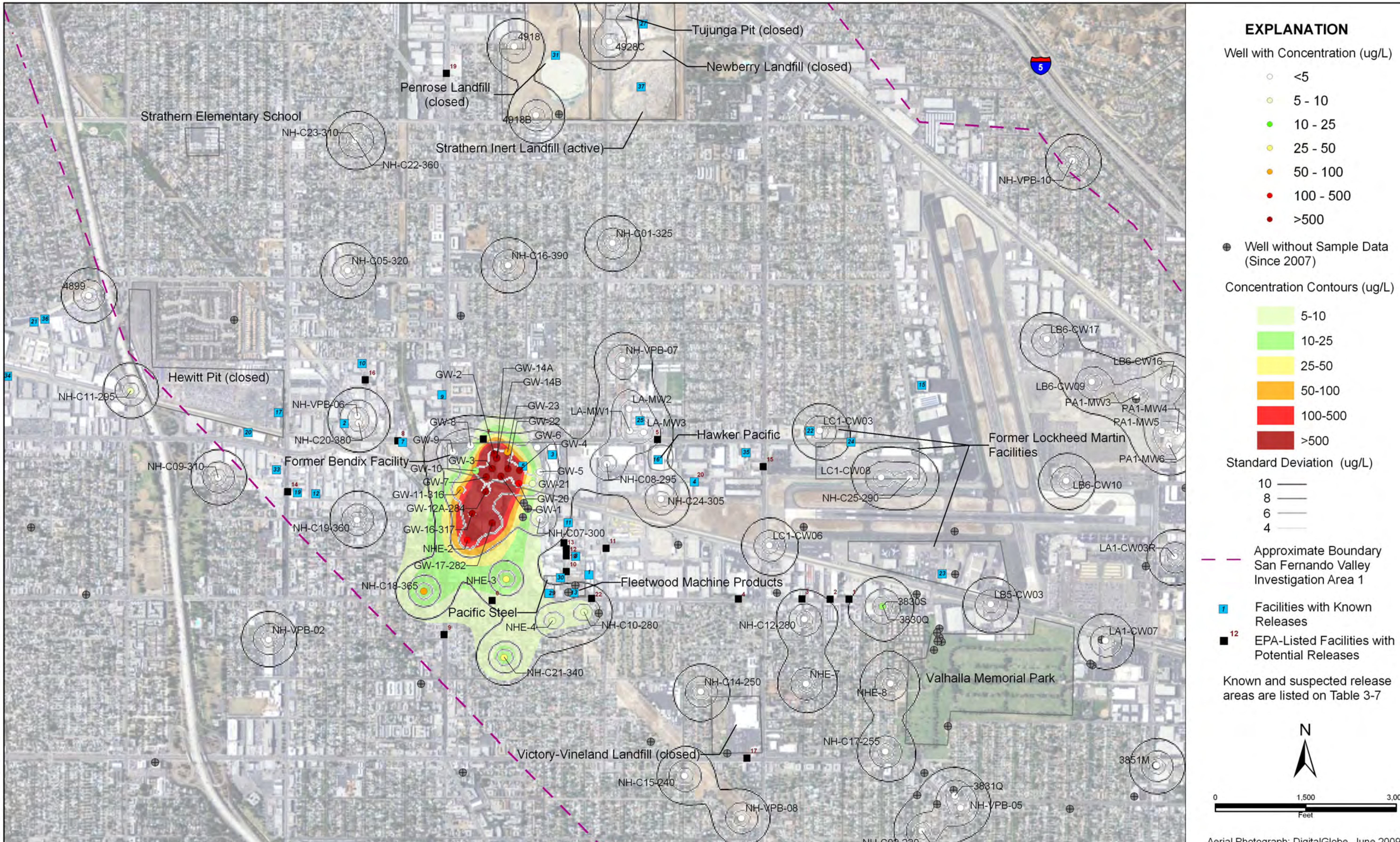
amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Depth Region 2
1,4-Dioxane Concentration Contours
(Maximum Concentrations, 2007-2011)

FIGURE **C-3b**

September 1, 2011 11:22:38 AM
P:\4088115718_NHOU\GIS\Projects\DataGapsAnalysis\FigureC-3b-Dioxane-DR2.mxd



DRAWN: TJH	PROJECT NO: 4088115718
ENGINEER:	SCALE: AS SHOWN
CHECKED:	APPROVED:
DATE: 8/2011	DATE:

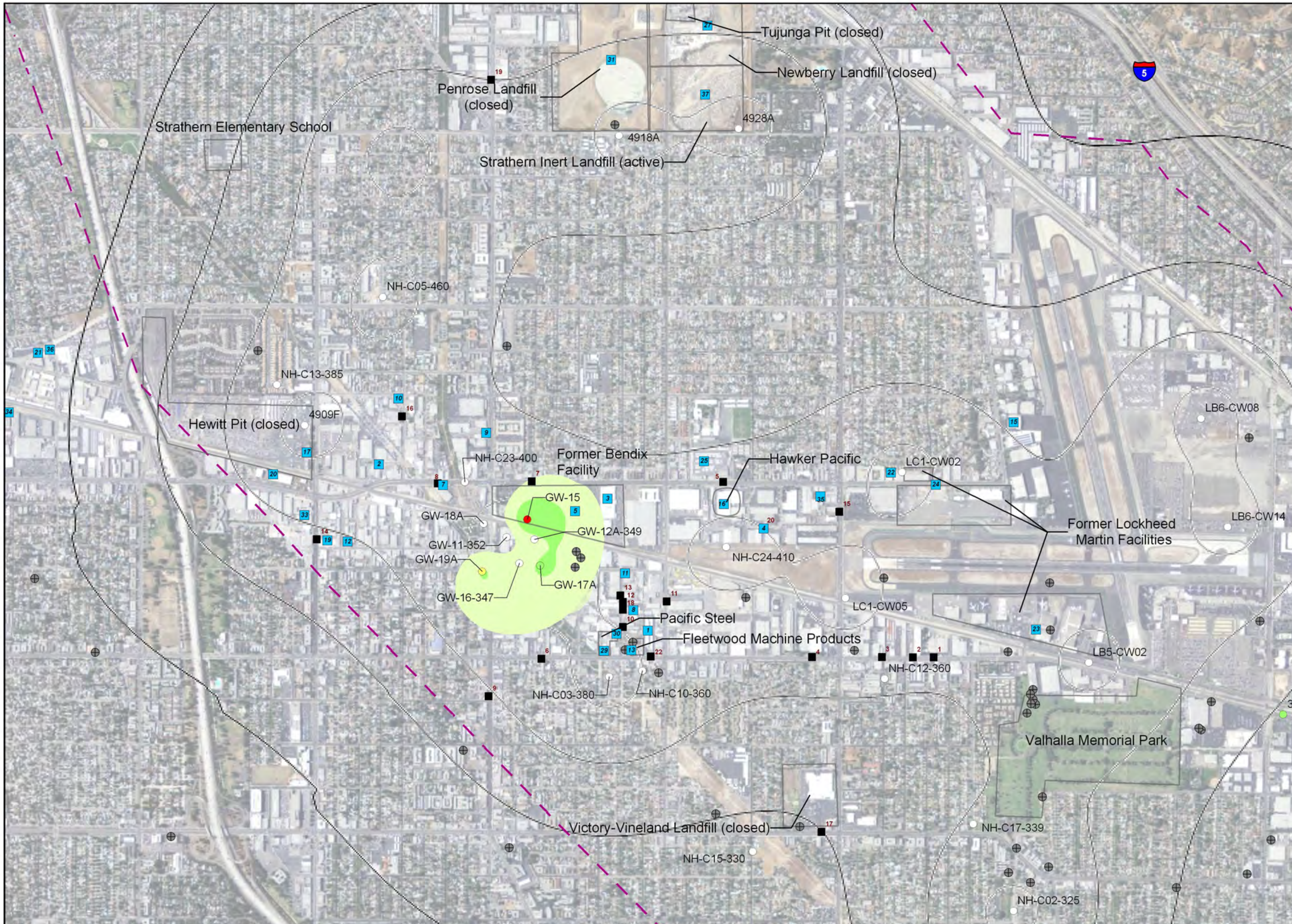
amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Depth Region 2
Hexavalent Chromium
Concentration Contours
(Maximum Concentrations, 2007-2011)

FIGURE
C-4a

September 1, 2011 11:44:41 AM
P:\4088115718_NHOU\GIS\Projects\DataGapsAnalysis\FigureC-4aHexCr-DR1.mxd



EXPLANATION

Well with Concentration (ug/L)

- <1
- 1 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- > 100

Well without Sample Data (Since 2007)

Concentration Contours (ug/L)

- 5-10
- 10-25
- 25-50
- 50-100
- 100 -200
- >200

Standard Deviation (ug/L)

- 10
- 8
- 6
- 4

Approximate Boundary San Fernando Valley Investigation Area 1

Facilities with Known Releases

EPA-Listed Facilities with Potential Releases

Known and suspected release areas are listed on Table 3-7

N

0 1,500 3,000 Feet

Aerial Photograph: DigitalGlobe, June 2009

DRAWN: TJH	PROJECT NO: 4088115718
ENGINEER:	SCALE: AS SHOWN
CHECKED:	APPROVED:
DATE: 8/2011	DATE:

amec

Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Depth Region 2
Hexavalent Chromium
Concentration Contours
(Maximum Concentrations, 2007-2011)

FIGURE **C-4b**

August 31, 2011 4:40:25 PM
P:\4088115718_NHOU\GIS\Projects\DataGapsAnalysis\Figure4C-4b-HexCr-B.mxd

APPENDIX D

COC CONCENTRATION VARIOGRAMS

Gridding Report

Thu Sep 29 12:48:00 2011
Elapsed time for gridding: 38.0 seconds

Data Source

Source Data File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\again\diox_A.xls (sheet 'Sheet1')
X Column: C
Y Column: D
Z Column: F

Data Counts

Active Data: 84

Original Data: 84
Excluded Data: 0
Deleted Duplicates: 0
Retained Duplicates: 0
Artificial Data: 0
Superseded Data: 0

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: First
X Duplicate Tolerance: 0.0033
Y Duplicate Tolerance: 0.0025

No duplicate data were found.

Breakline Filtering

Breakline Filtering: Not In Use

Data Counts

Active Data: 84

Univariate Statistics

	X	Y	Z
Count:	84	84	84
1%%-tile:	4164566.11358	4172881.21554	-0.698970004336
5%%-tile:	4167573.41017	4179550.96706	-0.698970004336
10%%-tile:	4169042.23901	4180481.09051	-0.698970004336
25%%-tile:	4171164.6681	4182891.10508	-0.698970004336
50%%-tile:	4172061.08183	4185013.05034	0.230448921378
75%%-tile:	4177889.97252	4185801.41561	0.857332496431
90%%-tile:	4182372.9963	4187998.89603	1.23044892138
95%%-tile:	4182501.0012	4190591.97379	1.43136376416
99%%-tile:	4191917.60774	4193546.92908	2.32221929473
Minimum:	4164566.11358	4172881.21554	-0.698970004336
Maximum:	4192338.91823	4194283.25562	2.50514997832
Mean:	4174565.60491	4184591.42731	0.278139530202
Median:	4172169.05792	4185013.3338	0.230448921378
Geometric Mean:	4174561.92502	4184590.00571	N/A
Harmonic Mean:	4174558.24843	4184588.58376	N/A
Root Mean Square:	4174569.28811	4184592.84856	0.857656621738
Trim Mean (10%%):	4174156.57789	4184599.95893	0.214969550223
Interquartile Mean:	4173142.89475	4184783.23245	0.227292585381
Midrange:	4178452.51591	4183582.23558	0.903089986992
Winsorized Mean:	4174417.63577	4184581.98487	0.227128053877
TriMean:	4173294.20107	4184679.65534	0.154815083713
Variance:	31122046.3682	12038058.6929	0.666143563063
Standard Deviation:	5578.71368401	3469.5905656	0.816176183837
Interquartile Range:	6725.30441785	2910.31053943	1.55630250077
Range:	27772.8046456	21402.0400719	3.20411998266
Mean Difference:	5985.04394453	3590.05450003	0.916301472967
Median Abs. Deviation:	1966.37171172	1209.13988853	0.751798748399
Average Abs. Deviation:	4140.60815798	2261.37372097	0.672124016249
Quartile Dispersion:	0.000805516876741	0.000347761676299	N/A
Relative Mean Diff.:	0.00143369263079	0.000857922347355	N/A
Standard Error:	608.687565178	378.563366604	0.0890521224489
Coef. of Variation:	0.00133635789014	0.000829134845272	N/A
Skewness:	0.99934632799	-0.429597121074	0.349350798804
Kurtosis:	3.7867609783	5.2197003264	2.43208936251
Sum:	350663510.813	351505679.894	23.363720537
Sum Absolute:	350663510.813	351505679.894	60.7408869786
Sum Squares:	1.46387041427e+015	1.47090865389e+015	61.7882899882
Mean Square:	1.74270287413e+013	1.75108173082e+013	0.735574880811

Inter-Variable Covariance

	X	Y	Z
X:	31122046	-9707984.9	-1885.4813
Y:	-9707984.9	12038059	288.97535
Z:	-1885.4813	288.97535	0.66614356

Inter-Variable Correlation

	X	Y	Z
X:	1.000	-0.502	-0.414
Y:	-0.502	1.000	0.102
Z:	-0.414	0.102	1.000

Inter-Variable Rank Correlation

	X	Y	Z
X:	1.000	-0.314	-0.477
Y:	-0.314	1.000	-0.022
Z:	-0.477	-0.022	1.000

Principal Component Analysis

	PC1	PC2	PC3
X:	0.386663030326	0.386663030326	7.09410823489e-005
Y:	0.922221067645	0.922221067645	3.32046579331e-005
Z:	-5.80523291436e-005	-5.80523291436e-005	3.32046579331e-005
Lambda:	35192349.1549	7967756.03041	0.54198080591

Planar Regression: Z = AX+BY+C

Fitted Parameters

	A	B	C

Parameter Value:	-7.09410802928e-005	-3.32046547064e-005	435.374246727
Standard Error:	1.69486664135e-005	2.7251560511e-005	161.567097004

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.502	-0.792
B:	0.502	1.000	-0.925
C:	-0.792	-0.925	1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2	10.3055085678	5.15275428388	9.27817266657
Residual:	81	44.9844071665	0.555363051438	
Total:	83	55.2899157342		

Coefficient of Multiple Determination (R^2): 0.186390382964

Nearest Neighbor Statistics

	Separation	|Delta Z|
1%%-tile:	12.9079144907	0
5%%-tile:	75.7071604928	0
10%%-tile:	127.129745751	0
25%%-tile:	230.613948264	0.0299632233774
50%%-tile:	542.216304853	0.393439507445
75%%-tile:	1289.07933886	0.845098040014
90%%-tile:	1796.65796729	1.17609125906
95%%-tile:	2472.41194419	1.30102999566
99%%-tile:	3554.48104348	1.43933269383
Minimum:	12.9079144907	0
Maximum:	4492.49417891	1.81291335664
Mean:	900.630027236	0.503492066148
Median:	558.949201155	0.395689758059
Geometric Mean:	507.084796113	N/A
Harmonic Mean:	174.000799066	N/A
Root Mean Square:	1273.66908776	0.683739661829
Trim Mean (10%%):	772.639743047	0.463668737119
Interquartile Mean:	637.655231737	0.422700410293
Midrange:	2252.7010467	0.906456678321
Winsorized Mean:	786.807011688	0.480681586045

TriMean:	651.031474207	0.415485069571
Variance:	820870.770232	0.216573925502
Standard Deviation:	906.019188667	0.465375037472
Interquartile Range:	1058.46539059	0.815134816637
Range:	4479.58626442	1.81291335664
Mean Difference:	922.634159388	0.522120455937
Median Abs. Deviation:	390.65088042	0.37161106995
Average Abs. Deviation:	643.723135463	0.389981197371
Quartile Dispersion:	0.696499352575	N/A
Relative Mean Diff.:	1.02443193263	1.03699837801
Standard Error:	98.8547979321	0.0507765794229
Coef. of Variation:	1.00598376833	0.92429467863
Skewness:	1.65512298872	0.620601034089
Kurtosis:	5.85152682602	2.40980655309
Sum:	75652.9222878	42.2933335564
Sum Absolute:	75652.9222878	42.2933335564
Sum Squares:	136267567.39	39.2699937133
Mean Square:	1622232.94512	0.467499925158

Complete Spatial Randomness

Lambda:	1.41320242456e-007
Clark and Evans:	0.677140211676
Skellam:	120.997596985

Gridding Rules

Gridding Method:	Kriging
Kriging Type:	Point
Polynomial Drift Order:	0
Kriging std. deviation grid:	yes

Semi-Variogram Model

Component Type:	Nugget Effect
Error Variance:	0.17
Micro Variance:	0
Component Type:	Gaussian
Anisotropy Angle:	0
Anisotropy Length:	2200
Anisotropy Ratio:	1
Variogram Scale:	0.55

Search Parameters

Search Ellipse Radius #1:	17500
Search Ellipse Radius #2:	17500
Search Ellipse Angle:	0
Number of Search Sectors:	1

Maximum Data Per Sector: 84
Maximum Empty Sectors: 1

Minimum Data: 1
Maximum Data: 84

Output Grid

Grid File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\again\diox_A_log.grd
Grid Size: 301 rows x 309 columns
Total Nodes: 93009
Filled Nodes: 91767
Blanked Nodes: 1242
Blank Value: 1.70141E+038

Grid Geometry

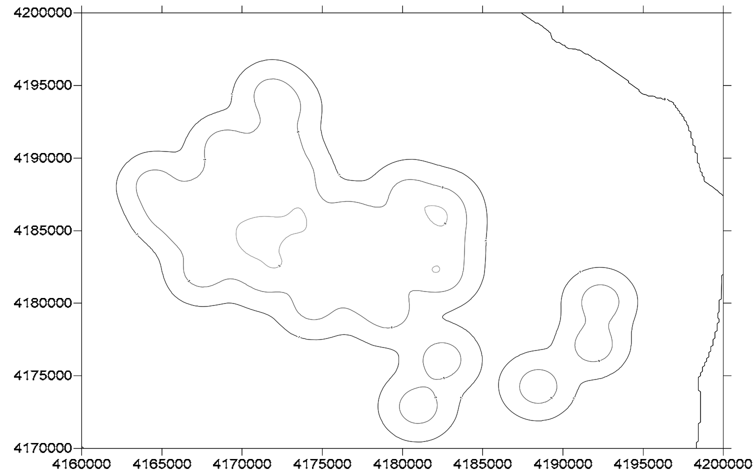
X Minimum: 4160000
X Maximum: 4200000
X Spacing: 129.87012987013

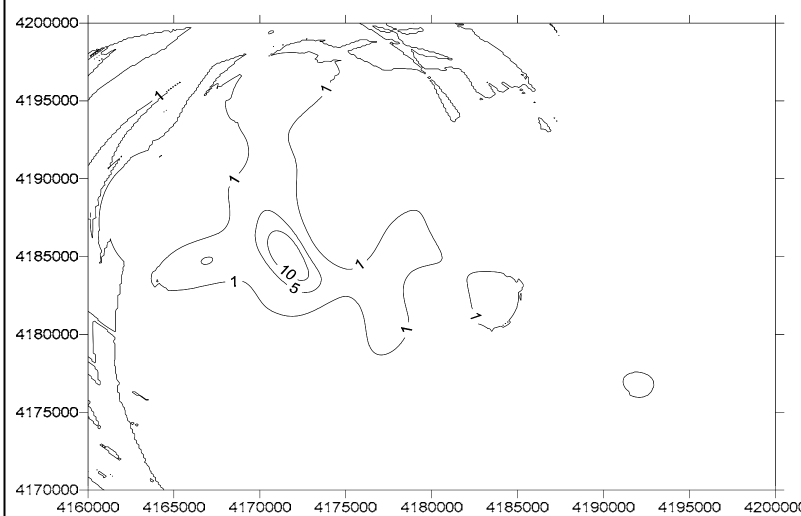
Y Minimum: 4170000
Y Maximum: 4200000
Y Spacing: 100

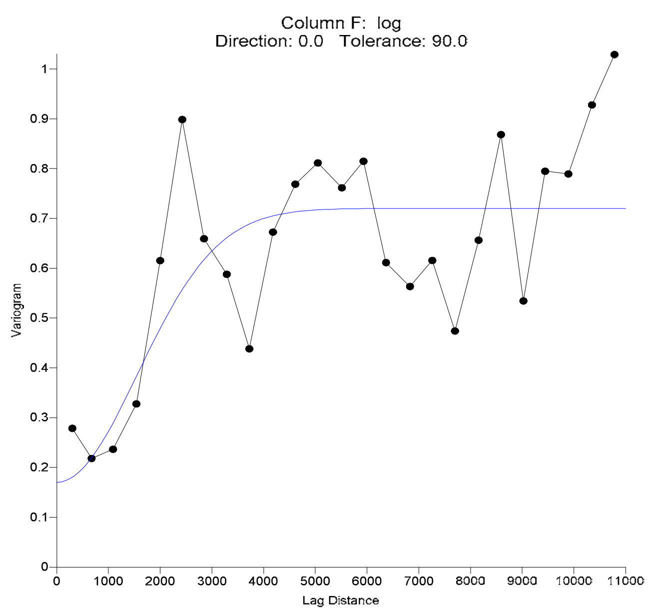
Univariate Grid Statistics

	Z
Count:	91767
1%%-tile:	-0.698970004336
5%%-tile:	-0.541940534659
10%%-tile:	-0.461370424325
25%%-tile:	-0.329167234235
50%%-tile:	-0.161801250884
75%%-tile:	-0.028002537793
90%%-tile:	0.0635218039957
95%%-tile:	0.22514586009
99%%-tile:	0.693179217156
Minimum:	-0.894651197226
Maximum:	1.31371058046
Mean:	-0.166186871488
Median:	-0.161801250884
Geometric Mean:	N/A
Harmonic Mean:	N/A
Root Mean Square:	0.302961690627
Trim Mean (10%%):	-0.177093621919
Interquartile Mean:	-0.1677126183

Midrange:	0.209529691618
Winsorized Mean:	-0.180275983753
TriMean:	-0.170193068449
Variance:	0.0641684089864
Standard Deviation:	0.253314841623
Interquartile Range:	0.301164696442
Range:	2.20836177769
Mean Difference:	N/A
Median Abs. Deviation:	0.146272369891
Average Abs. Deviation:	0.18451557127
Quartile Dispersion:	N/A
Relative Mean Diff.:	N/A
Standard Error:	0.000836213873497
Coef. of Variation:	N/A
Skewness:	0.969314535859
Kurtosis:	6.83896819844
Sum:	-15250.4706359
Sum Absolute:	21598.5168197
Sum Squares:	8422.90622275
Mean Square:	0.0917857859879







amec

Variogram
1,4-dioxane A-Zone
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

D-7

DRAWN	JOB NUMBER	CHECKED	DATE
SLC	4088115718	MDT	8/1/11

Gridding Report

Thu Sep 29 13:01:22 2011
Elapsed time for gridding: 2.03 seconds

Data Source

Source Data File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\again\diox_B.xls (sheet 'Sheet1')
X Column: C
Y Column: D
Z Column: F

Data Counts

Active Data: 19

Original Data: 19
Excluded Data: 0
Deleted Duplicates: 0
Retained Duplicates: 0
Artificial Data: 0
Superseded Data: 0

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: First
X Duplicate Tolerance: 0.0028
Y Duplicate Tolerance: 0.0021

No duplicate data were found.

Breakline Filtering

Breakline Filtering: Not In Use

Data Counts

Active Data: 19

Univariate Statistics

	X	Y	Z
Count:	19	19	19
1%%-tile:	4168984.03509	4172891.01243	-0.698970004336
5%%-tile:	4168984.03509	4172891.01243	-0.698970004336
10%%-tile:	4170389.65063	4176863.42559	-0.698970004336
25%%-tile:	4170938.71973	4182695.09849	-0.698970004336
50%%-tile:	4175862.85983	4184282.1841	-0.698970004336
75%%-tile:	4178414.02127	4184800.56248	0.0791812460476
90%%-tile:	4181220.90682	4185801.54028	0.518513939878
95%%-tile:	4181627.61771	4186628.5634	0.643452676486
99%%-tile:	4181627.61771	4186628.5634	0.643452676486
Minimum:	4168984.03509	4172891.01243	-0.698970004336
Maximum:	4192626.29638	4190592.07159	0.716003343635
Mean:	4175944.29504	4183303.74546	-0.272893483062
Median:	4175862.85983	4184282.1841	-0.698970004336
Geometric Mean:	4175940.52651	4183302.15195	N/A
Harmonic Mean:	4175936.76201	4183300.55743	N/A
Root Mean Square:	4175948.0676	4183305.33795	0.594269371277
Trim Mean (10%%):	N/A	N/A	N/A
Interquartile Mean:	4174644.99336	4183813.83223	-0.477221609915
Midrange:	4180805.16573	4181741.54201	0.00851666964939
Winsorized Mean:	4175396.58531	4183217.15907	-0.289863385186
TriMean:	4175269.61517	4184015.00729	-0.50443219174
Variance:	33258508.5539	14063979.3496	0.294167745459
Standard Deviation:	5767.01903534	3750.19724143	0.542372331023
Interquartile Range:	7475.30153772	2105.46398916	0.778151250384
Range:	23642.2612909	17701.0591611	1.41497334797
Mean Difference:	6297.3153164	3822.68732672	0.575948680719
Median Abs. Deviation:	4698.19173149	1371.40037624	0
Average Abs. Deviation:	4396.90519363	2359.16997344	0.426076521274
Quartile Dispersion:	0.000895315094428	0.000251624150698	N/A
Relative Mean Diff.:	0.0015079979213	0.000913796262313	N/A
Standard Error:	1323.04490424	860.354252302	0.124428746353
Coef. of Variation:	0.00138100957002	0.000896467832513	N/A
Skewness:	1.10491277381	-1.00422610089	0.585178619037
Kurtosis:	4.11755575784	4.46536137929	1.58570722141
Sum:	79342941.6057	79482771.1637	-5.18497617817
Sum Absolute:	79342941.6057	79482771.1637	10.1923639172
Sum Squares:	3.31332303003e+014	3.3250082746e+014	6.70996562712
Mean Square:	1.74385422633e+013	1.75000435505e+013	0.353156085638

Inter-Variable Covariance

	X	Y	Z
X:	33258509	-12668205	-872.2309
Y:	-12668205	14063979	255.51365
Z:	-872.2309	255.51365	0.29416775

Inter-Variable Correlation

	X	Y	Z
X:	1.000	-0.586	-0.279
Y:	-0.586	1.000	0.126
Z:	-0.279	0.126	1.000

Inter-Variable Rank Correlation

	X	Y	Z
X:	1.000	-0.382	-0.184
Y:	-0.382	1.000	0.098
Z:	-0.184	0.098	1.000

Principal Component Analysis

	PC1	PC2	PC3
X:	0.445048714915	0.445048714915	2.93888998077e-005
Y:	0.895506360073	0.895506360073	8.30426031449e-006
Z:	-2.05160100291e-005	-2.05160100291e-005	8.30426031449e-006
Lambda:	39554352.3863	7768135.5408	0.270655690811

Planar Regression: Z = AX+BY+C

Fitted Parameters

A	B	C

Parameter Value:	-2.93888993646e-005	-8.30425974713e-006	157.192754059
Standard Error:	2.78257682741e-005	4.27902120818e-005	264.408708683

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.586	-0.836
B:	0.586	1.000	-0.934
C:	-0.836	-0.934	1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2 0.694965749396	0.423216979128	0.211608489564	
Residual:	16	4.87180243914	0.304487652446	
Total:	18	5.29501941826		

Coefficient of Multiple Determination (R^2): 0.0799273705528

Nearest Neighbor Statistics

	Separation	|Delta Z|
1%%-tile:	409.74666388	0
5%%-tile:	409.74666388	0
10%%-tile:	409.74666388	0
25%%-tile:	507.215930962	0.124938736608
50%%-tile:	1351.94192981	0.740362689494
75%%-tile:	1960.10407875	1
90%%-tile:	5756.91392769	1.34242268082
95%%-tile:	6788.28633317	1.41497334797
99%%-tile:	6788.28633317	1.41497334797
Minimum:	409.74666388	0
Maximum:	12311.2185243	1.41497334797
Mean:	2372.71871629	0.681989164692
Median:	1351.94192981	0.740362689494
Geometric Mean:	1368.47248466	N/A
Harmonic Mean:	905.81171939	N/A
Root Mean Square:	3763.11116829	0.832594674023
Trim Mean (10%%):	N/A	N/A
Interquartile Mean:	1267.82262373	0.678542475239
Midrange:	6360.48259407	0.707486673985

Winsorized Mean:	1973.47255829	0.674352252361
TriMean:	1292.80096733	0.651416028899
Variance:	9005167.75596	0.240777152146
Standard Deviation:	3000.86116906	0.490690485077
Interquartile Range:	1452.88814778	0.875061263392
Range:	11901.4718604	1.41497334797
Mean Difference:	2738.99605242	0.56251746032
Median Abs. Deviation:	844.725998853	0.259637310506
Average Abs. Deviation:	1683.69322267	0.383998408558
Quartile Dispersion:	0.588852739842	N/A
Relative Mean Diff.:	1.15437031521	0.824818764641
Standard Error:	688.444767343	0.112572117737
Coef. of Variation:	1.26473532175	0.71949894585
Skewness:	2.05700334867	-0.160509628446
Kurtosis:	6.72995347517	1.65213470272
Sum:	45081.6556095	12.9577941292
Sum Absolute:	45081.6556095	12.9577941292
Sum Squares:	269059107.633	13.171063933
Mean Square:	14161005.6649	0.693213891212

Complete Spatial Randomness

Lambda:	4.54009912042e-008
Clark and Evans:	1.01113447714
Skellam:	76.7525654043

Gridding Rules

Gridding Method:	Kriging
Kriging Type:	Point
Polynomial Drift Order:	0
Kriging std. deviation grid:	yes

Semi-Variogram Model

Component Type:	Nugget Effect
Error Variance:	0.05
Micro Variance:	0
Component Type:	Spherical
Anisotropy Angle:	0
Anisotropy Length:	1500
Anisotropy Ratio:	1
Variogram Scale:	0.29

Search Parameters

Search Ellipse Radius #1:	14800
Search Ellipse Radius #2:	14800
Search Ellipse Angle:	0

Number of Search Sectors: 1
Maximum Data Per Sector: 19
Maximum Empty Sectors: 1

Minimum Data: 1
Maximum Data: 19

Output Grid

Grid File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\again\diox_B_log.grd
Grid Size: 301 rows x 309 columns
Total Nodes: 93009
Filled Nodes: 86978
Blanked Nodes: 6031
Blank Value: 1.70141E+038

Grid Geometry

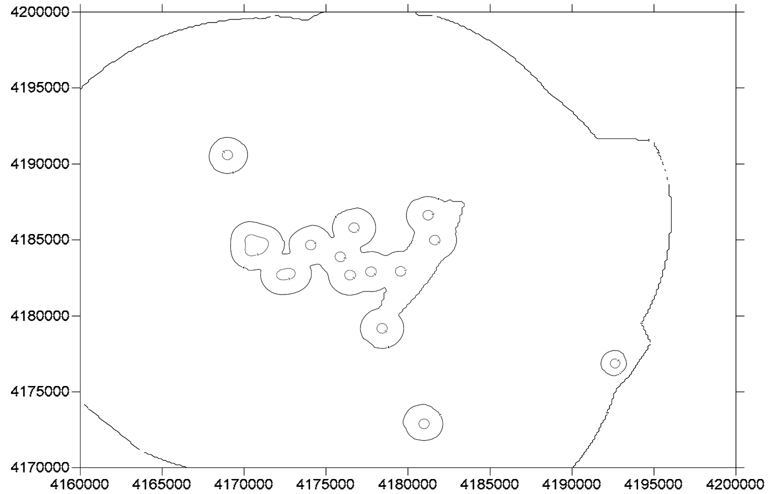
X Minimum: 4160000
X Maximum: 4200000
X Spacing: 129.87012987013

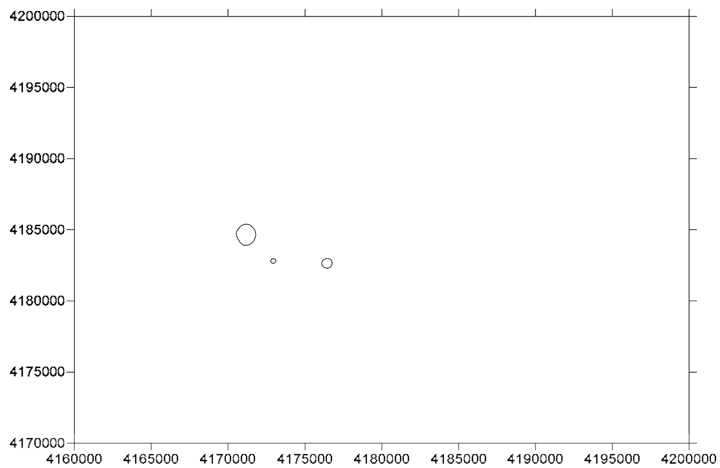
Y Minimum: 4170000
Y Maximum: 4200000
Y Spacing: 100

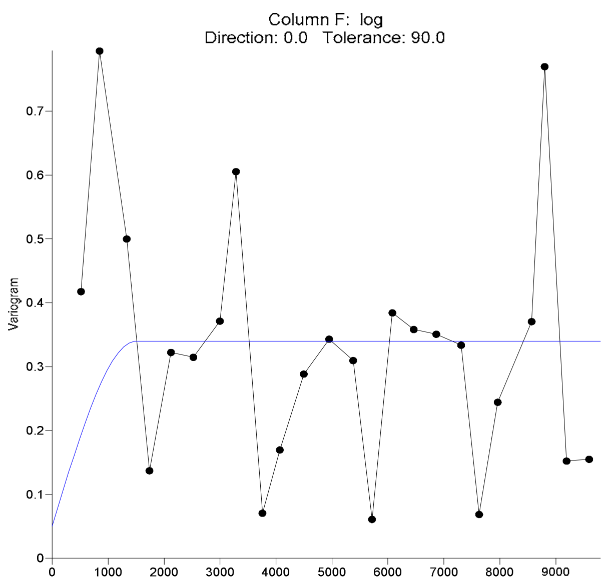
Univariate Grid Statistics

	Z
Count:	86978
1%%-tile:	-0.698970004336
5%%-tile:	-0.698970004336
10%%-tile:	-0.698970004336
25%%-tile:	-0.429522284688
50%%-tile:	-0.353429385142
75%%-tile:	-0.327775600854
90%%-tile:	-0.298007132393
95%%-tile:	-0.254433237177
99%%-tile:	-0.161179804724
Minimum:	-0.698970004336
Maximum:	0.56114134075
Mean:	-0.400176538999
Median:	-0.353429385142
Geometric Mean:	N/A
Harmonic Mean:	N/A
Root Mean Square:	0.422832316086
Trim Mean (10%%):	-0.39603606952

Interquartile Mean:	-0.358851912249
Midrange:	-0.0689143317931
Winsorized Mean:	-0.406960657471
TriMean:	-0.366039163957
Variance:	0.0186461195391
Standard Deviation:	0.136550794722
Interquartile Range:	0.101746683834
Range:	1.26011134509
Mean Difference:	N/A
Median Abs. Deviation:	0.0318710741847
Average Abs. Deviation:	0.0885579552853
Quartile Dispersion:	N/A
Relative Mean Diff.:	N/A
Standard Error:	0.000463009096537
Coef. of Variation:	N/A
Skewness:	-0.981693198304
Kurtosis:	4.50252148852
Sum:	-34806.555009
Sum Absolute:	34865.0764274
Sum Squares:	15550.5502571
Mean Square:	0.178787167527







amec

Variogram
1,4-dioxane B-Zone
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

D-7

DRAWN	JOB NUMBER	CHECKED	DATE
SLC	4088115718	MDT	8/1/11

Gridding Report

Fri Aug 26 11:44:52 2011
Elapsed time for gridding: 31.0 seconds

Data Source

Source Data File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\krig_err\diox_DR1.xls (sheet 'Sheet1')
X Column: B
Y Column: C
Z Column: E

Data Counts

Active Data: 80

Original Data: 80
Excluded Data: 0
Deleted Duplicates: 0
Retained Duplicates: 0
Artificial Data: 0
Superseded Data: 0

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: First
X Duplicate Tolerance: 0.0033
Y Duplicate Tolerance: 0.0023

No duplicate data were found.

Breakline Filtering

Breakline Filtering: Not In Use

Data Counts

Active Data: 80

Univariate Statistics

	X	Y	Z
Count:	80	80	80
1%%-tile:	4164566.11358	4174258.9507	-0.698970004336
5%%-tile:	4167573.41017	4179550.96706	-0.698970004336
10%%-tile:	4169042.23901	4180481.09051	-0.698970004336
25%%-tile:	4171272.22224	4182910.78373	-0.698970004336
50%%-tile:	4172477.51758	4185024.48698	0.204119982656
75%%-tile:	4177803.75873	4185810.06769	0.857332496431
90%%-tile:	4182372.9963	4188903.49696	1.2552725051
95%%-tile:	4182593.79431	4192159.07236	1.47712125472
99%%-tile:	4191917.60774	4193546.92908	2.32221929473
Minimum:	4164566.11358	4174258.9507	-0.698970004336
Maximum:	4192338.91823	4194283.25562	2.50514997832
Mean:	4174662.80854	4184928.34158	0.258288142829
Median:	4172638.4835	4185025.83162	0.217284452017
Geometric Mean:	4174659.24074	4184926.86297	N/A
Harmonic Mean:	4174655.67621	4184925.38442	N/A
Root Mean Square:	4174666.37962	4184929.82027	0.863497323035
Trim Mean (10%%):	4174261.93015	4184845.31008	0.194523265842
Interquartile Mean:	4173310.02172	4184843.65267	0.178617855197
Midrange:	4178452.51591	4184271.10316	0.903089986992
Winsorized Mean:	4174486.56042	4184805.62895	0.207518745857
TriMean:	4173507.75403	4184692.45635	0.141650614352
Variance:	30193498.2523	12533079.2633	0.687508721177
Standard Deviation:	5494.86107671	3540.20892933	0.82916145664
Interquartile Range:	6531.53648646	2899.28396494	1.55630250077
Range:	27772.8046456	20024.3049132	3.20411998266
Mean Difference:	5878.03229886	3749.08377718	0.929894498695
Median Abs. Deviation:	1960.65631336	1386.2334389	0.803411890562
Average Abs. Deviation:	4066.12541901	2375.41116856	0.683279294954
Quartile Dispersion:	0.000782306509289	0.000346442905243	N/A
Relative Mean Diff.:	0.00140802564625	0.000895853756905	N/A
Standard Error:	614.344144722	395.807391027	0.0927030690685
Coef. of Variation:	0.00131624069505	0.000845942544381	N/A
Skewness:	1.03563542274	0.0890931063977	0.408567881338
Kurtosis:	4.02375781409	4.27410387565	2.42418915476
Sum:	333973024.683	334794267.327	20.6630514263
Sum Absolute:	333973024.683	334794267.327	58.040217868
Sum Squares:	1.39422715049e+015	1.40109100805e+015	59.6502101511
Mean Square:	1.74278393811e+013	1.75136376006e+013	0.745627626889

Inter-Variable Covariance

	X	Y	Z
X:	30193498	-9251132.4	-1933.6268
Y:	-9251132.4	12533079	78.05306
Z:	-1933.6268	78.05306	0.68750872

Inter-Variable Correlation

	X	Y	Z
X:	1.000	-0.476	-0.424
Y:	-0.476	1.000	0.027
Z:	-0.424	0.027	1.000

Inter-Variable Rank Correlation

	X	Y	Z
X:	1.000	-0.290	-0.522
Y:	-0.290	1.000	-0.058
Z:	-0.522	-0.058	1.000

Principal Component Analysis

	PC1	PC2	PC3
X:	0.39340901193	0.39340901193	8.02919578484e-005
Y:	0.919363553159	0.919363553159	5.30387218162e-005
Z:	-8.0349447919e-005	-8.0349447919e-005	5.30387218162e-005
Lambda:	34152192.2916	8574385.37514	0.536393872312

Planar Regression: Z = AX+BY+C

Fitted Parameters

A	B	C

Parameter Value:	-8.02919554781e-005	-5.30387177678e-005	557.41336169
Standard Error:	1.7266910802e-005	2.68004736373e-005	159.577911476

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.476	-0.786
B:	0.476	1.000	-0.918
C:	-0.786	-0.918	1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2	11.9380726679	5.96903633397	10.846360737
Residual:	77	42.3751163051	0.55032618578	
Total:	79	54.313188973		

Coefficient of Multiple Determination (R^2): 0.219800621059

Nearest Neighbor Statistics

	Separation	|Delta Z|
1%%-tile:	12.9079144907	0
5%%-tile:	17.3343346589	0
10%%-tile:	167.477992746	0
25%%-tile:	230.613948264	0.0647253296367
50%%-tile:	605.371698953	0.431363764159
75%%-tile:	1197.00985173	0.845098040014
90%%-tile:	1768.62796541	1.04139268516
95%%-tile:	2472.41194419	1.19033169817
99%%-tile:	4492.49417891	1.43933269383
Minimum:	12.9079144907	0
Maximum:	4855.11120203	1.81291335664
Mean:	909.387708222	0.4898012748
Median:	636.097421059	0.431363764159
Geometric Mean:	503.831918725	N/A
Harmonic Mean:	148.992168341	N/A
Root Mean Square:	1291.31173117	0.645951209272
Trim Mean (10%%):	785.167949563	0.456572547153
Interquartile Mean:	665.375503656	0.436453019362
Midrange:	2434.00955826	0.906456678321
Winsorized Mean:	800.366905381	0.46496860821

TriMean:	659.591799475	0.443137724492
Variance:	851139.223493	0.179592583255
Standard Deviation:	922.572069539	0.423783651472
Interquartile Range:	966.395903465	0.780372710378
Range:	4842.20328754	1.81291335664
Mean Difference:	915.518957443	0.476745396872
Median Abs. Deviation:	434.987358504	0.37233620642
Average Abs. Deviation:	636.915392731	0.350293957782
Quartile Dispersion:	0.676926164631	N/A
Relative Mean Diff.:	1.00674217296	0.973344540737
Standard Error:	103.146693082	0.0473804526222
Coef. of Variation:	1.01449806413	0.865215493049
Skewness:	2.00779698215	0.607078176669
Kurtosis:	8.11689354748	2.75041306821
Sum:	72751.0166578	39.184101984
Sum Absolute:	72751.0166578	39.184101984
Sum Squares:	133398878.965	33.3802371808
Mean Square:	1667485.98707	0.41725296476

Complete Spatial Randomness

Lambda:	1.43850971066e-007
Clark and Evans:	0.689819511797
Skellam:	120.571550625

Gridding Rules

Gridding Method:	Kriging
Kriging Type:	Point
Polynomial Drift Order:	0
Kriging std. deviation grid:	yes

Semi-Variogram Model

Component Type:	Nugget Effect
Error Variance:	0.1
Micro Variance:	0
Component Type:	Gaussian
Anisotropy Angle:	90
Anisotropy Length:	1500
Anisotropy Ratio:	1
Variogram Scale:	0.52

Search Parameters

Search Ellipse Radius #1:	17100
Search Ellipse Radius #2:	17100
Search Ellipse Angle:	0
Number of Search Sectors:	1

Maximum Data Per Sector:	80
Maximum Empty Sectors:	1
Minimum Data:	1
Maximum Data:	80

Output Grid

Grid File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\krig_err\diox_DR1_log.grd

Grid Size:	301 rows x 309 columns
Total Nodes:	93009
Filled Nodes:	91514
Blanked Nodes:	1495
Blank Value:	1.70141E+038

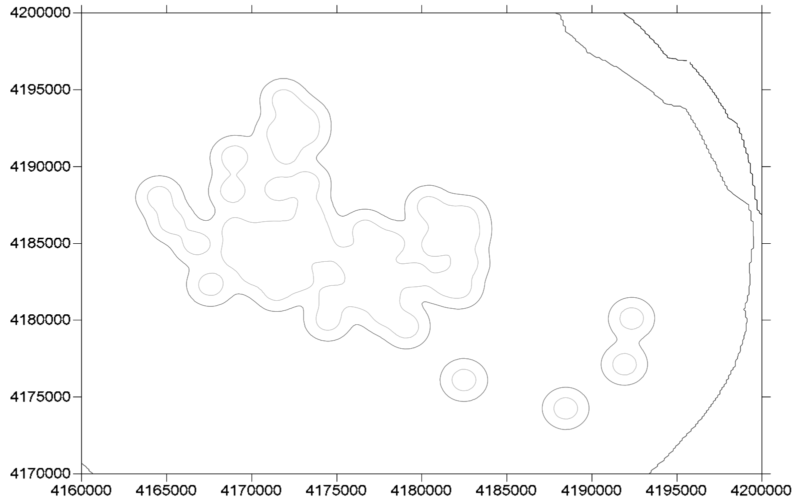
Grid Geometry

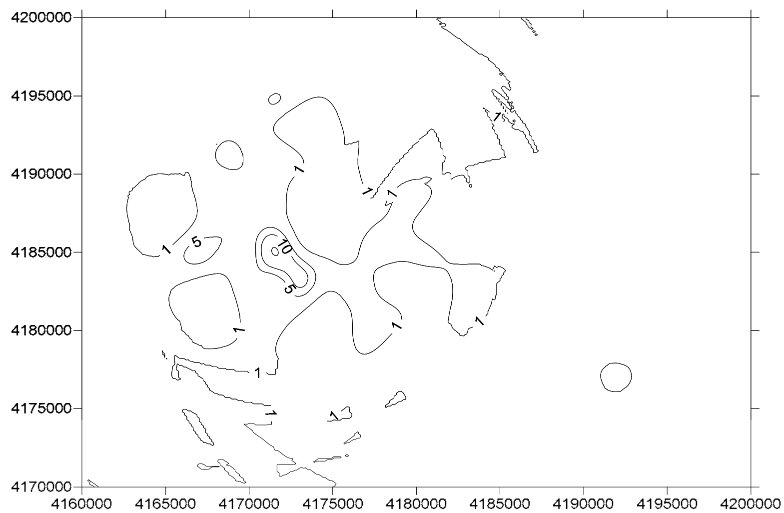
X Minimum:	4160000
X Maximum:	4200000
X Spacing:	129.87012987013
Y Minimum:	4170000
Y Maximum:	4200000
Y Spacing:	100

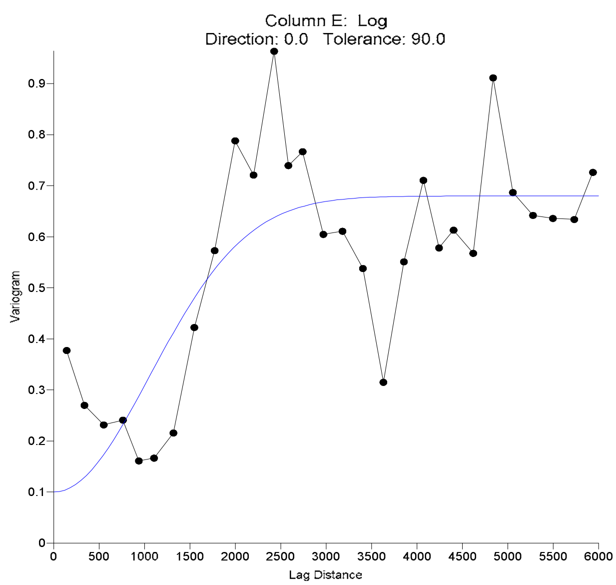
Univariate Grid Statistics

	Z
Count:	91514
1%%-tile:	-0.698970004336
5%%-tile:	-0.481791599871
10%%-tile:	-0.408697076833
25%%-tile:	-0.257324575272
50%%-tile:	-0.0472271519826
75%%-tile:	0.0689279458157
90%%-tile:	0.163040910025
95%%-tile:	0.25401764513
99%%-tile:	0.685860491492
Minimum:	-0.767168717776
Maximum:	1.42519623502
Mean:	-0.082844022458
Median:	-0.0472210960837
Geometric Mean:	N/A
Harmonic Mean:	N/A
Root Mean Square:	0.268104645955
Trim Mean (10%%):	-0.0878754661495
Interquartile Mean:	-0.0687240354635

Midrange:	0.329013758621
Winsorized Mean:	-0.0908375566267
TriMean:	-0.0707127333554
Variance:	0.0650176795927
Standard Deviation:	0.254985645856
Interquartile Range:	0.326252521088
Range:	2.19236495279
Mean Difference:	N/A
Median Abs. Deviation:	0.154295701962
Average Abs. Deviation:	0.192342168083
Quartile Dispersion:	N/A
Relative Mean Diff.:	N/A
Standard Error:	0.000842892061842
Coef. of Variation:	N/A
Skewness:	0.47297127504
Kurtosis:	5.57448191919
Sum:	-7581.38787122
Sum Absolute:	18031.3240044
Sum Squares:	6578.03557963
Mean Square:	0.0718801011827







amec

Variogram
1,4-dioxane Depth Region 1
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

D-7

DRAWN	JOB NUMBER	CHECKED	DATE
SLC	4088115718	MDT	8/1/11

Gridding Report

Thu Aug 25 17:24:13 2011
Elapsed time for gridding: 3.85 seconds

Data Source

Source Data File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\krig_err\diox_DR2.xls (sheet 'Sheet1')
X Column: B
Y Column: C
Z Column: E

Data Counts

Active Data: 27

Original Data: 27
Excluded Data: 0
Deleted Duplicates: 0
Retained Duplicates: 0
Artificial Data: 0
Superseded Data: 0

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: First
X Duplicate Tolerance: 0.003
Y Duplicate Tolerance: 0.0021

No duplicate data were found.

Breakline Filtering

Breakline Filtering: Not In Use

Data Counts

Active Data: 27

Univariate Statistics

	X	Y	Z
Count:	27	27	27
1%%-tile:	4167269.89434	4172881.21554	-0.698970004336
5%%-tile:	4167691.41447	4176863.42559	-0.698970004336
10%%-tile:	4170111.42389	4179178.26479	-0.698970004336
25%%-tile:	4170938.71973	4182678.8643	-0.698970004336
50%%-tile:	4174058.46035	4184407.25633	0.0413926851582
75%%-tile:	4177803.66532	4185068.63022	0.301029995664
90%%-tile:	4181220.90682	4186628.5634	0.672097857936
95%%-tile:	4181627.61771	4187088.74378	0.716003343635
99%%-tile:	4182474.89913	4190871.2737	0.857332496431
Minimum:	4167269.89434	4172881.21554	-0.698970004336
Maximum:	4192626.29638	4190978.72759	0.949390006645
Mean:	4174999.4816	4183794.49042	-0.0656769021976
Median:	4174058.46035	4184407.25633	0.0413926851582
Geometric Mean:	4174995.89288	4183792.88057	N/A
Harmonic Mean:	4174992.30788	4183791.27001	N/A
Root Mean Square:	4175003.07404	4183796.09957	0.578236355302
Trim Mean (10%%):	4174275.62139	4183655.00103	-0.120042869087
Interquartile Mean:	4173680.09703	4184095.46475	-0.161318996362
Midrange:	4179948.09536	4181929.97156	0.125210001154
Winsorized Mean:	4174710.42405	4183778.15093	-0.0844336530459
TriMean:	4174214.82644	4184140.5018	-0.0787886595889
Variance:	31150604.9064	13982508.6293	0.342737820461
Standard Deviation:	5581.27269593	3739.31927352	0.585438144009
Interquartile Range:	6864.94558741	2389.76592265	1
Range:	25356.4020346	18097.5120423	1.64836001098
Mean Difference:	6070.17358709	3973.01202276	0.659542932642
Median Abs. Deviation:	3316.272849	1620.13648955	0.674610658477
Average Abs. Deviation:	4218.16595519	2499.52496618	0.502321150033
Quartile Dispersion:	0.000822273016797	0.00028559249956	N/A
Relative Mean Diff.:	0.00145393397385	0.000949619306552	N/A
Standard Error:	1074.11643114	719.632329718	0.112667623346
Coef. of Variation:	0.00133683194945	0.000893762655426	N/A
Skewness:	1.12379133251	-0.70970424621	0.122826507885
Kurtosis:	4.3617639468	4.30311658156	1.46888038301
Sum:	112724986.003	112962451.241	-1.77327635934
Sum Absolute:	112724986.003	112962451.241	13.6040637361
Sum Squares:	4.70627568042e+014	4.72612044674e+014	9.02764663001
Mean Square:	1.74306506682e+013	1.75041498027e+013	0.334357282593

Inter-Variable Covariance

	X	Y	Z
X:	31150605	-11468228	-1237.6838
Y:	-11468228	13982509	199.45178
Z:	-1237.6838	199.45178	0.34273782

Inter-Variable Correlation

	X	Y	Z
X:	1.000	-0.550	-0.379
Y:	-0.550	1.000	0.091
Z:	-0.379	0.091	1.000

Inter-Variable Rank Correlation

	X	Y	Z
X:	1.000	-0.496	-0.436
Y:	-0.496	1.000	0.081
Z:	-0.436	0.081	1.000

Principal Component Analysis

	PC1	PC2	PC3
X:	0.447641195705	0.447641195705	4.93961351682e-005
Y:	0.89421326194	0.89421326194	2.62495376363e-005
Z:	-4.55844297554e-005	-4.55844297554e-005	2.62495376363e-005
Lambda:	36891574.8842	8241538.70733	0.286836541622

Planar Regression: Z = AX+BY+C

Fitted Parameters

A	B	C

Parameter Value:	-4.93961343099e-005	-2.62495363715e-005	315.985823882
Standard Error:	2.34442540145e-005	3.49926725258e-005	216.246631958

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.550	-0.825
B:	0.550	1.000	-0.926
C:	-0.825	-0.926	1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2	1.45343322648	0.72671661324	2.33866762375
Residual:	24	7.45775010551	0.31073958773	
Total:	26	8.91118333199		

Coefficient of Multiple Determination (R^2): 0.163102157405

Nearest Neighbor Statistics

	Separation	|Delta Z|
1%%-tile:	314.645646204	0
5%%-tile:	314.645646204	0
10%%-tile:	319.857615854	0
25%%-tile:	507.215930962	0.141329152796
50%%-tile:	1351.94192981	0.535113201697
75%%-tile:	1807.08319249	0.740362689494
90%%-tile:	2955.02438996	0.903089986992
95%%-tile:	3200.34228935	0.903089986992
99%%-tile:	6798.76974789	1
Minimum:	314.645646204	0
Maximum:	11449.5144946	1
Mean:	1844.56241218	0.495305068677
Median:	1351.94192981	0.535113201697
Geometric Mean:	1132.13892184	N/A
Harmonic Mean:	775.513004942	N/A
Root Mean Square:	2958.39557547	0.605509986956
Trim Mean (10%%):	1301.67730168	0.473884868928
Interquartile Mean:	1168.10511554	0.487054674481
Midrange:	5882.08007039	0.5
Winsorized Mean:	1378.89095208	0.488126549195

TriMean:	1254.54574577	0.487979561421
Variance:	5555451.34576	0.125981203755
Standard Deviation:	2357.00049762	0.354938309788
Interquartile Range:	1299.86726153	0.599033536698
Range:	11134.8688484	1
Mean Difference:	1990.69303418	0.410322868965
Median Abs. Deviation:	776.259832359	0.339948061694
Average Abs. Deviation:	1262.51816973	0.315660646663
Quartile Dispersion:	0.561667784582	N/A
Relative Mean Diff.:	1.07922237873	0.828424530484
Standard Error:	453.60495726	0.0683079095673
Coef. of Variation:	1.27781010935	0.716605446289
Skewness:	2.77519792328	-0.121231088291
Kurtosis:	10.9973555169	1.38631988634
Sum:	49803.1851289	13.3732368543
Sum Absolute:	49803.1851289	13.3732368543
Sum Squares:	236306818.286	9.89934329619
Mean Square:	8752104.38094	0.366642344303

Complete Spatial Randomness

Lambda:	5.88379131447e-008
Clark and Evans:	0.8948535814
Skellam:	87.3601521867

Gridding Rules

Gridding Method:	Kriging
Kriging Type:	Point
Polynomial Drift Order:	0
Kriging std. deviation grid:	yes

Semi-Variogram Model

Component Type:	Nugget Effect
Error Variance:	0.025
Micro Variance:	0
Component Type:	Gaussian
Anisotropy Angle:	0
Anisotropy Length:	1750
Anisotropy Ratio:	1
Variogram Scale:	0.385

Search Parameters

Search Ellipse Radius #1:	15600
Search Ellipse Radius #2:	15600
Search Ellipse Angle:	0
Number of Search Sectors:	1

Maximum Data Per Sector:	27
Maximum Empty Sectors:	1
Minimum Data:	1
Maximum Data:	27

Output Grid

Grid File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\krig_err\diox_DR2_log.grd

Grid Size:	301 rows x 309 columns
Total Nodes:	93009
Filled Nodes:	88340
Blanked Nodes:	4669
Blank Value:	1.70141E+038

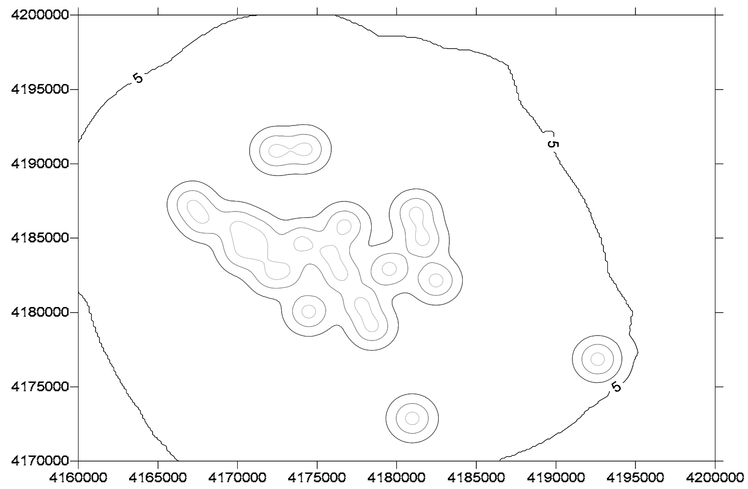
Grid Geometry

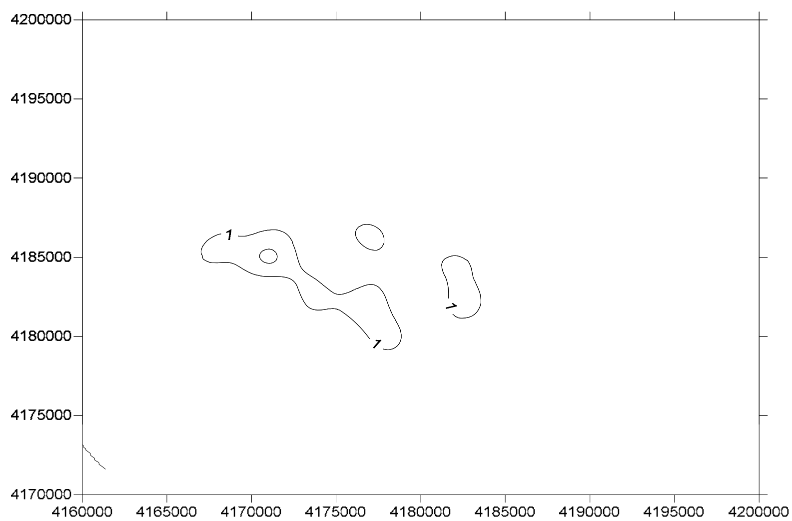
X Minimum:	4160000
X Maximum:	4200000
X Spacing:	129.87012987013
Y Minimum:	4170000
Y Maximum:	4200000
Y Spacing:	100

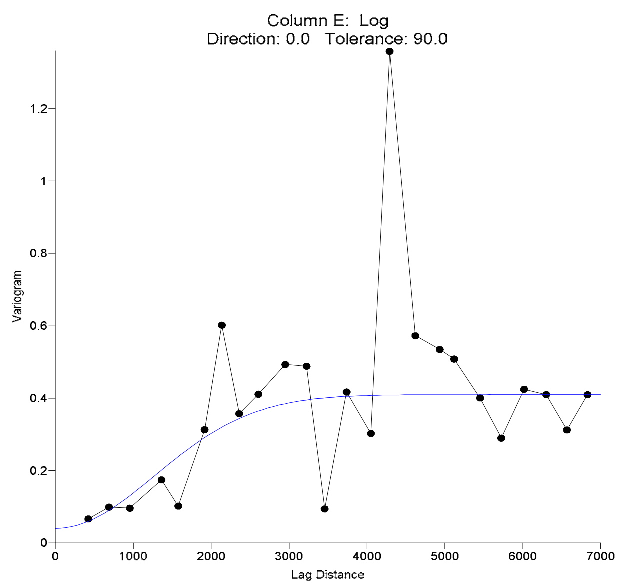
Univariate Grid Statistics

	Z
Count:	88340
1%%-tile:	-0.698970004336
5%%-tile:	-0.698970004336
10%%-tile:	-0.588189750137
25%%-tile:	-0.383266288586
50%%-tile:	-0.308306415322
75%%-tile:	-0.270426754557
90%%-tile:	-0.2016485127
95%%-tile:	-0.119913348205
99%%-tile:	0.1857219201
Minimum:	-1.04923989321
Maximum:	0.805160838437
Mean:	-0.334738210854
Median:	-0.308306415322
Geometric Mean:	N/A
Harmonic Mean:	N/A
Root Mean Square:	0.375755380656
Trim Mean (10%%):	-0.336518965652
Interquartile Mean:	-0.31499698168

Midrange:	-0.122039527389
Winsorized Mean:	-0.339659479609
TriMean:	-0.317576468447
Variance:	0.0291427661798
Standard Deviation:	0.170712524965
Interquartile Range:	0.112839534029
Range:	1.85440073165
Mean Difference:	N/A
Median Abs. Deviation:	0.0507503424499
Average Abs. Deviation:	0.107291371009
Quartile Dispersion:	N/A
Relative Mean Diff.:	N/A
Standard Error:	0.000574363308451
Coef. of Variation:	N/A
Skewness:	0.189515514151
Kurtosis:	7.29528423209
Sum:	-29570.7735468
Sum Absolute:	30510.4146112
Sum Squares:	12472.9106522
Mean Square:	0.141192106092







amec	Variogram 1,4-dioxane Depth Region 2 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	**D-8**

DRAWN	JOB NUMBER	CHECKED	DATE
SLC	4088115718	MDT	8/1/11

Gridding Report

Thu Sep 29 11:33:01 2011
Elapsed time for gridding: 41.4 seconds

Data Source

Source Data File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\again\hex_A.xls (sheet 'Sheet1')
X Column: C
Y Column: D
Z Column: F

Data Counts

Active Data: 89

Original Data: 89
Excluded Data: 0
Deleted Duplicates: 0
Retained Duplicates: 0
Artificial Data: 0
Superseded Data: 0

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: First
X Duplicate Tolerance: 0.0033
Y Duplicate Tolerance: 0.0025

No duplicate data were found.

Breakline Filtering

Breakline Filtering: Not In Use

Data Counts

Active Data: 89

Univariate Statistics

	X	Y	Z
Count:	89	89	89
1%%-tile:	4164566.11358	4172881.21554	-2.28399665637
5%%-tile:	4167573.41017	4177126.54907	-0.657577319178
10%%-tile:	4169030.46933	4179753.17507	-0.510041520575
25%%-tile:	4171171.46776	4182777.63002	-0.0809219076239
50%%-tile:	4172421.72288	4185013.05034	0.342422680822
75%%-tile:	4178197.86982	4185803.59916	1.17609125906
90%%-tile:	4182372.9963	4188432.57904	3.07918124605
95%%-tile:	4182501.0012	4190591.97379	3.94448267215
99%%-tile:	4191917.60774	4193546.92908	4.72509452108
Minimum:	4164566.11358	4172881.21554	-2.28399665637
Maximum:	4192338.91823	4194283.25562	5.14612803568
Mean:	4174643.79566	4184431.16841	0.777671084604
Median:	4172421.72288	4185013.05034	0.342422680822
Geometric Mean:	4174640.20154	4184429.58449	N/A
Harmonic Mean:	4174636.61045	4184428.00017	N/A
Root Mean Square:	4174647.39279	4184432.75193	1.59933490208
Trim Mean (10%%):	4174269.12929	4184438.60863	0.648368655353
Interquartile Mean:	4173410.82438	4184761.34541	0.41699841507
Midrange:	4178452.51591	4183582.23558	1.43106568966
Winsorized Mean:	4174503.08144	4184443.49034	0.720064721551
TriMean:	4173553.19584	4184651.83247	0.445003678269
Variance:	30374818.2803	13402930.6602	1.97529412925
Standard Deviation:	5511.33543529	3661.00131934	1.40545157485
Interquartile Range:	7026.40206659	3025.96913629	1.25701316668
Range:	27772.8046456	21402.0400719	7.43012469204
Mean Difference:	5964.27101794	3865.17409917	1.45684730182
Median Abs. Deviation:	2320.61002268	1392.08561154	0.488165987863
Average Abs. Deviation:	4186.29343004	2459.61735437	0.958416314928
Quartile Dispersion:	0.000841548838302	0.000361586875173	N/A
Relative Mean Diff.:	0.00142868980202	0.000923703591626	N/A
Standard Error:	584.200387742	388.06536372	0.148977568979
Coef. of Variation:	0.00132019298054	0.000874910154332	N/A
Skewness:	0.947543050069	-0.415769809347	1.23308194589
Kurtosis:	3.73422181638	4.46272061492	4.2828733424
Sum:	371543297.813	372414373.988	69.2127265297
Sum Absolute:	371543297.813	372414373.988	92.2434809256
Sum Squares:	1.55106359602e+015	1.55834349354e+015	227.650619483
Mean Square:	1.74276808541e+013	1.75094774555e+013	2.55787212902

Inter-Variable Covariance

	X	Y	Z
X:	30374818	-9415132.5	-2391.6649
Y:	-9415132.5	13402931	-613.22257
Z:	-2391.6649	-613.22257	1.9752941

Inter-Variable Correlation

	X	Y	Z
X:	1.000	-0.467	-0.309
Y:	-0.467	1.000	-0.119
Z:	-0.309	-0.119	1.000

Inter-Variable Rank Correlation

	X	Y	Z
X:	1.000	-0.327	-0.300
Y:	-0.327	1.000	-0.374
Z:	-0.300	-0.374	1.000

Principal Component Analysis

	PC1	PC2	PC3
X:	0.406508427442	0.406508427442	0.00011878439804
Y:	0.913647016497	0.913647016497	0.000129195147931
Z:	-0.000166325622866	-0.000166325622866	0.000129195147931
Lambda:	34563887.8575	9213861.44632	1.61197626545

Planar Regression: Z = AX+BY+C

Fitted Parameters

	A	B	C

Parameter Value:	-0.000118784385654	-0.000129195124396	1037.26827501
Standard Error:	2.80865154808e-005	4.22819317779e-005	253.792712463

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.467	-0.787
B:	0.467	1.000	-0.913
C:	-0.787	-0.913	1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2	31.9719676452	15.9859838226	9.69162255184
Residual:	86	141.853915729	1.64946413638	
Total:	88	173.825883374		

Coefficient of Multiple Determination (R^2): 0.183930994767

Nearest Neighbor Statistics

	Separation	|Delta Z|
1%%-tile:	12.9079144907	0
5%%-tile:	75.7071604928	0.0404286493389
10%%-tile:	121.002875893	0.0543576623226
25%%-tile:	230.613948264	0.176091259056
50%%-tile:	605.371698953	0.502675359192
75%%-tile:	1289.07933886	1.03218468337
90%%-tile:	2059.8934677	1.58922276662
95%%-tile:	3021.50039755	1.75221551629
99%%-tile:	3669.40306167	3.53926916147
Minimum:	12.9079144907	0
Maximum:	4492.49417891	3.53926916147
Mean:	957.478147716	0.725903840008
Median:	605.371698953	0.502675359192
Geometric Mean:	530.59527513	N/A
Harmonic Mean:	179.207706033	N/A
Root Mean Square:	1350.82119183	1.03031701704
Trim Mean (10%%):	835.783886541	0.632203480121
Interquartile Mean:	693.872262759	0.544701265031
Midrange:	2252.7010467	1.76963458073
Winsorized Mean:	847.753381365	0.655543007425

TriMean:	682.609171257	0.553406665203
Variance:	918271.14223	0.540691961234
Standard Deviation:	958.264651456	0.735317592088
Interquartile Range:	1058.46539059	0.856093424316
Range:	4479.58626442	3.53926916147
Mean Difference:	985.600308361	0.740075625598
Median Abs. Deviation:	437.893706206	0.367012757192
Average Abs. Deviation:	691.320021253	0.514203165444
Quartile Dispersion:	0.696499352575	N/A
Relative Mean Diff.:	1.02937107308	1.01952295168
Standard Error:	101.575849903	0.0779435088745
Coef. of Variation:	1.00082143257	1.01296831834
Skewness:	1.5303012605	1.8663574052
Kurtosis:	5.08153733902	7.31735419399
Sum:	85215.5551467	64.6054417607
Sum Absolute:	85215.5551467	64.6054417607
Sum Squares:	162399892.415	94.4782308481
Mean Square:	1824717.8923	1.0615531556

Complete Spatial Randomness

Lambda:	1.4973216165e-007
Clark and Evans:	0.740996938826
Skellam:	152.784993482

Gridding Rules

Gridding Method:	Kriging
Kriging Type:	Point
Polynomial Drift Order:	0
Kriging std. deviation grid:	yes

Semi-Variogram Model

Component Type:	Nugget Effect
Error Variance:	0.2
Micro Variance:	0
Component Type:	Exponential
Anisotropy Angle:	0
Anisotropy Length:	1000
Anisotropy Ratio:	1
Variogram Scale:	1.8

Search Parameters

Search Ellipse Radius #1:	17500
Search Ellipse Radius #2:	17500
Search Ellipse Angle:	0
Number of Search Sectors:	1

Maximum Data Per Sector:	89
Maximum Empty Sectors:	1
Minimum Data:	1
Maximum Data:	89

Output Grid

Grid File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\again\hex_A_log.grd

Grid Size:	301 rows x 309 columns
Total Nodes:	93009
Filled Nodes:	91994
Blanked Nodes:	1015
Blank Value:	1.70141E+038

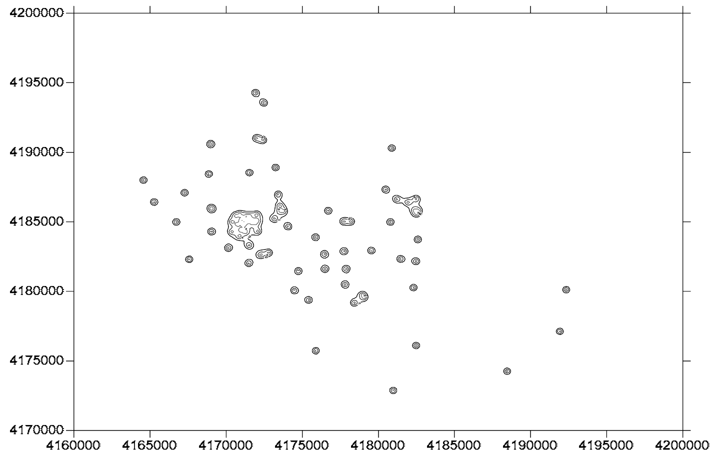
Grid Geometry

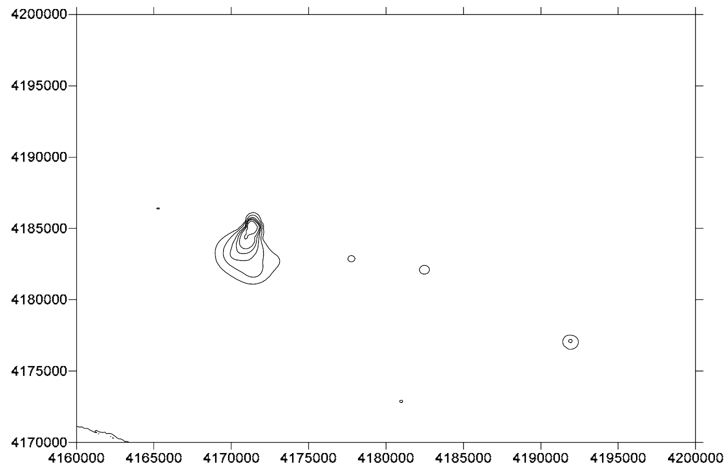
X Minimum:	4160000
X Maximum:	4200000
X Spacing:	129.87012987013
Y Minimum:	4170000
Y Maximum:	4200000
Y Spacing:	100

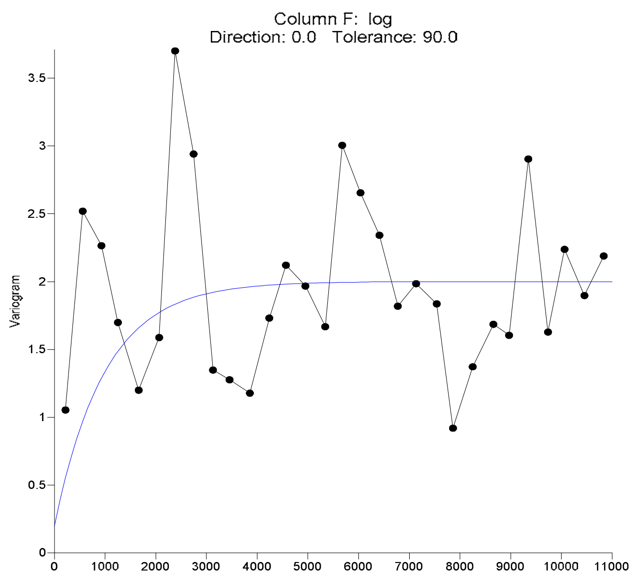
Univariate Grid Statistics

	Z
Count:	91994
1%%-tile:	-0.780285461044
5%%-tile:	-0.33216813119
10%%-tile:	-0.172379977105
25%%-tile:	-0.00301701904334
50%%-tile:	0.12173570481
75%%-tile:	0.242520874674
90%%-tile:	0.34997555195
95%%-tile:	0.443275005345
99%%-tile:	0.815118621775
Minimum:	-2.28399665637
Maximum:	4.31375317791
Mean:	0.0982665810612
Median:	0.121736442178
Geometric Mean:	N/A
Harmonic Mean:	N/A
Root Mean Square:	0.338475805462
Trim Mean (10%%):	0.110987265544
Interquartile Mean:	0.123291483598

Midrange:	1.01487826077
Winsorized Mean:	0.110537561956
TriMean:	0.120743816313
Variance:	0.104910690338
Standard Deviation:	0.323899197804
Interquartile Range:	0.245537893718
Range:	6.59774983428
Mean Difference:	N/A
Median Abs. Deviation:	0.121927614417
Average Abs. Deviation:	0.18831816209
Quartile Dispersion:	N/A
Relative Mean Diff.:	N/A
Standard Error:	0.00106789885526
Coef. of Variation:	N/A
Skewness:	-1.56299166522
Kurtosis:	27.8212997379
Sum:	9039.93585814
Sum Absolute:	20260.0308285
Sum Squares:	10539.372726
Mean Square:	0.114565870883







Variogram
Hexavalent Cr A-Zone
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

D-5

DRAWN	JOB NUMBER	CHECKED	DATE
SLC	4088115718	MDT	8/1/11

Gridding Report

Thu Sep 29 12:27:41 2011
Elapsed time for gridding: 2.45 seconds

Data Source

Source Data File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\again\hex_B.xls (sheet 'Sheet1')
X Column: C
Y Column: D
Z Column: F

Data Counts

Active Data: 20

Original Data: 20
Excluded Data: 0
Deleted Duplicates: 0
Retained Duplicates: 0
Artificial Data: 0
Superseded Data: 0

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: First
X Duplicate Tolerance: 0.0028
Y Duplicate Tolerance: 0.0021

No duplicate data were found.

Breakline Filtering

Breakline Filtering: Not In Use

Data Counts

Active Data: 20

Univariate Statistics

	X	Y	Z
Count:	20	20	20
1%%-tile:	4168864.81167	4172891.01243	-1.38721614328
5%%-tile:	4168864.81167	4172891.01243	-1.38721614328
10%%-tile:	4168984.03509	4176863.42559	-1.05060999336
25%%-tile:	4170742.1875	4182695.09849	-0.510041520575
50%%-tile:	4174058.46035	4184282.1841	-0.180456064458
75%%-tile:	4178414.02127	4184989.7062	0.113943352307
90%%-tile:	4181220.90682	4186628.5634	0.612783846618
95%%-tile:	4181627.61771	4188422.73511	0.63346845558
99%%-tile:	4181627.61771	4188422.73511	0.63346845558
Minimum:	4168864.81167	4172891.01243	-1.38721614328
Maximum:	4192626.29638	4190592.07159	0.770852011642
Mean:	4175590.32087	4183559.69494	-0.166648114238
Median:	4174960.66009	4184344.72022	-0.167679012222
Geometric Mean:	4175586.45571	4183558.03236	N/A
Harmonic Mean:	4175582.5947	4183556.36875	N/A
Root Mean Square:	4175594.19018	4183561.35647	0.58181955401
Trim Mean (10%%):	4174693.69058	4183189.56985	-0.215990226126
Interquartile Mean:	4174290.19282	4183920.72987	-0.221471320619
Midrange:	4180745.55403	4181741.54201	-0.308182065819
Winsorized Mean:	4175005.67702	4183470.4316	-0.158755445441
TriMean:	4174318.28236	4184062.29322	-0.189252574296
Variance:	34014014.9702	14633972.6658	0.327097262578
Standard Deviation:	5832.1535448	3825.43757834	0.571924175549
Interquartile Range:	7671.83377233	2294.60771461	0.623984872882
Range:	23761.4847036	17701.0591611	2.15806815492
Mean Difference:	6375.53212113	3975.15268056	0.659861306507
Median Abs. Deviation:	4120.20647379	1445.37827628	0.342362508353
Average Abs. Deviation:	4526.96234179	2448.23902528	0.436083216277
Quartile Dispersion:	0.00091887534267	0.000274222532059	N/A
Relative Mean Diff.:	0.0015268576731	0.000950184285733	N/A
Standard Error:	1304.10917814	855.393846885	0.12788613345
Coef. of Variation:	0.00139672551583	0.000914397751505	N/A
Skewness:	1.09865911926	-0.970001730631	-0.158203415384
Kurtosis:	4.09411149112	4.31245200411	2.30154226361
Sum:	83511806.4174	83671193.8988	-3.33296228476
Sum Absolute:	83511806.4174	83671193.8988	9.41086876342
Sum Squares:	3.48711736821e+014	3.50043712468e+014	6.77027986856
Mean Square:	1.7435586841e+013	1.75021856234e+013	0.338513993428

Inter-Variable Covariance

	X	Y	Z
X:	34014015	-13813447	632.42746
Y:	-13813447	14633973	-1239.5444
Z:	632.42746	-1239.5444	0.32709726

Inter-Variable Correlation

	X	Y	Z
X:	1.000	-0.619	0.190
Y:	-0.619	1.000	-0.567
Z:	0.190	-0.567	1.000

Inter-Variable Rank Correlation

	X	Y	Z
X:	1.000	-0.469	0.143
Y:	-0.469	1.000	-0.508
Z:	0.143	-0.508	1.000

Principal Component Analysis

	PC1	PC2	PC3
X:	0.461366581605	0.461366581605	2.56311622578e-005
Y:	0.88720959509	0.88720959509	0.000108897234943
Z:	-0.000108440034112	-0.000108440034112	0.000108897234943
Lambda:	41197281.3179	7450706.4368	0.208324150534

Planar Regression: Z = AX+BY+C

Fitted Parameters

	A	B	C

Parameter Value:	-2.56311611427e-005	-0.00010889723287	562.436654591
Standard Error:	2.41709360668e-005	3.68503230222e-005	230.696243294

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.619	-0.851
B:	0.619	1.000	-0.939
C:	-0.851	-0.939	1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2	2.2566890793	1.12834453965	4.84615641053
Residual:	17	3.95815890968	0.23283287704	
Total:	19	6.21484798898		

Coefficient of Multiple Determination (R^2): 0.363112514305

Nearest Neighbor Statistics

	Separation	|Delta Z|
1%%-tile:	409.74666388	0.0383449920762
5%%-tile:	409.74666388	0.0383449920762
10%%-tile:	409.74666388	0.0383449920762
25%%-tile:	507.215930962	0.172799352257
50%%-tile:	1351.94192981	0.355139560589
75%%-tile:	2086.4125138	0.53942529826
90%%-tile:	3791.48790967	0.674427063258
95%%-tile:	6788.28633317	0.743389144124
99%%-tile:	6788.28633317	0.743389144124
Minimum:	409.74666388	0.0383449920762
Maximum:	12311.2185243	0.877174622705
Mean:	2183.49810127	0.379854827975
Median:	1520.25567203	0.42699002745
Geometric Mean:	1333.86832682	0.27493124946
Harmonic Mean:	920.703956564	0.167265152146
Root Mean Square:	3502.55278033	0.453449802322
Trim Mean (10%%):	1650.46018427	0.353680101937
Interquartile Mean:	1342.23988646	0.347784389069
Midrange:	6360.48259407	0.457759807391
Winsorized Mean:	1607.67164937	0.366269345959

TriMean:	1324.3780761	0.355625942924
Variance:	7894960.02182	0.0645547714632
Standard Deviation:	2809.79714959	0.254076310315
Interquartile Range:	1579.19658283	0.366625946004
Range:	11901.4718604	0.838829630629
Mean Difference:	2389.23365143	0.29231437501
Median Abs. Deviation:	805.520152996	0.244951318333
Average Abs. Deviation:	1461.32678584	0.224403770522
Quartile Dispersion:	0.608875410056	0.514761663665
Relative Mean Diff.:	1.09422291233	0.769542344818
Standard Error:	628.289742946	0.0568131901336
Coef. of Variation:	1.28683287975	0.668877401584
Skewness:	2.4853552377	0.21024932871
Kurtosis:	8.85640970238	1.66511800913
Sum:	43669.9620254	7.5970965595
Sum Absolute:	43669.9620254	7.5970965595
Sum Squares:	245357519.58	4.11233446452
Mean Square:	12267875.979	0.205616723226

Complete Spatial Randomness

Lambda:	4.75507278096e-008
Clark and Evans:	0.952272841503
Skellam:	73.3054745452

Gridding Rules

Gridding Method:	Kriging
Kriging Type:	Point
Polynomial Drift Order:	0
Kriging std. deviation grid:	yes

Semi-Variogram Model

Component Type:	Nugget Effect
Error Variance:	0.01
Micro Variance:	0
Component Type:	Gaussian
Anisotropy Angle:	0
Anisotropy Length:	3300
Anisotropy Ratio:	1
Variogram Scale:	0.33

Search Parameters

Search Ellipse Radius #1:	14800
Search Ellipse Radius #2:	14800
Search Ellipse Angle:	0
Number of Search Sectors:	1

Maximum Data Per Sector:	20
Maximum Empty Sectors:	1
Minimum Data:	1
Maximum Data:	20

Output Grid

Grid File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\again\hex_B_log.grd

Grid Size:	301 rows x 309 columns
Total Nodes:	93009
Filled Nodes:	86978
Blanked Nodes:	6031
Blank Value:	1.70141E+038

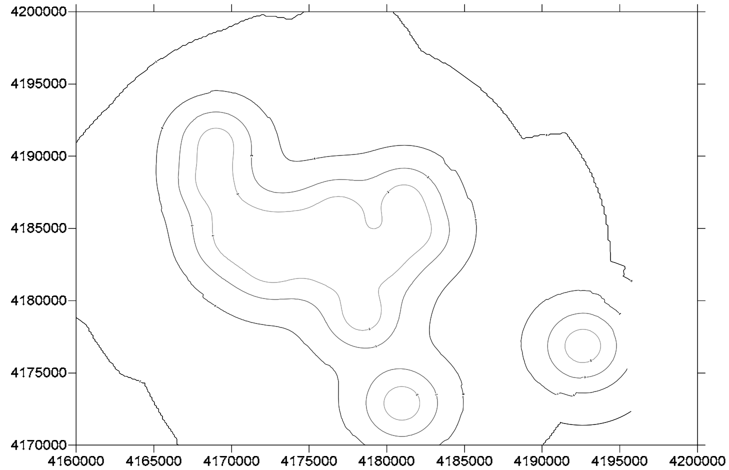
Grid Geometry

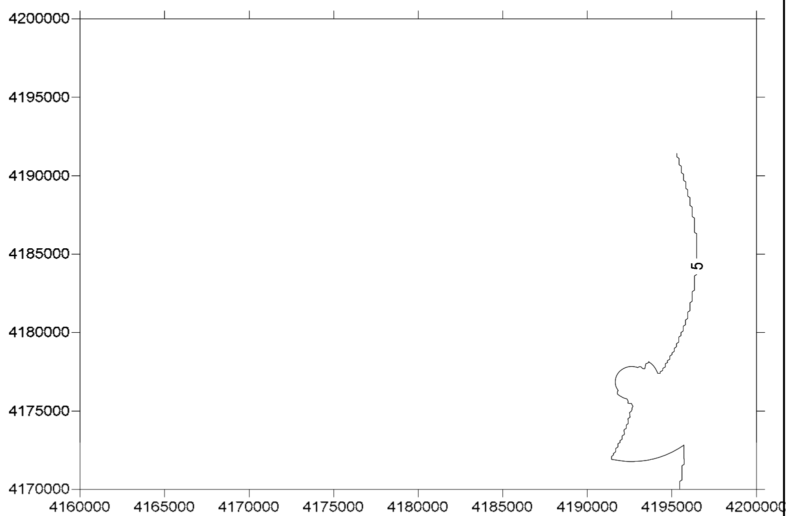
X Minimum:	4160000
X Maximum:	4200000
X Spacing:	129.87012987013
Y Minimum:	4170000
Y Maximum:	4200000
Y Spacing:	100

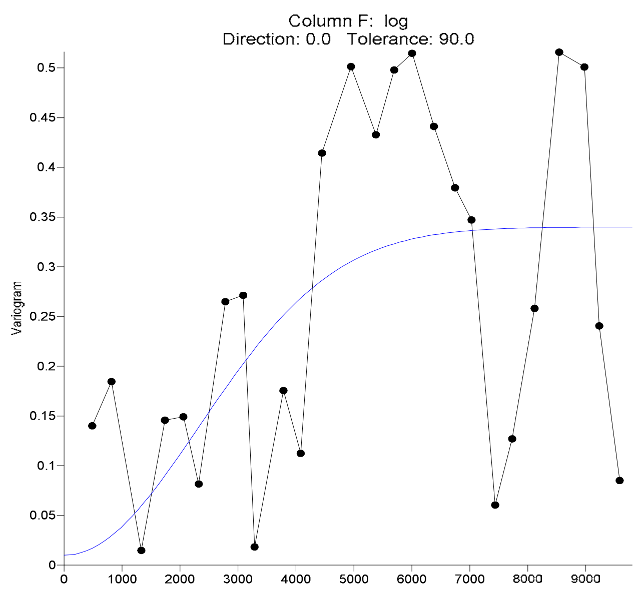
Univariate Grid Statistics

	Z
Count:	86978
1%%-tile:	-1.2185450981
5%%-tile:	-0.873154180153
10%%-tile:	-0.759734843709
25%%-tile:	-0.62883263842
50%%-tile:	-0.285543506634
75%%-tile:	0.139373232299
90%%-tile:	0.694857971672
95%%-tile:	0.770852011642
99%%-tile:	0.770852011642
Minimum:	-1.54025684497
Maximum:	0.770852011642
Mean:	-0.219052234752
Median:	-0.285531205593
Geometric Mean:	N/A
Harmonic Mean:	N/A
Root Mean Square:	0.558316362131
Trim Mean (10%%):	-0.227023449872
Interquartile Mean:	-0.300399682962

Midrange:	-0.384702416663
Winsorized Mean:	-0.207979912564
TriMean:	-0.265136604847
Variance:	0.263736310892
Standard Deviation:	0.513552636924
Interquartile Range:	0.768205870719
Range:	2.31110885661
Mean Difference:	N/A
Median Abs. Deviation:	0.364861993756
Average Abs. Deviation:	0.421828198482
Quartile Dispersion:	N/A
Relative Mean Diff.:	N/A
Standard Error:	0.00174132668309
Coef. of Variation:	N/A
Skewness:	0.450881320867
Kurtosis:	2.37946833064
Sum:	-19052.7252742
Sum Absolute:	42020.602531
Sum Squares:	27112.5351619
Mean Square:	0.311717160223







amec

Variogram
Hexavalent Cr B-Zone
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

D-5

DRAWN	JOB NUMBER	CHECKED	DATE
SLC	4088115718	MDT	8/1/11

Gridding Report

Thu Aug 25 16:18:36 2011
Elapsed time for gridding: 31.8 seconds

Data Source

Source Data File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\krig_err\hex_DR1.xls (sheet 'Sheet1')
X Column: B
Y Column: C
Z Column: E

Data Counts

Active Data: 85

Original Data: 85
Excluded Data: 0
Deleted Duplicates: 0
Retained Duplicates: 0
Artificial Data: 0
Superseded Data: 0

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: First
X Duplicate Tolerance: 0.0033
Y Duplicate Tolerance: 0.0023

No duplicate data were found.

Breakline Filtering

Breakline Filtering: Not In Use

Data Counts

Active Data: 85

Univariate Statistics

	X	Y	Z
Count:	85	85	85
1%%-tile:	4164566.11358	4174258.9507	-2.28399665637
5%%-tile:	4168864.68298	4179168.41271	-0.80966830183
10%%-tile:	4169032.89783	4180068.26896	-0.510041520575
25%%-tile:	4171299.81226	4182891.10508	-0.0861861514045
50%%-tile:	4173171.05848	4185024.48698	0.255272505103
75%%-tile:	4177889.97252	4185899.95263	1
90%%-tile:	4182307.00916	4188903.49696	3.07918124605
95%%-tile:	4182501.0012	4191018.52887	3.94448267215
99%%-tile:	4191917.60774	4193546.92908	4.72509452108
Minimum:	4164566.11358	4174258.9507	-2.28399665637
Maximum:	4192338.91823	4194283.25562	5.14612803568
Mean:	4174738.96099	4184740.7226	0.715704442962
Median:	4173171.05848	4185024.48698	0.255272505103
Geometric Mean:	4174735.47818	4184739.06405	N/A
Harmonic Mean:	4174731.99836	4184737.40549	N/A
Root Mean Square:	4174742.44678	4184742.38112	1.59594147685
Trim Mean (10%%):	4174351.85128	4184664.65507	0.572445841966
Interquartile Mean:	4173572.97819	4184822.81712	0.328464423801
Midrange:	4178452.51591	4184271.10316	1.43106568966
Winsorized Mean:	4174565.35283	4184645.30193	0.65907974777
TriMean:	4173882.97544	4184710.00792	0.356089714701
Variance:	29451024.8243	14046242.7856	2.05902011391
Standard Deviation:	5426.87984244	3747.83174457	1.43492860934
Interquartile Range:	6590.16025532	3008.84755833	1.0861861514
Range:	27772.8046456	20024.3049132	7.43012469204
Mean Difference:	5857.49910707	4031.44926413	1.46815808342
Median Abs. Deviation:	2557.59160066	1603.94768917	0.440209171387
Average Abs. Deviation:	4097.23408325	2576.41037765	0.953561737577
Quartile Dispersion:	0.000789317337993	0.000359531924932	N/A
Relative Mean Diff.:	0.00140308152481	0.000963368947176	N/A
Standard Error:	588.627764373	406.509428089	0.155639860081
Coef. of Variation:	0.00129993273667	0.000895594731672	N/A
Skewness:	0.98078720209	-0.0189030891483	1.30425659816
Kurtosis:	3.96476196799	3.80793667165	4.3410584368
Sum:	354852811.684	355702961.421	60.8348776518
Sum Absolute:	354852811.684	355702961.421	85.5563515317
Sum Squares:	1.48142033224e+015	1.48852584769e+015	216.497481791
Mean Square:	1.74284744969e+013	1.75120687964e+013	2.54702919754

Inter-Variable Covariance

	X	Y	Z
X:	29451025	-8979804.5	-2488.5694
Y:	-8979804.5	14046243	-777.28855
Z:	-2488.5694	-777.28855	2.0590201

Inter-Variable Correlation

	X	Y	Z
X:	1.000	-0.442	-0.320
Y:	-0.442	1.000	-0.145
Z:	-0.320	-0.145	1.000

Inter-Variable Rank Correlation

	X	Y	Z
X:	1.000	-0.304	-0.327
Y:	-0.304	1.000	-0.377
Z:	-0.327	-0.377	1.000

Principal Component Analysis

	PC1	PC2	PC3
X:	0.417698898471	0.417698898471	0.000125915910157
Y:	0.90858549363	0.90858549363	0.000135836254973
Z:	-0.000176013790769	-0.000176013790769	0.000135836254973
Lambda:	33579260.0923	9918007.93646	1.64008565664

Planar Regression: Z = AX+BY+C

Fitted Parameters

A	B	C

Parameter Value:	-0.0001259158976	-0.000135836232034	1094.82111976
Standard Error:	2.90441487569e-005	4.20560783332e-005	254.005700475

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.442	-0.783
B:	0.442	1.000	-0.904
C:	-0.783	-0.904	1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2	35.1904896839	17.595244842	10.4728126742
Residual:	82	137.767199884	1.68008780347	
Total:	84	172.957689568		

Coefficient of Multiple Determination (R^2): 0.203462995903

Nearest Neighbor Statistics

	Separation	|Delta Z|
1%%-tile:	12.9079144907	0
5%%-tile:	19.6998786755	0.0404286493389
10%%-tile:	121.002875893	0.0543576623226
25%%-tile:	230.613948264	0.145142122697
50%%-tile:	666.823143165	0.387599175334
75%%-tile:	1282.84575062	0.782950133265
90%%-tile:	2042.55499346	1.50267535919
95%%-tile:	2994.51929203	1.64591327503
99%%-tile:	4165.84935295	3.53926916147
Minimum:	12.9079144907	0
Maximum:	4492.49417891	3.53926916147
Mean:	962.514023985	0.629943443465
Median:	666.823143165	0.387599175334
Geometric Mean:	520.808857751	N/A
Harmonic Mean:	153.437569702	N/A
Root Mean Square:	1355.40213629	0.975990129311
Trim Mean (10%%):	833.979738839	0.505745986945
Interquartile Mean:	703.17769014	0.419270762983
Midrange:	2252.7010467	1.76963458073
Winsorized Mean:	854.51378506	0.540789089208

TriMean:	711.776496303	0.425822651657
Variance:	921523.153562	0.562343799958
Standard Deviation:	959.959974979	0.749895859408
Interquartile Range:	1052.23180236	0.637808010569
Range:	4479.58626442	3.53926916147
Mean Difference:	986.080484087	0.697627228608
Median Abs. Deviation:	465.149066267	0.294980412814
Average Abs. Deviation:	692.53026062	0.466157984024
Quartile Dispersion:	0.695249304049	N/A
Relative Mean Diff.:	1.02448427713	1.1074442251
Standard Error:	104.12227843	0.0813376260489
Coef. of Variation:	0.997346481255	1.19041775446
Skewness:	1.58148295668	2.3362984002
Kurtosis:	5.47700251954	8.88508774565
Sum:	81813.6920387	53.5451926946
Sum Absolute:	81813.6920387	53.5451926946
Sum Squares:	156154770.84	80.9673222635
Mean Square:	1837114.95106	0.952556732512

Complete Spatial Randomness

Lambda:	1.52841656757e-007
Clark and Evans:	0.752589110338
Skellam:	149.960493983

Gridding Rules

Gridding Method:	Kriging
Kriging Type:	Point
Polynomial Drift Order:	0
Kriging std. deviation grid:	yes

Semi-Variogram Model

Component Type:	Nugget Effect
Error Variance:	0.4151
Micro Variance:	0
Component Type:	Exponential
Anisotropy Angle:	0
Anisotropy Length:	453.4
Anisotropy Ratio:	1
Variogram Scale:	1.7

Search Parameters

Search Ellipse Radius #1:	17100
Search Ellipse Radius #2:	17100
Search Ellipse Angle:	0
Number of Search Sectors:	1

Maximum Data Per Sector:	85
Maximum Empty Sectors:	1
Minimum Data:	1
Maximum Data:	85

Output Grid

Grid File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\krig_err\hex_DR1_log.grd

Grid Size:	301 rows x 309 columns
Total Nodes:	93009
Filled Nodes:	91777
Blanked Nodes:	1232
Blank Value:	1.70141E+038

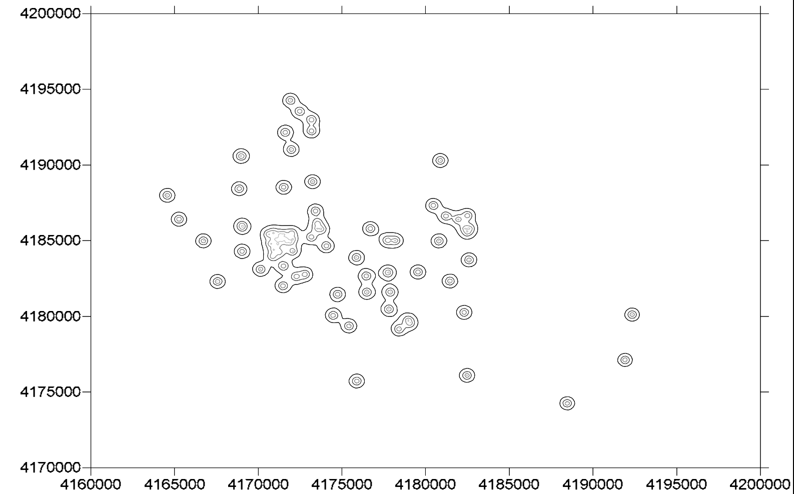
Grid Geometry

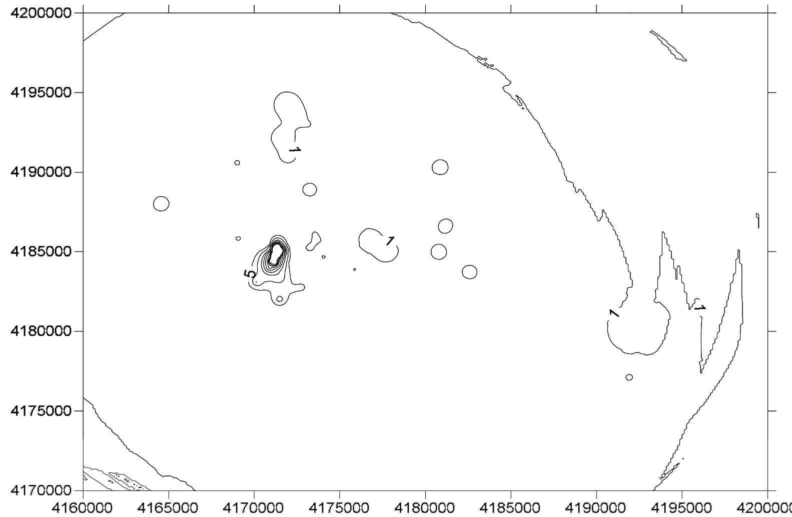
X Minimum:	4160000
X Maximum:	4200000
X Spacing:	129.87012987013
Y Minimum:	4170000
Y Maximum:	4200000
Y Spacing:	100

Univariate Grid Statistics

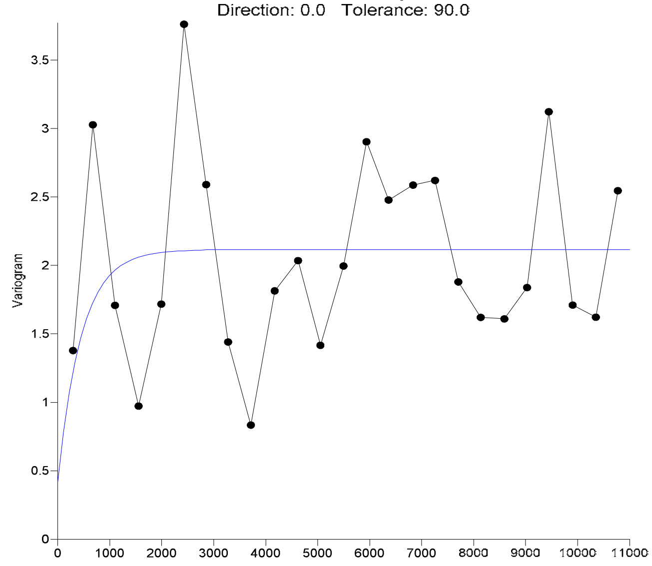
	Z
Count:	91777
1%%-tile:	-0.517572306616
5%%-tile:	-0.276171952337
10%%-tile:	-0.164706579027
25%%-tile:	0.0149828619586
50%%-tile:	0.215525947512
75%%-tile:	0.298831550672
90%%-tile:	0.387133606811
95%%-tile:	0.480620122874
99%%-tile:	0.89003051041
Minimum:	-2.28399665637
Maximum:	4.24136481067
Mean:	0.152185816214
Median:	0.215525947512
Geometric Mean:	N/A
Harmonic Mean:	N/A
Root Mean Square:	0.360098526573
Trim Mean (10%%):	0.164494669483
Interquartile Mean:	0.191776781414

Midrange:	0.978684077154
Winsorized Mean:	0.159488373792
TriMean:	0.186216576914
Variance:	0.106511586731
Standard Deviation:	0.32636112932
Interquartile Range:	0.283848688714
Range:	6.52536146704
Mean Difference:	N/A
Median Abs. Deviation:	0.118063049731
Average Abs. Deviation:	0.191893932584
Quartile Dispersion:	N/A
Relative Mean Diff.:	N/A
Standard Error:	0.00107728719713
Coef. of Variation:	N/A
Skewness:	-2.14806466337
Kurtosis:	28.6947892186
Sum:	13967.1576547
Sum Absolute:	23672.9732384
Sum Squares:	11900.8106717
Mean Square:	0.12967094884





Column E: Log
Direction: 0.0 Tolerance: 90.0



amec

Variogram
Hexavalent Cr Depth Region 1
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

D-5

DRAWN	JOB NUMBER	CHECKED	DATE
SLC	4088115718	MDT	8/1/11

Gridding Report

Sun Aug 28 16:36:53 2011
Elapsed time for gridding: 4.38 seconds

Data Source

Source Data File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\krig_err\hex_DR2.xls (sheet 'Sheet1')
X Column: B
Y Column: C
Z Column: E

Data Counts

Active Data: 28

Original Data: 28
Excluded Data: 0
Deleted Duplicates: 0
Retained Duplicates: 0
Artificial Data: 0
Superseded Data: 0

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: First
X Duplicate Tolerance: 0.003
Y Duplicate Tolerance: 0.0021

No duplicate data were found.

Breakline Filtering

Breakline Filtering: Not In Use

Data Counts

Active Data: 28

Univariate Statistics

	X	Y	Z
Count:	28	28	28
1%%-tile:	4167269.89434	4172881.21554	-1.38721614328
5%%-tile:	4167691.41447	4176870.0784	-1.05060999336
10%%-tile:	4168864.81167	4179178.26479	-0.585026652029
25%%-tile:	4170742.1875	4182678.8643	-0.431798275933
50%%-tile:	4172799.29793	4184407.25633	0.0791812460476
75%%-tile:	4177803.66532	4185630.79876	0.556302500767
90%%-tile:	4181220.90682	4187088.74378	1.07918124605
95%%-tile:	4181627.61771	4188422.73511	1.36172783602
99%%-tile:	4182474.89913	4190871.2737	1.53147891704
Minimum:	4167269.89434	4172881.21554	-1.38721614328
Maximum:	4192633.10141	4190978.72759	2.38021124171
Mean:	4174780.62928	4183960.02248	0.176231009145
Median:	4173428.87914	4184533.24086	0.0965622991772
Geometric Mean:	4174777.01251	4183958.38237	N/A
Harmonic Mean:	4174773.39955	4183956.74151	N/A
Root Mean Square:	4174784.24986	4183961.66184	0.80288693378
Trim Mean (10%%):	4174059.189	4183845.9765	0.0963997696232
Interquartile Mean:	4173484.23639	4184197.82035	0.0611138350386
Midrange:	4179951.49788	4181929.97156	0.496497549216
Winsorized Mean:	4174412.60845	4183945.69143	0.148798815429
TriMean:	4173536.11217	4184281.04393	0.0707166792324
Variance:	31349953.8389	14226165.605	0.636294876883
Standard Deviation:	5599.10294948	3771.75895372	0.797680936768
Interquartile Range:	7061.47782203	2951.9344572	0.9881007767
Range:	25363.2070686	18097.5120423	3.76742738499
Mean Difference:	6089.91370889	4045.85335579	0.887788124201
Median Abs. Deviation:	3042.61831008	1792.13169223	0.49405038835
Average Abs. Deviation:	4253.2476606	2553.42857369	0.591718105311
Quartile Dispersion:	0.000845833268035	0.000352751580195	N/A
Relative Mean Diff.:	0.001458738614	0.00096699139907	N/A
Standard Error:	1058.13099781	712.795442631	0.150747527447
Coef. of Variation:	0.00134117297331	0.000901480638787	N/A
Skewness:	1.14078591575	-0.727270632032	0.608329661447
Kurtosis:	4.37907235332	4.20444725834	3.48119974319
Sum:	116893857.62	117150880.629	4.93446825605
Sum Absolute:	116893857.62	117150880.629	16.7852369962
Sum Squares:	4.88007058922e+014	4.90154985258e+014	18.0495679962
Mean Square:	1.74288235329e+013	1.75055351878e+013	0.644627428435

Inter-Variable Covariance

	X	Y	Z
X:	31349954	-12054896	-133.34275
Y:	-12054896	14226166	-858.91964
Z:	-133.34275	-858.91964	0.63629488

Inter-Variable Correlation

	X	Y	Z
X:	1.000	-0.571	-0.030
Y:	-0.571	1.000	-0.285
Z:	-0.030	-0.285	1.000

Inter-Variable Rank Correlation

	X	Y	Z
X:	1.000	-0.531	-0.044
Y:	-0.531	1.000	-0.401
Z:	-0.044	-0.401	1.000

Principal Component Analysis

	PC1	PC2	PC3
X:	0.458773839418	0.458773839418	4.07462645387e-005
Y:	0.888553067438	0.888553067438	9.49034123245e-005
Z:	-0.000103020038905	-0.000103020038905	9.49034123245e-005
Lambda:	37574084.9399	8002034.5909	0.549347252383

Planar Regression: Z = AX+BY+C

Fitted Parameters

A	B	C

Parameter Value:	-4.07462616067e-005	-9.49034064972e-005	567.354993462
Standard Error:	3.22443027365e-005	4.78660414864e-005	298.338774932

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.571	-0.834
B:	0.571	1.000	-0.929
C:	-0.834	-0.929	1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2	2.34758570328	1.17379285164	1.97843024916
Residual:	25	14.8323759726	0.593295038902	
Total:	27	17.1799616758		

Coefficient of Multiple Determination (R^2): 0.136646736912

Nearest Neighbor Statistics

	Separation	|Delta Z|
1%%-tile:	314.645646204	0.172799352257
5%%-tile:	314.645646204	0.172799352257
10%%-tile:	319.857615854	0.187086643357
25%%-tile:	507.215930962	0.293851411037
50%%-tile:	1351.94192981	0.53942529826
75%%-tile:	1960.10407875	0.728259380438
90%%-tile:	2955.02438996	1.04979746836
95%%-tile:	3200.34228935	1.07999377104
99%%-tile:	6798.76974789	1.82390874094
Minimum:	314.645646204	0.172799352257
Maximum:	11452.4746811	1.82390874094
Mean:	1853.04994955	0.637910987322
Median:	1399.88906126	0.564324032442
Geometric Mean:	1156.99791501	0.524819311649
Harmonic Mean:	793.277920476	0.428277768988
Root Mean Square:	2931.95392317	0.760437452468
Trim Mean (10%%):	1332.78034049	0.561635632435
Interquartile Mean:	1220.90504642	0.548878941047
Midrange:	5883.56016364	0.998354046601
Winsorized Mean:	1403.90389208	0.582559406406

TriMean:	1292.80096733	0.525240346999
Variance:	5353765.60663	0.17768042068
Standard Deviation:	2313.82056492	0.42152155423
Interquartile Range:	1452.88814778	0.434407969401
Range:	11137.8290349	1.65110938869
Mean Difference:	1955.14249844	0.439114045531
Median Abs. Deviation:	765.426437086	0.239828546628
Average Abs. Deviation:	1243.50936112	0.284155171919
Quartile Dispersion:	0.588852739842	0.425010647598
Relative Mean Diff.:	1.05509433187	0.688362568224
Standard Error:	437.270985228	0.0796600860533
Coef. of Variation:	1.24865525912	0.660784282772
Skewness:	2.82050662926	1.41255035376
Kurtosis:	11.3902503817	4.83523503642
Sum:	51885.3985873	17.861507645
Sum Absolute:	51885.3985873	17.861507645
Sum Squares:	240697906.613	16.1914233353
Mean Square:	8596353.80762	0.578265119116

Complete Spatial Randomness

Lambda:	6.10007240205e-008
Clark and Evans:	0.915344584698
Skellam:	92.2544175405

Gridding Rules

Gridding Method:	Kriging
Kriging Type:	Point
Polynomial Drift Order:	0
Kriging std. deviation grid:	yes

Semi-Variogram Model

Component Type:	Nugget Effect
Error Variance:	0.1435
Micro Variance:	0
Component Type:	Spherical
Anisotropy Angle:	0
Anisotropy Length:	300
Anisotropy Ratio:	1
Variogram Scale:	0.55

Search Parameters

Search Ellipse Radius #1:	15600
Search Ellipse Radius #2:	15600
Search Ellipse Angle:	0
Number of Search Sectors:	1

Maximum Data Per Sector:	28
Maximum Empty Sectors:	1
Minimum Data:	1
Maximum Data:	28

Output Grid

Grid File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\krig_err\hex_DR2_log.grd

Grid Size:	301 rows x 309 columns
Total Nodes:	93009
Filled Nodes:	88342
Blanked Nodes:	4667
Blank Value:	1.70141E+038

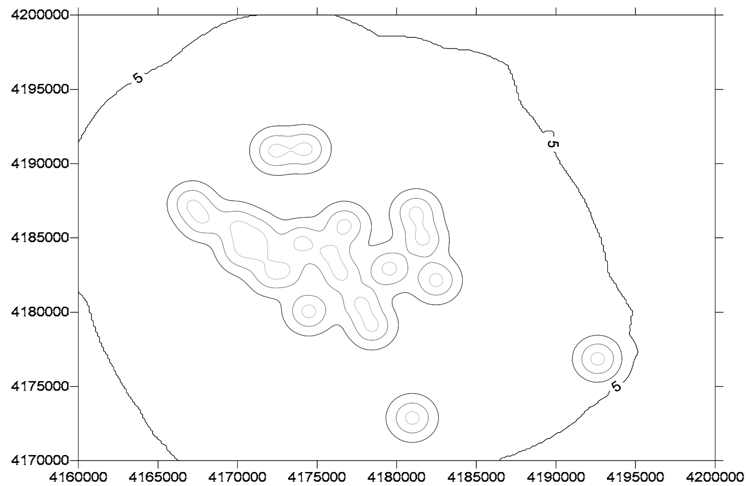
Grid Geometry

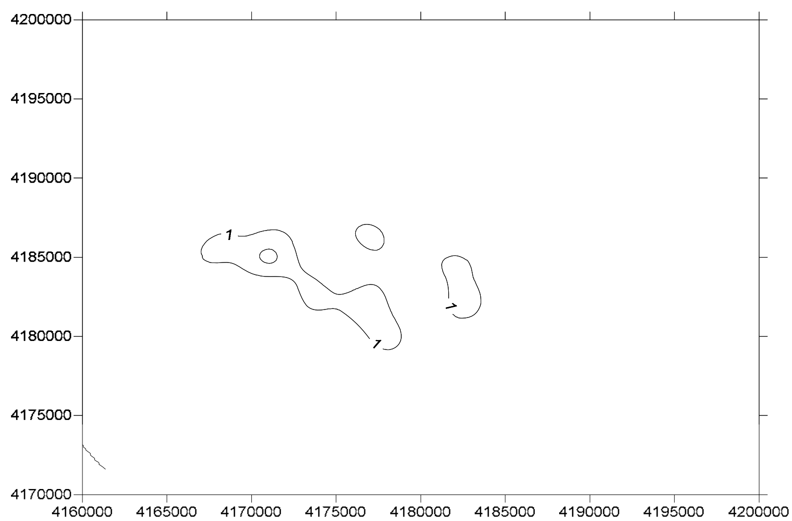
X Minimum:	4160000
X Maximum:	4200000
X Spacing:	129.87012987013
Y Minimum:	4170000
Y Maximum:	4200000
Y Spacing:	100

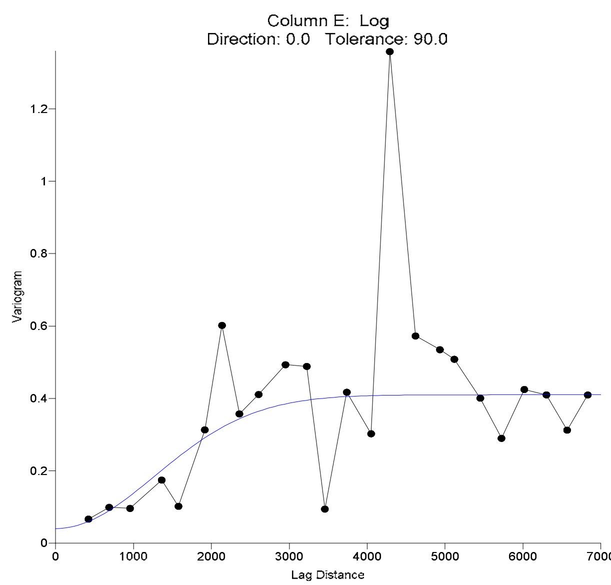
Univariate Grid Statistics

	Z
Count:	88342
1%%-tile:	-0.510041520575
5%%-tile:	-0.270119869202
10%%-tile:	-0.133825498947
25%%-tile:	0.0910275953644
50%%-tile:	0.153671793372
75%%-tile:	0.260830328392
90%%-tile:	0.631298286248
95%%-tile:	0.785329835011
99%%-tile:	0.932255540529
Minimum:	-0.789249055708
Maximum:	1.60262218429
Mean:	0.188196549562
Median:	0.153671793372
Geometric Mean:	N/A
Harmonic Mean:	N/A
Root Mean Square:	0.33380493503
Trim Mean (10%%):	0.183877044708
Interquartile Mean:	0.164438213867

Midrange:	0.406686564293
Winsorized Mean:	0.187254842496
TriMean:	0.164800377625
Variance:	0.0760086537743
Standard Deviation:	0.275696669864
Interquartile Range:	0.169802733027
Range:	2.39187124
Mean Difference:	N/A
Median Abs. Deviation:	0.0830075532853
Average Abs. Deviation:	0.178780511588
Quartile Dispersion:	N/A
Relative Mean Diff.:	N/A
Standard Error:	0.00092757259017
Coef. of Variation:	N/A
Skewness:	0.533613407002
Kurtosis:	4.30750810624
Sum:	16625.6595814
Sum Absolute:	22642.3601373
Sum Squares:	9843.57225047
Mean Square:	0.11142573465







amec	Variogram 1,4-dioxane Depth Region 2 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California		**D-8**
DRAWN SLC	JOB NUMBER 4088115718	CHECKED MDT	DATE 8/1/11

Gridding Report

Thu Sep 29 10:53:44 2011
Elapsed time for gridding: 43.2 seconds

Data Source

Source Data File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\again\PCE_A.xls (sheet 'Sheet1')
X Column: C
Y Column: D
Z Column: F

Data Counts

Active Data: 90

Original Data: 90
Excluded Data: 0
Deleted Duplicates: 0
Retained Duplicates: 0
Artificial Data: 0
Superseded Data: 0

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: First
X Duplicate Tolerance: 0.0033
Y Duplicate Tolerance: 0.0025

No duplicate data were found.

Breakline Filtering

Breakline Filtering: Not In Use

Data Counts

Active Data: 90

Univariate Statistics

	X	Y	Z
Count:	90	90	90
1%%-tile:	4164566.11358	4172881.21554	-1.13076828027
5%%-tile:	4167573.41017	4177126.54907	-0.327902142064
10%%-tile:	4169042.23901	4179753.17507	0.0791812460476
25%%-tile:	4171171.46776	4182673.34367	0.591064607026
50%%-tile:	4172421.72288	4184998.53462	1
75%%-tile:	4178197.86982	4185786.46732	1.6232492904
90%%-tile:	4182372.9963	4187998.89603	2.04532297879
95%%-tile:	4182501.0012	4190296.41703	2.17609125906
99%%-tile:	4191917.60774	4193546.92908	2.43136376416
Minimum:	4164566.11358	4172881.21554	-1.13076828027
Maximum:	4192338.91823	4194283.25562	3.04921802267
Mean:	4174744.99255	4184363.30098	1.03113236234
Median:	4172449.62023	4185005.79248	1
Geometric Mean:	4174741.37196	4184361.76838	N/A
Harmonic Mean:	4174737.7543	4184360.2354	N/A
Root Mean Square:	4174748.61608	4184364.83319	1.29642718406
Trim Mean (10%%):	4174386.19579	4184363.10853	1.03472581114
Interquartile Mean:	4173410.81999	4184687.98561	1.01818250298
Midrange:	4178452.51591	4183582.23558	0.959224871201
Winsorized Mean:	4174606.27942	4184356.01876	1.05577466351
TriMean:	4173553.19584	4184614.22005	1.05357847436
Variance:	30594568.2824	12966753.6471	0.624427579121
Standard Deviation:	5531.23569218	3600.93788438	0.790207301359
Interquartile Range:	7026.40206659	3113.1236457	1.03218468337
Range:	27772.8046456	21402.0400719	4.17998630294
Mean Difference:	6000.19764308	3791.45535706	0.882924635867
Median Abs. Deviation:	2324.31275266	1336.4207789	0.526353175258
Average Abs. Deviation:	4240.22404363	2421.6337297	0.591790302573
Quartile Dispersion:	0.000841548838302	0.000372006763014	N/A
Relative Mean Diff.:	0.00143726087552	0.000906100900984	N/A
Standard Error:	583.043435417	379.572180914	0.0832951631996
Coef. of Variation:	0.00132492779848	0.000860570085664	N/A
Skewness:	0.910469677661	-0.427887252883	-0.226142457905
Kurtosis:	3.60840678572	4.59408844917	3.13892296713
Sum:	375727049.329	376592697.088	92.8019126106
Sum Absolute:	375727049.329	376592697.088	100.940901455
Sum Squares:	1.56856734067e+015	1.57580181515e+015	151.265109922
Mean Square:	1.74285260074e+013	1.75089090573e+013	1.68072344357

Inter-Variable Covariance

	X	Y	Z
X:	30594568	-9063222.6	576.83261
Y:	-9063222.6	12966754	-43.326589
Z:	576.83261	-43.326589	0.62442758

Inter-Variable Correlation

	X	Y	Z
X:	1.000	-0.455	0.132
Y:	-0.455	1.000	-0.015
Z:	0.132	-0.015	1.000

Inter-Variable Rank Correlation

	X	Y	Z
X:	1.000	-0.324	0.153
Y:	-0.324	1.000	-0.130
Z:	0.153	-0.130	1.000

Principal Component Analysis

	PC1	PC2	PC3
X:	0.389115893575	0.389115893575	-2.25290490588e-005
Y:	0.921188808529	0.921188808529	-1.24055110439e-005
Z:	2.01942290003e-005	2.01942290003e-005	-1.24055110439e-005
Lambda:	34422930.0121	9138391.9299	0.611969577474

Planar Regression: Z = AX+BY+C

Fitted Parameters

A	B	C

Parameter Value:	2.25290482792e-005	1.24055099124e-005	-144.931059536
Standard Error:	1.70279400798e-005	2.61558385504e-005	155.2812066

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.455	-0.779
B:	0.455	1.000	-0.913
C:	-0.779	-0.913	1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2 0.885539205895	1.10876211054	0.554381055269	
Residual:	87	54.4652924312	0.626037844037	
Total:	89	55.5740545418		

Coefficient of Multiple Determination (R^2): 0.0199510746459

Nearest Neighbor Statistics

	Separation	|Delta Z|
1%%-tile:	12.9079144907	0
5%%-tile:	78.6721746515	0.0277303419452
10%%-tile:	127.129745751	0.0705810742857
25%%-tile:	245.425359523	0.198367653767
50%%-tile:	597.867308048	0.38933983691
75%%-tile:	1289.07933886	0.752215516289
90%%-tile:	2085.48411969	0.865800902272
95%%-tile:	3021.50039755	1.37874154663
99%%-tile:	3669.40306167	1.80617997398
Minimum:	12.9079144907	0
Maximum:	4492.49417891	1.80617997398
Mean:	974.338018439	0.508697564877
Median:	601.619503501	0.38933983691
Geometric Mean:	573.09749592	N/A
Harmonic Mean:	231.737233461	N/A
Root Mean Square:	1357.93356578	0.662310392682
Trim Mean (10%%):	854.578170178	0.458163564379
Interquartile Mean:	697.179687888	0.427270345391
Midrange:	2252.7010467	0.903089986992

Winsorized Mean:	869.339231189	0.451424207377
TriMean:	682.559828619	0.432315710969
Variance:	904701.230795	0.181902988055
Standard Deviation:	951.157836952	0.426500865245
Interquartile Range:	1043.65397933	0.553847862522
Range:	4479.58626442	1.80617997398
Mean Difference:	983.193148733	0.45171485116
Median Abs. Deviation:	451.931394328	0.270773054553
Average Abs. Deviation:	691.866706015	0.323142735165
Quartile Dispersion:	0.680124329652	N/A
Relative Mean Diff.:	1.00908835551	0.887983120715
Standard Error:	100.260839303	0.0449571386069
Coef. of Variation:	0.976209302062	0.838417351866
Skewness:	1.48929726185	1.28848156687
Kurtosis:	4.96526284697	4.49847298265
Sum:	87690.4216595	45.782780839
Sum Absolute:	87690.4216595	45.782780839
Sum Squares:	165958521.216	39.478955063
Mean Square:	1843983.56907	0.438655056255

Complete Spatial Randomness

Lambda:	1.51414545488e-007
Clark and Evans:	0.758269247866
Skellam:	157.887235996

Gridding Rules

Gridding Method:	Kriging
Kriging Type:	Point
Polynomial Drift Order:	0
Kriging std. deviation grid:	yes

Semi-Variogram Model

Component Type:	Nugget Effect
Error Variance:	0.05
Micro Variance:	0
Component Type:	Spherical
Anisotropy Angle:	0
Anisotropy Length:	4500
Anisotropy Ratio:	1
Variogram Scale:	0.41

Search Parameters

Search Ellipse Radius #1:	17500
Search Ellipse Radius #2:	17500
Search Ellipse Angle:	0

Number of Search Sectors:	1
Maximum Data Per Sector:	90
Maximum Empty Sectors:	1
Minimum Data:	1
Maximum Data:	90

Output Grid

Grid File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\again\PCE_A_log.grd

Grid Size:	301 rows x 309 columns
Total Nodes:	93009
Filled Nodes:	91994
Blanked Nodes:	1015
Blank Value:	1.70141E+038

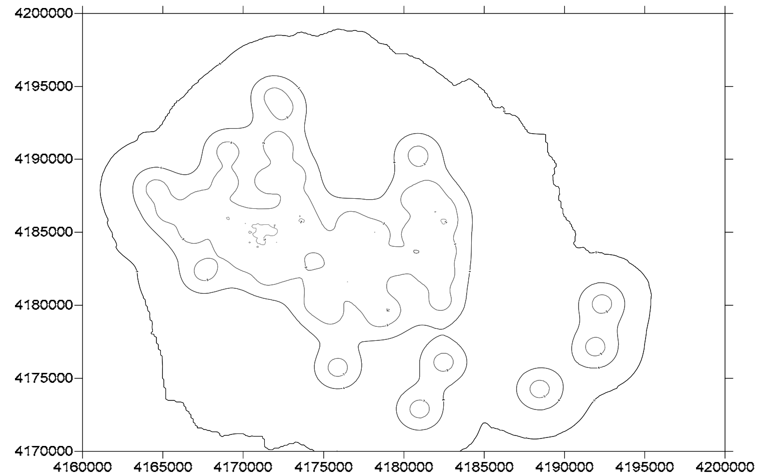
Grid Geometry

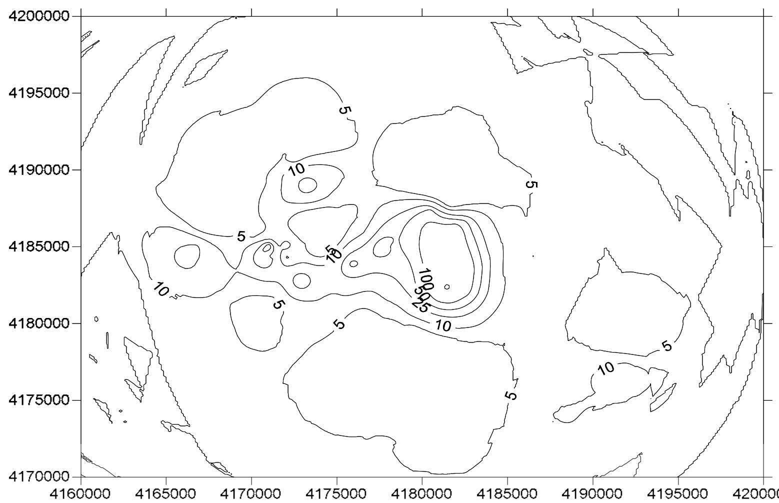
X Minimum:	4160000
X Maximum:	4200000
X Spacing:	129.87012987013
Y Minimum:	4170000
Y Maximum:	4200000
Y Spacing:	100

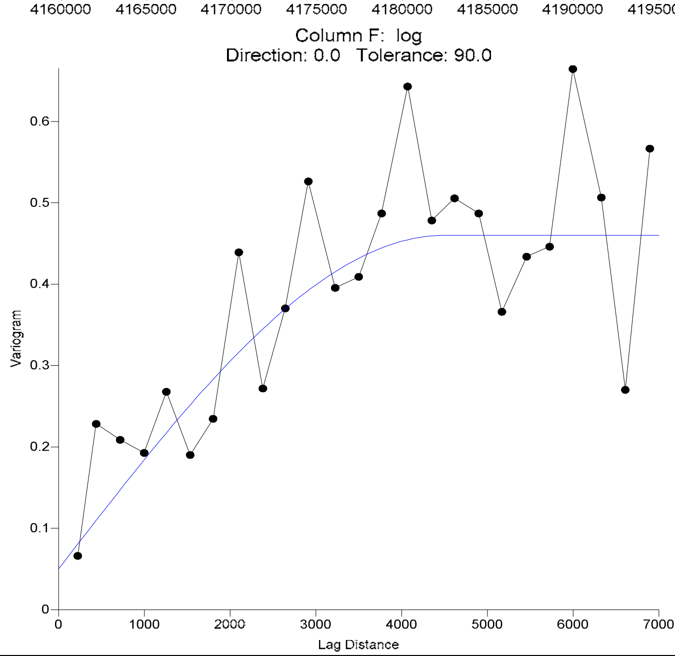
Univariate Grid Statistics

	Z
Count:	91994
1%%-tile:	-0.602059991328
5%%-tile:	0.14531103895
10%%-tile:	0.34547037881
25%%-tile:	0.636848158651
50%%-tile:	0.787437691779
75%%-tile:	0.914743617628
90%%-tile:	1.09405654544
95%%-tile:	1.27678289091
99%%-tile:	2.05915687843
Minimum:	-1.13076828027
Maximum:	2.75851508427
Mean:	0.762716594149
Median:	0.787437691779
Geometric Mean:	N/A
Harmonic Mean:	N/A
Root Mean Square:	0.853077495463
Trim Mean (10%%):	0.764785524567

Interquartile Mean:	0.781370092102
Midrange:	0.813873402001
Winsorized Mean:	0.761670526278
TriMean:	0.781616789959
Variance:	0.146006197403
Standard Deviation:	0.382107573078
Interquartile Range:	0.277895458977
Range:	3.88928336454
Mean Difference:	N/A
Median Abs. Deviation:	0.138855403884
Average Abs. Deviation:	0.243578035281
Quartile Dispersion:	N/A
Relative Mean Diff.:	N/A
Standard Error:	0.00125981244363
Coef. of Variation:	N/A
Skewness:	-0.136985578118
Kurtosis:	8.10417843229
Sum:	70165.3503621
Sum Absolute:	72396.8976515
Sum Squares:	66947.8251731
Mean Square:	0.727741213265







Variogram
PCE A-Zone
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

D-3

DRAWN	JOB NUMBER	CHECKED	DATE
SLC	4088115718	MDT	8/1/11

Gridding Report

Thu Sep 29 11:14:13 2011
Elapsed time for gridding: 0.02 seconds

Data Source

Source Data File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\again\PCE_B.xls (sheet 'Sheet1')
X Column: C
Y Column: D
Z Column: F

Data Counts

Active Data: 20

Original Data: 20
Excluded Data: 0
Deleted Duplicates: 0
Retained Duplicates: 0
Artificial Data: 0
Superseded Data: 0

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: First
X Duplicate Tolerance: 0.0028
Y Duplicate Tolerance: 0.0021

No duplicate data were found.

Breakline Filtering

Breakline Filtering: Not In Use

Data Counts

Active Data: 20

Univariate Statistics

	X	Y	Z
Count:	20	20	20
1%%-tile:	4168864.81167	4172891.01243	-0.602059991328
5%%-tile:	4168864.81167	4172891.01243	-0.602059991328
10%%-tile:	4168984.03509	4176863.42559	-0.602059991328
25%%-tile:	4170742.1875	4182342.14801	0.0791812460476
50%%-tile:	4174058.46035	4182934.18515	0.61278385672
75%%-tile:	4178414.02127	4184768.28611	0.913813852384
90%%-tile:	4181442.04067	4185801.54028	1.07918124605
95%%-tile:	4182290.20399	4188422.73511	1.79028516403
99%%-tile:	4182290.20399	4188422.73511	1.79028516403
Minimum:	4168864.81167	4172891.01243	-0.602059991328
Maximum:	4192626.29638	4190592.07159	1.88138465677
Mean:	4175634.50688	4183108.20541	0.54752764371
Median:	4174960.66009	4183413.90293	0.617498939843
Geometric Mean:	4175630.57628	4183106.56134	N/A
Harmonic Mean:	4175626.64984	4183104.91653	N/A
Root Mean Square:	4175638.44164	4183109.84872	0.863300022922
Trim Mean (10%%):	4174740.20216	4182714.31771	0.477324643023
Interquartile Mean:	4174290.19282	4183487.1611	0.553520464343
Midrange:	4180745.55403	4181741.54201	0.639662332721
Winsorized Mean:	4175038.84709	4182936.23976	0.471862277275
TriMean:	4174318.28236	4183244.7011	0.554640702968
Variance:	34589781.2349	14471923.1715	0.468947798895
Standard Deviation:	5881.30778271	3804.19809835	0.684797633535
Interquartile Range:	7671.83377233	2426.13809588	0.834632606336
Range:	23761.4847036	17701.0591611	2.4834446481
Mean Difference:	6452.27409175	4036.14676041	0.779649489691
Median Abs. Deviation:	4120.20647379	1299.8528129	0.378114098003
Average Abs. Deviation:	4571.14834797	2555.48207891	0.504630616117
Quartile Dispersion:	0.00091887534267	0.000289961285318	N/A
Relative Mean Diff.:	0.0015452200333	0.000964867883453	N/A
Standard Error:	1315.10039987	850.644554779	0.153125405942
Coef. of Variation:	0.00140848241699	0.000909419004135	N/A
Skewness:	1.07513760536	-0.710004761151	0.00716176937336
Kurtosis:	3.96200099249	3.99915063082	2.42886979836
Sum:	83512690.1375	83662164.1081	10.9505528742
Sum Absolute:	83512690.1375	83662164.1081	14.7110516264
Sum Squares:	3.48719127906e+014	3.49968160129e+014	14.9057385915
Mean Square:	1.74359563953e+013	1.74984080065e+013	0.745286929577

Inter-Variable Covariance

	X	Y	Z
X:	34589781	-16699649	398.09622
Y:	-16699649	14471923	-535.78194
Z:	398.09622	-535.78194	0.4689478

Inter-Variable Correlation

	X	Y	Z
X:	1.000	-0.746	0.099
Y:	-0.746	1.000	-0.206
Z:	0.099	-0.206	1.000

Inter-Variable Rank Correlation

	X	Y	Z
X:	1.000	-0.805	0.268
Y:	-0.805	1.000	-0.236
Z:	0.268	-0.236	1.000

Principal Component Analysis

	PC1	PC2	PC3
X:	0.49194958234	0.49194958234	1.43713065027e-005
Y:	0.870623687679	0.870623687679	5.36057113946e-005
Z:	-5.37403604495e-005	-5.37403604495e-005	5.36057113946e-005
Lambda:	44025988.1843	5035716.2451	0.445947989532

Planar Regression: Z = AX+BY+C

Fitted Parameters

A	B	C

Parameter Value:	-1.43713043058e-005	-5.36057072647e-005	284.795315728
Standard Error:	4.13804861386e-005	6.39744221745e-005	412.916759094

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.746	-0.902
B:	0.746	1.000	-0.960
C:	-0.902	-0.960	1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2	0.436996351804	0.218498175902	0.438388269258
Residual:	17	8.4730118272	0.498412460424	
Total:	19	8.91000817901		

Coefficient of Multiple Determination (R^2): 0.0490455612413

Nearest Neighbor Statistics

	Separation	|Delta Z|
1%%-tile:	409.74666388	0.0791812460476
5%%-tile:	409.74666388	0.0791812460476
10%%-tile:	409.74666388	0.0879551703551
25%%-tile:	507.215930962	0.137746266979
50%%-tile:	1351.94192981	0.360615685648
75%%-tile:	2172.6101718	0.94448267215
90%%-tile:	3791.48790967	1.2076083105
95%%-tile:	6788.28633317	1.22969689611
99%%-tile:	6788.28633317	1.22969689611
Minimum:	409.74666388	0.0791812460476
Maximum:	10875.6082372	1.33696682399
Mean:	2155.69364027	0.597398530209
Median:	1570.16113457	0.376190393618
Geometric Mean:	1356.40109222	0.394061579417
Harmonic Mean:	930.571780178	0.245585894468
Root Mean Square:	3282.24377919	0.753214171572
Trim Mean (10%%):	1696.75076675	0.558473883169
Interquartile Mean:	1414.16675491	0.495445385759
Midrange:	5642.67745055	0.708074035017

Winsorized Mean:	1651.64770272	0.59026487147
TriMean:	1345.9274906	0.450865077607
Variance:	6448535.95295	0.22152272038
Standard Deviation:	2539.3967695	0.470662002269
Interquartile Range:	1665.39424083	0.806736405171
Range:	10465.8615733	1.25778557794
Mean Difference:	2270.72159073	0.535739736081
Median Abs. Deviation:	849.682910083	0.292622185417
Average Abs. Deviation:	1433.52232484	0.415338807086
Quartile Dispersion:	0.621456085945	0.745439690256
Relative Mean Diff.:	1.05336006393	0.896787837581
Standard Error:	567.826379845	0.10524322315
Coef. of Variation:	1.17799520398	0.787852628468
Skewness:	2.23208913911	0.268502639483
Kurtosis:	7.58538626595	1.25423600578
Sum:	43113.8728055	11.9479706042
Sum Absolute:	43113.8728055	11.9479706042
Sum Squares:	215462484.52	11.3466317651
Mean Square:	10773124.226	0.567331588257

Complete Spatial Randomness

Lambda:	4.75507278096e-008
Clark and Evans:	0.940146688033
Skellam:	64.3737338946

Gridding Rules

Gridding Method:	Kriging
Kriging Type:	Point
Polynomial Drift Order:	0
Kriging std. deviation grid:	no

Semi-Variogram Model

Component Type:	Nugget Effect
Error Variance:	0.05
Micro Variance:	0
Component Type:	Exponential
Anisotropy Angle:	0
Anisotropy Length:	1800
Anisotropy Ratio:	1
Variogram Scale:	0.39

Search Parameters

No Search (use all data):	true

Output Grid

Grid File Name:	C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\again\out.grd
Grid Size:	75 rows x 100 columns
Total Nodes:	7500
Filled Nodes:	7500
Blanked Nodes:	0
Blank Value:	1.70141E+038

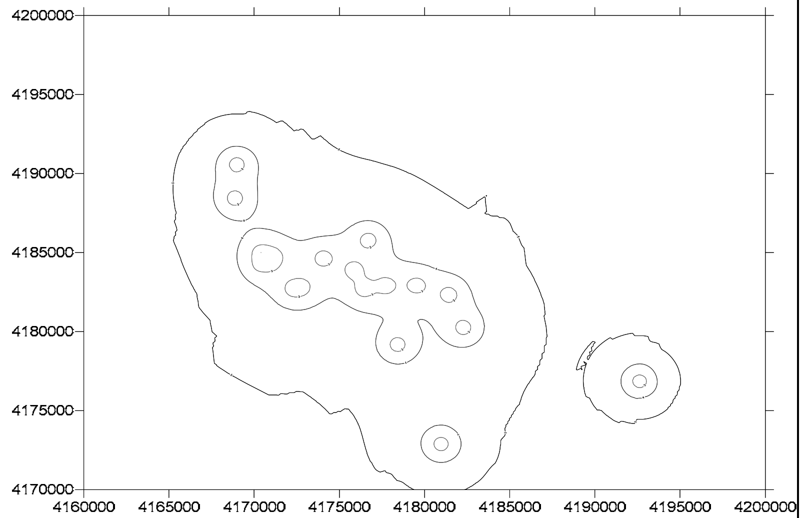
Grid Geometry

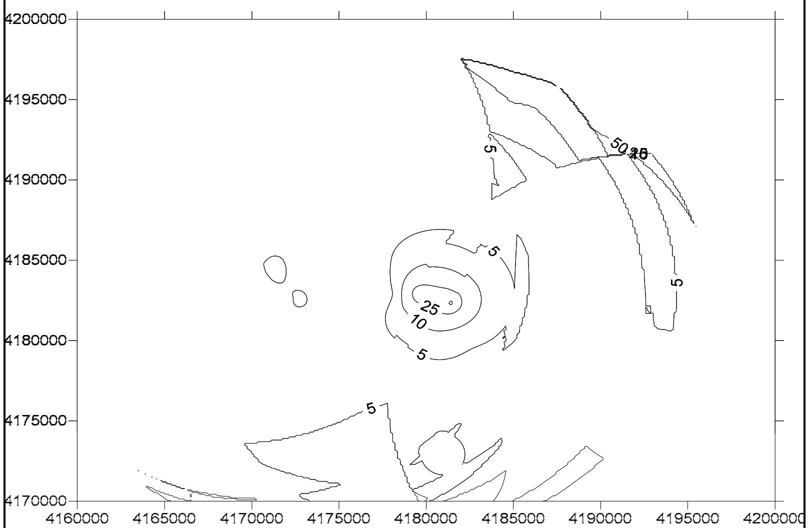
X Minimum:	4168864.811
X Maximum:	4192626.297
X Spacing:	240.01501010101
Y Minimum:	4172891.012
Y Maximum:	4190592.072
Y Spacing:	239.20351351351

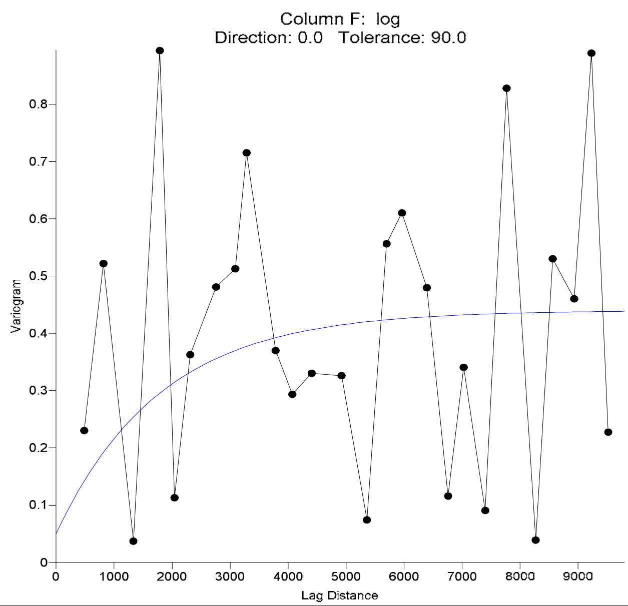
Univariate Grid Statistics

	Z
Count:	7500
1%%-tile:	-0.0418788493515
5%%-tile:	0.209855541978
10%%-tile:	0.306929989809
25%%-tile:	0.439536196721
50%%-tile:	0.473871921577
75%%-tile:	0.544075972629
90%%-tile:	0.676813130499
95%%-tile:	0.850068737554
99%%-tile:	1.35775374526
Minimum:	-0.414406776413
Maximum:	1.68891485027
Mean:	0.497098333216
Median:	0.473875860791
Geometric Mean:	N/A
Harmonic Mean:	N/A
Root Mean Square:	0.538934180562
Trim Mean (10%%):	0.486127188581
Interquartile Mean:	0.481327462315
Midrange:	0.637254036928
Winsorized Mean:	0.485302862247
TriMean:	0.482839003126
Variance:	0.0433490779685
Standard Deviation:	0.208204413902
Interquartile Range:	0.104539775907
Range:	2.10332162668
Mean Difference:	0.194821486849

Median Abs. Deviation:	0.0556800270862
Average Abs. Deviation:	0.120667189911
Quartile Dispersion:	N/A
Relative Mean Diff.:	N/A
Standard Error:	0.00240413748826
Coef. of Variation:	N/A
Skewness:	1.35992958203
Kurtosis:	9.98713433764
Sum:	3728.23749912
Sum Absolute:	3754.32755523
Sum Squares:	2178.37538234
Mean Square:	0.290450050978







amec

Variogram
PCE B-Zone
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

D-3

DRAWN	JOB NUMBER	CHECKED	DATE
SLC	4088115718	MDT	8/1/11

Gridding Report

Wed Aug 24 17:56:19 2011
Elapsed time for gridding: 35.3 seconds

Data Source

Source Data File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\krig_err\PCE_DR1.xls (sheet 'Sheet1')
X Column: B
Y Column: C
Z Column: E

Data Counts

Active Data: 86

Original Data: 86
Excluded Data: 0
Deleted Duplicates: 0
Retained Duplicates: 0
Artificial Data: 0
Superseded Data: 0

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: First
X Duplicate Tolerance: 0.0033
Y Duplicate Tolerance: 0.0023

No duplicate data were found.

Breakline Filtering

Breakline Filtering: Not In Use

Data Counts

Active Data: 86

Univariate Statistics

	X	Y	Z
Count:	86	86	86
1%%-tile:	4164566.11358	4174258.9507	-1.13076828027
5%%-tile:	4168864.68298	4179168.41271	-0.327902142064
10%%-tile:	4169042.23901	4180068.26896	0.113943352307
25%%-tile:	4171299.81226	4182777.63002	0.591064607026
50%%-tile:	4173171.05848	4185013.61726	0.995635194598
75%%-tile:	4177889.97252	4185810.06769	1.54406804435
90%%-tile:	4182307.00916	4188903.49696	1.99782308075
95%%-tile:	4182501.0012	4191018.52887	2.13353890837
99%%-tile:	4191917.60774	4193546.92908	2.43136376416
Minimum:	4164566.11358	4174258.9507	-1.13076828027
Maximum:	4192338.91823	4194283.25562	3.04921802267
Mean:	4174830.55244	4184723.86345	1.01460452597
Median:	4173179.36905	4185019.05212	0.997817597299
Geometric Mean:	4174827.02631	4184722.20716	N/A
Harmonic Mean:	4174823.50308	4184720.55087	N/A
Root Mean Square:	4174834.08147	4184725.51973	1.26787933256
Trim Mean (10%%):	4174459.17562	4184646.81326	1.01886368703
Interquartile Mean:	4173572.97448	4184750.19755	0.986239346875
Midrange:	4178452.51591	4184271.10316	0.959224871201
Winsorized Mean:	4174659.83192	4184629.55232	1.03803005387
TriMean:	4173882.97544	4184653.73306	1.03160076014
Variance:	29812886.2819	14025226.8701	0.584896783216
Standard Deviation:	5460.11779011	3745.02695185	0.76478544914
Interquartile Range:	6590.16025532	3032.43766976	0.953003437324
Range:	27772.8046456	20024.3049132	4.17998630294
Mean Difference:	5916.58294628	4040.66972546	0.846031740965
Median Abs. Deviation:	2627.8133786	1670.18324681	0.454459765326
Average Abs. Deviation:	4159.20116871	2593.04679725	0.560412023128
Quartile Dispersion:	0.000789317337993	0.000362359549699	N/A
Relative Mean Diff.:	0.00141720313483	0.000965576190284	N/A
Standard Error:	588.779643325	403.836641939	0.0824689358864
Coef. of Variation:	0.00130786572569	0.000894928094195	N/A
Skewness:	0.935569081752	-0.00453942378188	-0.213255618276
Kurtosis:	3.80621007446	3.78163337244	3.42951132
Sum:	359035427.51	359886252.257	87.2559892332
Sum Absolute:	359035427.51	359886252.257	94.7857662946
Sum Squares:	1.49891460627e+015	1.50602578009e+015	138.246548167
Mean Square:	1.74292396078e+013	1.75119276755e+013	1.60751800194

Inter-Variable Covariance

	X	Y	Z
X:	29812886	-8996677.6	519.4235
Y:	-8996677.6	14025227	-152.60799
Z:	519.4235	-152.60799	0.58489678

Inter-Variable Correlation

	X	Y	Z
X:	1.000	-0.440	0.124
Y:	-0.440	1.000	-0.053
Z:	0.124	-0.053	1.000

Inter-Variable Rank Correlation

	X	Y	Z
X:	1.000	-0.317	0.151
Y:	-0.317	1.000	-0.114
Z:	0.151	-0.114	1.000

Principal Component Analysis

	PC1	PC2	PC3
X:	0.412593874291	0.412593874291	-1.75332237051e-005
Y:	0.910915086515	0.910915086515	-3.65967445236e-007
Z:	7.5674659655e-006	7.5674659655e-006	-3.65967445236e-007
Lambda:	33887880.9175	9950232.24346	0.575845464288

Planar Regression: Z = AX+BY+C

Fitted Parameters

A	B	C

Parameter Value:	1.75332232822e-005	3.65967157275e-007	-73.7151032115
Standard Error:	1.69875231575e-005	2.4767212251e-005	149.129793941

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.440	-0.781
B:	0.440	1.000	-0.904
C:	-0.781	-0.904	1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2 0.652309953551	0.769362093858	0.384681046929	
Residual:	83	48.9468644795	0.589721258789	
Total:	85	49.7162265734		

Coefficient of Multiple Determination (R^2): 0.0154750701508

Nearest Neighbor Statistics

	Separation	|Delta Z|
1%%-tile:	12.9079144907	0.00886346033131
5%%-tile:	19.6998786755	0.0347621062592
10%%-tile:	121.002875893	0.105958141985
25%%-tile:	230.613948264	0.164810248646
50%%-tile:	666.823143165	0.401400540782
75%%-tile:	1282.84575062	0.75966784469
90%%-tile:	1888.74742854	1.1161648123
95%%-tile:	2661.33372497	1.37874154663
99%%-tile:	4165.84935295	1.80617997398
Minimum:	12.9079144907	0.00886346033131
Maximum:	4492.49417891	1.80617997398
Mean:	947.111922591	0.533105714562
Median:	691.934468652	0.407031903137
Geometric Mean:	519.548313321	0.34519228849
Harmonic Mean:	154.773051223	0.160062251321
Root Mean Square:	1329.44055159	0.692123750094
Trim Mean (10%%):	818.446668258	0.481987881557
Interquartile Mean:	694.573803217	0.442620864325
Midrange:	2252.7010467	0.907521717158

Winsorized Mean:	830.343272801	0.498903847505
TriMean:	711.776496303	0.431819793725
Variance:	880631.082608	0.19712574234
Standard Deviation:	938.419459841	0.443988448431
Interquartile Range:	1052.23180236	0.594857596044
Range:	4479.58626442	1.79731651365
Mean Difference:	959.807583682	0.477755895608
Median Abs. Deviation:	479.862513044	0.285408455978
Average Abs. Deviation:	672.513747833	0.343653517112
Quartile Dispersion:	0.695249304049	0.643452343903
Relative Mean Diff.:	1.01340460487	0.896174778394
Standard Error:	101.192372783	0.0478765056646
Coef. of Variation:	0.990822137762	0.832833781936
Skewness:	1.64569485902	1.13797055257
Kurtosis:	5.86681203385	3.84644044889
Sum:	81451.6253428	45.8470914524
Sum Absolute:	81451.6253428	45.8470914524
Sum Squares:	151997447.498	41.1970345482
Mean Square:	1767412.18021	0.479035285444

Complete Spatial Randomness

Lambda:	1.54639793896e-007
Clark and Evans:	0.744889633755
Skellam:	147.68535301

Gridding Rules

Gridding Method:	Kriging
Kriging Type:	Point
Polynomial Drift Order:	0
Kriging std. deviation grid:	yes

Semi-Variogram Model

Component Type:	Nugget Effect
Error Variance:	0.1
Micro Variance:	0
Component Type:	Gaussian
Anisotropy Angle:	0
Anisotropy Length:	2200
Anisotropy Ratio:	1
Variogram Scale:	0.4

Search Parameters

Search Ellipse Radius #1:	17100
Search Ellipse Radius #2:	17100
Search Ellipse Angle:	0

Number of Search Sectors:	1
Maximum Data Per Sector:	86
Maximum Empty Sectors:	1
Minimum Data:	1
Maximum Data:	86

Output Grid

Grid File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\krig_err\PCE_DR1_log.grd

Grid Size:	301 rows x 309 columns
Total Nodes:	93009
Filled Nodes:	91777
Blanked Nodes:	1232
Blank Value:	1.70141E+038

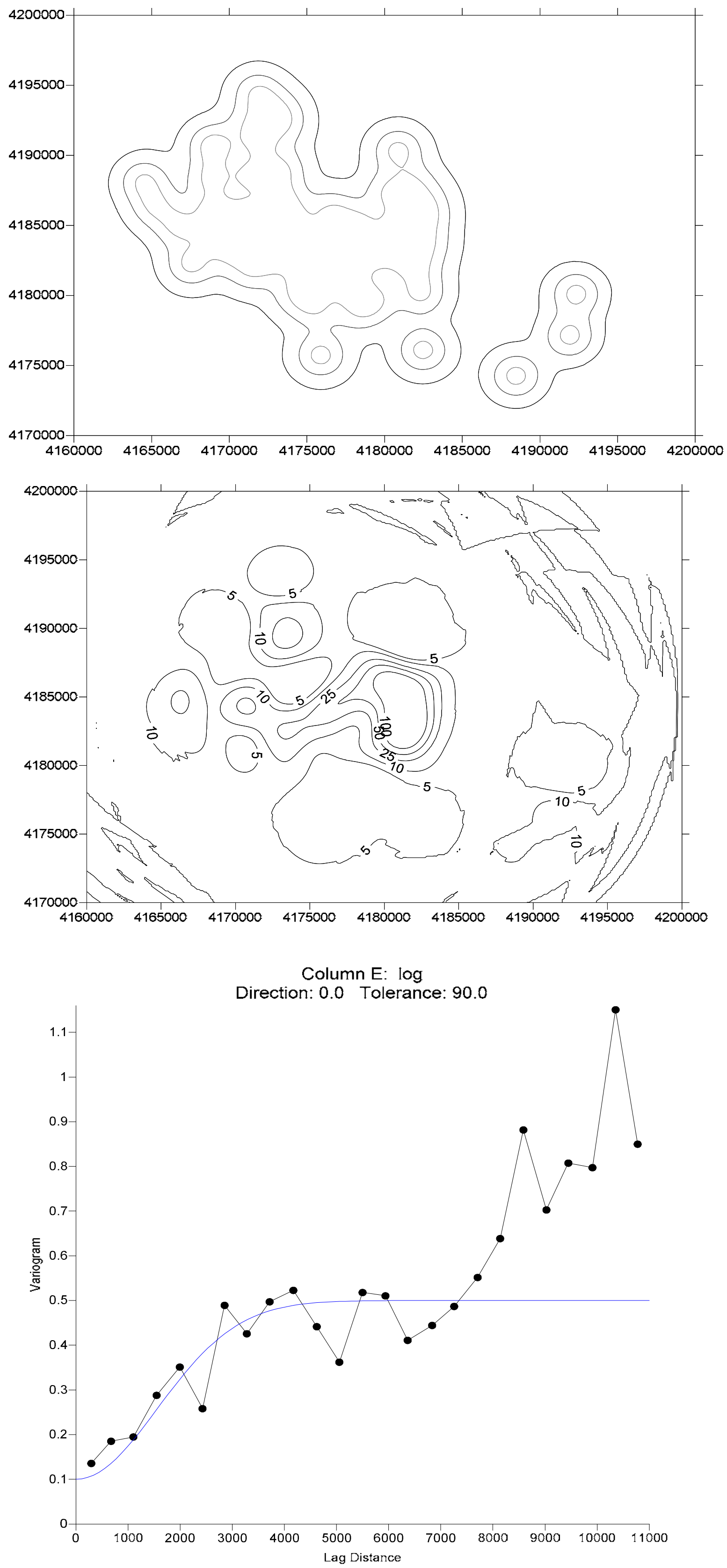
Grid Geometry

X Minimum:	4160000
X Maximum:	4200000
X Spacing:	129.87012987013
Y Minimum:	4170000
Y Maximum:	4200000
Y Spacing:	100

Univariate Grid Statistics

	Z
Count:	91777
1%%-tile:	-0.602059991328
5%%-tile:	0.171134518767
10%%-tile:	0.442614058614
25%%-tile:	0.706953192613
50%%-tile:	0.838911831532
75%%-tile:	0.948608925982
90%%-tile:	1.11141251787
95%%-tile:	1.30602502355
99%%-tile:	2.10521261182
Minimum:	-1.13076828027
Maximum:	2.62300000411
Mean:	0.811296187709
Median:	0.838911831532
Geometric Mean:	N/A
Harmonic Mean:	N/A
Root Mean Square:	0.89610883696
Trim Mean (10%%):	0.818672699945

Interquartile Mean:	0.839002487576
Midrange:	0.746115861923
Winsorized Mean:	0.817104875359
TriMean:	0.833346445415
Variance:	0.144811121346
Standard Deviation:	0.380540564652
Interquartile Range:	0.24165573337
Range:	3.75376828438
Mean Difference:	N/A
Median Abs. Deviation:	0.117382718801
Average Abs. Deviation:	0.229699053625
Quartile Dispersion:	N/A
Relative Mean Diff.:	N/A
Standard Error:	0.00125612838497
Coef. of Variation:	N/A
Skewness:	-0.431198308704
Kurtosis:	9.21998377981
Sum:	74458.3302193
Sum Absolute:	76963.3336945
Sum Squares:	73697.9449227
Mean Square:	0.803011047678



amec

Variogram
PCE Depth Region 1
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

D-3

DRAWN	JOB NUMBER	CHECKED	DATE
SLC	4088115718	MDT	8/1/11

Gridding Report

Thu Aug 25 14:06:10 2011
Elapsed time for gridding: 3.93 seconds

Data Source

Source Data File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\krig_err\PCE_DR2.xls (sheet 'Sheet1')
X Column: B
Y Column: C
Z Column: E

Data Counts

Active Data: 28

Original Data: 28
Excluded Data: 0
Deleted Duplicates: 0
Retained Duplicates: 0
Artificial Data: 0
Superseded Data: 0

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: First
X Duplicate Tolerance: 0.003
Y Duplicate Tolerance: 0.0021

No duplicate data were found.

Breakline Filtering

Breakline Filtering: Not In Use

Data Counts

Active Data: 28

Univariate Statistics

	X	Y	Z
Count:	28	28	28
1%%-tile:	4167269.89434	4172891.01243	-0.602059991328
5%%-tile:	4167691.41447	4176863.42559	-0.468521082958
10%%-tile:	4168864.81167	4179178.26479	-0.244125144328
25%%-tile:	4170742.1875	4182158.75524	0.342422680822
50%%-tile:	4172799.29793	4184282.15495	0.761175813156
75%%-tile:	4177803.66532	4185068.63022	1.07918124605
90%%-tile:	4181442.04067	4187088.74378	1.79028516403
95%%-tile:	4182290.20399	4188422.73511	1.88138465677
99%%-tile:	4182474.89913	4190871.2737	2.11394335231
Minimum:	4167269.89434	4172891.01243	-0.602059991328
Maximum:	4192626.29638	4190978.72759	2.36172783602
Mean:	4174811.81416	4183637.64224	0.818934158631
Median:	4173428.87914	4184327.70831	0.793625307928
Geometric Mean:	4174808.14572	4183635.98004	N/A
Harmonic Mean:	4174804.48111	4183634.31729	N/A
Root Mean Square:	4174815.48644	4183639.30391	1.07670820001
Trim Mean (10%%):	4174094.38826	4183484.51876	0.762261809787
Interquartile Mean:	4173484.23639	4183789.8469	0.764047086792
Midrange:	4179948.09536	4181934.87001	0.879833922345
Winsorized Mean:	4174444.06548	4183623.19891	0.804510245511
TriMean:	4173536.11217	4183947.92384	0.735988888295
Variance:	31797850.609	14418574.9252	0.506745443349
Standard Deviation:	5638.95829112	3797.17986474	0.711860550494
Interquartile Range:	7061.47782203	2909.87498095	0.736758565225
Range:	25356.4020346	18087.7151604	2.96378782735
Mean Difference:	6141.84102992	4136.54726903	0.802481707005
Median Abs. Deviation:	3042.61831008	1640.72691321	0.319029332935
Average Abs. Deviation:	4284.43253807	2673.11226444	0.529315382097
Quartile Dispersion:	0.000845833268035	0.000347770515476	N/A
Relative Mean Diff.:	0.00147116595989	0.000988744155867	N/A
Standard Error:	1065.66294941	717.599543248	0.134528998912
Coef. of Variation:	0.00135070957498	0.000907626374329	N/A
Skewness:	1.12547452845	-0.514130857654	0.156867864607
Kurtosis:	4.26939562045	3.89406626992	2.73844494237
Sum:	116894730.796	117141853.983	22.9301564417
Sum Absolute:	116894730.796	117141853.983	25.5595688789
Sum Squares:	4.88014361683e+014	4.90079459106e+014	32.4604153433
Mean Square:	1.74290843458e+013	1.75028378252e+013	1.15930054797

Inter-Variable Covariance

	X	Y	Z
X:	31797851	-14373001	-129.0222
Y:	-14373001	14418575	-235.86839
Z:	-129.0222	-235.86839	0.50674544

Inter-Variable Correlation

	X	Y	Z
X:	1.000	-0.671	-0.032
Y:	-0.671	1.000	-0.087
Z:	-0.032	-0.087	1.000

Inter-Variable Rank Correlation

	X	Y	Z
X:	1.000	-0.731	-0.032
Y:	-0.731	1.000	-0.133
Z:	-0.032	-0.133	1.000

Principal Component Analysis

	PC1	PC2	PC3
X:	0.49123561795	0.49123561795	2.08436901099e-005
Y:	0.871026730843	0.871026730843	3.71364569587e-005
Z:	-4.25860097299e-005	-4.25860097299e-005	3.71364569587e-005
Lambda:	39903836.0265	6312589.51915	0.495296828089

Planar Regression: Z = AX+BY+C

Fitted Parameters

A	B	C

Parameter Value:	-2.08436884884e-005	-3.71364540814e-005	243.202878305
Standard Error:	3.36754060112e-005	5.00092744347e-005	320.978249429

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.671	-0.876
B:	0.671	1.000	-0.946
C:	-0.876	-0.946	1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2 0.288933163218	0.309112587787	0.154556293894	
Residual:	25	13.3730143826	0.534920575306	
Total:	27	13.6821269704		

Coefficient of Multiple Determination (R^2): 0.0225924367209

Nearest Neighbor Statistics

	Separation	|Delta Z|
1%%-tile:	314.645646204	0.0445821326527
5%%-tile:	314.645646204	0.0445821326527
10%%-tile:	319.857615854	0.0543576623226
25%%-tile:	507.215930962	0.0879551703551
50%%-tile:	1049.01359232	0.360615685648
75%%-tile:	1921.32219074	0.639384314352
90%%-tile:	2086.4125138	1.22969689611
95%%-tile:	3200.34228935	1.39025318001
99%%-tile:	6788.28633317	1.39025318001
Minimum:	314.645646204	0.0445821326527
Maximum:	10875.6082372	1.60055202286
Mean:	1716.0174042	0.508026446123
Median:	1200.47776107	0.360615685648
Geometric Mean:	1084.16104664	0.302957526647
Harmonic Mean:	769.956509591	0.164327548095
Root Mean Square:	2767.90473869	0.685207452962
Trim Mean (10%%):	1202.79788404	0.447574126237
Interquartile Mean:	1133.04547763	0.35589188515
Midrange:	5595.12694171	0.822567077757

Winsorized Mean:	1194.78256924	0.484011566295
TriMean:	1131.64132659	0.362142714001
Variance:	4891269.0928	0.219248694139
Standard Deviation:	2211.62137194	0.468239996304
Interquartile Range:	1414.10625978	0.551429143997
Range:	10560.962591	1.55596989021
Mean Difference:	1806.50957163	0.513967350153
Median Abs. Deviation:	707.053129891	0.272660515293
Average Abs. Deviation:	1149.75229256	0.355102904173
Quartile Dispersion:	0.582287033974	0.758145481706
Relative Mean Diff.:	1.05273382846	1.01169408419
Standard Error:	417.95715317	0.0884890417225
Coef. of Variation:	1.2888105718	0.921684293953
Skewness:	2.89935178429	0.905713452143
Kurtosis:	11.5487690748	2.52572353596
Sum:	48048.4873177	14.2247404914
Sum Absolute:	48048.4873177	14.2247404914
Sum Squares:	214516305.988	13.1462591006
Mean Square:	7661296.64244	0.469509253595

Complete Spatial Randomness

Lambda:	6.10501439127e-008
Clark and Evans:	0.847998394319
Skellam:	82.2861740754

Gridding Rules

Gridding Method:	Kriging
Kriging Type:	Point
Polynomial Drift Order:	0
Kriging std. deviation grid:	yes

Semi-Variogram Model

Component Type:	Nugget Effect
Error Variance:	0.12
Micro Variance:	0
Component Type:	Gaussian
Anisotropy Angle:	0
Anisotropy Length:	3000
Anisotropy Ratio:	1
Variogram Scale:	0.6

Search Parameters

Search Ellipse Radius #1:	15600
Search Ellipse Radius #2:	15600
Search Ellipse Angle:	0

Number of Search Sectors:	1
Maximum Data Per Sector:	28
Maximum Empty Sectors:	1
Minimum Data:	1
Maximum Data:	28

Output Grid

Grid File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\krig_err\PCE_DR2_log.grd

Grid Size:	301 rows x 309 columns
Total Nodes:	93009
Filled Nodes:	86489
Blanked Nodes:	6520
Blank Value:	1.70141E+038

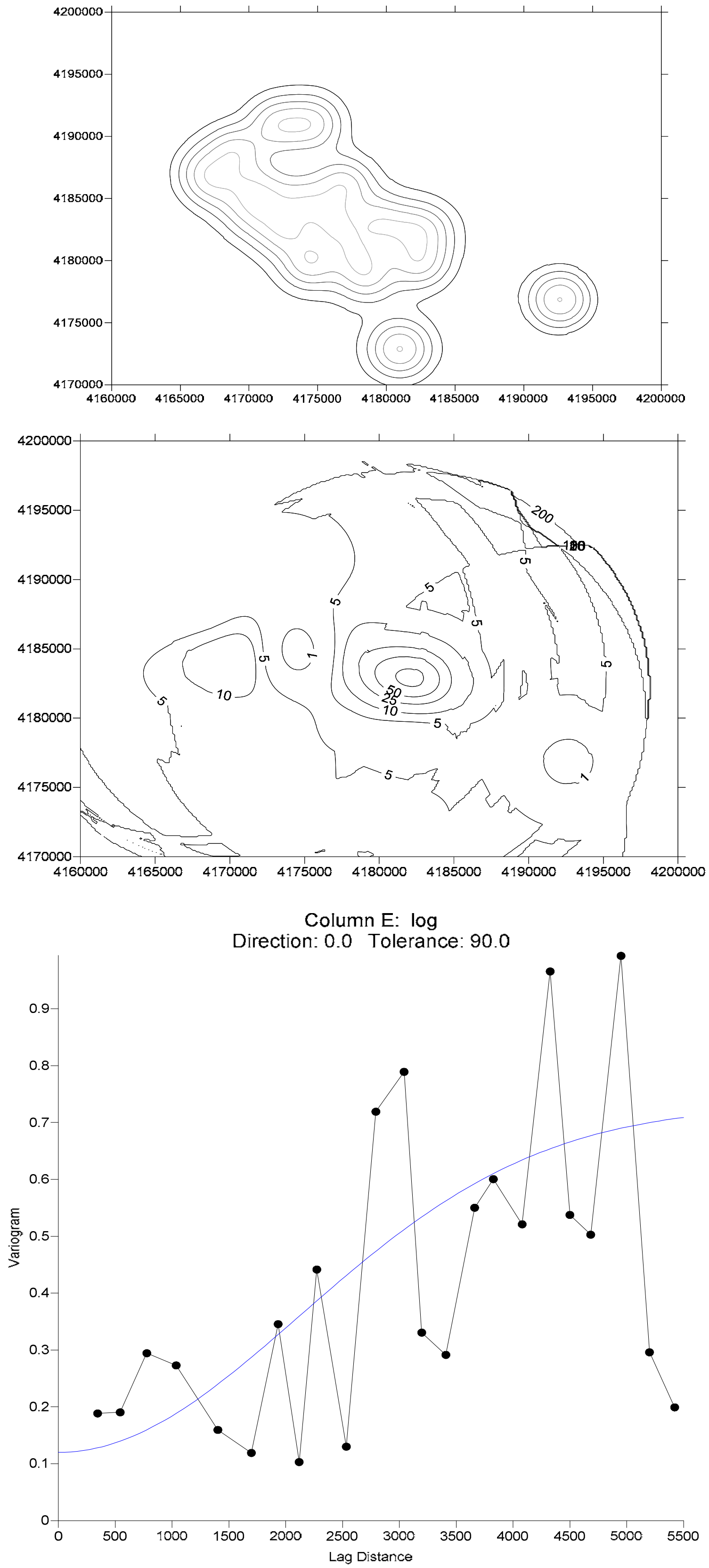
Grid Geometry

X Minimum:	4160000
X Maximum:	4200000
X Spacing:	129.87012987013
Y Minimum:	4170000
Y Maximum:	4200000
Y Spacing:	100

Univariate Grid Statistics

	Z
Count:	86489
1%%-tile:	-0.468521082958
5%%-tile:	-0.468521082958
10%%-tile:	0.203270090127
25%%-tile:	0.474238256317
50%%-tile:	0.659509029962
75%%-tile:	0.780346527554
90%%-tile:	0.946603376532
95%%-tile:	1.12634131216
99%%-tile:	1.9354268457
Minimum:	-0.468521082958
Maximum:	2.36172783602
Mean:	0.611192293401
Median:	0.659509029962
Geometric Mean:	N/A
Harmonic Mean:	N/A
Root Mean Square:	0.731373344645
Trim Mean (10%%):	0.61899869291

Interquartile Mean:	0.646113245568
Midrange:	0.94660337653
Winsorized Mean:	0.621047028758
TriMean:	0.643400710949
Variance:	0.161352815332
Standard Deviation:	0.401687459765
Interquartile Range:	0.306108271237
Range:	2.83024891898
Mean Difference:	N/A
Median Abs. Deviation:	0.158521611033
Average Abs. Deviation:	0.262833230945
Quartile Dispersion:	N/A
Relative Mean Diff.:	N/A
Standard Error:	0.00136586518685
Coef. of Variation:	N/A
Skewness:	-0.20577389065
Kurtosis:	6.44256180297
Sum:	52861.4102639
Sum Absolute:	57659.4816736
Sum Squares:	46263.5688641
Mean Square:	0.534906969257



amec

Variogram
PCE Depth Region 2
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

D-4

DRAWN	JOB NUMBER	CHECKED	DATE
SLC	4088115718	MDT	8/1/11

Gridding Report

Thu Sep 29 10:16:29 2011
Elapsed time for gridding: 42.0 seconds

Data Source

Source Data File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\again\TCE_A.xls (sheet 'Sheet1')
X Column: C
Y Column: D
Z Column: F

Data Counts

Active Data: 90

Original Data: 91
Excluded Data: 0
Deleted Duplicates: 1
Retained Duplicates: 1
Artificial Data: 0
Superseded Data: 0

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: First
X Duplicate Tolerance: 0.0033
Y Duplicate Tolerance: 0.0025

Deleted Duplicates: 1
Retained Duplicates: 1
Artificial Data: 0

X	Y	Z	ID	Status
4170742.2	4184800.6	2.5314789	57	Retained
4170742.2	4184800.6	2.2787536	58	Deleted

Breakline Filtering

Breakline Filtering: Not In Use

Data Counts

Active Data: 90

Univariate Statistics

	X	Y	Z
Count:	90	90	90
1%%-tile:	4164566.11358	4172881.21554	-1
5%%-tile:	4167573.41017	4177126.54907	-0.80966830183
10%%-tile:	4169042.23901	4179753.17507	-0.13667713988
25%%-tile:	4171171.46776	4182673.34367	0.963787827346
50%%-tile:	4172421.72288	4184998.53462	1.51851393988
75%%-tile:	4178197.86982	4185786.46732	1.98944981767
90%%-tile:	4182372.9963	4187998.89603	2.53147891704
95%%-tile:	4182501.0012	4190296.41703	2.96378782735
99%%-tile:	4191917.60774	4193546.92908	3.11394335231
Minimum:	4164566.11358	4172881.21554	-1
Maximum:	4192338.91823	4194283.25562	3.23552844691
Mean:	4174744.99509	4184363.20399	1.38874671394
Median:	4172449.62023	4185005.79248	1.53740822032
Geometric Mean:	4174741.3745	4184361.67144	N/A
Harmonic Mean:	4174737.75684	4184360.13851	N/A
Root Mean Square:	4174748.61862	4184364.73615	1.70195566457
Trim Mean (10%%):	4174386.19861	4184363.00075	1.39607003985
Interquartile Mean:	4173410.82508	4184687.98561	1.4800476893
Midrange:	4178452.51591	4183582.23558	1.11776422345
Winsorized Mean:	4174606.28196	4184356.01398	1.40004417923
TriMean:	4173553.19584	4184614.22005	1.49756638119
Variance:	30594551.2047	12966305.8638	0.978912453731
Standard Deviation:	5531.23414842	3600.87570791	0.989400047367
Interquartile Range:	7026.40206659	3113.1236457	1.02566199032
Range:	27772.8046456	21402.0400719	4.23552844691
Mean Difference:	6000.19619952	3791.33048685	1.09023548288
Median Abs. Deviation:	2324.31275266	1336.4207789	0.460409376976
Average Abs. Deviation:	4240.2213483	2421.54628816	0.730051229563
Quartile Dispersion:	0.000841548838302	0.000372006763014	N/A
Relative Mean Diff.:	0.00143726052886	0.000906071079882	N/A
Standard Error:	583.04327269	379.565626939	0.104291922225
Coef. of Variation:	0.00132492742788	0.000860555246371	N/A

Skewness:	0.910469560172	-0.427999129251	-0.586087691873
Kurtosis:	3.60840876137	4.59432497651	3.20419585185
Sum:	375727049.558	376592688.359	124.987204255
Sum Absolute:	375727049.558	376592688.359	138.108847497
Sum Squares:	1.56856734258e+015	1.57580174206e+015	260.698777575
Mean Square:	1.74285260287e+013	1.75089082451e+013	2.89665308417

Inter-Variable Covariance

	X	Y	Z
X:	30594551	-9063133.1	-700.71252
Y:	-9063133.1	12966306	-176.43574
Z:	-700.71252	-176.43574	0.97891245

Inter-Variable Correlation

	X	Y	Z
X:	1.000	-0.455	-0.128
Y:	-0.455	1.000	-0.050
Z:	-0.128	-0.050	1.000

Inter-Variable Rank Correlation

	X	Y	Z
X:	1.000	-0.324	-0.191
Y:	-0.324	1.000	-0.323
Z:	-0.191	-0.323	1.000

Principal Component Analysis

	PC1	PC2	PC3
X:	0.389107992884	0.389107992884	3.39673973957e-005
Y:	0.921192144781	0.921192144781	3.73496368428e-005
Z:	-4.76231779548e-005	-4.76231779548e-005	3.73496368428e-005
Lambda:	34422783.5125	9138073.58642	0.948521262342

Planar Regression: Z = AX+BY+C

Fitted Parameters

	A	B	C
Parameter Value:	-3.39673950902e-005	-3.73496325164e-005	299.478387347
Standard Error:	2.11993098633e-005	3.25638417291e-005	193.323094039

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.455	-0.779
B:	0.455	1.000	-0.913
C:	-0.779	-0.913	1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2	2.7048158184	1.3524079092	1.39376603282
Residual:	87	84.4183925636	0.970326351306	
Total:	89	87.123208382		

Coefficient of Multiple Determination (R^2): 0.0310458701951

Nearest Neighbor Statistics

	Separation	|Delta Z|
1%%-tile:	12.9079144907	0
5%%-tile:	78.6721746515	0.0147232568207
10%%-tile:	127.129745751	0.0413926851582
25%%-tile:	245.425359523	0.184865183363
50%%-tile:	597.867308048	0.408935392974
75%%-tile:	1289.07933886	0.673415899864
90%%-tile:	2085.48411969	1.45863784903
95%%-tile:	3021.50039755	1.63346845558
99%%-tile:	3669.40306167	2.80530349643
Minimum:	12.9079144907	0
Maximum:	4492.49417891	2.80530349643
Mean:	974.31210458	0.574849560393

Median:	601.619503501	0.408935392974
Geometric Mean:	573.069064256	N/A
Harmonic Mean:	231.733897554	N/A
Root Mean Square:	1357.94567876	0.807851601879
Trim Mean (10%%):	854.549377002	0.501748773839
Interquartile Mean:	696.906746823	0.424538429515
Midrange:	2252.7010467	1.40265174821
Winsorized Mean:	869.31331733	0.530574747738
TriMean:	682.559828619	0.419037967293
Variance:	904785.562253	0.325792105862
Standard Deviation:	951.202166867	0.57078201256
Interquartile Range:	1043.65397933	0.4885507165
Range:	4479.58626442	2.80530349643
Mean Difference:	983.232569958	0.573159519594
Median Abs. Deviation:	451.931394328	0.252786943536
Average Abs. Deviation:	691.840792157	0.386821761563
Quartile Dispersion:	0.680124329652	N/A
Relative Mean Diff.:	1.00915565488	0.997060029413
Standard Error:	100.265512086	0.0601657069048
Coef. of Variation:	0.976280765061	0.992924152485
Skewness:	1.48928581053	1.80717574109
Kurtosis:	4.96461349234	6.6615701725
Sum:	87688.0894122	51.7364604354
Sum Absolute:	87688.0894122	51.7364604354
Sum Squares:	165961481.982	58.7361789593
Mean Square:	1844016.46647	0.652624210659

Complete Spatial Randomness

Lambda:	1.51414545488e-007
Clark and Evans:	0.758249080654
Skellam:	157.890052767

Gridding Rules

Gridding Method:	Kriging
Kriging Type:	Point
Polynomial Drift Order:	0
Kriging std. deviation grid:	yes

Semi-Variogram Model

Component Type:	Nugget Effect
Error Variance:	0.1
Micro Variance:	0
Component Type:	Spherical
Anisotropy Angle:	0
Anisotropy Length:	3200
Anisotropy Ratio:	1

Variogram Scale: 0.95

Search Parameters

Search Ellipse Radius #1:	17500
Search Ellipse Radius #2:	17500
Search Ellipse Angle:	0
Number of Search Sectors:	1
Maximum Data Per Sector:	91
Maximum Empty Sectors:	1
Minimum Data:	1
Maximum Data:	91

Output Grid

Grid File Name:	C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\again\TCE_A_log.grd
Grid Size:	301 rows x 309 columns
Total Nodes:	93009
Filled Nodes:	91994
Blanked Nodes:	1015
Blank Value:	1.70141E+038

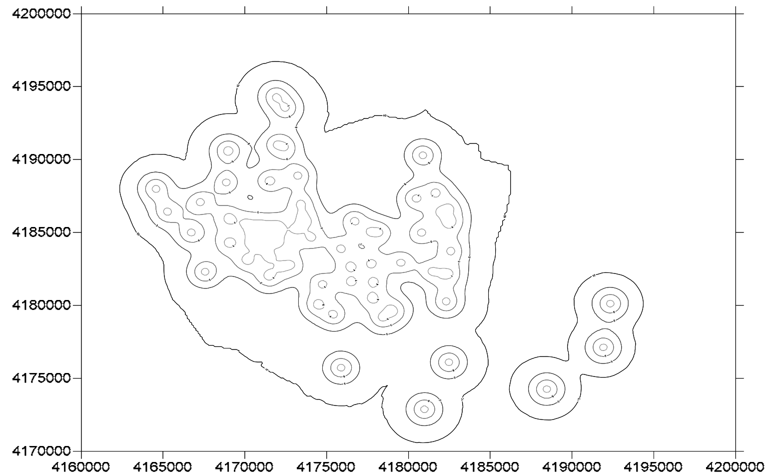
Grid Geometry

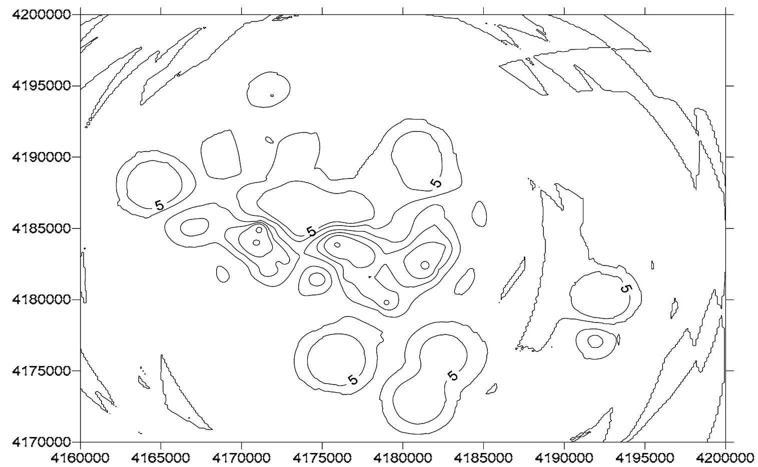
X Minimum:	4160000
X Maximum:	4200000
X Spacing:	129.87012987013
Y Minimum:	4170000
Y Maximum:	4200000
Y Spacing:	100

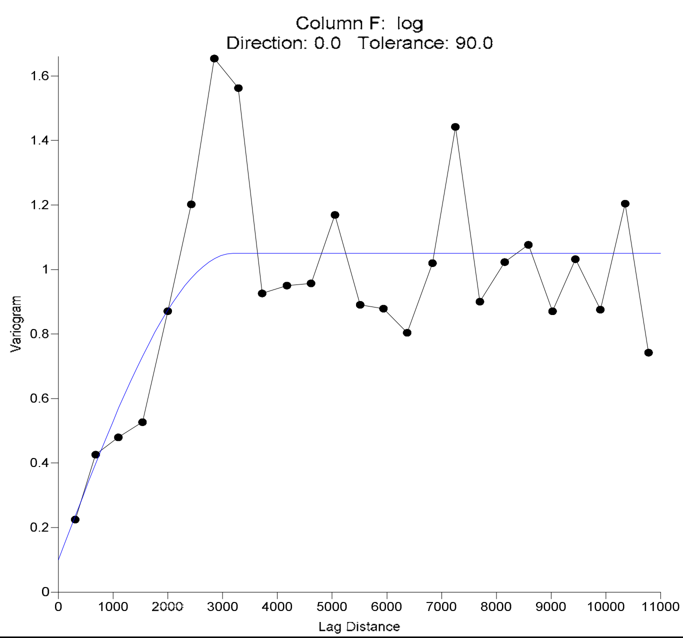
Univariate Grid Statistics

	Z
Count:	91994
1%%-tile:	-0.264818947121
5%%-tile:	0.391743166313
10%%-tile:	0.651894385172
25%%-tile:	0.967683242863
50%%-tile:	1.06088850429
75%%-tile:	1.12747362226
90%%-tile:	1.22939284942
95%%-tile:	1.51941573379
99%%-tile:	2.08484325358
Minimum:	-0.93590460225
Maximum:	2.92115353661

Mean:	1.02052769867
Median:	1.0608885043
Geometric Mean:	N/A
Harmonic Mean:	N/A
Root Mean Square:	1.08026383603
Trim Mean (10%%):	1.02905709714
Interquartile Mean:	1.05624155642
Midrange:	0.992624467181
Winsorized Mean:	1.0201837282
TriMean:	1.05423346843
Variance:	0.125494535845
Standard Deviation:	0.35425207952
Interquartile Range:	0.159790379401
Range:	3.85705813886
Mean Difference:	N/A
Median Abs. Deviation:	0.0788201600592
Average Abs. Deviation:	0.197057514902
Quartile Dispersion:	N/A
Relative Mean Diff.:	N/A
Standard Error:	0.00116797260616
Coef. of Variation:	N/A
Skewness:	-0.879334721251
Kurtosis:	10.6056206777
Sum:	93882.4251112
Sum Absolute:	95288.4387845
Sum Squares:	107354.23408
Mean Square:	1.16696995543







Variogram
TCE A-Zone
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

D-1

DRAWN	JOB NUMBER	CHECKED	DATE
SLC	4088115718	MDT	8/1/11

Gridding Report

Thu Sep 29 10:39:17 2011
Elapsed time for gridding: 2.45 seconds

Data Source

Source Data File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\again\TCE_B.xls (sheet 'Sheet1')
X Column: C
Y Column: D
Z Column: F

Data Counts

Active Data: 20

Original Data: 20
Excluded Data: 0
Deleted Duplicates: 0
Retained Duplicates: 0
Artificial Data: 0
Superseded Data: 0

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: First
X Duplicate Tolerance: 0.0028
Y Duplicate Tolerance: 0.0021

No duplicate data were found.

Breakline Filtering

Breakline Filtering: Not In Use

Data Counts

Active Data: 20

Univariate Statistics

	X	Y	Z
Count:	20	20	20
1%%-tile:	4168864.81167	4172891.01243	-0.80966830183
5%%-tile:	4168864.81167	4172891.01243	-0.80966830183
10%%-tile:	4168984.03509	4176863.42559	-0.80966830183
25%%-tile:	4170742.1875	4182342.14801	-0.167491087294
50%%-tile:	4174058.46035	4182934.18515	0.556302500767
75%%-tile:	4178414.02127	4184768.28611	0.995635194598
90%%-tile:	4181442.04067	4185801.54028	1.63346845558
95%%-tile:	4182290.20399	4188422.73511	2.07918124605
99%%-tile:	4182290.20399	4188422.73511	2.07918124605
Minimum:	4168864.81167	4172891.01243	-0.80966830183
Maximum:	4192626.29638	4190592.07159	2.07918124605
Mean:	4175634.50688	4183108.20541	0.556352018233
Median:	4174960.66009	4183413.90293	0.618771869071
Geometric Mean:	4175630.57628	4183106.56134	N/A
Harmonic Mean:	4175626.64984	4183104.91653	N/A
Root Mean Square:	4175638.44164	4183109.84872	0.987436719659
Trim Mean (10%%):	4174740.20216	4182714.31771	0.476203111506
Interquartile Mean:	4174290.19282	4183487.1611	0.492536980602
Midrange:	4180745.55403	4181741.54201	0.634756472109
Winsorized Mean:	4175038.84709	4182936.23976	0.511780739187
TriMean:	4174318.28236	4183244.7011	0.48518727721
Variance:	34589781.2349	14471923.1715	0.700530218041
Standard Deviation:	5881.30778271	3804.19809835	0.83697683244
Interquartile Range:	7671.83377233	2426.13809588	1.16312628189
Range:	23761.4847036	17701.0591611	2.88884954788
Mean Difference:	6452.27409175	4036.14676041	0.971859942914
Median Abs. Deviation:	4120.20647379	1299.8528129	0.493882771791
Average Abs. Deviation:	4571.14834797	2555.48207891	0.660993933583
Quartile Dispersion:	0.00091887534267	0.000289961285318	N/A
Relative Mean Diff.:	0.0015452200333	0.000964867883453	N/A
Standard Error:	1315.10039987	850.644554779	0.187153709293
Coef. of Variation:	0.00140848241699	0.000909419004135	N/A
Skewness:	1.07513760536	-0.710004761151	0.129622680216
Kurtosis:	3.96200099249	3.99915063082	2.16323570197
Sum:	83512690.1375	83662164.1081	11.1270403647
Sum Absolute:	83512690.1375	83662164.1081	16.078035842
Sum Squares:	3.48719127906e+014	3.49968160129e+014	19.5006255066
Mean Square:	1.74359563953e+013	1.74984080065e+013	0.975031275331

Inter-Variable Covariance

	X	Y	Z
X:	34589781	-16699649	-1265.1869
Y:	-16699649	14471923	-265.42479
Z:	-1265.1869	-265.42479	0.70053022

Inter-Variable Correlation

	X	Y	Z
X:	1.000	-0.746	-0.257
Y:	-0.746	1.000	-0.083
Z:	-0.257	-0.083	1.000

Inter-Variable Rank Correlation

	X	Y	Z
X:	1.000	-0.805	-0.188
Y:	-0.805	1.000	-0.062
Z:	-0.188	-0.062	1.000

Principal Component Analysis

	PC1	PC2	PC3
X:	0.491949571578	0.491949571578	0.000102579820308
Y:	0.870623678921	0.870623678921	0.00013671105192
Z:	-0.0001694879801	-0.0001694879801	0.00013671105192
Lambda:	44025988.1973	5035716.37521	0.534461064758

Planar Regression: Z = AX+BY+C

Fitted Parameters

A	B	C

Parameter Value:	-0.000102579812724	-0.000136711038387	1000.76922418
Standard Error:	4.53013897284e-005	7.00361571844e-005	452.041645099

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.746	-0.902
B:	0.746	1.000	-0.960
C:	-0.902	-0.960	1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2	3.15531361571	1.57765680786	2.64114211873
Residual:	17	10.1547605271	0.597338854533	
Total:	19	13.3100741428		

Coefficient of Multiple Determination (R^2): 0.237062061553

Nearest Neighbor Statistics

	Separation	|Delta Z|
1%%-tile:	409.74666388	0
5%%-tile:	409.74666388	0
10%%-tile:	409.74666388	0.124938736608
25%%-tile:	507.215930962	0.224783182955
50%%-tile:	1351.94192981	0.933053210369
75%%-tile:	2172.6101718	1.22184874962
90%%-tile:	3791.48790967	1.31361912297
95%%-tile:	6788.28633317	1.59207577042
99%%-tile:	6788.28633317	1.59207577042
Minimum:	409.74666388	0
Maximum:	10875.6082372	1.88884954788
Mean:	2155.69364027	0.887973672489
Median:	1570.16113457	0.973420747428
Geometric Mean:	1356.40109222	N/A
Harmonic Mean:	930.571780178	N/A
Root Mean Square:	3282.24377919	1.02790963947
Trim Mean (10%%):	1696.75076675	0.835295994838
Interquartile Mean:	1414.16675491	0.913789977934
Midrange:	5642.67745055	0.944424773939
Winsorized Mean:	1651.64770272	0.851536255702

TriMean:	1345.9274906	0.828184588328
Variance:	6448535.95295	0.282211561981
Standard Deviation:	2539.3967695	0.531235881677
Interquartile Range:	1665.39424083	0.997065566661
Range:	10465.8615733	1.88884954788
Mean Difference:	2270.72159073	0.607778659013
Median Abs. Deviation:	849.682910083	0.277961329626
Average Abs. Deviation:	1433.52232484	0.4244548608
Quartile Dispersion:	0.621456085945	N/A
Relative Mean Diff.:	1.05336006393	0.684455719626
Standard Error:	567.826379845	0.118787954352
Coef. of Variation:	1.17799520398	0.598256342655
Skewness:	2.23208913911	-0.206221469135
Kurtosis:	7.58538626595	1.9588131306
Sum:	43113.8728055	17.7594734498
Sum Absolute:	43113.8728055	17.7594734498
Sum Squares:	215462484.52	21.1319645383
Mean Square:	10773124.226	1.05659822692

Complete Spatial Randomness

Lambda:	4.75507278096e-008
Clark and Evans:	0.940146688033
Skellam:	64.3737338946

Gridding Rules

Gridding Method:	Kriging
Kriging Type:	Point
Polynomial Drift Order:	0
Kriging std. deviation grid:	yes

Semi-Variogram Model

Component Type:	Nugget Effect
Error Variance:	0.1
Micro Variance:	0
Component Type:	Exponential
Anisotropy Angle:	0
Anisotropy Length:	2500
Anisotropy Ratio:	1
Variogram Scale:	0.7

Search Parameters

Search Ellipse Radius #1:	14800
Search Ellipse Radius #2:	14800
Search Ellipse Angle:	0
Number of Search Sectors:	1

Maximum Data Per Sector:	20
Maximum Empty Sectors:	1
Minimum Data:	1
Maximum Data:	20

Output Grid

Grid File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\again\TCE_B_log.grd

Grid Size:	301 rows x 309 columns
Total Nodes:	93009
Filled Nodes:	84009
Blanked Nodes:	9000
Blank Value:	1.70141E+038

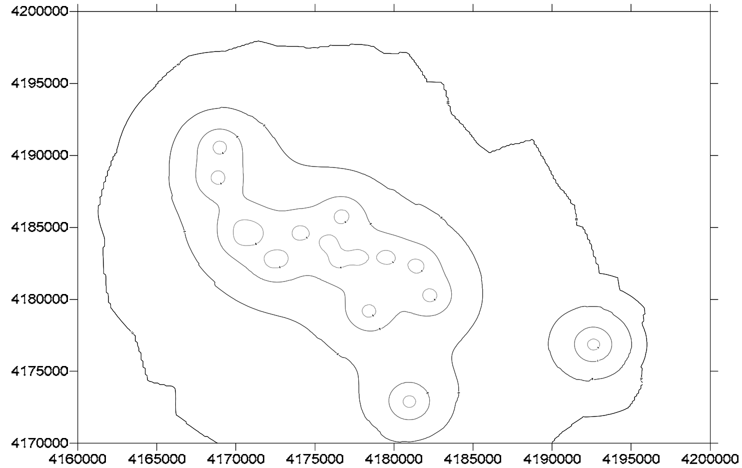
Grid Geometry

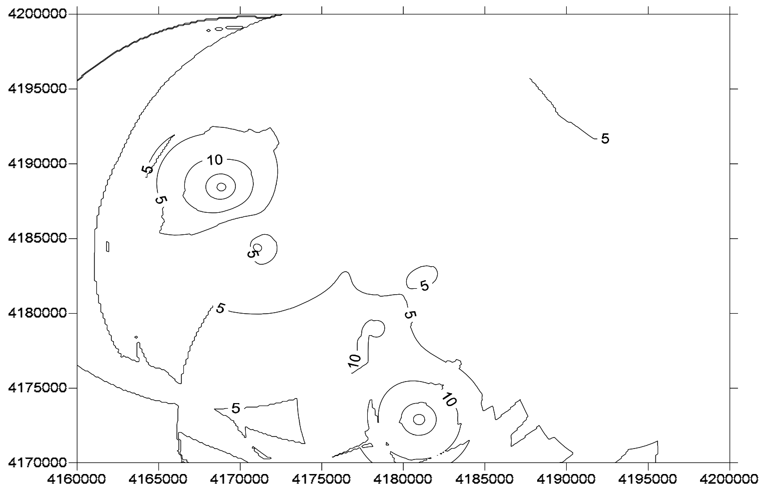
X Minimum:	4160000
X Maximum:	4200000
X Spacing:	129.87012987013
Y Minimum:	4170000
Y Maximum:	4200000
Y Spacing:	100

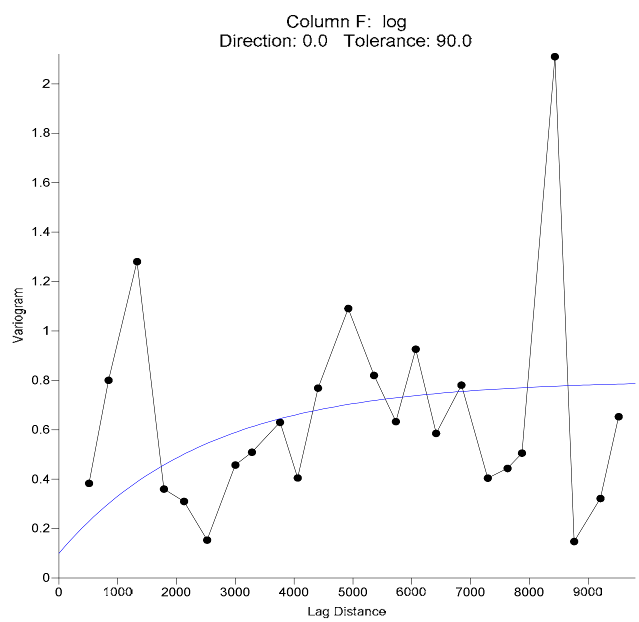
Univariate Grid Statistics

	Z
Count:	84009
1%%-tile:	-0.49485002168
5%%-tile:	-0.49485002168
10%%-tile:	-0.168888383288
25%%-tile:	0.29590260792
50%%-tile:	0.537021926745
75%%-tile:	0.747776688715
90%%-tile:	0.941713623475
95%%-tile:	1.03094589396
99%%-tile:	1.46272133365
Minimum:	-0.80966830183
Maximum:	1.84537941059
Mean:	0.473689126288
Median:	0.537021926745
Geometric Mean:	N/A
Harmonic Mean:	N/A
Root Mean Square:	0.644614058016
Trim Mean (10%%):	0.484803155079
Interquartile Mean:	0.537121047644

Midrange:	0.517855554381
Winsorized Mean:	0.485856040937
TriMean:	0.529430787532
Variance:	0.191148170758
Standard Deviation:	0.437204952805
Interquartile Range:	0.451874080796
Range:	2.65504771242
Mean Difference:	N/A
Median Abs. Deviation:	0.219050964508
Average Abs. Deviation:	0.317358513698
Quartile Dispersion:	N/A
Relative Mean Diff.:	N/A
Standard Error:	0.0015084195955
Coef. of Variation:	N/A
Skewness:	-0.672230282917
Kurtosis:	3.69643731972
Sum:	39794.1498103
Sum Absolute:	48281.9084953
Sum Squares:	34908.031584
Mean Square:	0.415527283792







amec	Variogram TCE B-Zone Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	**D-1**

DRAWN	JOB NUMBER	CHECKED	DATE
SLC	4088115718	MDT	8/1/11

Gridding Report

Wed Aug 24 16:27:44 2011
Elapsed time for gridding: 36.3 seconds

Data Source

Source Data File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\krig_err\TCE_DR1.xls (sheet 'Sheet1')
X Column: B
Y Column: C
Z Column: E

Data Counts

Active Data: 87

Original Data: 87
Excluded Data: 0
Deleted Duplicates: 0
Retained Duplicates: 0
Artificial Data: 0
Superseded Data: 0

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: First
X Duplicate Tolerance: 0.0033
Y Duplicate Tolerance: 0.0023

No duplicate data were found.

Breakline Filtering

Breakline Filtering: Not In Use

Data Counts

Active Data: 87

Univariate Statistics

	X	Y	Z
Count:	87	87	87
1%%-tile:	4164566.11358	4174258.9507	-1
5%%-tile:	4168864.68298	4179168.41271	-0.80966830183
10%%-tile:	4169042.23901	4180068.26896	-0.408935392974
25%%-tile:	4171299.81226	4182777.63002	0.812913356643
50%%-tile:	4173171.05848	4185024.48698	1.47712125472
75%%-tile:	4177889.97252	4185899.95263	1.97772360529
90%%-tile:	4182307.00916	4188903.49696	2.53147891704
95%%-tile:	4182501.0012	4191018.52887	2.95424250944
99%%-tile:	4191917.60774	4193546.92908	3.11394335231
Minimum:	4164566.11358	4174258.9507	-1
Maximum:	4192338.91823	4194283.25562	3.23552844691
Mean:	4174792.5117	4184767.61199	1.29937011896
Median:	4173171.05848	4185024.48698	1.47712125472
Geometric Mean:	4174789.01122	4184765.95507	N/A
Harmonic Mean:	4174785.51366	4184764.29812	N/A
Root Mean Square:	4174796.01511	4184769.26888	1.65358207814
Trim Mean (10%%):	4174421.50681	4184696.59753	1.29666242721
Interquartile Mean:	4173526.33889	4184776.32835	1.40334692256
Midrange:	4178452.51591	4184271.10316	1.11776422345
Winsorized Mean:	4174623.75349	4184674.3849	1.29735834937
TriMean:	4173882.97544	4184681.63915	1.43621986784
Variance:	29592122.3052	14028655.1811	1.05813343642
Standard Deviation:	5439.86418076	3745.48463901	1.02865613128
Interquartile Range:	6590.16025532	3122.32261254	1.16481024865
Range:	27772.8046456	20024.3049132	4.23552844691
Mean Difference:	5880.45224833	4052.03308548	1.14420270605
Median Abs. Deviation:	2557.59160066	1703.1239948	0.52287874528
Average Abs. Deviation:	4130.36035168	2603.53476148	0.776285494557
Quartile Dispersion:	0.000789317337993	0.000373096296482	N/A
Relative Mean Diff.:	0.00140856155889	0.000968281505973	N/A
Standard Error:	583.214657601	401.558103053	0.110283513238
Coef. of Variation:	0.00130302623795	0.000895028108199	N/A
Skewness:	0.953333430257	-0.0270638435705	-0.503184389785
Kurtosis:	3.84675871149	3.7490516364	2.89105980443
Sum:	363206948.518	364074782.243	113.045200349
Sum Absolute:	363206948.518	364074782.243	128.427619122
Sum Squares:	1.51631619379e+015	1.52356956354e+015	237.887030957
Mean Square:	1.74289217677e+013	1.75122938338e+013	2.73433368916

Inter-Variable Covariance

	X	Y	Z
X:	29592122	-9036852.8	-411.5096
Y:	-9036852.8	14028655	-816.63502
Z:	-411.5096	-816.63502	1.0581334

Inter-Variable Correlation

	X	Y	Z
X:	1.000	-0.444	-0.074
Y:	-0.444	1.000	-0.212
Z:	-0.074	-0.212	1.000

Inter-Variable Rank Correlation

	X	Y	Z
X:	1.000	-0.319	-0.154
Y:	-0.319	1.000	-0.386
Z:	-0.154	-0.386	1.000

Principal Component Analysis

	PC1	PC2	PC3
X:	0.416819445994	0.416819445994	3.94416911703e-005
Y:	0.908989296359	0.908989296359	8.36191237216e-005
Z:	-9.24489526916e-005	-9.24489526916e-005	8.36191237216e-005
Lambda:	33735995.0751	9884782.4956	0.97361649712

Planar Regression: Z = AX+BY+C

Fitted Parameters

A	B	C

Parameter Value:	-3.94416875171e-005	-8.36191158139e-005	515.886799415
Standard Error:	2.20816754218e-005	3.2070967246e-005	193.61164844

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.444	-0.784
B:	0.444	1.000	-0.904
C:	-0.784	-0.904	1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2	7.268456064	3.634228032	3.64590275656
Residual:	84	83.731019468	0.99679785081	
Total:	86	90.999475532		

Coefficient of Multiple Determination (R^2): 0.0798736039027

Nearest Neighbor Statistics

	Separation	|Delta Z|
1%%-tile:	8.30199681301	0
5%%-tile:	17.3343346589	0.0147232568207
10%%-tile:	78.6721746515	0.0377885608894
25%%-tile:	224.996004559	0.229674087128
50%%-tile:	605.371698953	0.463110540277
75%%-tile:	1197.00985173	0.692236621677
90%%-tile:	1888.74742854	1.63346845558
95%%-tile:	2661.33372497	1.92361165414
99%%-tile:	4165.84935295	2.80530349643
Minimum:	8.30199681301	0
Maximum:	4492.49417891	2.80530349643
Mean:	916.105083123	0.641825630738
Median:	605.371698953	0.463110540277
Geometric Mean:	465.81951353	N/A
Harmonic Mean:	109.297542016	N/A
Root Mean Square:	1308.13101961	0.925396018852
Trim Mean (10%%):	785.743269493	0.546944276802
Interquartile Mean:	659.967026211	0.438986416498
Midrange:	2250.39808786	1.40265174821
Winsorized Mean:	798.890388469	0.580018063438

TriMean:	658.187313548	0.46203294734
Variance:	882097.290462	0.449585298545
Standard Deviation:	939.200346285	0.670511221789
Interquartile Range:	972.01384717	0.462562534549
Range:	4484.1921821	2.80530349643
Mean Difference:	954.71358916	0.660908027936
Median Abs. Deviation:	437.893706206	0.233436453149
Average Abs. Deviation:	666.569071271	0.432578807689
Quartile Dispersion:	0.68355122651	N/A
Relative Mean Diff.:	1.0421441893	1.02973143527
Standard Error:	100.692846398	0.0718863485629
Coef. of Variation:	1.02521027728	1.04469374496
Skewness:	1.69005541298	1.76700919515
Kurtosis:	6.01310334223	5.69759661175
Sum:	79701.1422317	55.8388298742
Sum Absolute:	79701.1422317	55.8388298742
Sum Squares:	148874988.509	74.5031278786
Mean Square:	1711206.76447	0.856357791708

Complete Spatial Randomness

Lambda:	1.56437931034e-007
Clark and Evans:	0.724680074549
Skellam:	146.333470595

Gridding Rules

Gridding Method:	Kriging
Kriging Type:	Point
Polynomial Drift Order:	0
Kriging std. deviation grid:	yes

Semi-Variogram Model

Component Type:	Nugget Effect
Error Variance:	0.141
Micro Variance:	0
Component Type:	Spherical
Anisotropy Angle:	0
Anisotropy Length:	3000
Anisotropy Ratio:	1
Variogram Scale:	1

Search Parameters

Search Ellipse Radius #1:	17100
Search Ellipse Radius #2:	17100
Search Ellipse Angle:	0
Number of Search Sectors:	1

Maximum Data Per Sector:	87
Maximum Empty Sectors:	1
Minimum Data:	1
Maximum Data:	87

Output Grid

Grid File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\krig_err\TCE_DR1_log.grd

Grid Size:	301 rows x 309 columns
Total Nodes:	93009
Filled Nodes:	91777
Blanked Nodes:	1232
Blank Value:	1.70141E+038

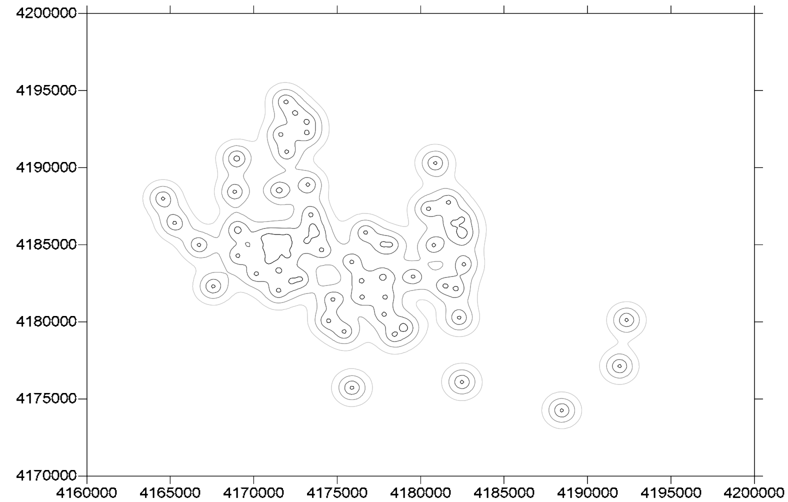
Grid Geometry

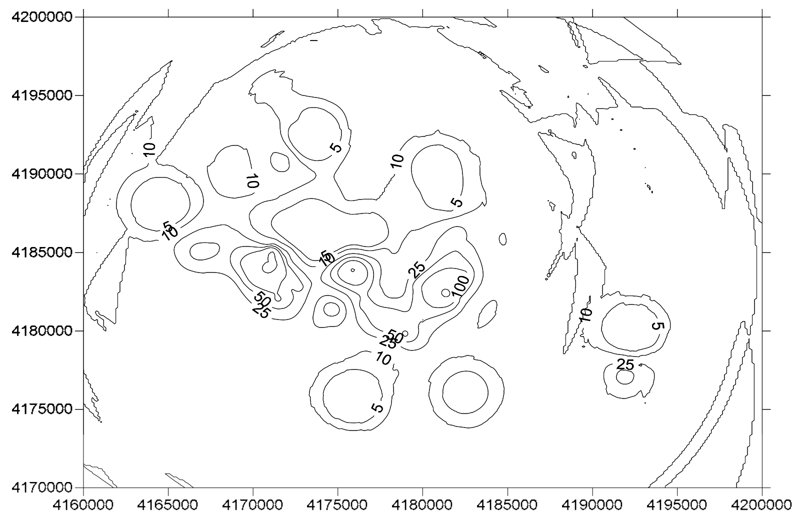
X Minimum:	4160000
X Maximum:	4200000
X Spacing:	129.87012987013
Y Minimum:	4170000
Y Maximum:	4200000
Y Spacing:	100

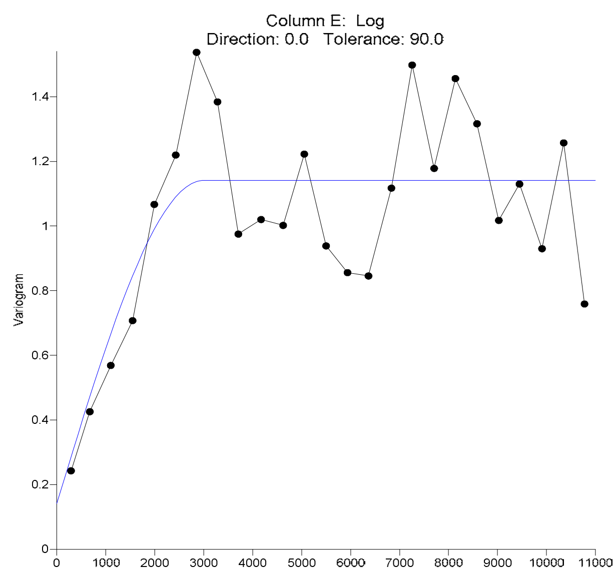
Univariate Grid Statistics

	Z
Count:	91777
1%%-tile:	-0.30271796707
5%%-tile:	0.47860075217
10%%-tile:	0.697090479986
25%%-tile:	0.952787007174
50%%-tile:	1.05362050248
75%%-tile:	1.14702813
90%%-tile:	1.26568040833
95%%-tile:	1.47182178377
99%%-tile:	2.01499122022
Minimum:	-0.903564496585
Maximum:	2.91331018133
Mean:	1.02534662633
Median:	1.05362050248
Geometric Mean:	N/A
Harmonic Mean:	N/A
Root Mean Square:	1.08229489485
Trim Mean (10%%):	1.03707973037
Interquartile Mean:	1.05725148542

Midrange:	1.00487284237
Winsorized Mean:	1.03208739551
TriMean:	1.05176403553
Variance:	0.120027843115
Standard Deviation:	0.346450347257
Interquartile Range:	0.194241122823
Range:	3.81687467792
Mean Difference:	N/A
Median Abs. Deviation:	0.0959532559576
Average Abs. Deviation:	0.199545694731
Quartile Dispersion:	N/A
Relative Mean Diff.:	N/A
Standard Error:	0.00114359980406
Coef. of Variation:	N/A
Skewness:	-1.08350326197
Kurtosis:	11.5480768104
Sum:	94103.2373243
Sum Absolute:	95597.4253681
Sum Squares:	107504.112246
Mean Square:	1.17136223941







Variogram
TCE Depth Region 1
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

D-1

DRAWN	JOB NUMBER	CHECKED	DATE
SLC	4088115718	MDT	8/1/11

Gridding Report

Thu Aug 25 10:01:24 2011
Elapsed time for gridding: 3.91 seconds

Data Source

Source Data File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\krig_err\TCE_DR2.xls (sheet 'Sheet1')
X Column: B
Y Column: C
Z Column: E

Data Counts

Active Data: 28

Original Data: 28
Excluded Data: 0
Deleted Duplicates: 0
Retained Duplicates: 0
Artificial Data: 0
Superseded Data: 0

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: First
X Duplicate Tolerance: 0.003
Y Duplicate Tolerance: 0.0021

No duplicate data were found.

Breakline Filtering

Breakline Filtering: Not In Use

Data Counts

Active Data: 28

Univariate Statistics

	X	Y	Z
Count:	28	28	28
1%%-tile:	4167269.89434	4172891.01243	-0.80966830183
5%%-tile:	4167691.41447	4176863.42559	-0.80966830183
10%%-tile:	4168864.81167	4179178.26479	-0.80966830183
25%%-tile:	4170742.1875	4182158.75524	0.431363764159
50%%-tile:	4172799.29793	4184282.15495	1.07918124605
75%%-tile:	4177803.66532	4185068.63022	1.64345267649
90%%-tile:	4181442.04067	4187088.74378	2.07918124605
95%%-tile:	4182290.20399	4188422.73511	2.07918124605
99%%-tile:	4182474.89913	4190871.2737	2.27875360095
Minimum:	4167269.89434	4172891.01243	-0.80966830183
Maximum:	4192626.29638	4190978.72759	2.96378782735
Mean:	4174811.81416	4183637.64224	0.98699497989
Median:	4173428.87914	4184327.70831	1.11265464086
Geometric Mean:	4174808.14572	4183635.98004	N/A
Harmonic Mean:	4174804.48111	4183634.31729	N/A
Root Mean Square:	4174815.48644	4183639.30391	1.3654357257
Trim Mean (10%%):	4174094.38826	4183484.51876	0.928119452418
Interquartile Mean:	4173484.23639	4183789.8469	1.0335678869
Midrange:	4179948.09536	4181934.87001	1.07705976276
Winsorized Mean:	4174444.06548	4183623.19891	0.948274303597
TriMean:	4173536.11217	4183947.92384	1.05829473319
Variance:	31797850.609	14418574.9252	0.923228061457
Standard Deviation:	5638.95829112	3797.17986474	0.960847574518
Interquartile Range:	7061.47782203	2909.87498095	1.21208891233
Range:	25356.4020346	18087.7151604	3.77345612918
Mean Difference:	6141.84102992	4136.54726903	1.09441059698
Median Abs. Deviation:	3042.61831008	1640.72691321	0.548455006504
Average Abs. Deviation:	4284.43253807	2673.11226444	0.738034145055
Quartile Dispersion:	0.000845833268035	0.000347770515476	N/A
Relative Mean Diff.:	0.00147116595989	0.000988744155867	N/A
Standard Error:	1065.66294941	717.599543248	0.181583123572
Coef. of Variation:	0.00135070957498	0.000907626374329	N/A
Skewness:	1.12547452845	-0.514130857654	-0.294557753822
Kurtosis:	4.26939562045	3.89406626992	2.49348421091
Sum:	116894730.796	117141853.983	27.6358594369
Sum Absolute:	116894730.796	117141853.983	33.4835692913
Sum Squares:	4.88014361683e+014	4.90079459106e+014	52.2036121885
Mean Square:	1.74290843458e+013	1.75028378252e+013	1.86441472102

Inter-Variable Covariance

	X	Y	Z
X:	31797851	-14373001	-2065.9814
Y:	-14373001	14418575	-334.84138
Z:	-2065.9814	-334.84138	0.92322806

Inter-Variable Correlation

	X	Y	Z
X:	1.000	-0.671	-0.381
Y:	-0.671	1.000	-0.092
Z:	-0.381	-0.092	1.000

Inter-Variable Rank Correlation

	X	Y	Z
X:	1.000	-0.731	-0.427
Y:	-0.731	1.000	0.035
Z:	-0.427	0.035	1.000

Principal Component Analysis

	PC1	PC2	PC3
X:	0.491235599095	0.491235599095	0.00013736268789
Y:	0.871026717928	0.871026717928	0.000160151437934
Z:	-0.000206973628241	-0.000206973628241	0.000160151437934
Lambda:	39903836.0935	6312589.77813	0.585813962022

Planar Regression: Z = AX+BY+C

Fitted Parameters

A	B	C

Parameter Value:	-0.000137362680988	-0.000160151425064	1244.46586875
Standard Error:	3.66235075369e-005	5.43873187028e-005	349.078176912

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.671	-0.876
B:	0.671	1.000	-0.946
C:	-0.876	-0.946	1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2	9.11017998062	4.55508999031	7.19968454599
Residual:	25	15.8169776787	0.632679107149	
Total:	27	24.9271576593		

Coefficient of Multiple Determination (R^2): 0.365472072874

Nearest Neighbor Statistics

	Separation	|Delta Z|
1%%-tile:	314.645646204	0
5%%-tile:	314.645646204	0.114954515702
10%%-tile:	319.857615854	0.114954515702
25%%-tile:	507.215930962	0.507084478097
50%%-tile:	1049.01359232	0.690749674089
75%%-tile:	1921.32219074	1.01378828449
90%%-tile:	2086.4125138	1.88884954788
95%%-tile:	3200.34228935	1.88884954788
99%%-tile:	6788.28633317	2.1929358157
Minimum:	314.645646204	0
Maximum:	10875.6082372	2.1929358157
Mean:	1716.0174042	0.859815246884
Median:	1200.47776107	0.741472000928
Geometric Mean:	1084.16104664	N/A
Harmonic Mean:	769.956509591	N/A
Root Mean Square:	2767.90473869	1.06115647673
Trim Mean (10%%):	1202.79788404	0.787558211254
Interquartile Mean:	1133.04547763	0.727177172594
Midrange:	5595.12694171	1.09646790785
Winsorized Mean:	1194.78256924	0.8422003176

TriMean:	1131.64132659	0.72559302769
Variance:	4891269.0928	0.401095654126
Standard Deviation:	2211.62137194	0.633321130333
Interquartile Range:	1414.10625978	0.506703806389
Range:	10560.962591	2.1929358157
Mean Difference:	1806.50957163	0.710816283849
Median Abs. Deviation:	707.053129891	0.253351903194
Average Abs. Deviation:	1149.75229256	0.480655855262
Quartile Dispersion:	0.582287033974	N/A
Relative Mean Diff.:	1.05273382846	0.826708163673
Standard Error:	417.95715317	0.119686443636
Coef. of Variation:	1.2888105718	0.736578157492
Skewness:	2.89935178429	0.668233231927
Kurtosis:	11.5487690748	2.43428759374
Sum:	48048.4873177	24.0748269127
Sum Absolute:	48048.4873177	24.0748269127
Sum Squares:	214516305.988	31.5294859071
Mean Square:	7661296.64244	1.12605306811

Complete Spatial Randomness

Lambda:	6.10501439127e-008
Clark and Evans:	0.847998394319
Skellam:	82.2861740754

Gridding Rules

Gridding Method:	Kriging
Kriging Type:	Point
Polynomial Drift Order:	0
Kriging std. deviation grid:	yes

Semi-Variogram Model

Component Type:	Nugget Effect
Error Variance:	0.4
Micro Variance:	0
Component Type:	Gaussian
Anisotropy Angle:	0
Anisotropy Length:	4700
Anisotropy Ratio:	1
Variogram Scale:	1

Search Parameters

Search Ellipse Radius #1:	15600
Search Ellipse Radius #2:	15600
Search Ellipse Angle:	0
Number of Search Sectors:	1

Maximum Data Per Sector:	28
Maximum Empty Sectors:	1
Minimum Data:	1
Maximum Data:	28

Output Grid

Grid File Name: C:\Documents and Settings\SLCULKIN\Desktop\NHOU\contouring\krig_err\TCE_DR2_log.grd

Grid Size:	301 rows x 309 columns
Total Nodes:	93009
Filled Nodes:	86489
Blanked Nodes:	6520
Blank Value:	1.70141E+038

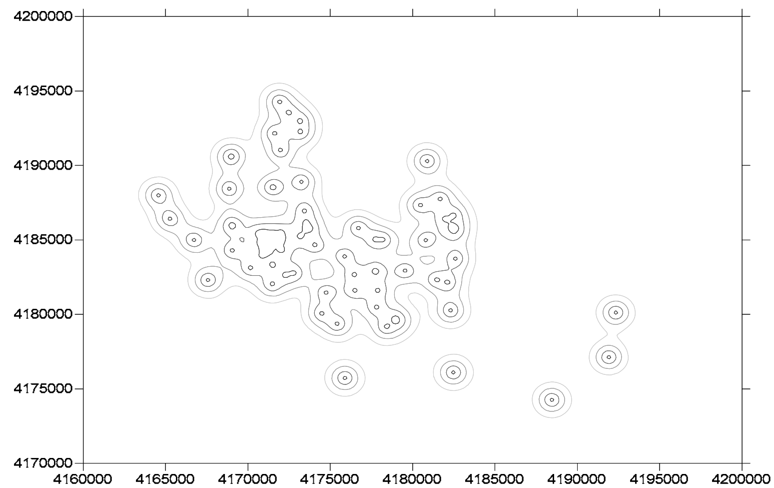
Grid Geometry

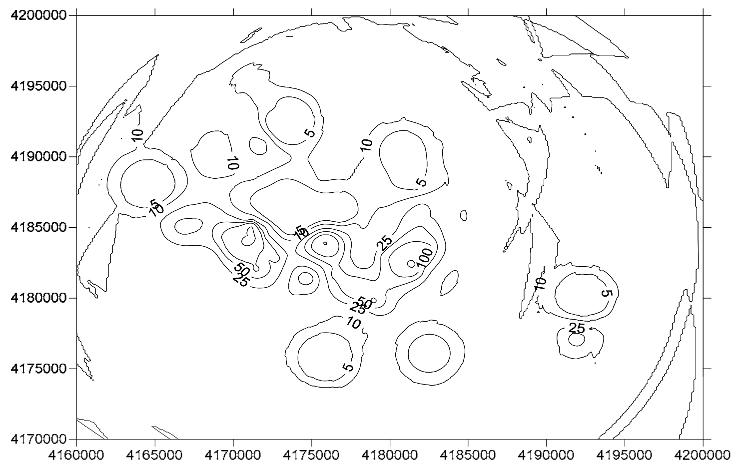
X Minimum:	4160000
X Maximum:	4200000
X Spacing:	129.87012987013
Y Minimum:	4170000
Y Maximum:	4200000
Y Spacing:	100

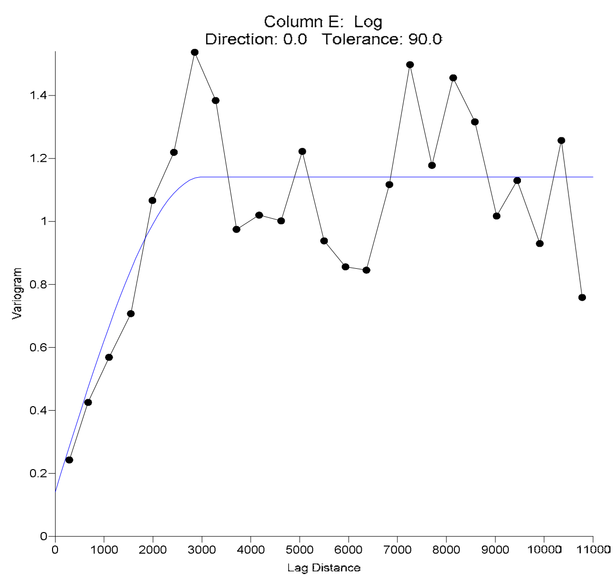
Univariate Grid Statistics

	Z
Count:	86489
1%%-tile:	-0.549370743561
5%%-tile:	-0.49485002168
10%%-tile:	-0.182378874179
25%%-tile:	0.259136118433
50%%-tile:	0.642857583528
75%%-tile:	1.03276934425
90%%-tile:	1.31199835125
95%%-tile:	1.45082539981
99%%-tile:	1.67985126448
Minimum:	-0.80966830183
Maximum:	2.27875360095
Mean:	0.61665937176
Median:	0.642857583528
Geometric Mean:	N/A
Harmonic Mean:	N/A
Root Mean Square:	0.830014605749
Trim Mean (10%%):	0.626463339043
Interquartile Mean:	0.646227813749

Midrange:	0.734542649562
Winsorized Mean:	0.627864618085
TriMean:	0.644405157435
Variance:	0.308659033743
Standard Deviation:	0.555570907934
Interquartile Range:	0.773633225818
Range:	3.08842190278
Mean Difference:	N/A
Median Abs. Deviation:	0.385708612315
Average Abs. Deviation:	0.448014549869
Quartile Dispersion:	N/A
Relative Mean Diff.:	N/A
Standard Error:	0.0018891178789
Coef. of Variation:	N/A
Skewness:	-0.322384336266
Kurtosis:	2.60358570789
Sum:	53334.2524042
Sum Absolute:	61819.9444034
Sum Squares:	59584.3690912
Mean Square:	0.688924245756







amec

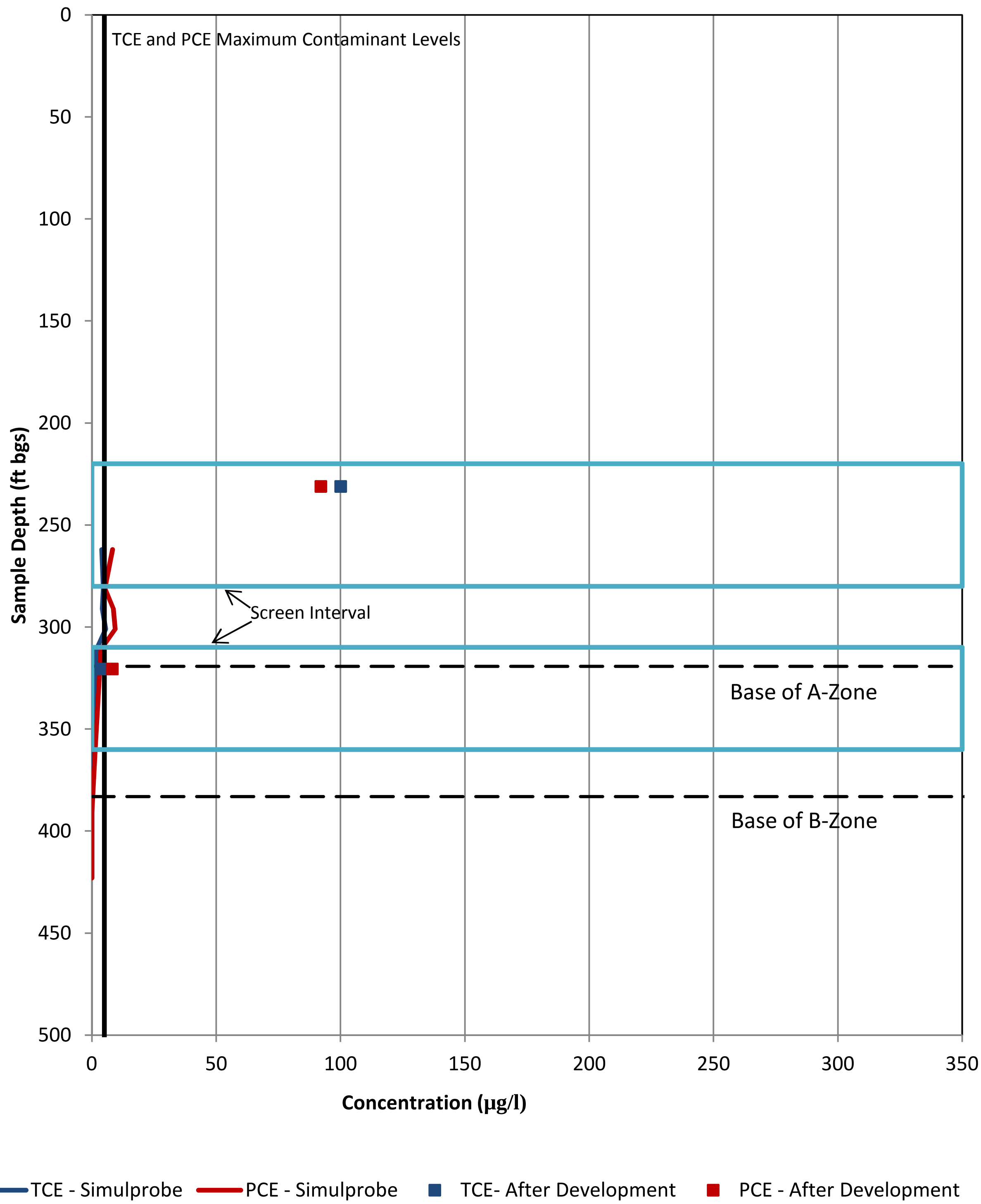
Variogram
TCE Depth Region 2
Data Gap Analysis
North Hollywood Operable Unit
Lost Angeles County, California

D-2

DRAWN	JOB NUMBER	CHECKED	DATE
SLC	4088115718	MDT	8/1/11

APPENDIX E

GROUNDWATER QUALITY DEPTH PROFILES

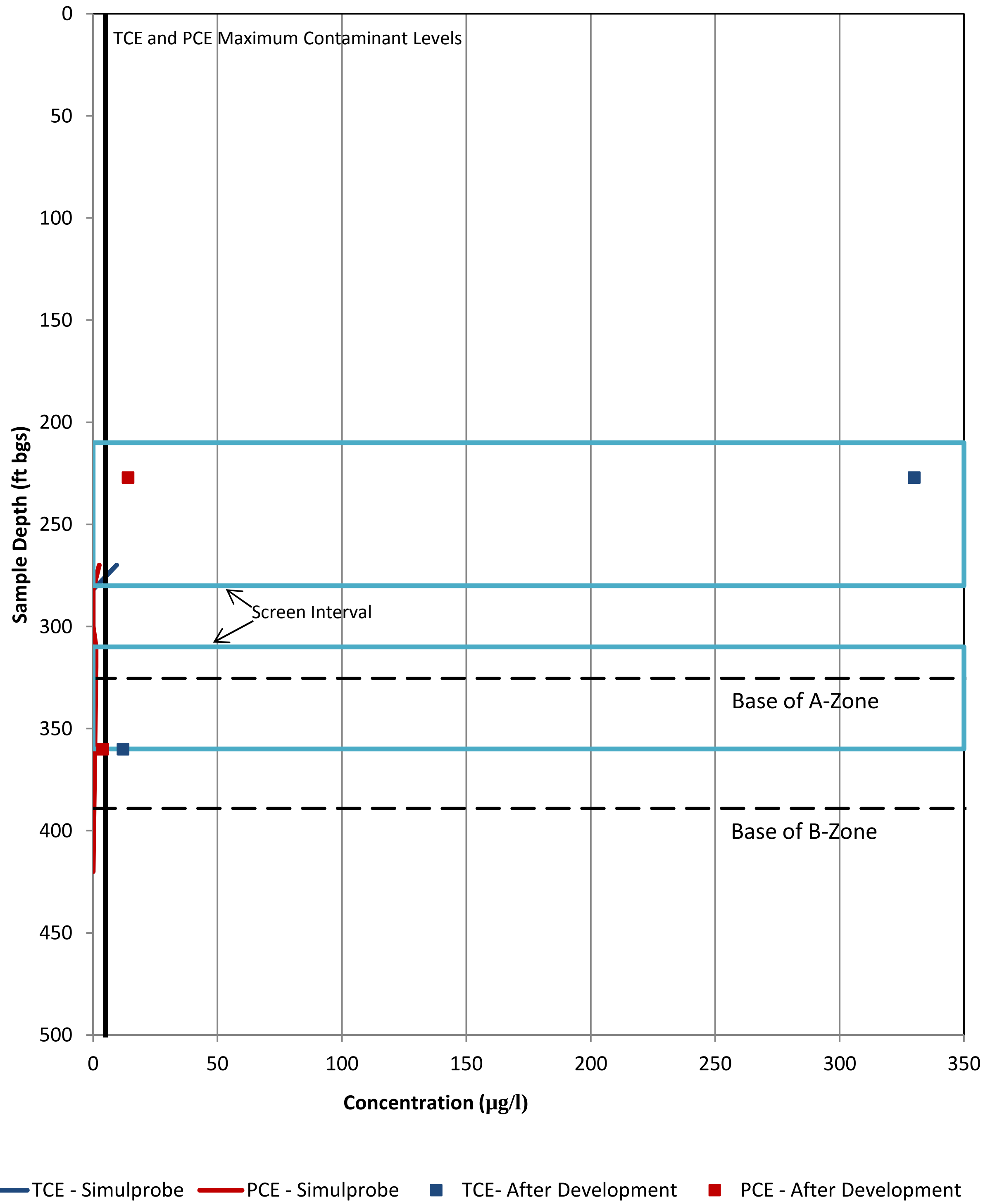


amec

Groundwater Quality Depth Profile
NH-C10
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

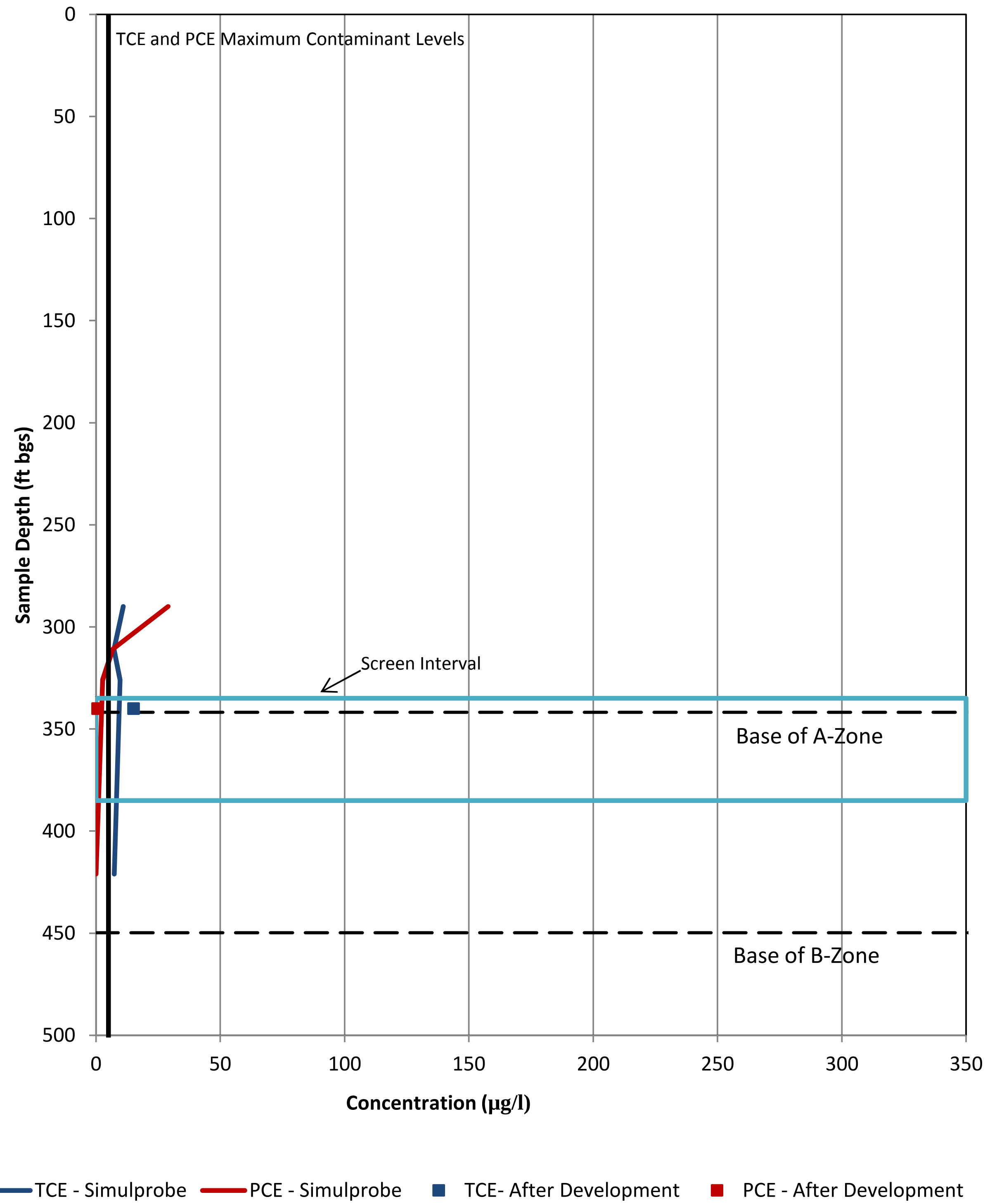
Figure: **E-1**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011



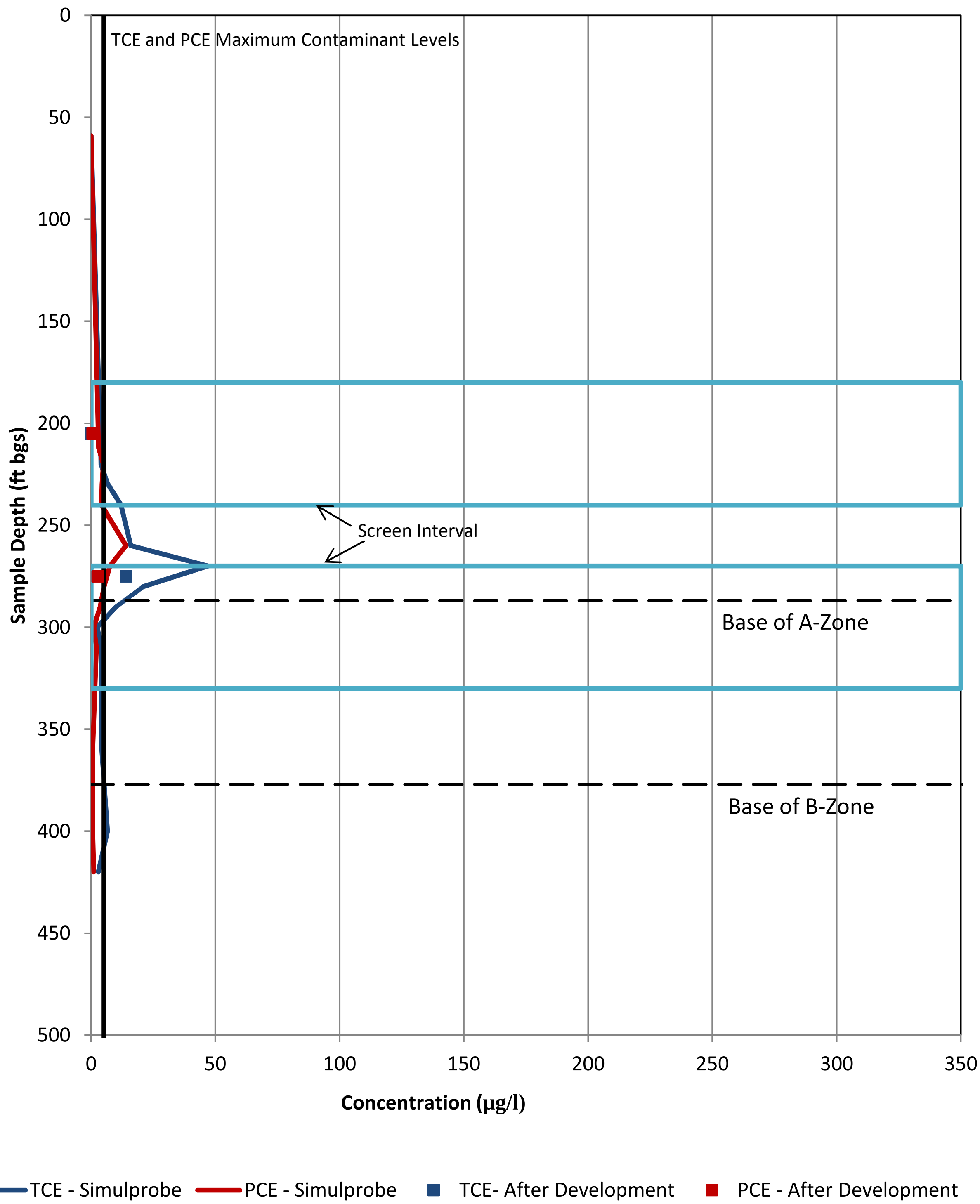
amec	Groundwater Quality Depth Profile NH-C12 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **E-2**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011

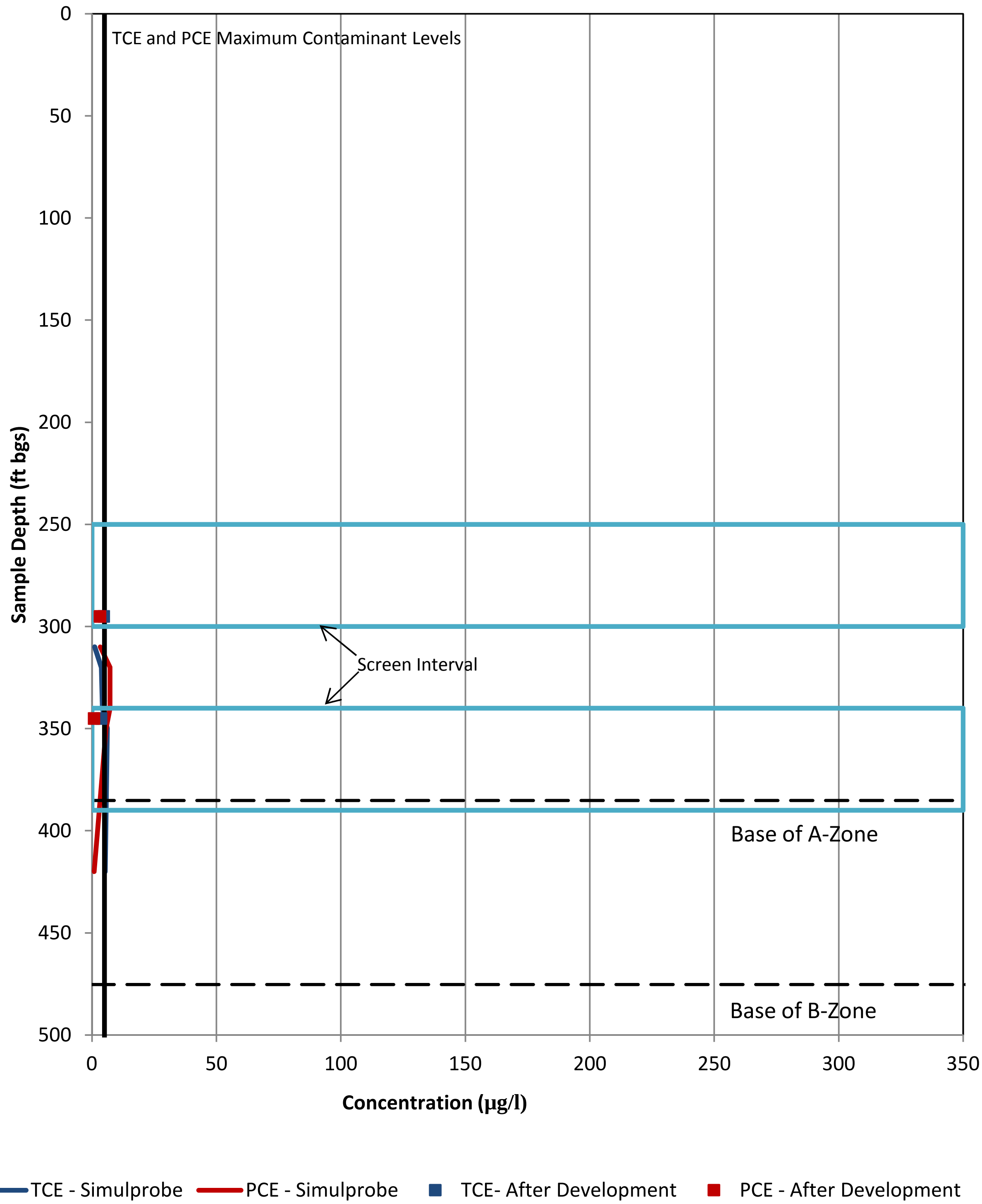


amec	Groundwater Quality Depth Profile NH-C13 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **E-3**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011

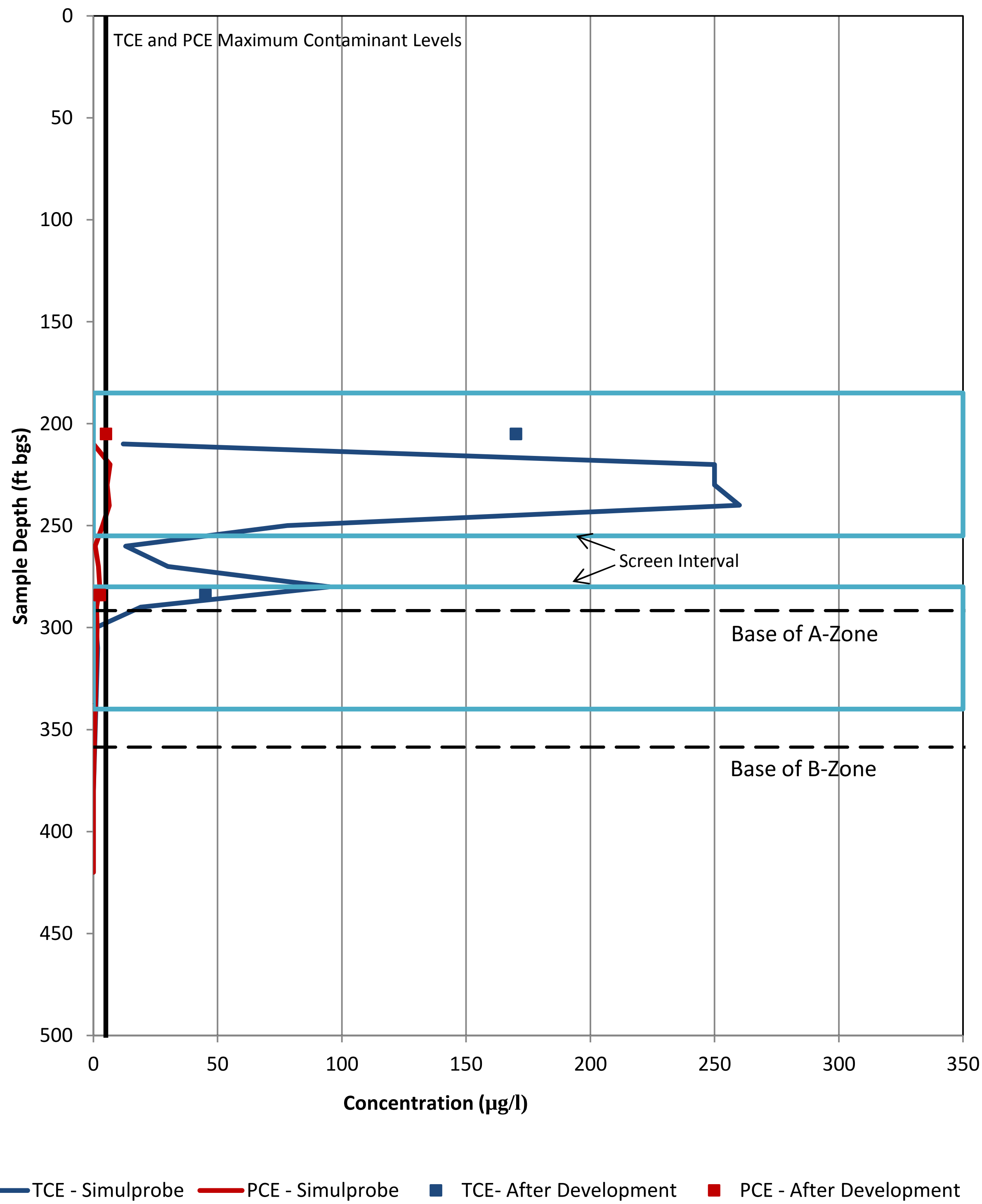


amec	Groundwater Quality Depth Profile NH-C15 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **E-4**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 10/2011

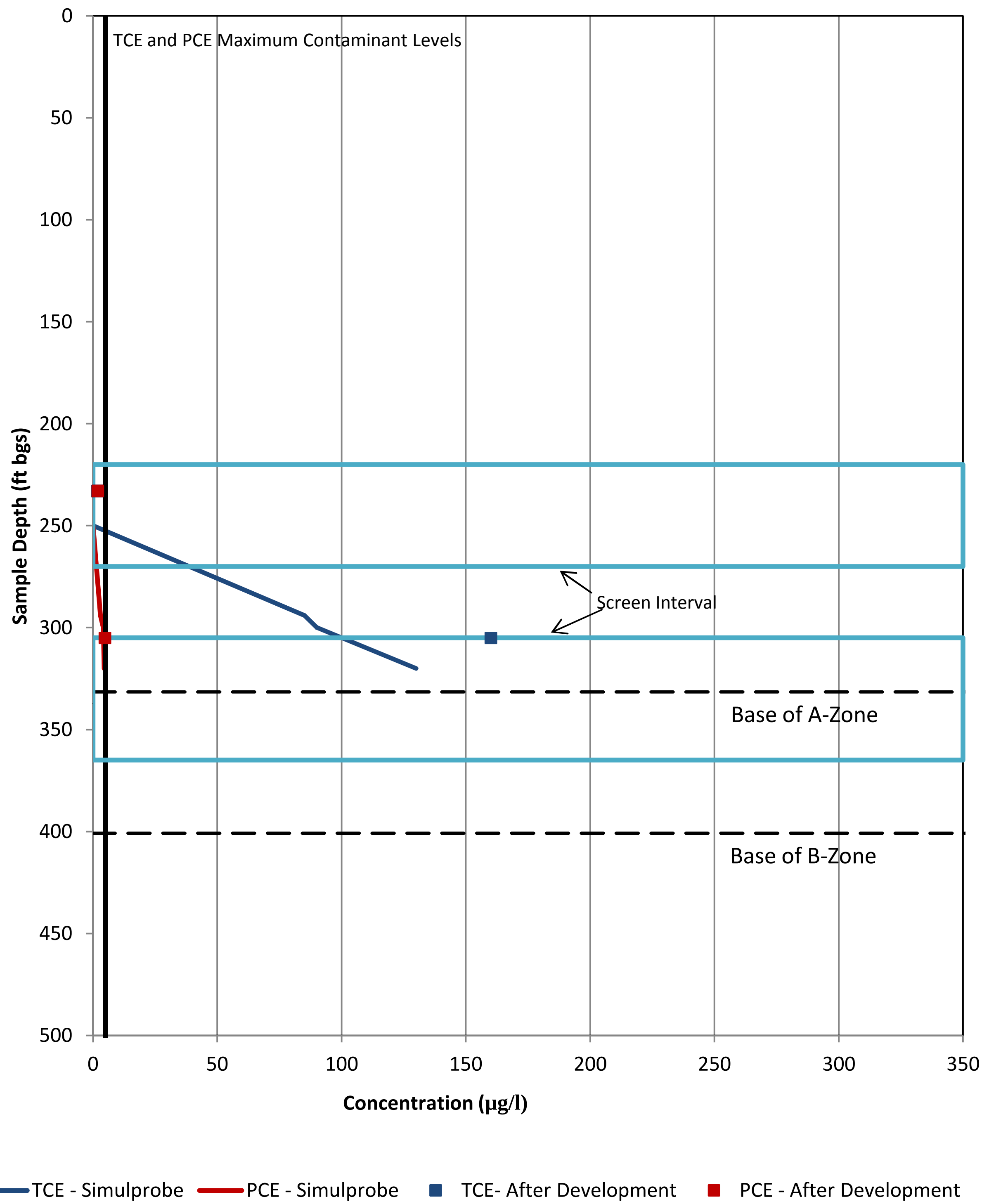


amec	Groundwater Quality Depth Profile NH-C16 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **E-5**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011



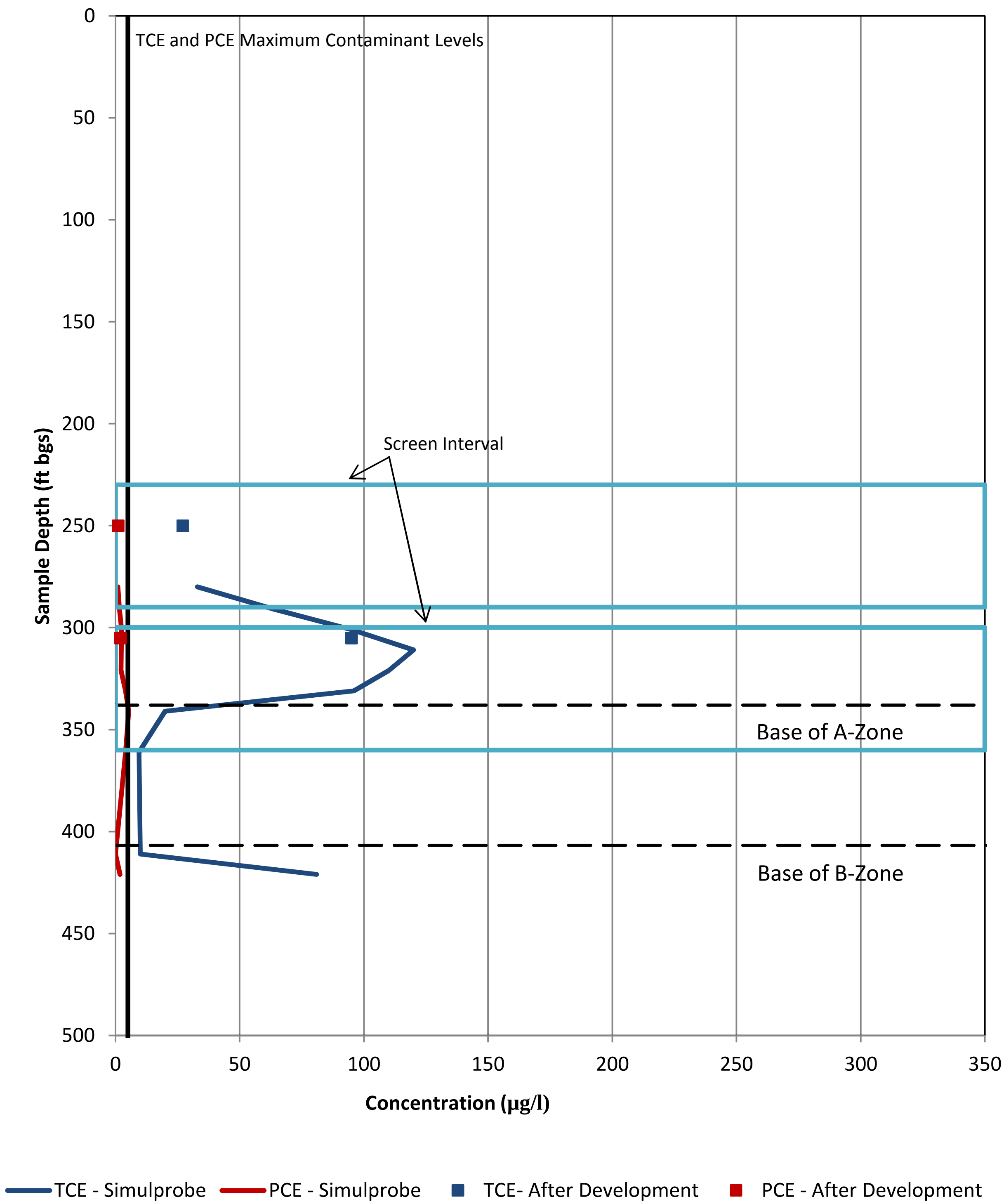
amec	Groundwater Quality Depth Profile NH-C17 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **E-6**	
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 10/2011



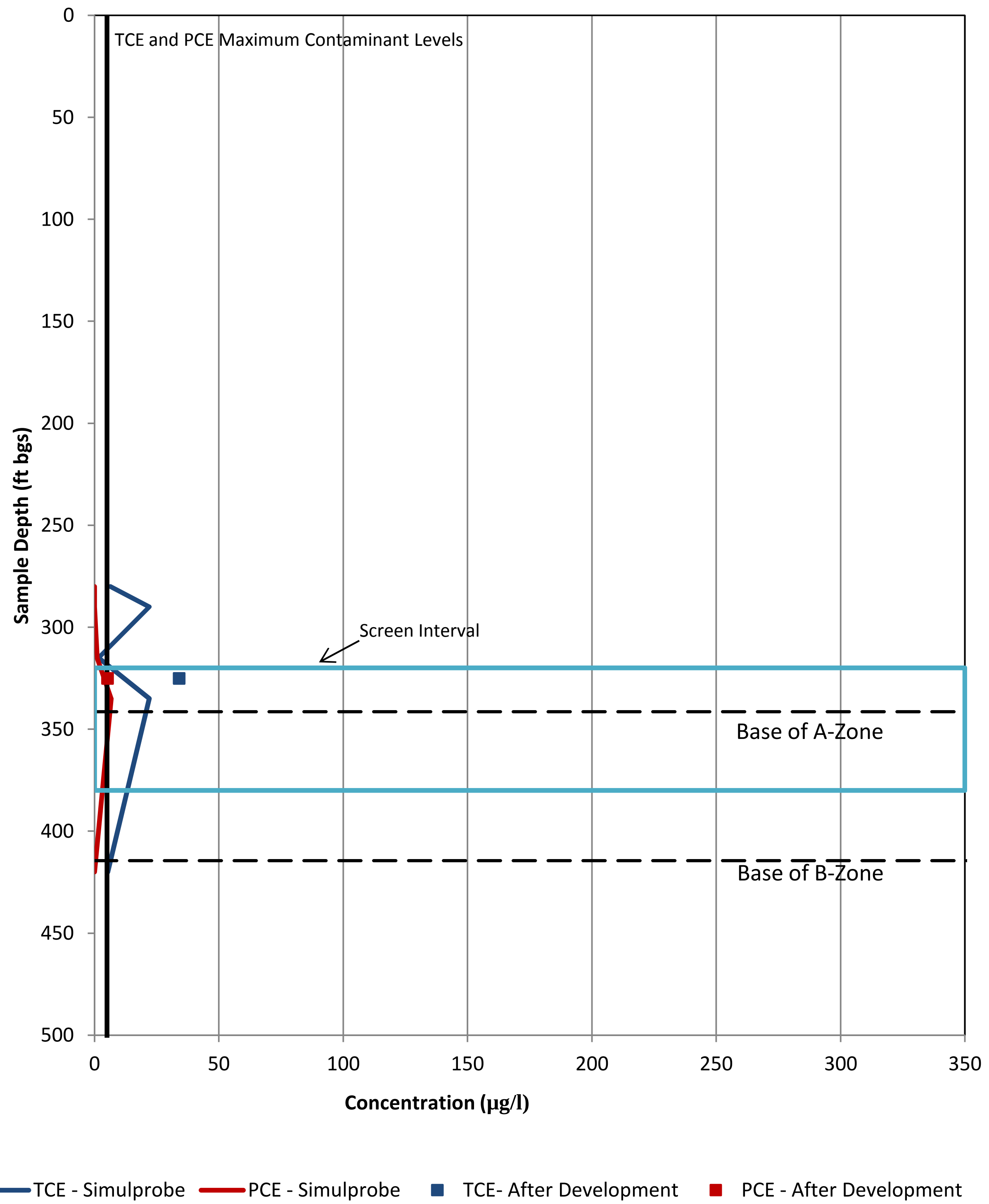
Groundwater Quality Depth Profile
NH-C18
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **E-7**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011



amec	Groundwater Quality Depth Profile NH-C19 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **E-8**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 10/2011

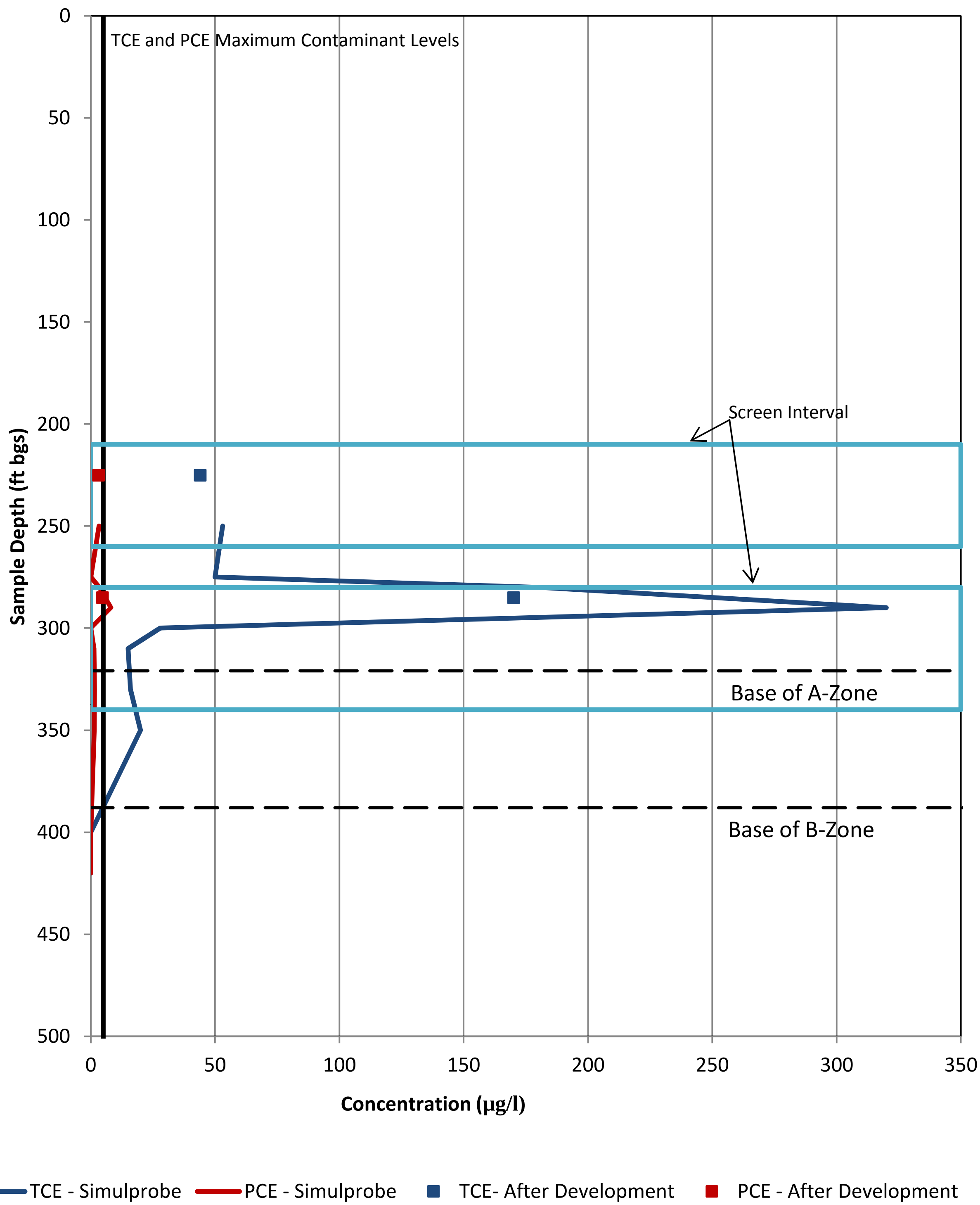


amec

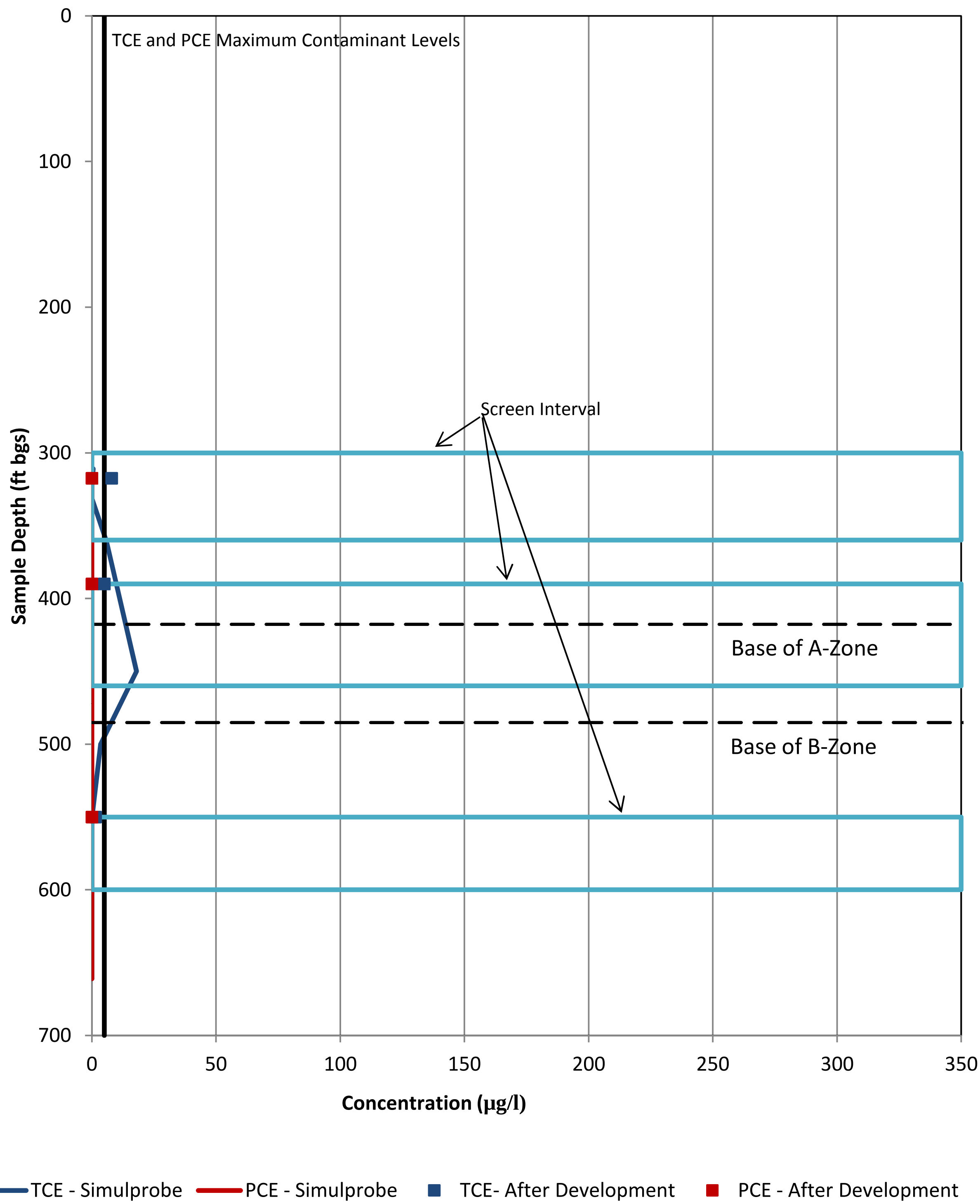
Groundwater Quality Depth Profile
NH-C20
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **E-9**

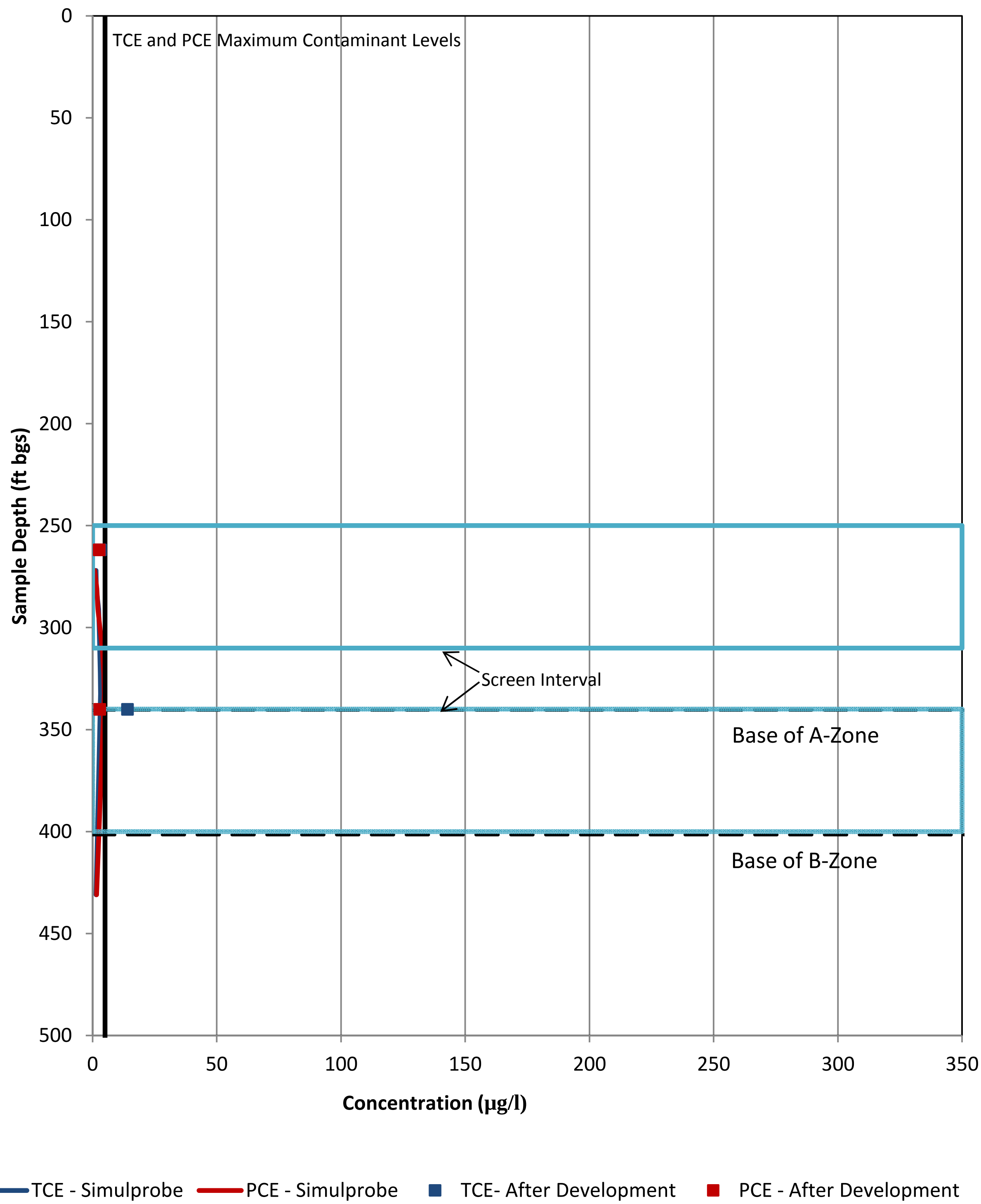
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011



amec	Groundwater Quality Depth Profile NH-C21 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **E-10**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 10/2011

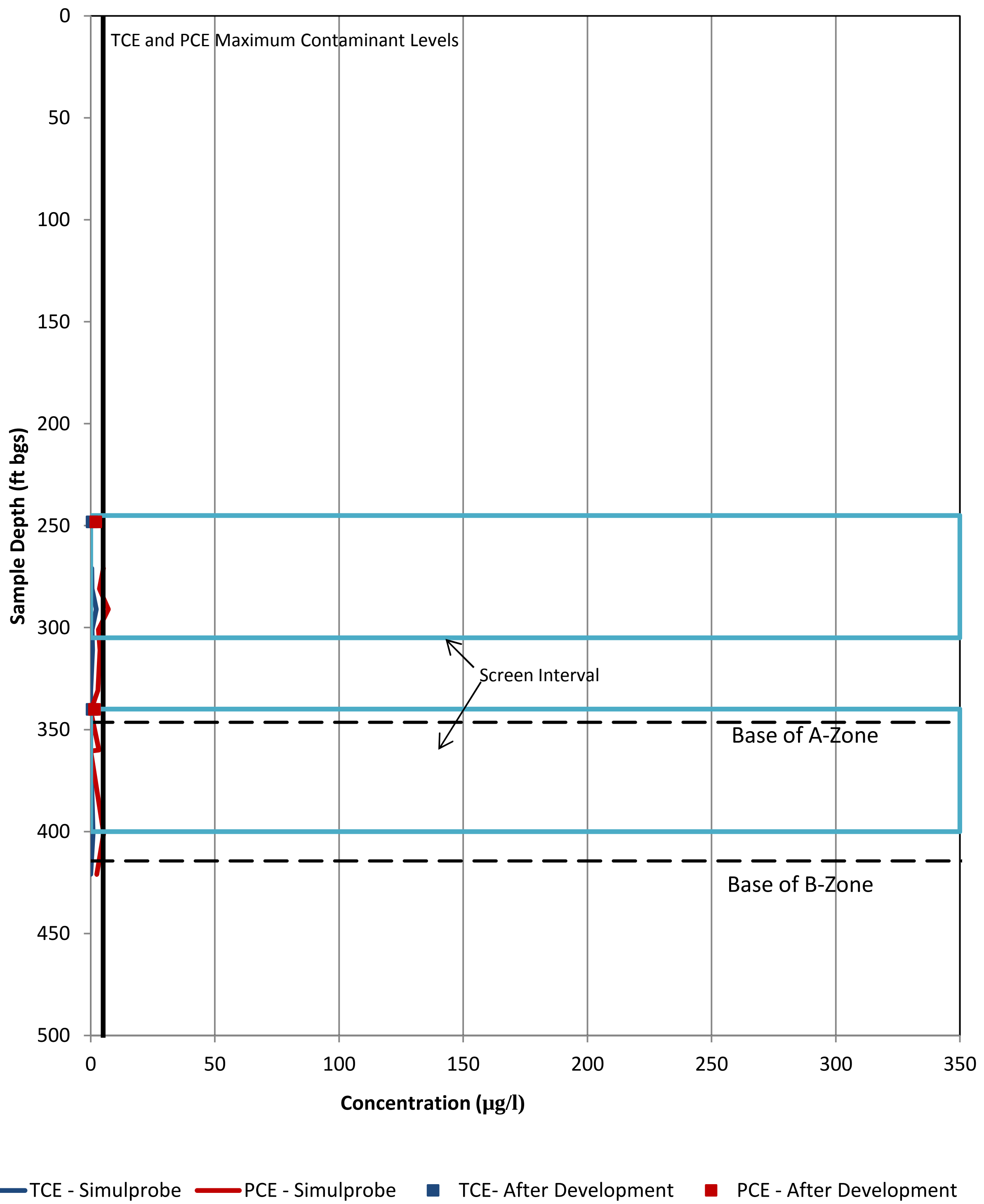


amec	Groundwater Quality Depth Profile NH-C22 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **E-11**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 10/2011

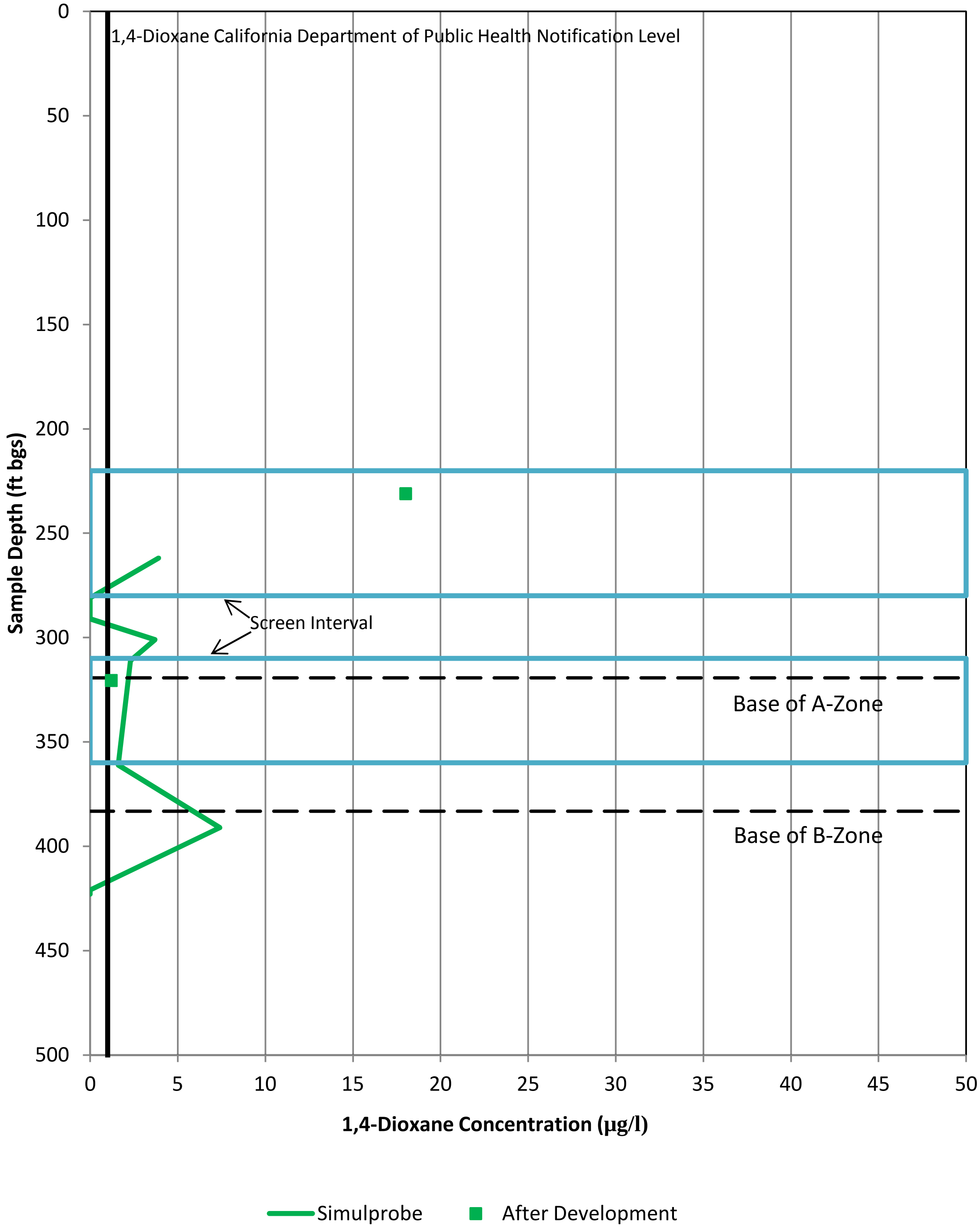


amec	Groundwater Quality Depth Profile NH-C23 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **E-12**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011



amec	Groundwater Quality Depth Profile NH-C24 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **E-13**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 10/2011

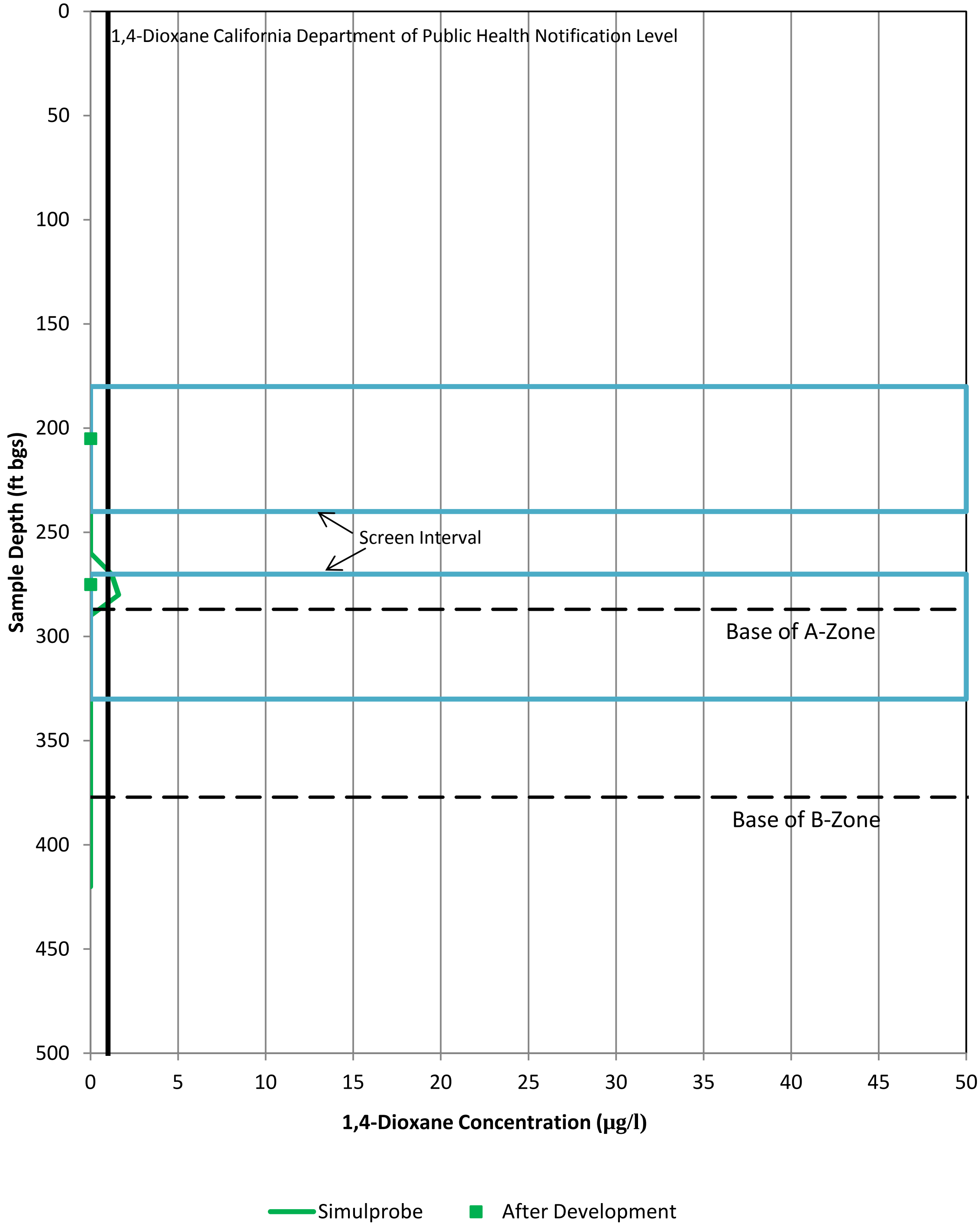


Groundwater Quality Depth Profile
NH-C10
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

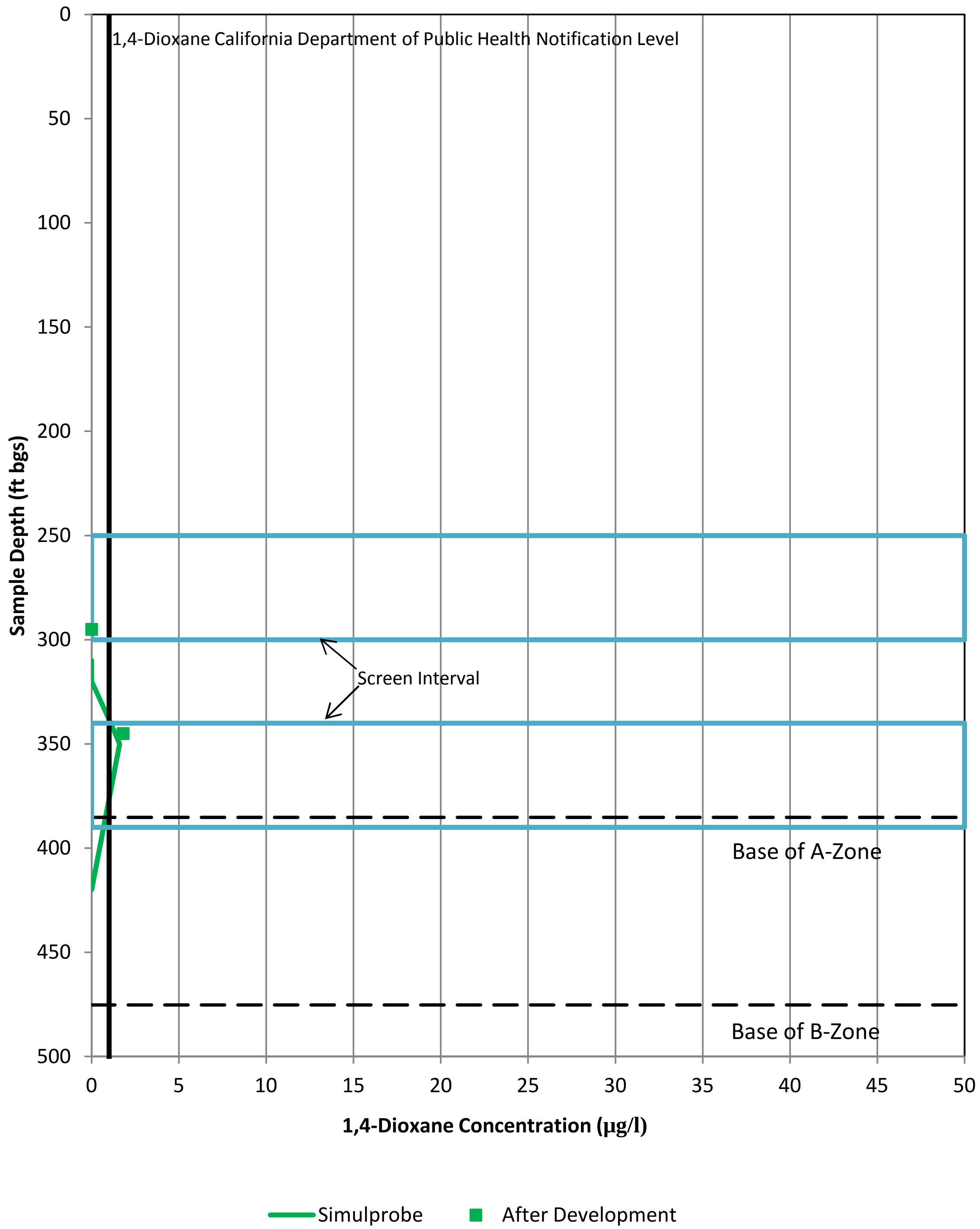
E-14

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011

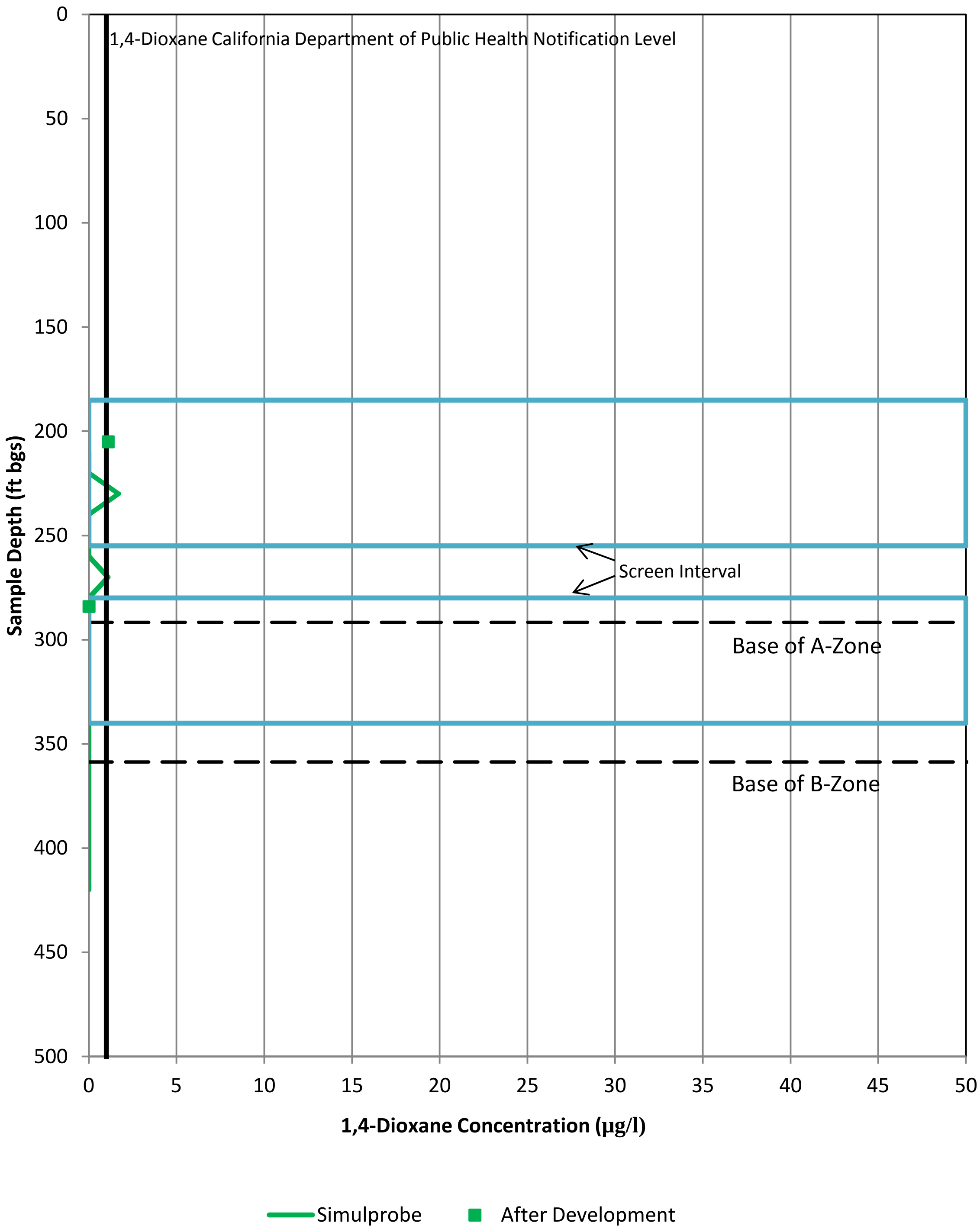


amec	Groundwater Quality Depth Profile NH-C15 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **E-15**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011



amec	Groundwater Quality Depth Profile NH-C16 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **E-16**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 10/2011



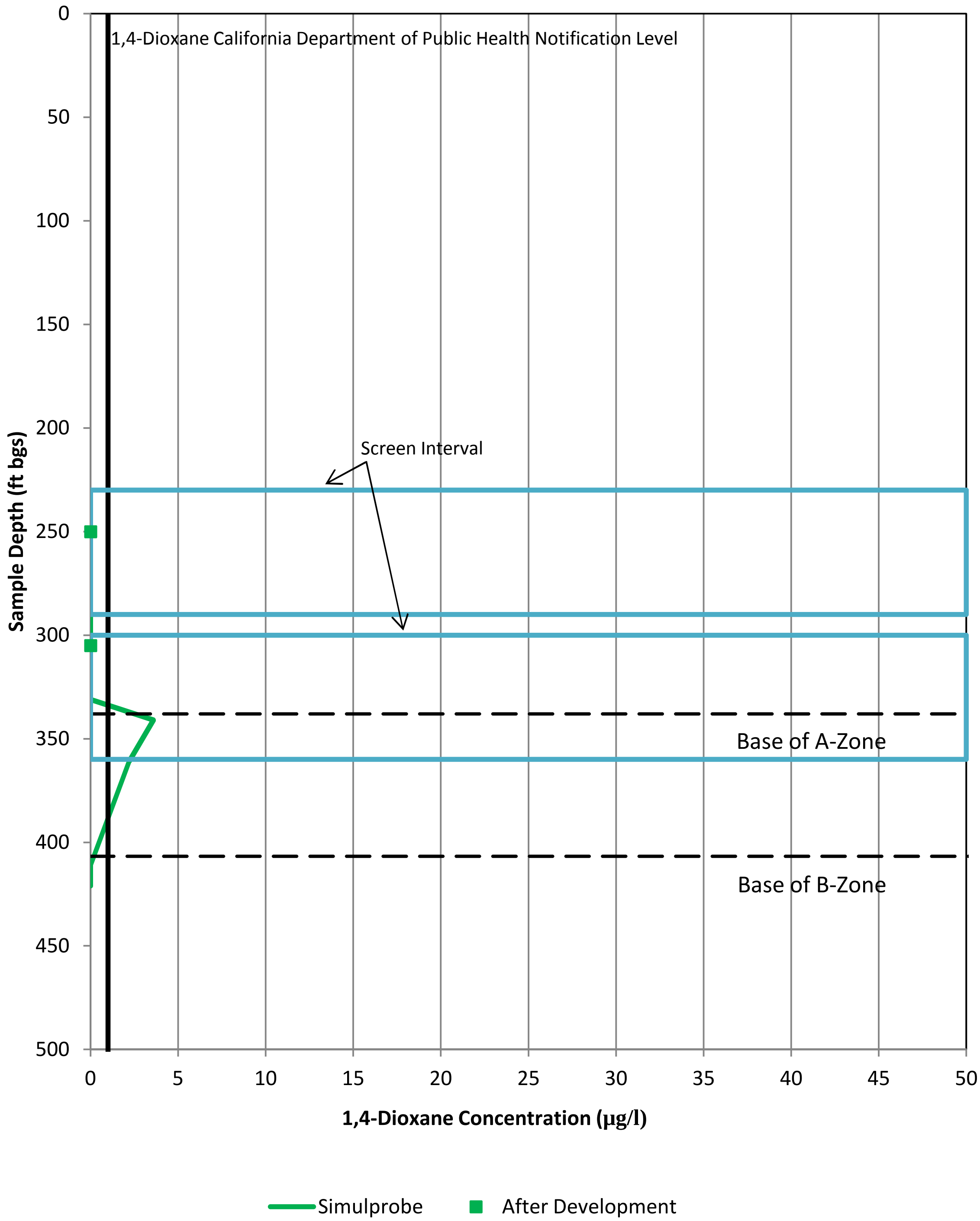
amec

Groundwater Quality Depth Profile
NH-C17
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

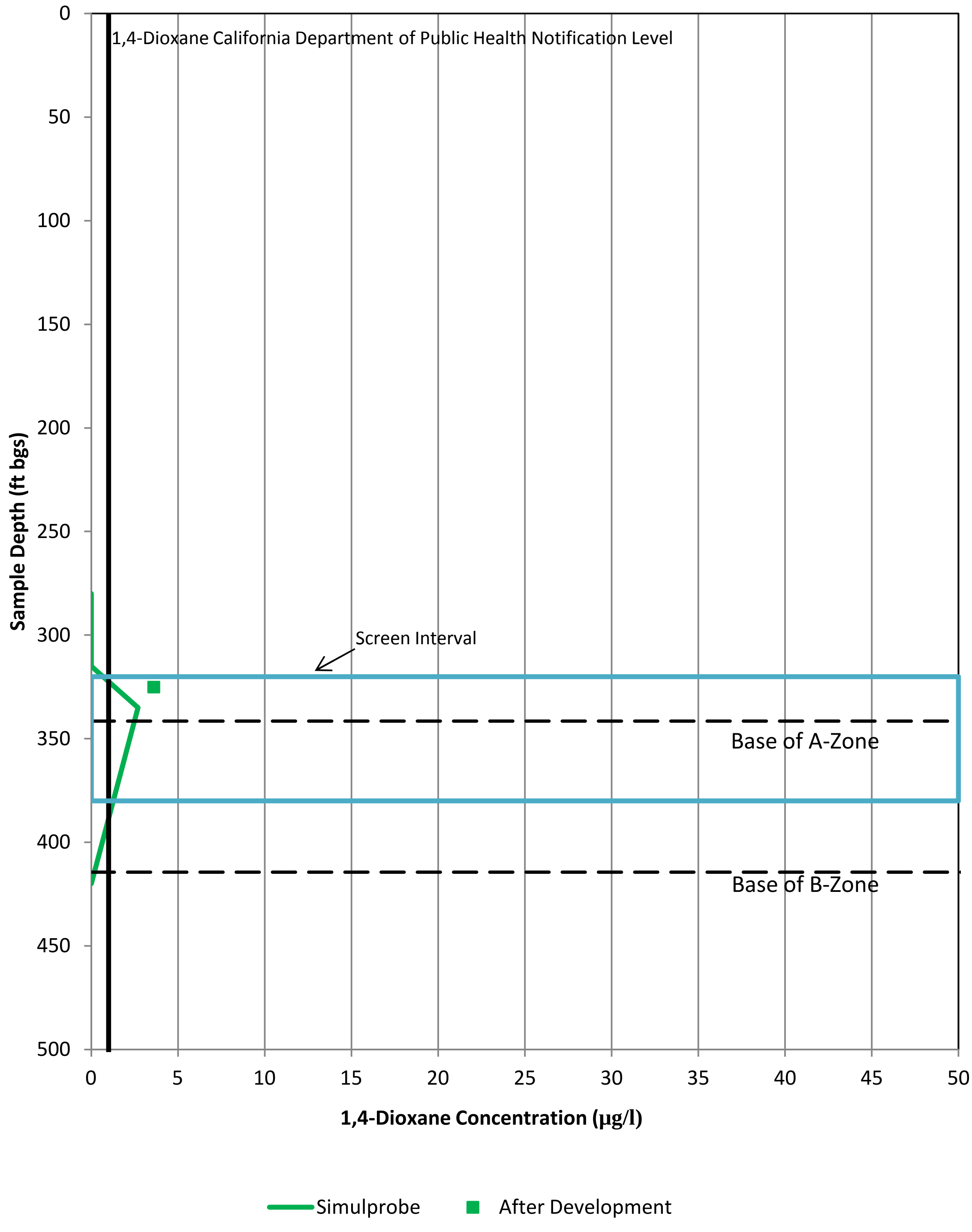
Figure:

E-17

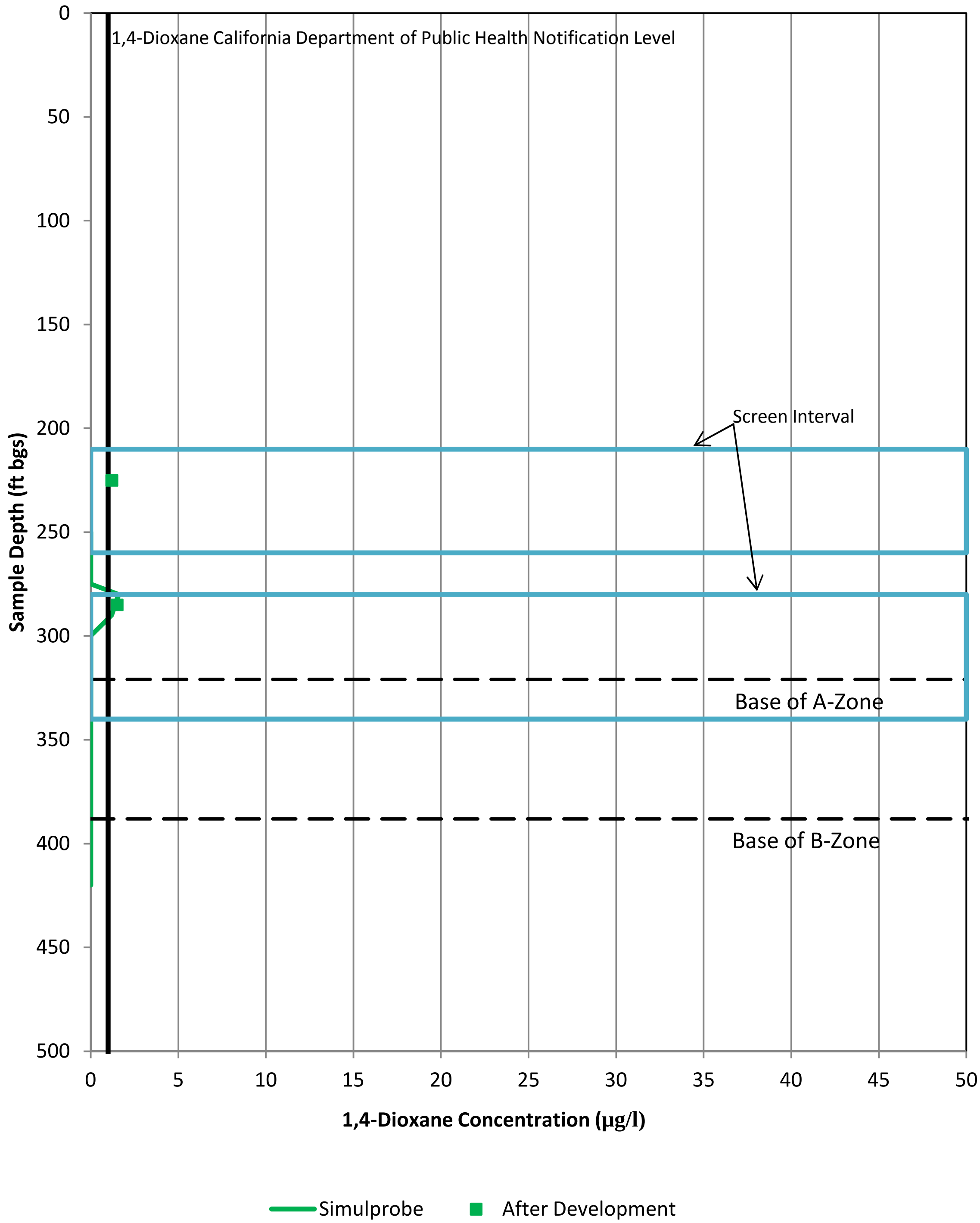
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011



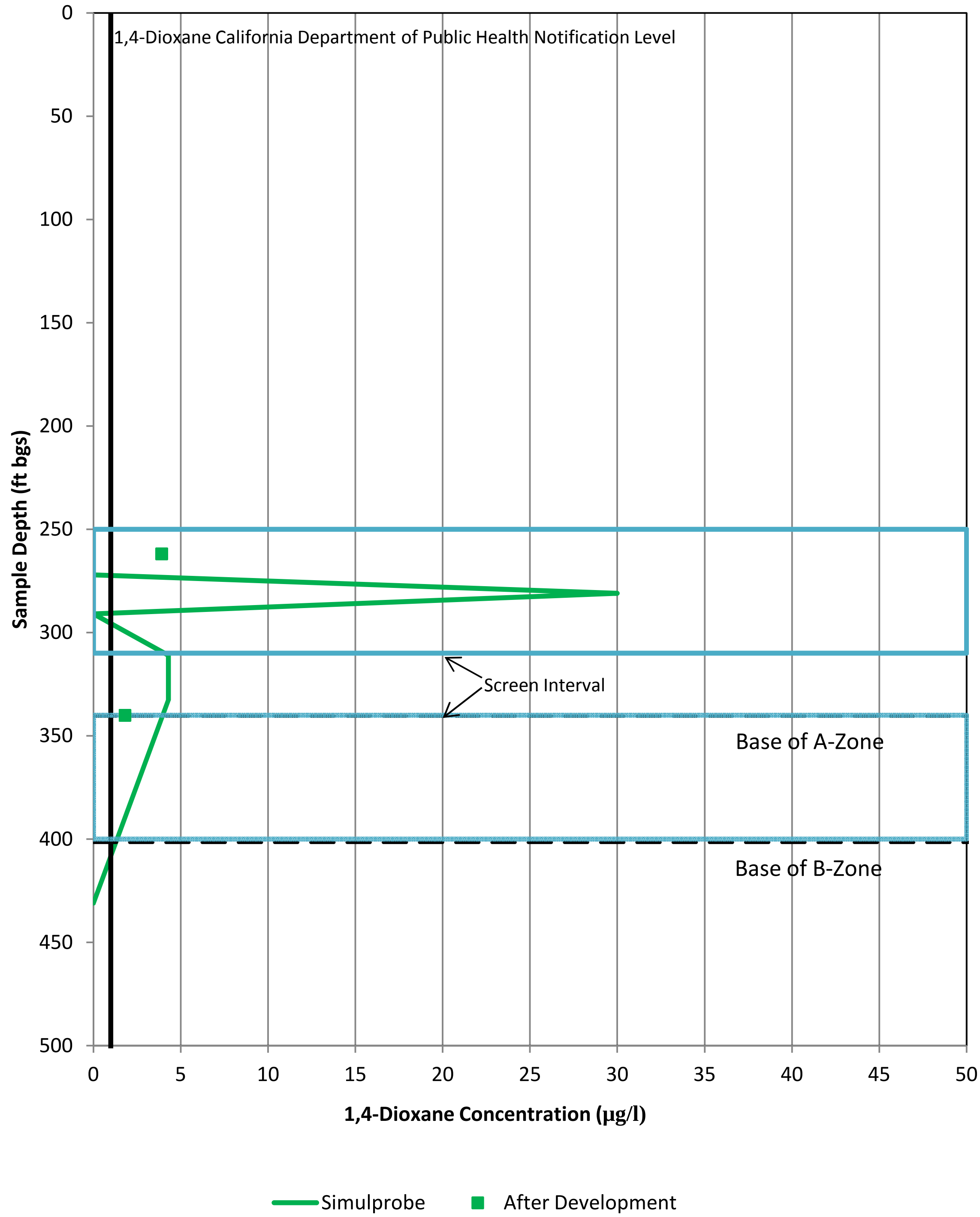
amec	Groundwater Quality Depth Profile NH-C19 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **E-18**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 10/2011



amec	Groundwater Quality Depth Profile NH-C20 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **E-19**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 10/2011

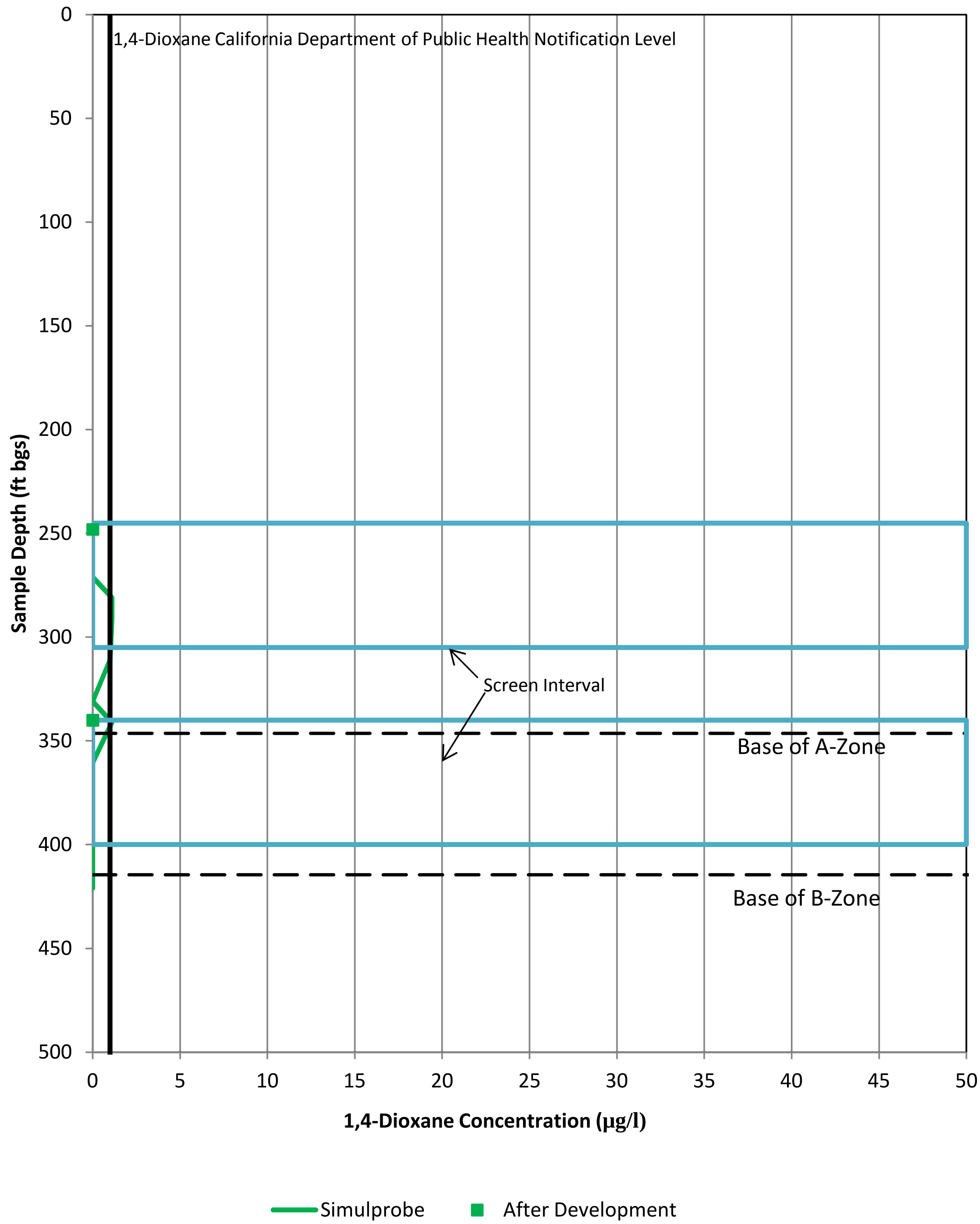


amec	Groundwater Quality Depth Profile NH-C21 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **E-20**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 10/2011



amec	Groundwater Quality Depth Profile NH-C23 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **E-21**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011



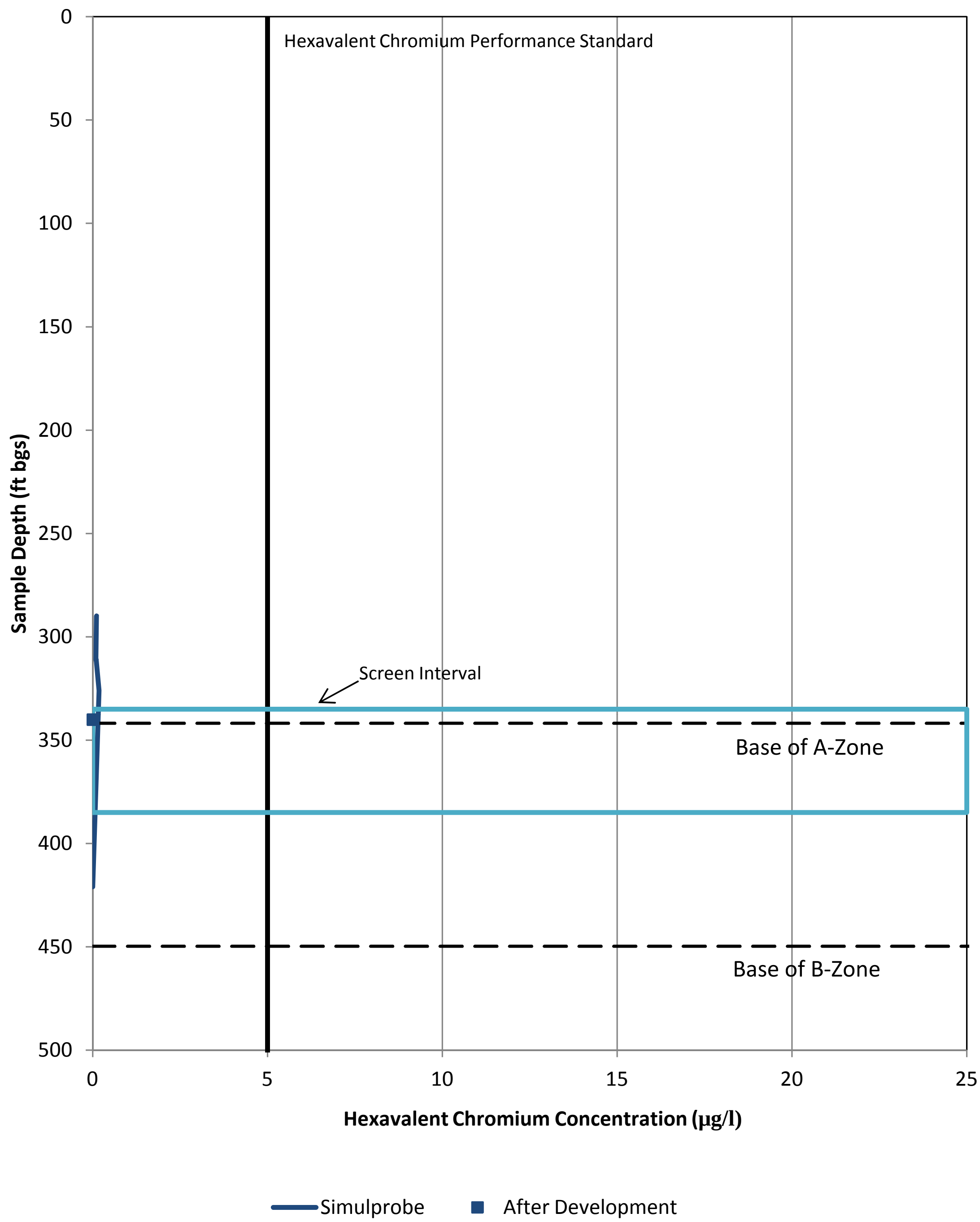
amec

Groundwater Quality Depth Profile
NH-C24
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

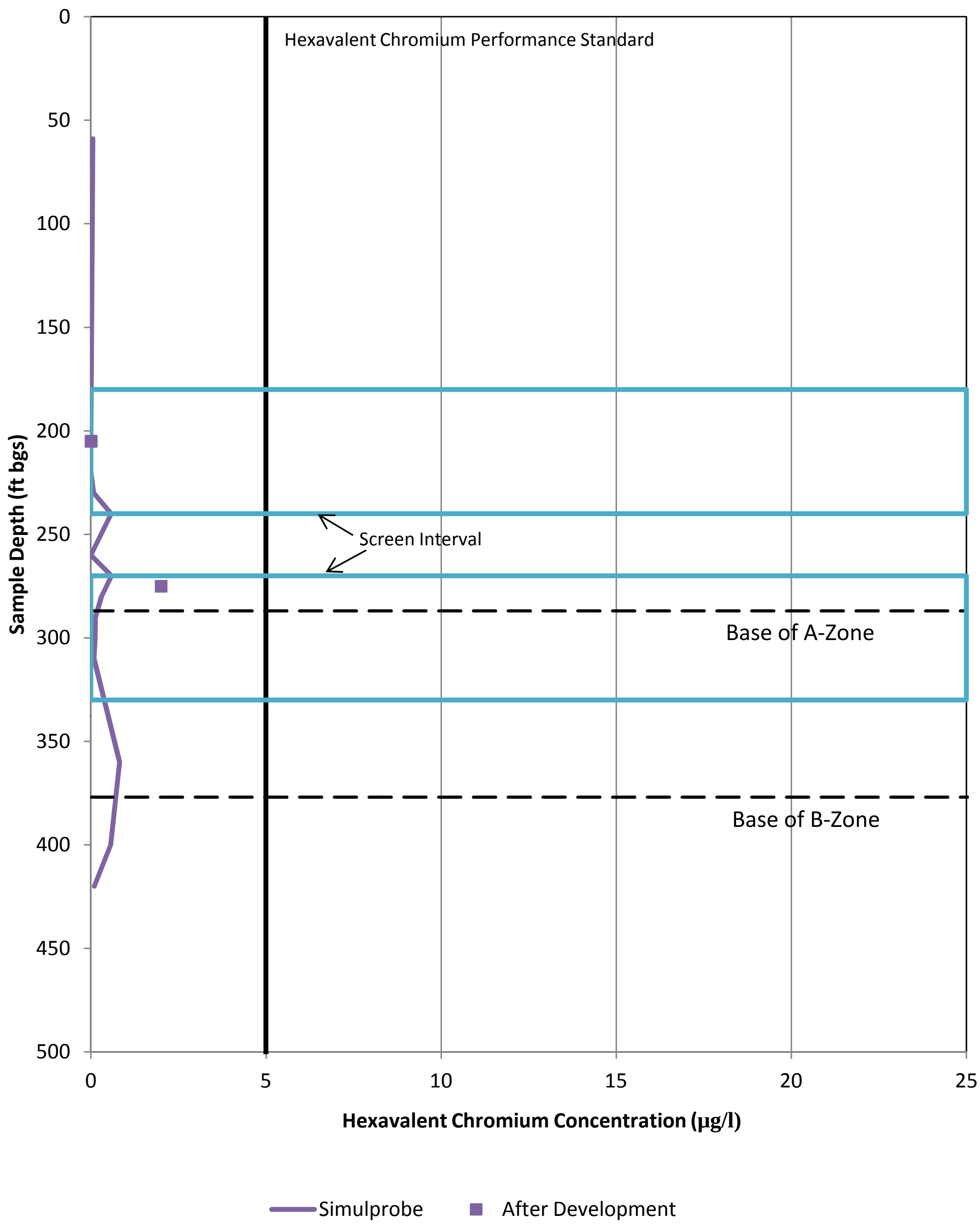
E-22

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011



amec	Groundwater Quality Depth Profile NH-C13 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **E-23**

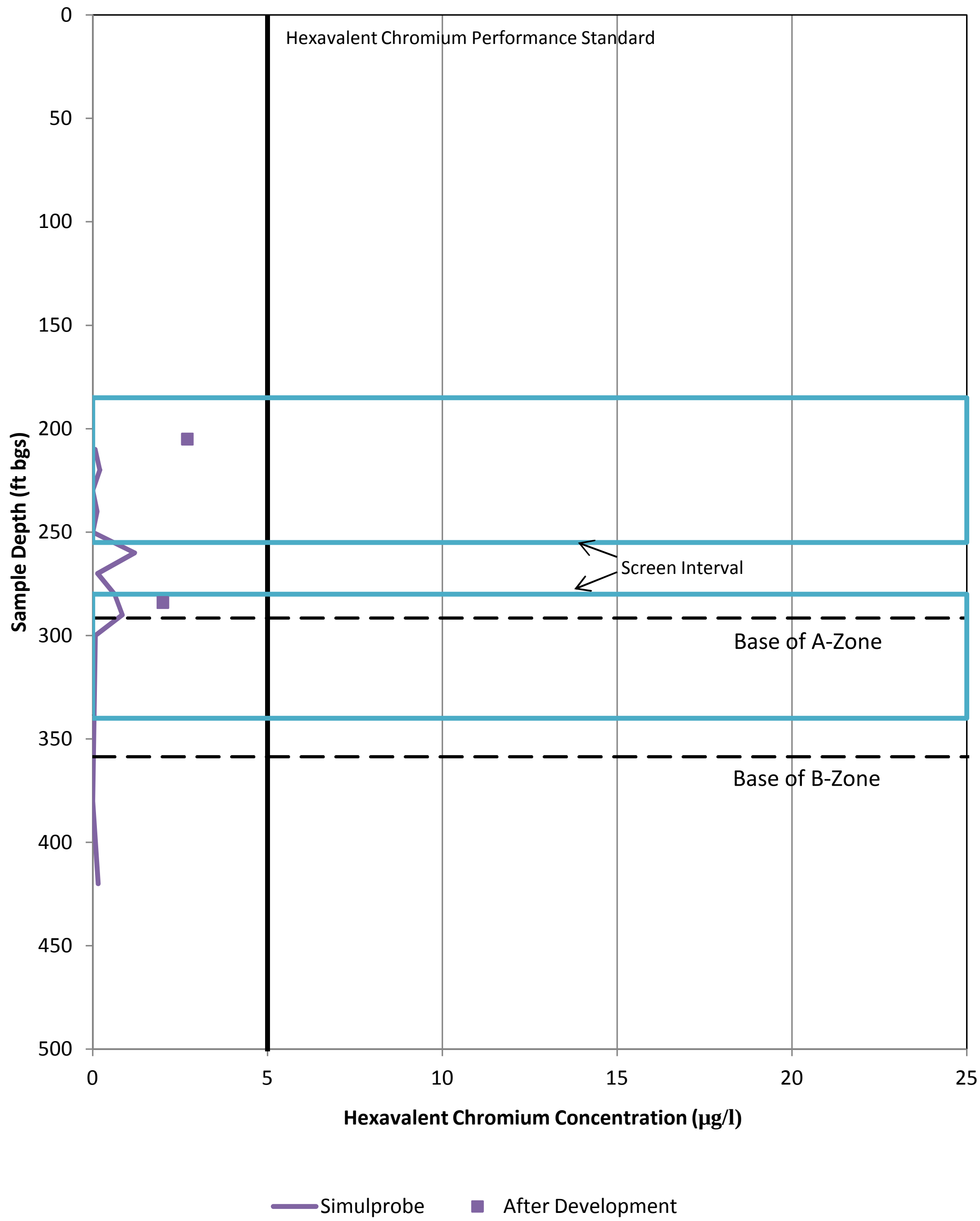
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011



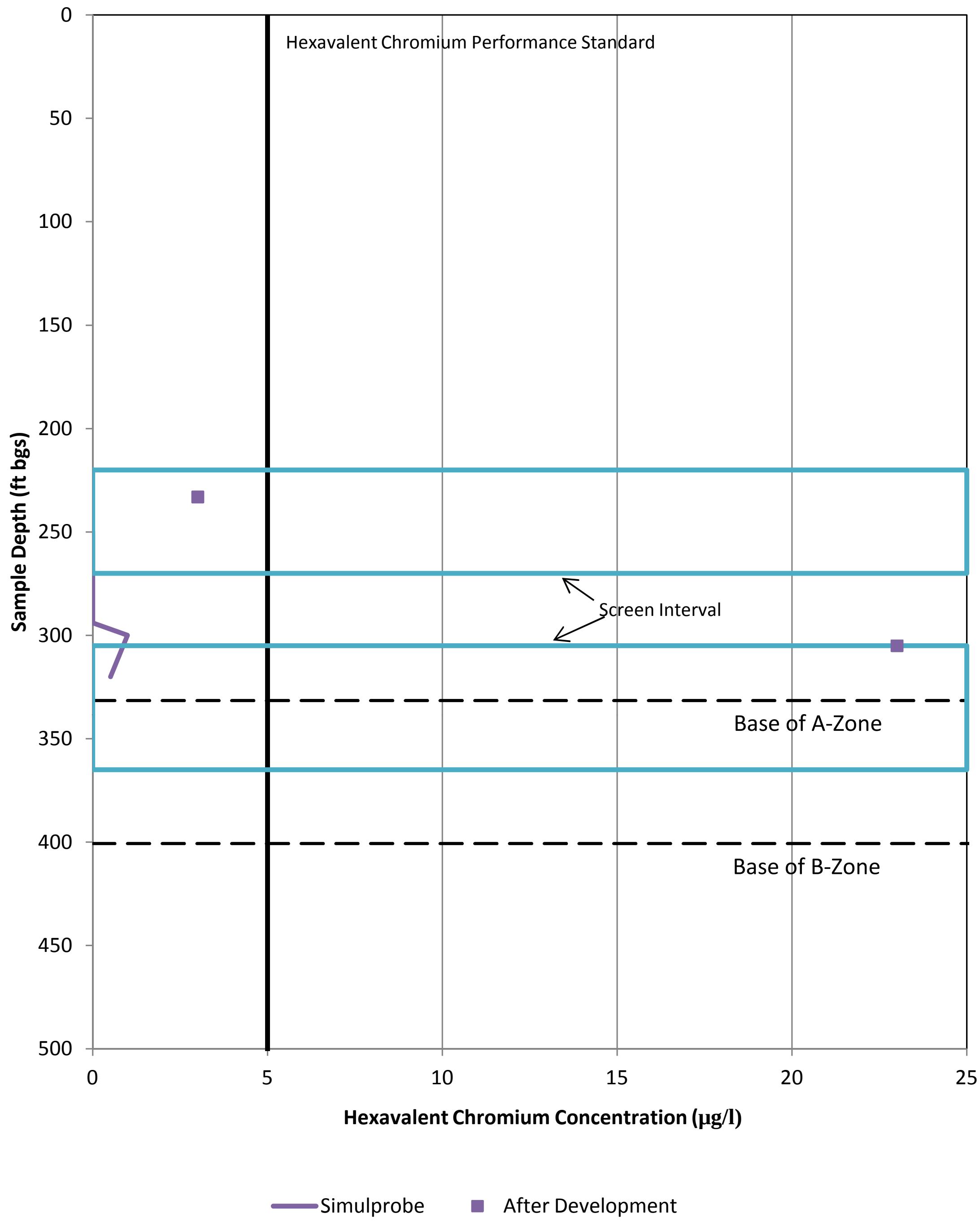
Groundwater Quality Depth Profile
NH-C15
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **E-24**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011



amec		Groundwater Quality Depth Profile NH-C17 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **E-25**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 10/2011



amec	Groundwater Quality Depth Profile NH-C18 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **E-26**

DRAWN	JOB NUMBER	CHECKED	DATE
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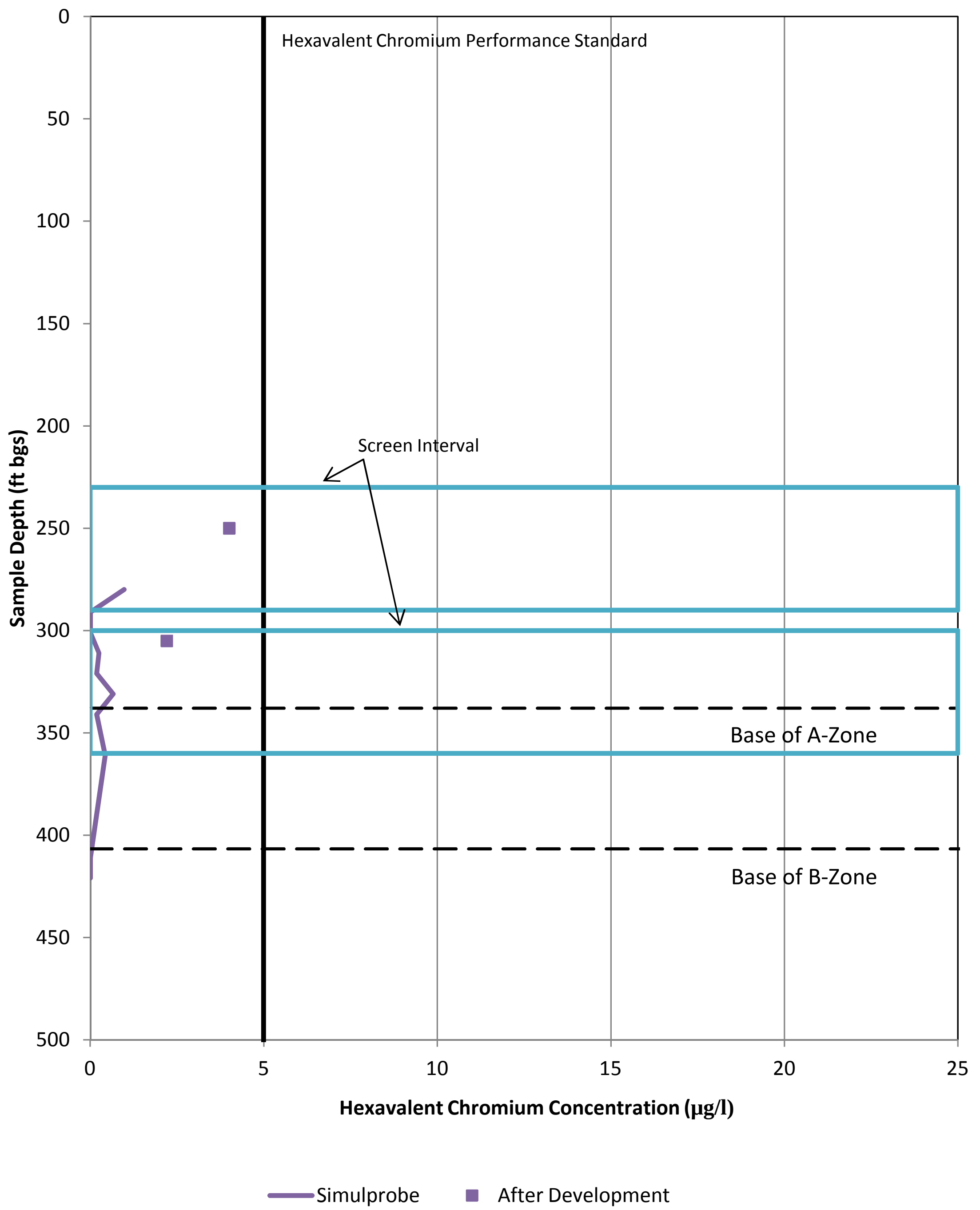
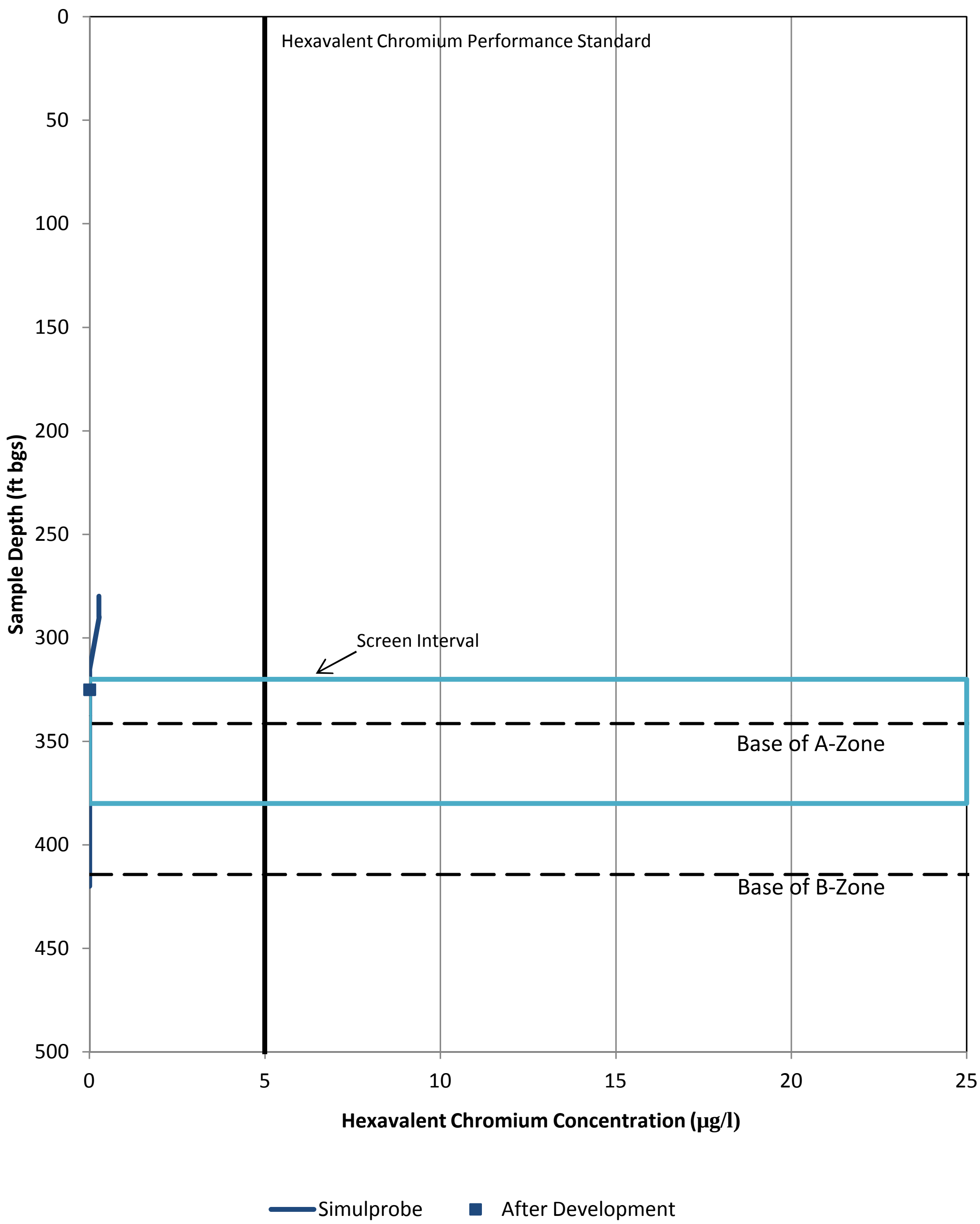


amec	Groundwater Quality Depth Profile NH-C19 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **E-27**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011

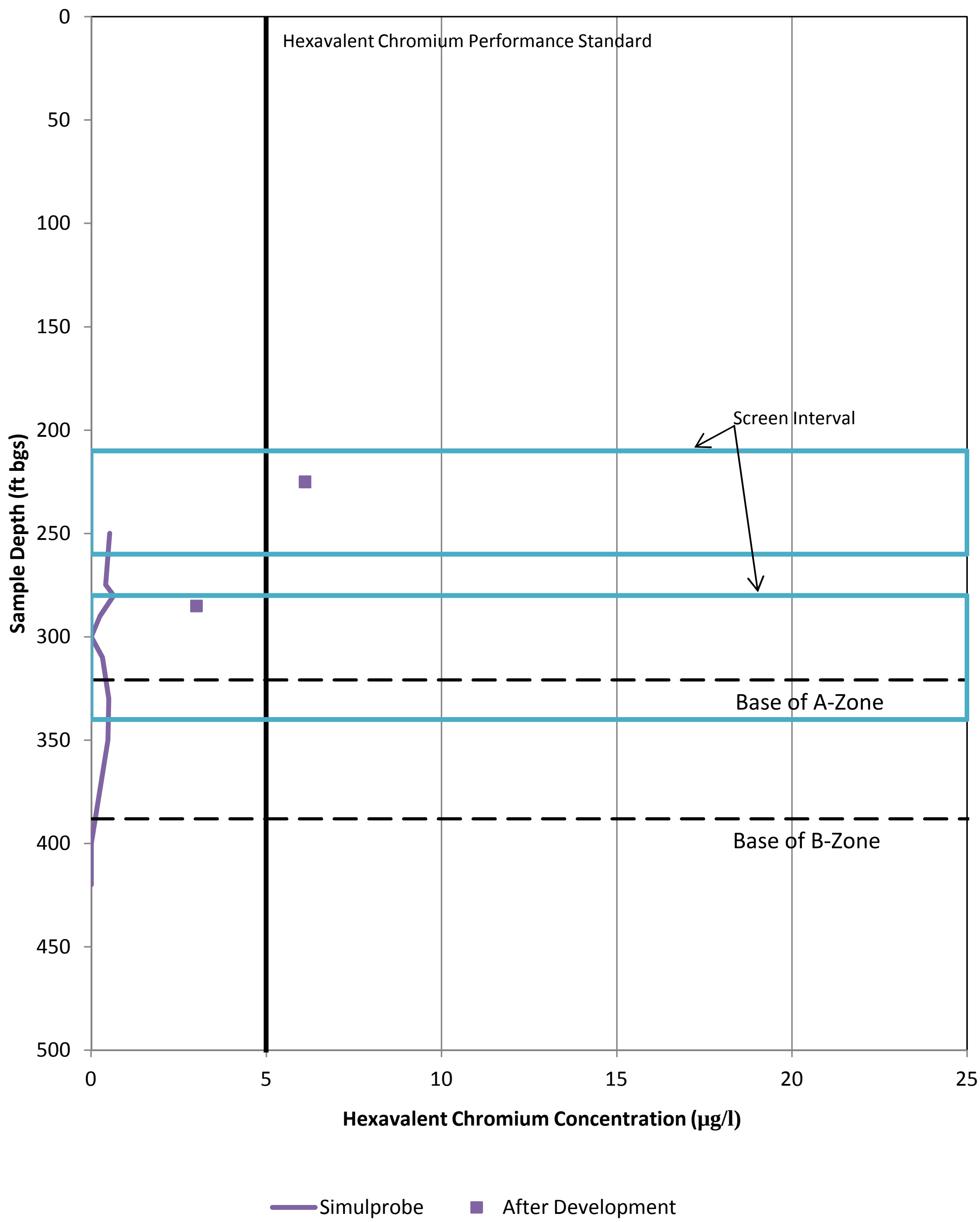


amec

Groundwater Quality Depth Profile
NH-C20
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **E-28**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011

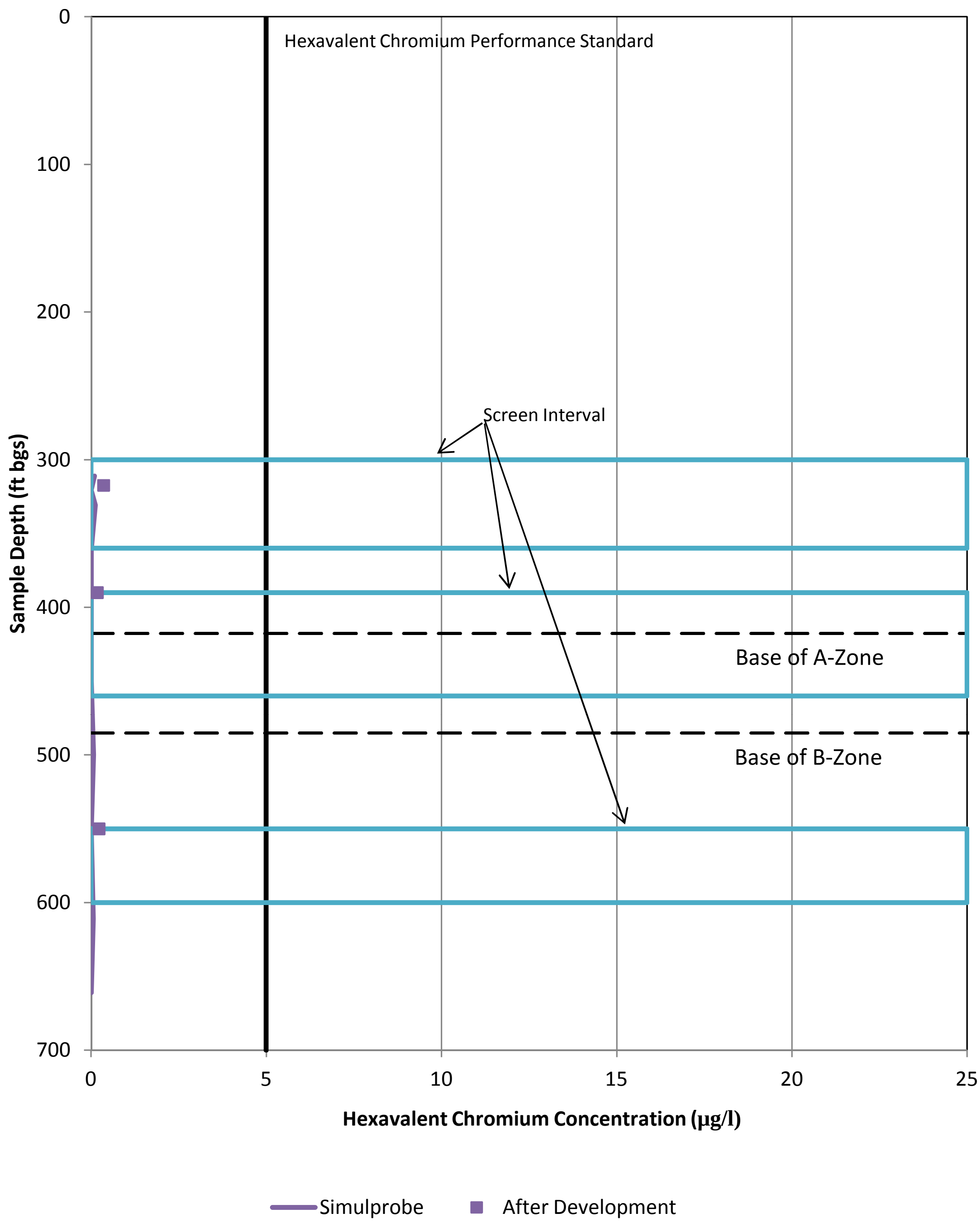


Groundwater Quality Depth Profile
NH-C21
Data Gap Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

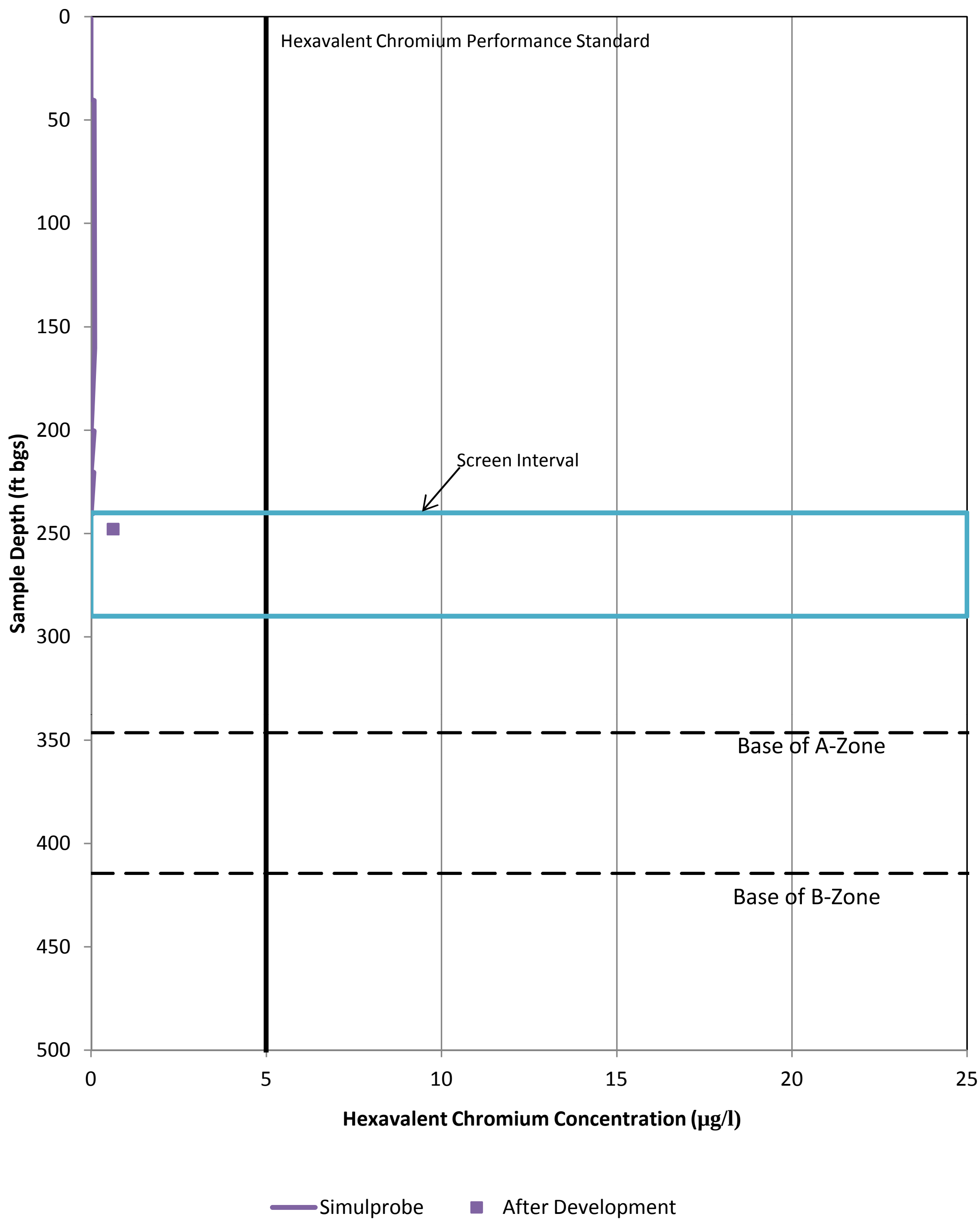
E-29

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011



amec	Groundwater Quality Depth Profile NH-C22 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **E-30**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011



amec	Groundwater Quality Depth Profile NH-C25 Data Gap Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **E-31**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	10/2011

APPENDIX F

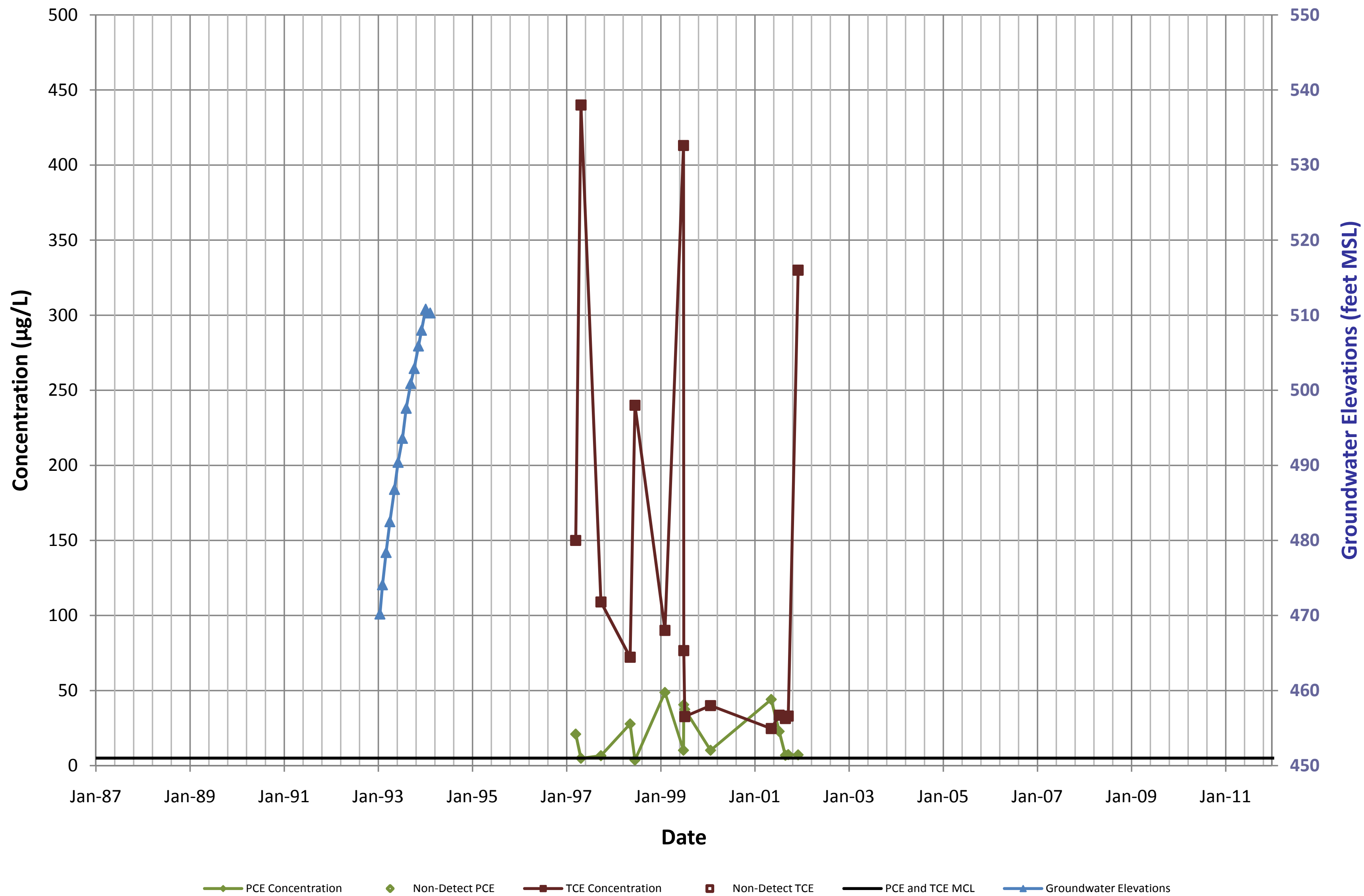
TIME CONCENTRATION PLOTS

Appendix F. Time Concentration Plot Index

Station Name	Time Concentration Plot Number		
	PCE and TCE	1,4-Dioxane	Chromium (VI)
Extraction Wells			
NHE-1	F-E-1		
NHE-2	F-E-2	F-E-9	F-E-16
NHE-3	F-E-3	F-E-10	F-E-17
NHE-4	F-E-4	F-E-11	F-E-18
NHE-5	F-E-5	F-E-12	F-E-19
NHE-6	F-E-6	F-E-13	F-E-20
NHE-7	F-E-7	F-E-14	F-E-21
NHE-8	F-E-8	F-E-15	F-E-22
Production Wells			
NH-2	F-P-1		
NH-4	F-P-2		F-P-38
NH-7	F-P-3		F-P-39
NH-10	F-P-4		
NH-11	F-P-5		F-P-40
NH-13	F-P-6		
NH-14	F-P-7		
NH-14A	F-P-8		
NH-15	F-P-9		
NH-16	F-P-10		F-P-41
NH-17	F-P-11		
NH-18	F-P-12		F-P-42
NH-19	F-P-13		
NH-20	F-P-14		
NH-21	F-P-15		F-P-43
NH-22	F-P-16		F-P-44
NH-23	F-P-17		F-P-45
NH-24	F-P-18		F-P-46
NH-25	F-P-19		F-P-47
NH-26	F-P-20		F-P-48
NH-27	F-P-21		F-P-49
NH-28	F-P-22		F-P-50
NH-29	F-P-23		
NH-30	F-P-24		F-P-51
NH-32	F-P-25		F-P-52
NH-33	F-P-26		F-P-53
NH-34	F-P-27		F-P-54
NH-35	F-P-28		F-P-55
NH-36	F-P-29		F-P-56
NH-37	F-P-30		F-P-57
NH-38	F-P-31		
NH-39	F-P-32		
NH-40	F-P-33		F-P-58
NH-41	F-P-34		F-P-59
NH-43A	F-P-35		F-P-60
NH-44	F-P-36		F-P-61
NH-45	F-P-37		F-P-62

Appendix F. Time Concentration Plot Index

Station Name	Time Concentration Plot Number		
	PCE and TCE	**1,4-Dioxane**	**Chromium (VI)**
Monitoring Wells			
NH-C02-220	F-M-1	F-M-11	F-M-19
NH-C02-325	F-M-2	F-M-12	F-M-20
NH-C02-520	F-M-3		F-M-21
NH-C02-681	F-M-4	F-M-13	F-M-22
NH-C03-380	F-M-5	F-M-14	F-M-23
NH-C03-580	F-M-6	F-M-15	F-M-24
NH-C03-680	F-M-7	F-M-16	F-M-25
NH-C03-800	F-M-8	F-M-17	F-M-26
NH-C05-320	F-M-9		F-M-27
NH-C05-460	F-M-10	F-M-18	F-M-28
Vertical Profile Wells			
NH-VPB-02	F-V-1	F-V-7	F-V-12
NH-VPB-03	F-V-2		F-V-13
NH-VPB-05	F-V-3	F-V-8	F-V-14
NH-VPB-06	F-V-4	F-V-9	F-V-15
NH-VPB-07	F-V-5	F-V-10	F-V-16
NH-VPB-08	F-V-6	F-V-11	F-V-17

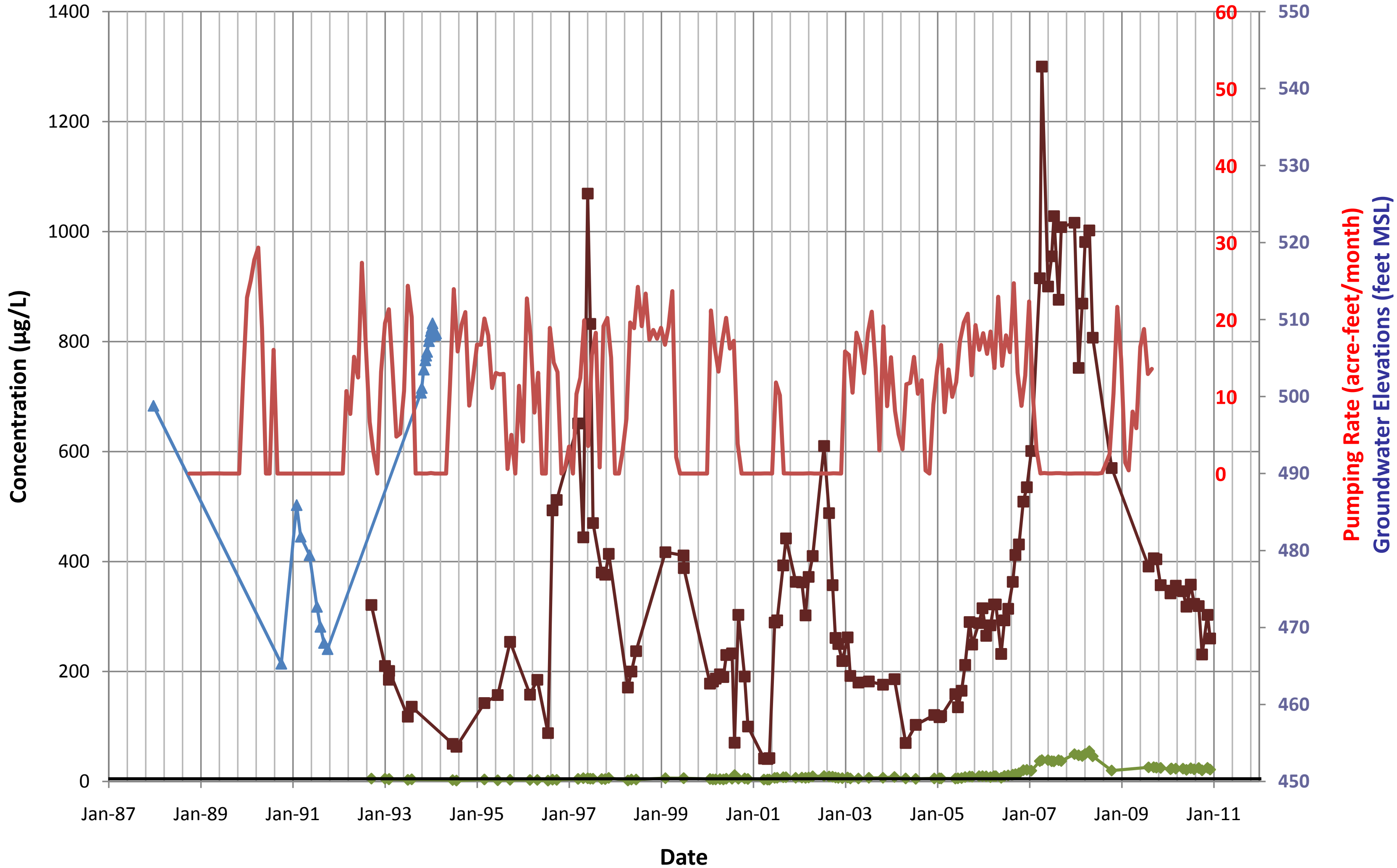


amec

PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Operable Unit (NHOU) Extraction Well NHE-1
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:
F-E-1

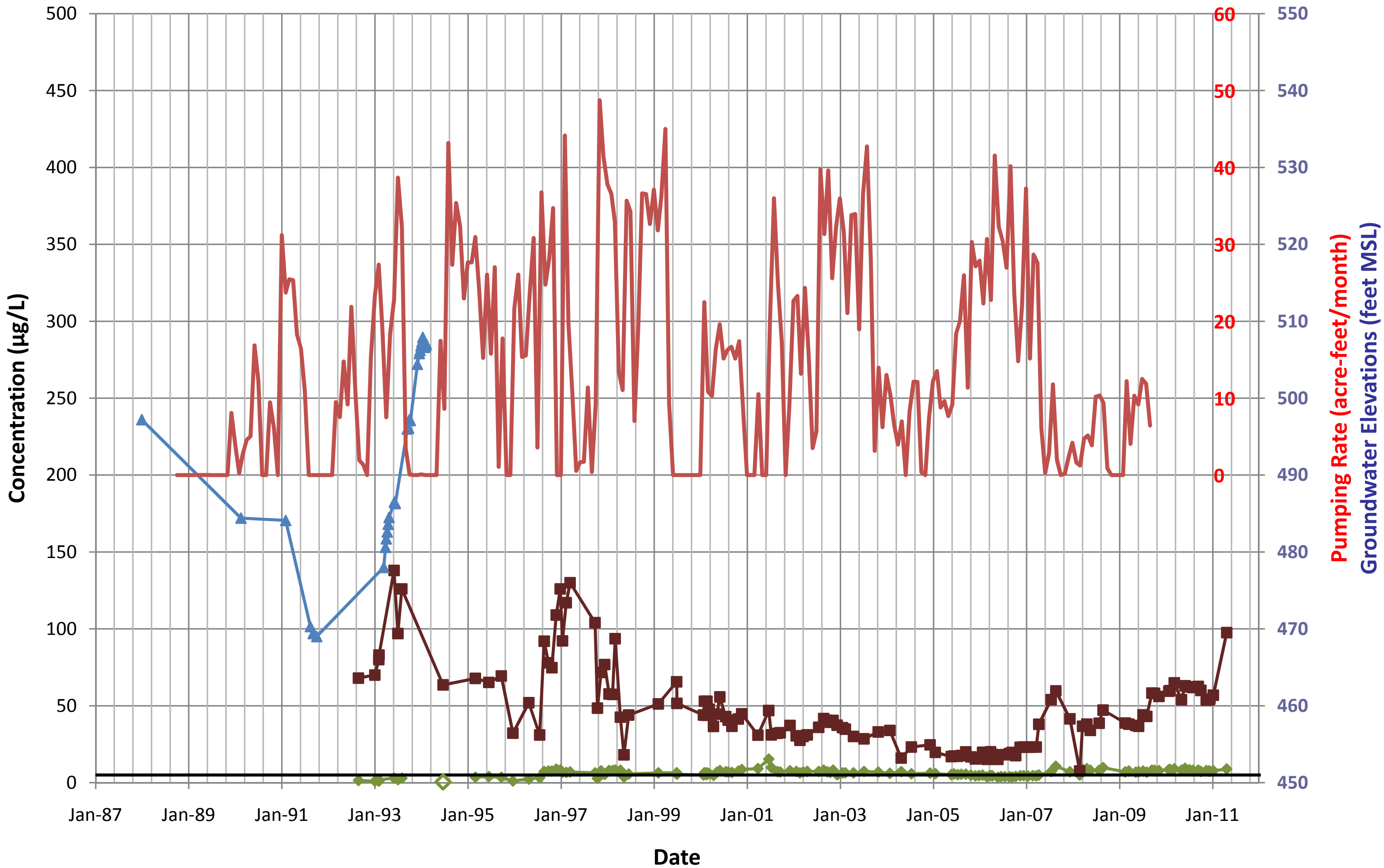
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



Note: 10 acre feet per month is approximately equal to 75 gallons per minute.

amec	PCE and TCE Concentrations and Groundwater Elevations North Hollywood Operable Unit (NHOU) Extraction Well NHE-2 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-E-2**

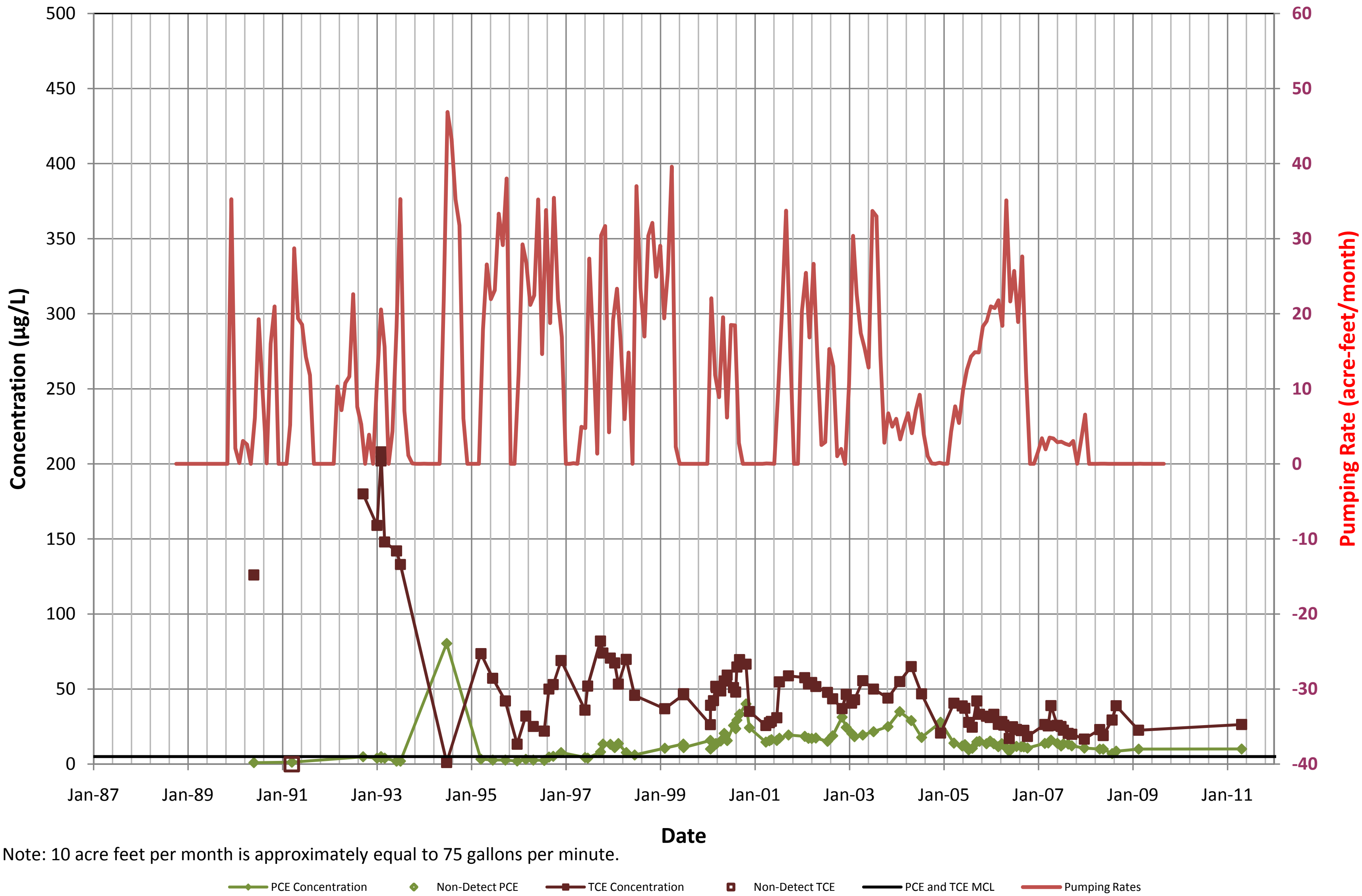
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



Note: 10 acre feet per month is approximately equal to 75 gallons per minute.

amec	PCE and TCE Concentrations and Groundwater Elevations North Hollywood Operable Unit (NHOU) Extraction Well NHE-3 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-E-3**

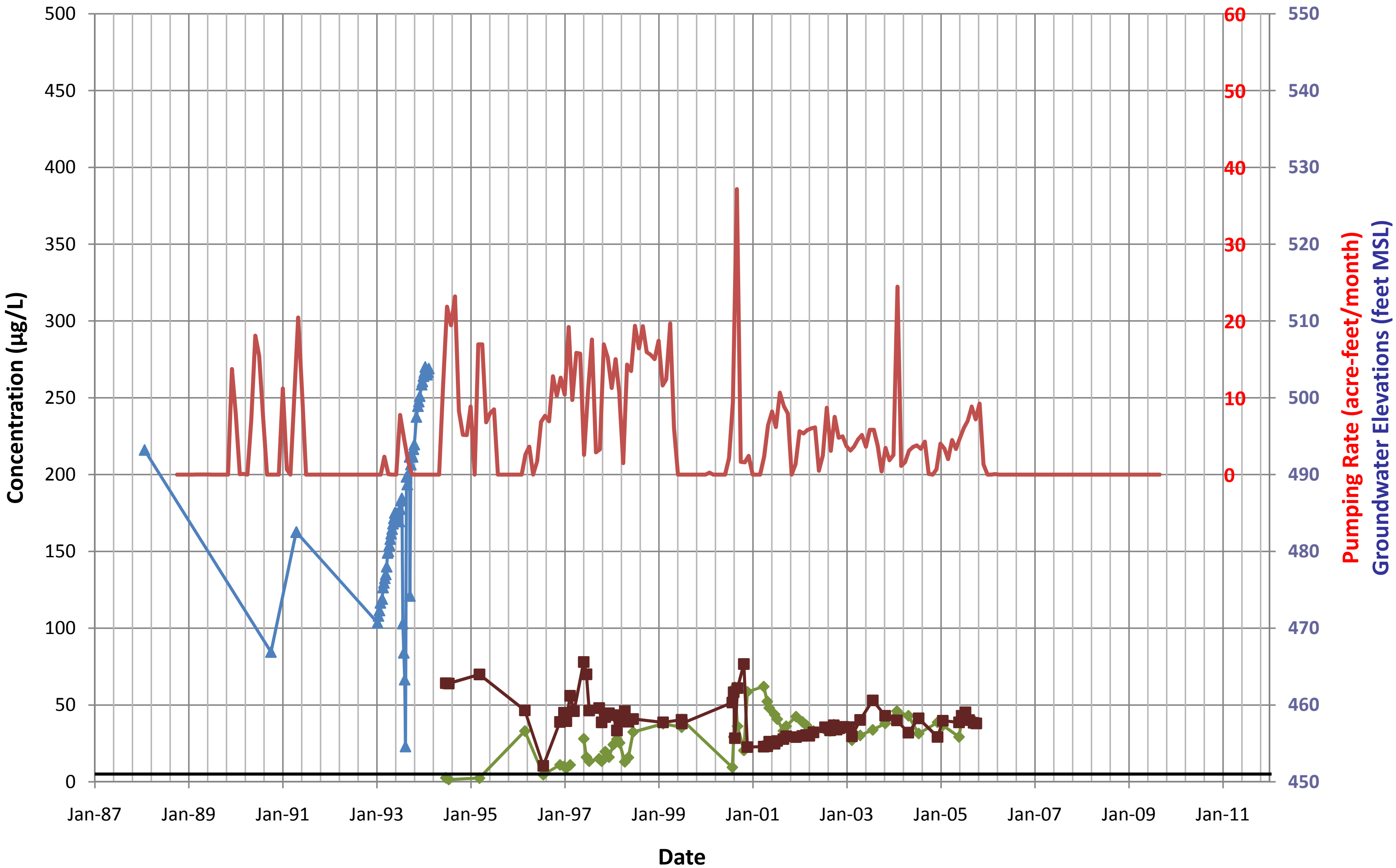
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



Note: 10 acre feet per month is approximately equal to 75 gallons per minute.

amec	PCE and TCE Concentrations North Hollywood Operable Unit (NHOU) Extraction Well NHE-4 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-E-4**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



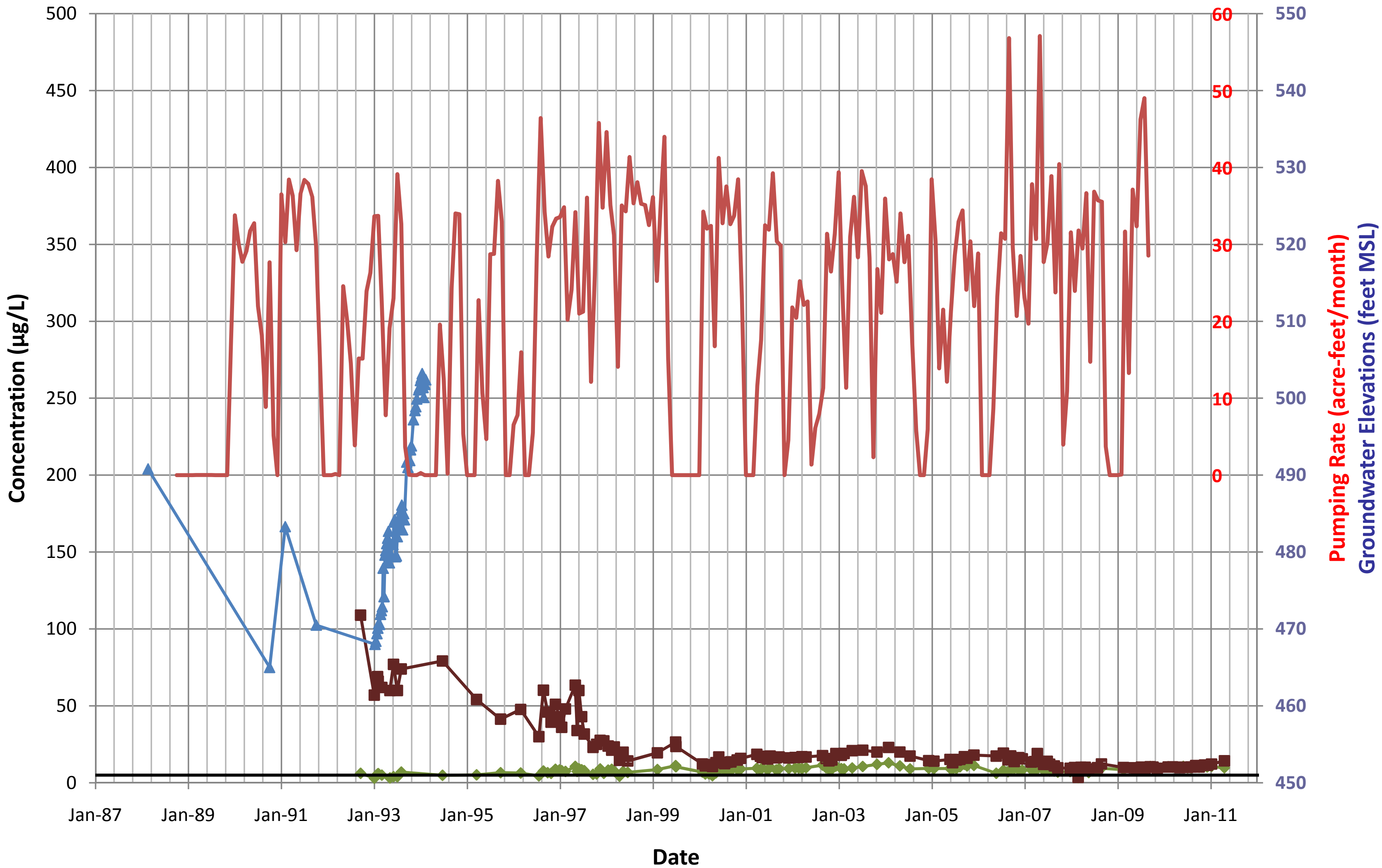
Note: 10 acre feet per month is approximately equal to 75 gallons per minute.

PCE Concentration | Non-Detect PCE | TCE Concentration | Non-Detect TCE | PCE and TCE MCL | Groundwater Elevations | Pumping Rate

PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Operable Unit (NHOU) Extraction Well NHE-5
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-E-5**

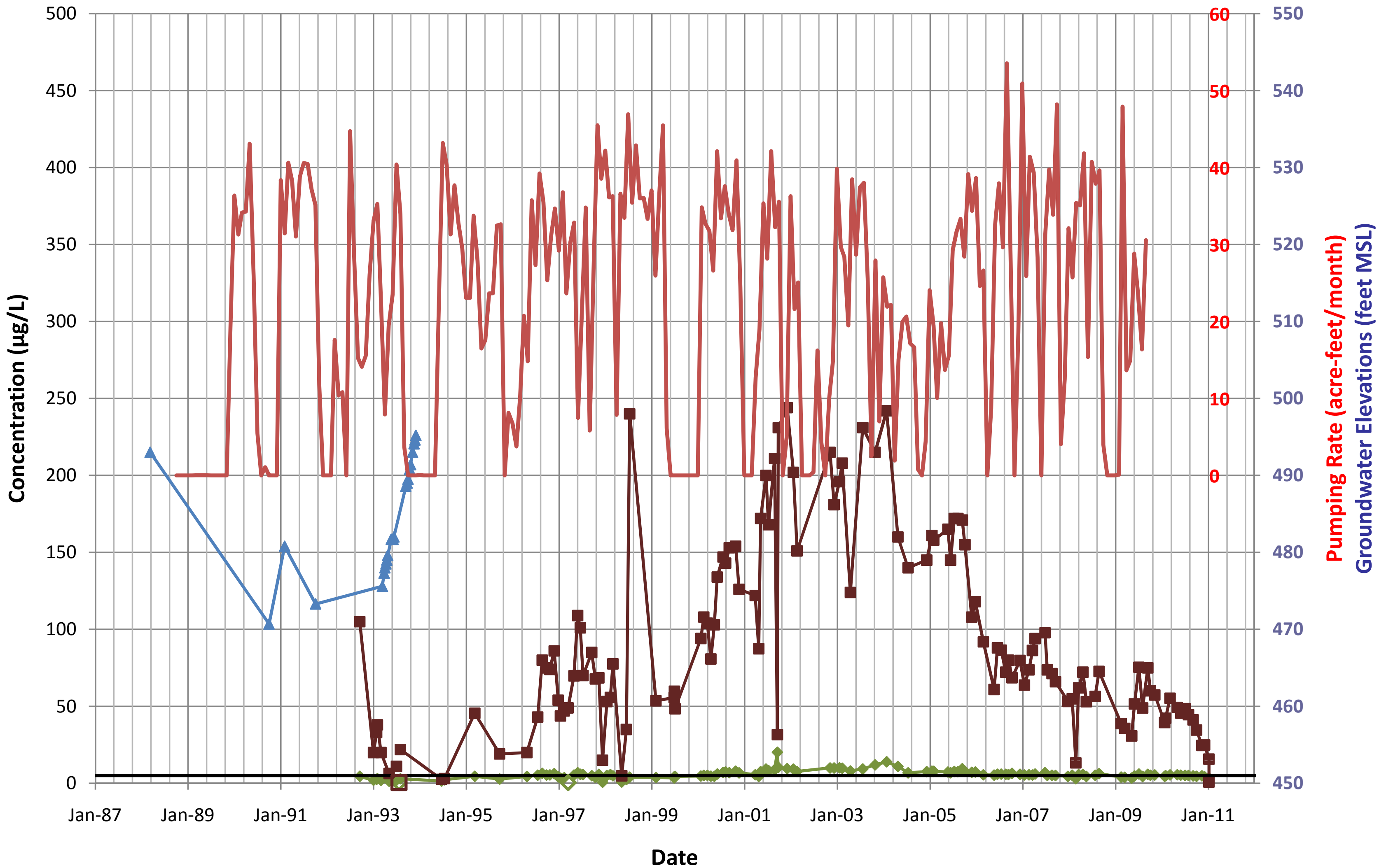
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



Note: 10 acre feet per month is approximately equal to 75 gallons per minute.

amec	PCE and TCE Concentrations and Groundwater Elevations North Hollywood Operable Unit (NHOU) Extraction Well NHE-6 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-E-6**

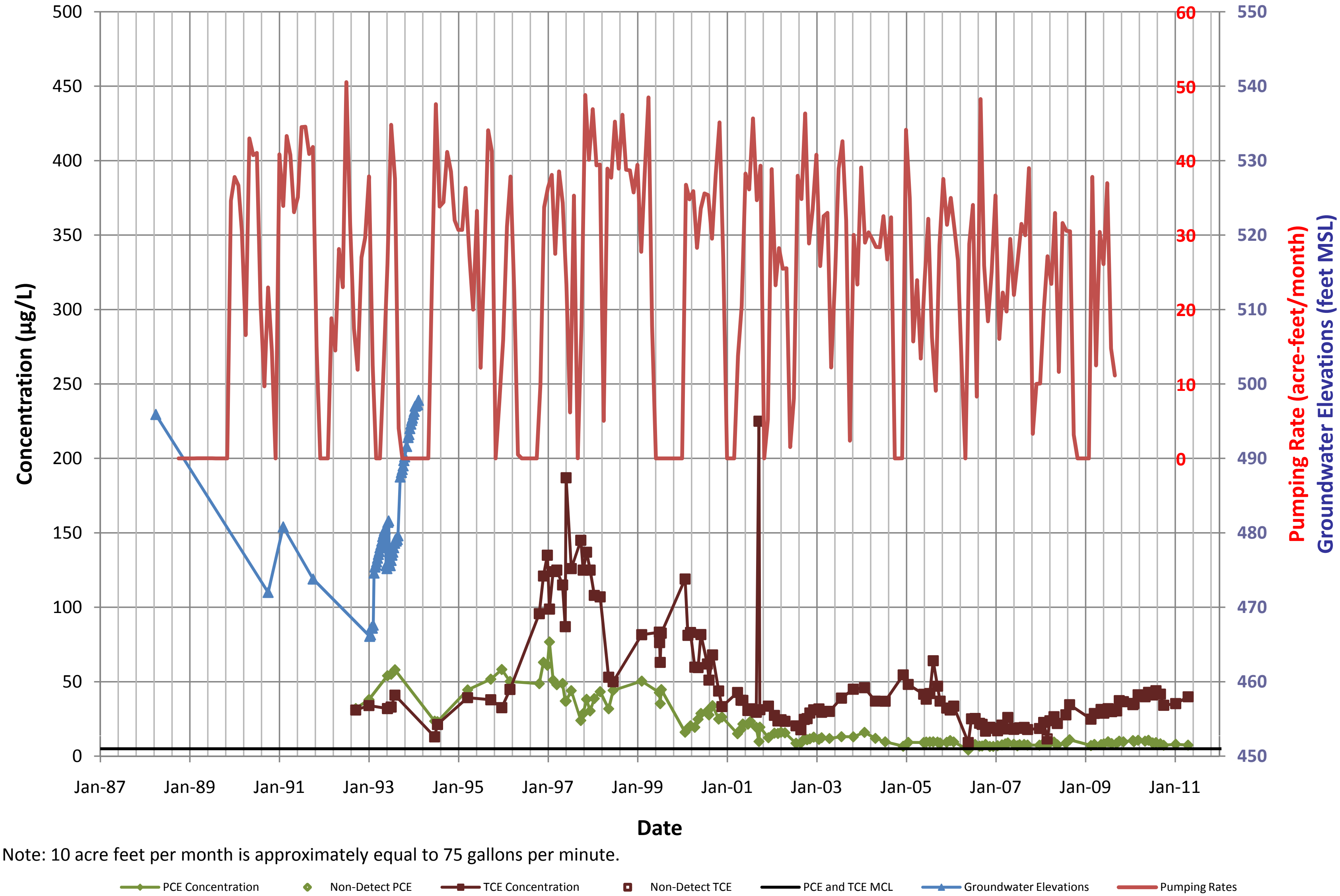
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



Note: 10 acre feet per month is approximately equal to 75 gallons per minute.

amec	PCE and TCE Concentrations and Groundwater Elevations North Hollywood Operable Unit (NHOU) Extraction Well NHE-7 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-E-7**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



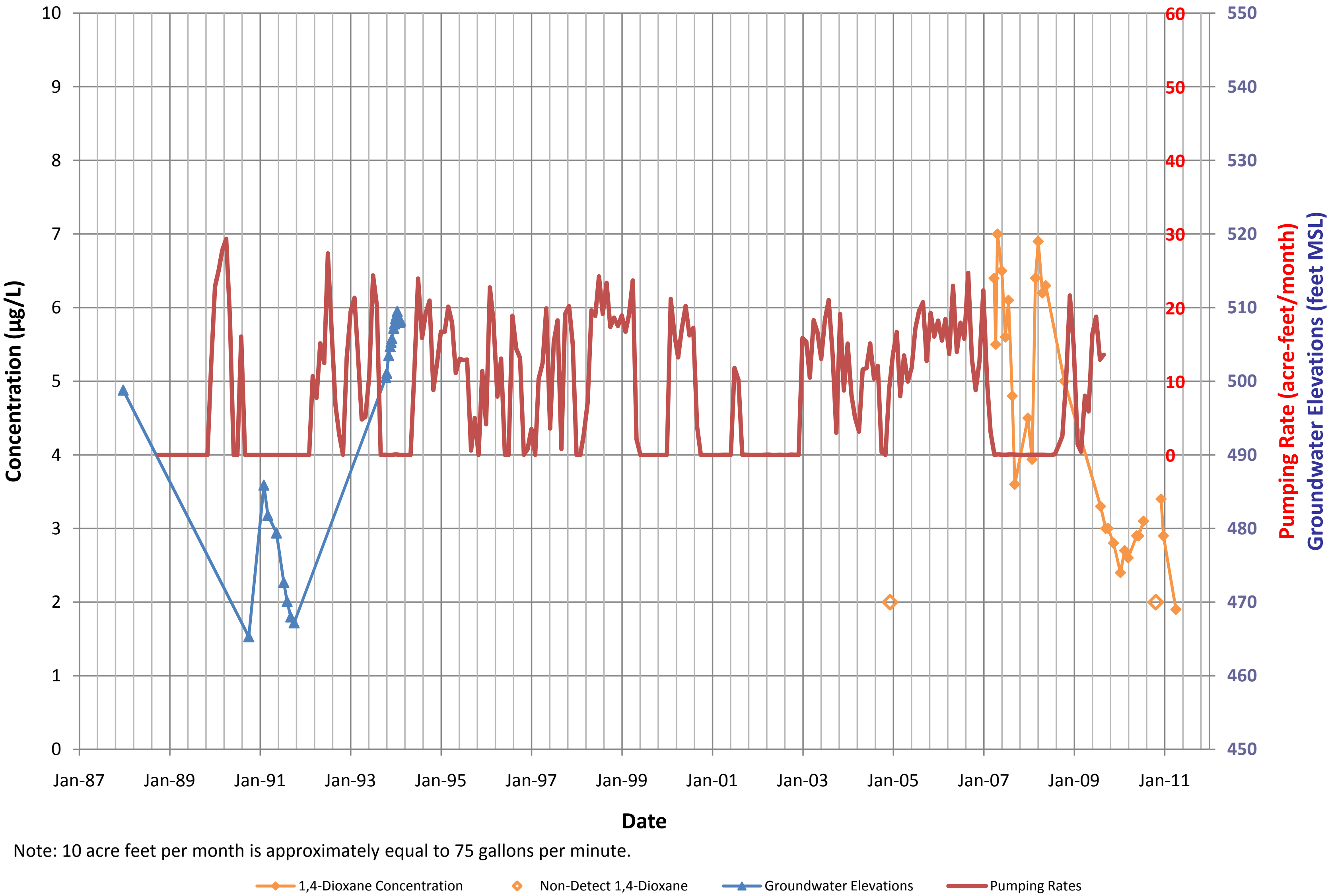
Note: 10 acre feet per month is approximately equal to 75 gallons per minute.

amec

PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Operable Unit (NHOU) Extraction Well NHE-8
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

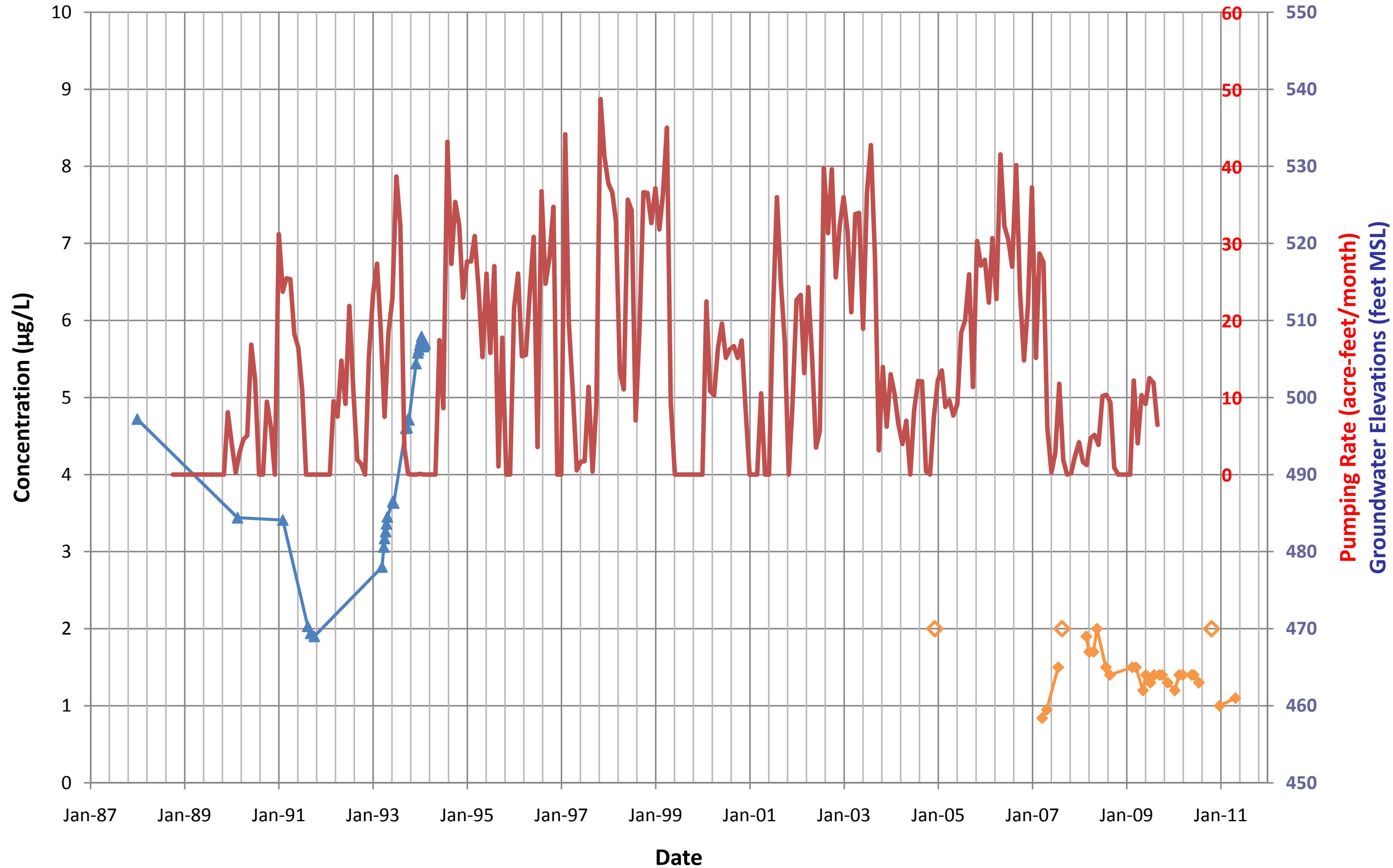
Figure: **F-E-8**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	1,4-Dioxane Concentrations and Groundwater Elevations North Hollywood Operable Unit (NHOU) Extraction Well NHE-2 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-E-9**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

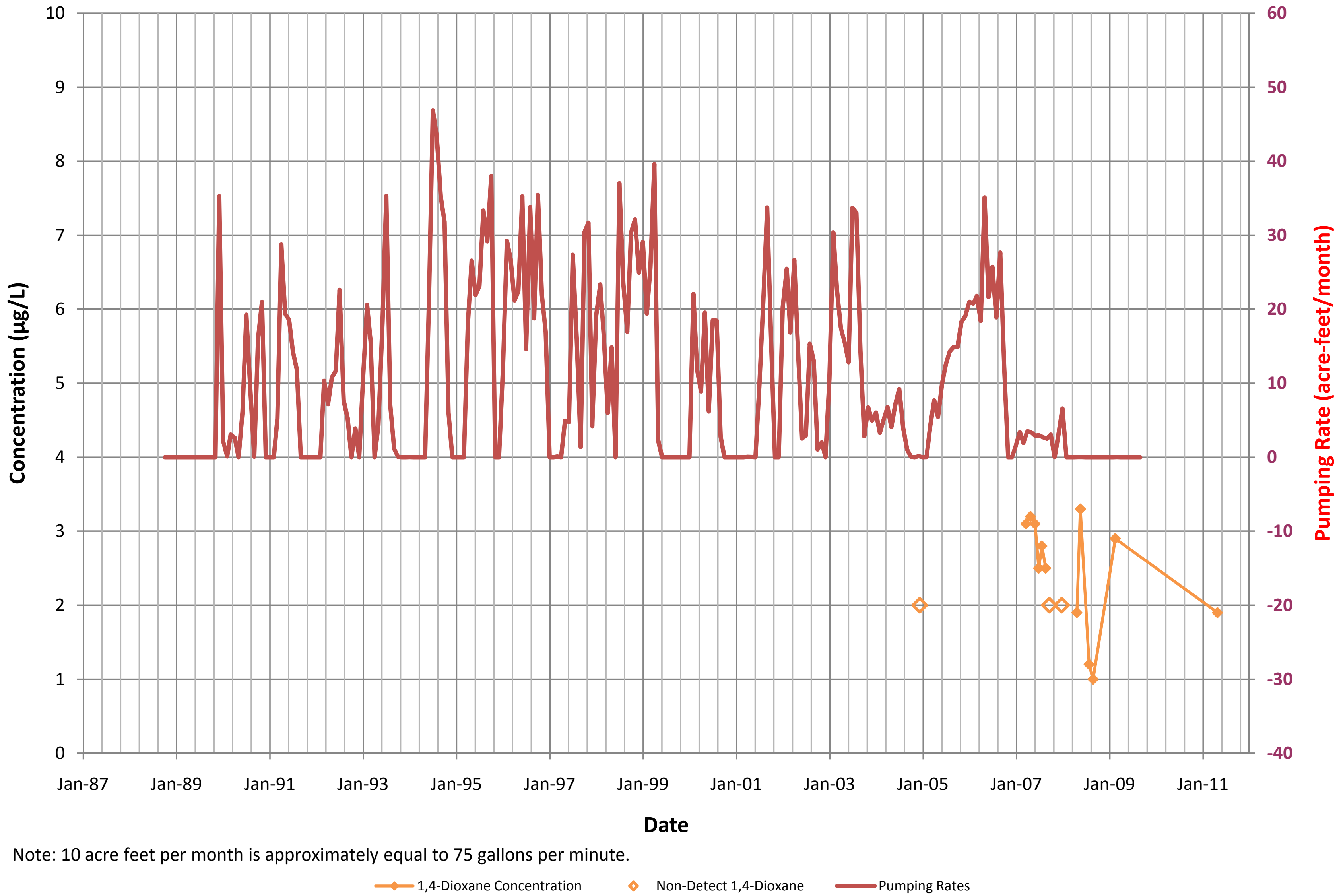


Note: 10 acre feet per month is approximately equal to 75 gallons per minute.

1,4-Dioxane Concentration | Non-Detect 1,4-Dioxane | Groundwater Elevations | Pumping Rates

amec	1,4-Dioxane Concentrations and Groundwater Elevations North Hollywood Operable Unit (NHOU) Extraction Well NHE-3 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-E-10**

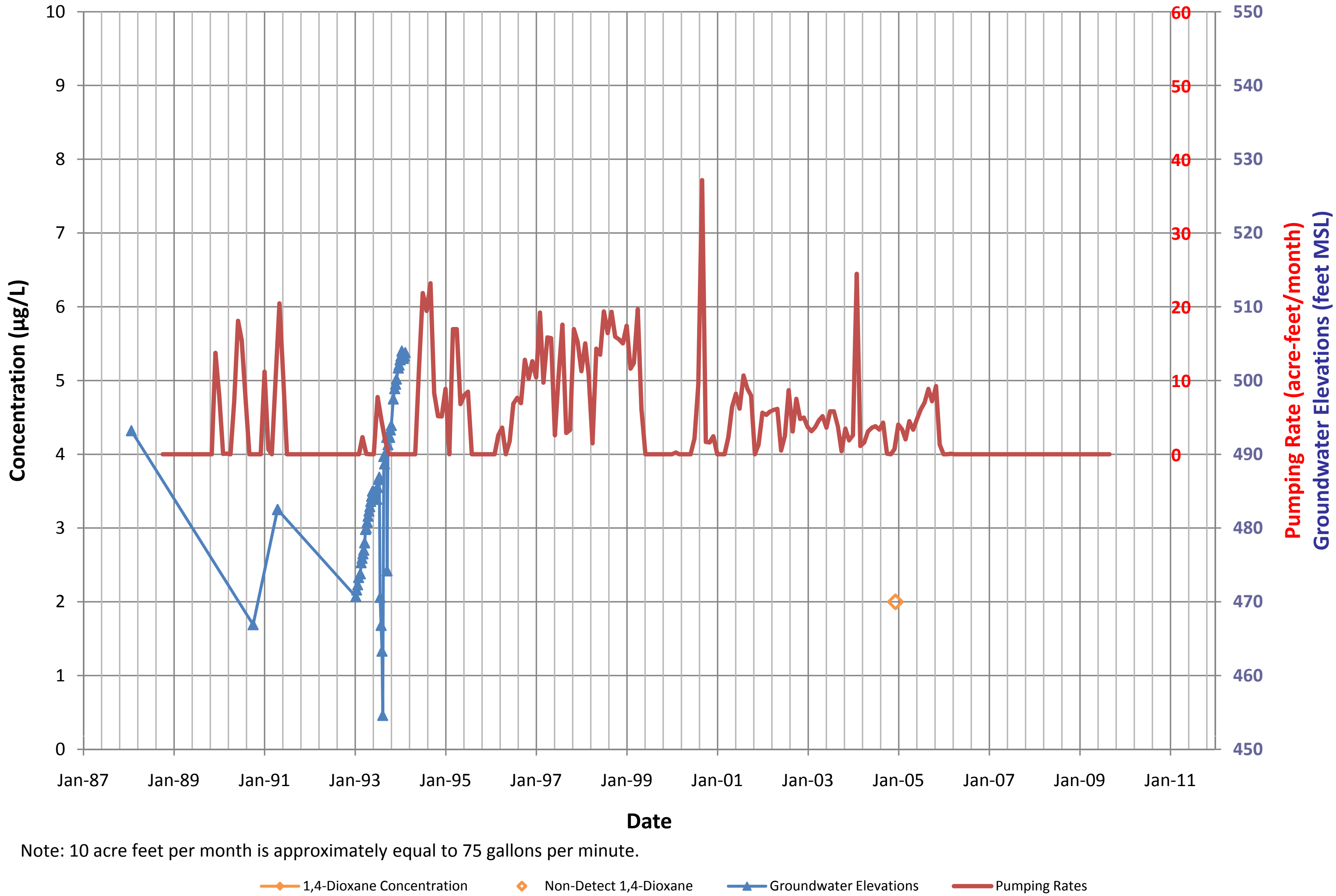
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



1,4-Dioxane Concentrations
North Hollywood Operable Unit (NHOU) Extraction Well NHE-4
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-E-11**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

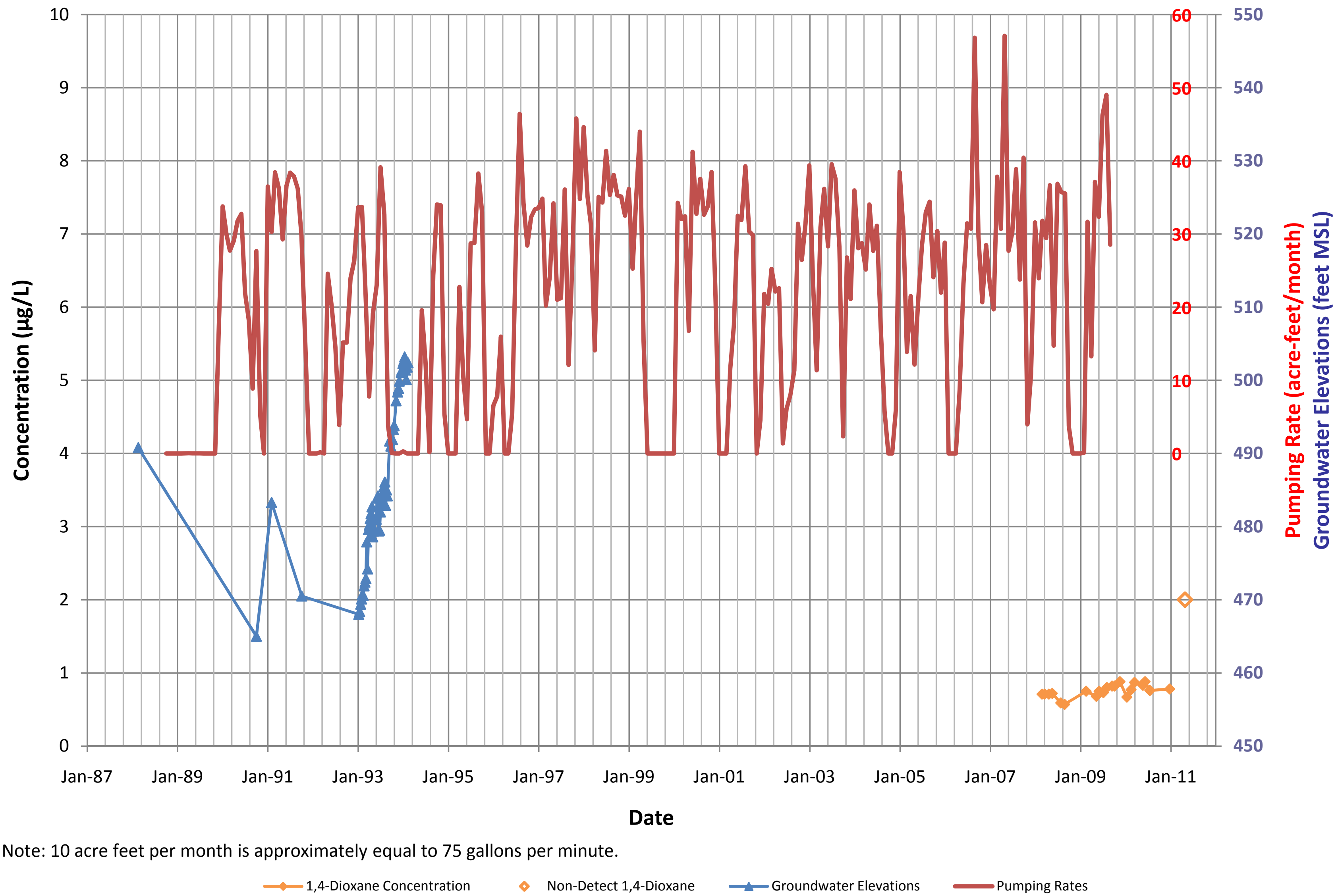


amec

1,4-Dioxane Concentrations and Groundwater Elevations
North Hollywood Operable Unit (NHOU) Extraction Well NHE-5
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-E-12**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



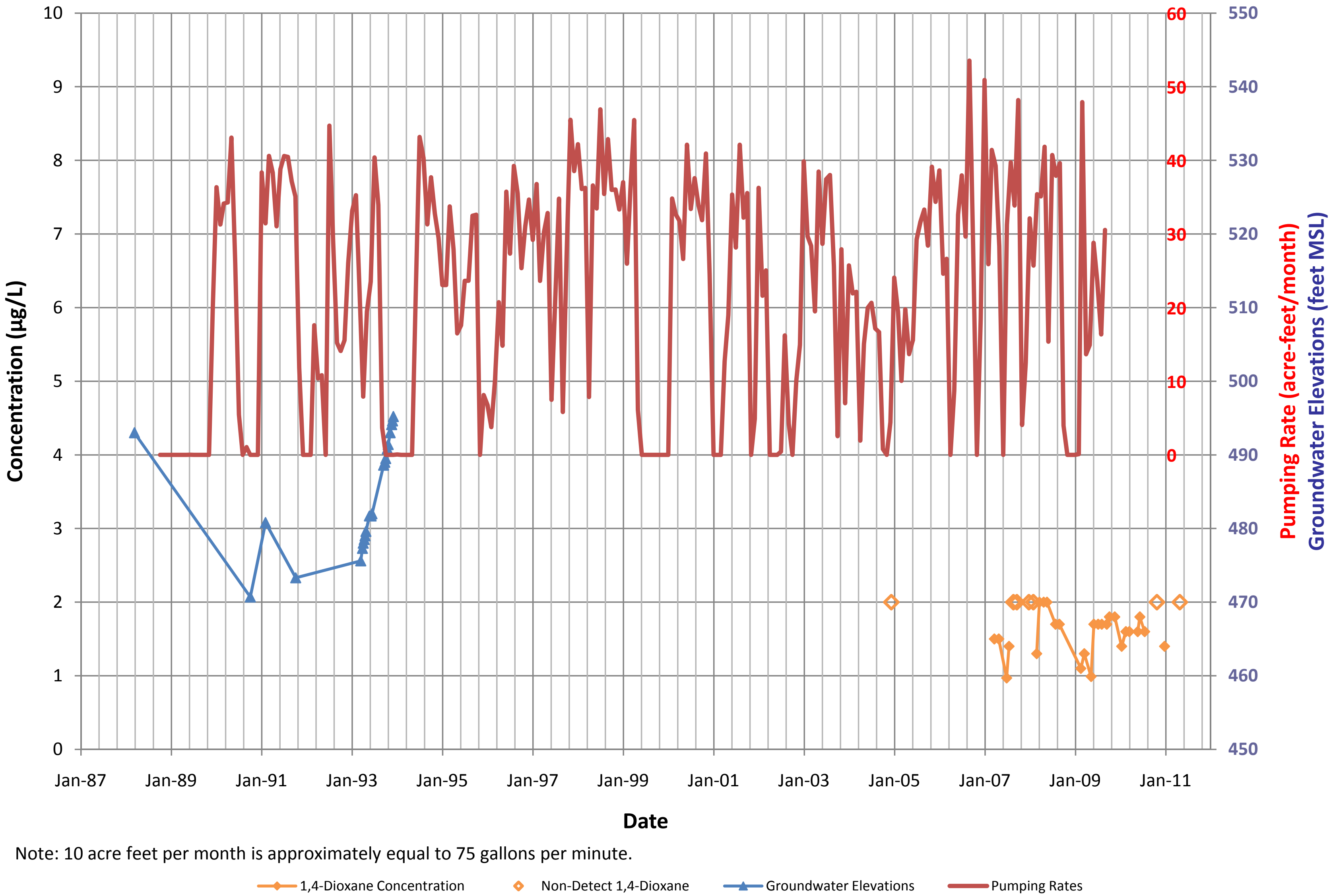
Note: 10 acre feet per month is approximately equal to 75 gallons per minute.

amec

1,4-Dioxane Concentrations and Groundwater Elevations
North Hollywood Operable Unit (NHOU) Extraction Well NHE-6
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: F-E-13

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



Note: 10 acre feet per month is approximately equal to 75 gallons per minute.

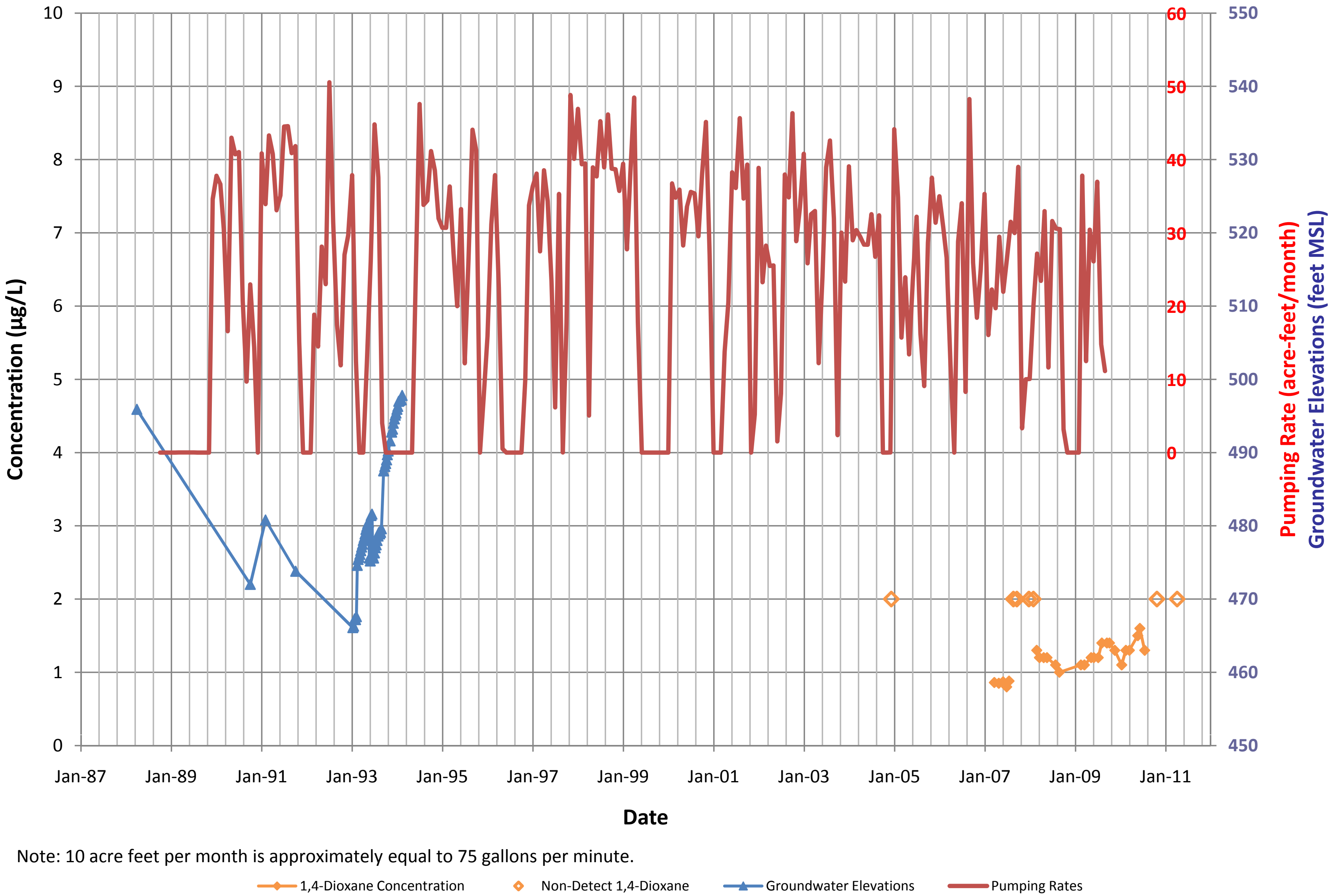
amec

1,4-Dioxane Concentrations and Groundwater Elevations
North Hollywood Operable Unit (NHOU) Extraction Well NHE-7
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-E-14

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



Note: 10 acre feet per month is approximately equal to 75 gallons per minute.

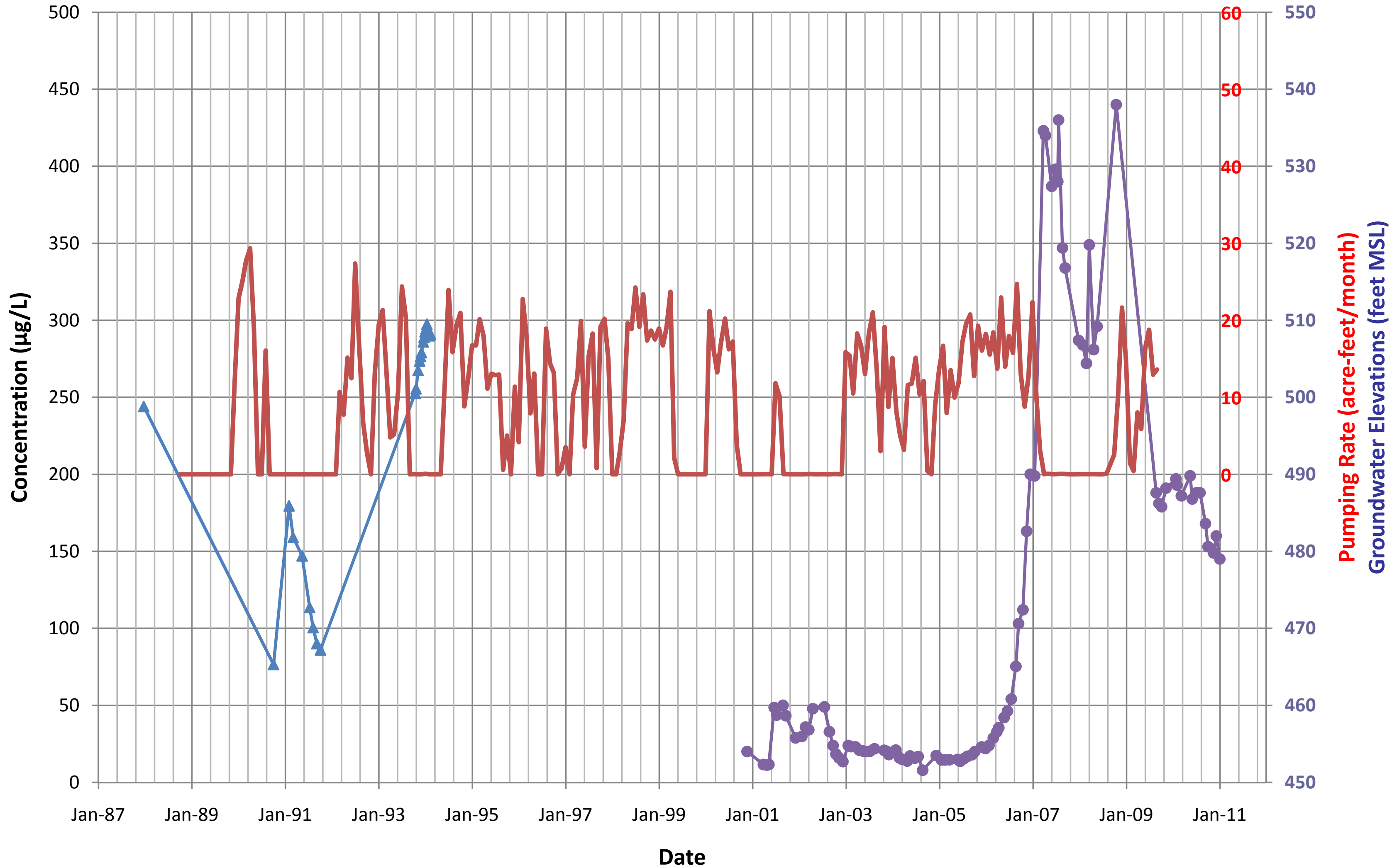
amec

1,4-Dioxane Concentrations and Groundwater Elevations
North Hollywood Operable Unit (NHOU) Extraction Well NHE-8
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-E-15

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



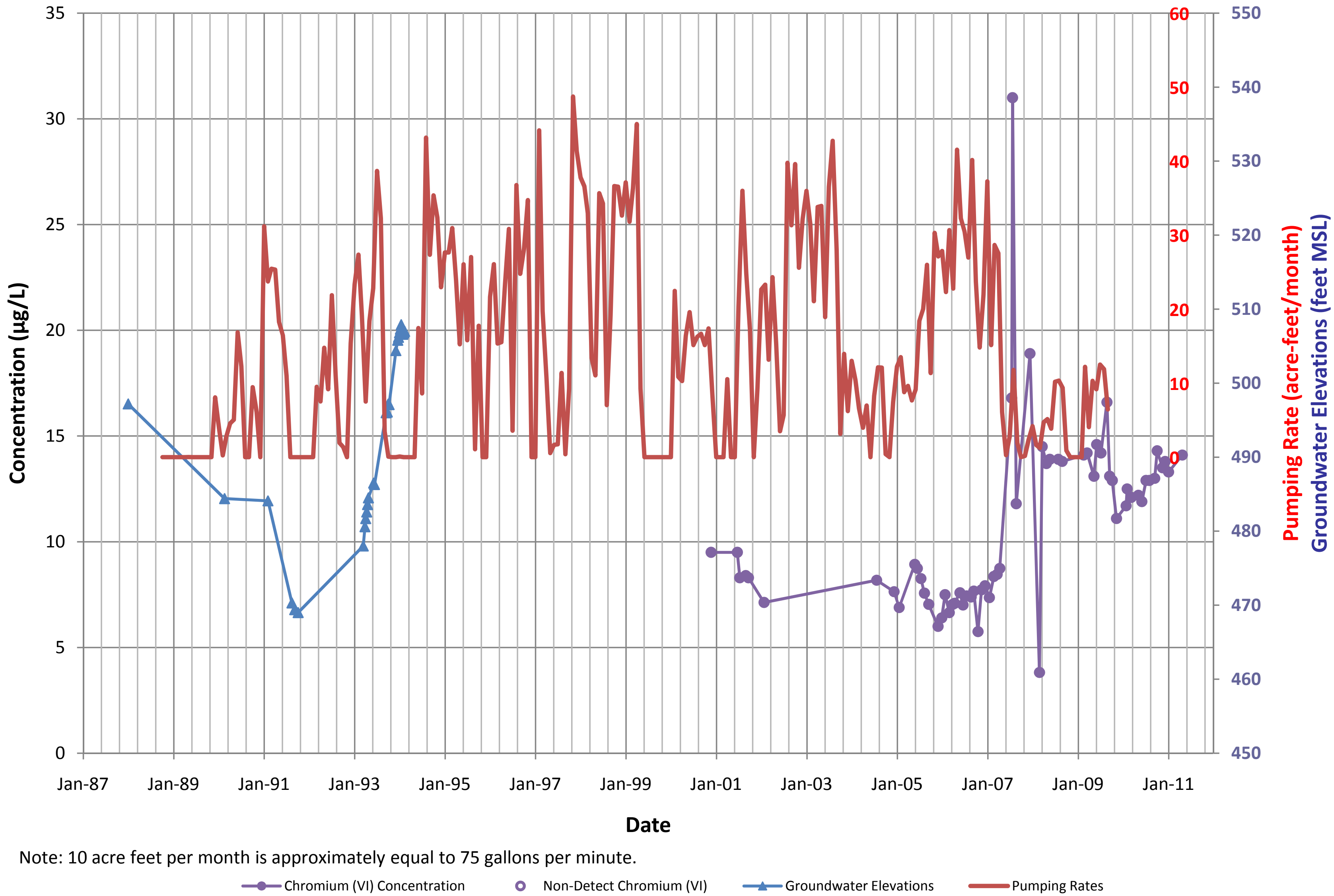
Note: 10 acre feet per month is approximately equal to 75 gallons per minute.

amec

Chromium (VI) Concentrations and Groundwater Elevations
North Hollywood Operable Unit (NHOU) Extraction Well NHE-2
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

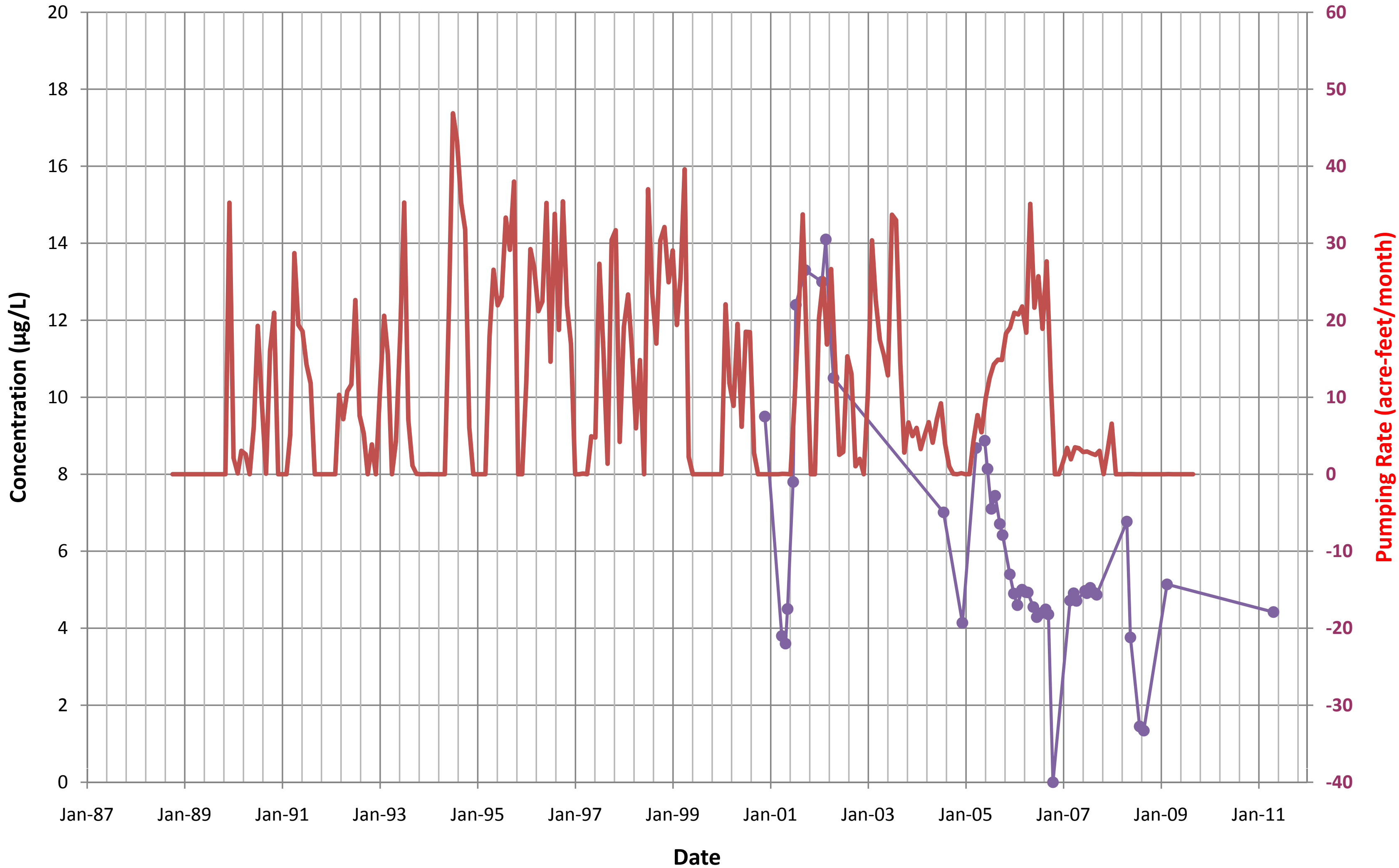
Figure: **F-E-16**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



Note: 10 acre feet per month is approximately equal to 75 gallons per minute.

amec	Chromium (VI) Concentrations and Groundwater Elevations North Hollywood Operable Unit (NHOU) Extraction Well NHE-3 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **F-E-17**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 7/2011

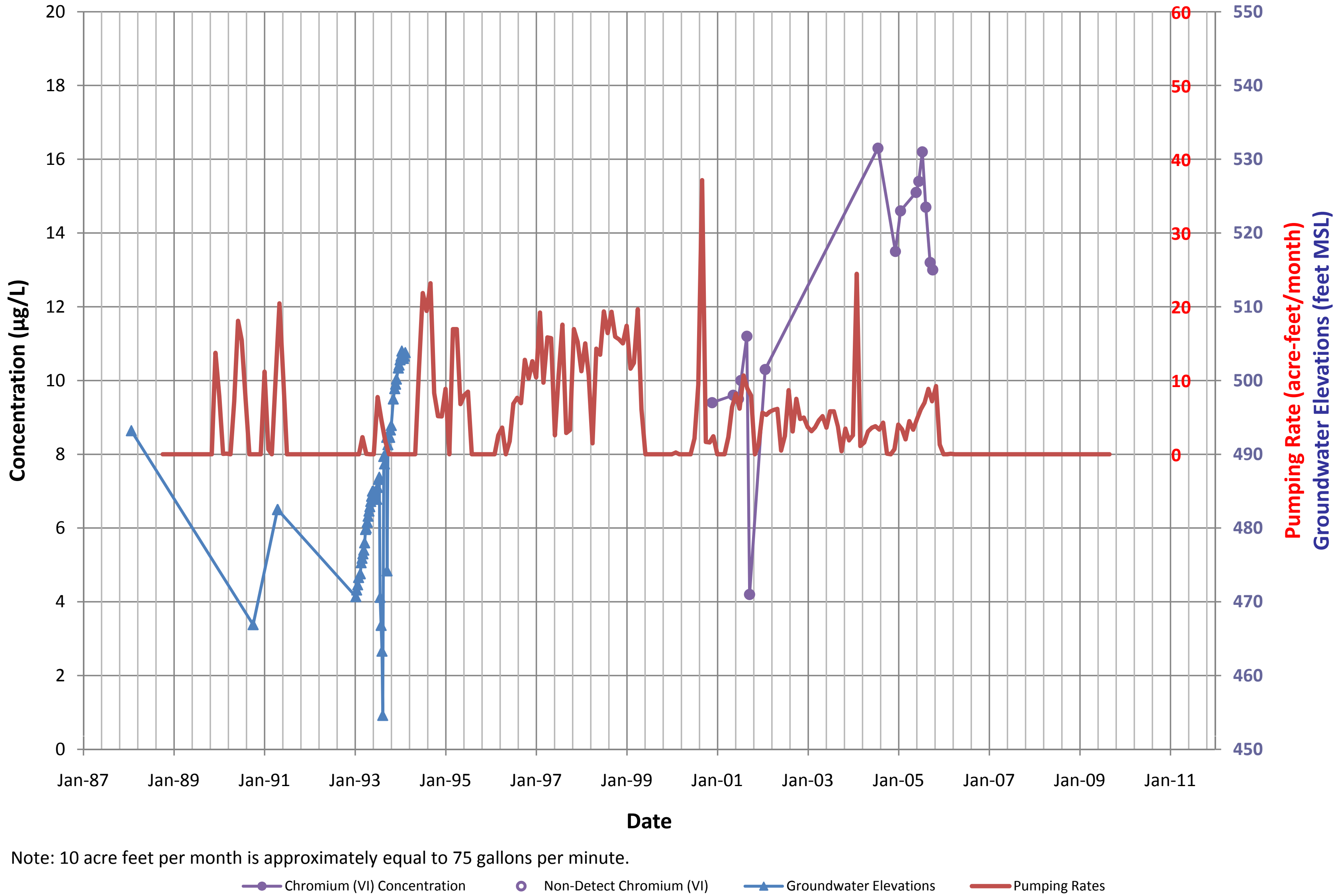


Note: 10 acre feet per month is approximately equal to 75 gallons per minute.

Chromium (VI) Concentration   Non-Detect Chromium (VI)   Pumping Rates

amec	Chromium (VI) Concentrations North Hollywood Operable Unit (NHOU) Extraction Well NHE-4 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-E-18**

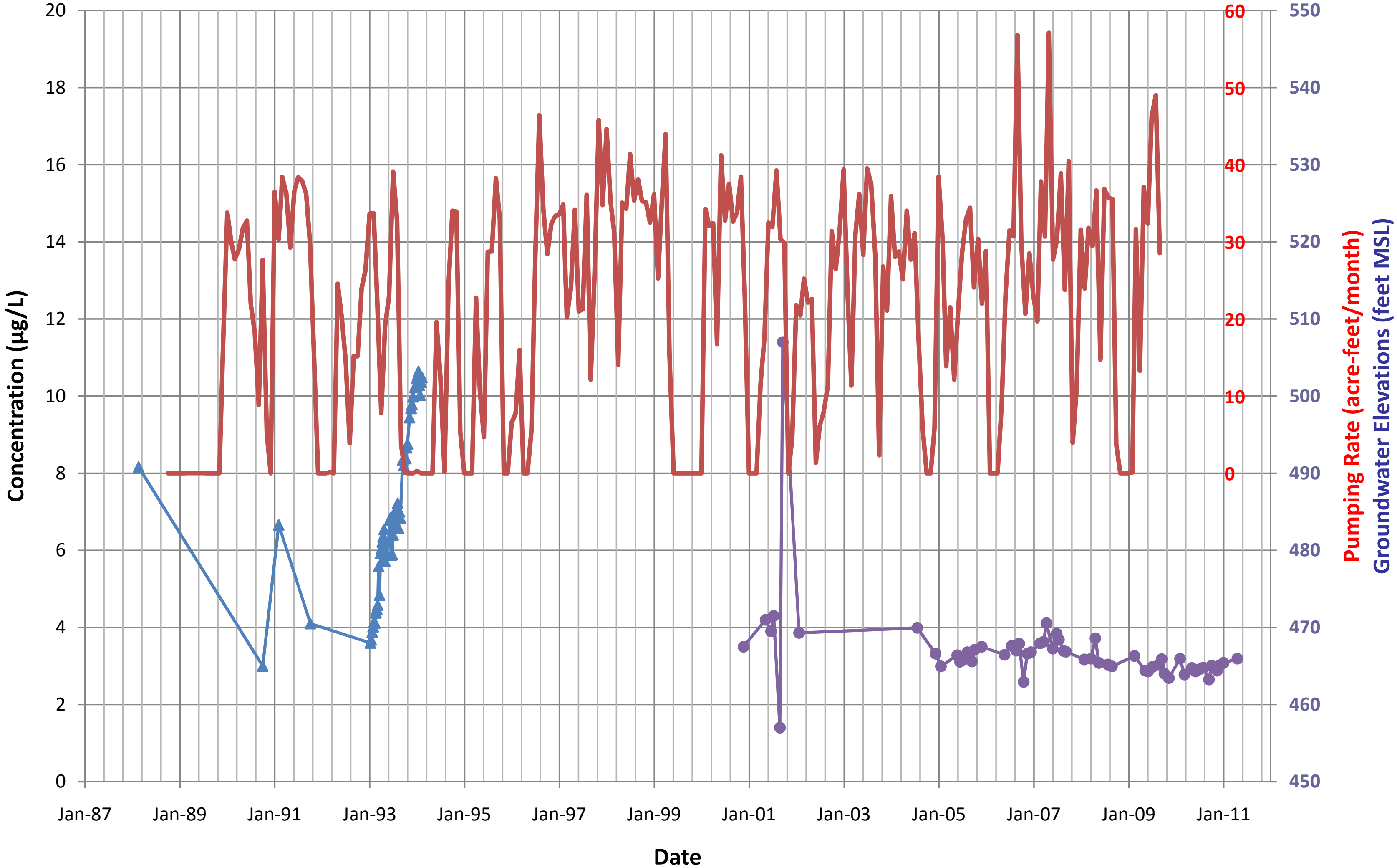
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



Chromium (VI) Concentrations and Groundwater Elevations
North Hollywood Operable Unit (NHOU) Extraction Well NHE-5
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-E-19**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



Note: 10 acre feet per month is approximately equal to 75 gallons per minute.

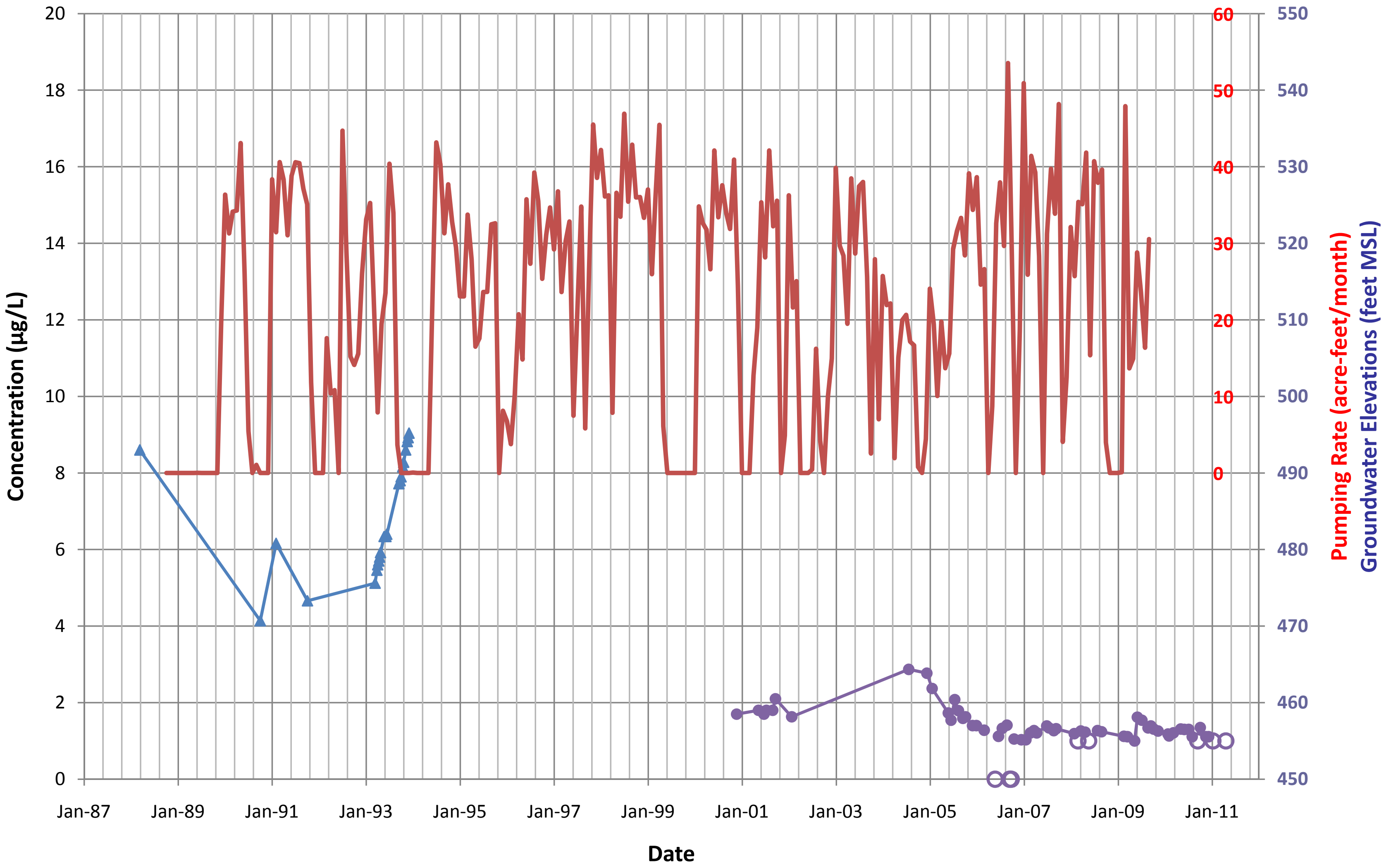
amec

Chromium (VI) Concentrations and Groundwater Elevations
North Hollywood Operable Unit (NHOU) Extraction Well NHE-6
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-E-20

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

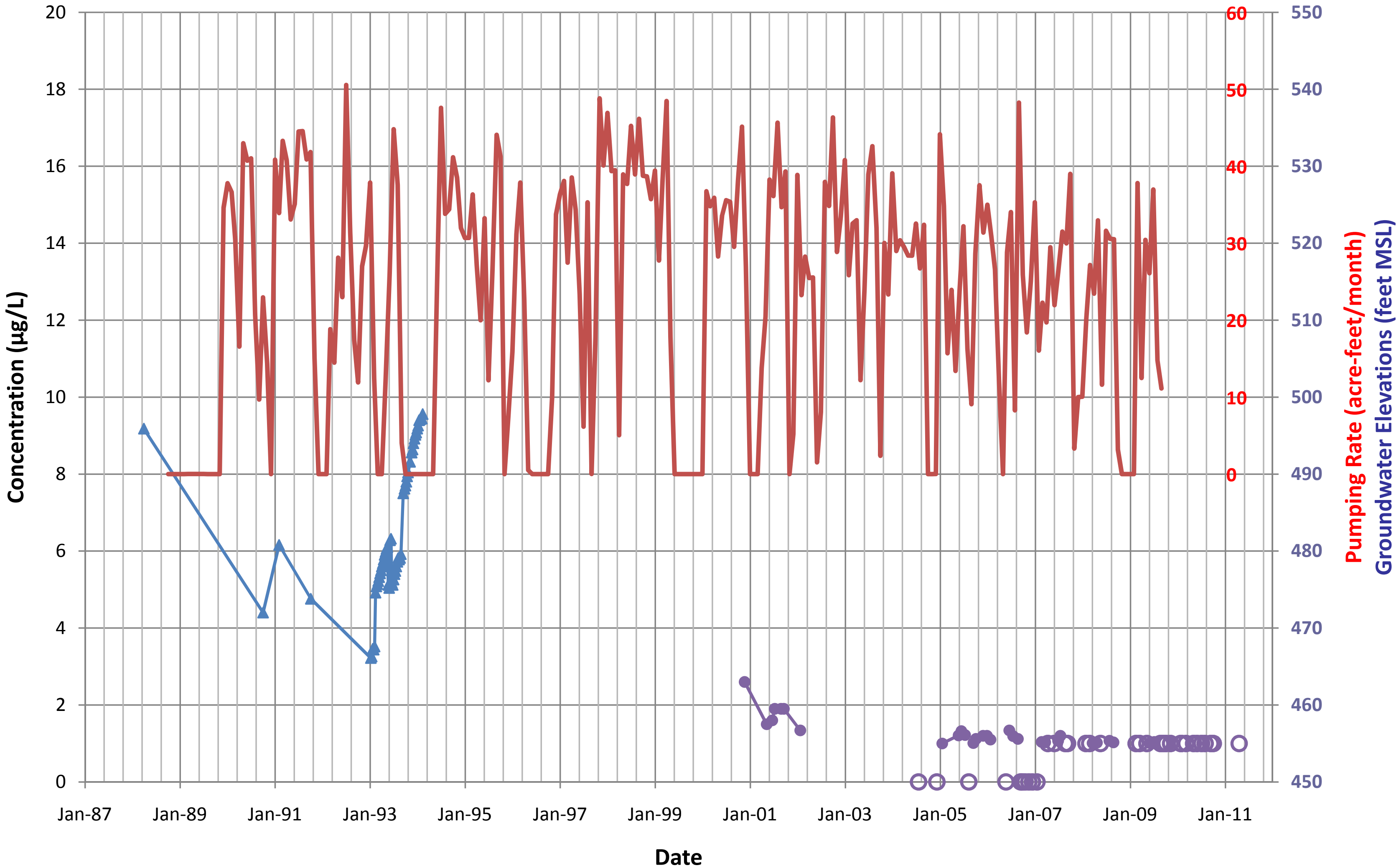


Note: 10 acre feet per month is approximately equal to 75 gallons per minute.

Chromium (VI) Concentrations and Groundwater Elevations
North Hollywood Operable Unit (NHOU) Extraction Well NHE-7
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-E-21**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

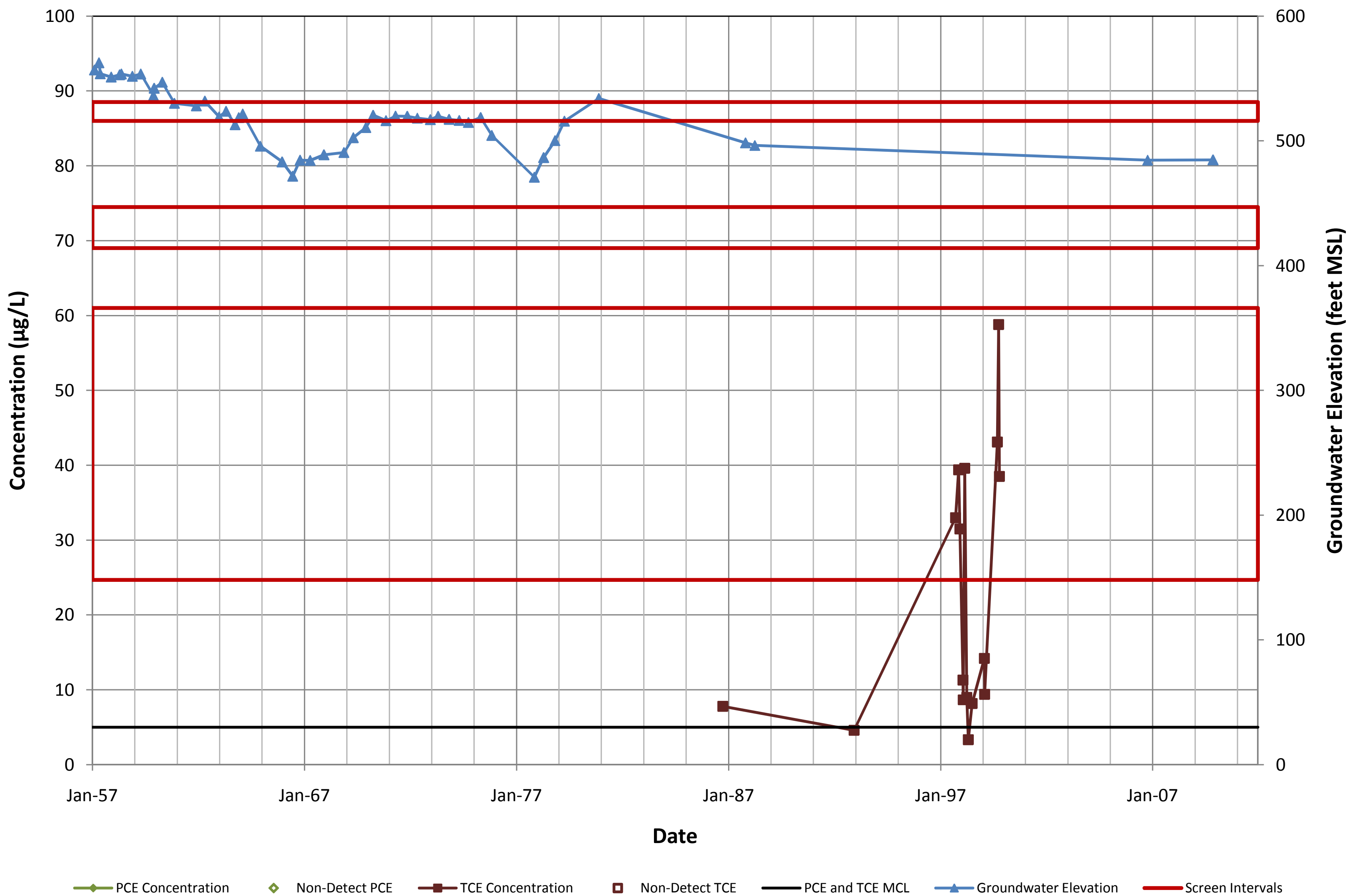


Note: 10 acre feet per month is approximately equal to 75 gallons per minute.

Chromium (VI) Concentration | Non-Detect Chromium (VI) | Groundwater Elevations | Pumping Rates

amec	Chromium (VI) Concentrations and Groundwater Elevations North Hollywood Operable Unit (NHOU) Extraction Well NHE-8 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-E-22**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



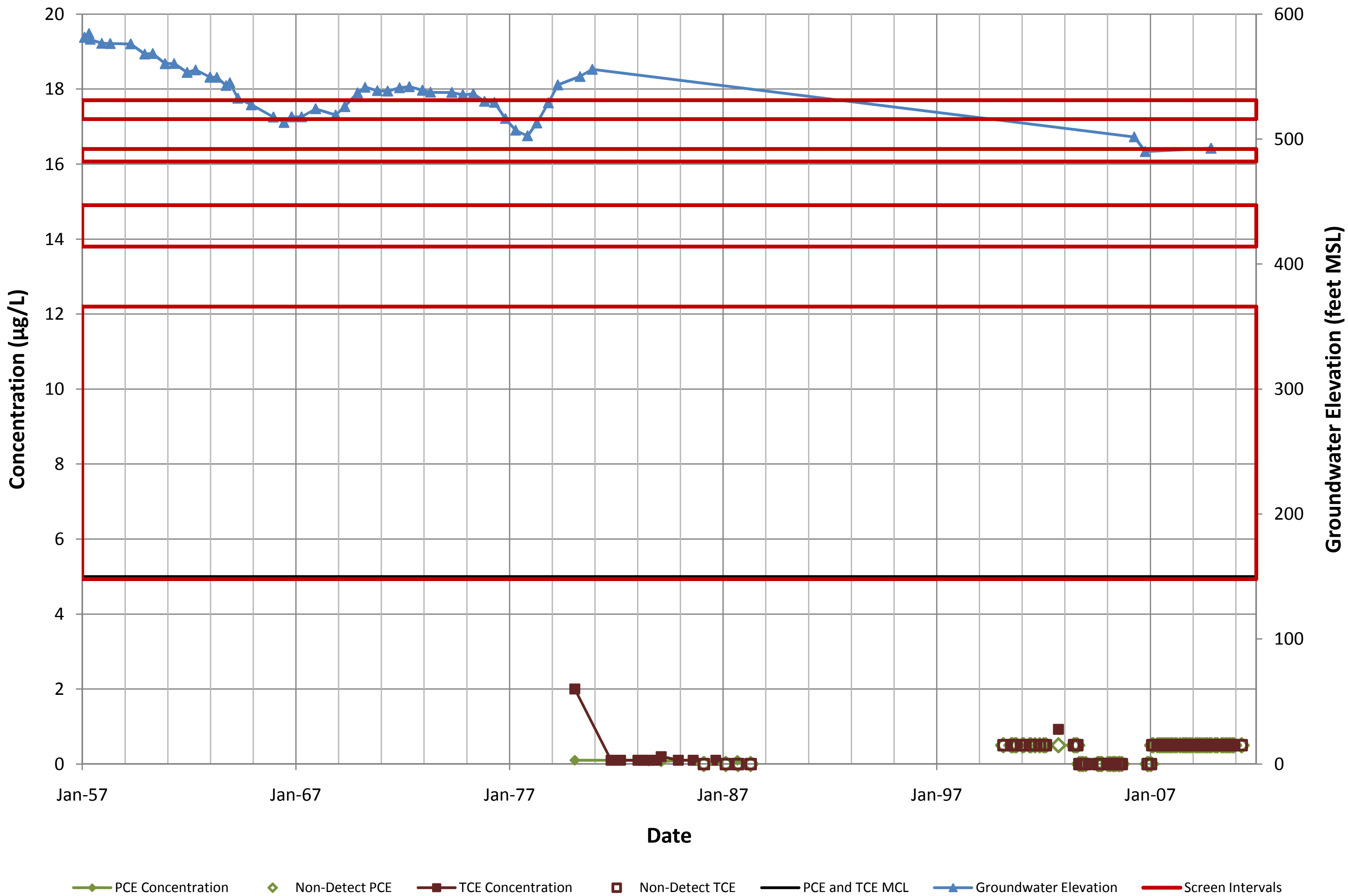
amec

PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Production Well Field NH-2
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

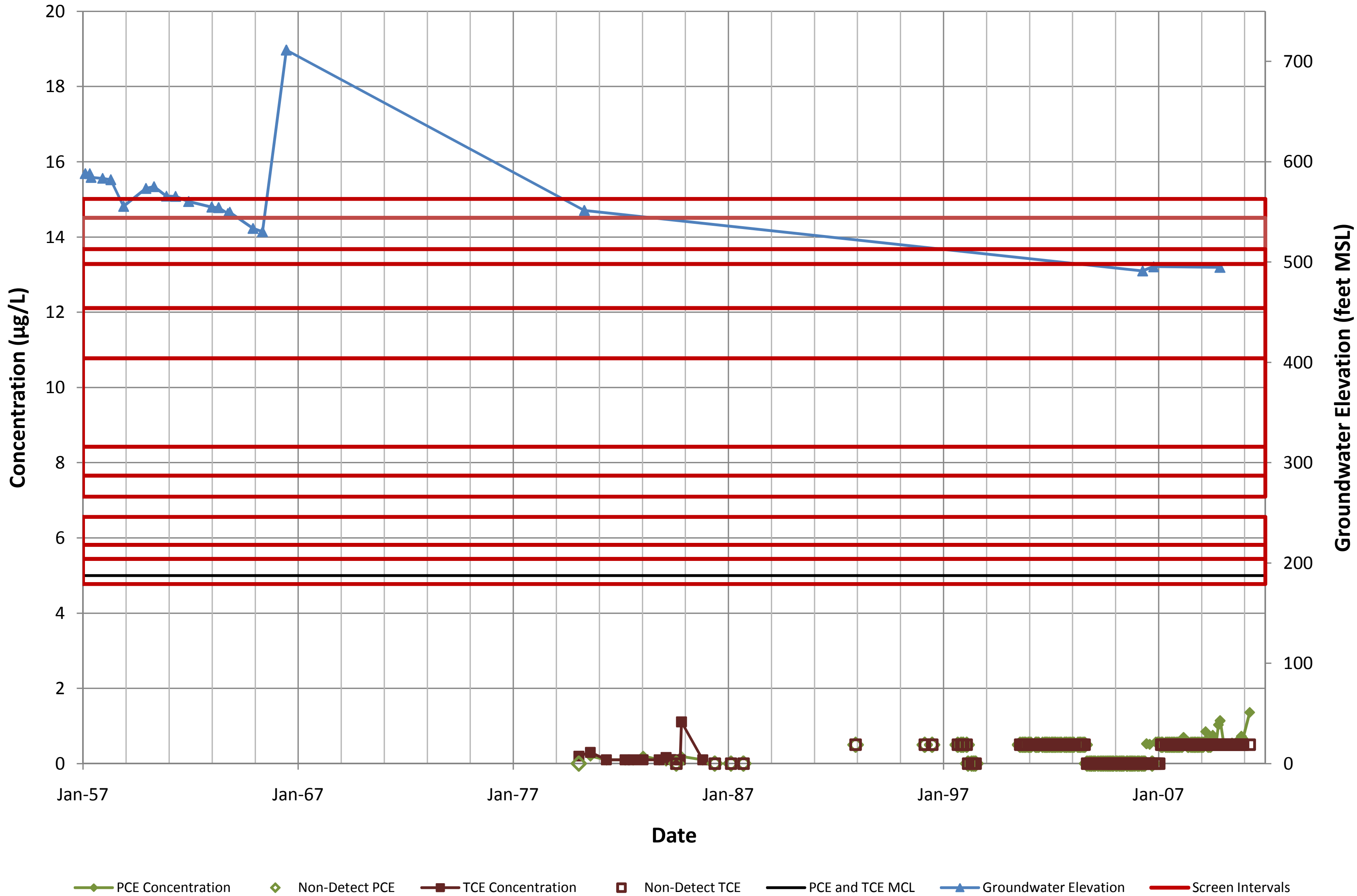
F-P-1

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	PCE and TCE Concentrations and Groundwater Elevations North Hollywood Production Well Field NH-4 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-P-2**

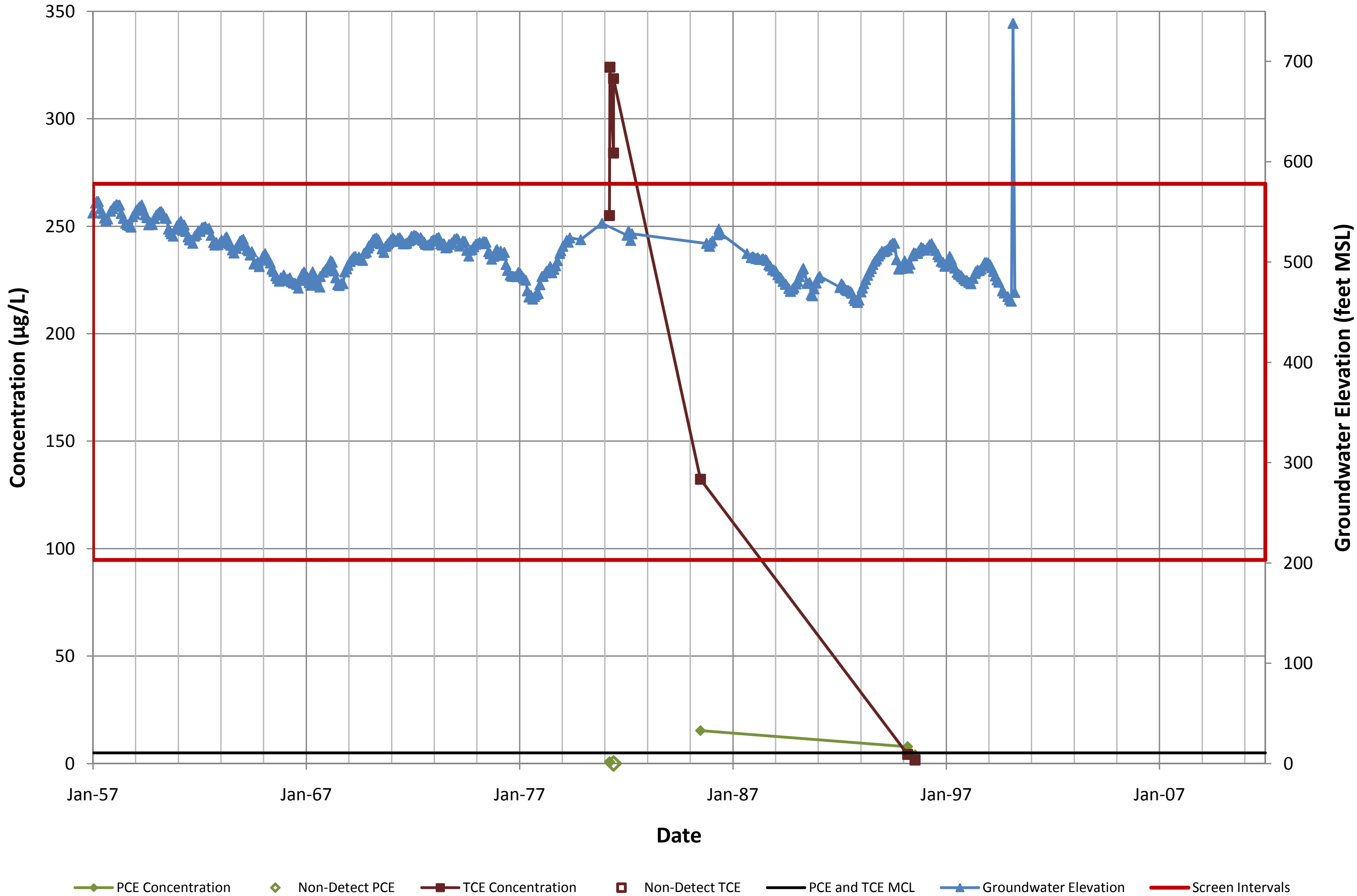
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Production Well Field NH-7
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-P-3**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

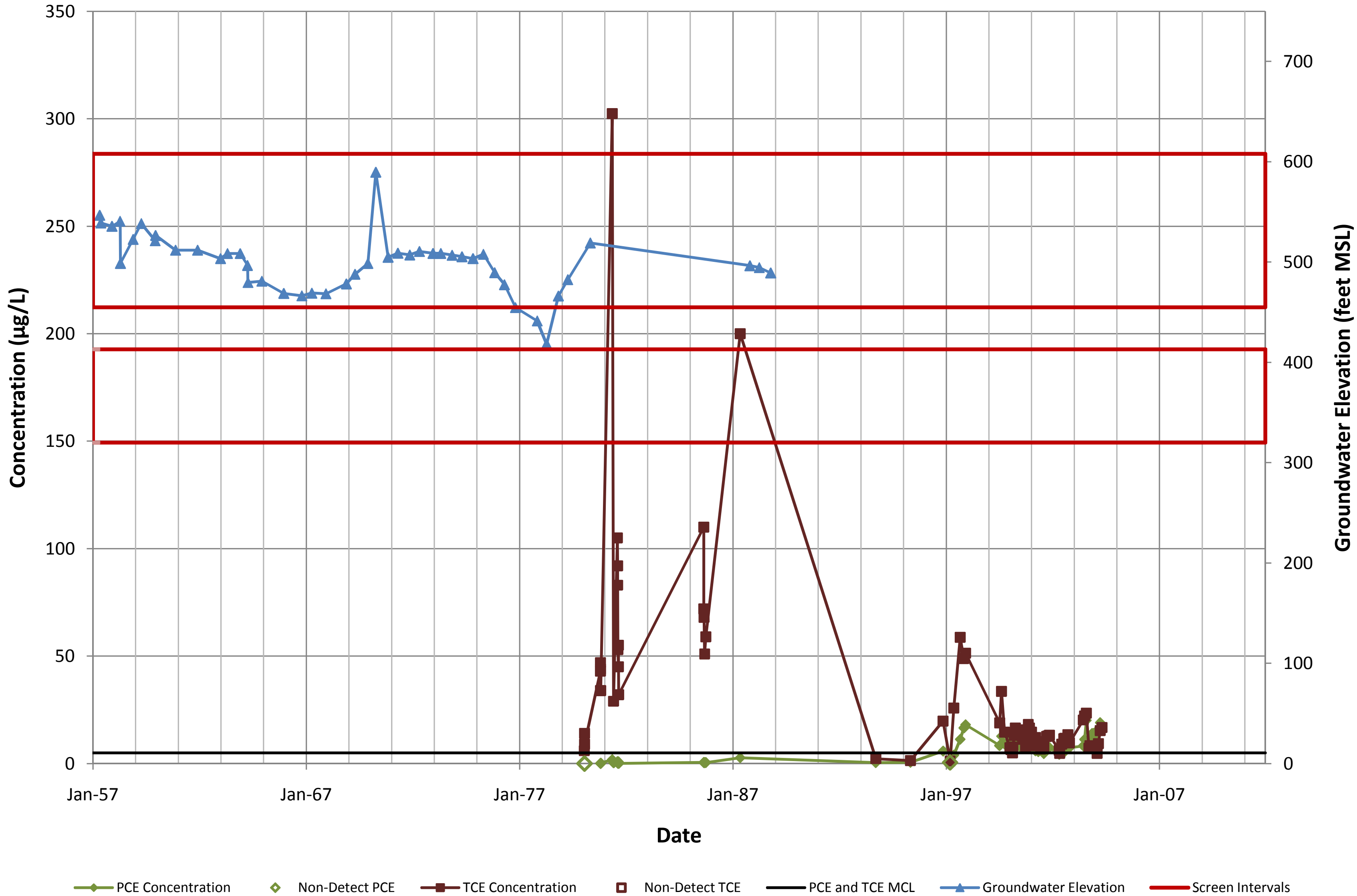


amec

PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Production Well Field NH-10
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-P-4**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

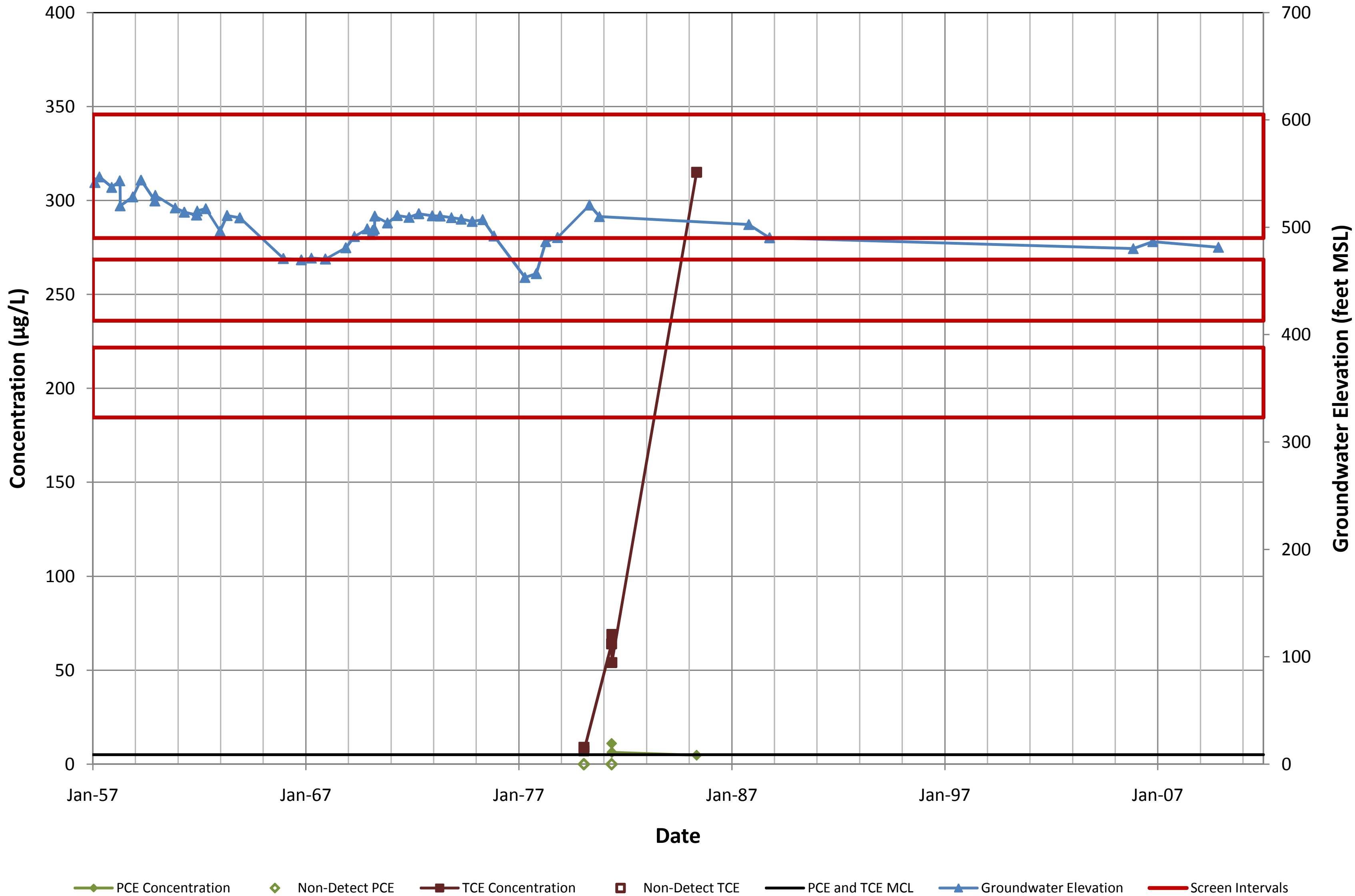


amec

PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Production Well Field NH-11
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

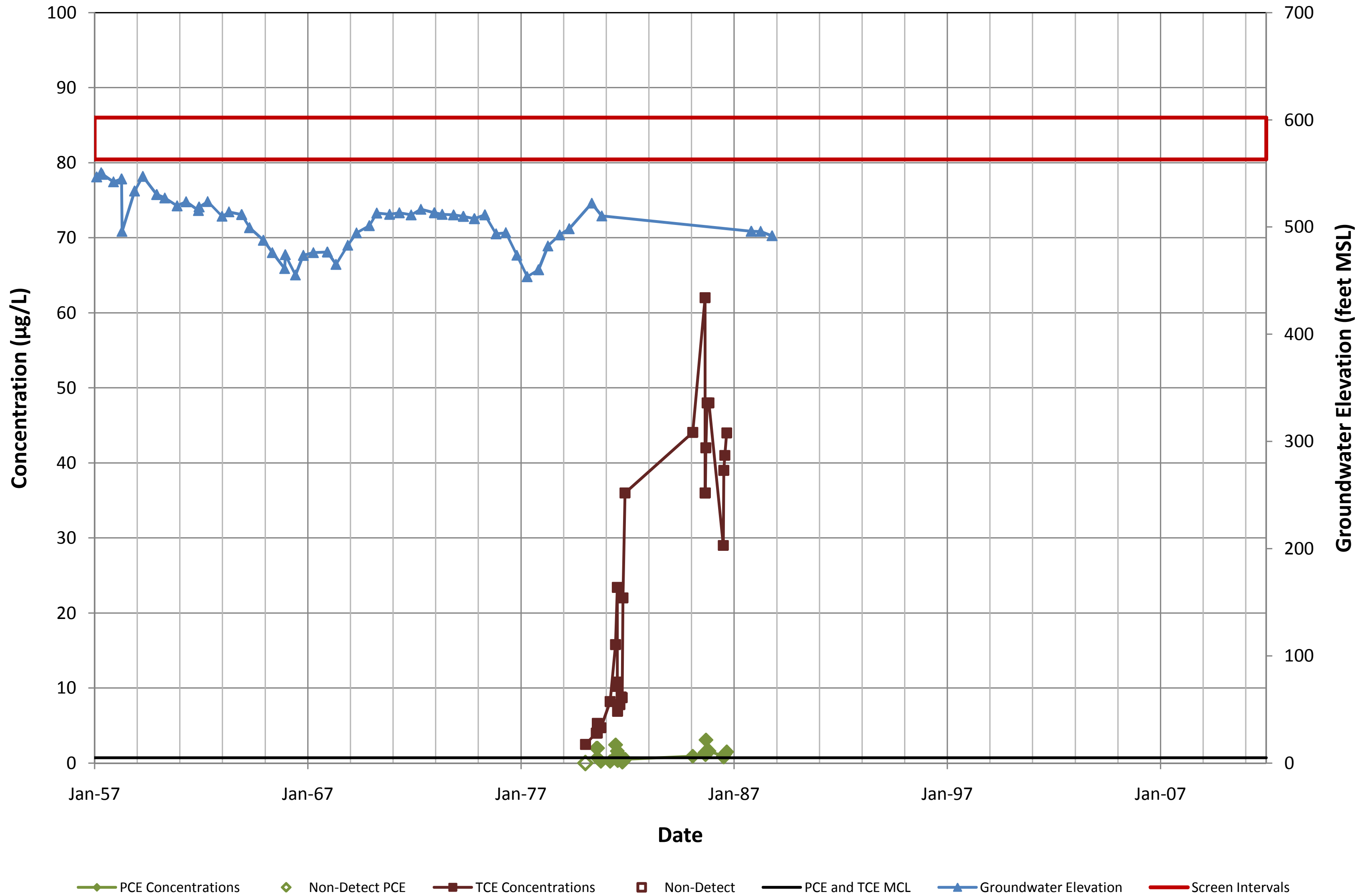
Figure:
F-P-5

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

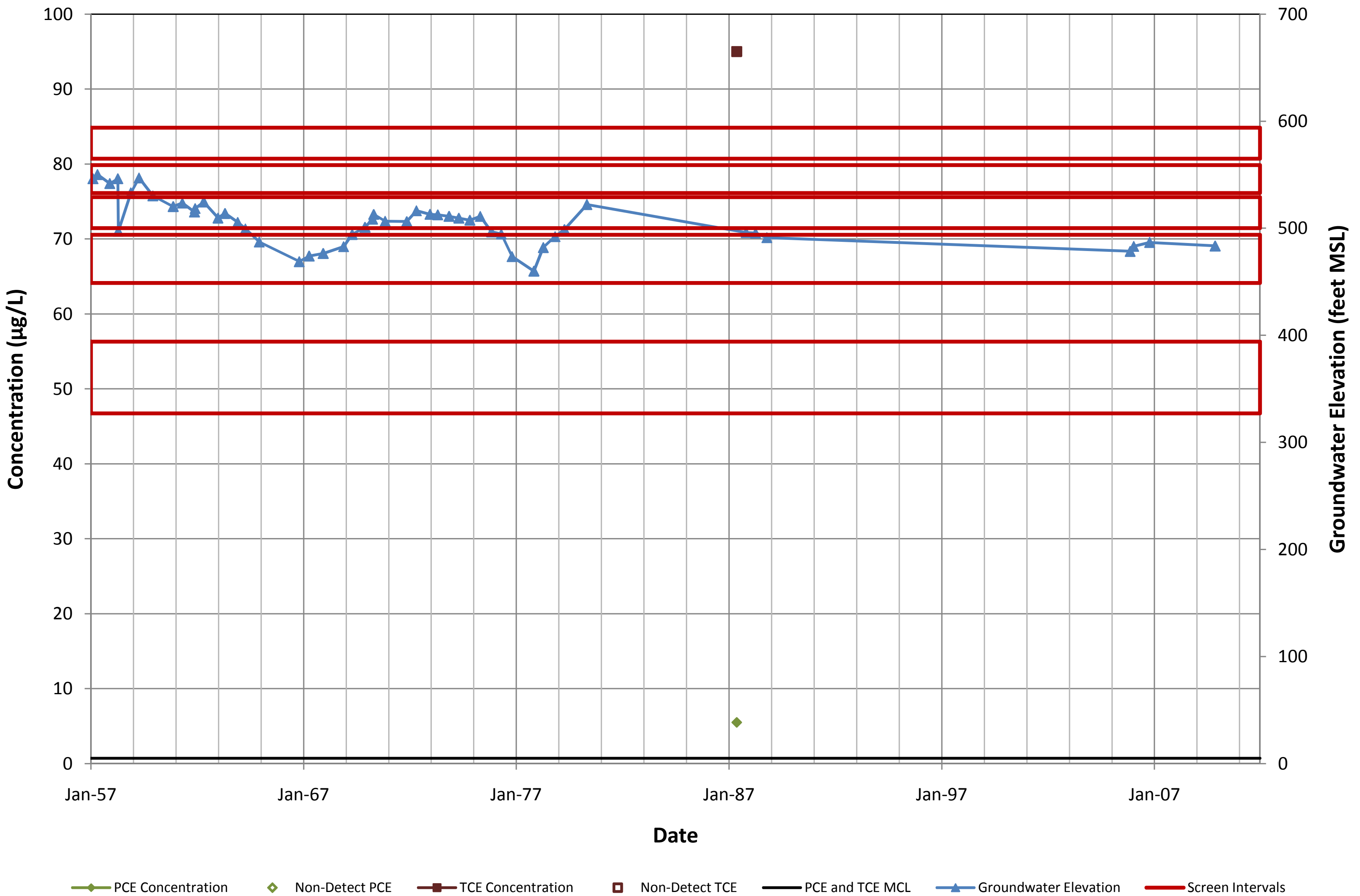


amec	PCE and TCE Concentrations and Groundwater Elevations North Hollywood Production Well Field NH-13 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-P-6**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	PCE and TCE Concentrations and Groundwater Elevations North Hollywood Production Well Field NH-14 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **F-P-7**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 7/2011

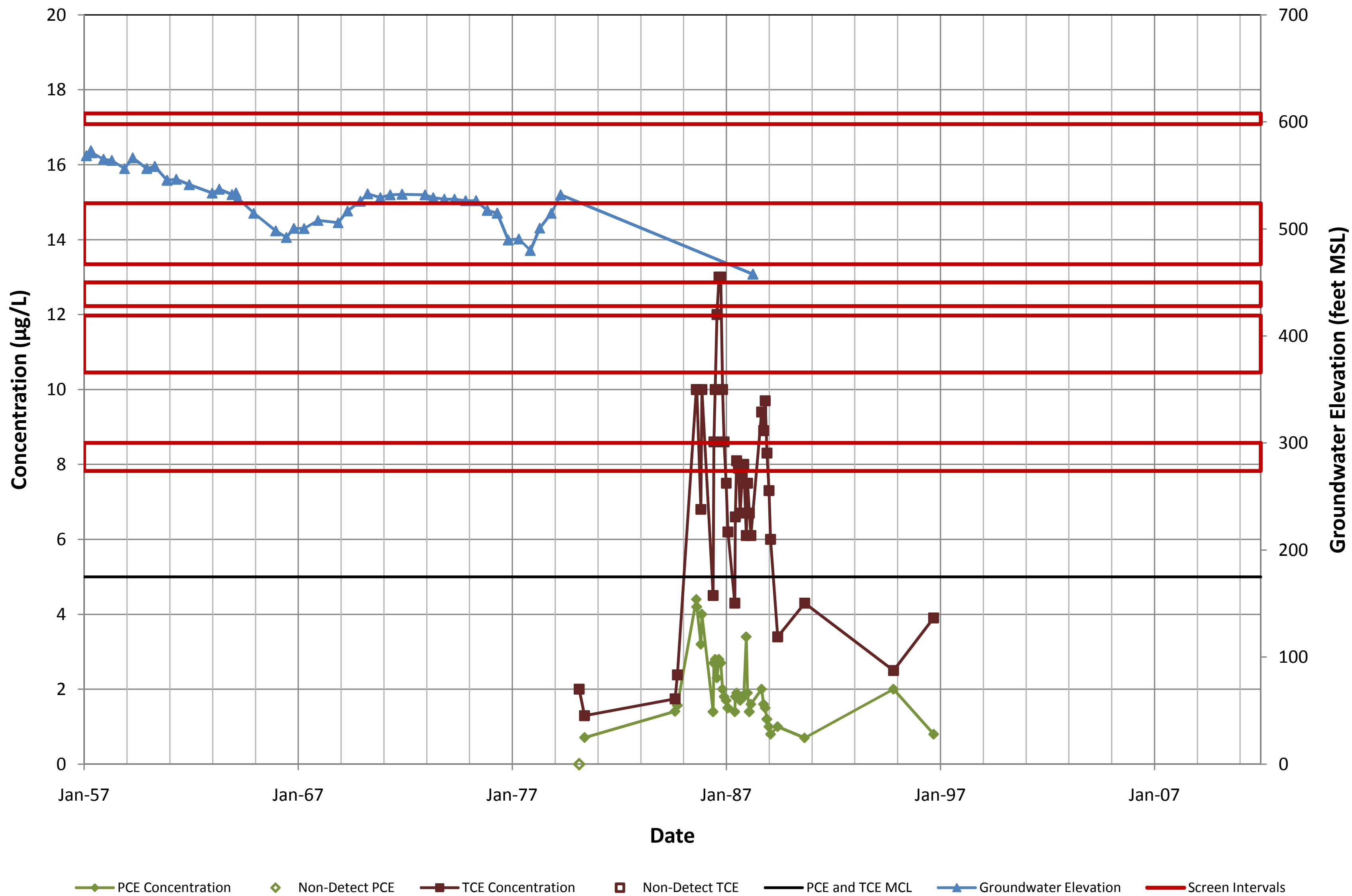


amec

PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Production Well Field NH-14A
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-P-8**

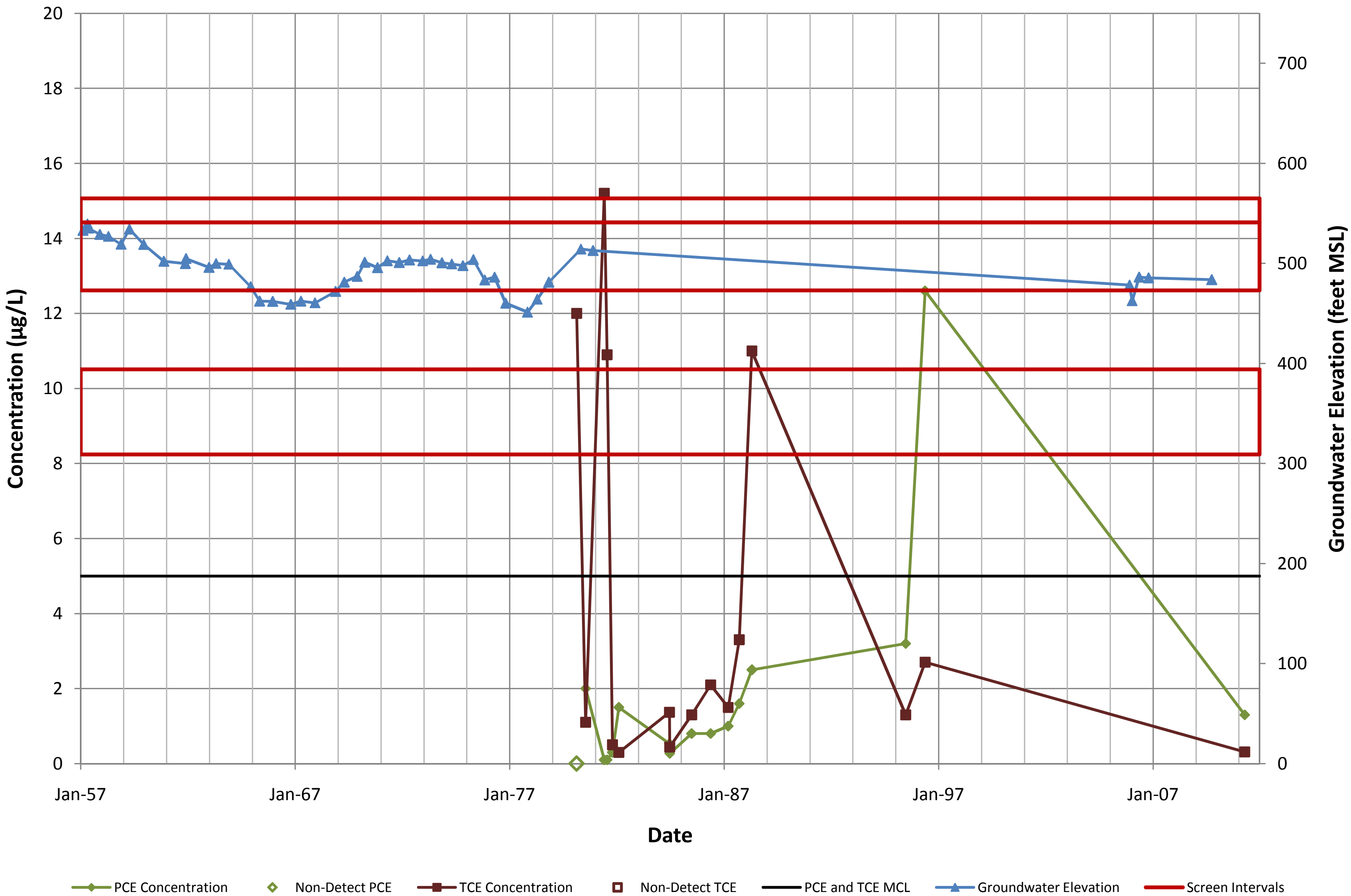
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Production Well Field NH-15
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-P-9**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



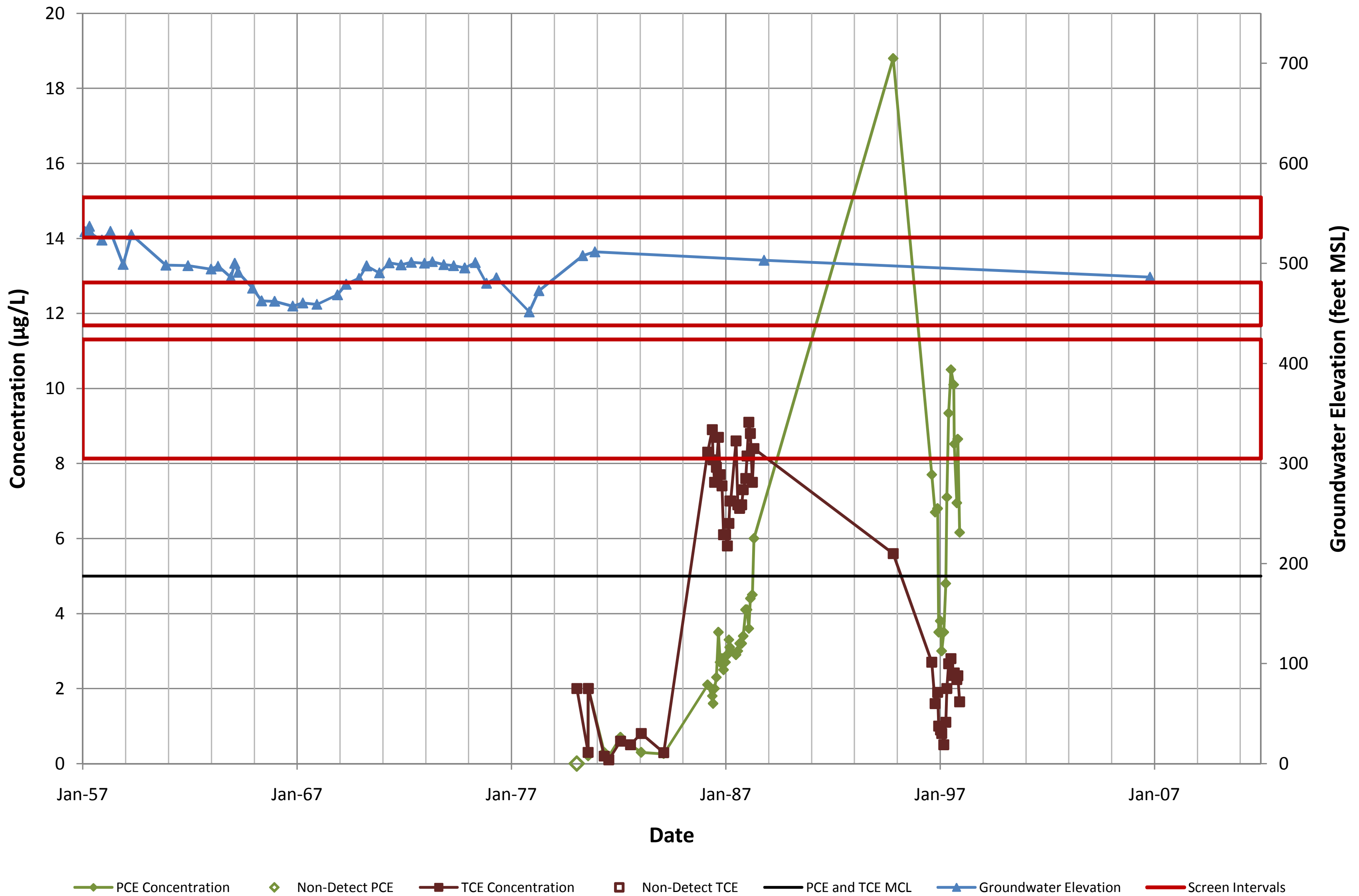
amec

PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Production Well Field NH-16
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-P-10

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

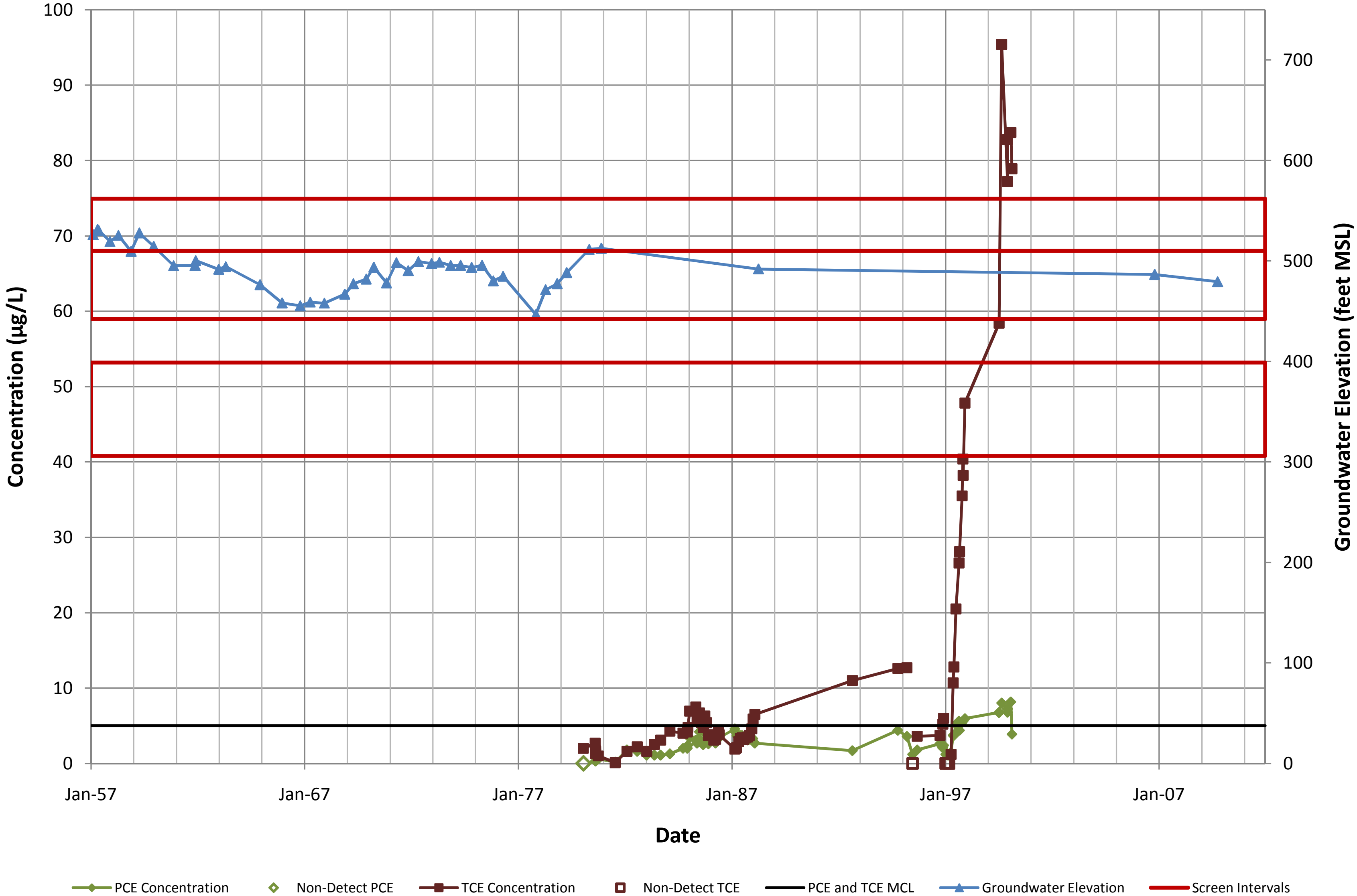


amec

PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Production Well Field NH-17
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-P-11**

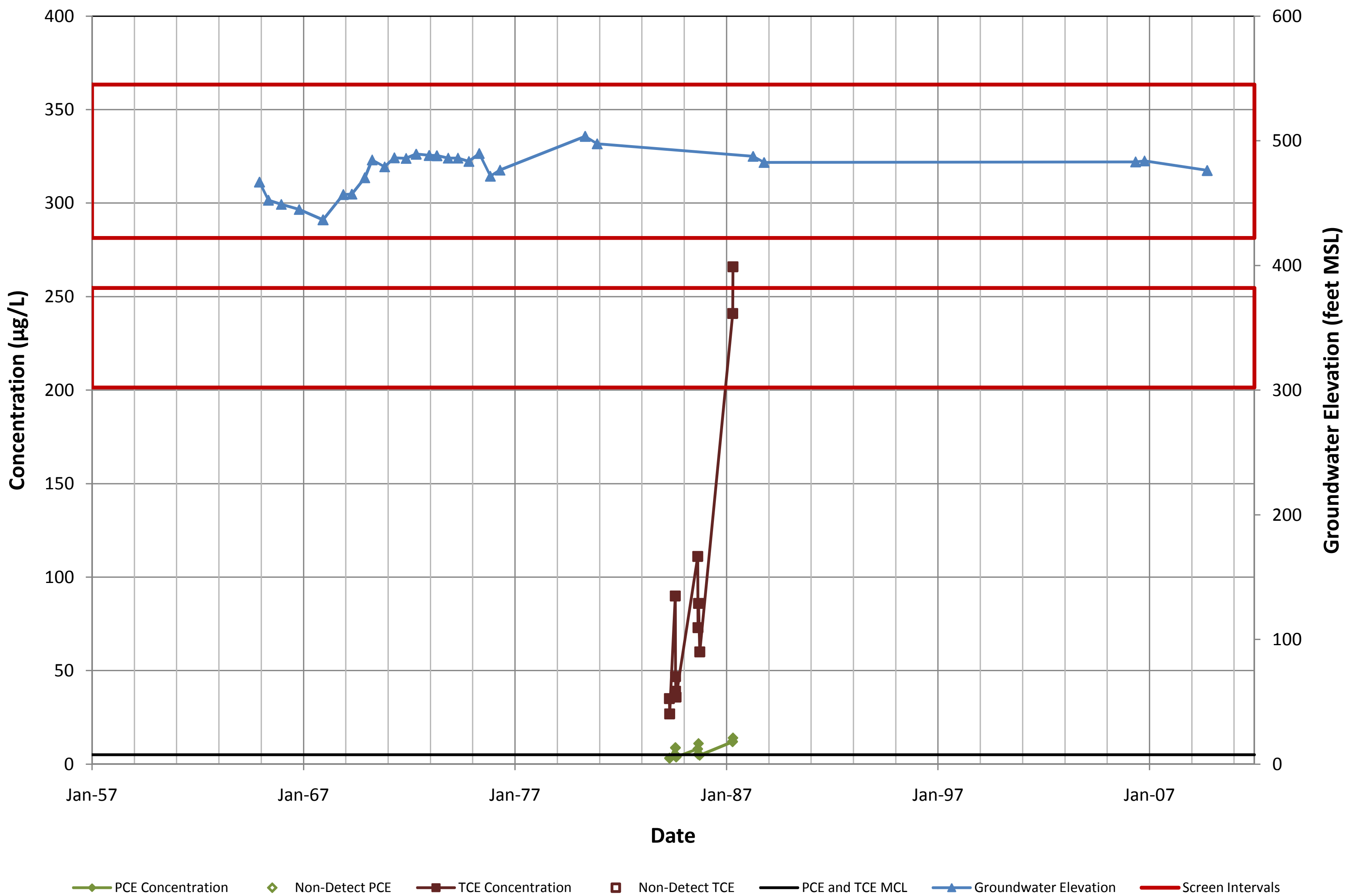
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Production Well Field NH-18
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-P-12**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



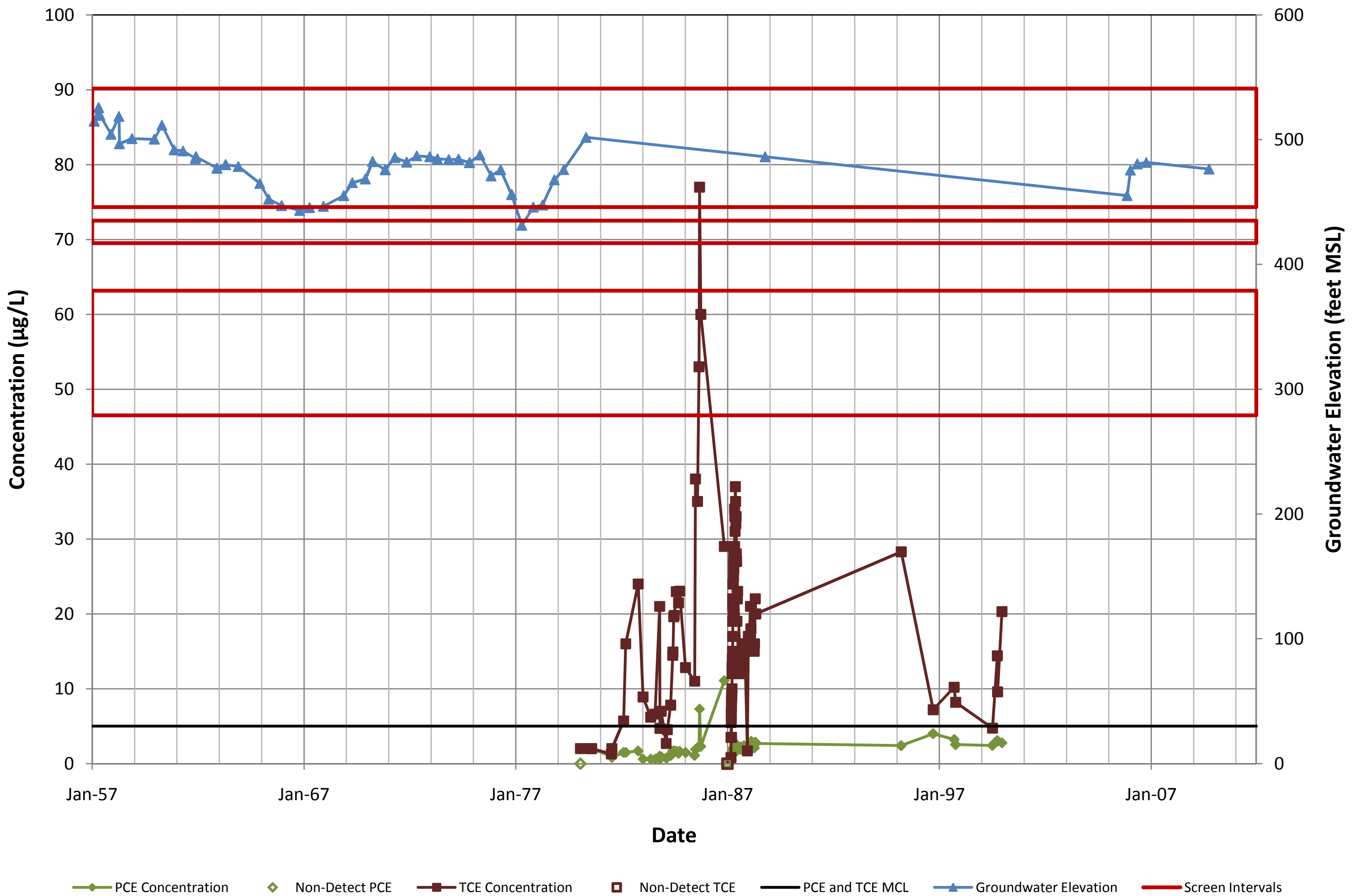
amec

PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Production Well Field NH-19
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-P-13

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



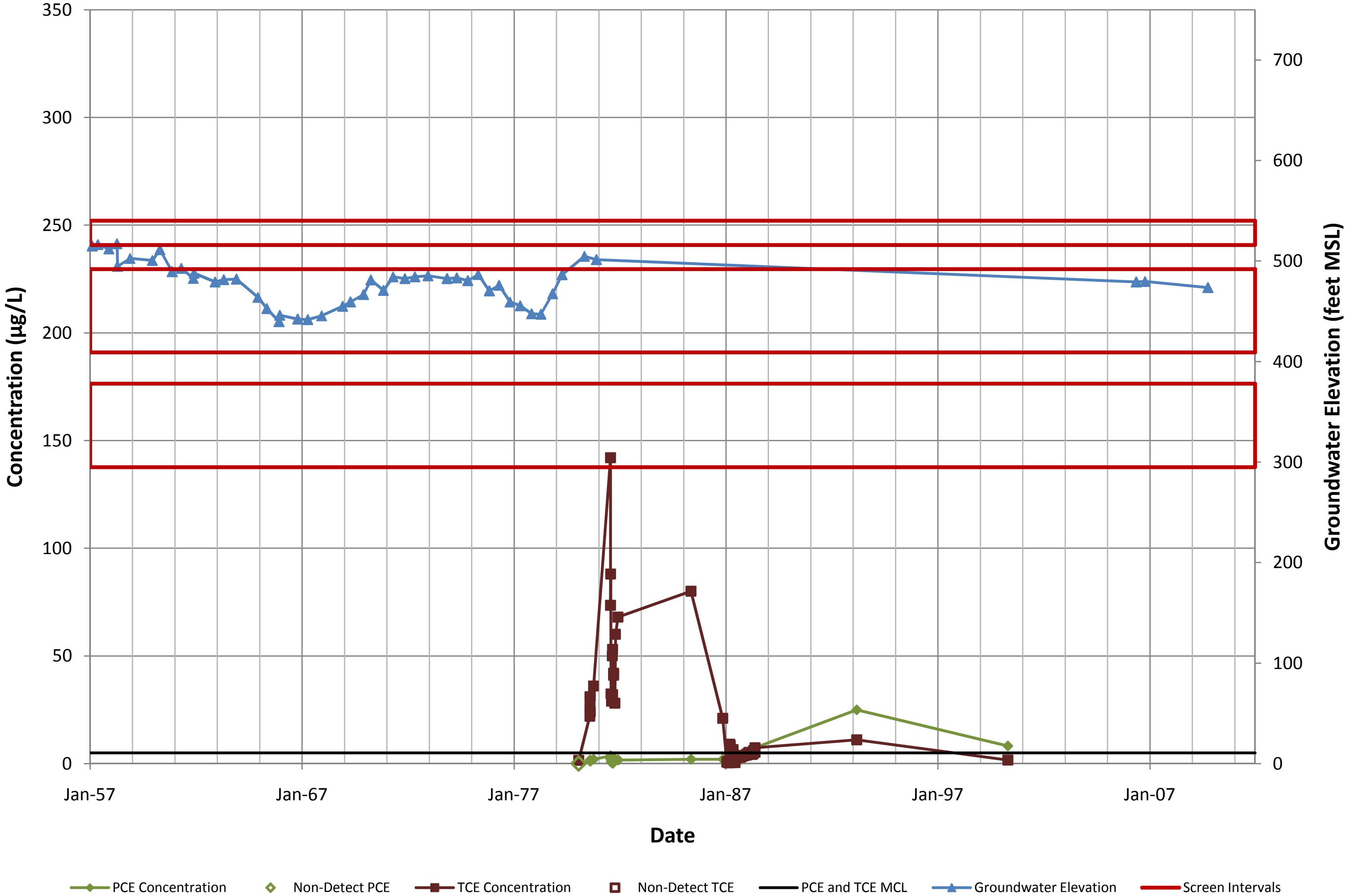
amec

PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Production Well Field NH-20
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-P-14

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



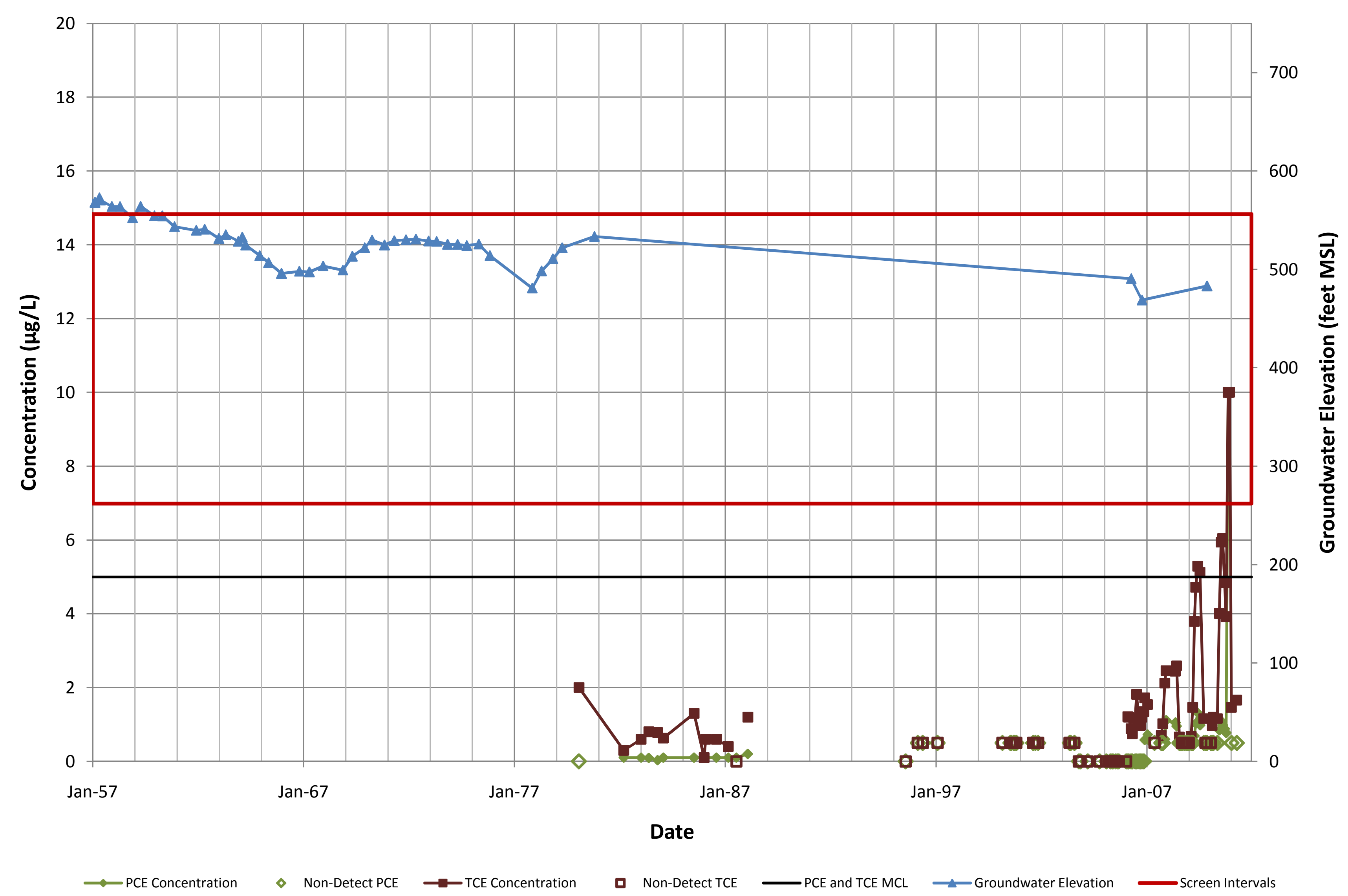
amec

PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Production Well Field NH-21
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

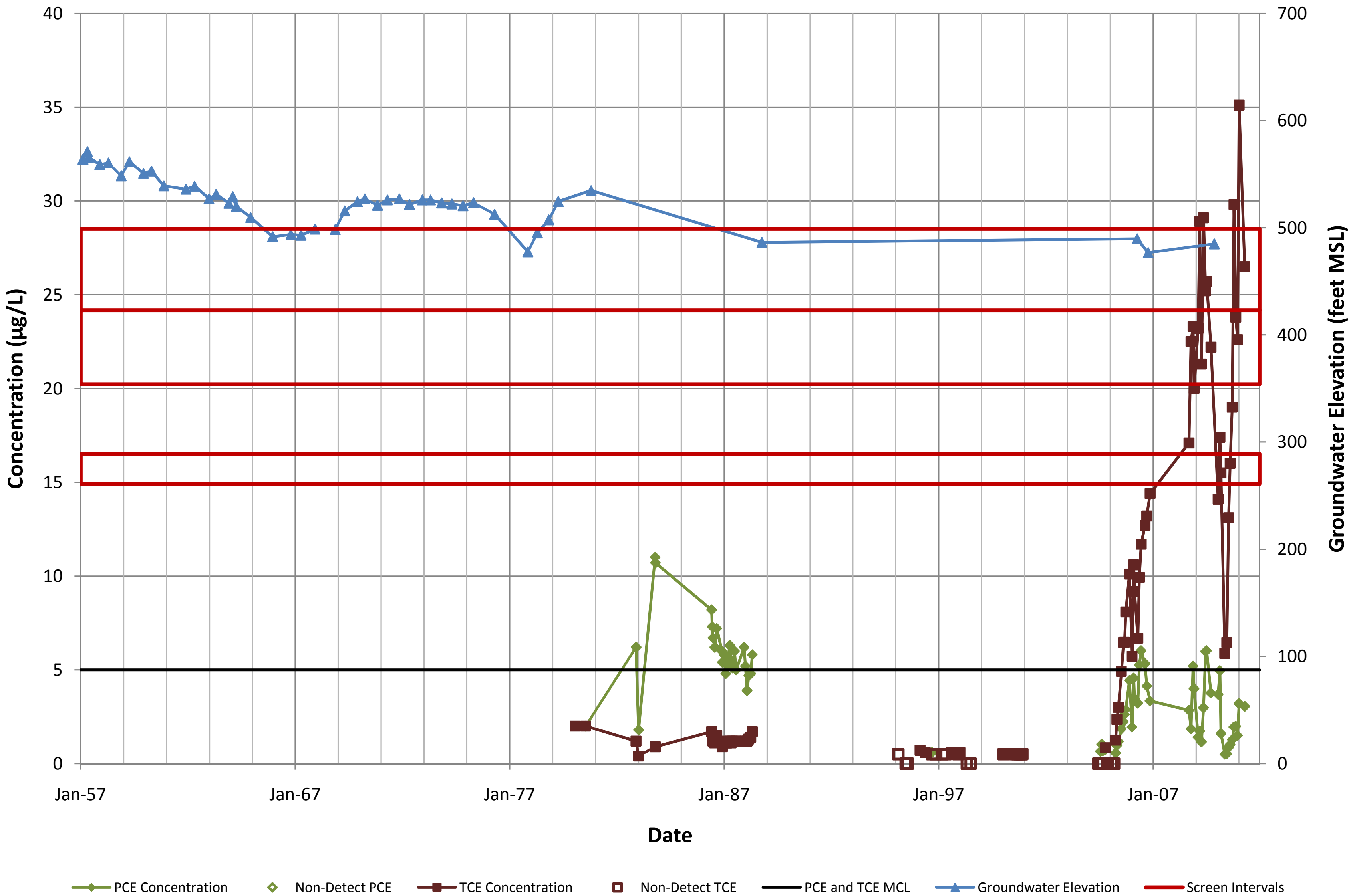
F-P-15

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

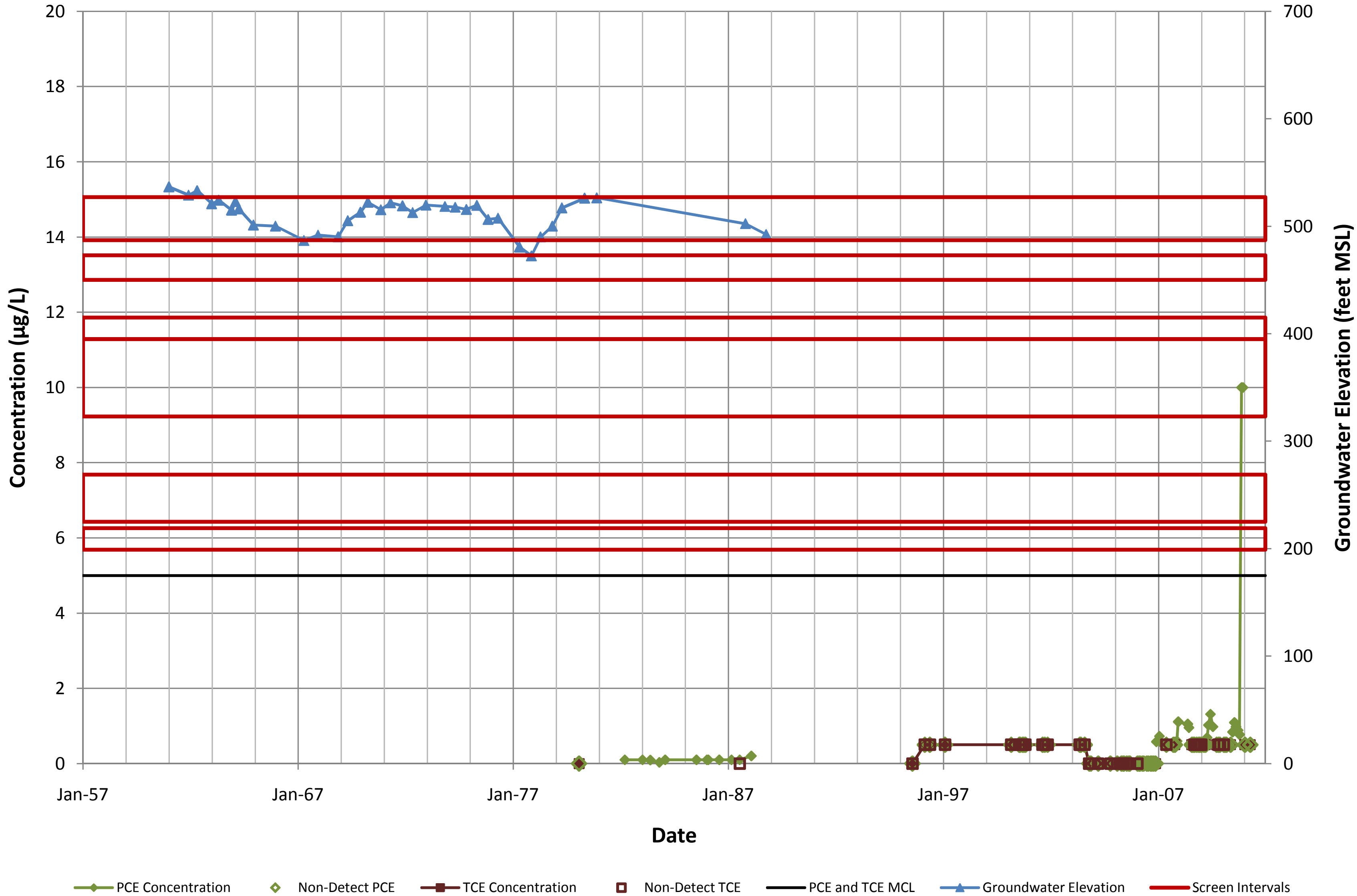


amec	PCE and TCE Concentrations and Groundwater Elevations North Hollywood Production Well Field NH-22 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-P-16**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	PCE and TCE Concentrations and Groundwater Elevations North Hollywood Production Well Field NH-23 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **F-P-17**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 7/2011



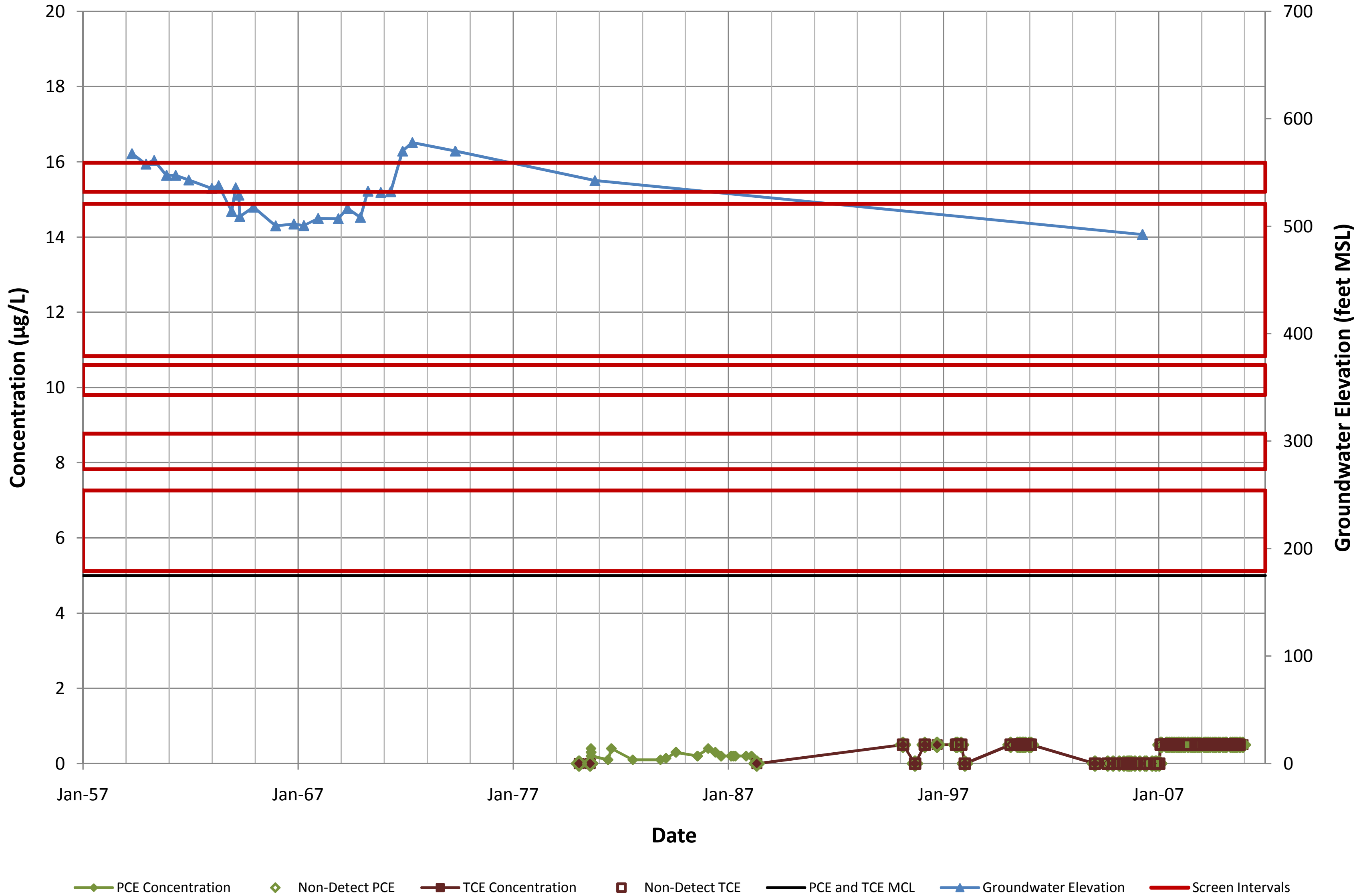
amec

PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Production Well Field NH-24
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

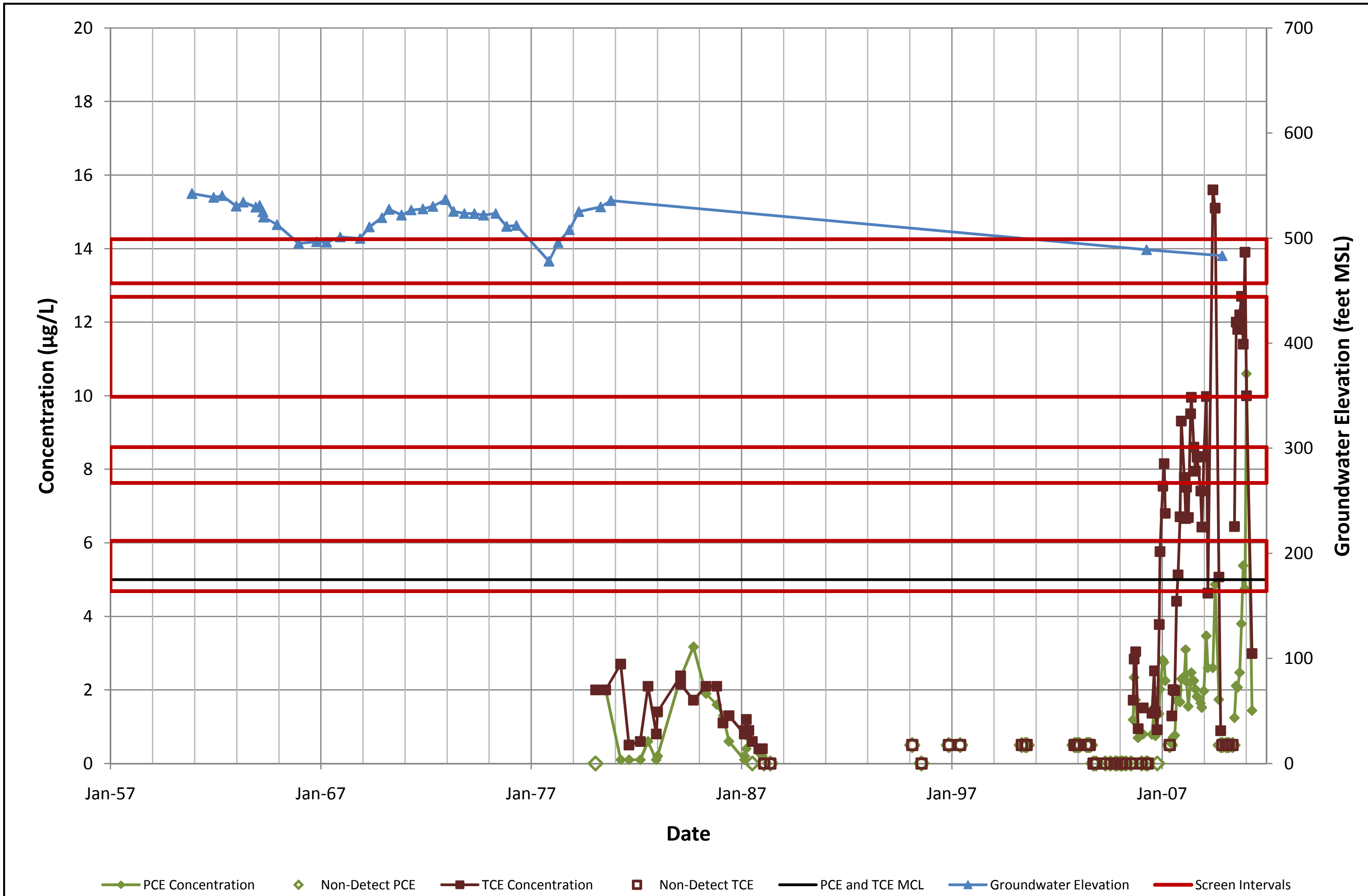
Figure:

F-P-18

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	PCE and TCE Concentrations and Groundwater Elevations North Hollywood Production Well Field NH-25 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **F-P-19**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 7/2011



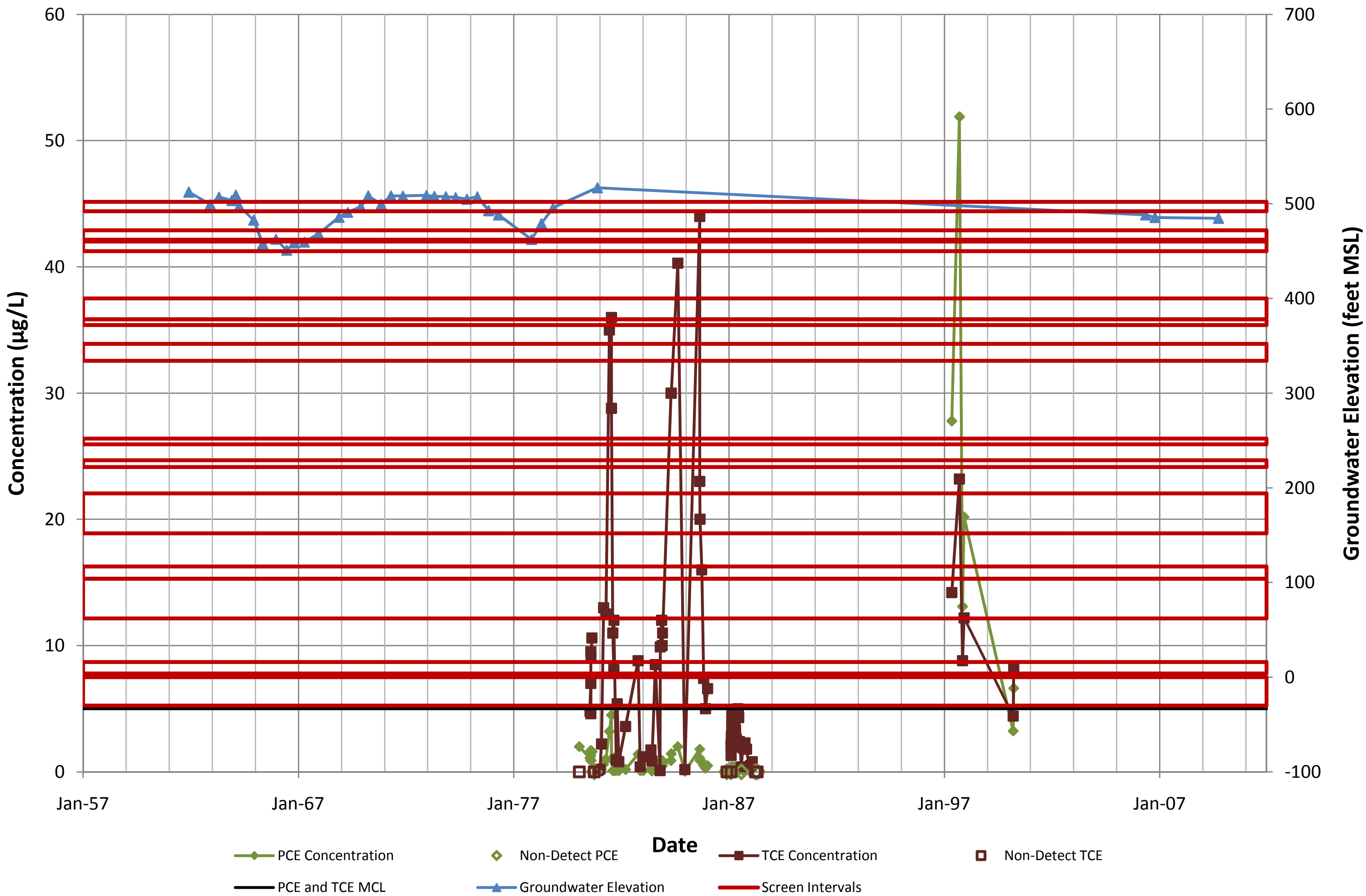
amec

PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Production Well Field NH-26
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

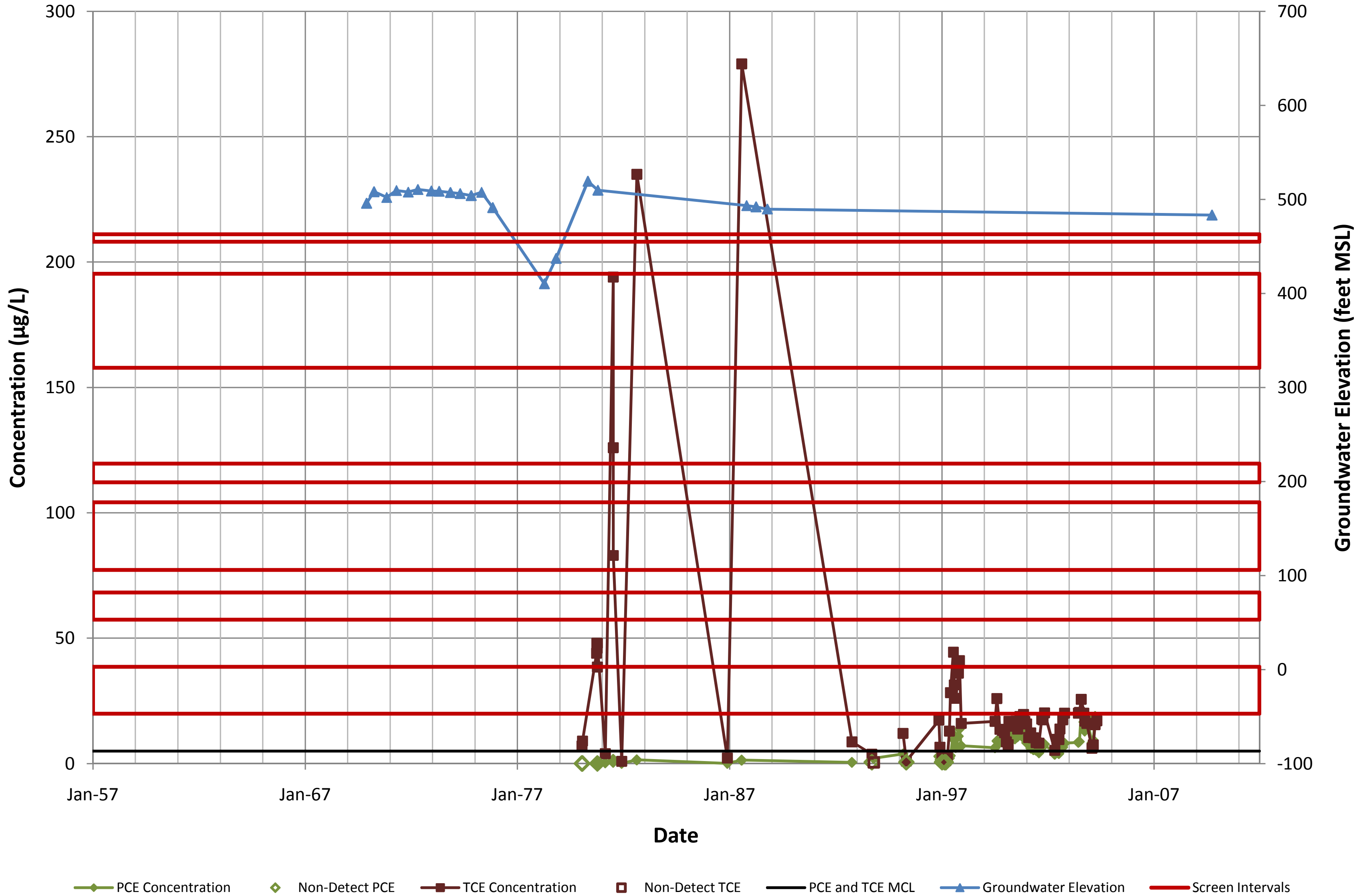
F-P-20

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	PCE and TCE Concentrations and Groundwater Elevations North Hollywood Production Well Field NH-27 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-P-21**

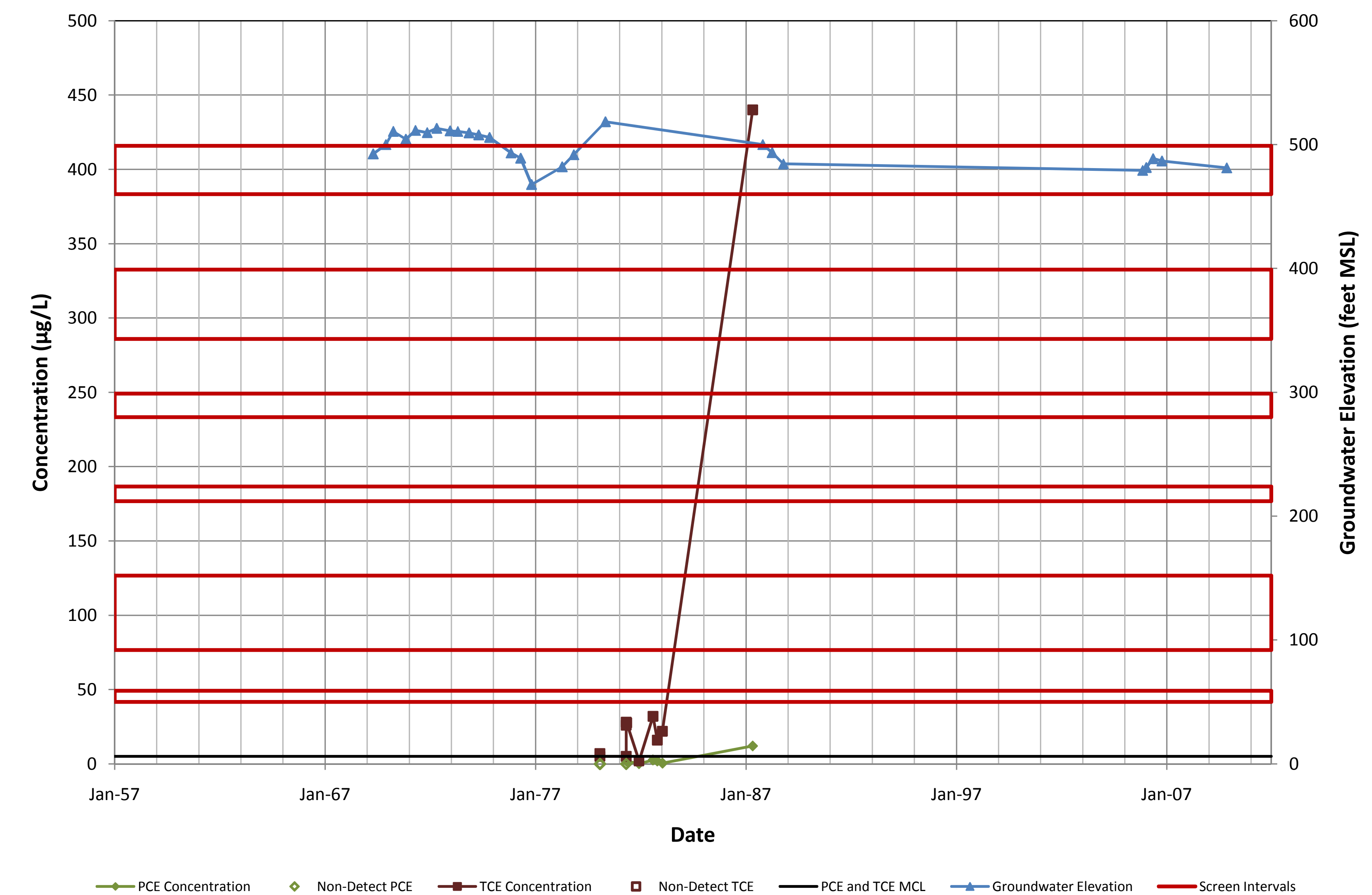
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Production Well Field NH-28
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-P-22**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



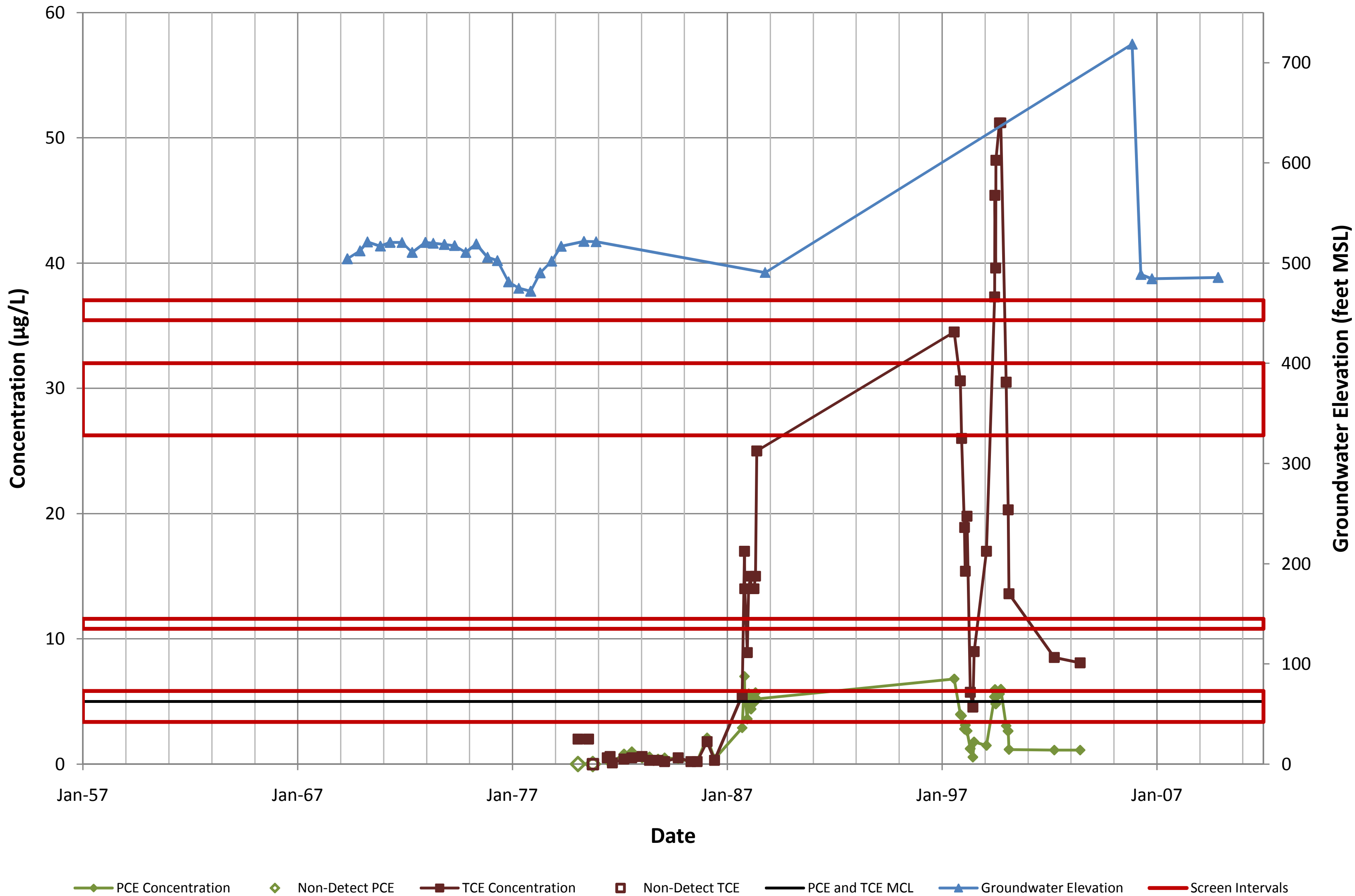
amec

PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Production Well Field NH-29
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-P-23

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	PCE and TCE Concentrations and Groundwater Elevations North Hollywood Production Well Field NH-30 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **F-P-24**
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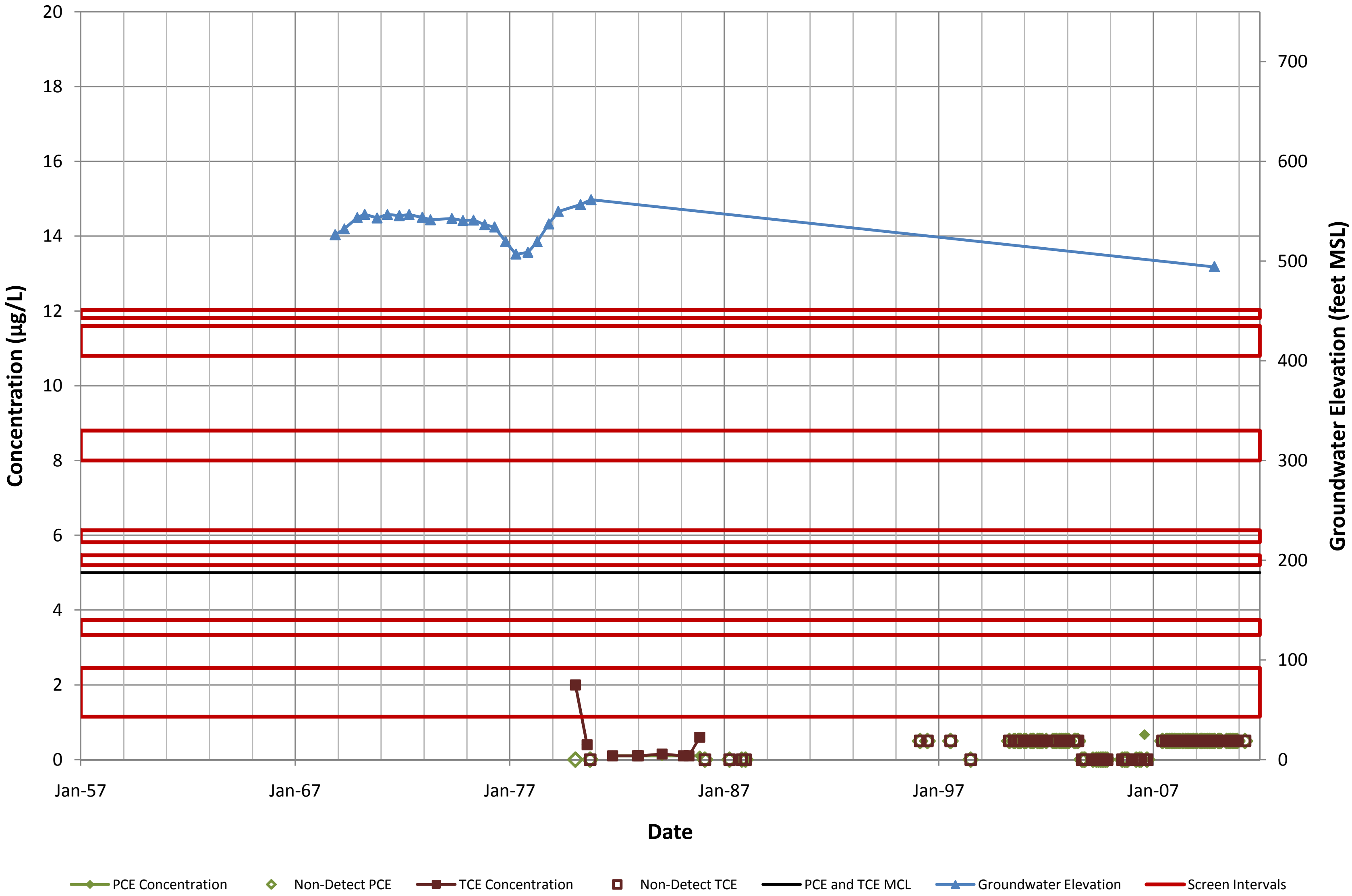
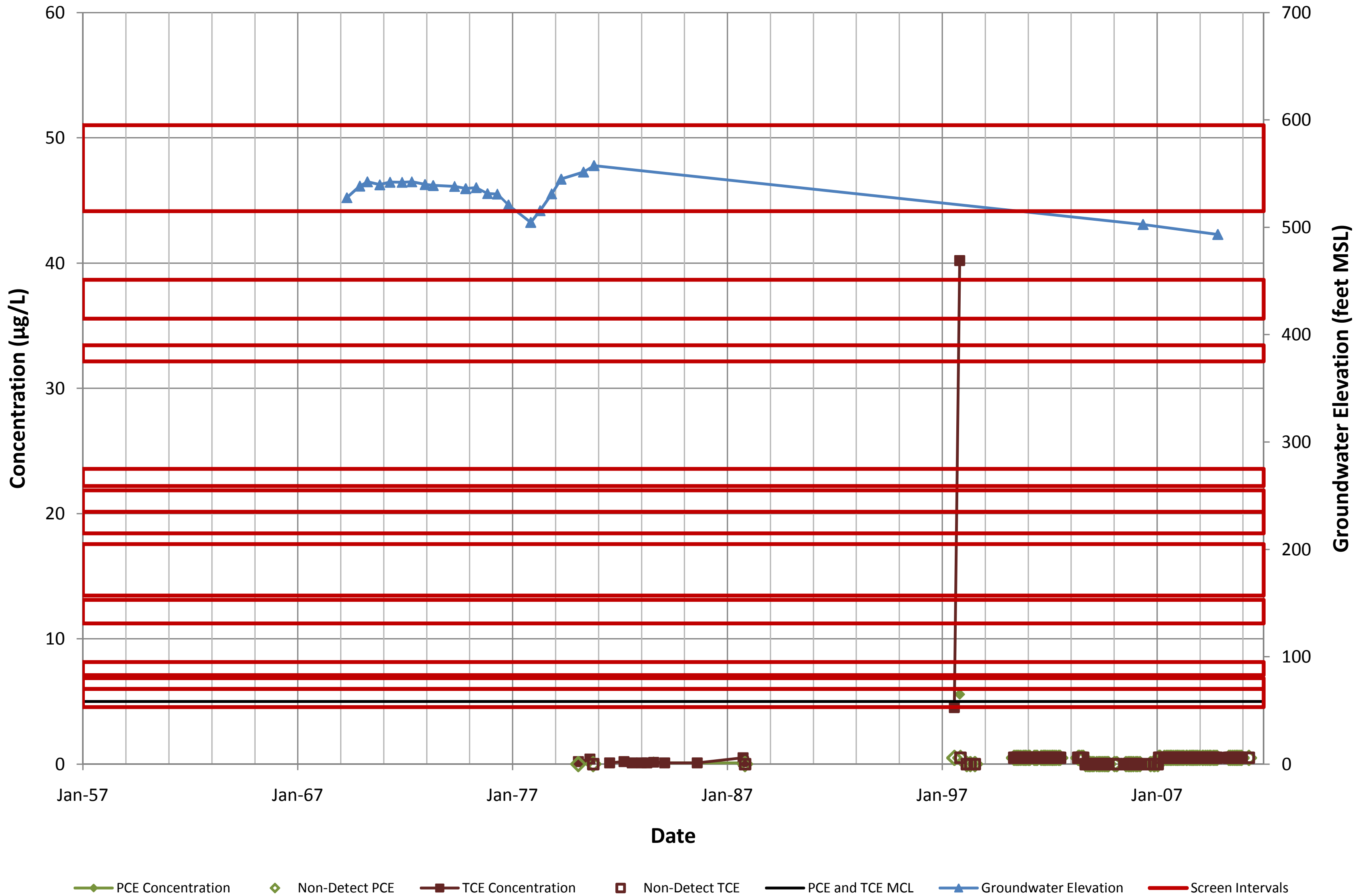


amec

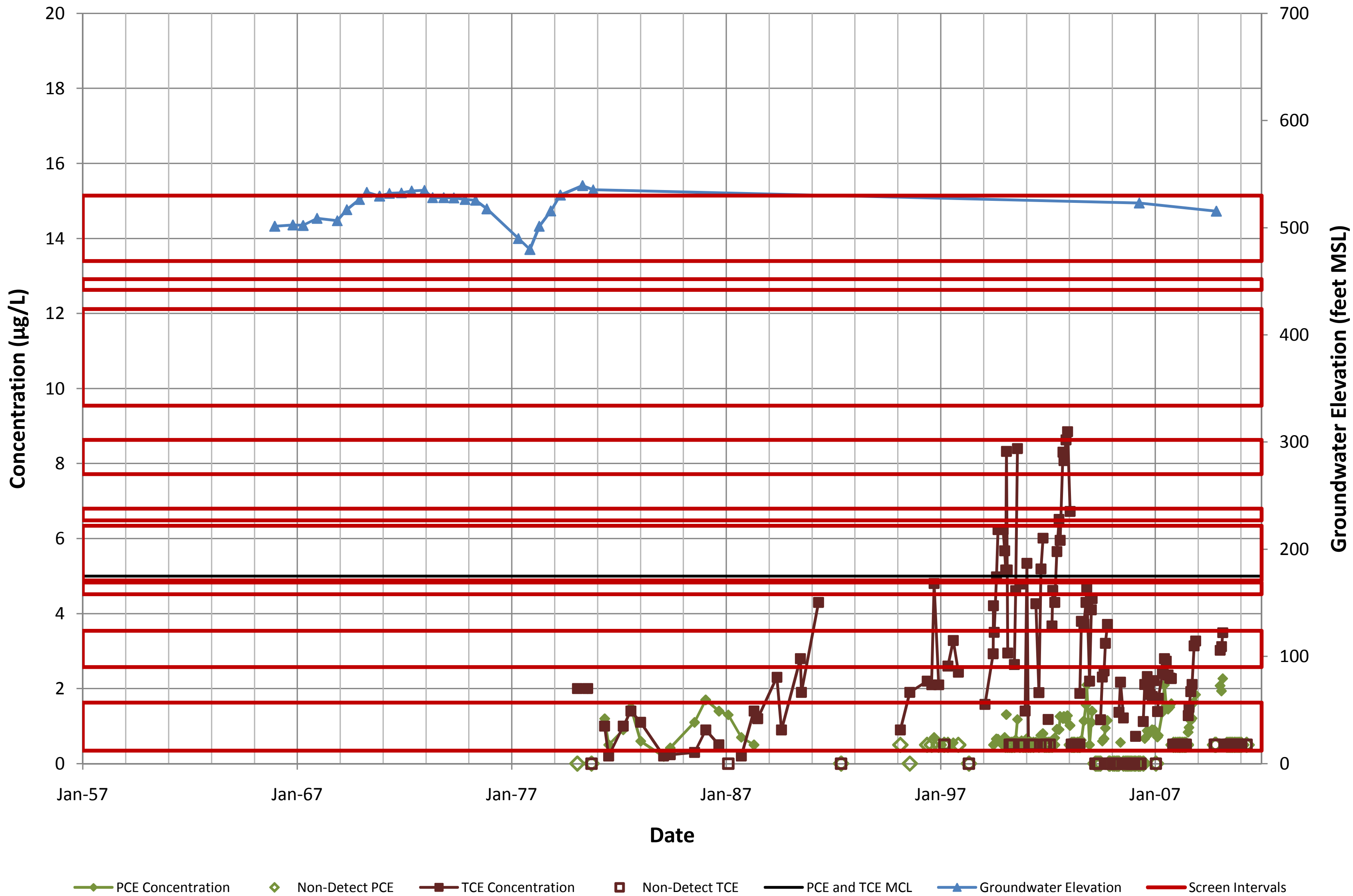
PCE and TCE Concentrations and Groundwater Elevations
North Hollywood Production Well Field NH-32
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-P-25**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

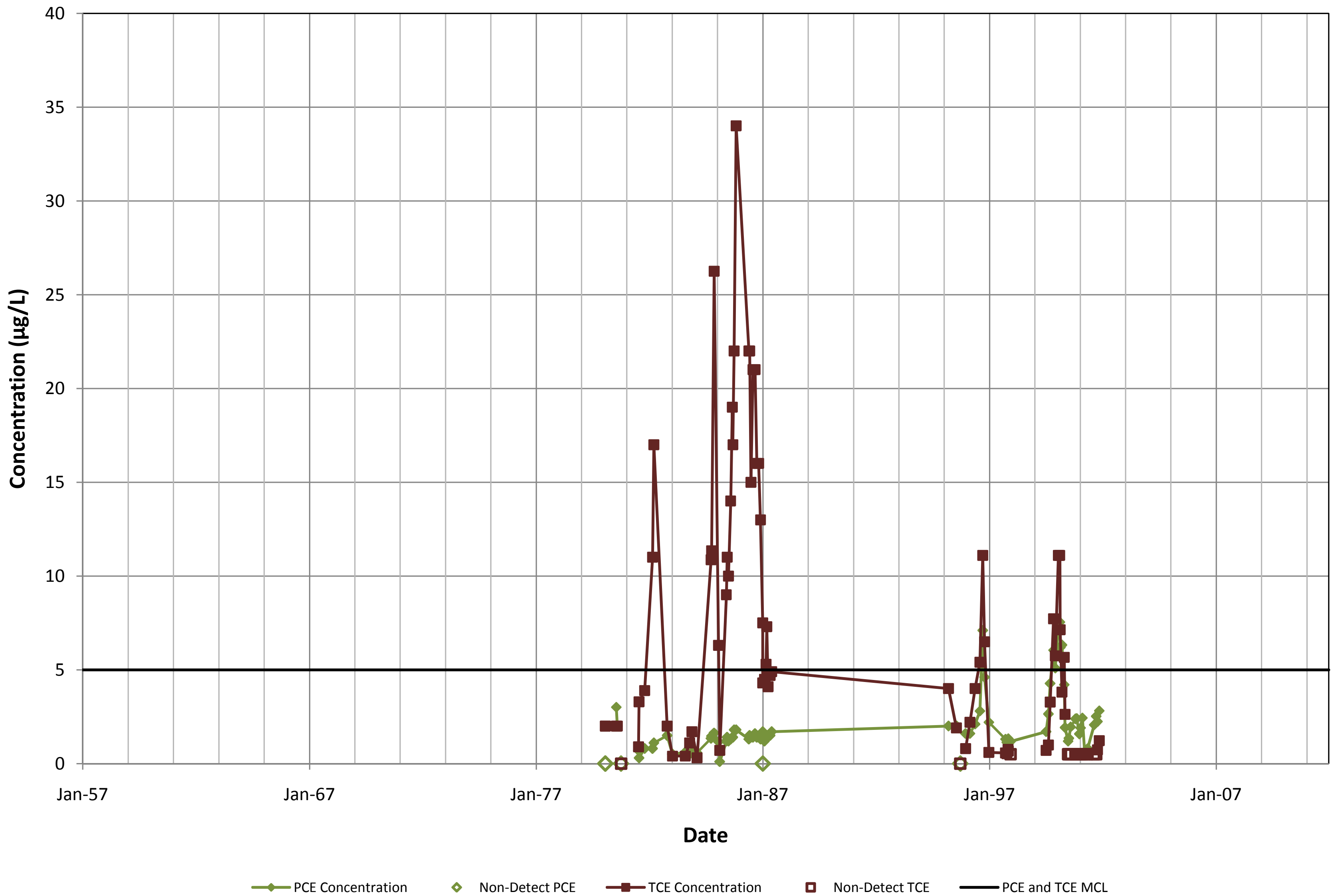


amec	PCE and TCE Concentrations and Groundwater Elevations North Hollywood Production Well Field NH-33 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **F-P-26**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 7/2011



amec	PCE and TCE Concentrations and Groundwater Elevations North Hollywood Production Well Field NH-34 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: F-P-27

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



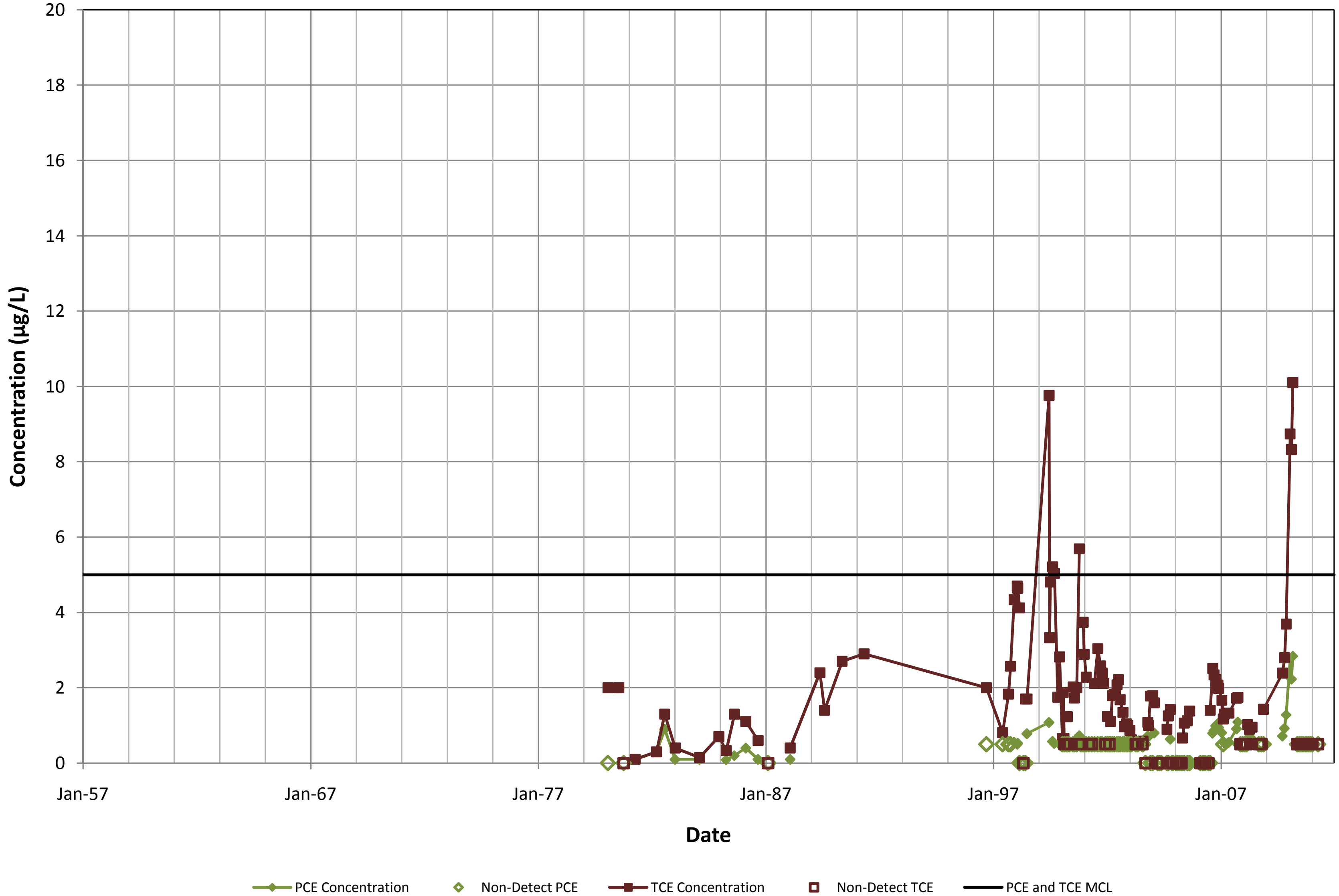
amec

PCE and TCE Concentrations
North Hollywood Production Well Field NH-35
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

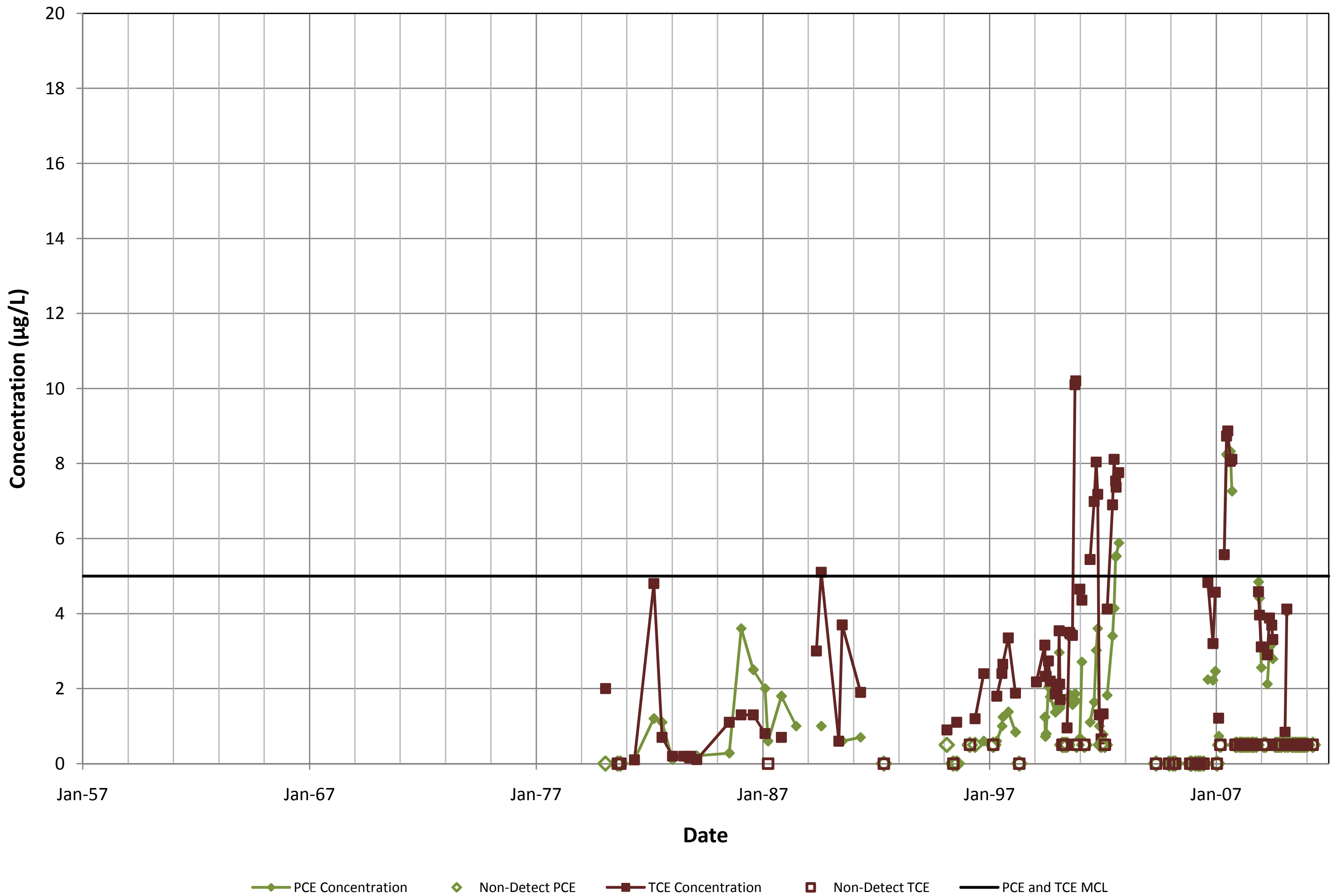
F-P-28

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	PCE and TCE Concentrations North Hollywood Production Well Field NH-36 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-P-29**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



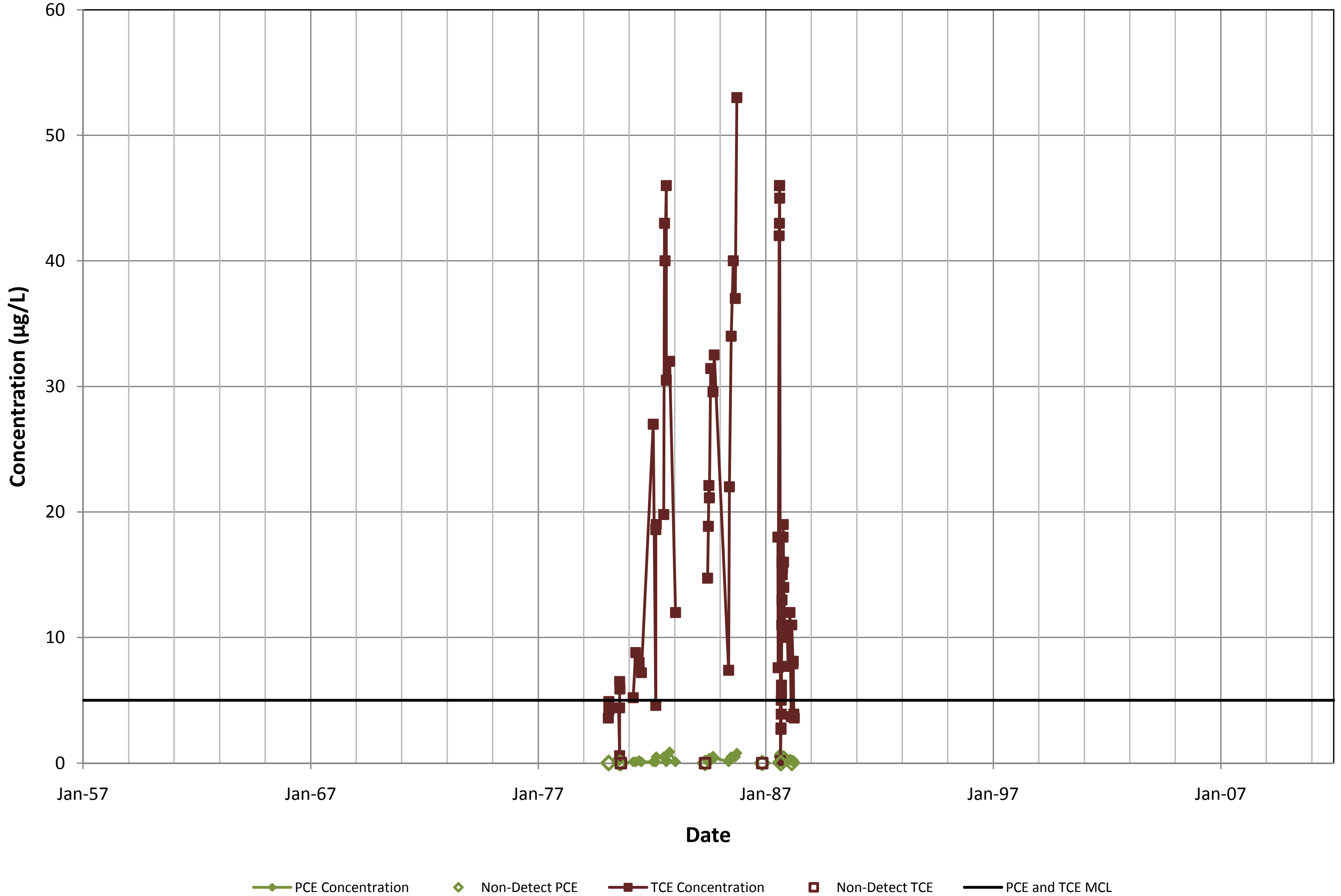
amec

PCE and TCE Concentrations
North Hollywood Production Well Field NH-37
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

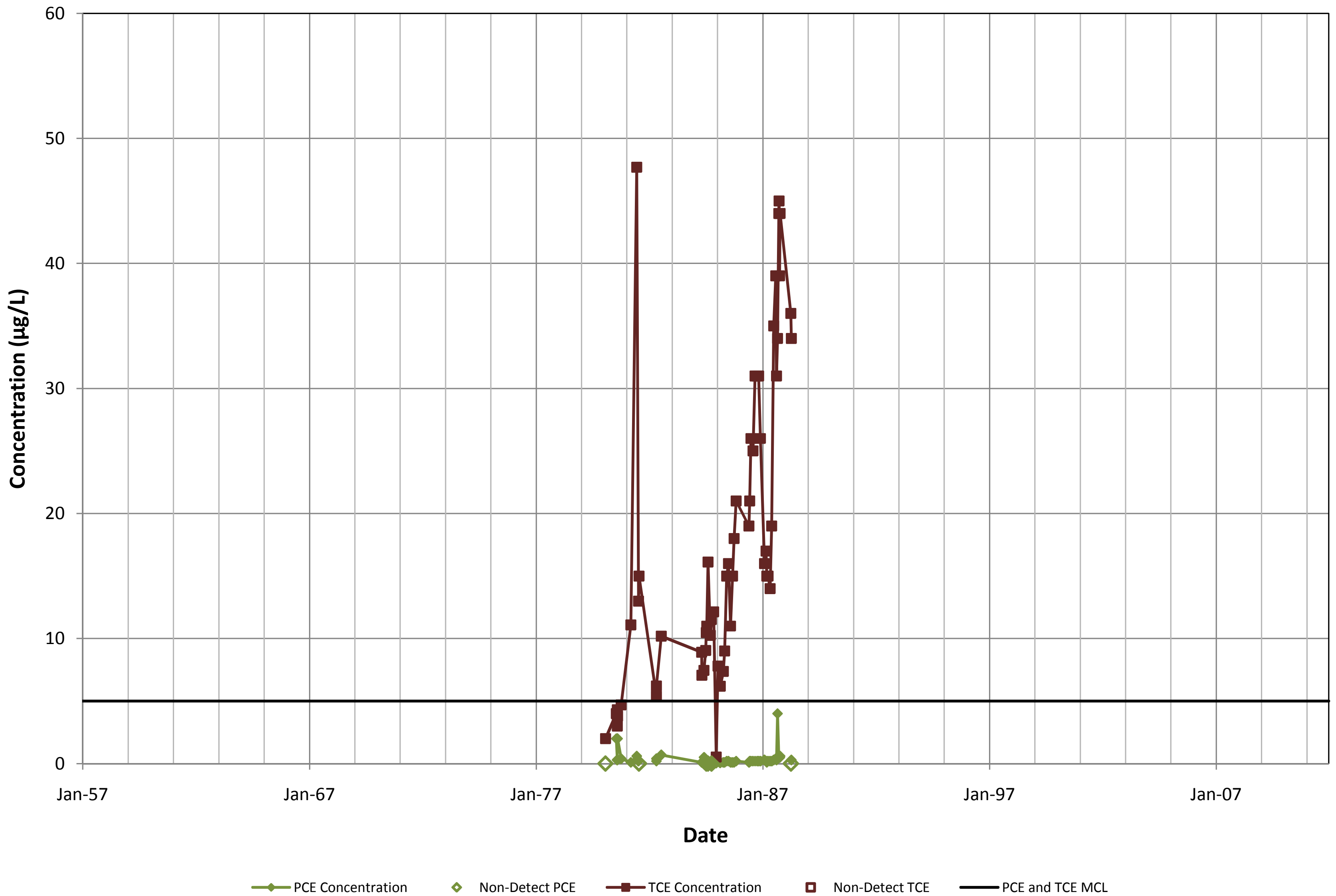
F-P-30

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



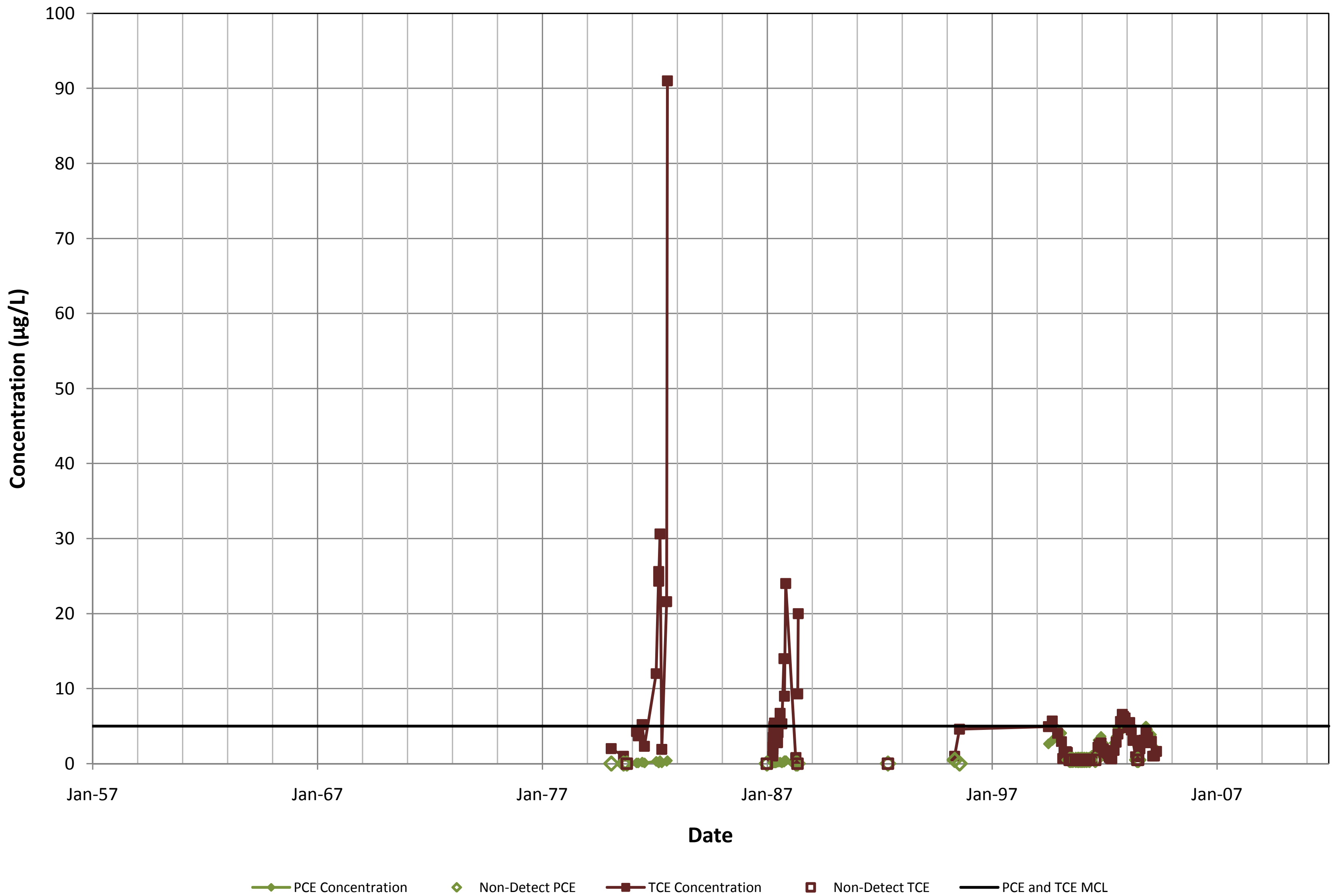
amec	PCE and TCE Concentrations North Hollywood Production Well Field NH-38 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-P-31**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	PCE and TCE Concentrations North Hollywood Production Well Field NH-39 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-P-32**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

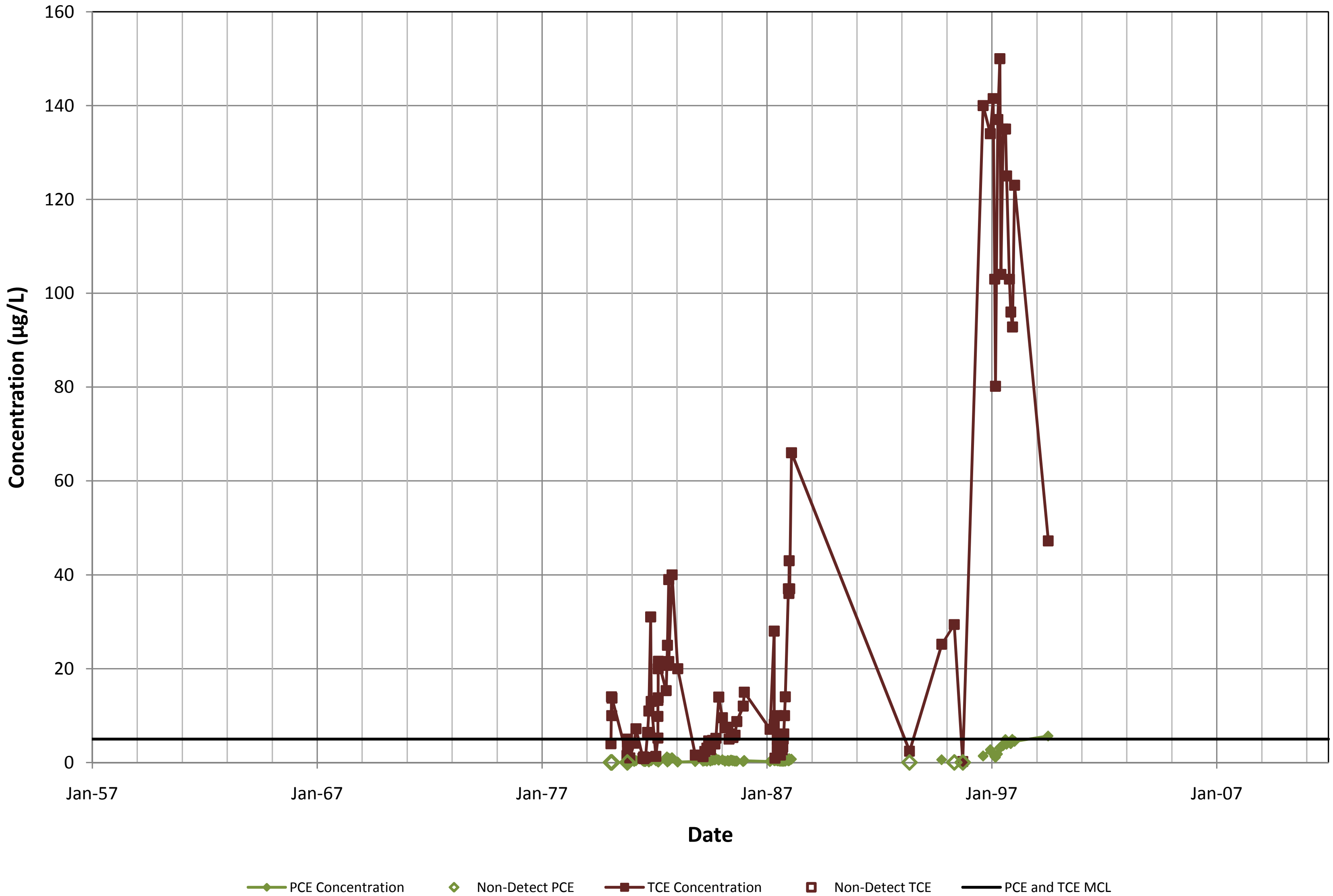


amec

PCE and TCE Concentrations
North Hollywood Production Well Field NH-40
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

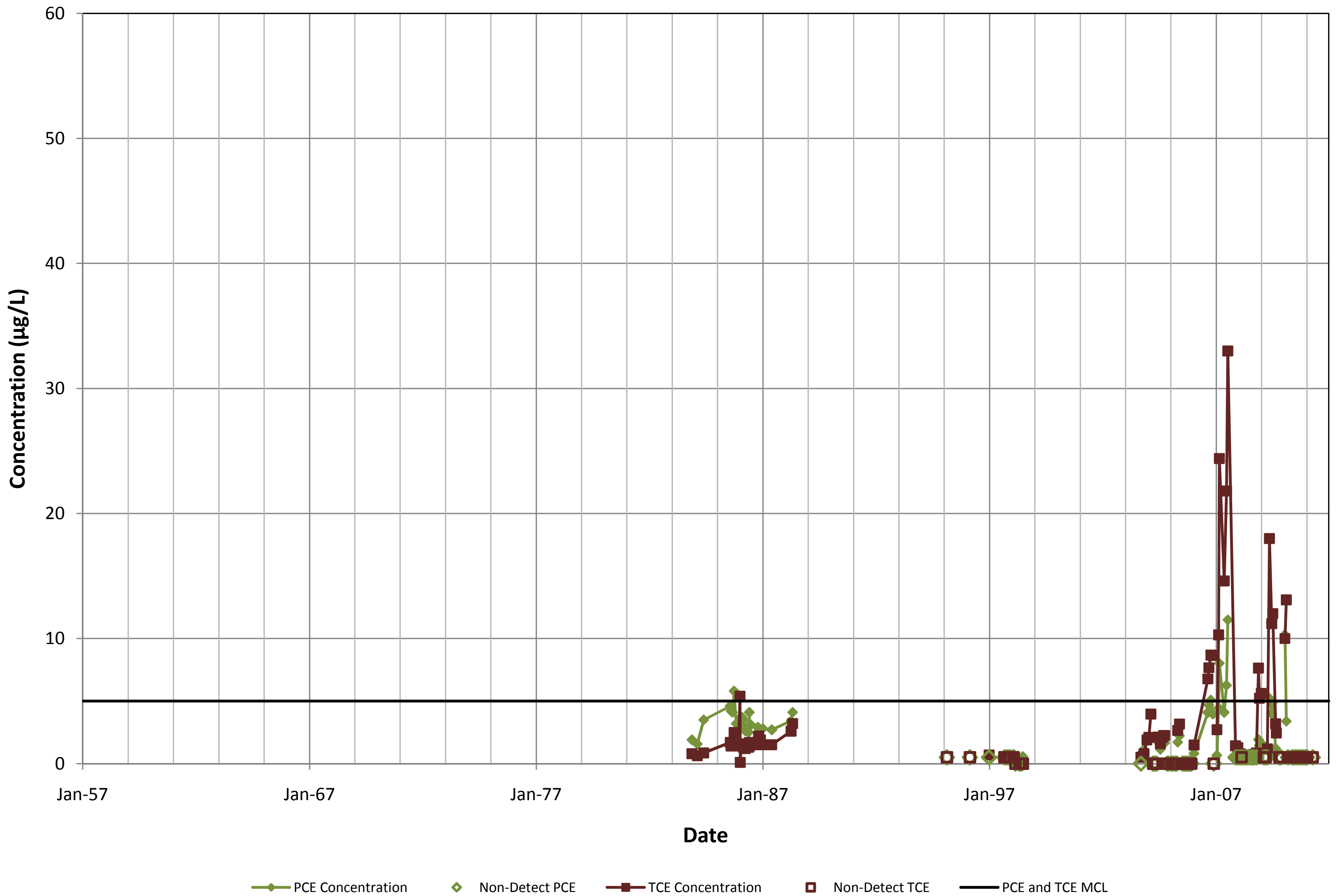
Figure: **F-P-33**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	PCE and TCE Concentrations North Hollywood Production Well Field NH-41 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-P-34**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

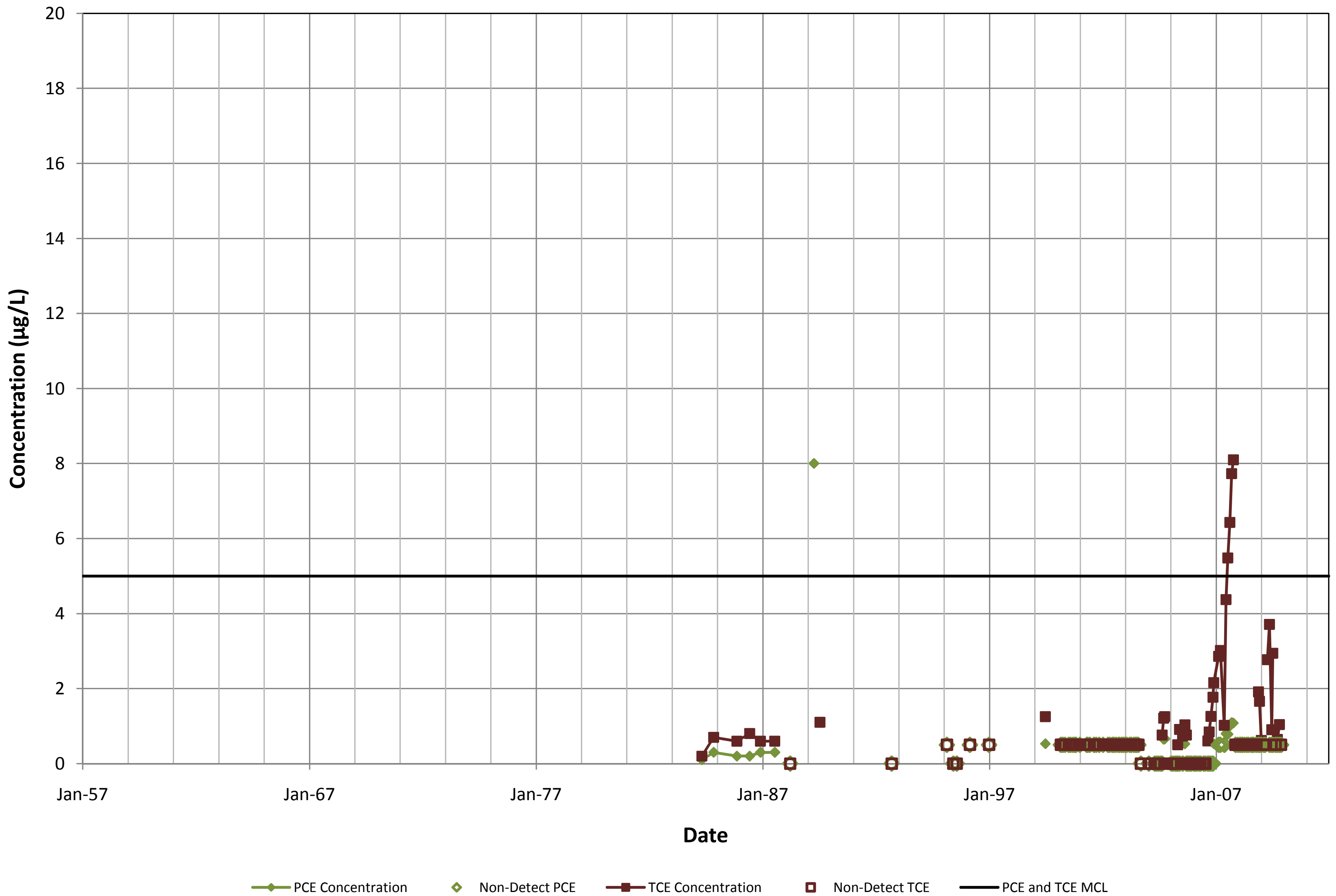


PCE and TCE Concentrations
North Hollywood Production Well Field NH-43A
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-P-35

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

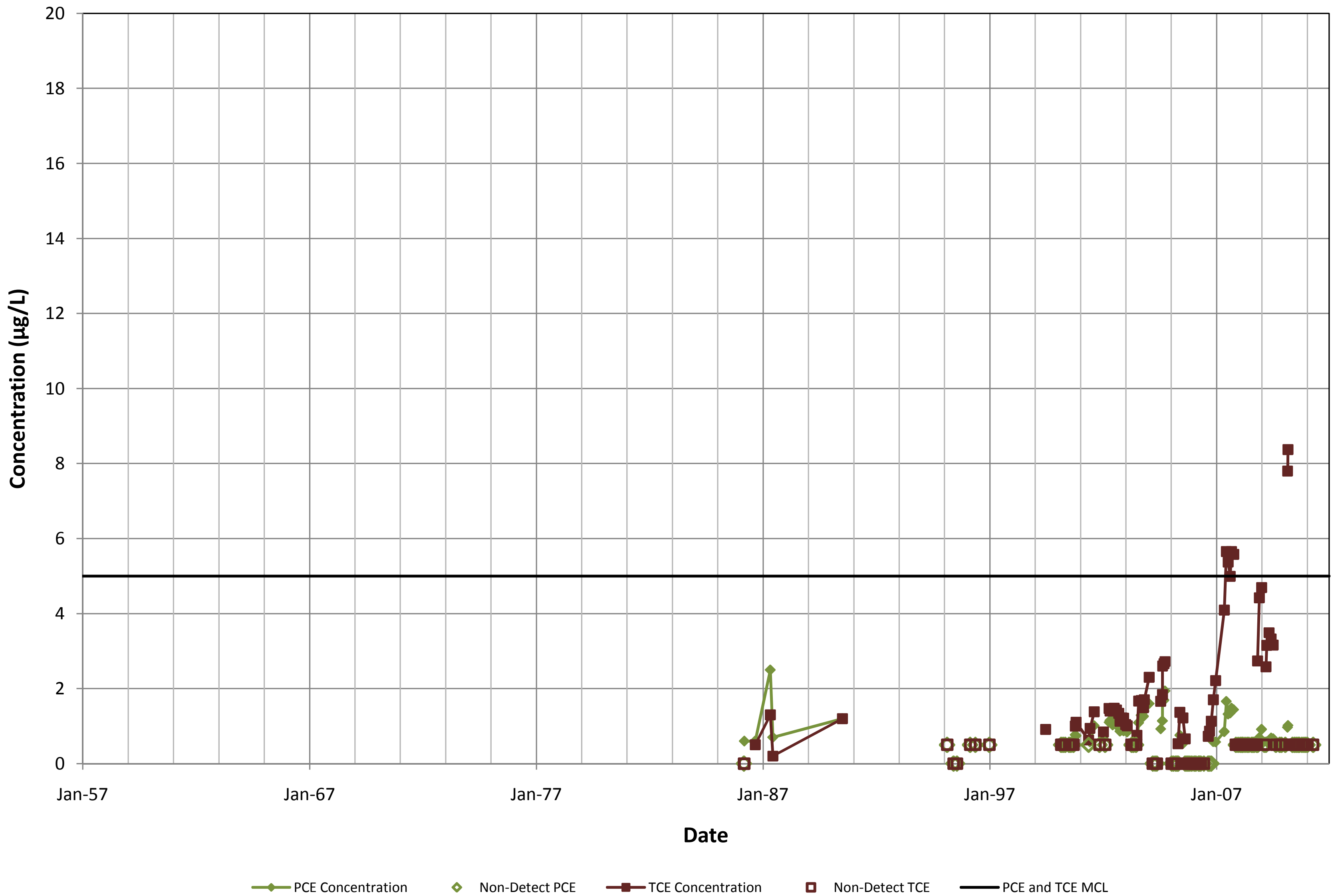


amec

PCE and TCE Concentrations
North Hollywood Production Well Field NH-44
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

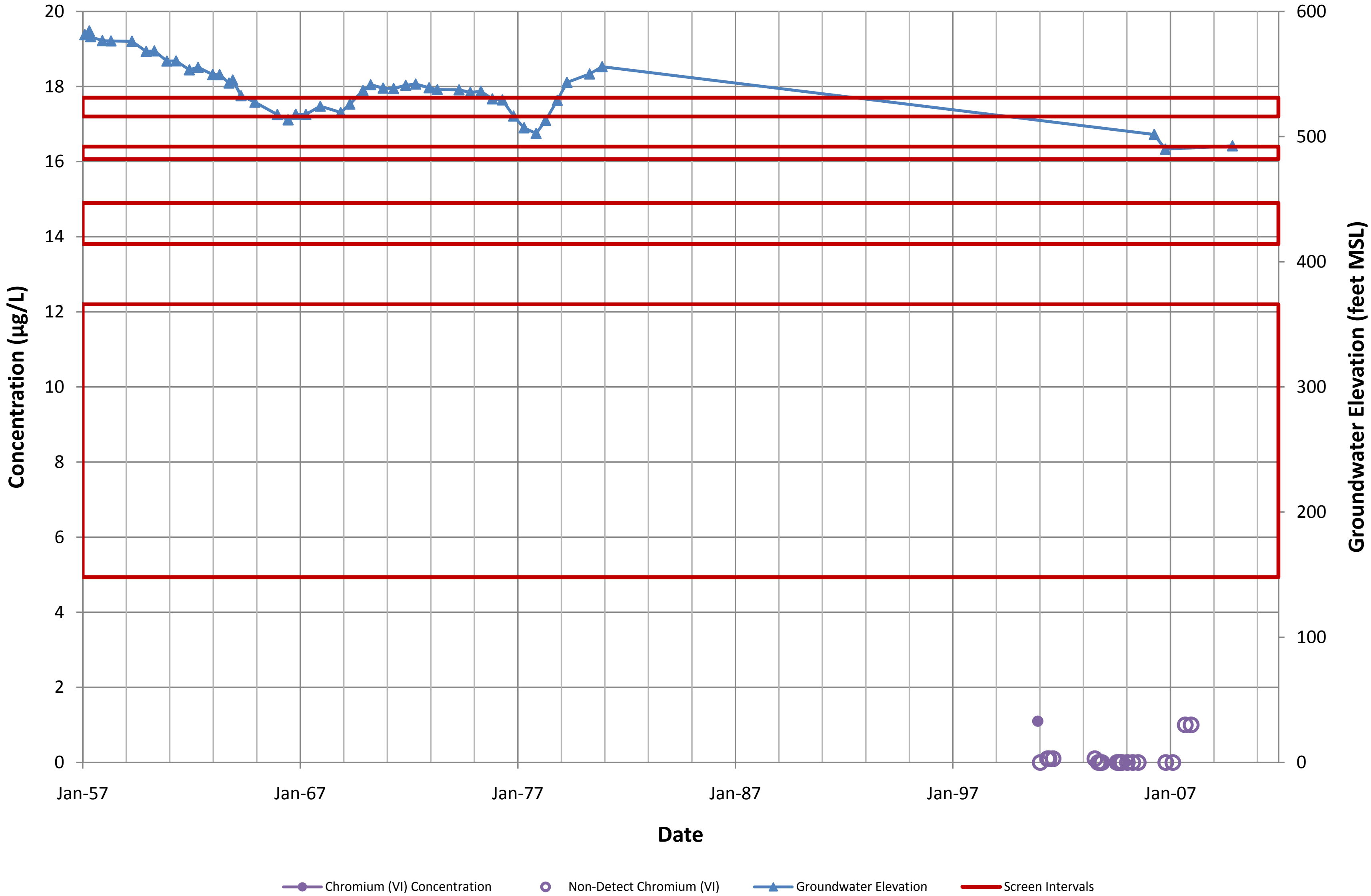
Figure: **F-P-36**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	PCE and TCE Concentrations North Hollywood Production Well Field NH-45 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-P-37**

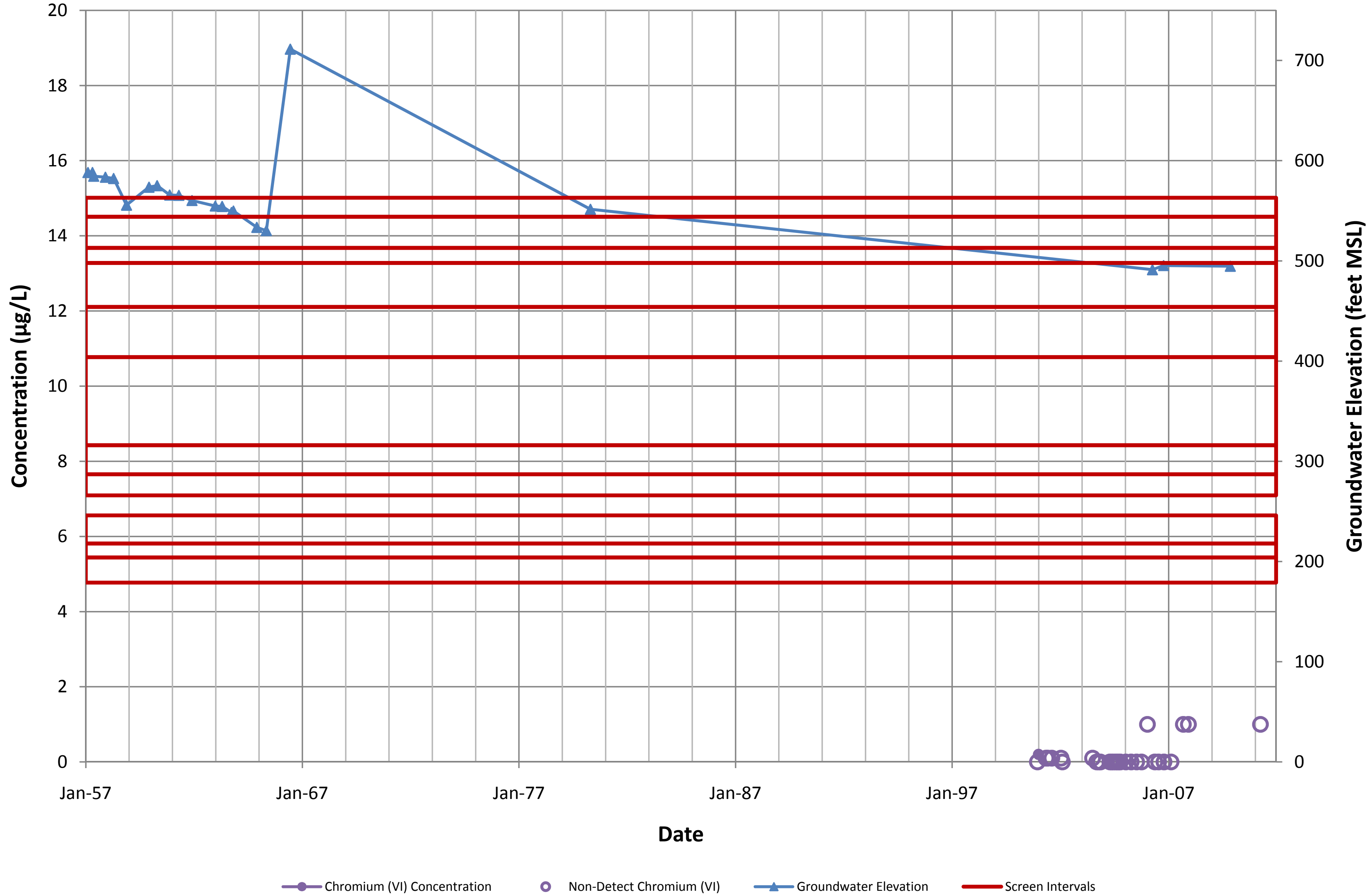
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



Chromium (VI) Concentration and Groundwater Elevation
North Hollywood Production Well Field NH-4
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-P-38**

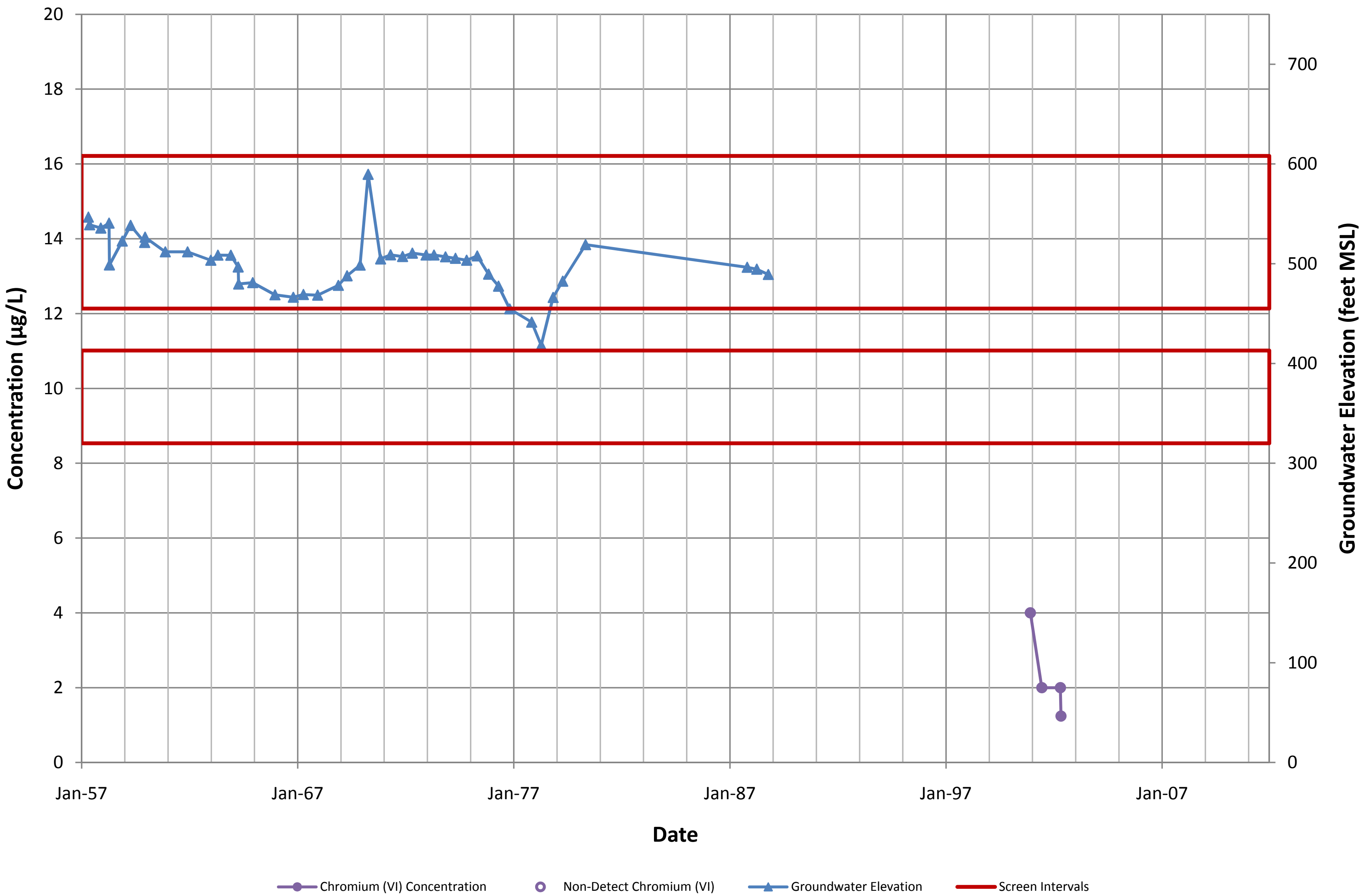
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



Chromium (VI) Concentration and Groundwater Elevation
North Hollywood Production Well Field NH-7
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-P-39**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

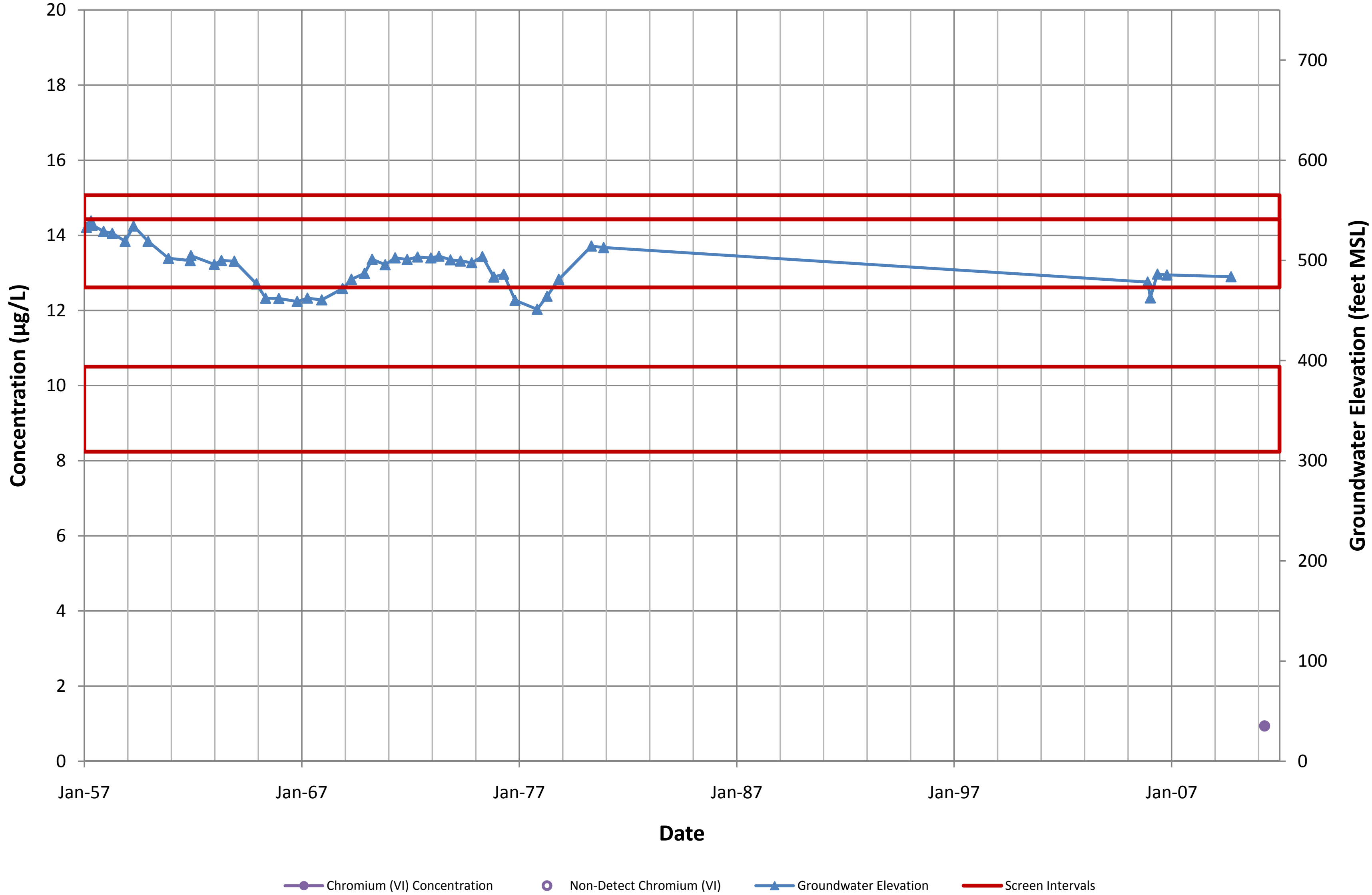


amec

Chromium (VI) Concentration and Groundwater Elevation
North Hollywood Production Well Field NH-11
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-P-40**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



Chromium (VI) Concentration and Groundwater Elevation
North Hollywood Production Well Field NH-16
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-P-41**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

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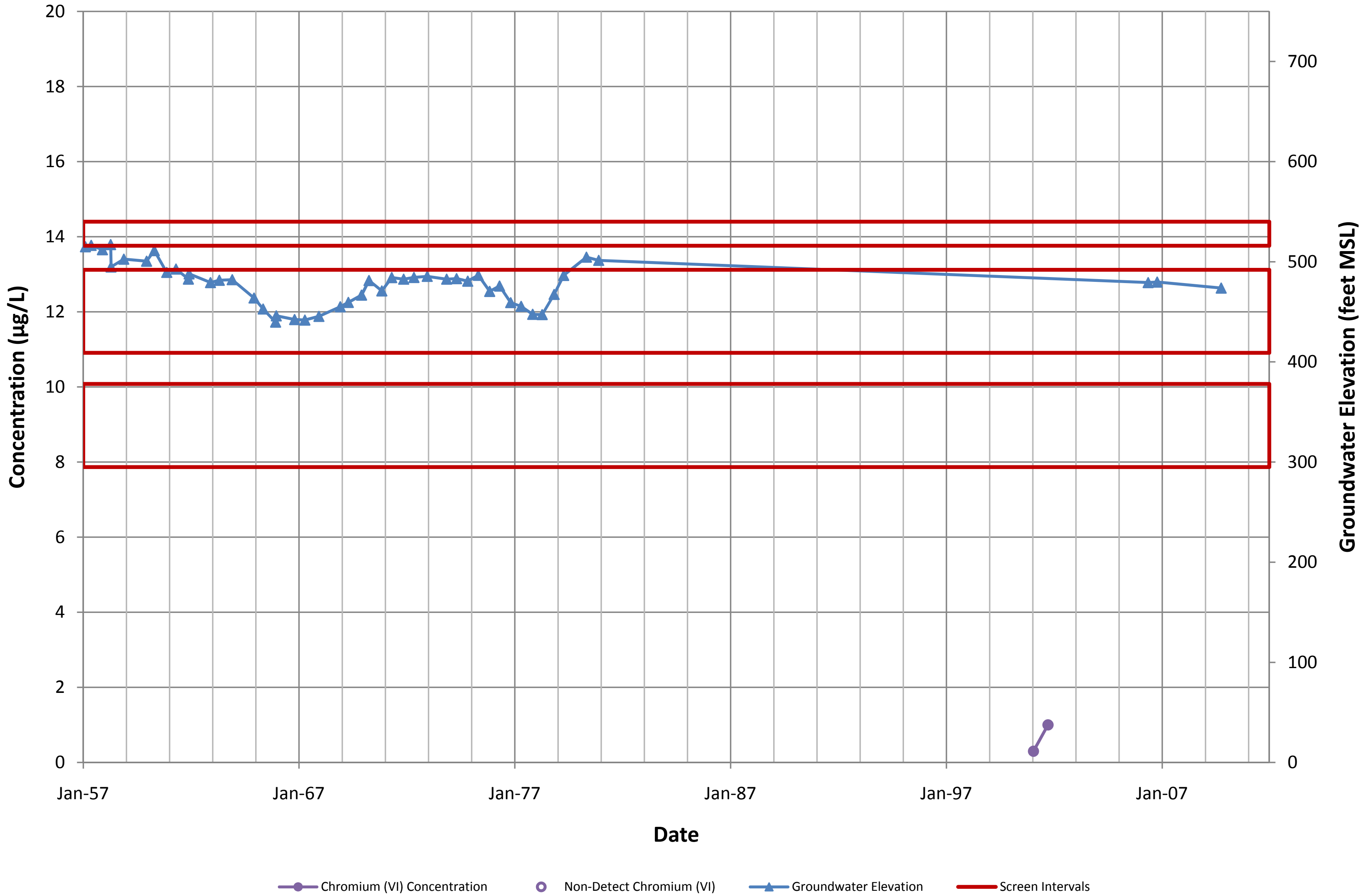
Chromium (VI) Concentration and Groundwater Elevation
North Hollywood Production Well Field NH-18
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:
F-P-42

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	Chromium (VI) Concentration and Groundwater Elevation North Hollywood Production Well Field NH-21 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **F-P-43**
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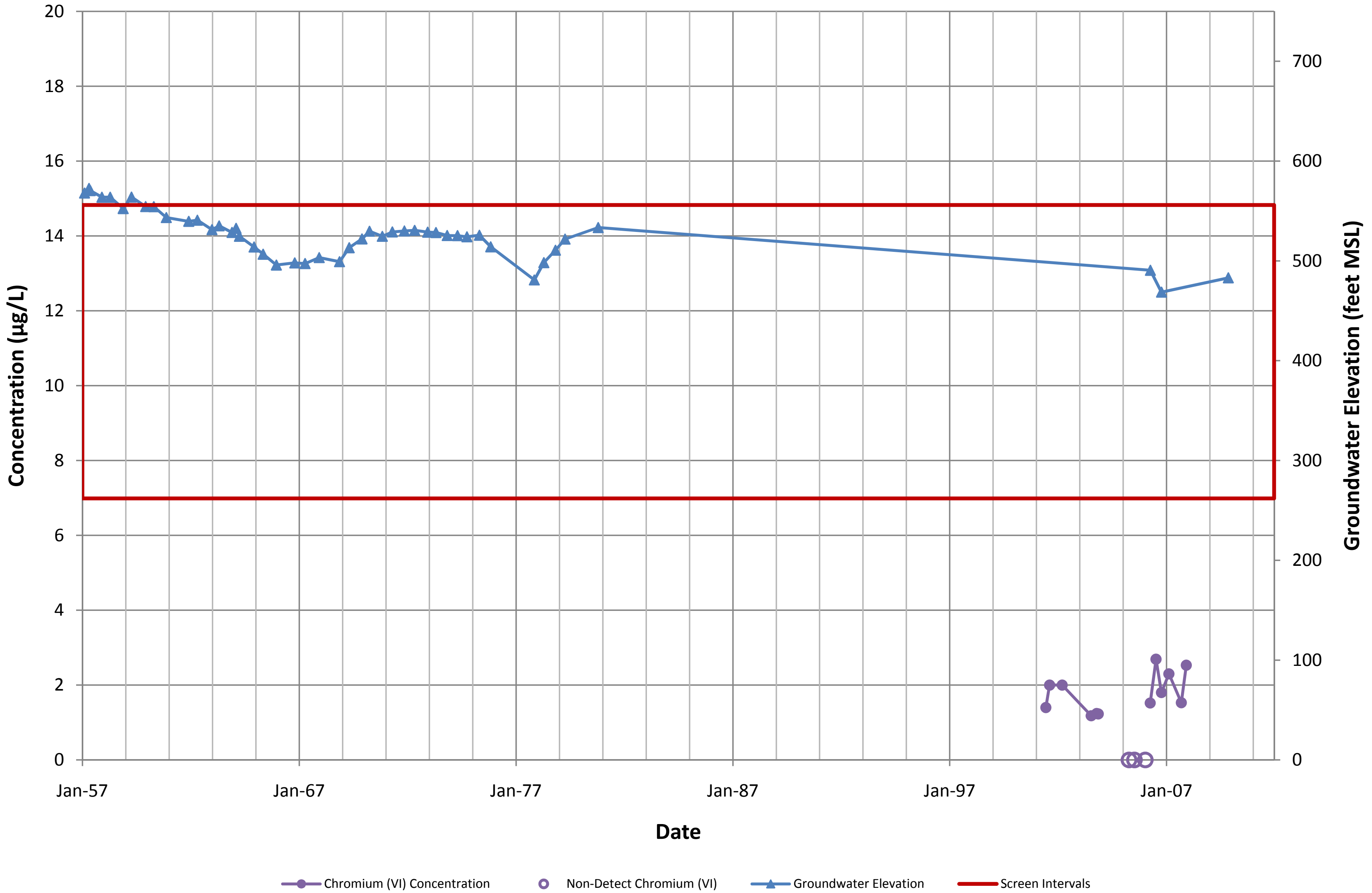
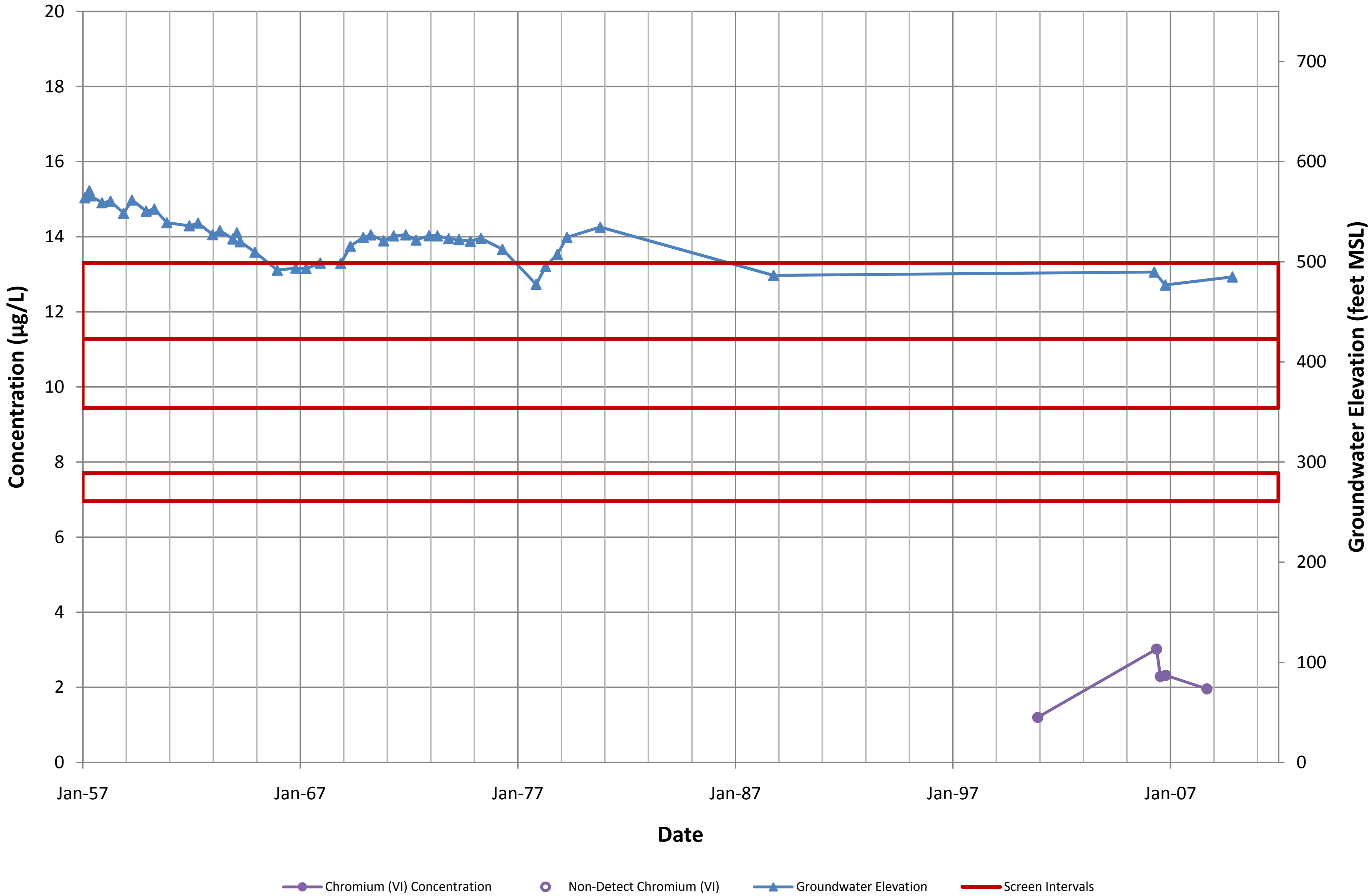


Chromium (VI) Concentration and Groundwater Elevation
North Hollywood Production Well Field NH-22
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

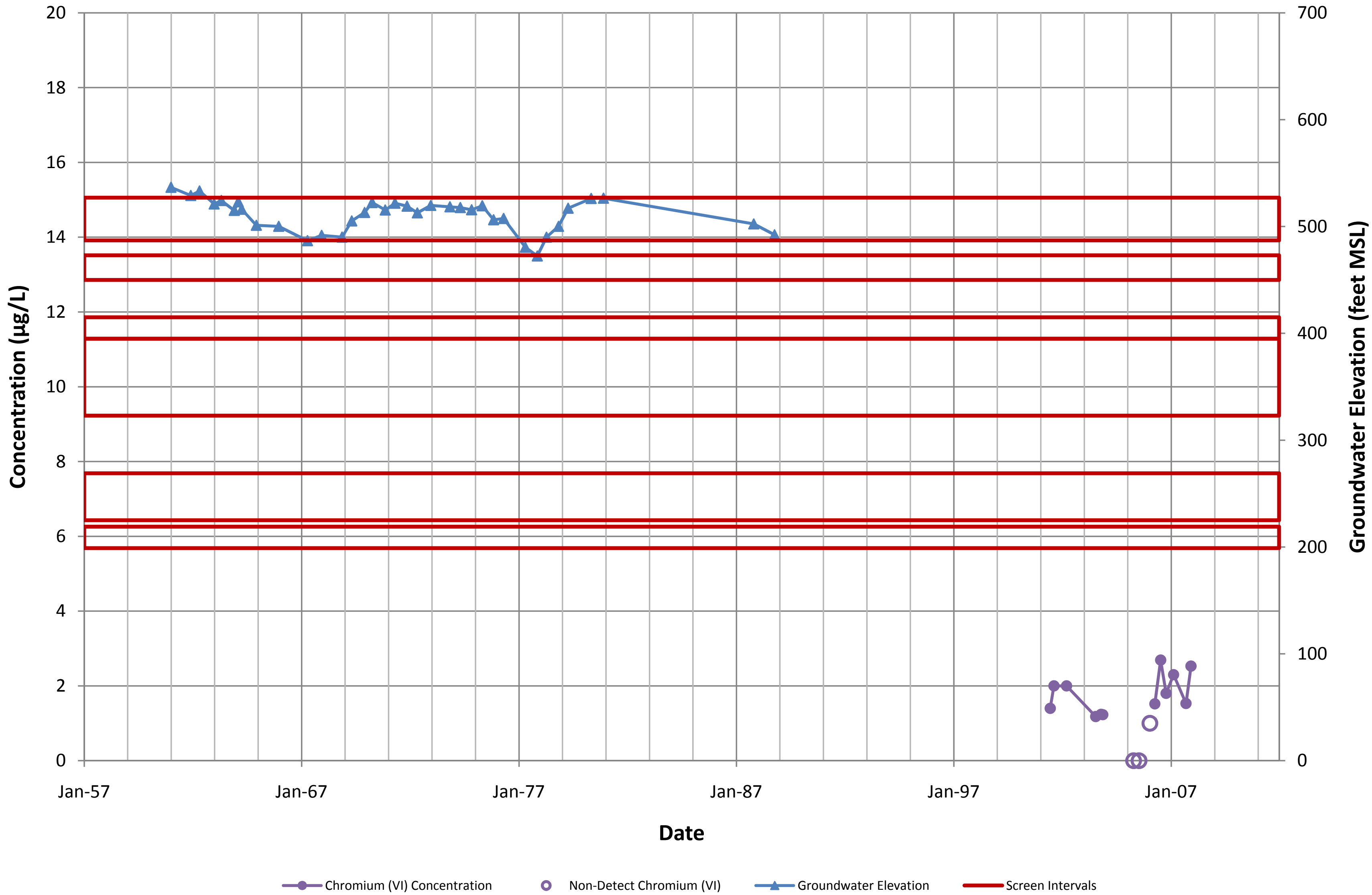
Figure: **F-P-44**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	Chromium (VI) Concentration and Groundwater Elevation North Hollywood Production Well Field NH-23 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-P-45**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	Chromium (VI) Concentration and Groundwater Elevation North Hollywood Production Well Field NH-24 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **F-P-46**
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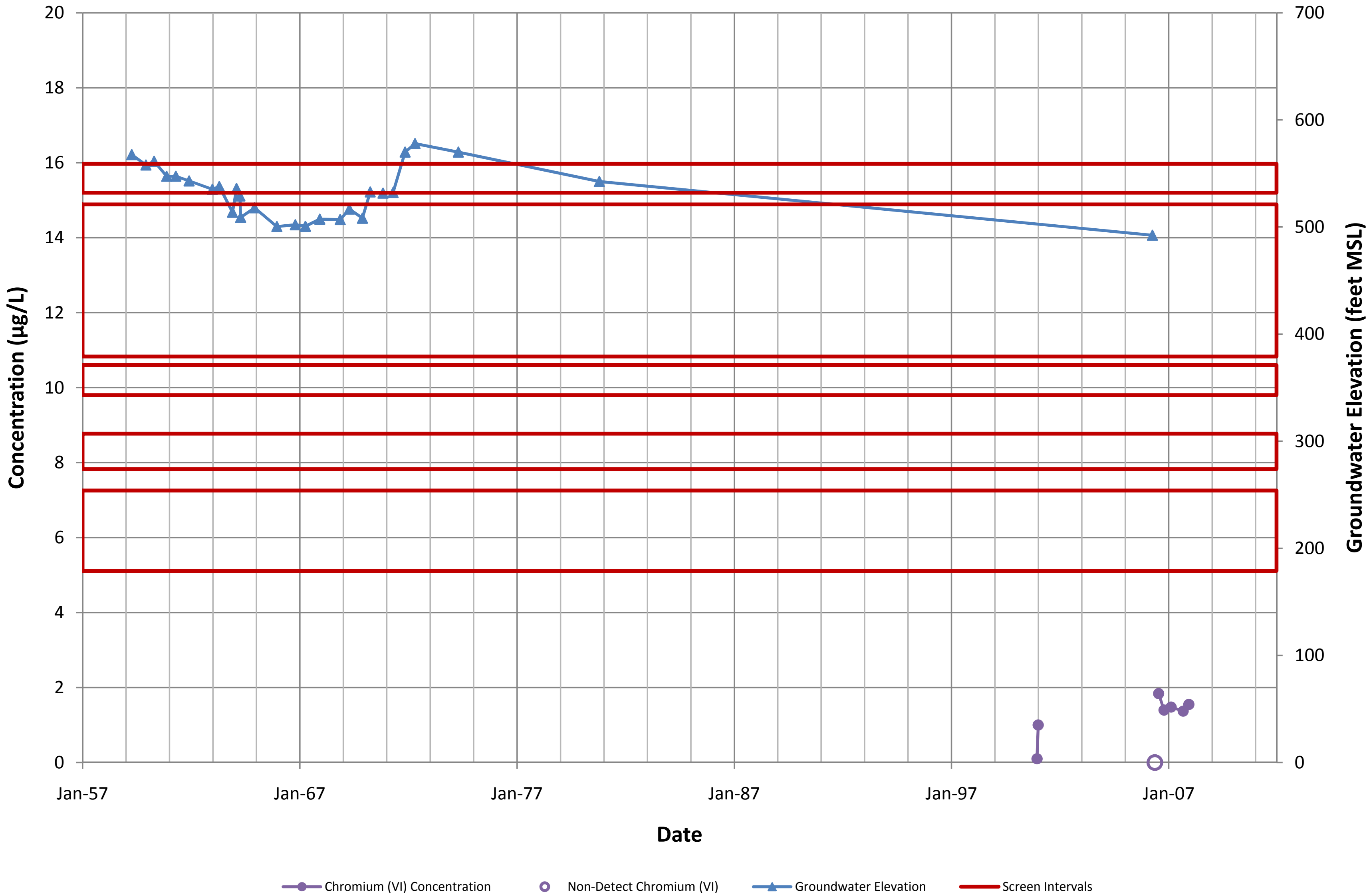
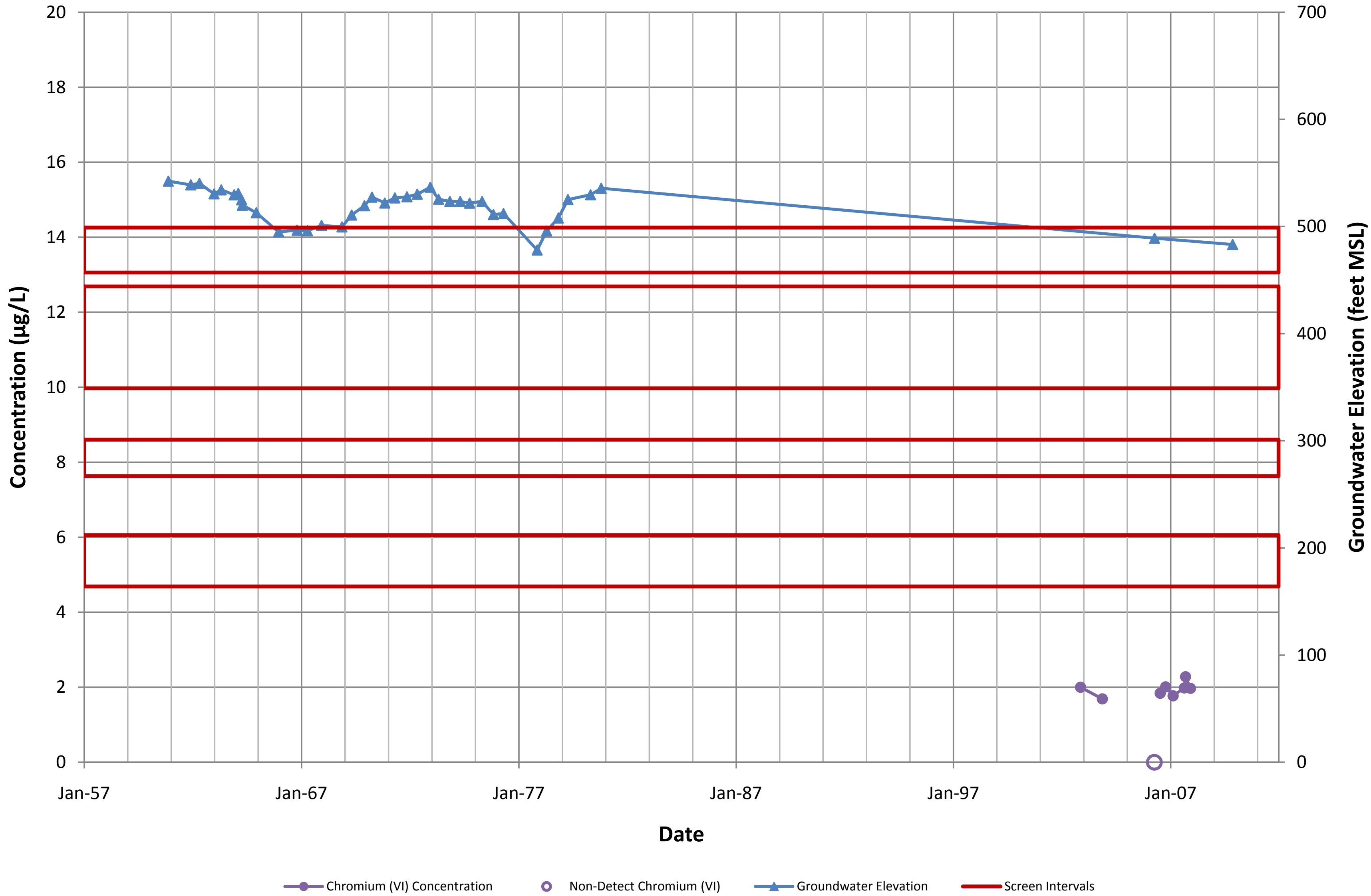


Chromium (VI) Concentration and Groundwater Elevation
North Hollywood Production Well Field NH-25
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-P-47

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

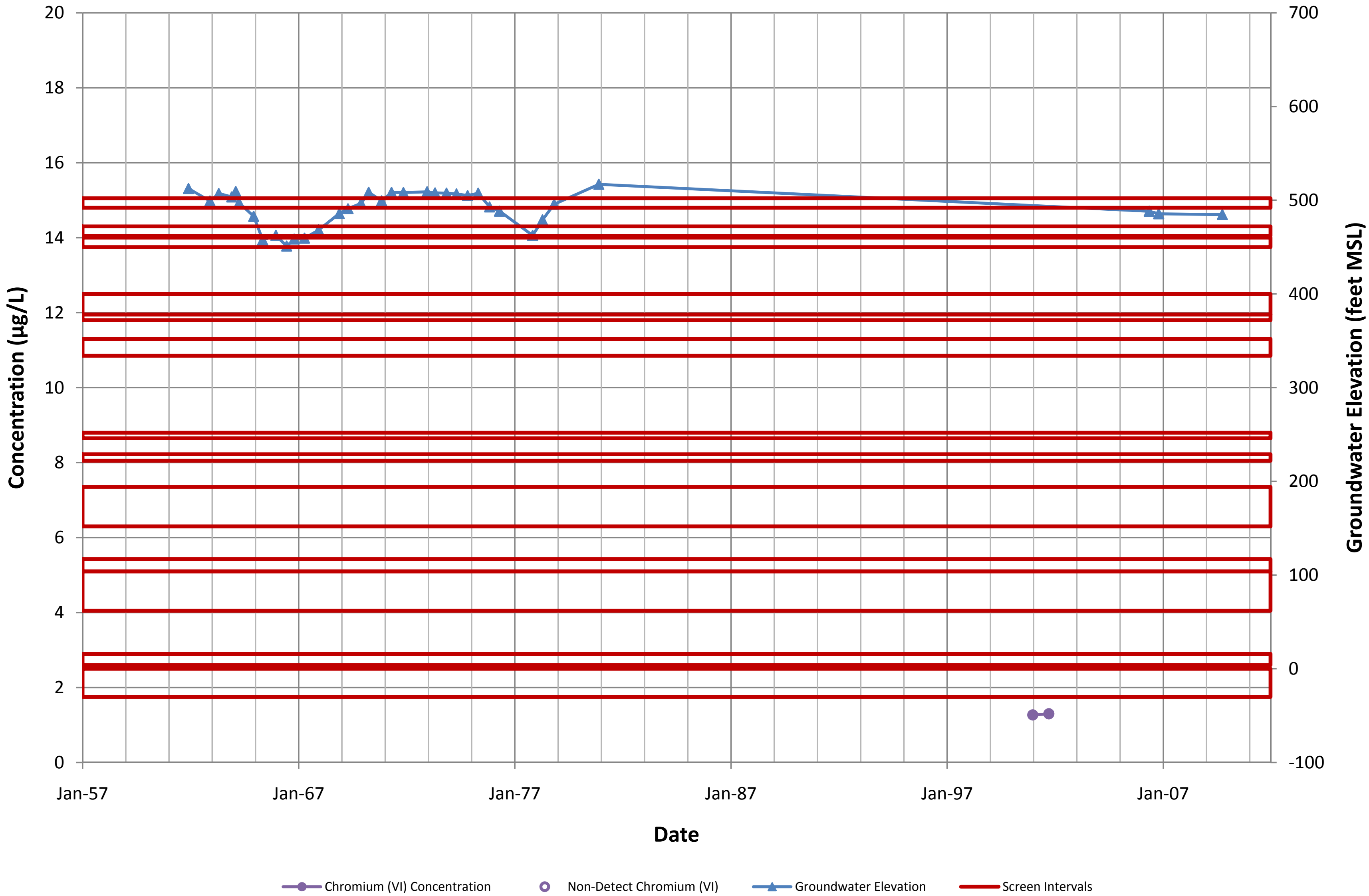


Chromium (VI) Concentration and Groundwater Elevation
North Hollywood Production Well Field NH-26
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-P-48

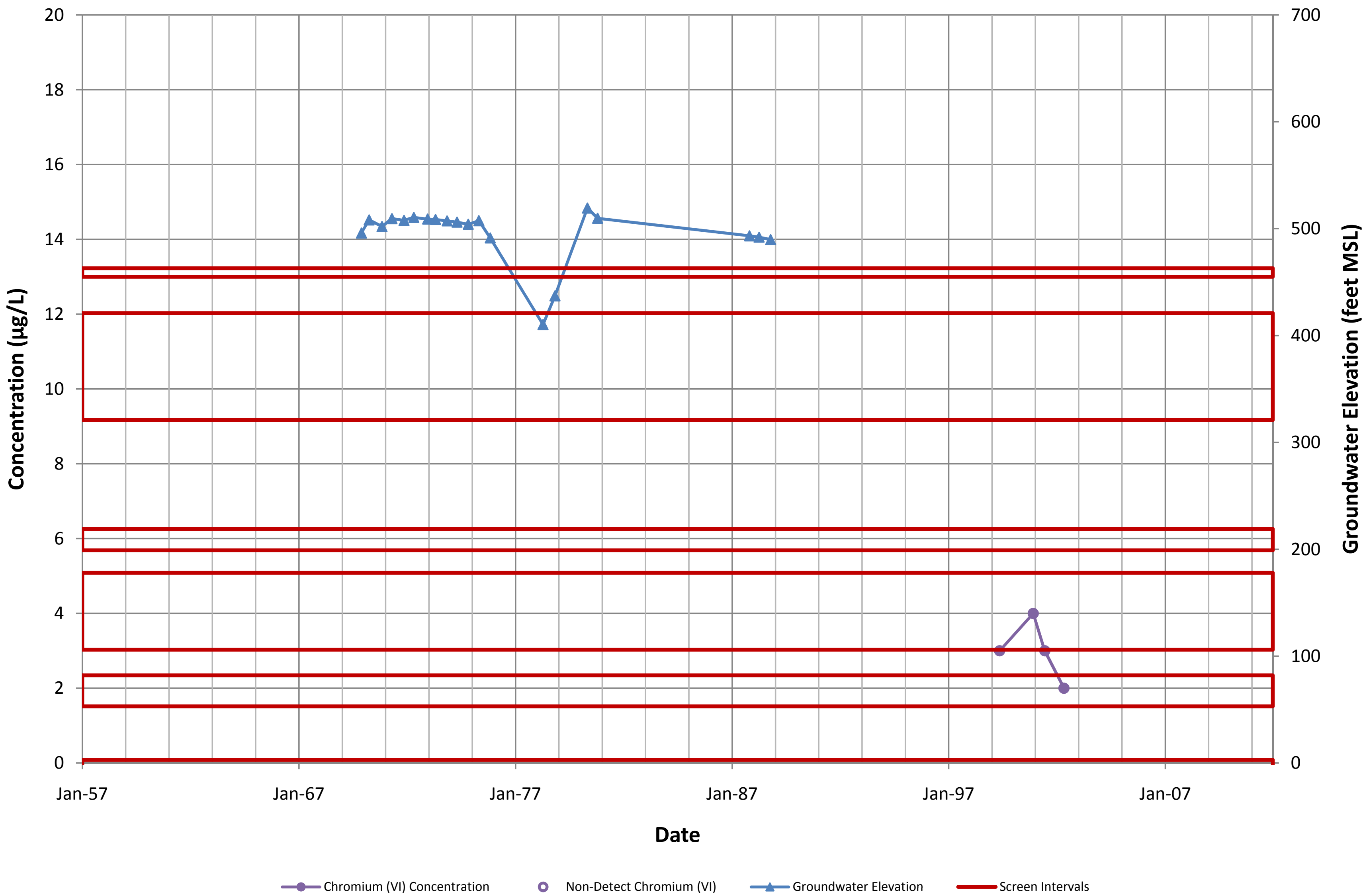
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



Chromium (VI) Concentration and Groundwater Elevation
North Hollywood Production Well Field NH-27
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:
F-P-49

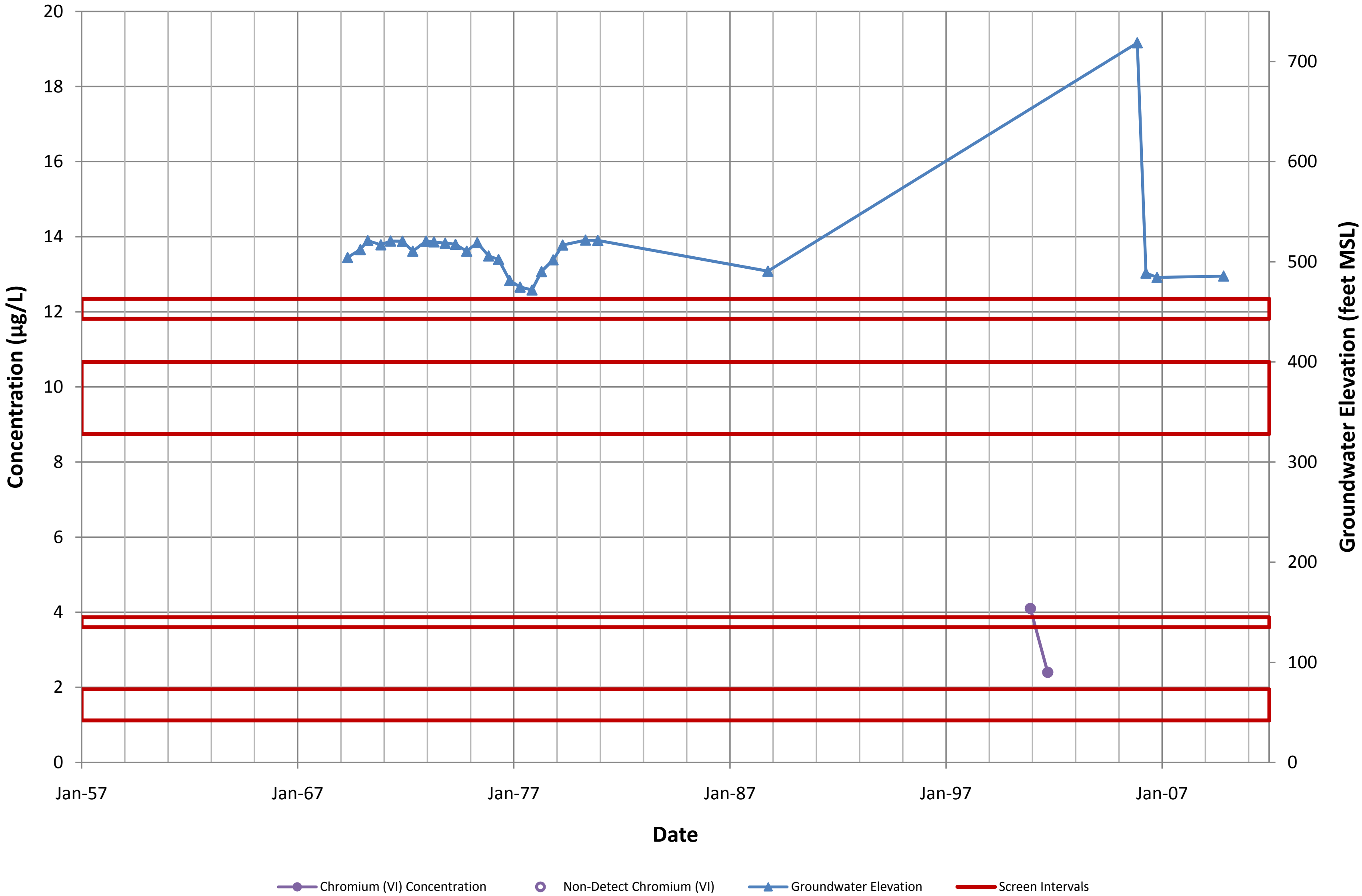
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



Chromium (VI) Concentration and Groundwater Elevation
North Hollywood Production Well Field NH-28
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:
F-P-50

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

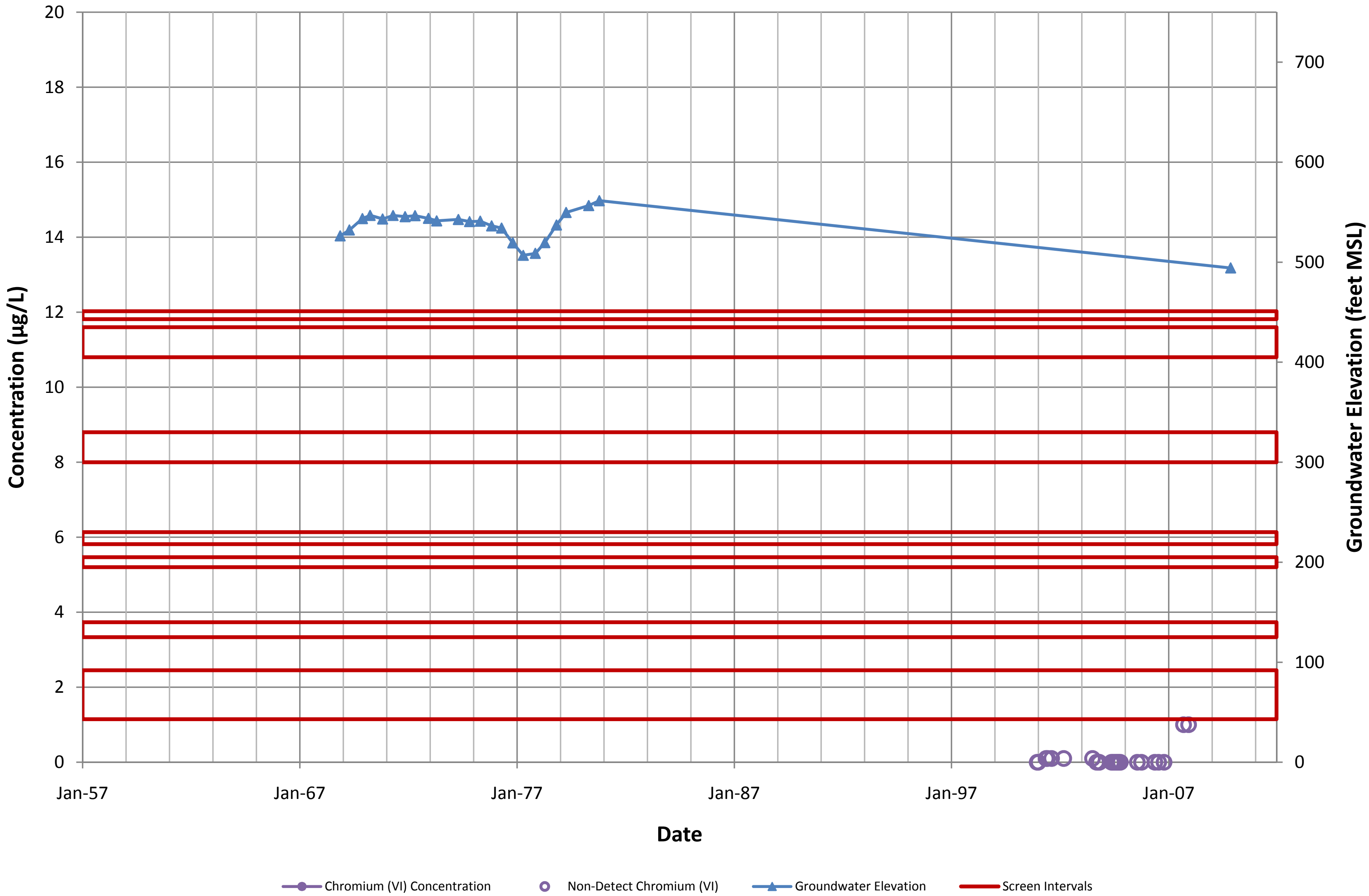


amec

Chromium (VI) Concentration and Groundwater Elevation
North Hollywood Production Well Field NH-30
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

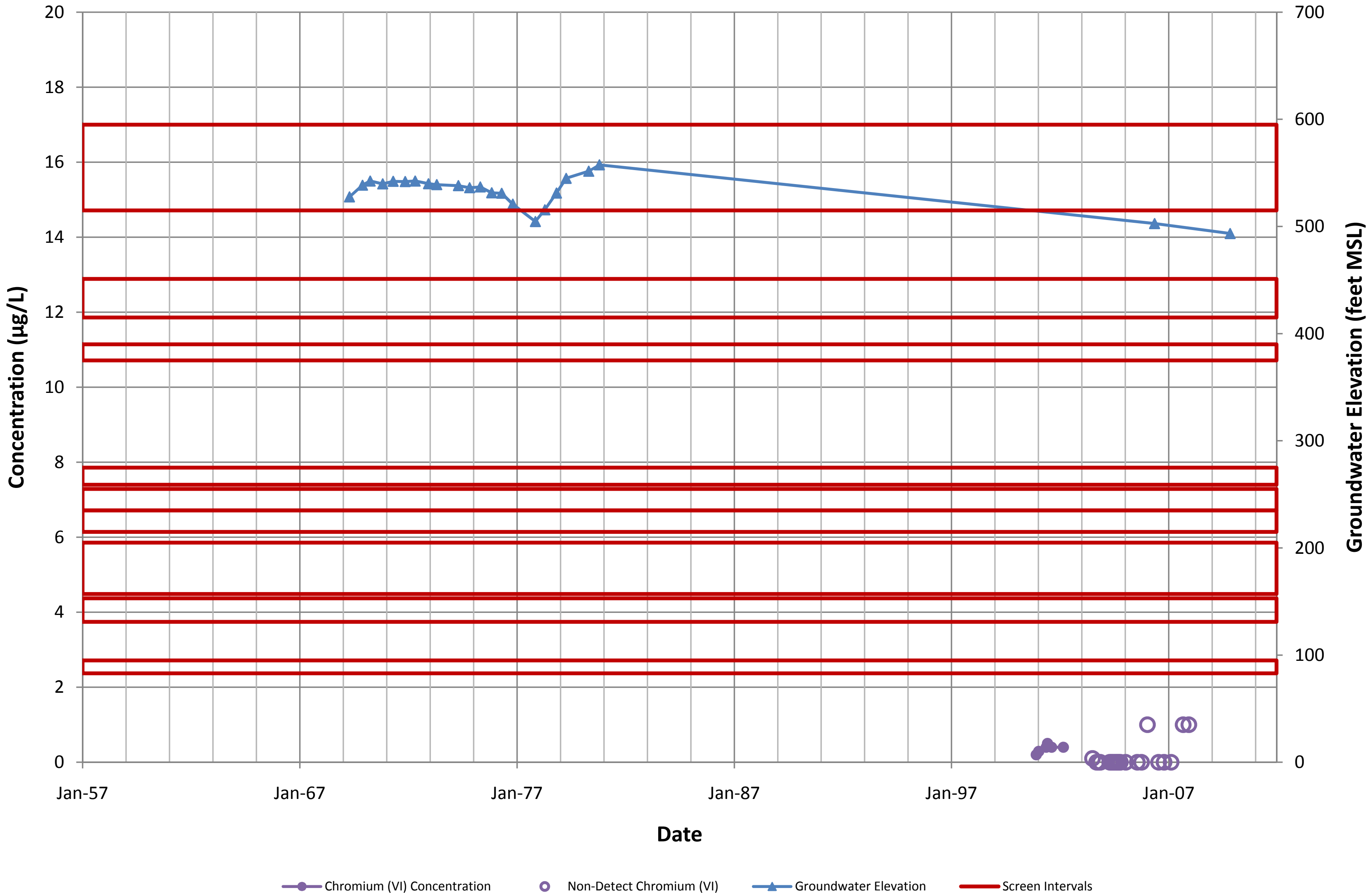
Figure:
F-P-51

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

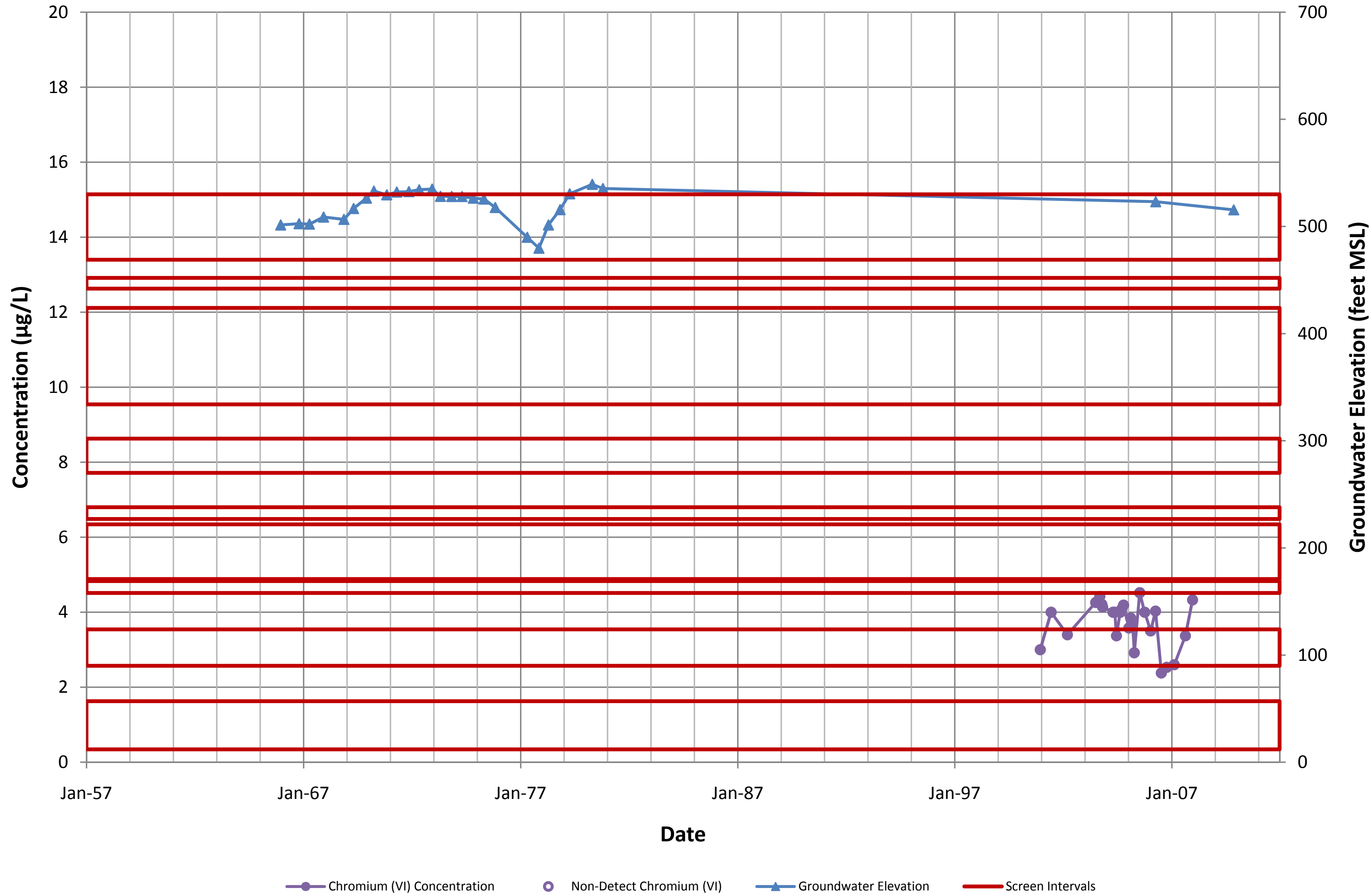


amec	Chromium (VI) Concentration and Groundwater Elevation North Hollywood Production Well Field NH-32 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-P-52**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	Chromium (VI) Concentration and Groundwater Elevation North Hollywood Production Well Field NH-33 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: F-P-53
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 7/2011

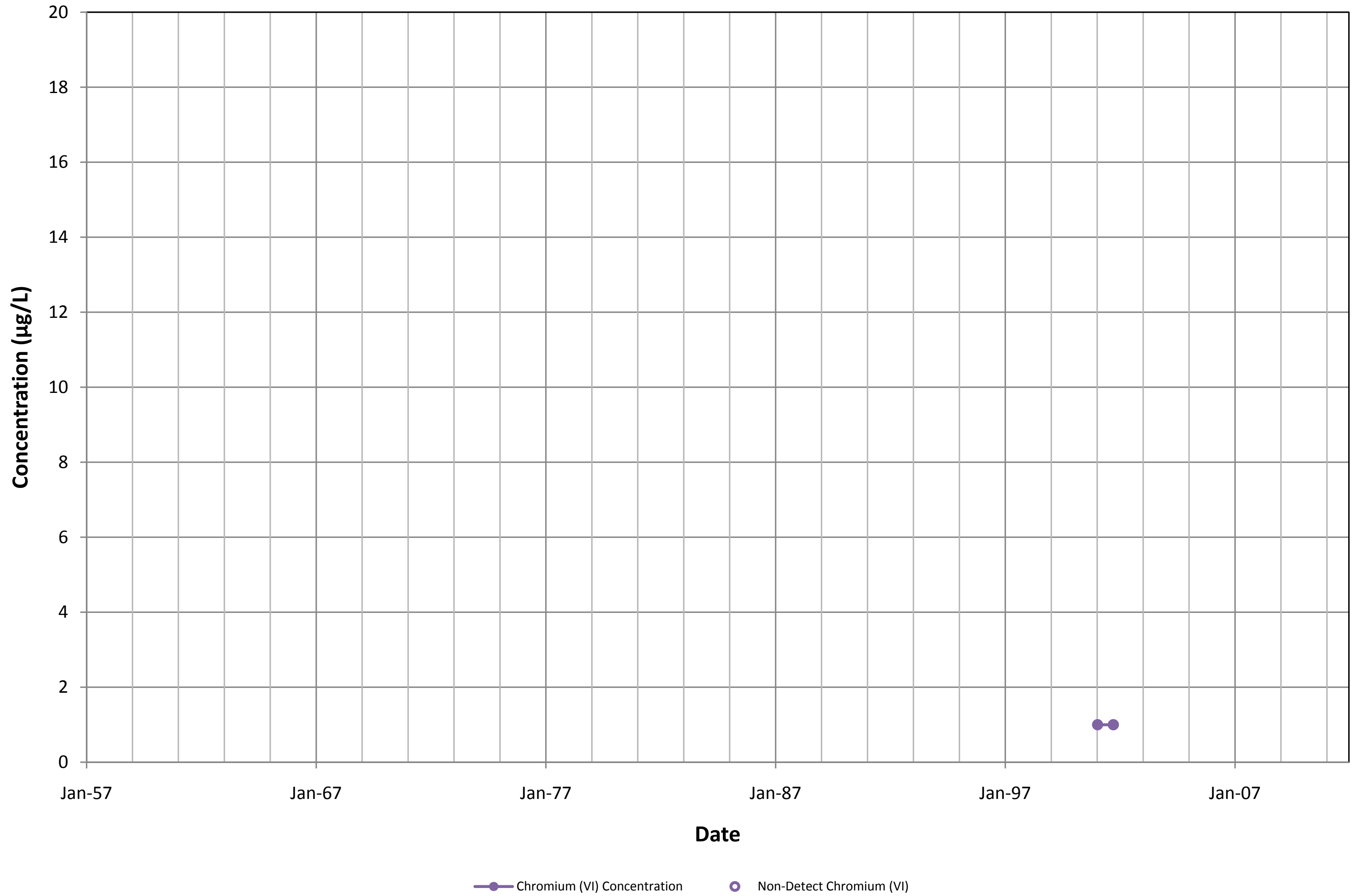


Chromium (VI) Concentration and Groundwater Elevation
North Hollywood Production Well Field NH-34
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

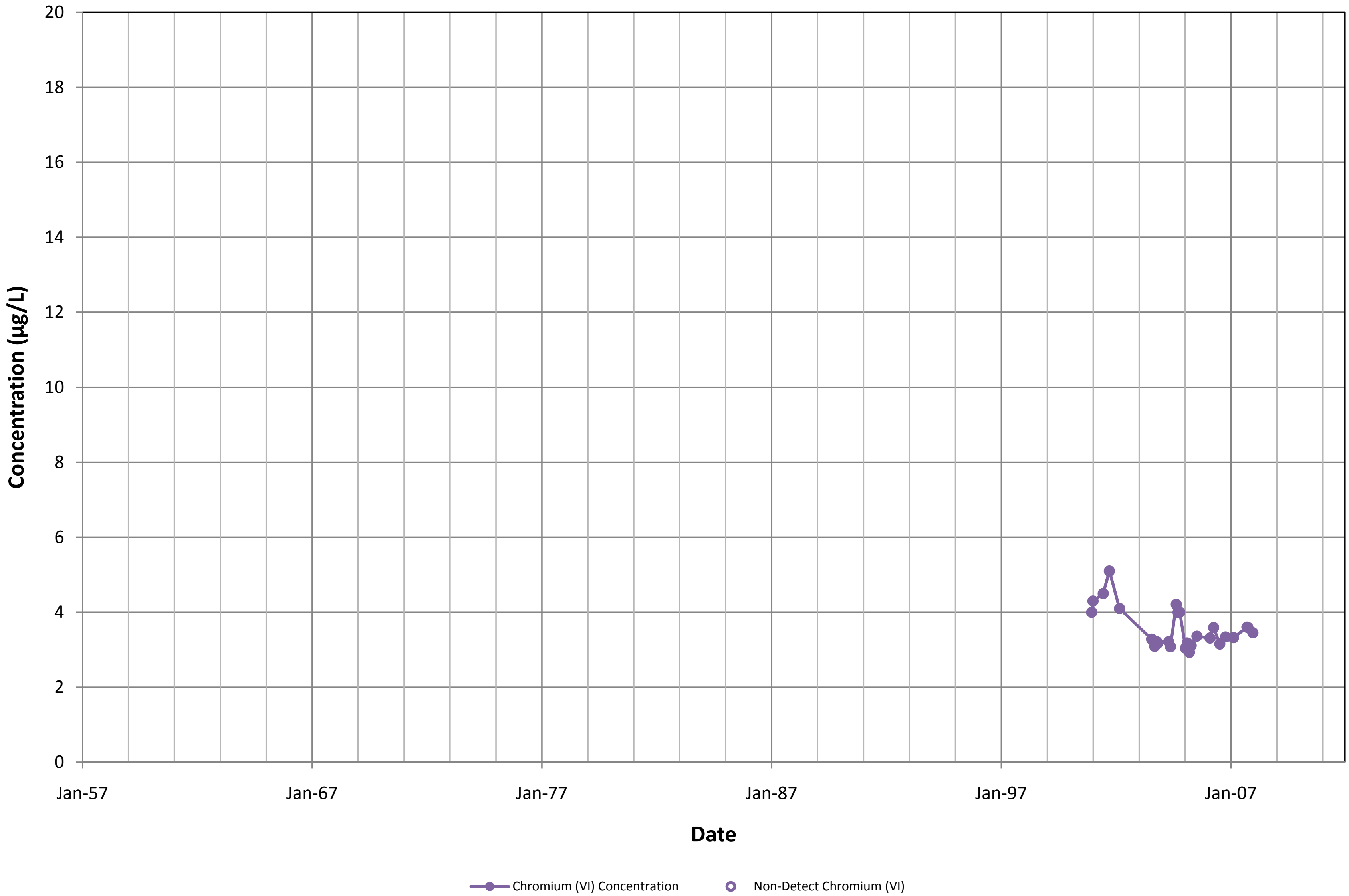
F-P-54

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	Chromium (VI) Concentration North Hollywood Production Well Field NH-35 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-P-55**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



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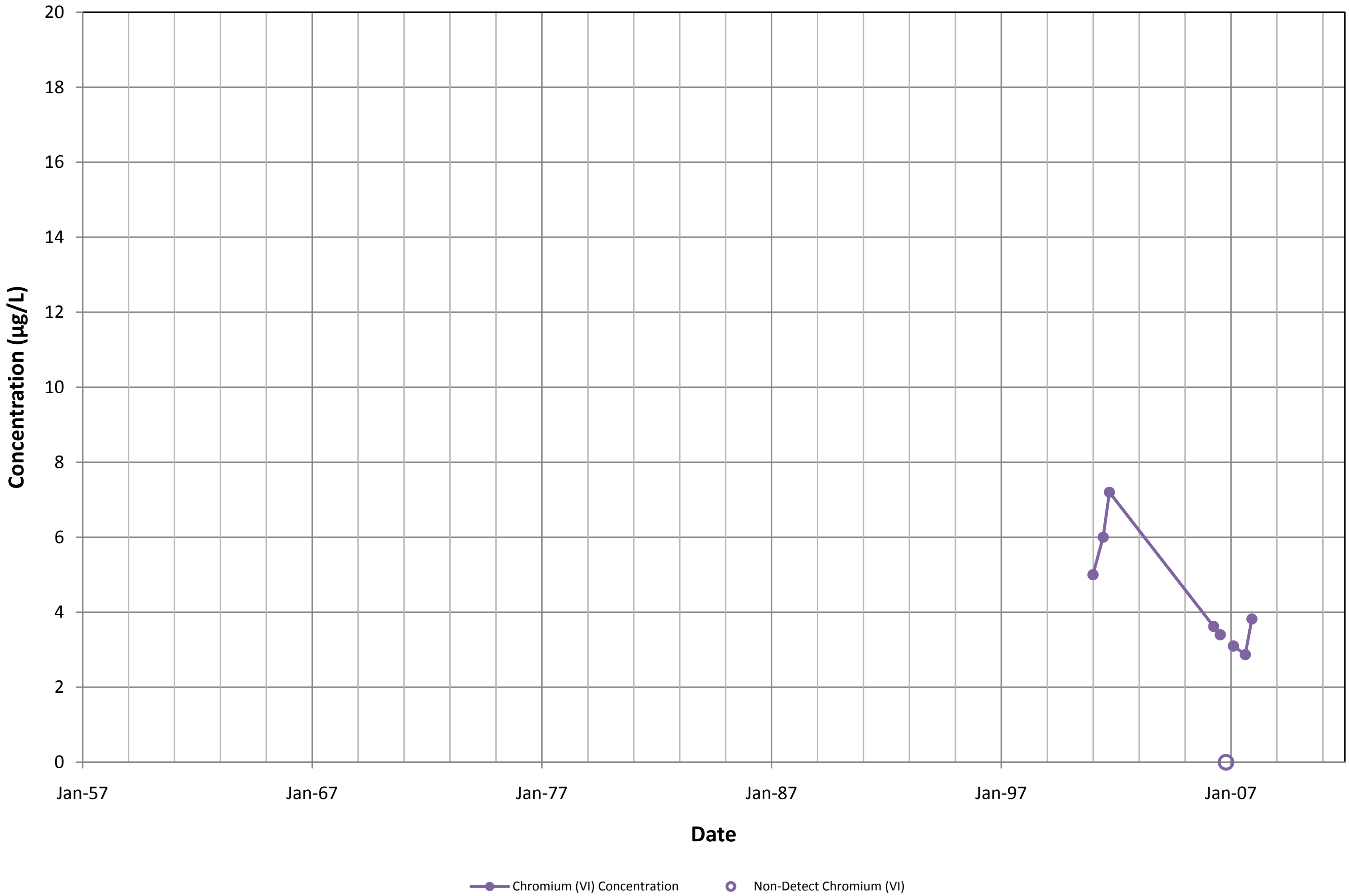
Chromium (VI) Concentration
North Hollywood Production Well Field NH-36
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

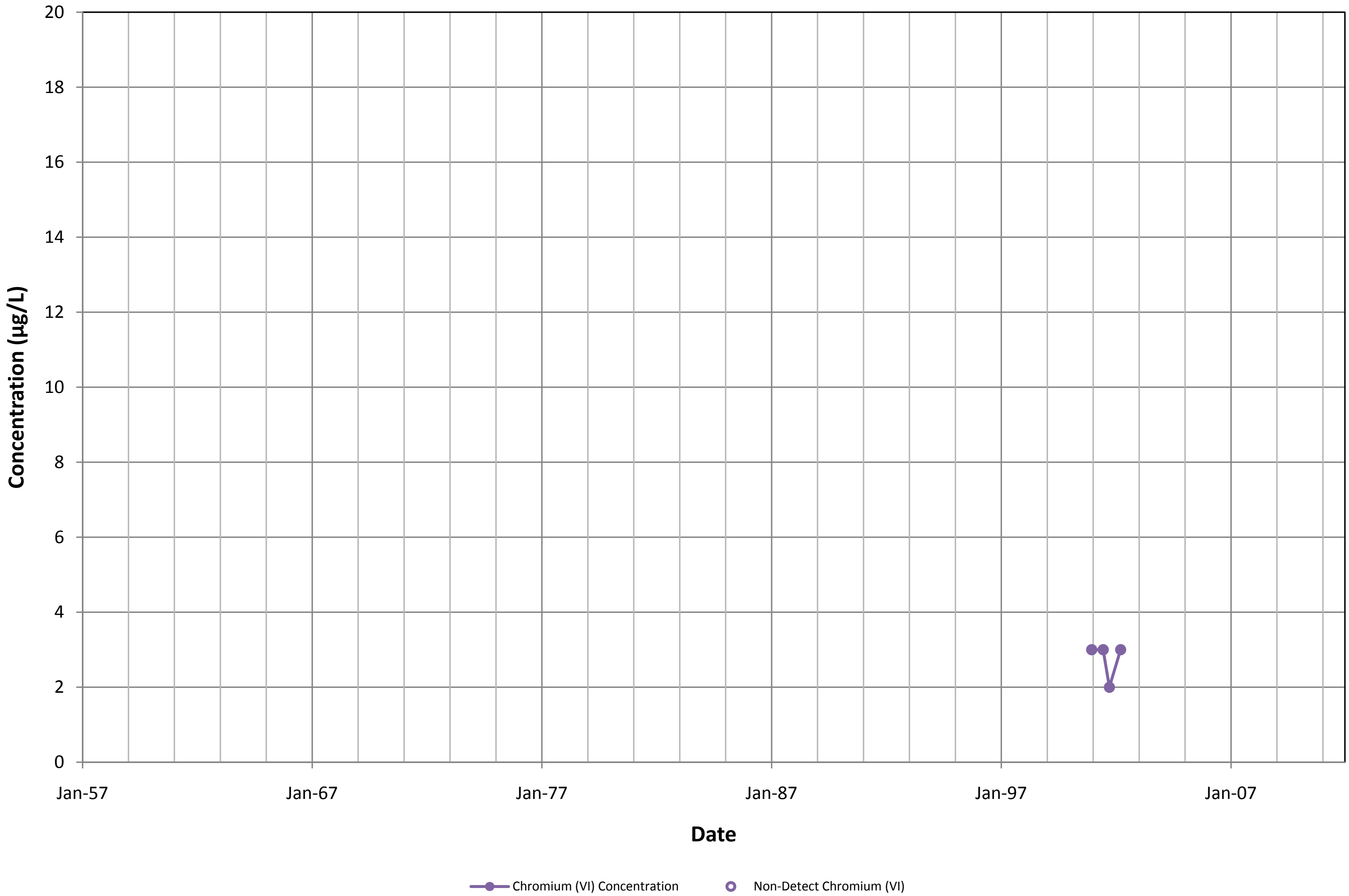
Figure:

F-P-56

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	Chromium (VI) Concentration North Hollywood Production Well Field NH-37 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **F-P-57**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 7/2011

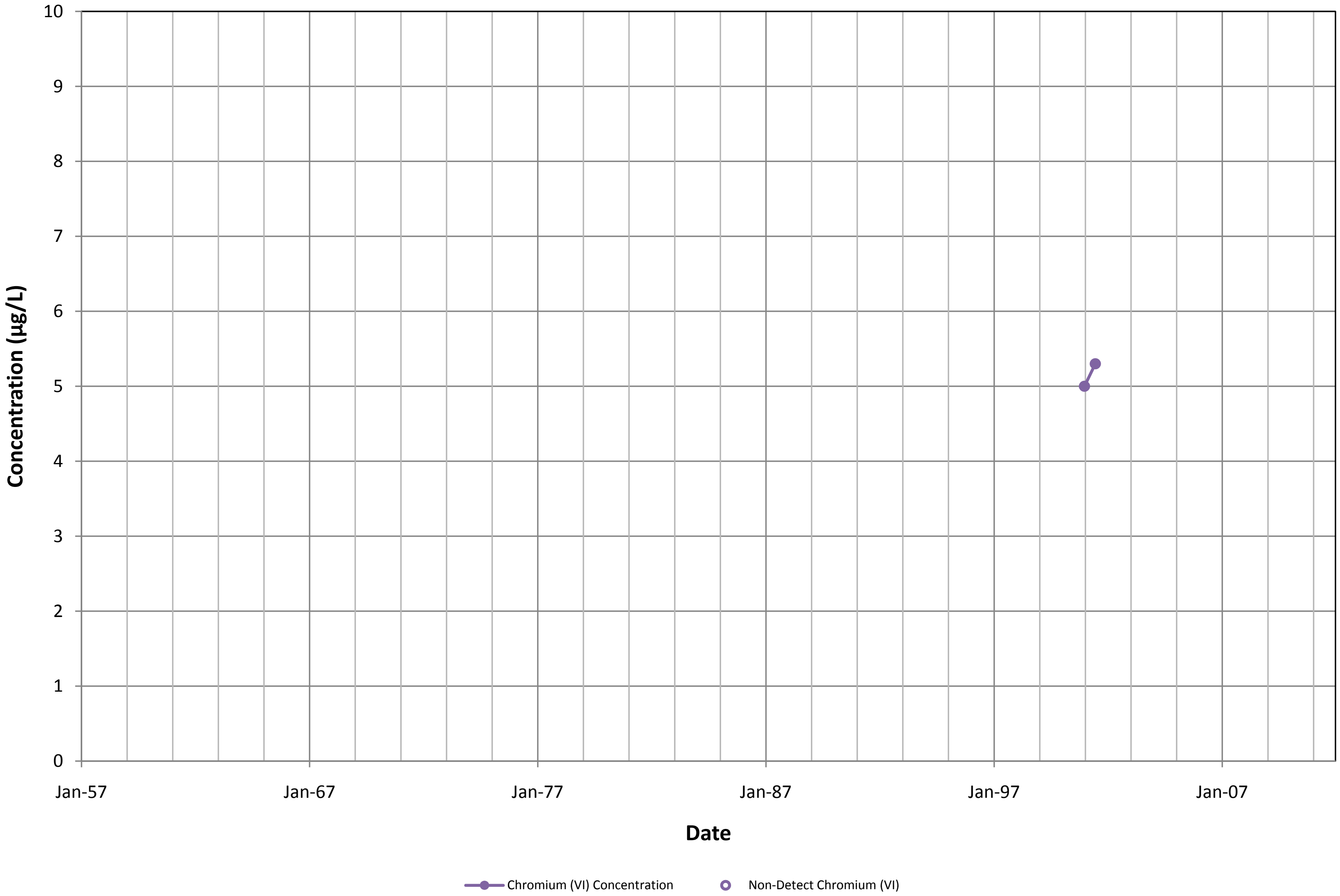


Chromium (VI) Concentration
North Hollywood Production Well Field NH-40
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-P-58

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

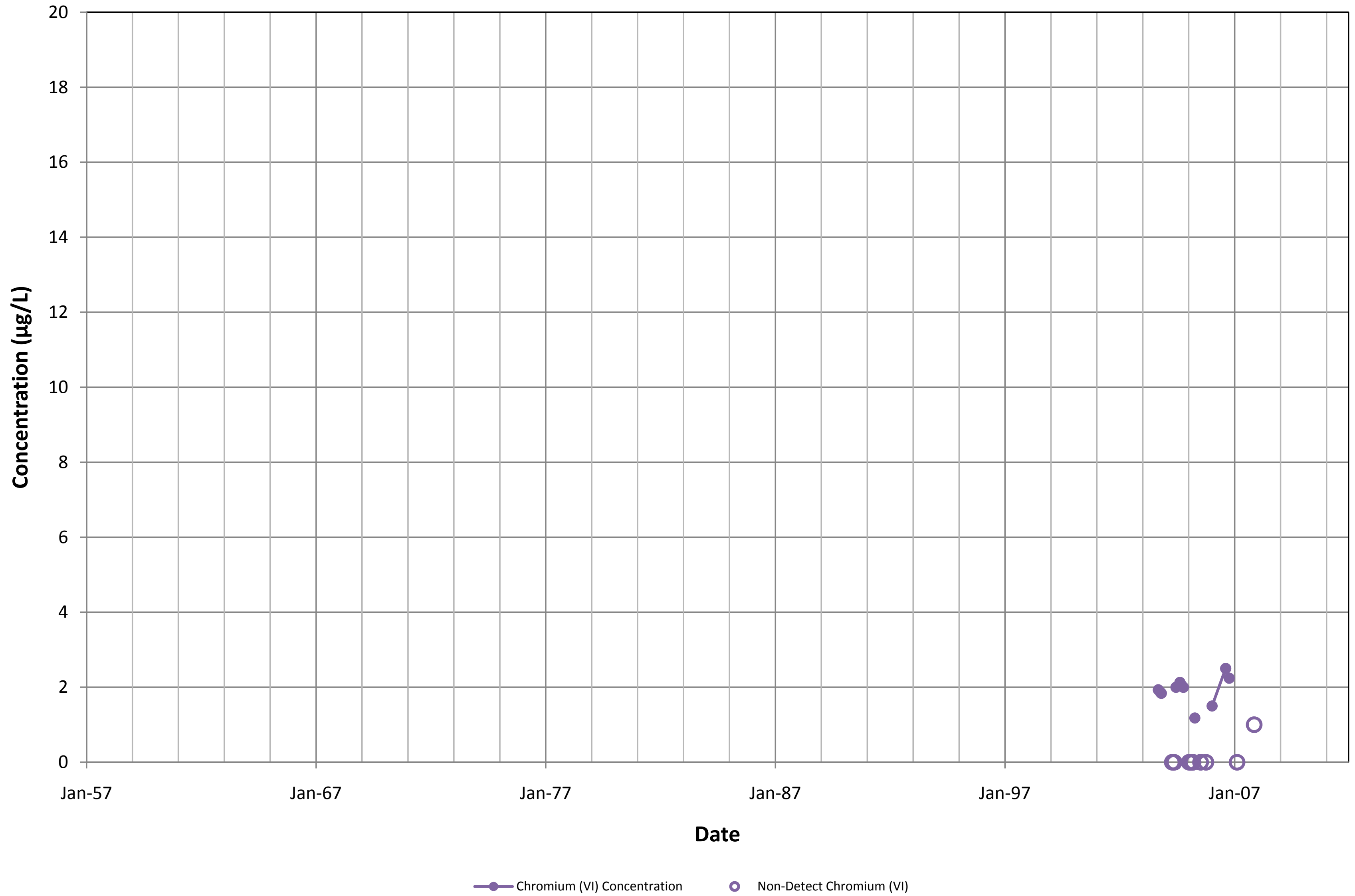


Chromium (VI) Concentration
North Hollywood Production Well Field NH-41
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

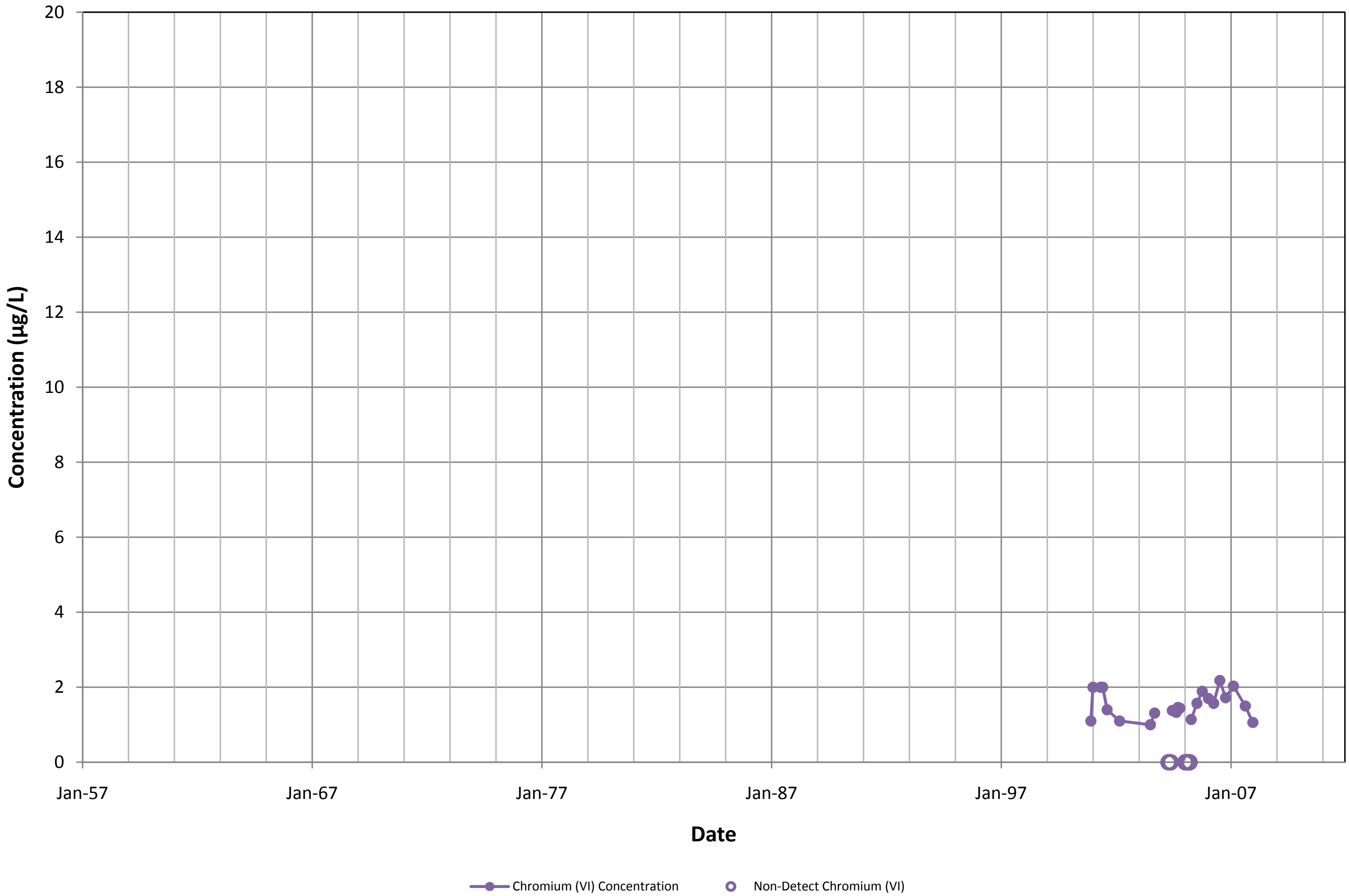
F-P-59

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	Chromium (VI) Concentration North Hollywood Production Well Field NH-43A Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-P-60**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



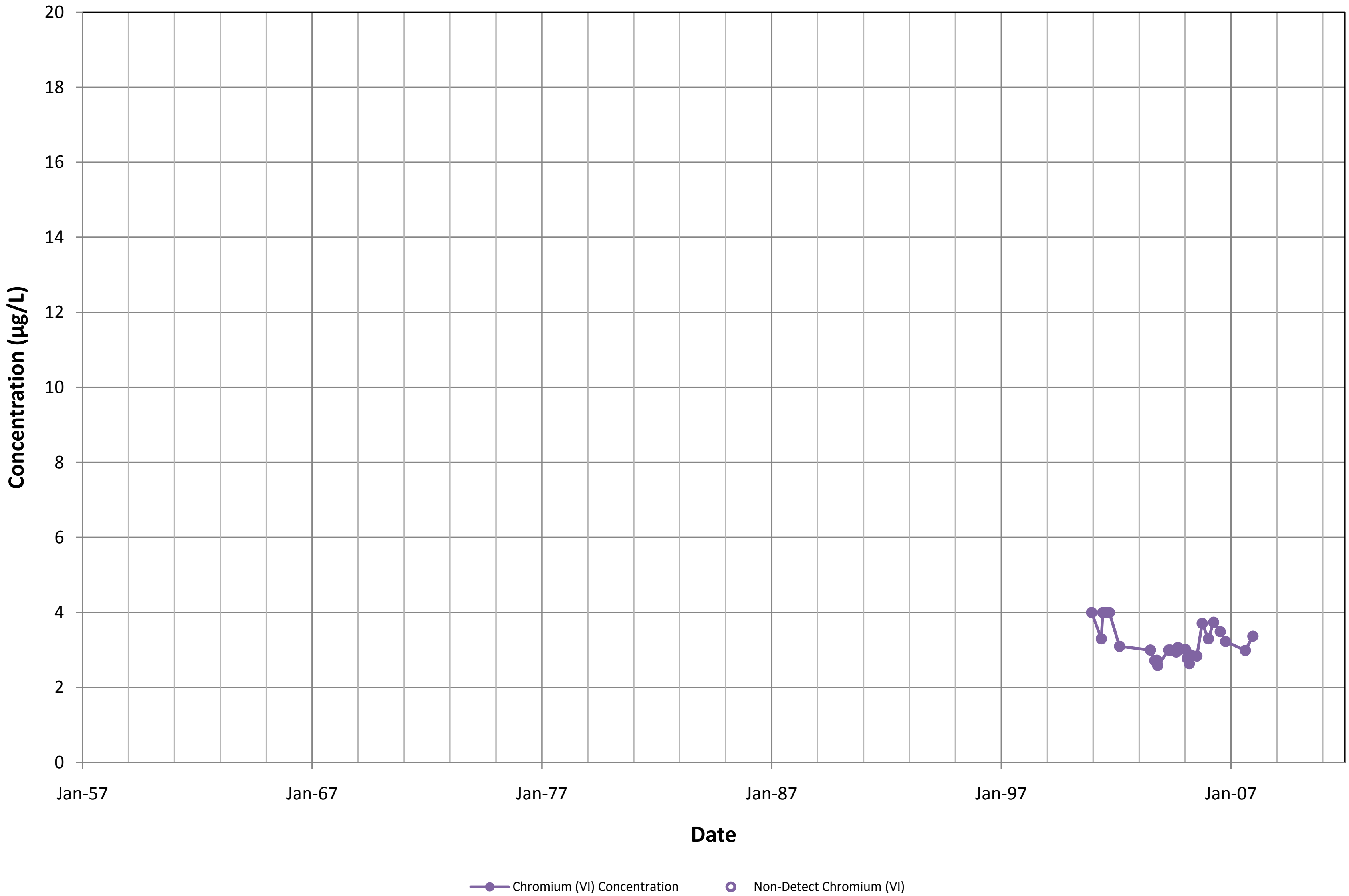
amec

Chromium (VI) Concentration
North Hollywood Production Well Field NH-44
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-P-61

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



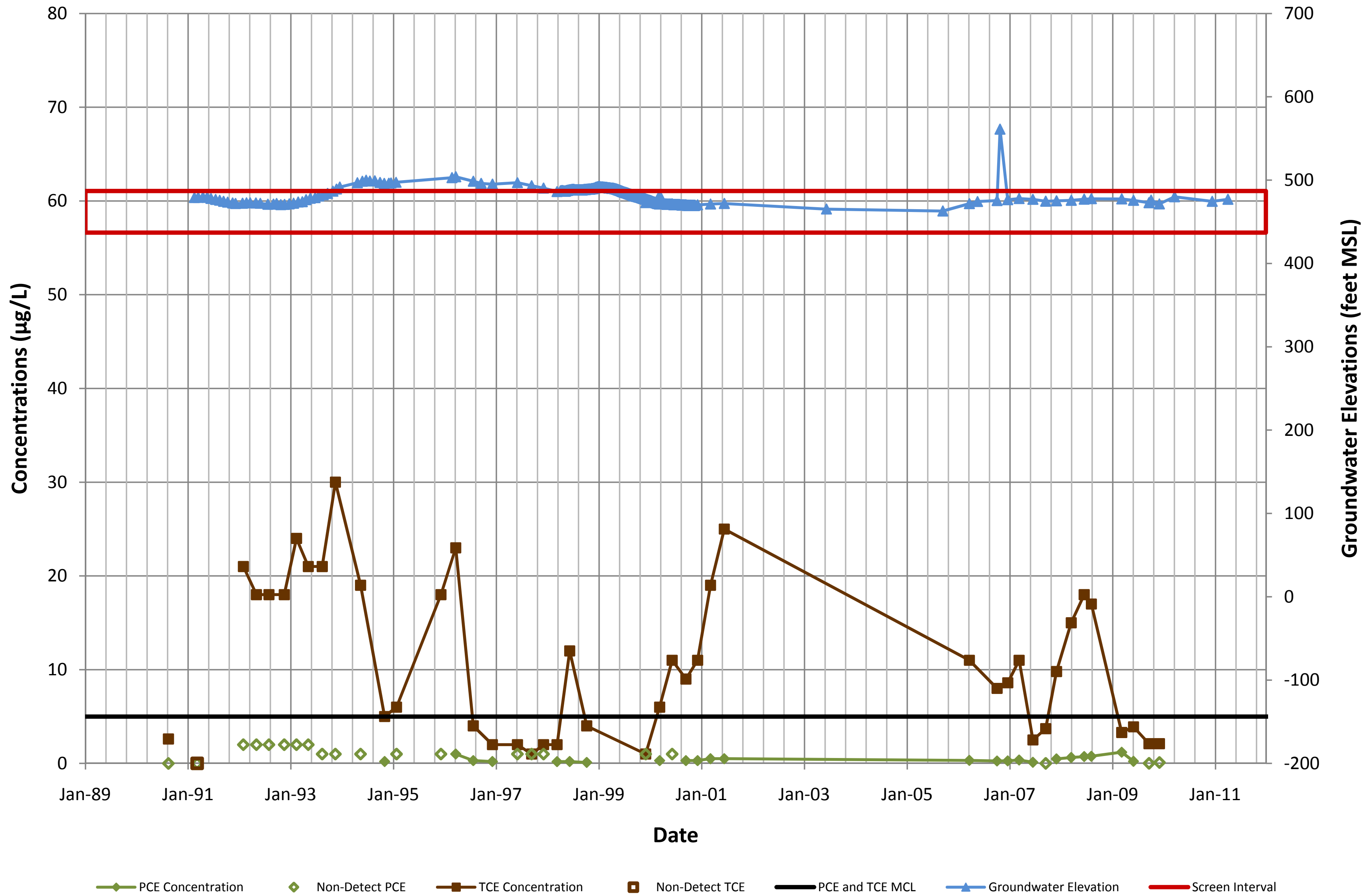
amec

Chromium (VI) Concentration
North Hollywood Production Well Field NH-45
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-P-62

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



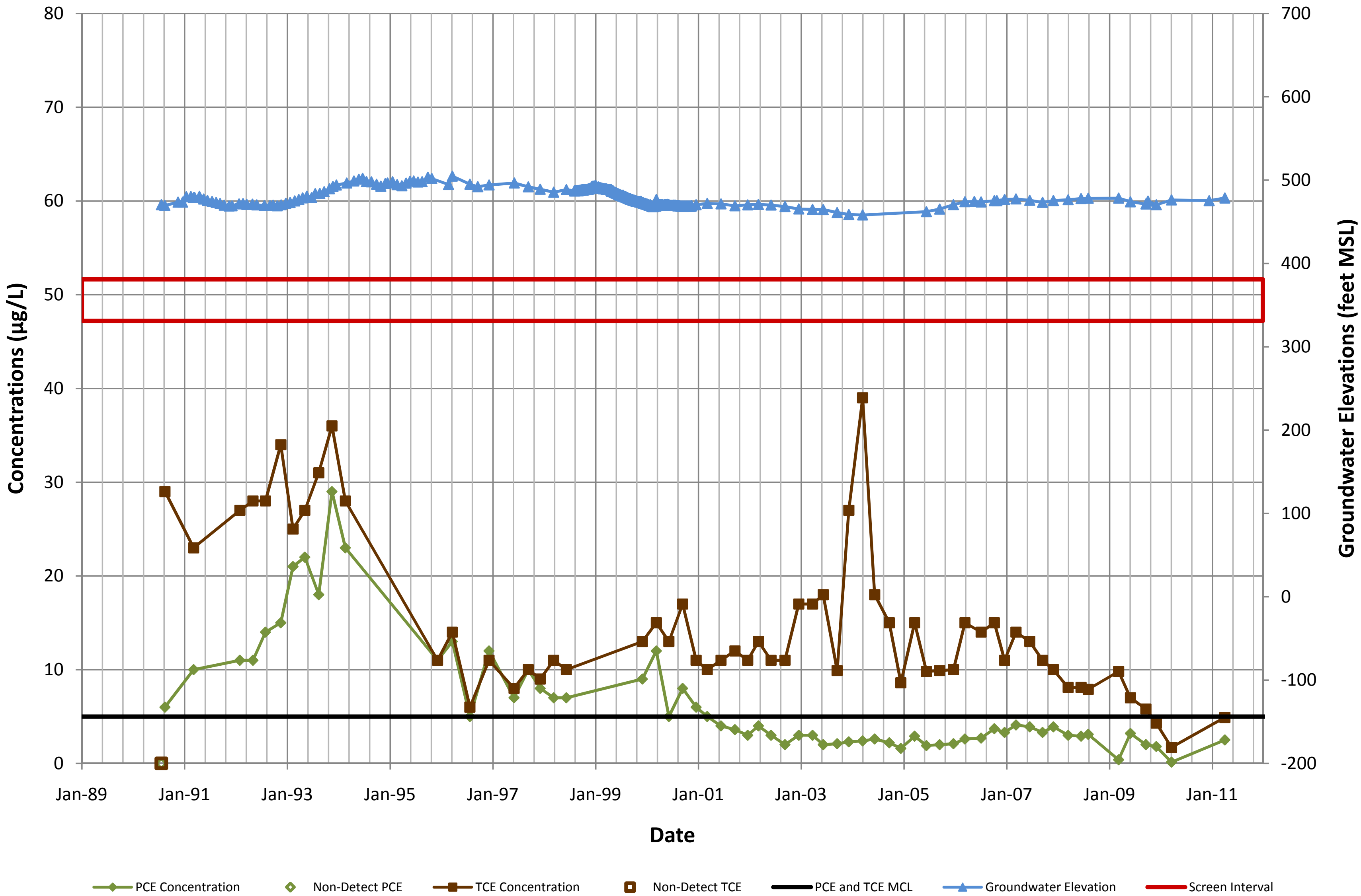
amec

PCE and TCE Concentrations and Groundwater Elevations
NHOU Monitoring Well NH-C02-220
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-M-1

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	PCE and TCE Concentrations and Groundwater Elevations NHOU Monitoring Well NH-C02-325 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-M-2**

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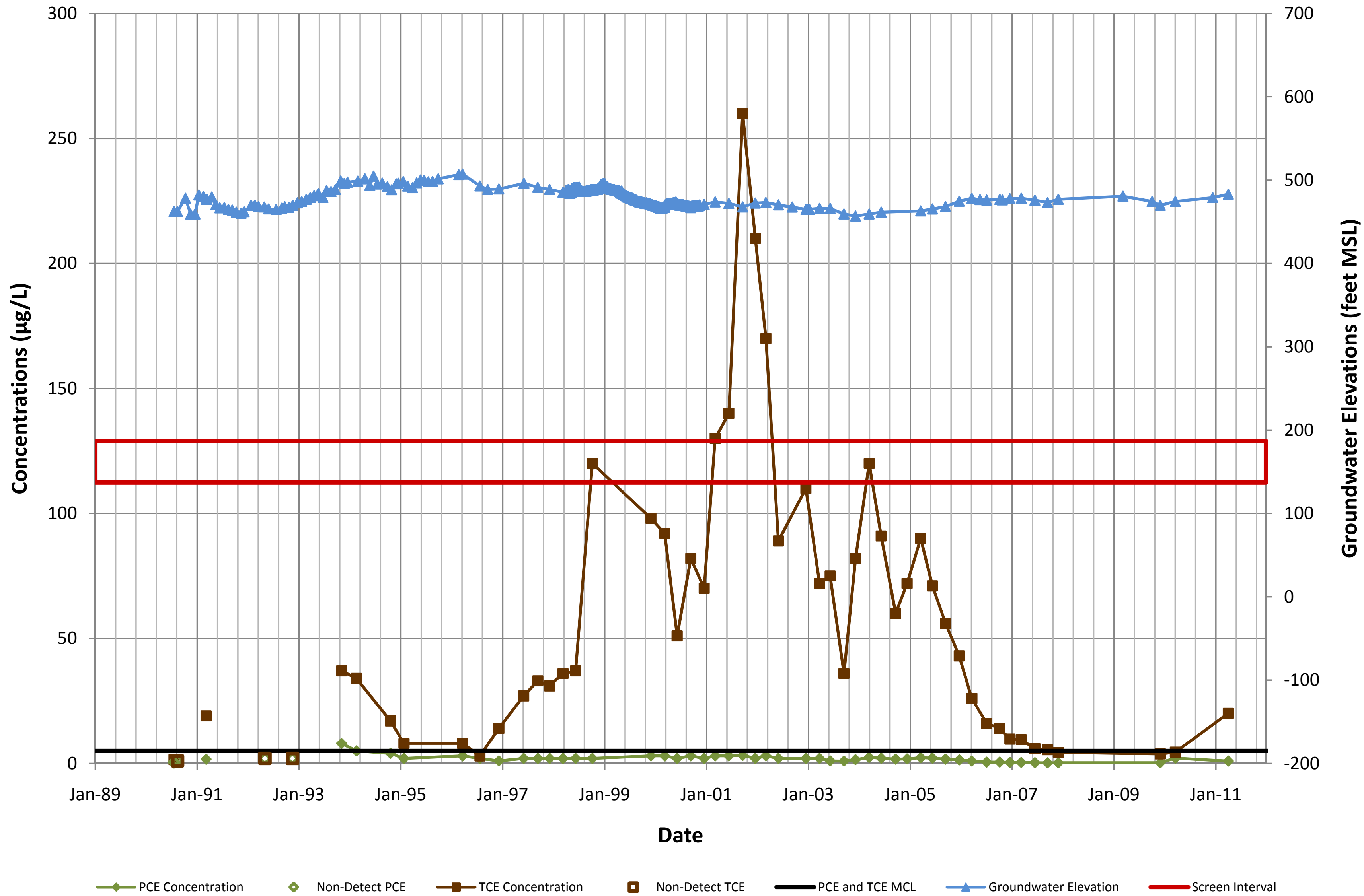
NAM	4088115718	SLC	7/2011



amec

PCE and TCE Concentrations and Groundwater Elevations
NHOU Monitoring Well NH-C02-520
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-M-3**

DRAWN	JOB NUMBER	CHECKED	DATE
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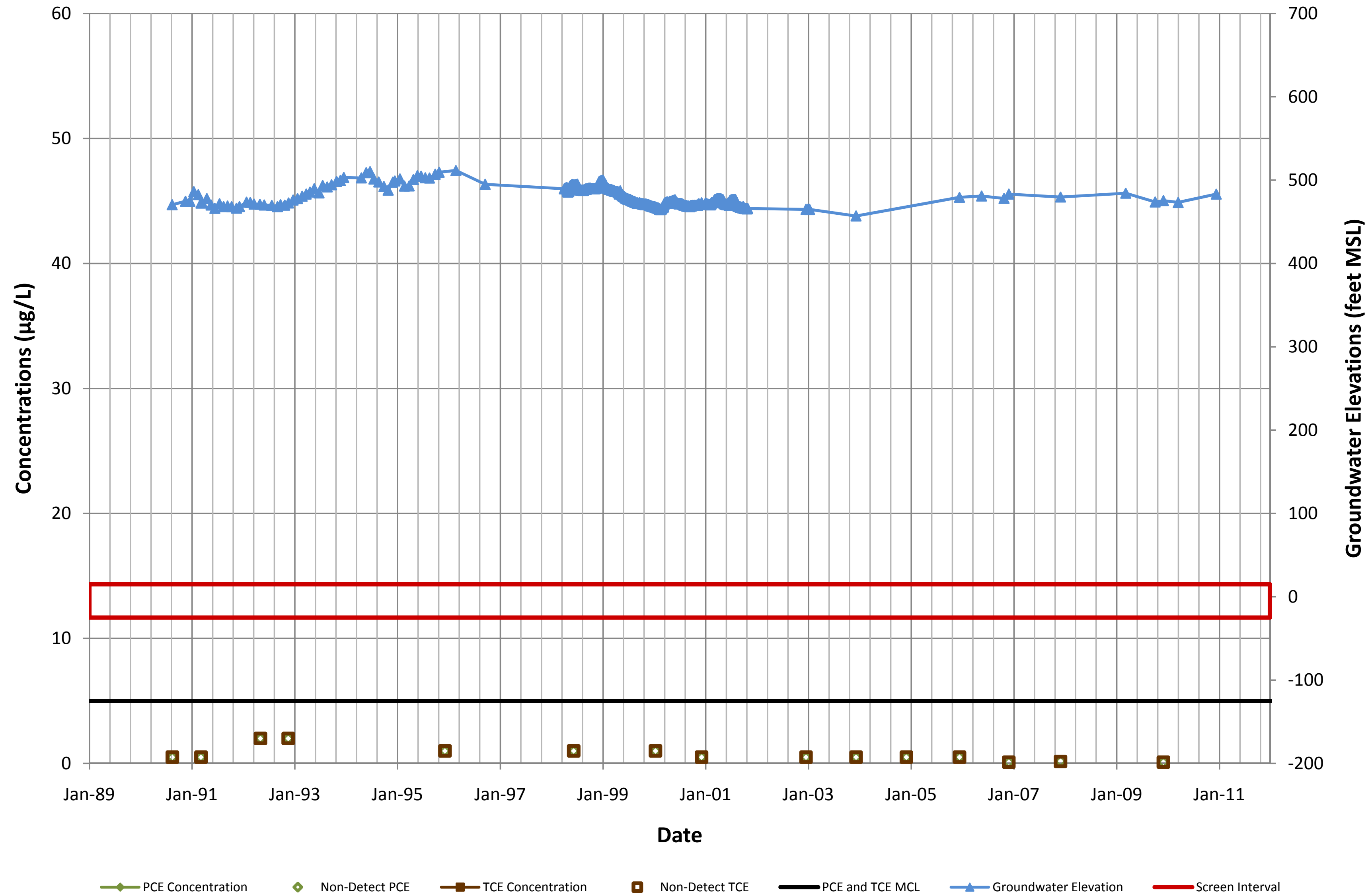

amec

PCE and TCE Concentrations and Groundwater Elevations
NHOU Monitoring Well NH-C02-681
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-M-4**

DRAWN	JOB NUMBER	CHECKED	DATE
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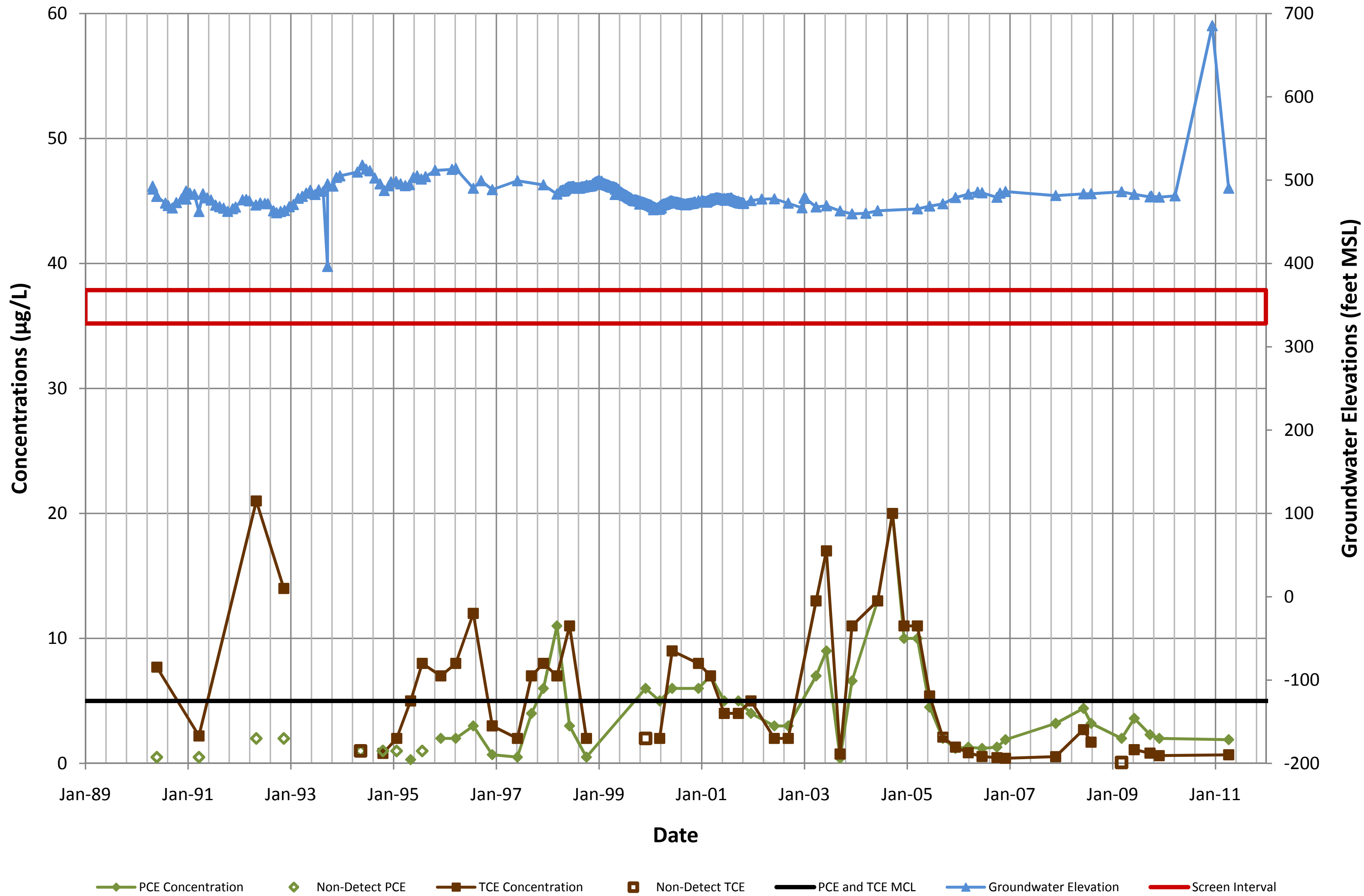
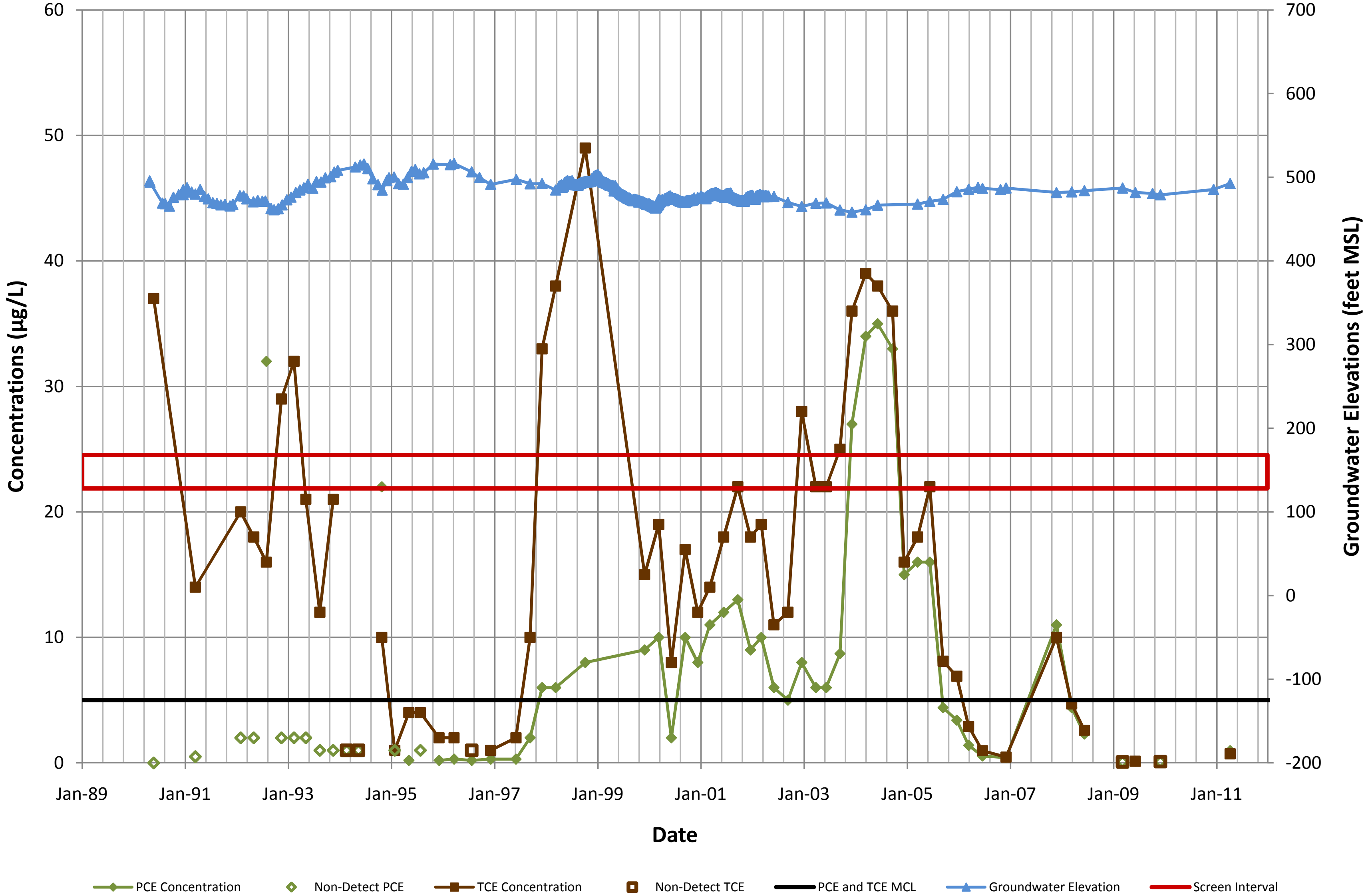


amec

PCE and TCE Concentrations and Groundwater Elevations
NHOU Monitoring Well NH-C03-380
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-M-5**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	PCE and TCE Concentrations and Groundwater Elevations NHOU Monitoring Well NH-C03-580 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **F-M-6**
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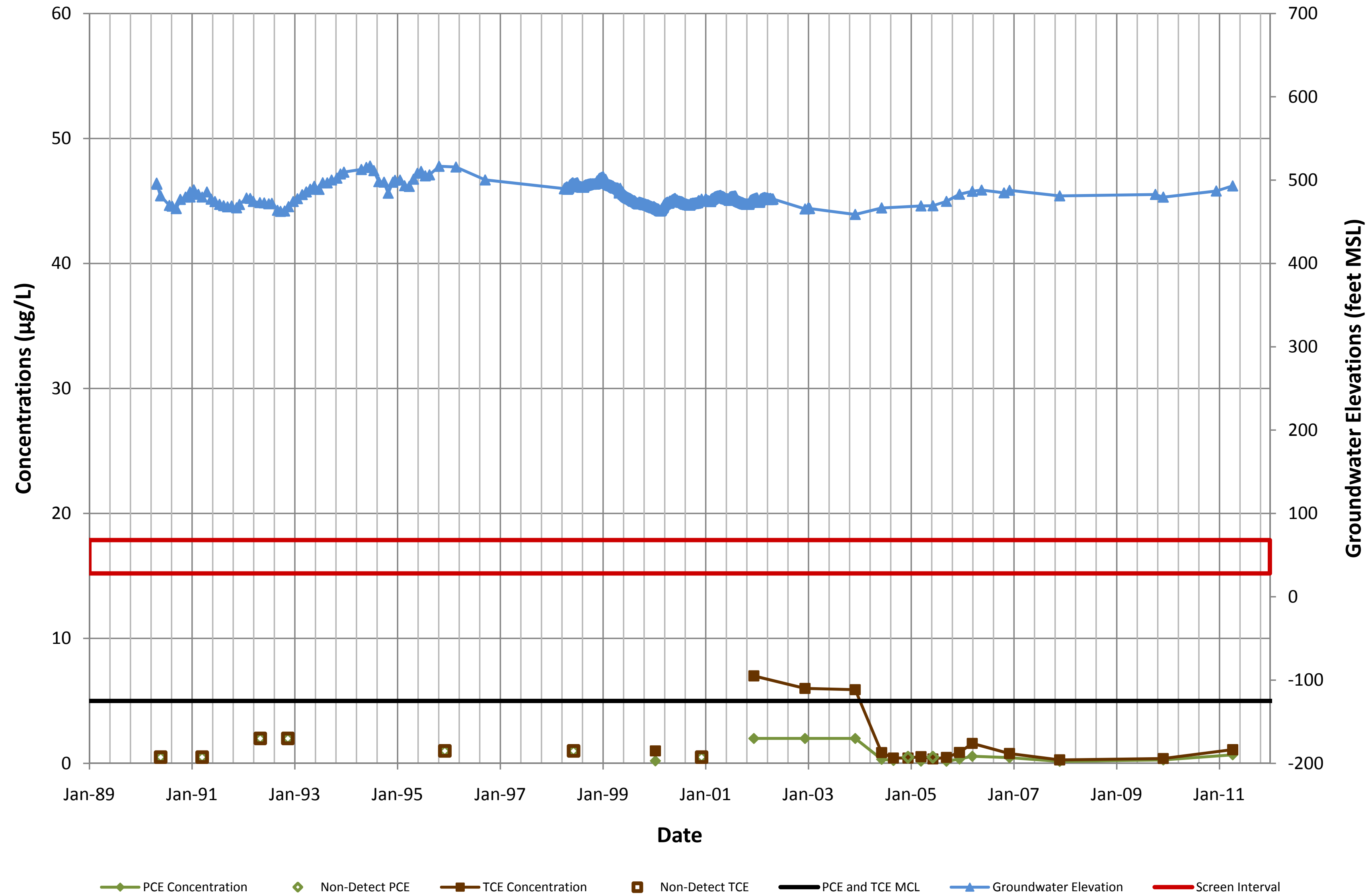
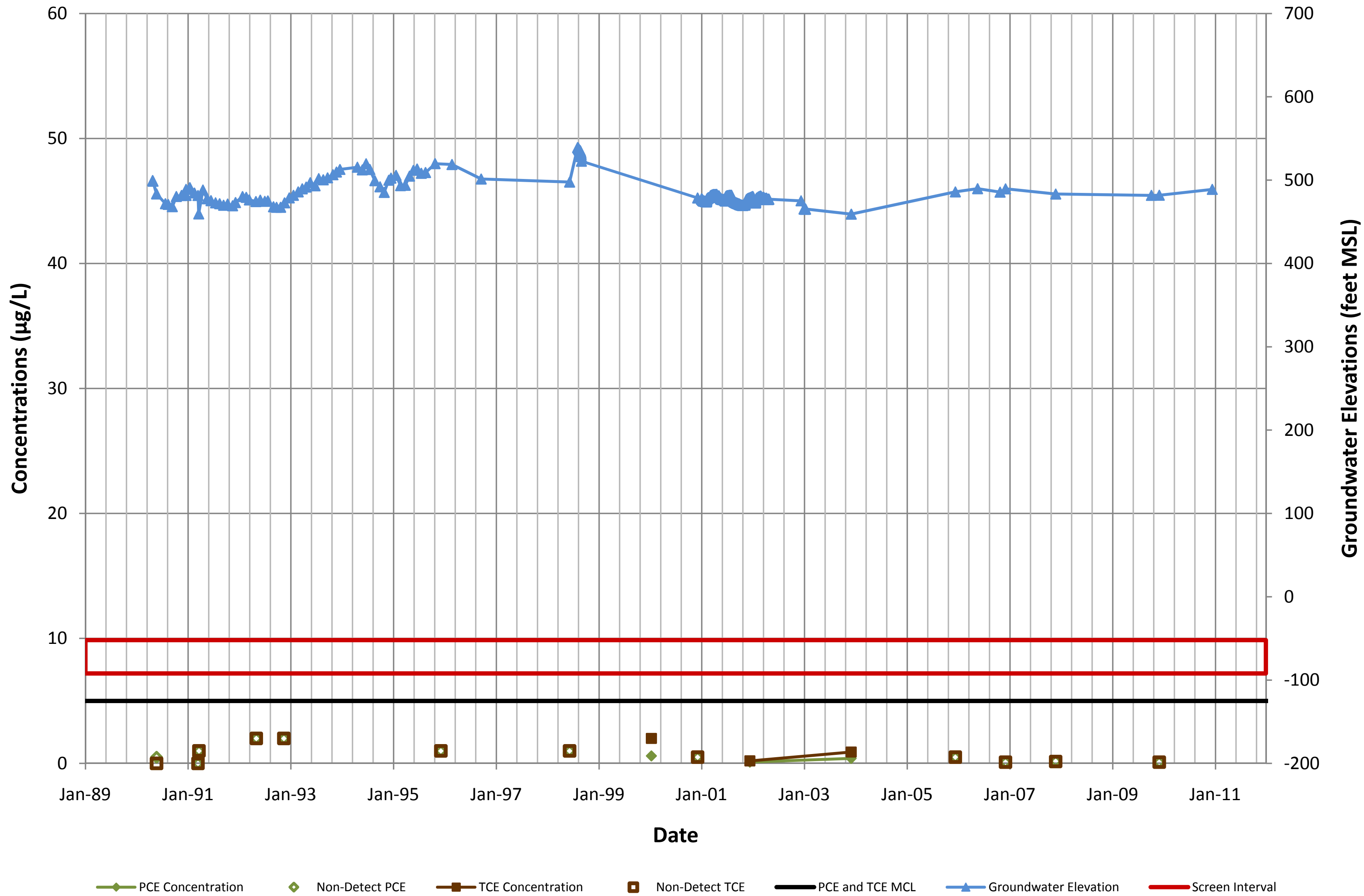


amec	PCE and TCE Concentrations and Groundwater Elevations NHOU Monitoring Well NH-C03-680 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-M-7**

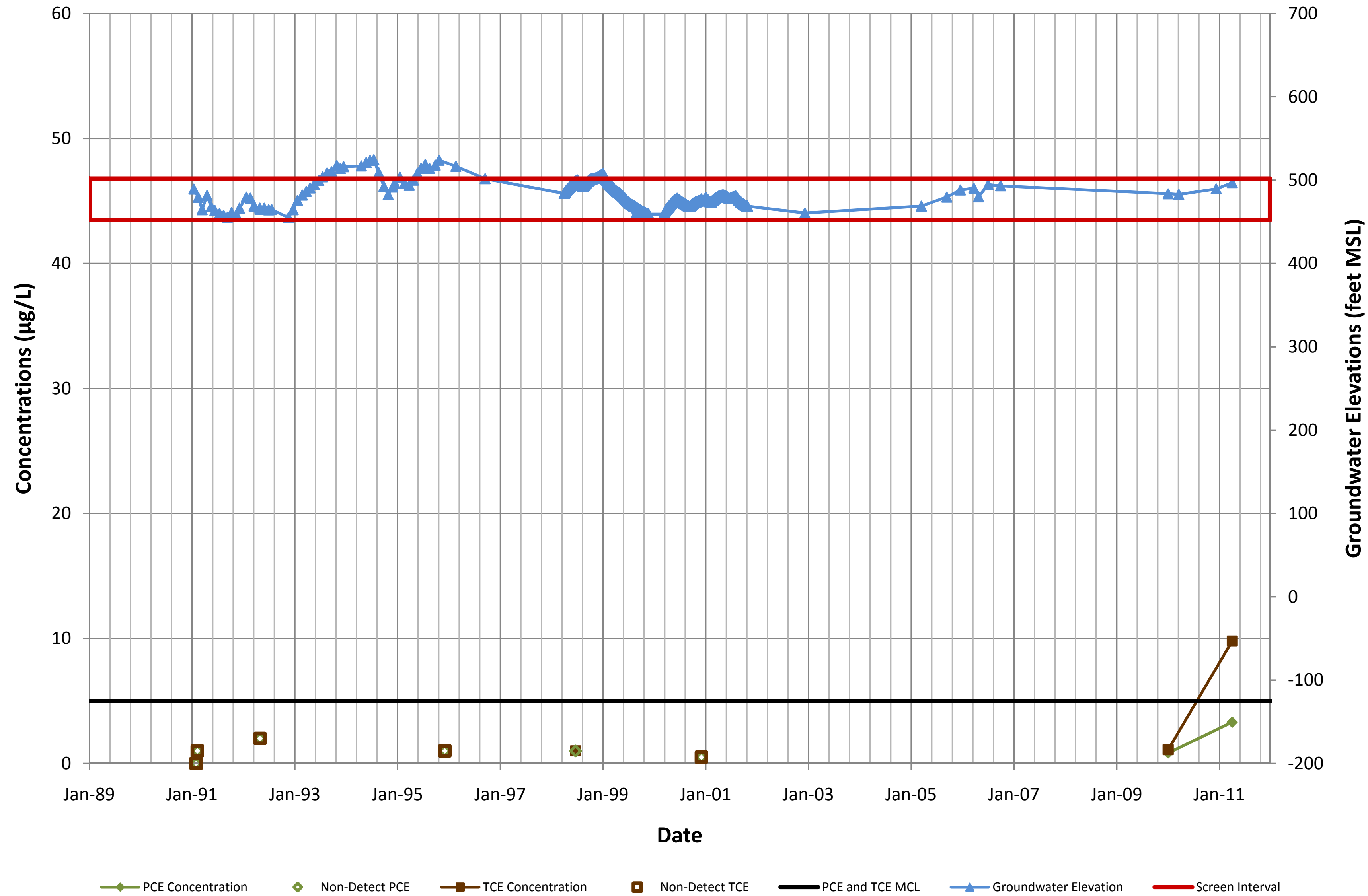
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



PCE and TCE Concentrations and Groundwater Elevations
NHOU Monitoring Well NH-C03-800
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:
F-M-8

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	PCE and TCE Concentrations and Groundwater Elevations NHOU Monitoring Well NH-C05-320 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-M-9**

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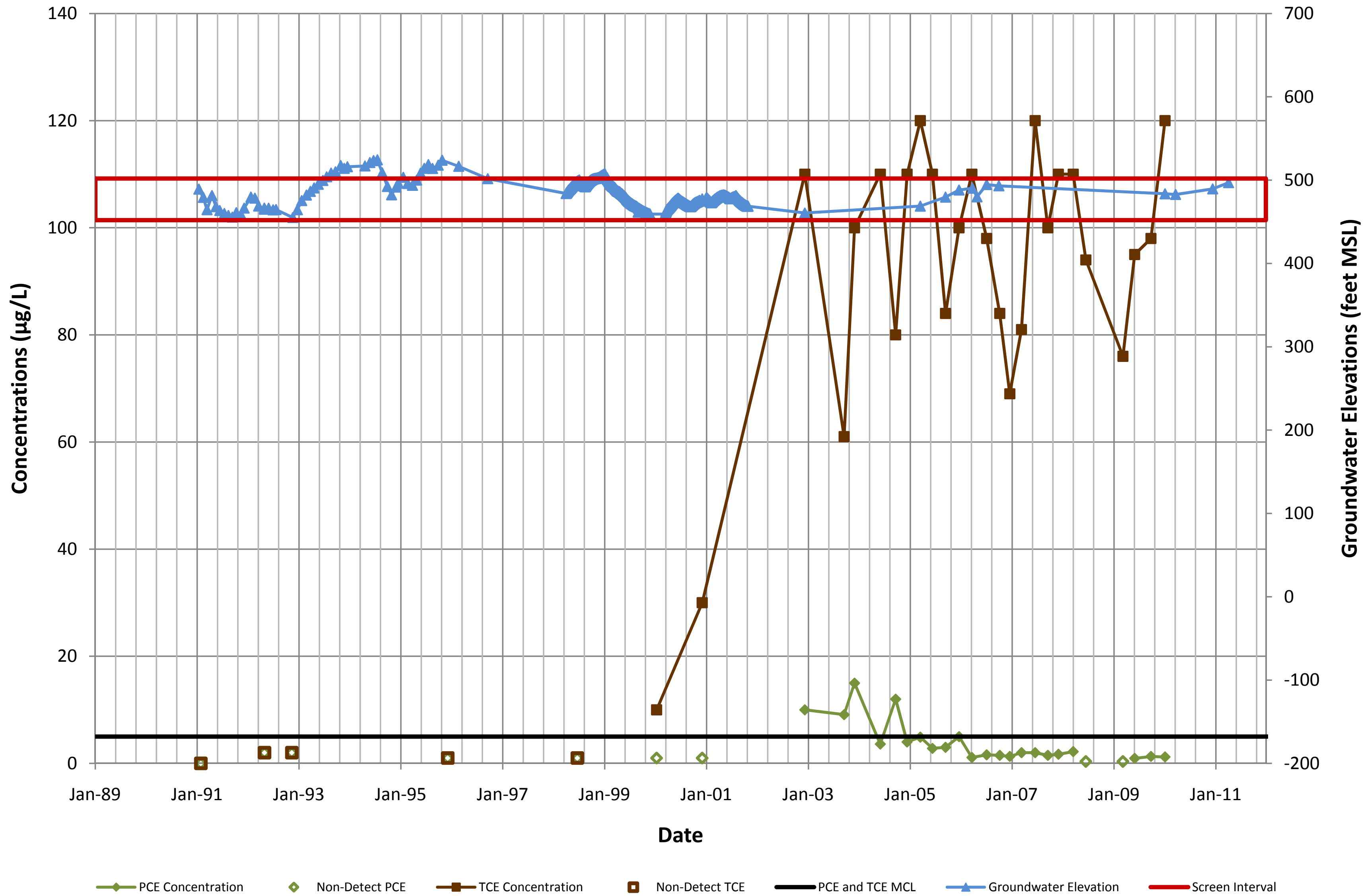
NAM	4088115718	SLC	7/2011

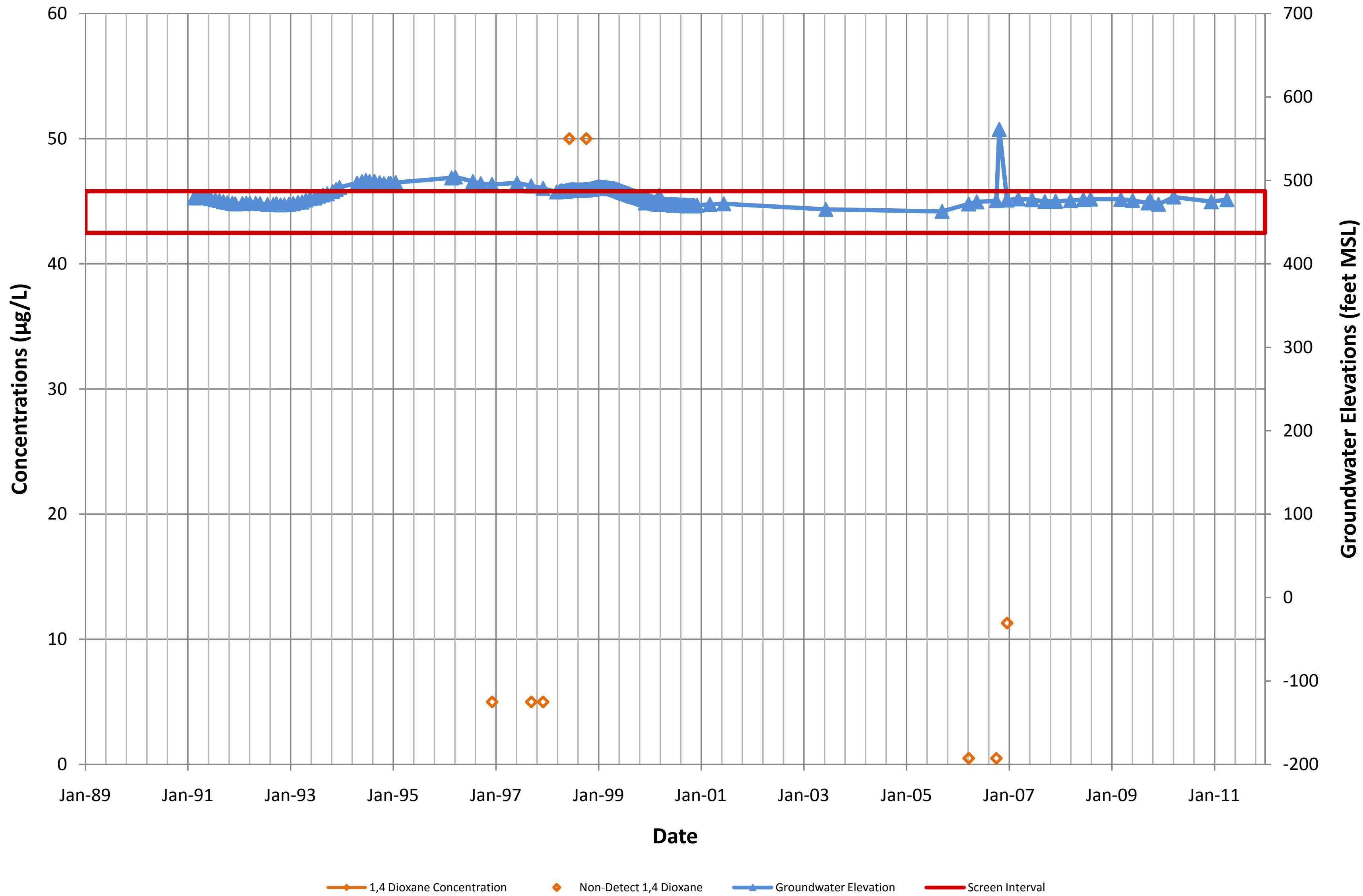


amec

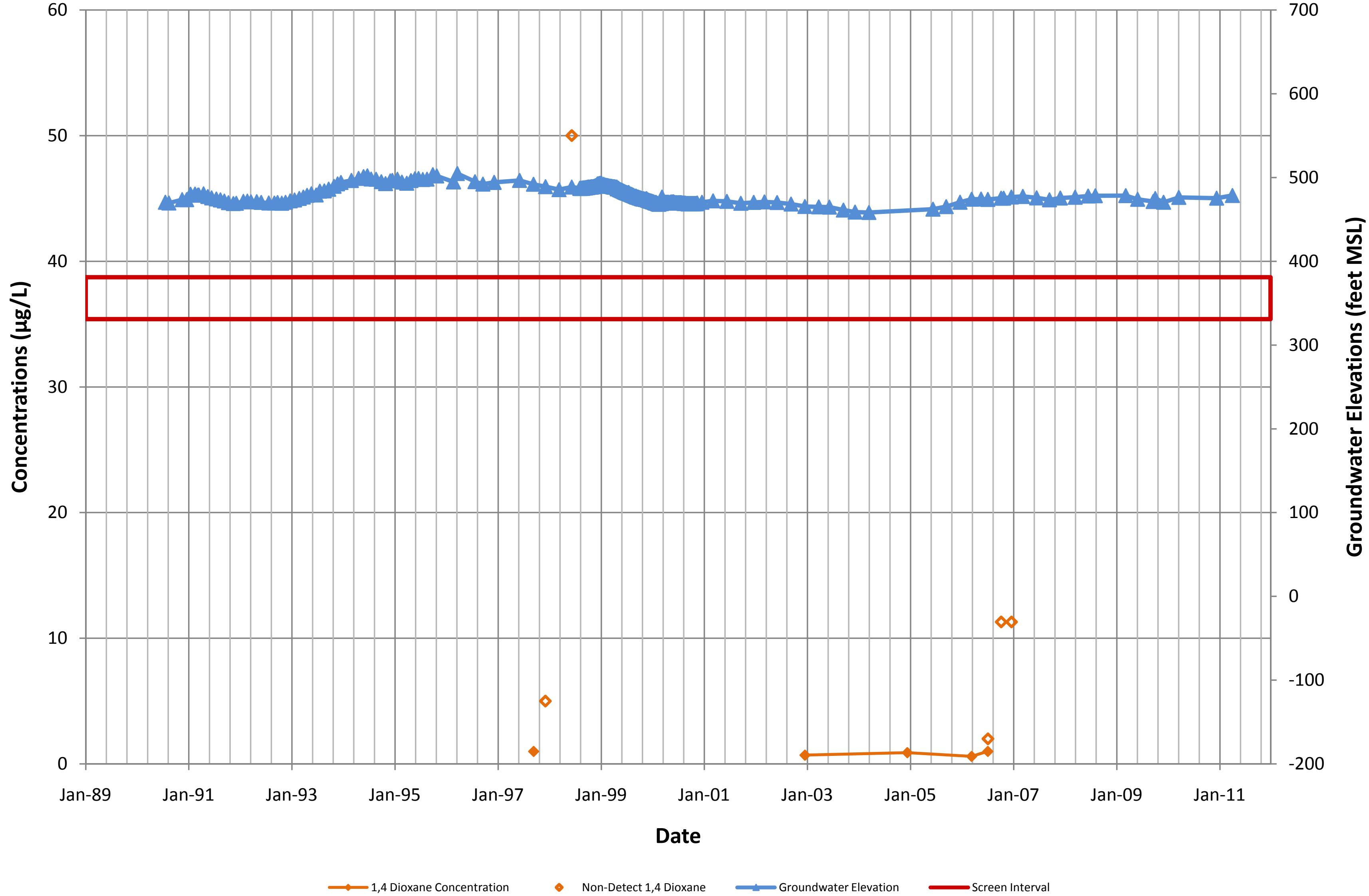
PCE and TCE Concentrations and Groundwater Elevations
NHOU Monitoring Well NH-C05-460
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-M-10**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	1,4-Dioxane Concentration and Groundwater Elevations NHOU Monitoring Well NH-C02-220 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **F-M-11**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 7/2011



amec	1,4-Dioxane Concentration and Groundwater Elevations NHOU Monitoring Well NH-C02-325 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **F-M-12**
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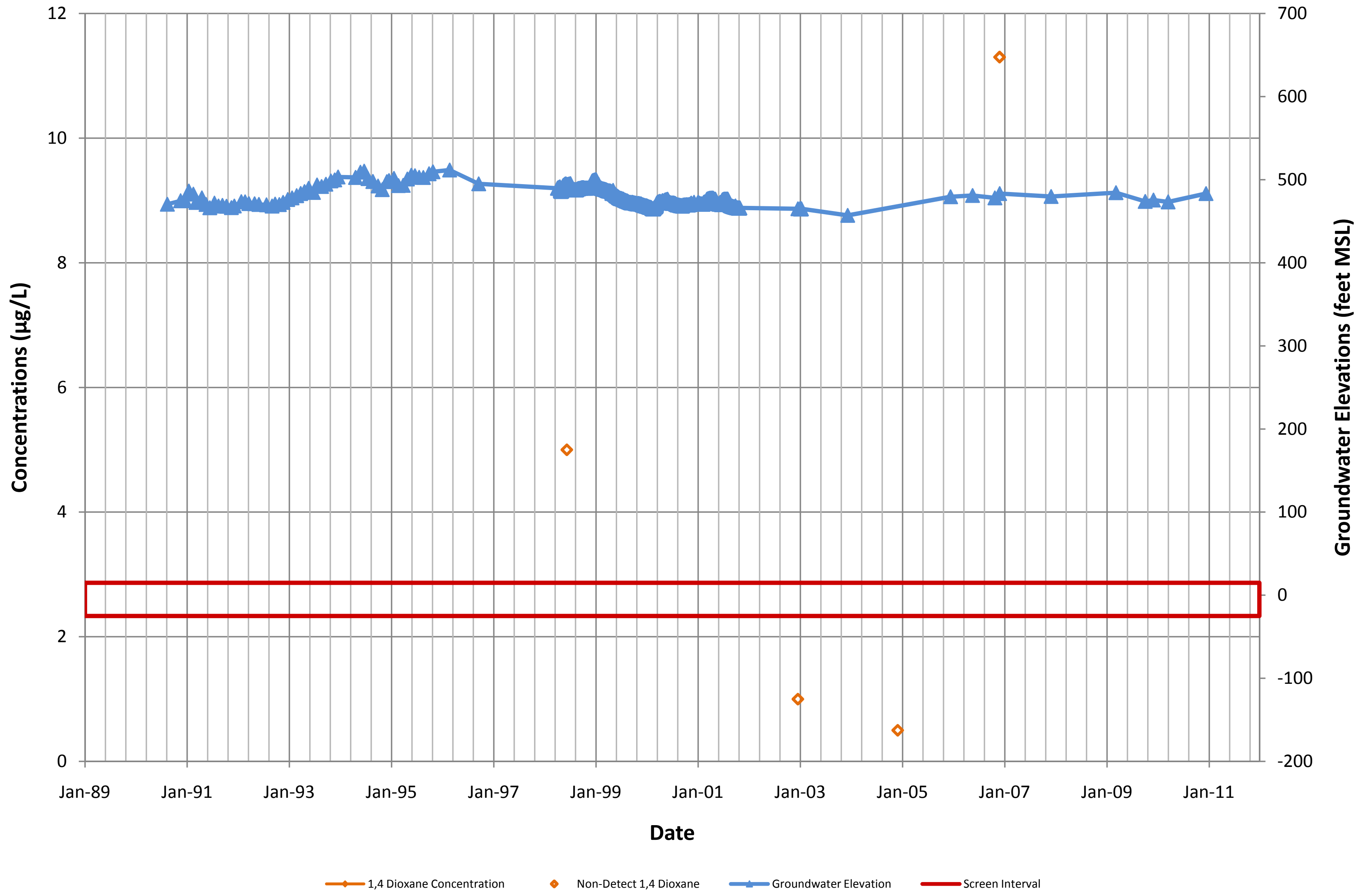
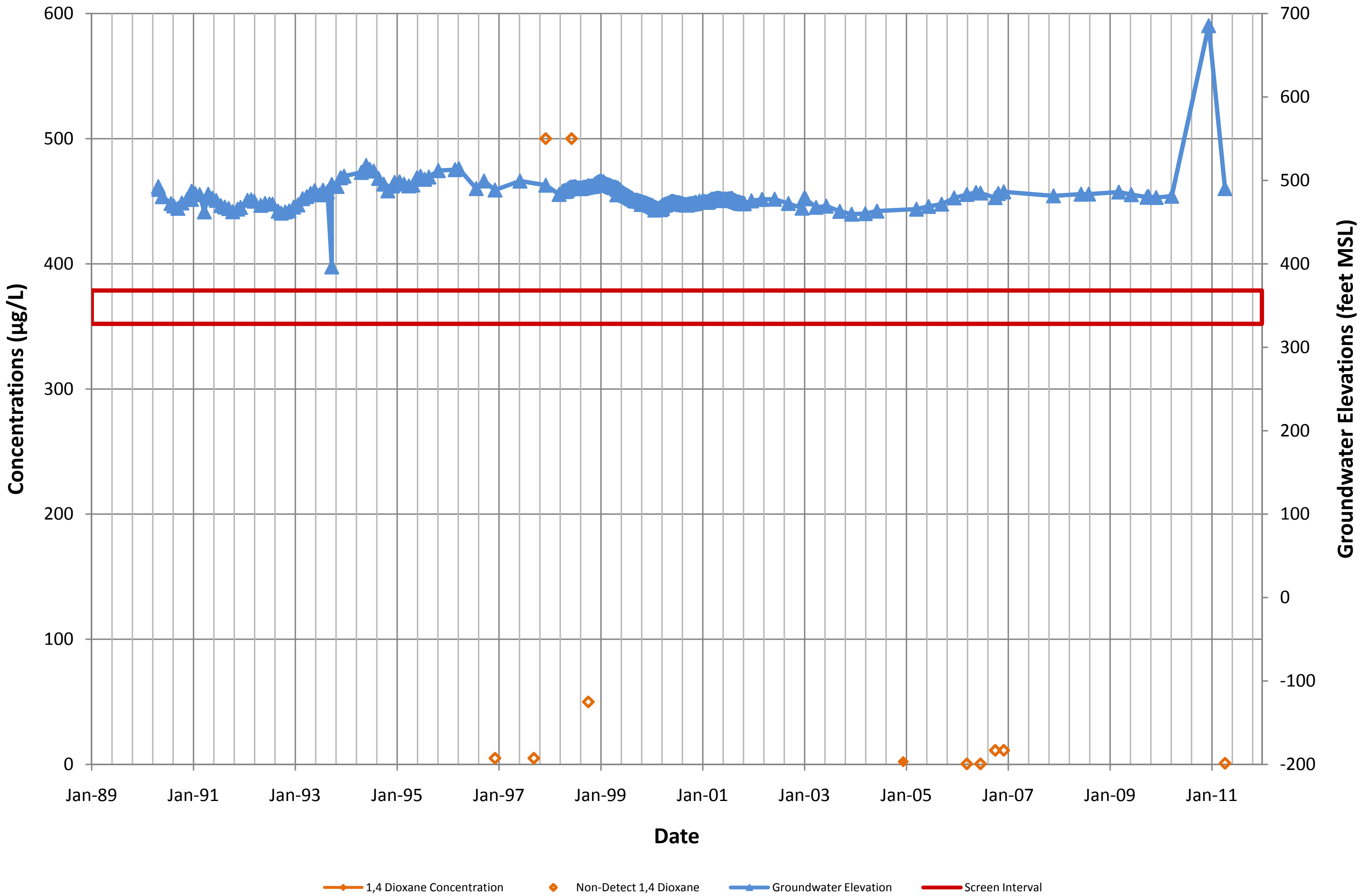


amec

1,4-Dioxane Concentration and Groundwater Elevations
NHOU Monitoring Well NH-C02-681
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-M-13**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

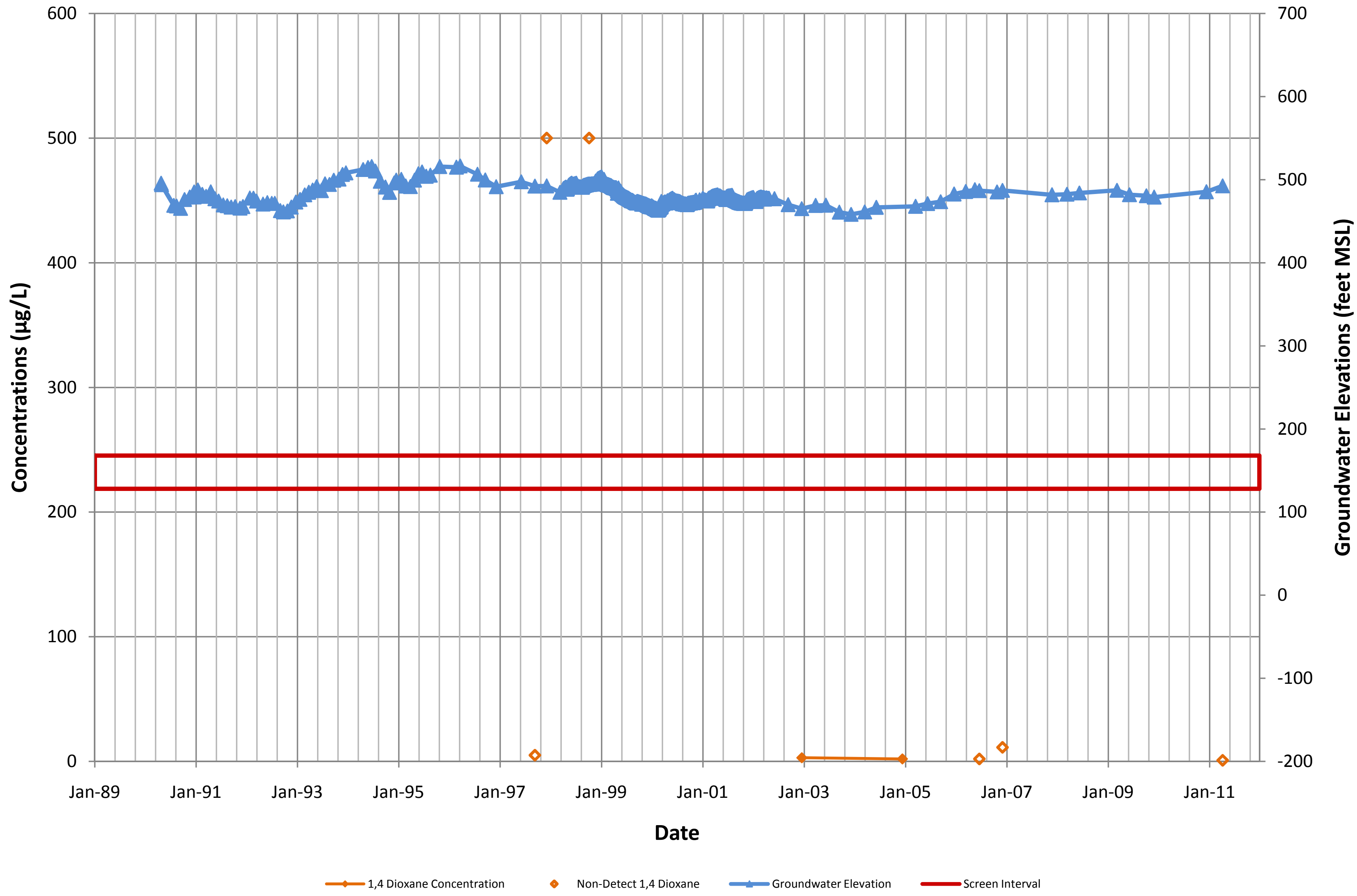


amec

1,4-Dioxane Concentration and Groundwater Elevations
NHOU Monitoring Well NH-C03-380
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:
F-M-14

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

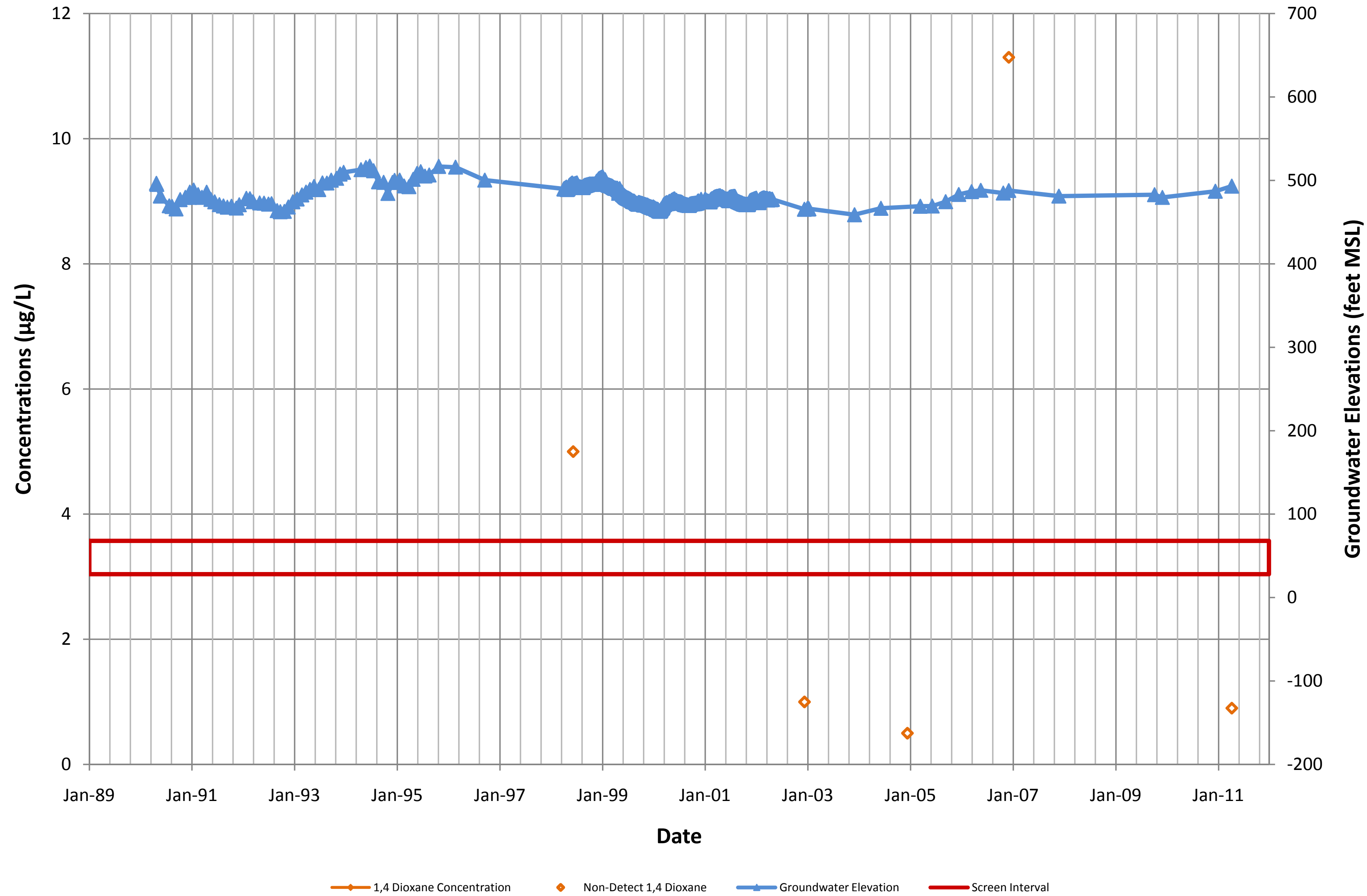


amec

1,4-Dioxane Concentration and Groundwater Elevations
NHOU Monitoring Well NH-C03-580
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:
F-M-15

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	1,4-Dioxane Concentration and Groundwater Elevations NHOU Monitoring Well NH-C03-680 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-M-16**

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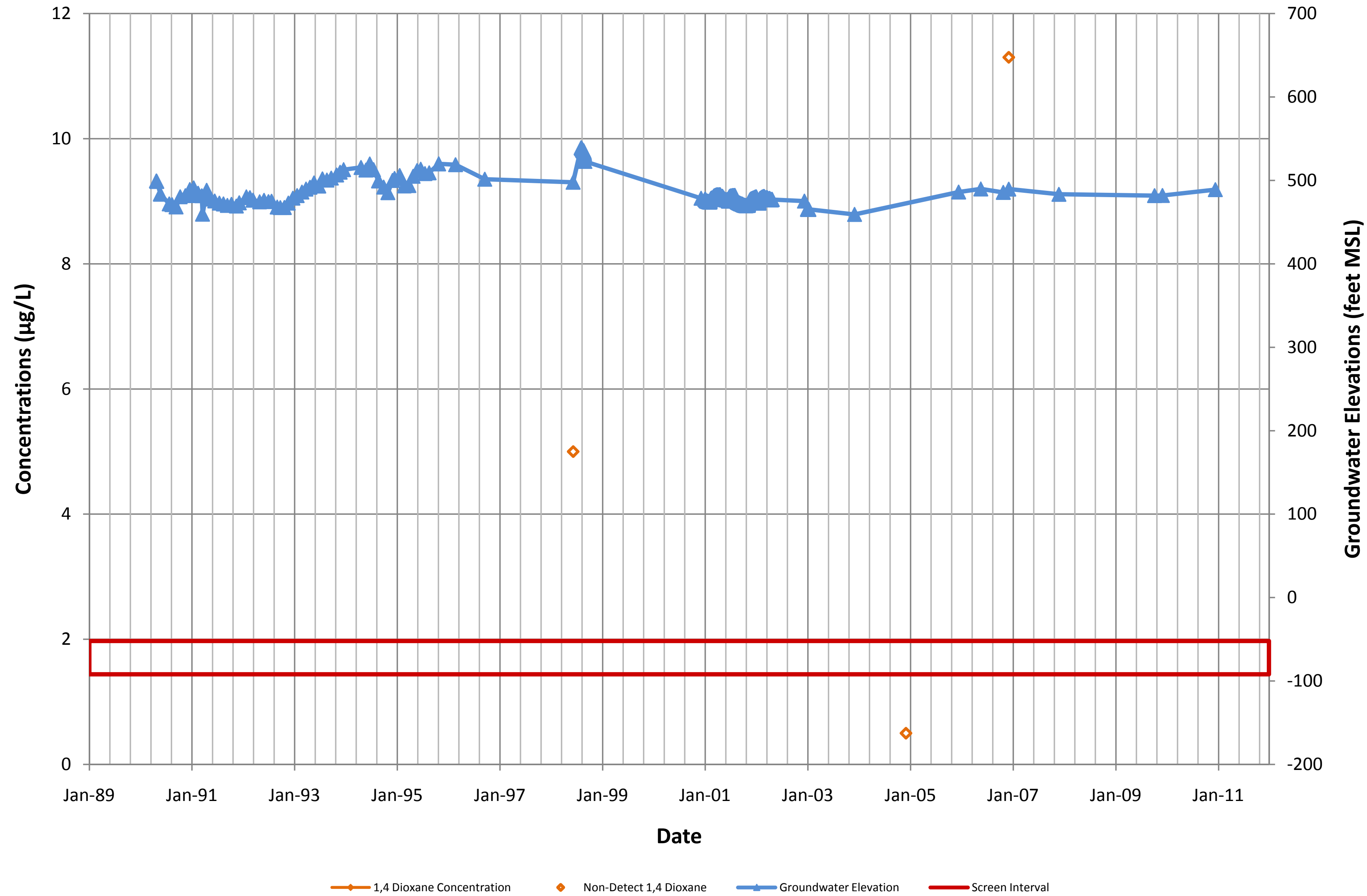
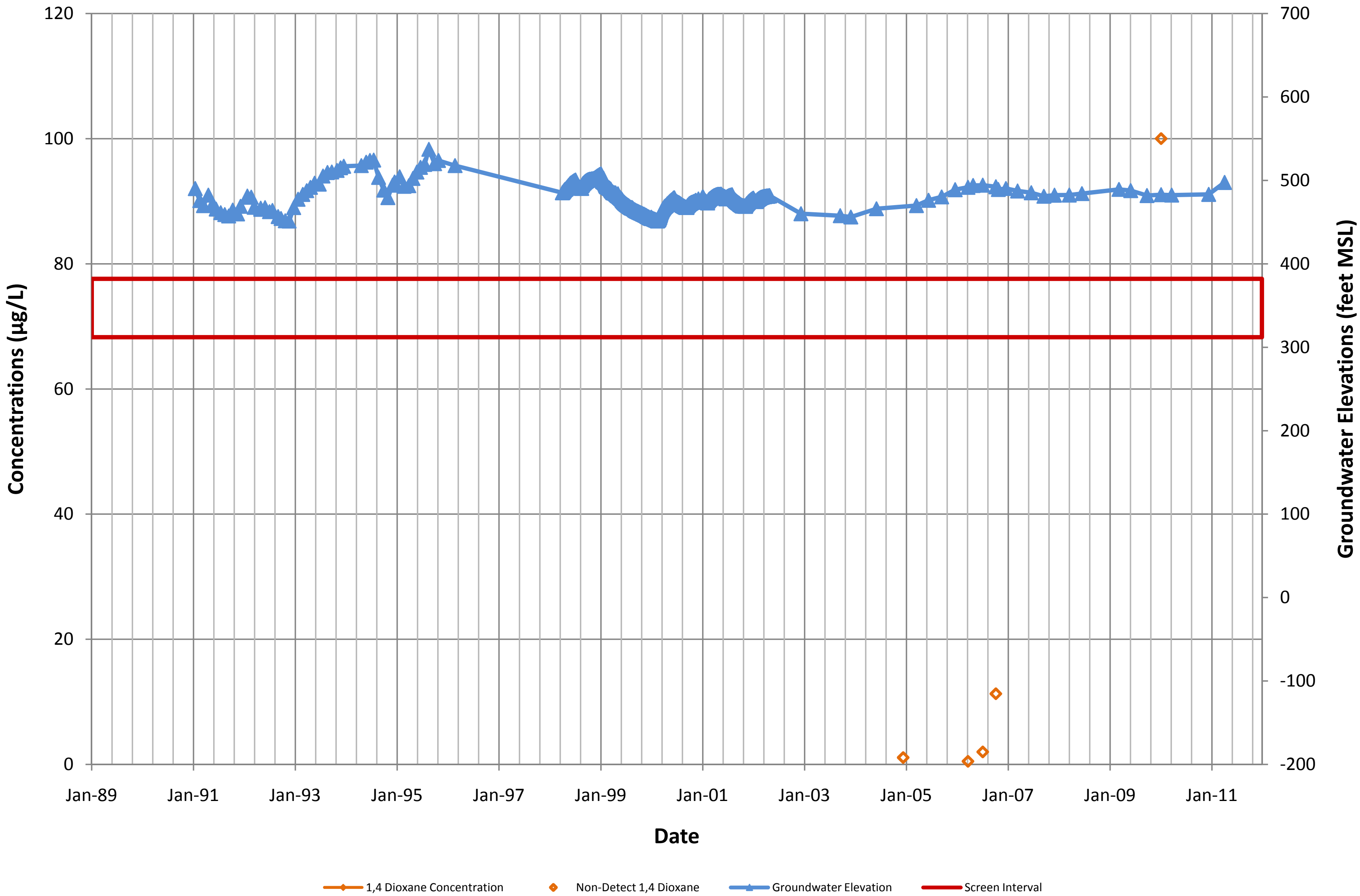


amec

1,4-Dioxane Concentration and Groundwater Elevations
NHOU Monitoring Well NH-C03-800
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:
F-M-17

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	1,4-Dioxane Concentration and Groundwater Elevations NHOU Monitoring Well NH-C05-460 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-M-18**

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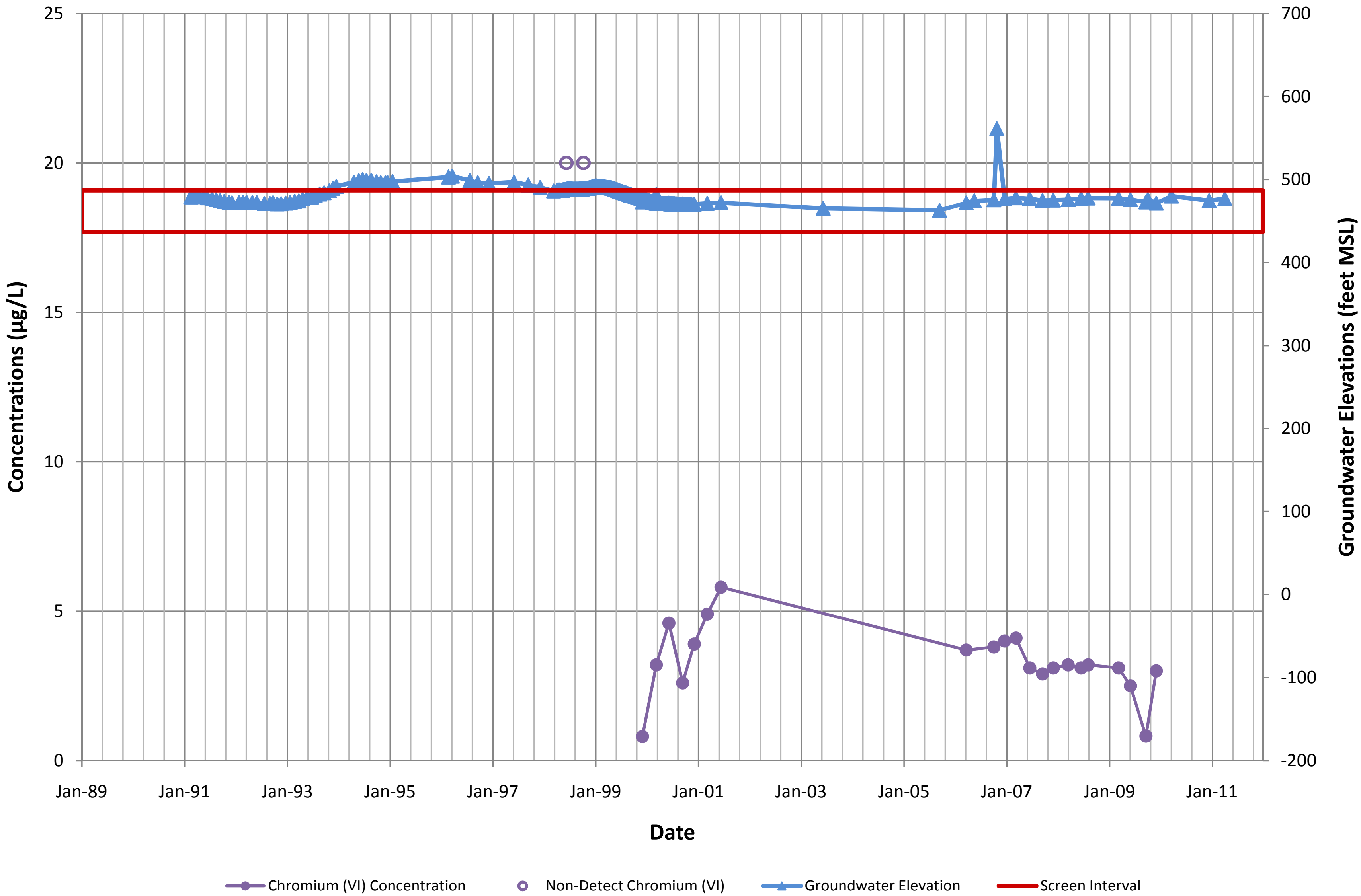
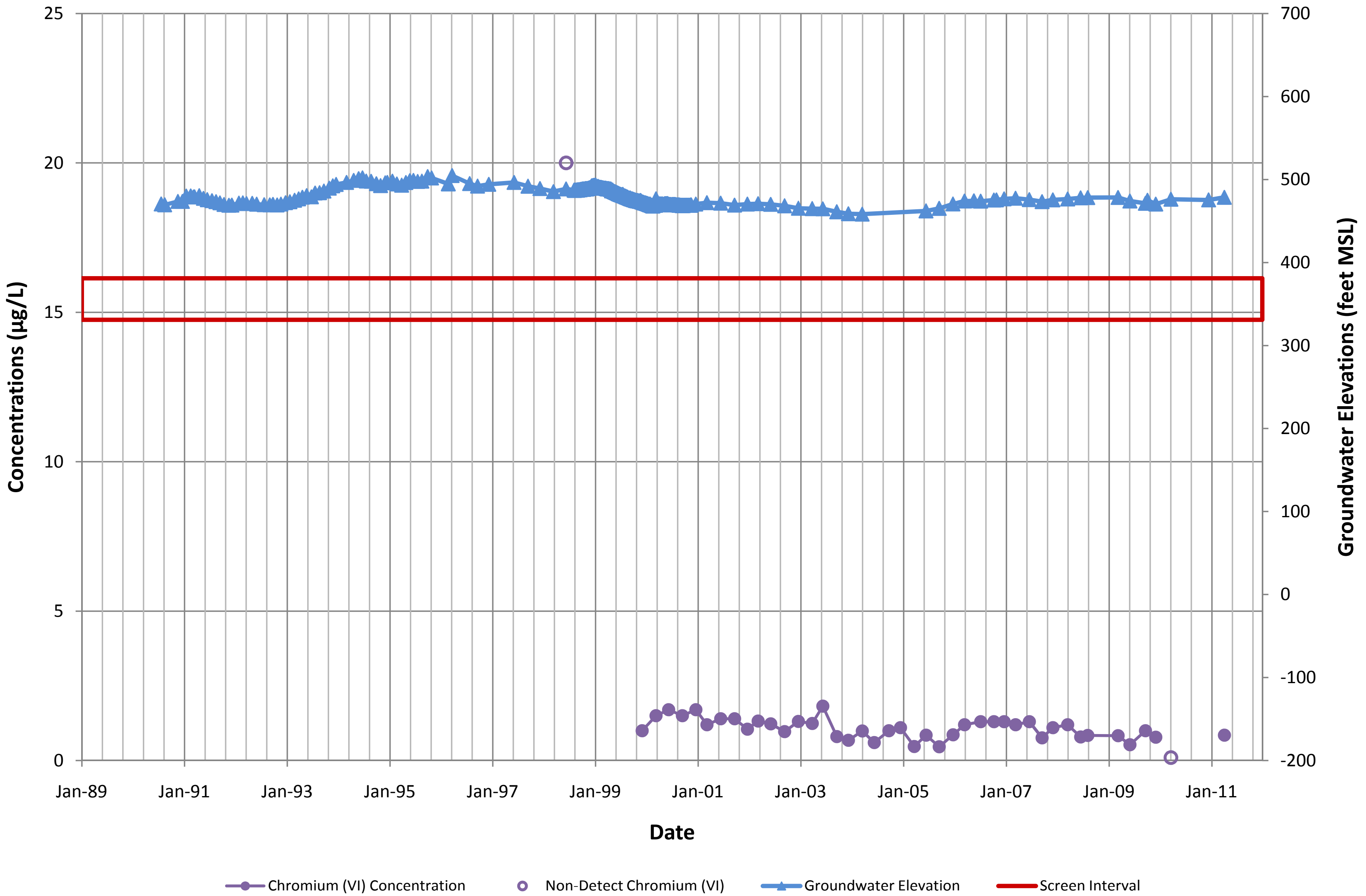
NAM	4088115718	SLC	7/2011



amec	Chromium (VI) Concentration and Groundwater Elevations NHOU Monitoring Well NH-C02-220 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-M-19**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	Chromium (VI) Concentration and Groundwater Elevations NHOU Monitoring Well NH-C02-325 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-M-20**

DRAWN	JOB NUMBER	CHECKED	DATE
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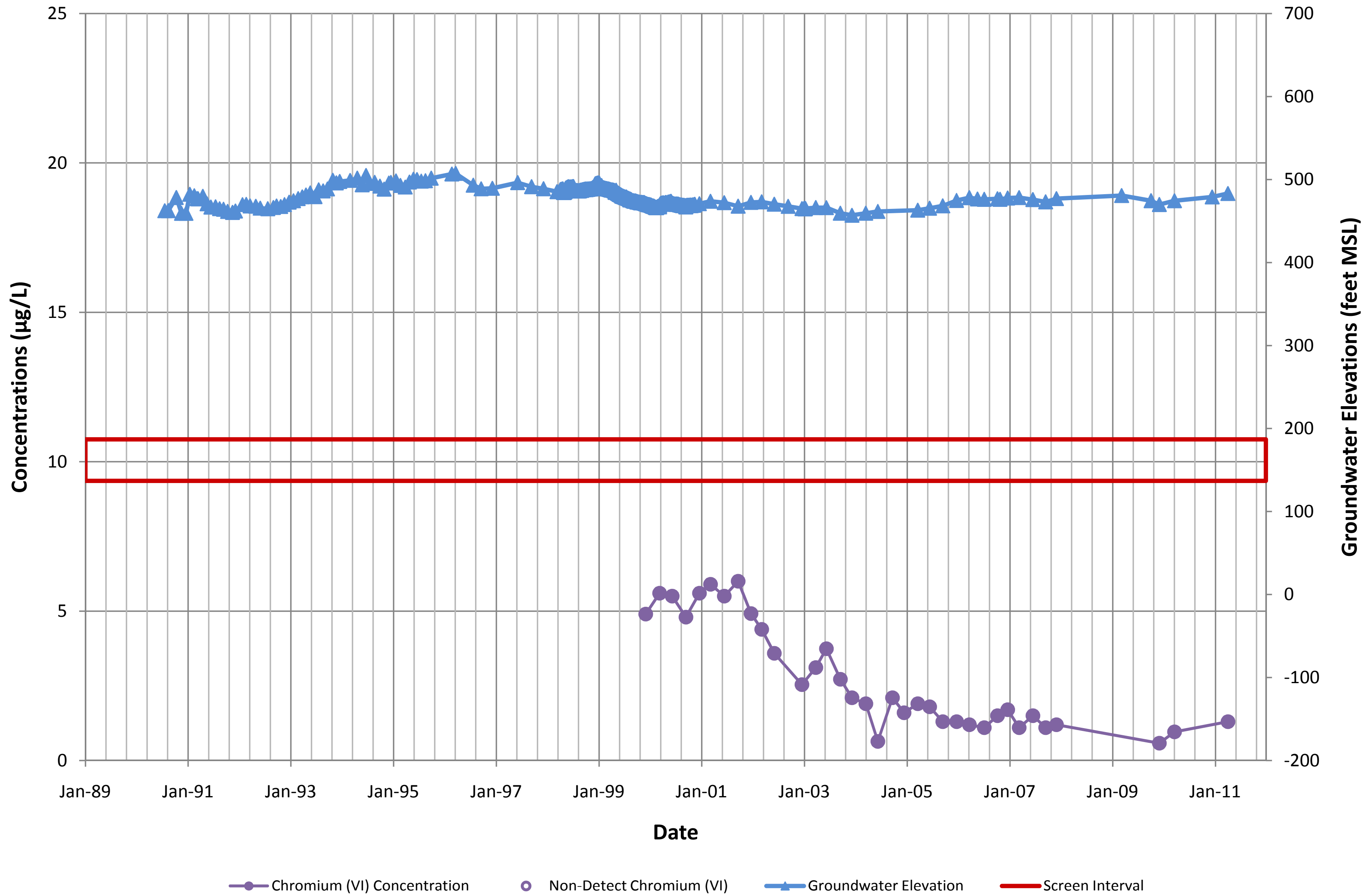

Chromium (VI) Concentration and Groundwater Elevations
NHOU Monitoring Well NH-C02-520
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-M-21**

DRAWN	JOB NUMBER	CHECKED	DATE
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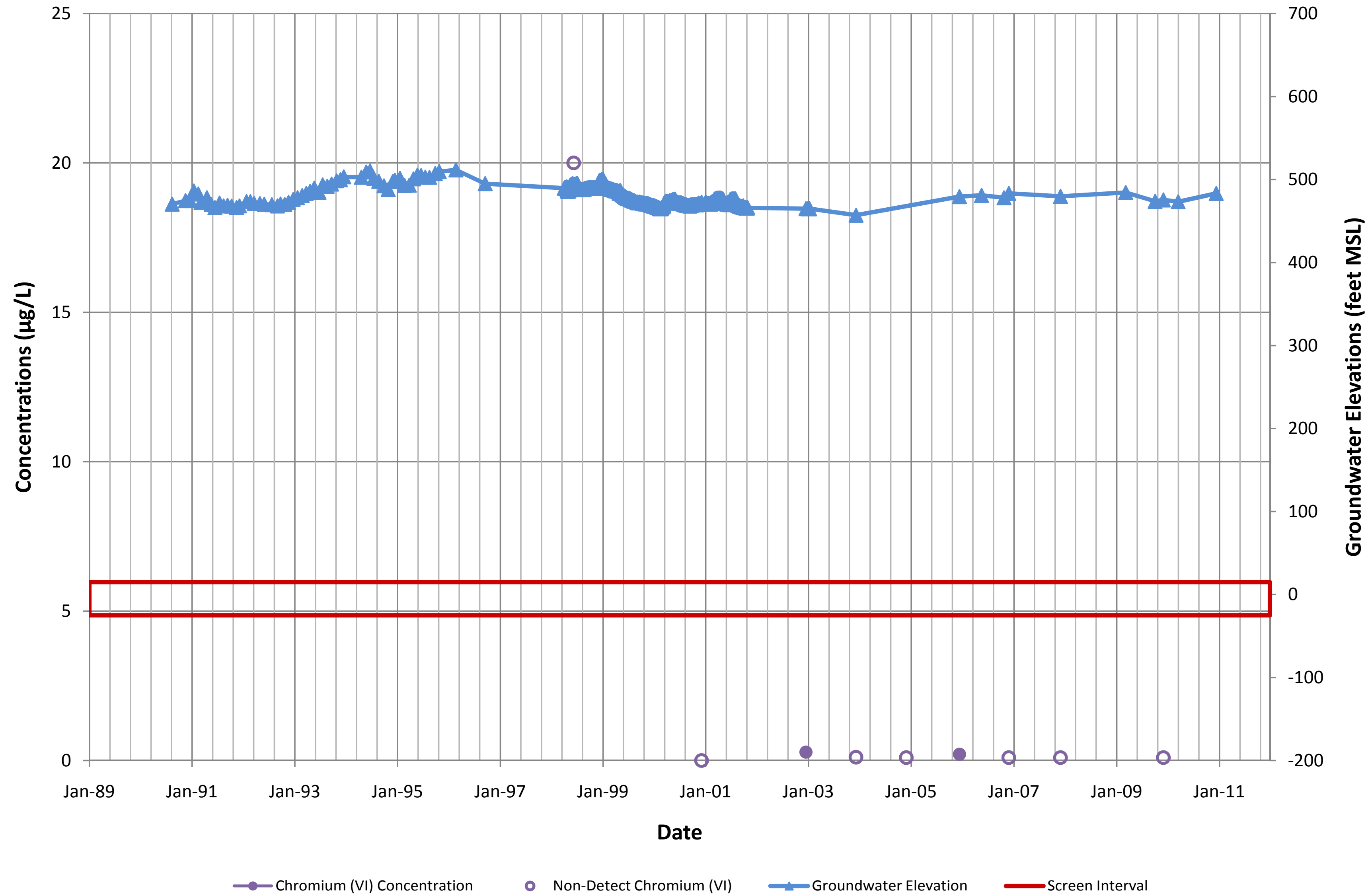

amec	Chromium (VI) Concentration and Groundwater Elevations NHOU Monitoring Well NH-C02-681 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-M-22**

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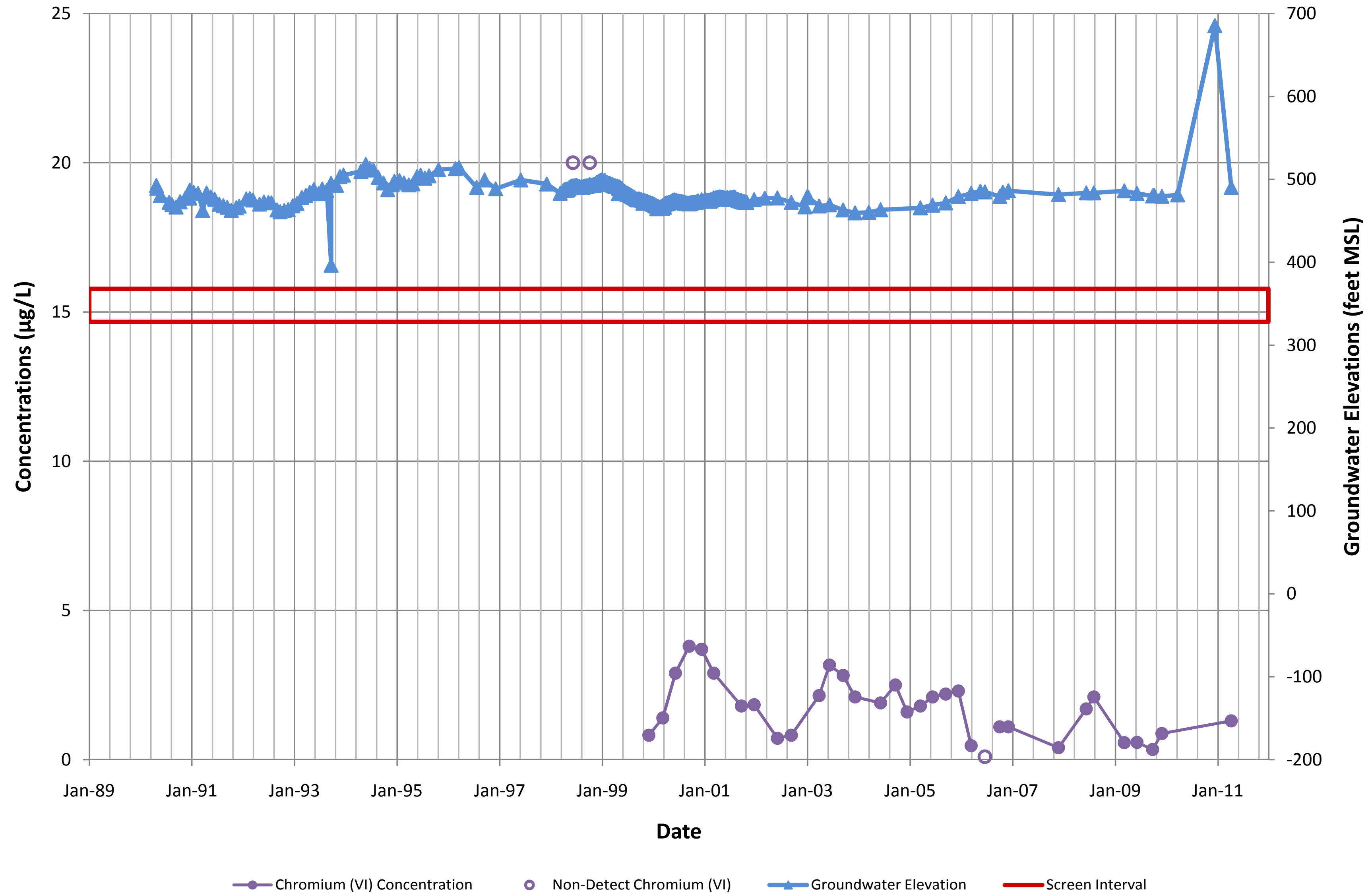
NAM	4088115718	SLC	7/2011



amec	Chromium (VI) Concentration and Groundwater Elevations NHOU Monitoring Well NH-C03-380 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **F-M-23**
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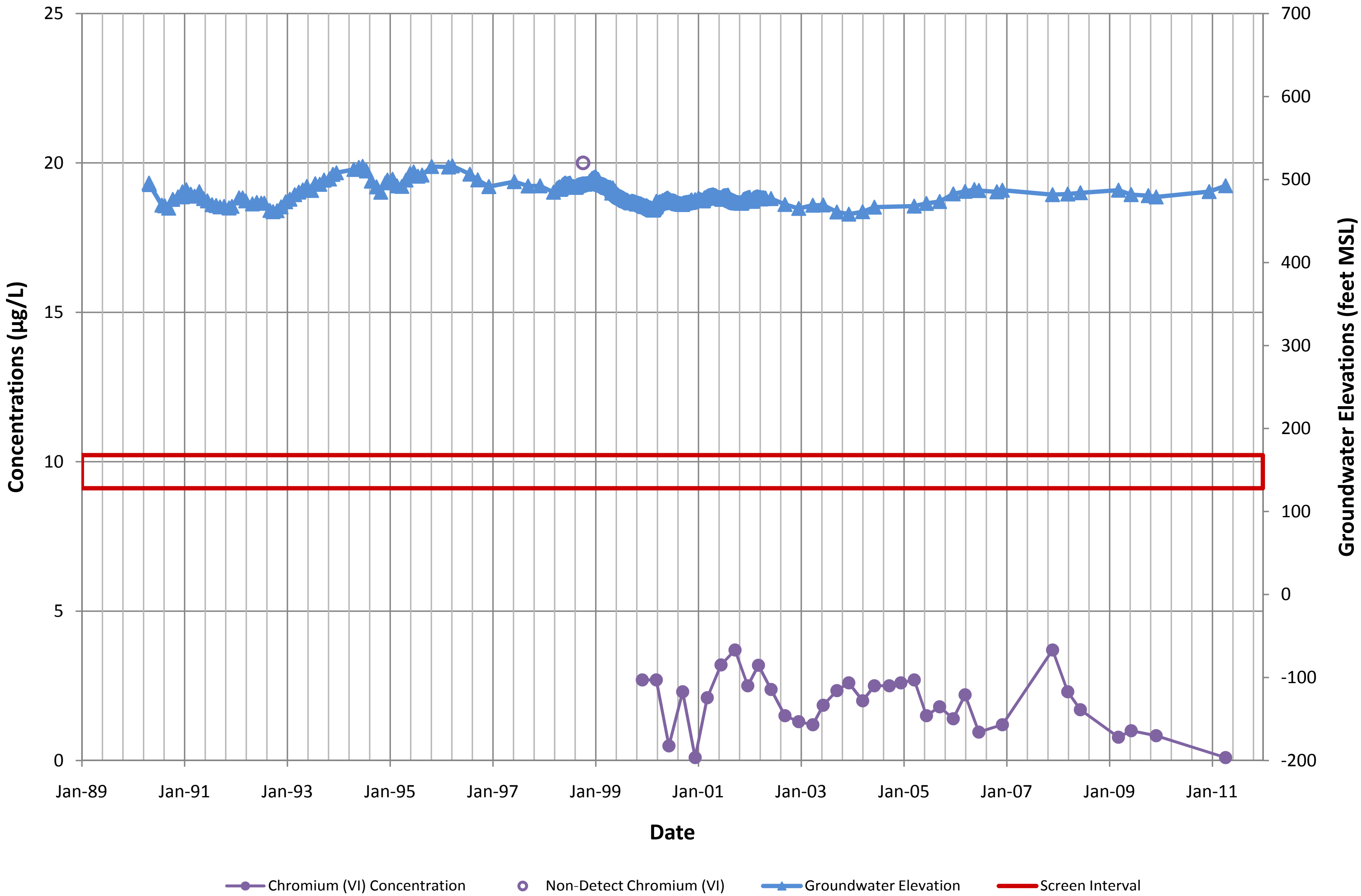


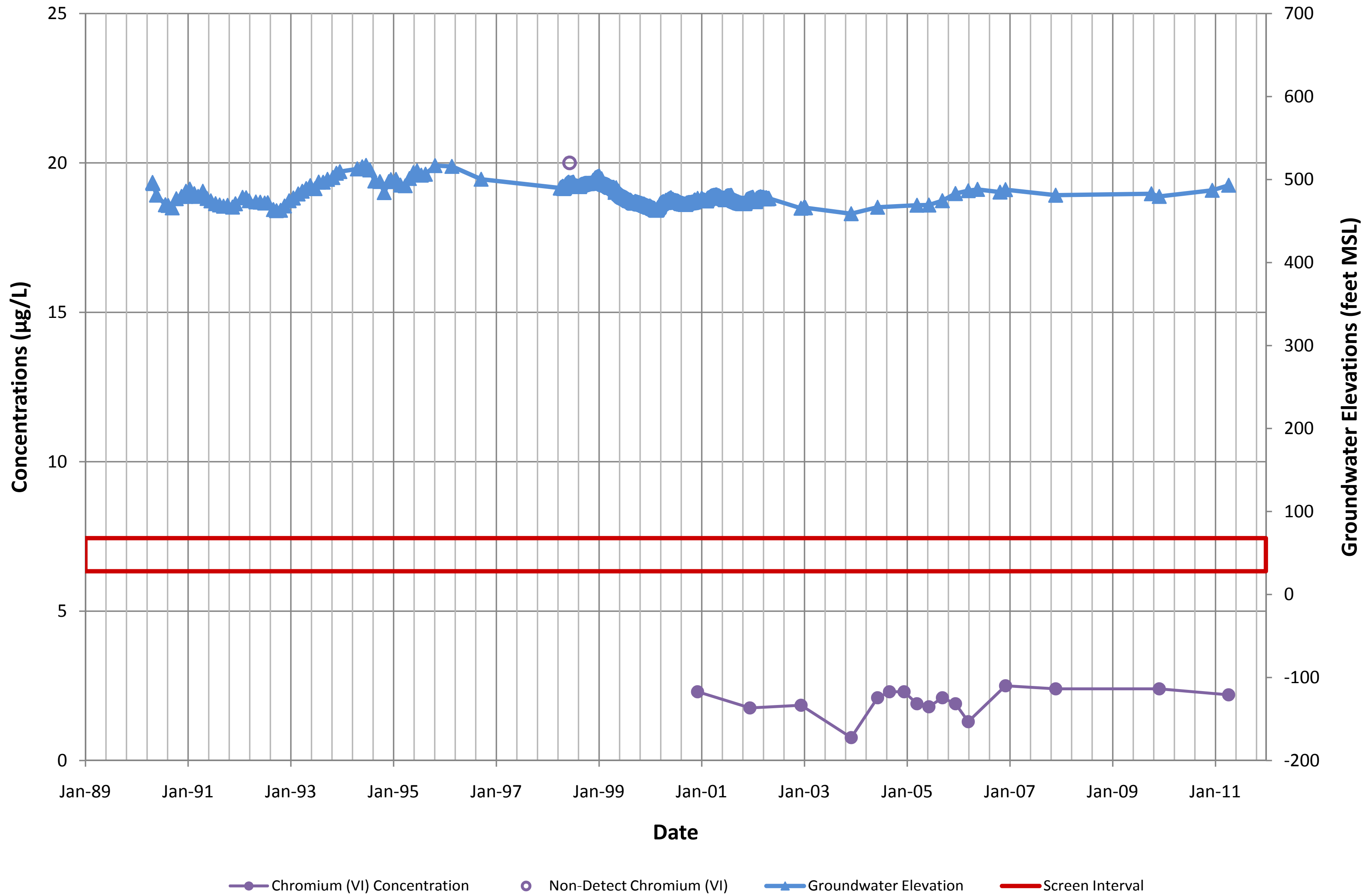
amec

Chromium (VI) Concentration and Groundwater Elevations
NHOU Monitoring Well NH-C03-580
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-M-24

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	Chromium (VI) Concentration and Groundwater Elevations NHOU Monitoring Well NH-C03-680 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-M-25**

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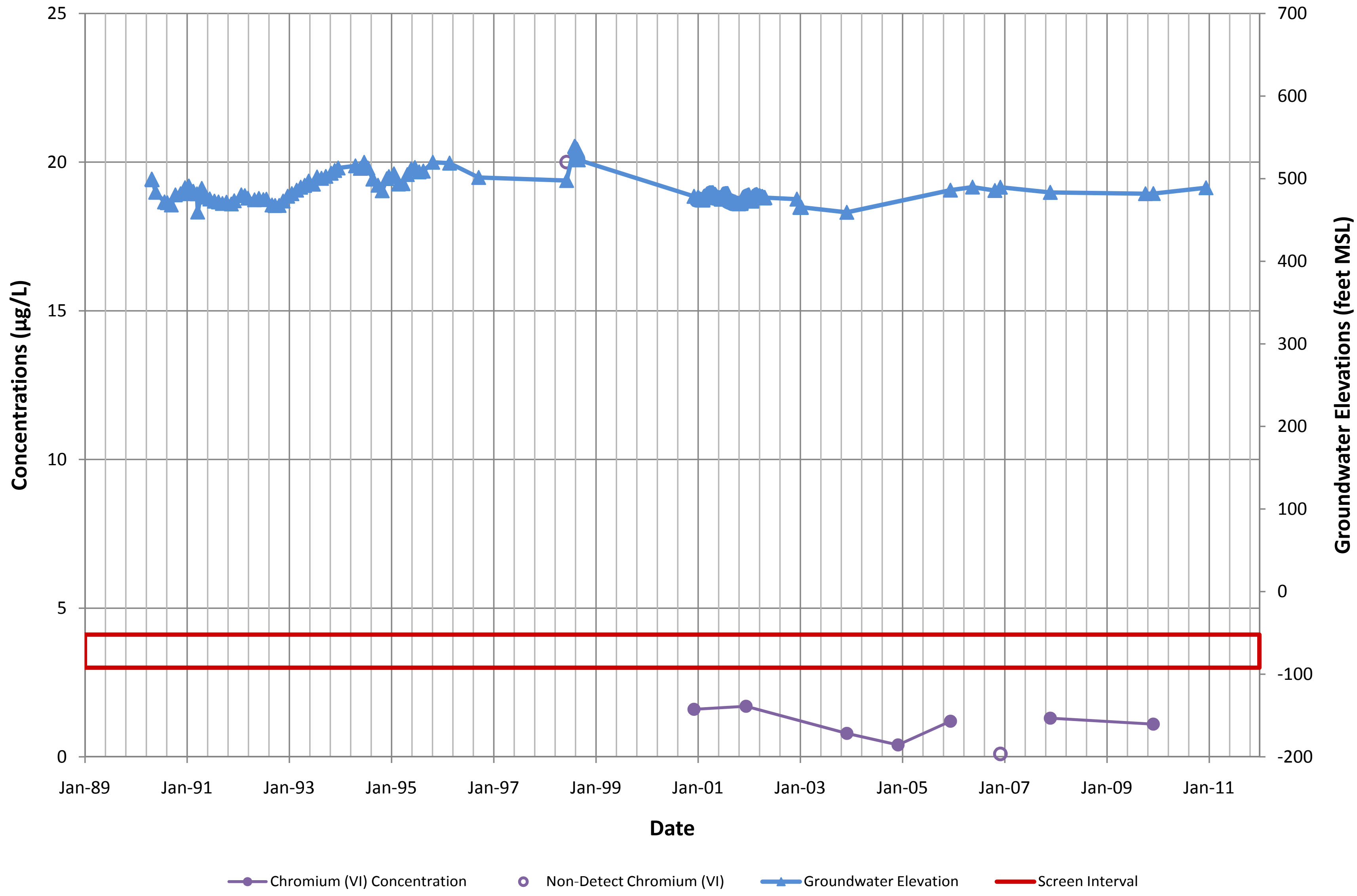

amec

Chromium (VI) Concentration and Groundwater Elevations
NHOU Monitoring Well NH-C03-800
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:
F-M-26

DRAWN	JOB NUMBER	CHECKED	DATE
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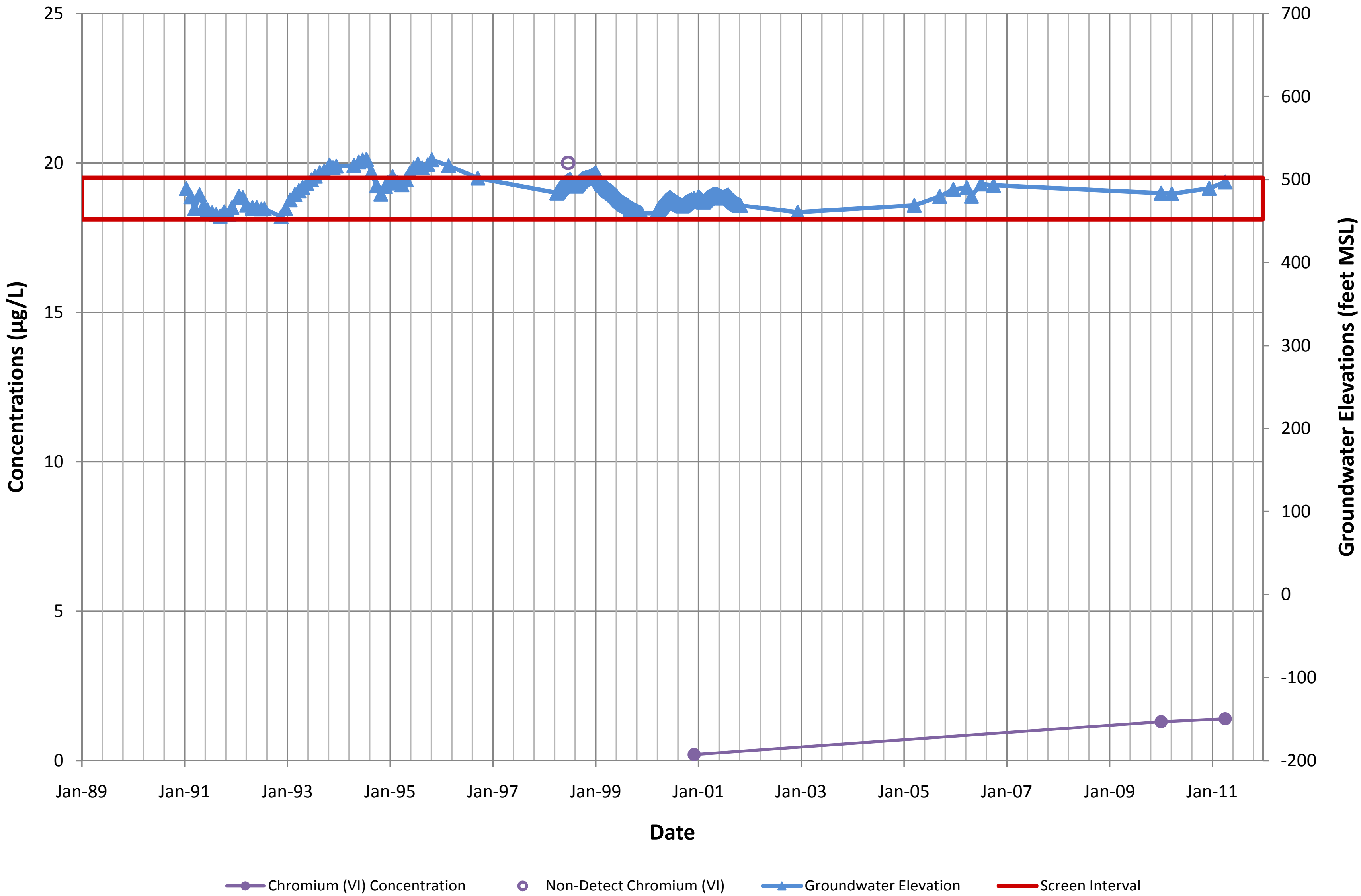

Chromium (VI) Concentration and Groundwater Elevations
NHOU Monitoring Well NH-C05-320
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-M-27**

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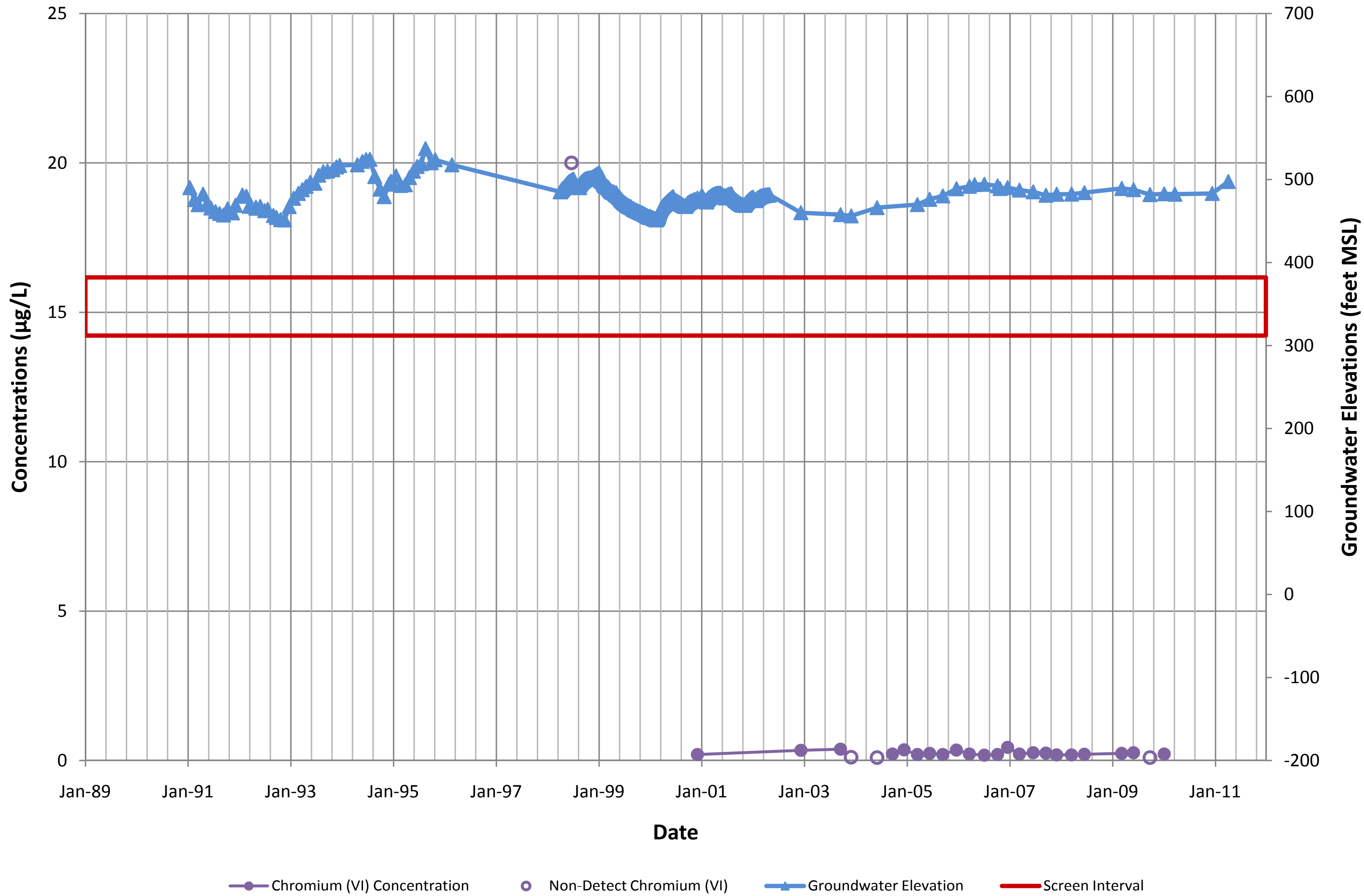
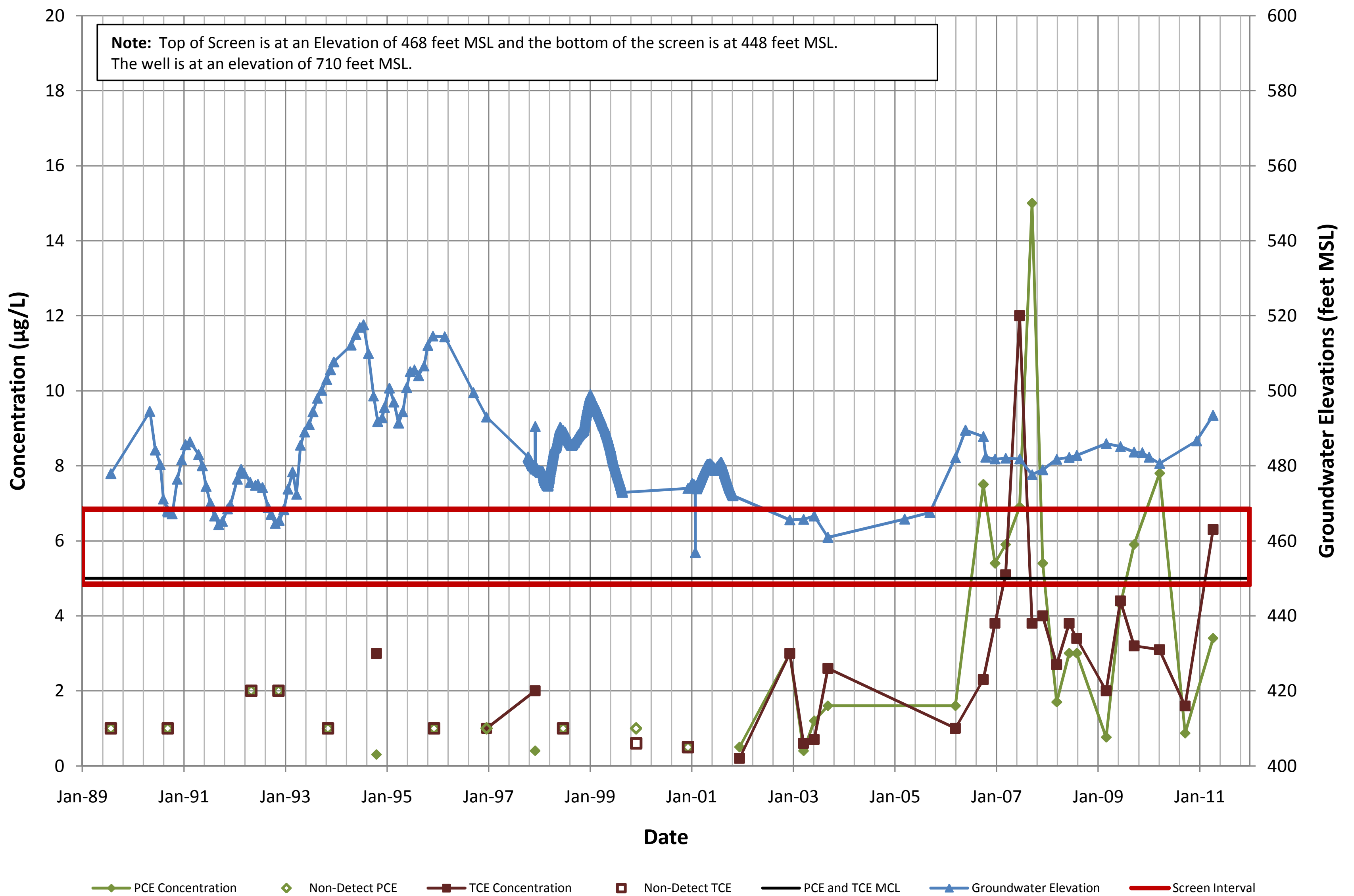


Chromium (VI) Concentration and Groundwater Elevations
NHOU Monitoring Well NH-C05-460
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-M-28

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

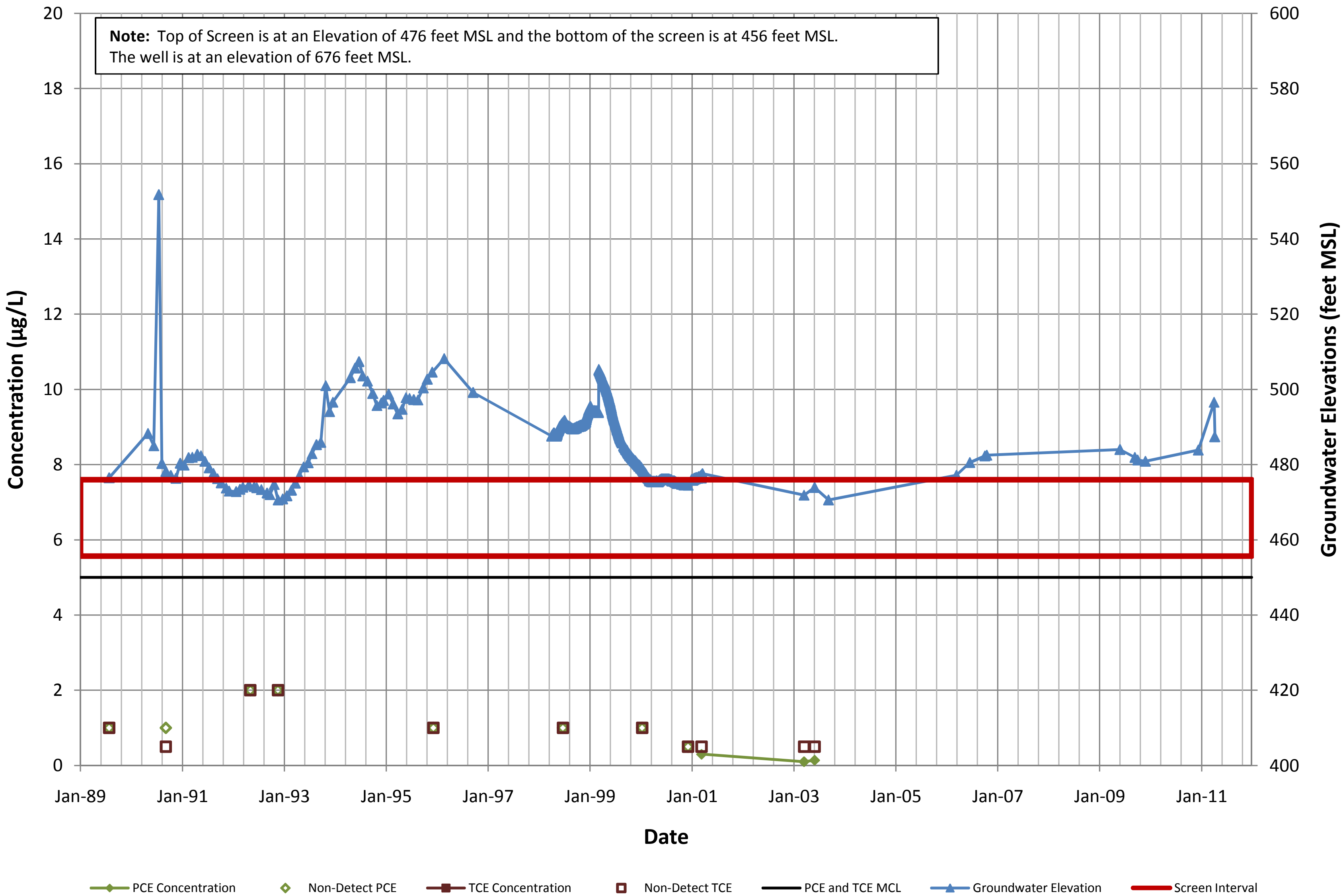


amec

PCE and TCE Concentrations and Groundwater Elevations
North Hollwood Operable Unit Vertical Profile Well NH-VPB-02
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-V-1**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

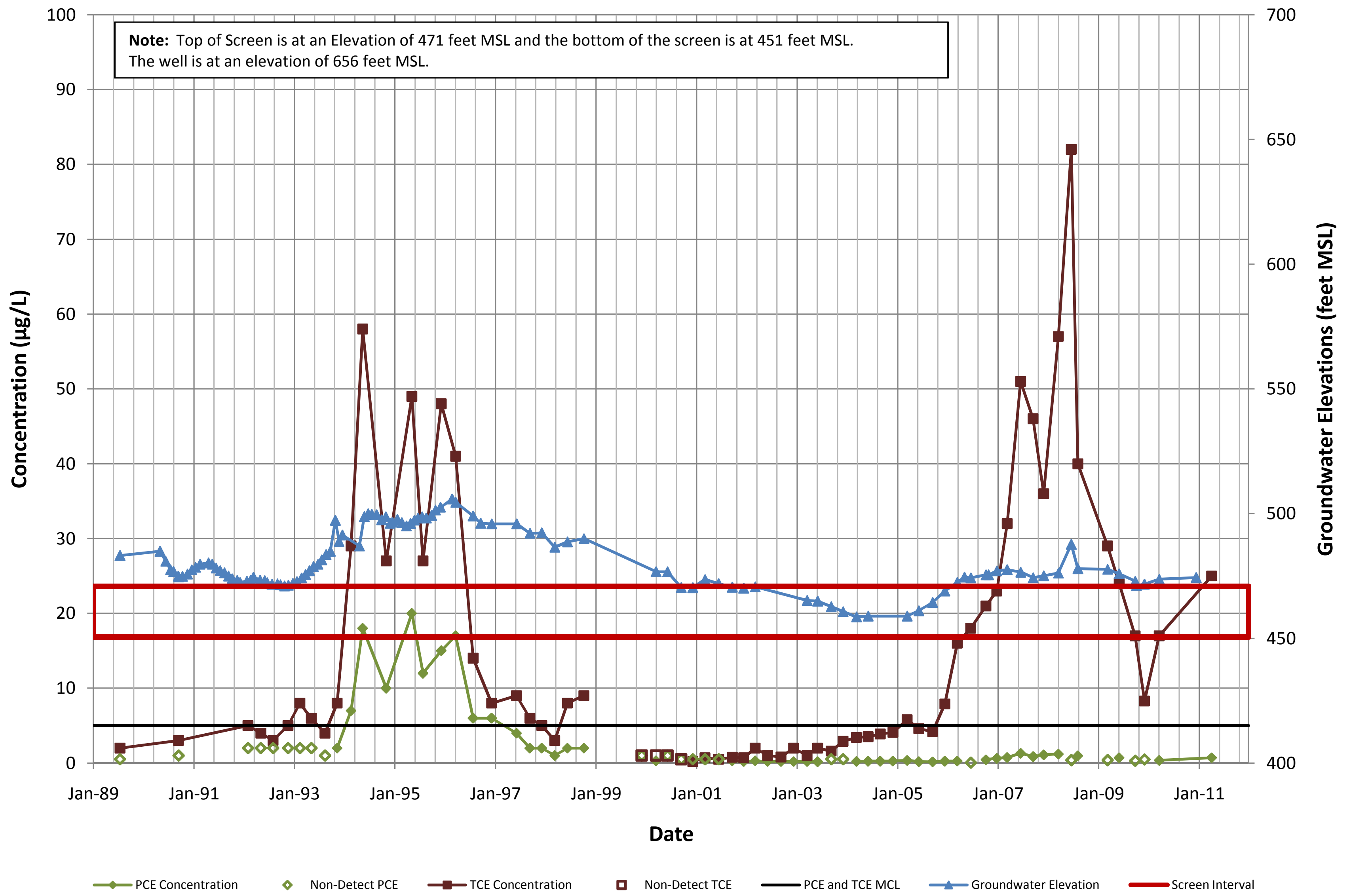


amec

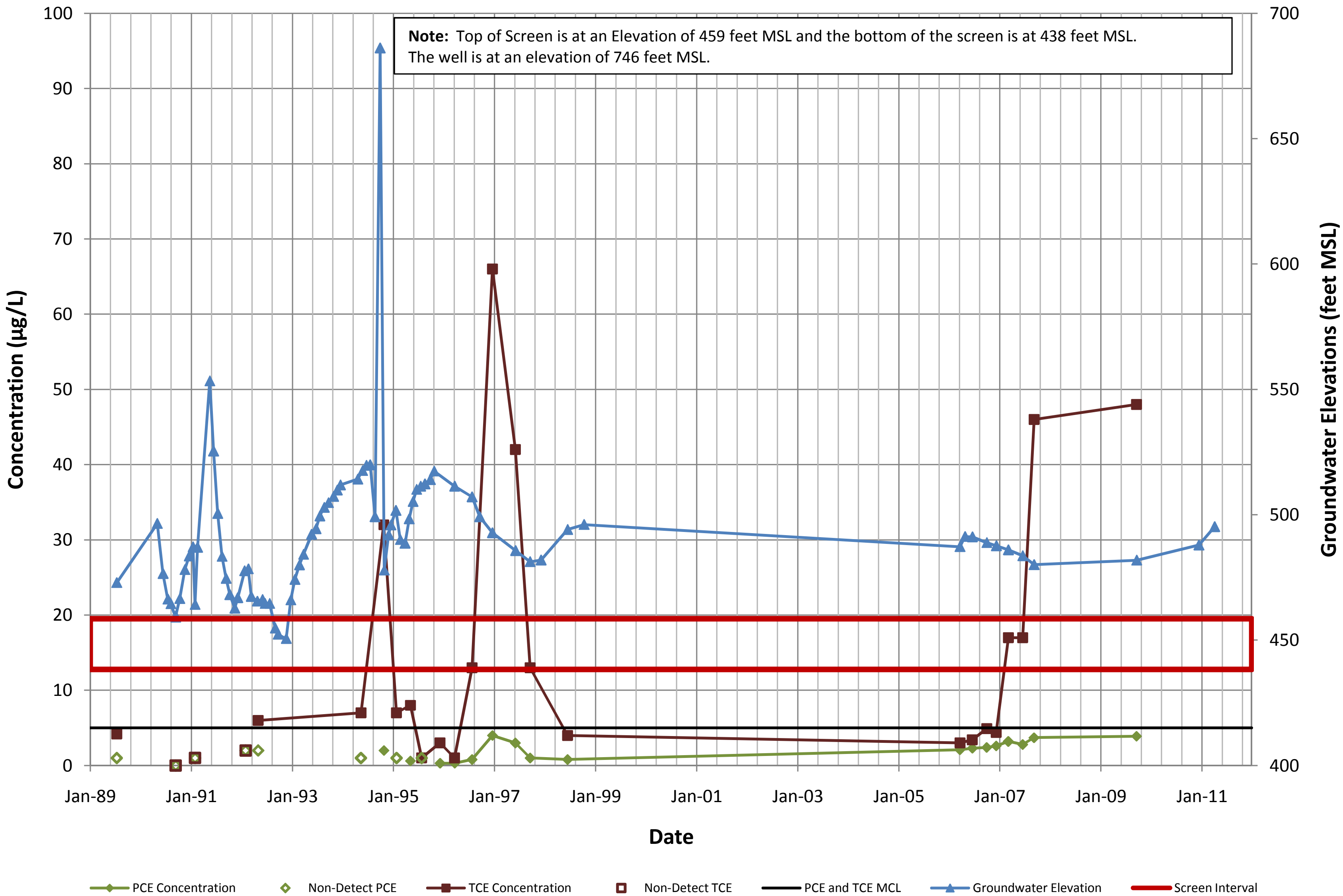
PCE and TCE Concentrations and Groundwater Elevations
North Hollwood Operable Unit Vertical Profile Well NH-VPB-03
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-V-2**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	PCE and TCE Concentrations and Groundwater Elevations North Hollwood Operable Unit Vertical Profile Well NH-VPB-05 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **F-V-3**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 7/2011



amec

PCE and TCE Concentrations and Groundwater Elevations
North Hollwood Operable Unit Vertical Profile Well NH-VPB-06
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:
F-V-4

DRAWN	JOB NUMBER	CHECKED	DATE
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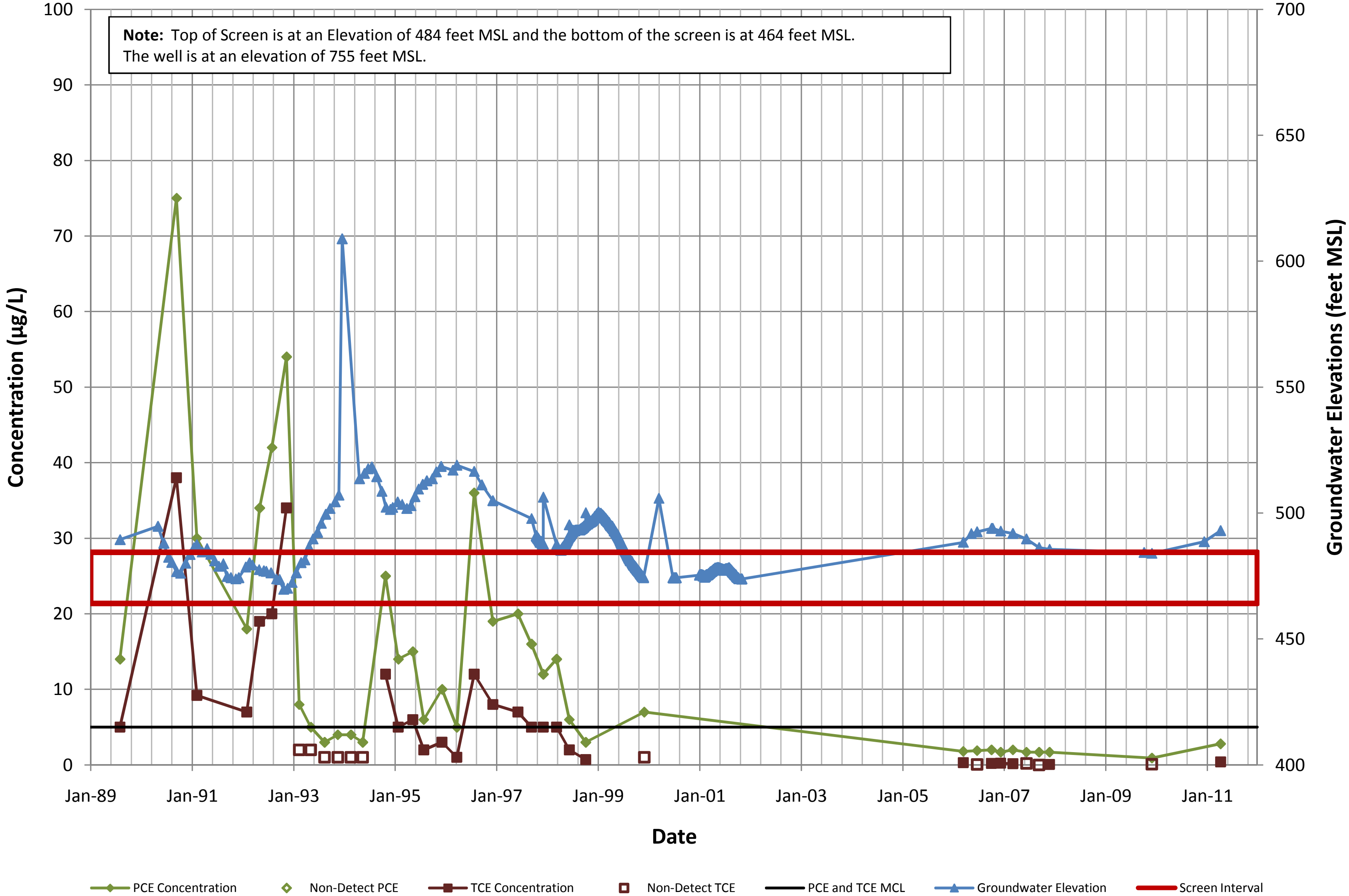
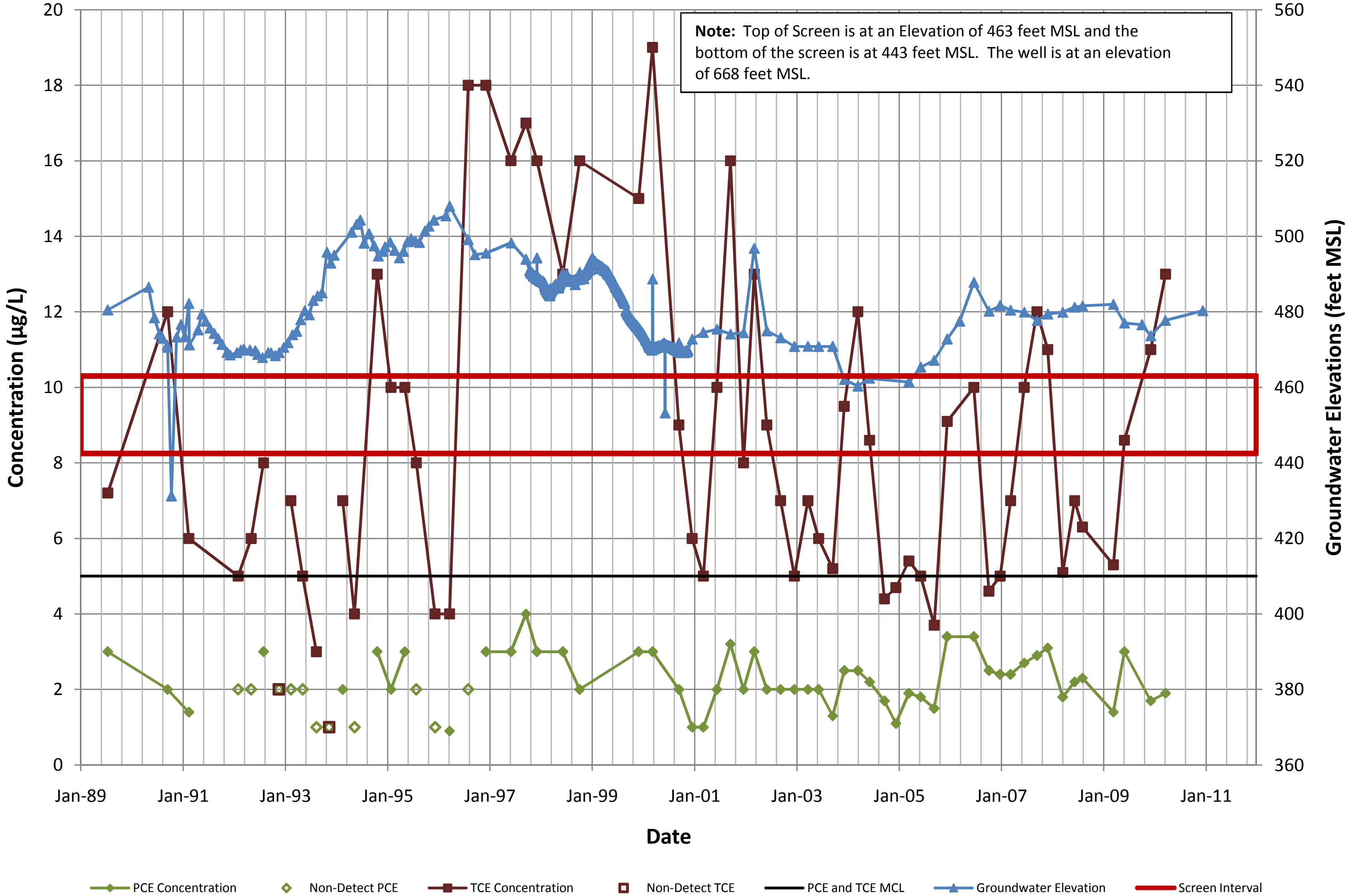


amec	PCE and TCE Concentrations and Groundwater Elevations North Hollwood Operable Unit Vertical Profile Well NH-VPB-07 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California		Figure: **F-V-5**
DRAWN NAM	JOB NUMBER 4088115718	CHECKED SLC	DATE 7/2011



amec	PCE and TCE Concentrations and Groundwater Elevations North Hollwood Operable Unit Vertical Profile Well NH-VPB-08 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-V-6**

DRAWN	JOB NUMBER	CHECKED	DATE
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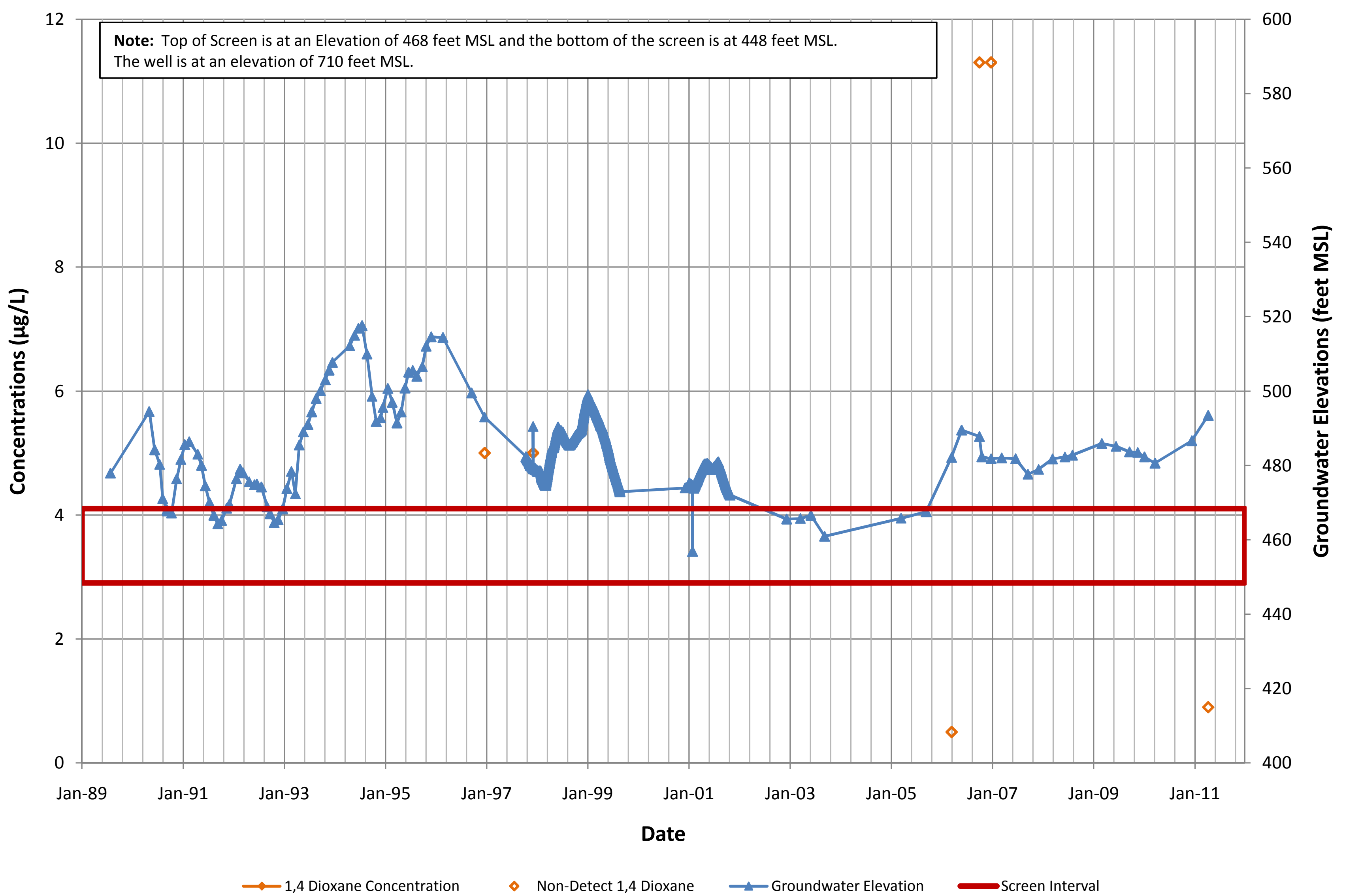


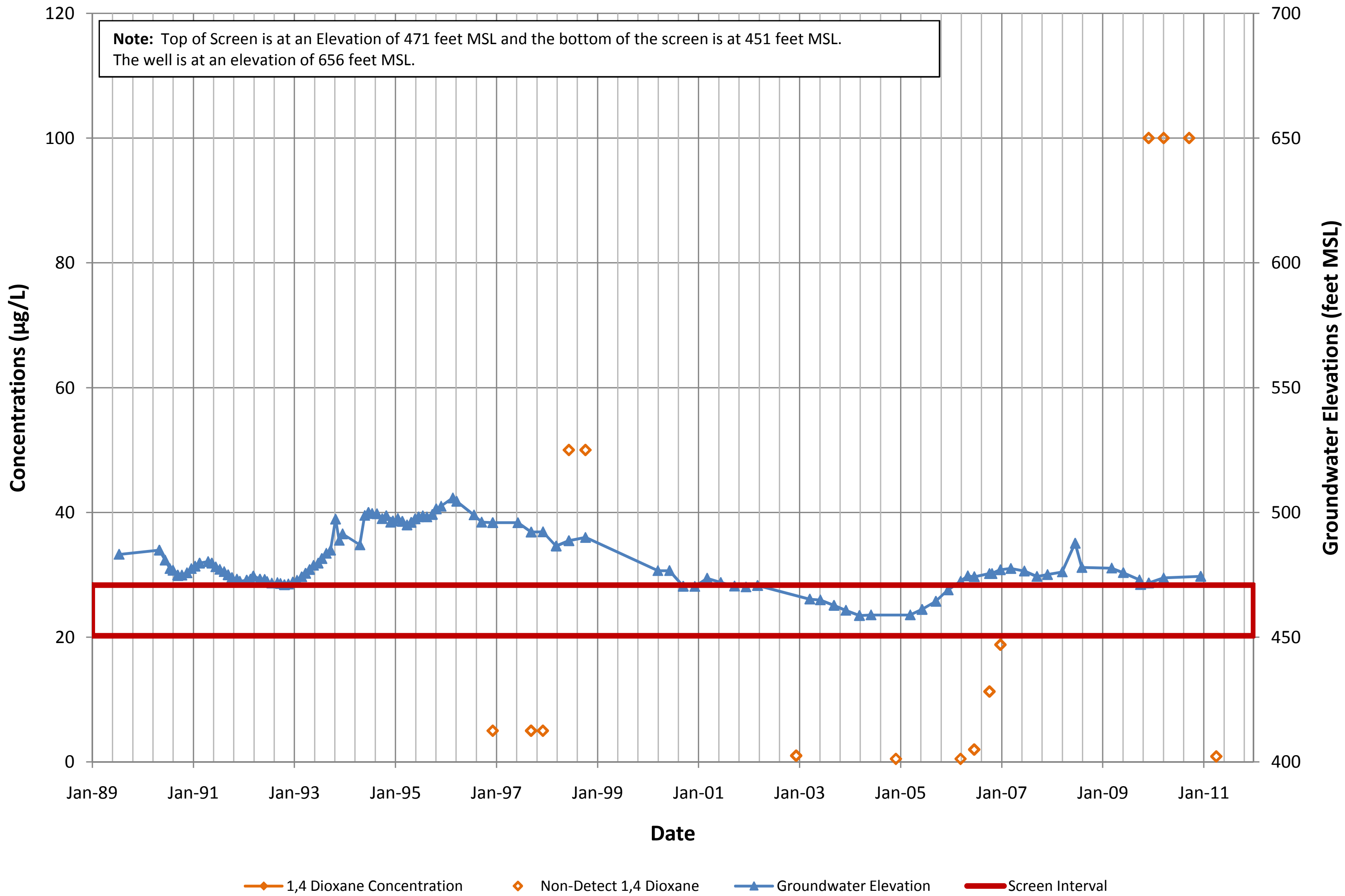
amec

1,4-Dioxane Concentration and Groundwater Elevations
North Hollwood Operable Unit Vertical Profile Well NH-VPB-02
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-V-7

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec

1,4-Dioxane Concentration and Groundwater Elevations
North Hollwood Operable Unit Vertical Profile Well NH-VPB-05
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-V-8

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

1,4-Dioxane Concentration and Groundwater Elevations
North Hollwood Operable Unit Vertical Profile Well NH-VPB-06
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-V-9**

DRAWN	JOB NUMBER	CHECKED	DATE
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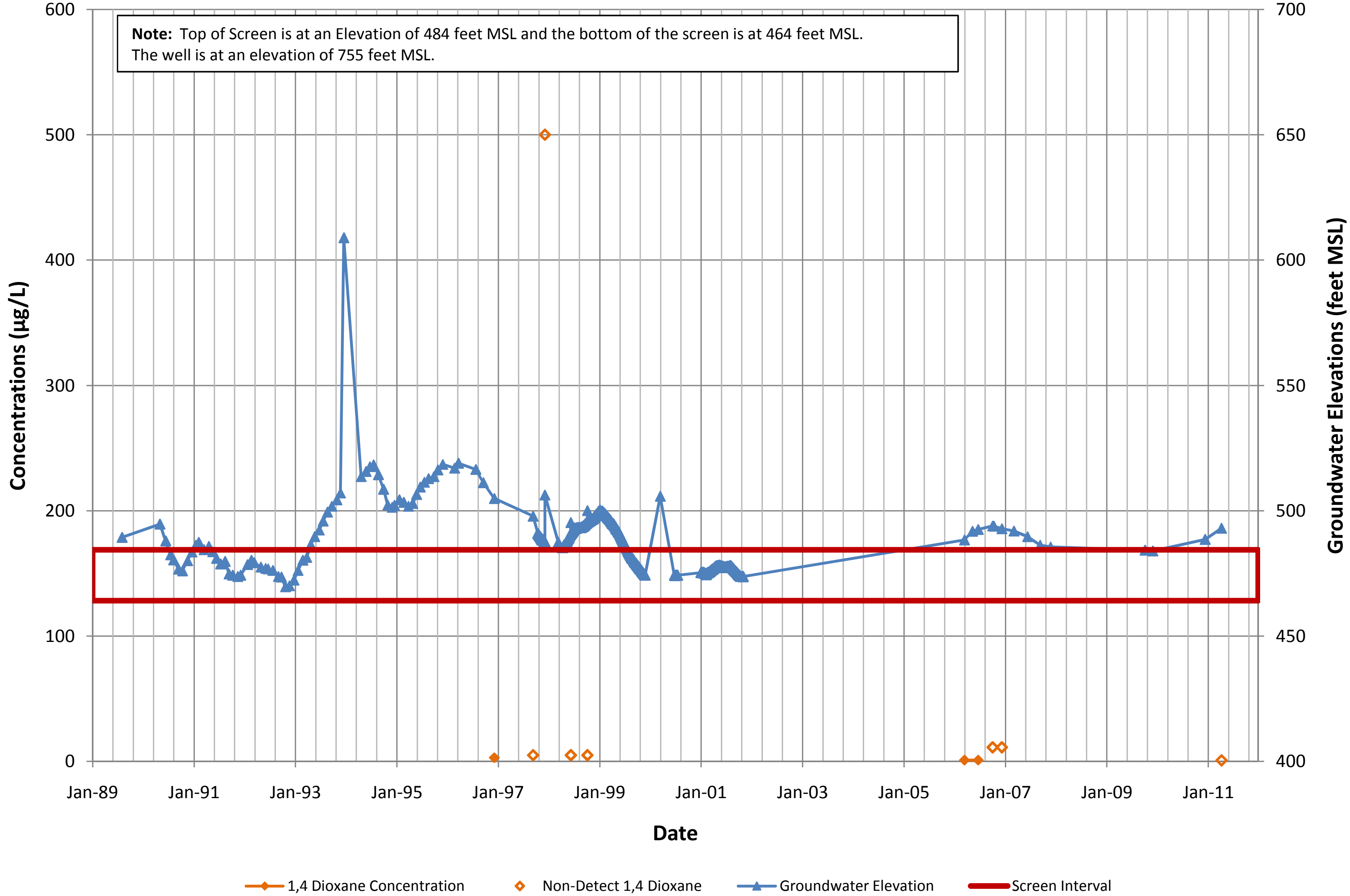

1,4-Dioxane Concentration and Groundwater Elevations
North Hollwood Operable Unit Vertical Profile Well NH-VPB-07
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-V-10**

DRAWN	JOB NUMBER	CHECKED	DATE
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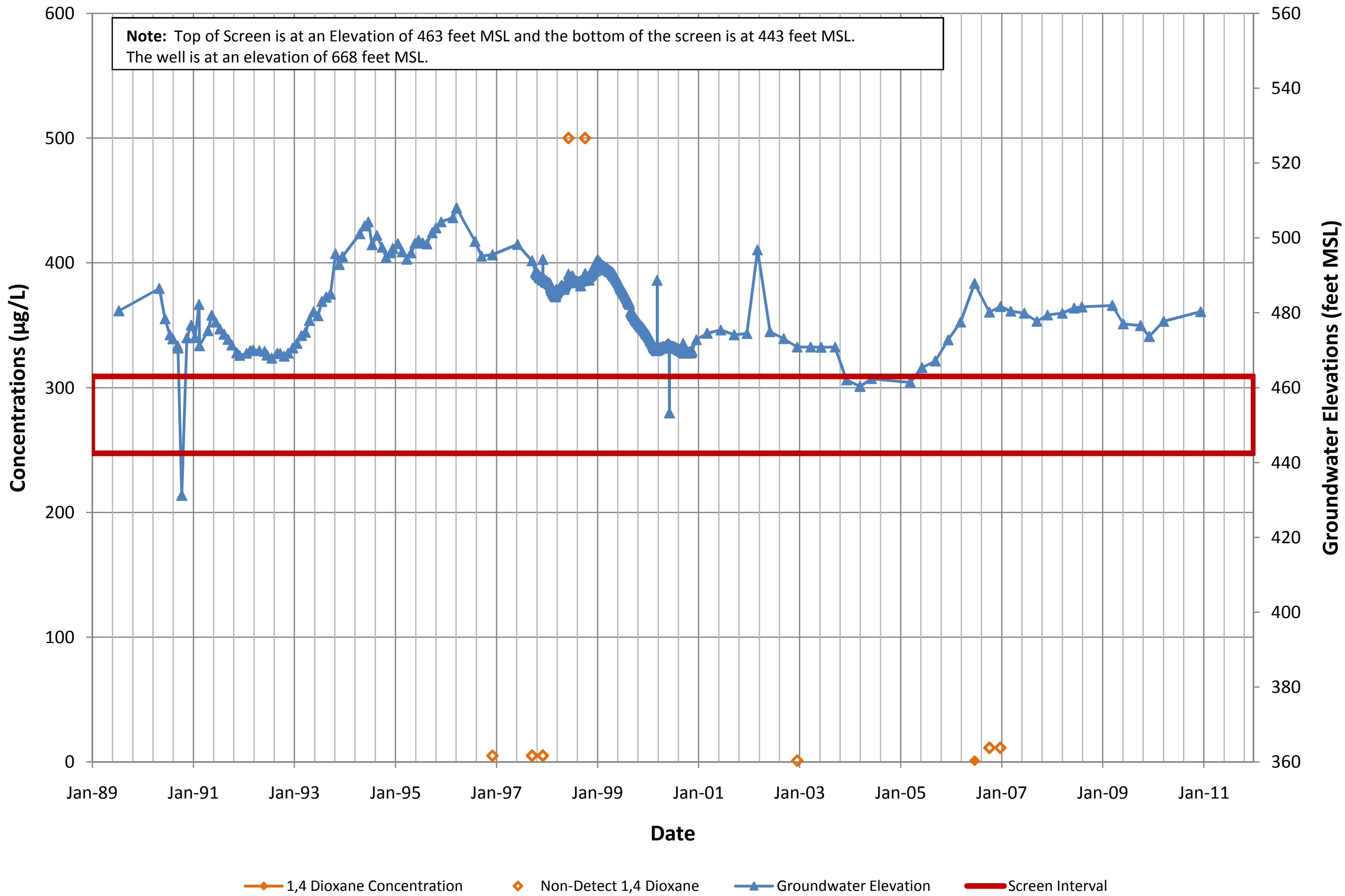
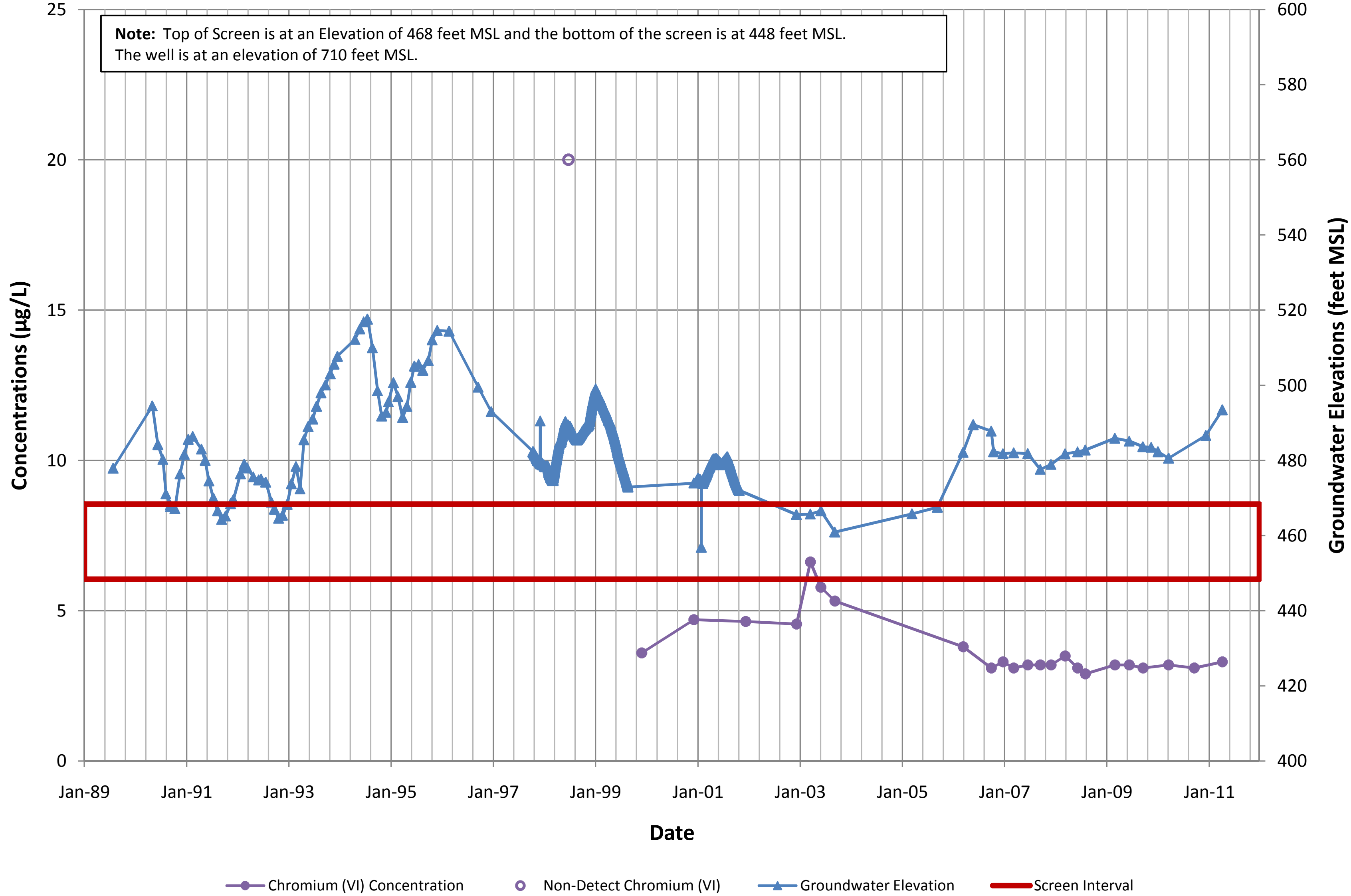


amec	1,4-Dioxane Concentration and Groundwater Elevations North Hollwood Operable Unit Vertical Profile Well NH-VPB-08 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-V-11**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec

Chromium (VI) Concentration and Groundwater Elevations
North Hollwood Operable Unit Vertical Profile Well NH-VPB-02
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-V-12

DRAWN	JOB NUMBER	CHECKED	DATE
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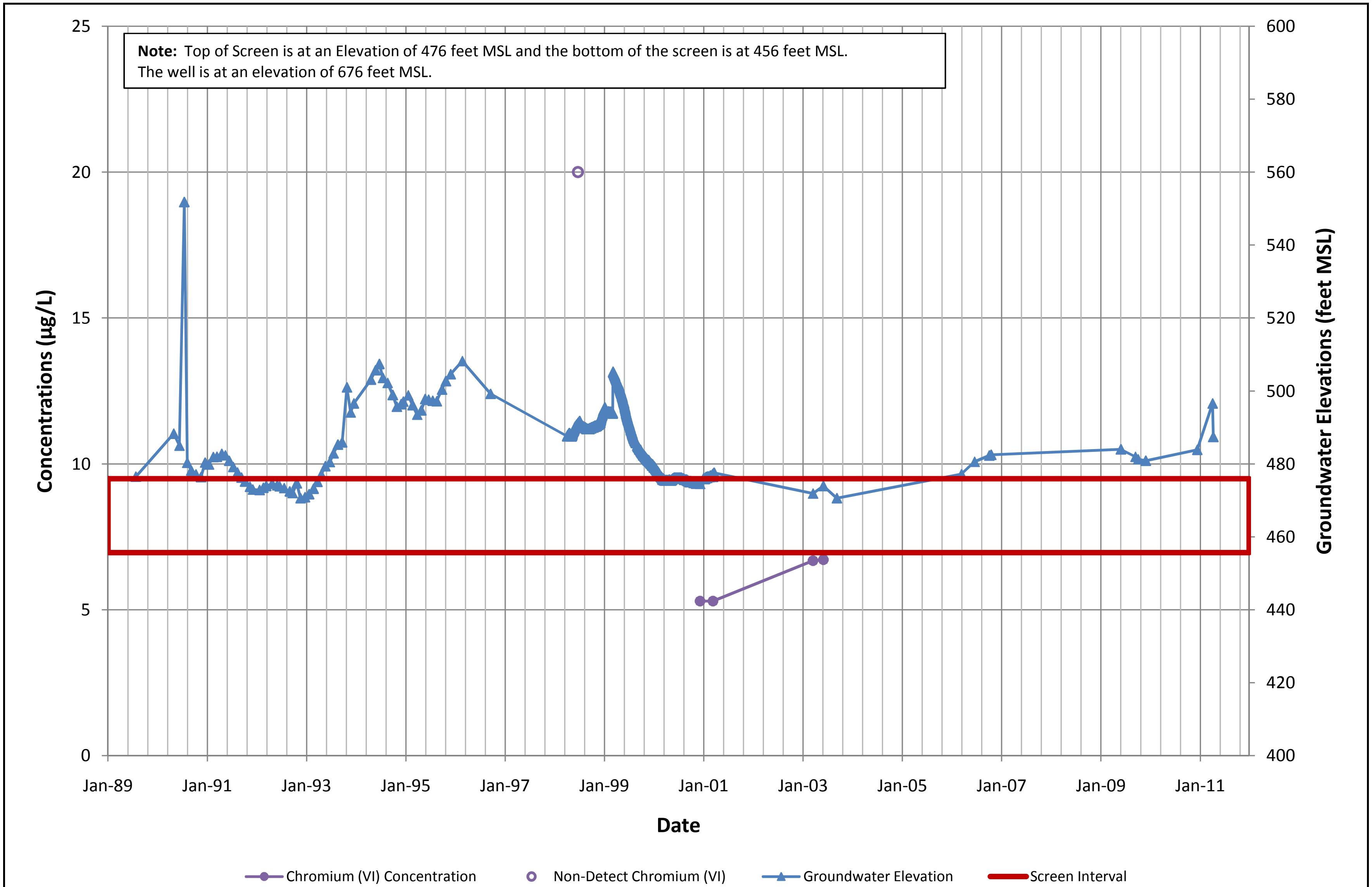


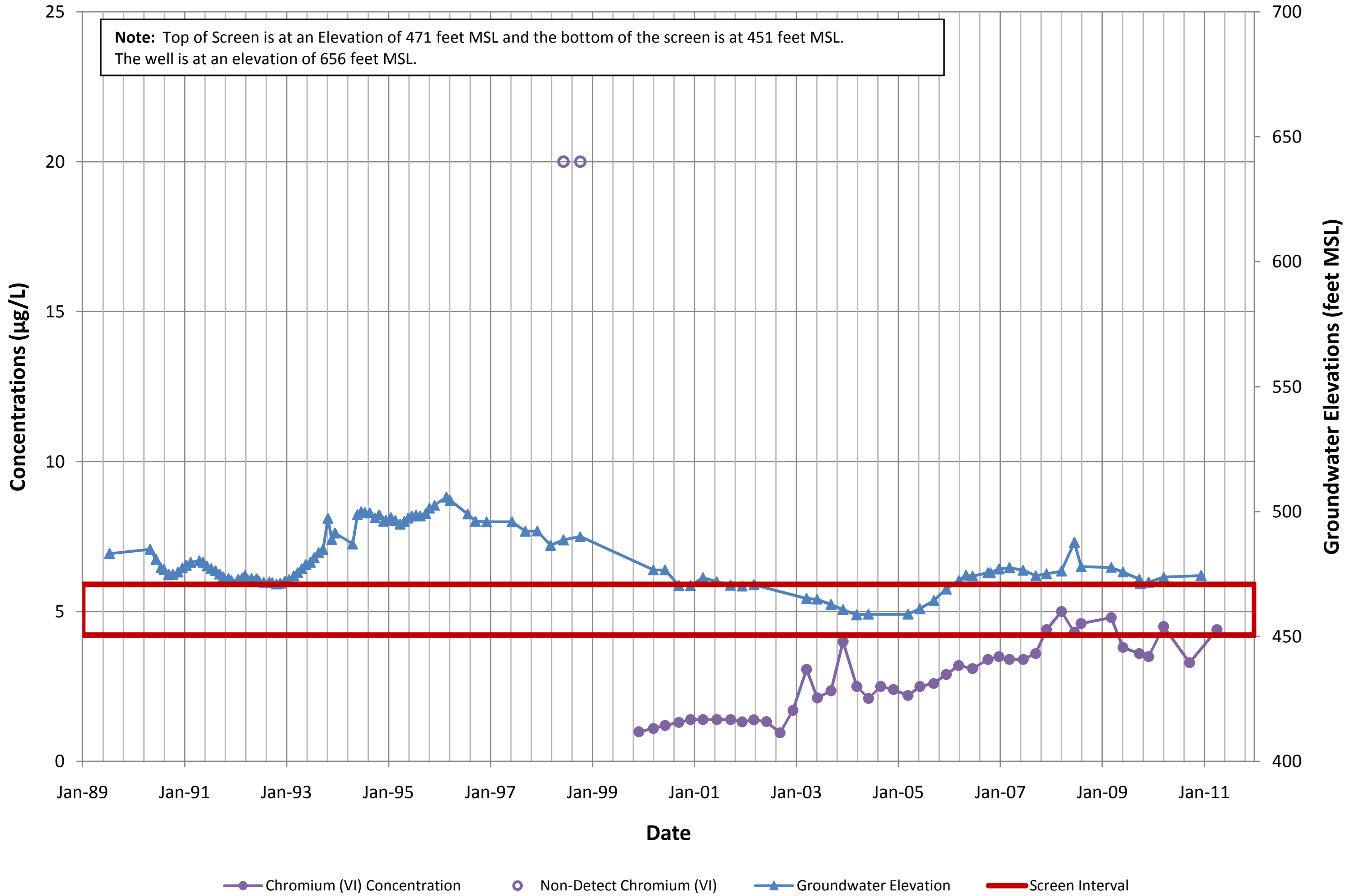
amec

Chromium (VI) Concentration and Groundwater Elevations
North Hollwood Operable Unit Vertical Profile Well NH-VPB-03
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:

F-V-13

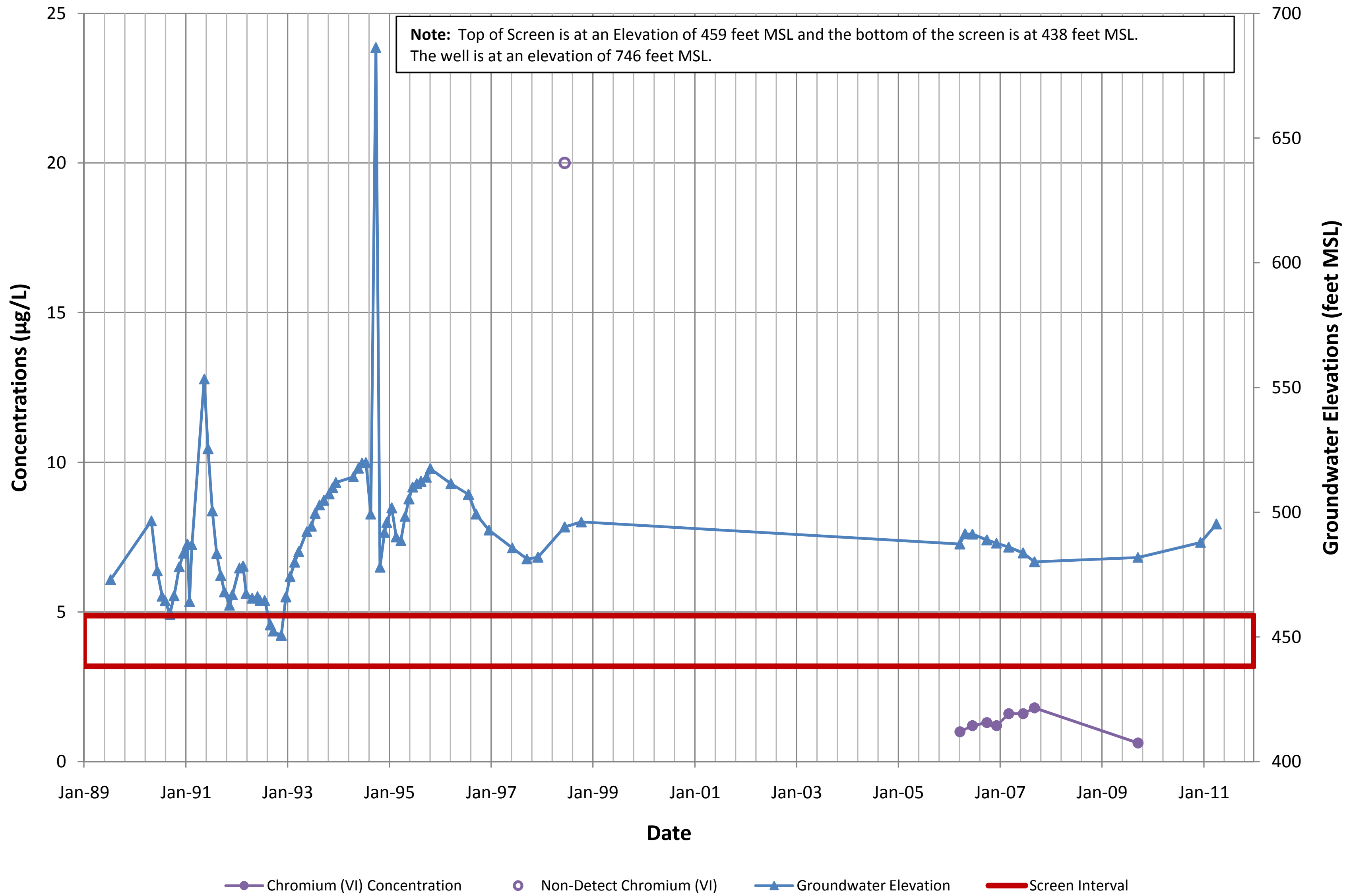
DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



Chromium (VI) Concentration and Groundwater Elevations
North Hollwood Operable Unit Vertical Profile Well NH-VPB-05
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure: **F-V-14**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

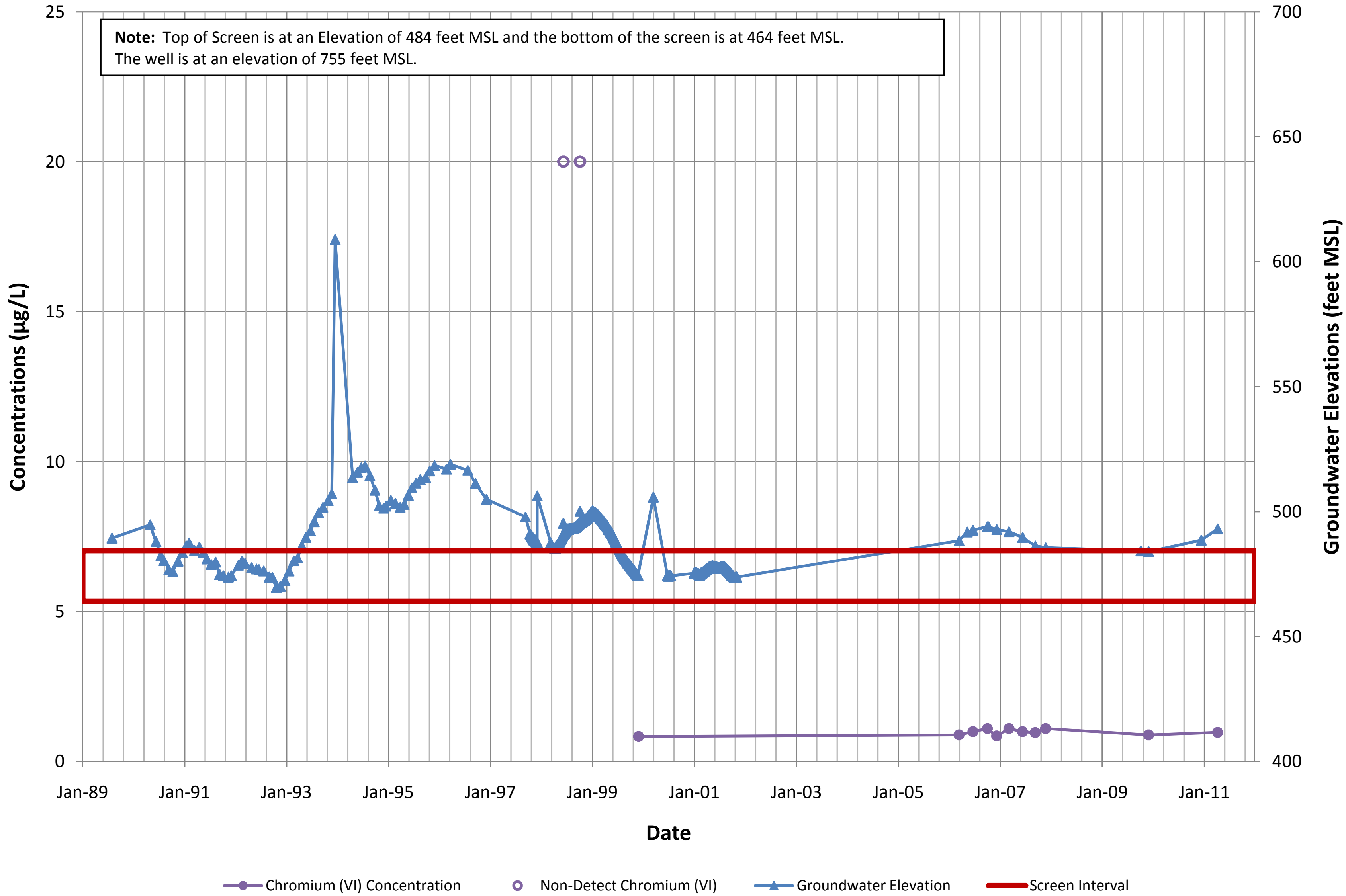


amec

Chromium (VI) Concentration and Groundwater Elevations
North Hollywood Operable Unit Vertical Profile Well NH-VPB-06
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

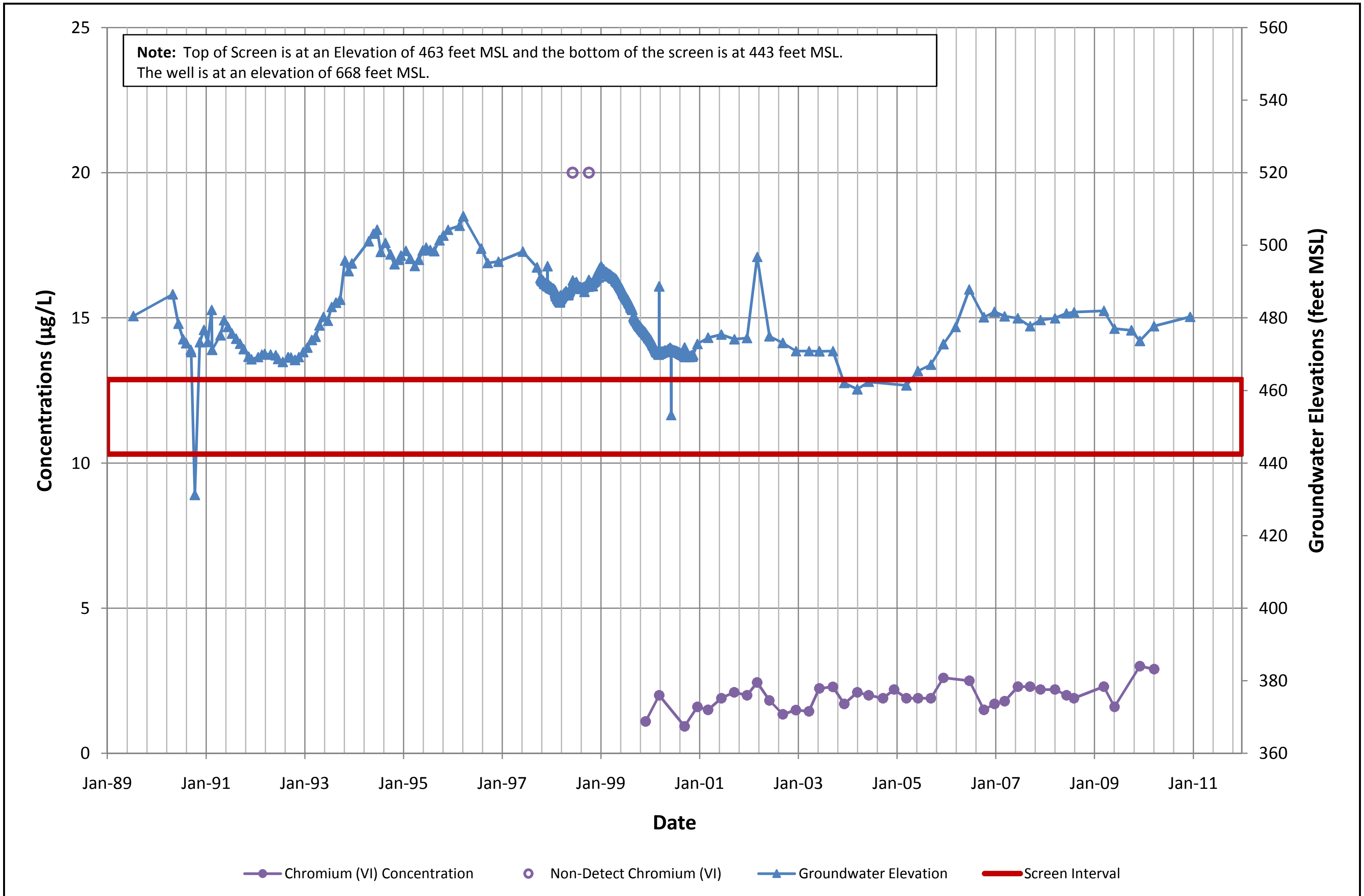
Figure: **F-V-15**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



amec	Chromium (VI) Concentration and Groundwater Elevations North Hollywood Operable Unit Vertical Profile Well NH-VPB-07 Data Gaps Analysis North Hollywood Operable Unit Los Angeles County, California	Figure: **F-V-16**

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011



Chromium (VI) Concentration and Groundwater Elevations
North Hollwood Operable Unit Vertical Profile Well NH-VPB-08
Data Gaps Analysis
North Hollywood Operable Unit
Los Angeles County, California

Figure:
F-V-17

DRAWN	JOB NUMBER	CHECKED	DATE
NAM	4088115718	SLC	7/2011

APPENDIX G

AGREEMENT AND ORDER ON CONSENT FOR REMEDIAL DESIGN

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION IX

IN THE MATTER OF:
North Hollywood Operable Unit,
San Fernando Valley (Area 1)
Superfund Site
Los Angeles, California

Honeywell International Inc.; Lockheed Martin Corporation

Respondents

ADMINISTRATIVE SETTLEMENT AGREEMENT AND ORDER ON CONSENT FOR REMEDIAL DESIGN

U.S. EPA Region IX
CERCLA Docket No. 2011-01

Proceeding under Sections 104, 106, 107, and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. §§ 9604, 9606, 9607, and 9622.

Table of Contents

I. JURISDICTION AND GENERAL PROVISIONS

1. This Administrative Settlement Agreement and Order on Consent ("Settlement Agreement") is entered into voluntarily by the United States Environmental Protection Agency ("EPA") and Honeywell International Inc. and Lockheed Martin Corporation (collectively "Respondents"). This Settlement Agreement provides that Respondents shall undertake a Remedial Design ("RD"), including various procedures and technical analyses, to produce a detailed set of plans and specifications for implementation of the Remedial Action selected in EPA's September 30, 2009 Record of Decision for the North Hollywood Operable Unit ("NHOU") of the San Fernando Valley Area 1 Superfund Site (the "ROD"). Honeywell has been developing an approach to treatment and disposal of water extracted from NHOU well NHE-2 pursuant to a Cleanup and Abatement Order issued by the Regional Water Quality Control Board, Los Angeles Region ("Proposed NHE-2 Treatment and Disposal Approach"). Honeywell intends to separately submit a design of the Proposed NHE-2 Treatment and Disposal Approach to EPA for its evaluation as an alternative to the NHE-2 treatment and disposal approach selected by EPA in the ROD.[1] The NHOU generally comprises approximately 4 square miles of groundwater contaminated with hazardous substances underlying an area of mixed industrial, commercial and residential land use in the community of North Hollywood, and includes any areas to which and from which such hazardous substance groundwater contamination migrates. The NHOU is generally shown on the maps included in Appendix A. In addition, Respondents shall reimburse the United States for certain response costs that it incurs, as provided herein.

2. This Settlement Agreement is issued under the authority vested in the President of the United States by Sections 104, 106, 107, and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 ("CERCLA"), as amended, 42 U.S.C. §§ 9604, 9606, 9607, and 9622. This authority was delegated to the EPA Administrator by Executive Order 12580 (52 *Fed. Reg.* 2923, Jan. 29, 1987) and further delegated to EPA Regional Administrators by EPA Delegation No. 14-14-C on April 15, 1994, and by EPA Delegation 14-14-D on May 11, 1994. The Regional Administrator of EPA Region IX further re-delegated the authority to the Superfund Branch Chief, now called Assistant Director, by Regional Delegations R9-1290.15 and R9-1290.20 (both dated September 29, 1997).

3. EPA and Respondents recognize that this Settlement Agreement has been negotiated in good faith and that the actions undertaken by Respondents in accordance with this Settlement Agreement do not constitute an admission of any liability. Respondents do not admit, and retain the right to controvert in any subsequent proceedings other than proceedings to implement or enforce this

[1] Irrespective of the final treatment and disposal approach selected for well NHE-2, this Settlement Agreement and Section 1.3.2 of the SOW require Respondents to design well NHE-2 in order to achieve (along with the rest of the NHOU extractions well network) the hydraulic containment of the groundwater plume required by the ROD.

Settlement Agreement, the validity of the findings of fact, conclusions of law, and determinations in Sections IV and V of this Settlement Agreement. Respondents agree to comply with, and be bound by, the terms of this Settlement Agreement and further agree that they will not contest the basis or validity of this Settlement Agreement or its terms.

4. The objectives of EPA and Respondents in entering into this Settlement Agreement are to protect public health or welfare or the environment at the Site by the design and implementation of response actions at the Site by Respondents, to reimburse response costs of EPA, and to resolve the claims of EPA against Respondents as provided in this Settlement Agreement.

5. In accordance with the National Oil and Hazardous Substances Pollution Contingency Plan, 40 C.F.R. Part 300, *et seq.*, as amended ("NCP"), and Section 121(f)(1)(F) of CERCLA, 42 U.S.C. § 9621(f)(1)(F), EPA notified the State of California (the "State") on October 6, 2010, of negotiations with potentially responsible parties ("PRPs") regarding the implementation of the remedial design for the Site, and EPA has provided the State with an opportunity to participate in such negotiations and be a party to this Settlement Agreement.

6. In accordance with Section 122(j)(1) of CERCLA, 42 U.S.C. § 9622(j)(1), EPA notified the United States Department of the Interior and the National Oceanic and Atmospheric Administration on February 22 and February 25, 2010, respectively, of negotiations with PRPs regarding the release of hazardous substances that may have resulted in injury to the natural resources under federal trusteeship and encouraged the trustee(s) to participate in negotiations for cleanup of the NHOU.

II. PARTIES BOUND

7. This Settlement Agreement applies to and is binding upon EPA and upon Respondents and their successors, and assigns. Any change in ownership or corporate status of a Respondent including, but not limited to, any transfer of assets or real or personal property shall not alter such Respondent's responsibilities under this Settlement Agreement. The signatories to this Settlement Agreement certify that they are authorized to execute and legally bind the parties they represent.

8. Respondents are jointly and severally liable for carrying out all activities required by this Settlement Agreement. In the event of the insolvency or other failure of any one or more Respondents to implement the requirements of this Settlement Agreement, the remaining Respondents shall complete all such requirements.

9. Respondents shall ensure that their contractors, subcontractors, and representatives receive a copy of this Settlement Agreement and comply with this Settlement Agreement within 14 days after the Effective Date of this Settlement

Agreement or after the date of such retention. Respondents shall be responsible for any noncompliance with this Settlement Agreement.

III. DEFINITIONS

10. Unless otherwise expressly provided herein, terms used in this Settlement Agreement that are defined in CERCLA or in regulations promulgated under CERCLA shall have the meaning assigned to them in CERCLA or its implementing regulations. Whenever terms listed below are used in this Settlement Agreement, in the documents attached to this Settlement Agreement, or incorporated by reference into this Settlement Agreement, the following definitions shall apply:

a. "CERCLA" shall mean the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. §§ 9601, *et seq*.

b. "Day" shall mean a calendar day. In computing any period of time under this Settlement Agreement, where the last day would fall on a Saturday, Sunday, or federal holiday, the period shall run until the close of business of the next working day.

c. "Effective Date" shall be the effective date of this Settlement Agreement as provided in Section XXVIII.

d. "EPA" shall mean the United States Environmental Protection Agency and any successor departments or agencies of the United States.

e. "Future Response Costs" shall mean all costs, including, but not limited to, direct and indirect costs, that the United States incurs in reviewing or developing plans, reports and other items pursuant to this Settlement Agreement, verifying the Work, or otherwise implementing, overseeing, or enforcing this Settlement Agreement, including but not limited to, payroll costs, contractor costs, travel costs, laboratory costs, Agency for Toxic Substances and Disease Registry ("ATSDR") costs, and the costs incurred pursuant to Section XI (Site Access and Institutional Controls), Paragraph 44 (emergency response), and Paragraph 92 (Work takeover).

f. "Institutional controls" shall mean non-engineered instruments, such as administrative and/or legal controls, that help to minimize the potential for human exposure to contamination and/or protect the integrity of a remedy by limiting land and/or resource use. Examples of institutional controls include easements and covenants, zoning restrictions, special building permit requirements, and well-drilling prohibitions.

g. "Interest" shall mean interest at the rate specified for interest on investments of the EPA Hazardous Substance Superfund established by 26 U.S.C. § 9507, compounded annually on October 1 of each year, in accordance with CERCLA § 107(a), 42 U.S.C. § 9607(a). The applicable rate of interest shall be the rate in effect at the time the interest accrues. The rate of interest is subject to change on October 1 of each year.

h. "NCP" shall mean the National Oil and Hazardous Substances Pollution Contingency Plan promulgated pursuant to Section 105 of CERCLA, 42 U.S.C. § 9605, codified at 40 CFR Part 300, and any amendments thereto.

i. "Paragraph" shall mean a portion of this Settlement Agreement identified by an Arabic numeral.

j. "Parties" shall mean EPA and Respondents.

k. "Performance Standards" shall mean the cleanup standards and other measures of achievement of the objectives of the Remedial Action, including those set forth in Section 2.13.2 (including Table 6) and 2.8 of the ROD and Section 1.3 of the SOW.

l. "Record of Decision" or "ROD" shall mean the EPA Record of Decision relating to the NHOU, and all attachments thereto that the Regional Administrator, EPA Region IX, or his/her delegate, signed on September 30, 2009. The ROD is included as Appendix B.

m. "Remedial Action" or "RA" shall mean all actions to be taken by Respondents and any other potentially responsible parties to implement the remedy selected by EPA in the September 30, 2009 Interim Action Record of Decision for the North Hollywood Operable Unit of the San Fernando Valley Area 1 Superfund site in accordance with the Remedial Design as approved pursuant to this Settlement Agreement.

n. "Remedial Design" or "RD" shall mean those activities that Respondents shall undertake to develop the final plans and specifications for the Remedial Action pursuant to the Remedial Design Work Plan.

o. "Remedial Design Work Plan" or "RD Work Plan" shall mean the document developed pursuant to Paragraph 36 of this Settlement Agreement and approved by EPA, and any amendments thereto.

p. "RCRA" shall mean the Resource Conservation and Recovery Act, also known as the Solid Waste Disposal Act, as amended, 42 U.S.C. §§ 6901, et seq.

q. "Respondents" shall mean Honeywell International Inc. and Lockheed Martin Corporation.

r. "Section" shall mean a portion of this Settlement Agreement identified by a Roman numeral and includes one or more paragraphs.

s. "Settlement Agreement" shall mean this Administrative Settlement Agreement and Order on Consent and all appendices attached hereto. In the event of conflict between this Settlement Agreement and any appendix, this Settlement Agreement shall control.

t. "Site" or "NHOU" shall mean the North Hollywood Operable Unit of the San Fernando Valley (Area 1) Superfund Site, which is generally comprised of approximately 4 square miles of groundwater contaminated with hazardous substances underlying an area of mixed industrial, commercial and residential land use in the community of North Hollywood, and includes any areas to which and from which such hazardous substance groundwater contamination migrates. The Site is generally shown on the maps included in Appendix A.

u. "State" shall mean the state of California.

v. "Statement of Work" or "SOW" shall mean the statement of work for implementation of the Remedial Design, and any modifications made thereto in accordance with this Settlement Agreement, as set forth in Appendix A of this Settlement Agreement. The Statement of Work is incorporated into this Settlement Agreement and is an enforceable part of this Settlement Agreement.

w. "Waste Material" shall mean (1) any "hazardous substance" under Section 101(14) of CERCLA, 42 U.S.C. § 9601(14); (2) any pollutant or contaminant under Section 101(33) of CERCLA, 42 U.S.C. § 9601(33); (3) any "solid waste" under Section 1004(27) of RCRA, 42 U.S.C. § 6903(27); and (4) any "hazardous material" under California Health and Safety Code Section 25117; or (5) any "hazardous substance" under California Health and Safety Code Section 25316.

x. "Work" shall mean all activities Respondents are required to perform under this Settlement Agreement, except those required by Section XIV (Retention of Records).

IV. FINDINGS OF FACT

11. The Site is an area of contaminated groundwater in the San Fernando Valley Basin (the "Basin"), which lies beneath the San Fernando Valley in Los Angeles County, California. Beginning in the 1940s, the San Fernando Valley was developed for both residential and industrial uses, and was home to many large aerospace companies.

12. The Basin is an important source of drinking water for the Los Angeles metropolitan area. The Los Angeles Department of Water and Power ("LADWP") produces groundwater for public distribution from seven well fields near or within the NHOU. Over the past ten years, groundwater from LADWP well fields located in the Basin, including in the NHOU, has contributed approximately fifteen percent of the City of Los Angeles' municipal water supply.

13. Tests conducted in the early 1980s to determine the presence of certain industrial chemicals in the State's drinking water revealed extensive contamination from volatile organic compounds ("VOCs") in the Basin's groundwater. In 1985,

groundwater from 27 of the 38 production wells in the NHOU well field exceeded the federal Maximum Contaminant Level ("MCL") for trichloroethylene ("TCE"), and four wells exceeded the MCL for tetrachloroethylene ("PCE").

14. Pursuant to Section 105 of CERCLA, 42 U.S.C. § 9605, EPA placed the Site on the National Priorities List, set forth at 40 CFR Part 300, Appendix B, by publication in the Federal Register on June 10, 1986, 51 Fed. Reg. 21054.

15. On September 23, 1987, EPA signed a Record of Decision for the remediation of VOC-contaminated groundwater in the NHOU ("1987 ROD"). The 1987 ROD called for 15 years of extraction and treatment of VOC-contaminated groundwater in order to contain the VOC plume and remove contaminant mass. The groundwater extraction and treatment remedy selected in the 1987 ROD began operating in December 1989 and continues to operate today (the "First Interim Remedy").

16. The First Interim Remedy was constructed to operate in conjunction with the Los Angeles Department of Water and Power's ("LADWP") North Hollywood municipal water treatment and distribution plant. Since its startup, the First Interim Remedy has been operated by LADWP under a series of cooperative agreements with EPA, and the treated water has been delivered to LADWP's water supply system.

17. In 1996 and 1997, 37 parties entered into consent decrees with the United States, in which they agreed to (1) reimburse the United States for all NHOU past costs and a proportional share of past Basin-wide costs, and (2) pay future costs to operate and maintain the First Interim Remedy for the remainder of its fifteen-year term.

18. Chromium contamination was detected in the Basin for the first time in 1987. EPA began a chromium monitoring program in the early 1990s, and in 1999 EPA began quarterly monitoring for hexavalent chromium (also referred to as chromium VI), the predominant form of chromium in the Basin's groundwater.

19. On September 30, 2009, EPA issued a new ROD for the NHOU, selecting a new interim remedy for the Site ("Second Interim Remedy"). The Second Interim Remedy includes construction of new extraction wells, chromium and 1,4 dioxane treatment, expanded VOC treatment, and continued use of the treated water in LADWP's water supply system. 1,4 dioxane was used typically as a stabilizer in conjunction with VOCs.

20. According to the ATSDR, drinking or breathing high levels of TCE may cause nervous system effects, liver and lung damage, abnormal heartbeat, coma, and possibly death. Drinking small amounts of TCE for long periods may cause liver and kidney damage, impaired immune system function, and impaired fetal development in pregnant women. ATSDR also considers exposure to very high concentrations of PCE to cause dizziness, headaches, sleepiness, confusion,

nausea, difficulty in speaking and walking, unconsciousness, and death. The National Institute for Occupational Safety and Health considers PCE a potential carcinogen.

21. The Department of Health and Human Services, the International Agency for Research on Cancer, and the EPA have determined that chromium (VI) compounds are known human carcinogens. In workers, inhalation of chromium (VI) has been shown to cause lung cancer.

22. Honeywell International Inc. is a Delaware corporation that is the successor to the former owner and operator of an aerospace manufacturing facility from which there have been releases of VOCs and chromium that have impacted or threaten to impact groundwater in the NHOU.

23. Lockheed Martin Corporation is a Maryland corporation that is the successor to the former owner and operator of an aerospace manufacturing facility from which there have been releases of VOCs and chromium that have impacted or threaten to impact groundwater in the NHOU.

V. CONCLUSIONS OF LAW AND DETERMINATIONS

Based on the Findings of Fact set forth above, as well as the Administrative Record supporting this Settlement Agreement, EPA has determined that:

24. The Site is a "facility" as defined in Section 101(9) of CERCLA, 42 U.S.C.§ 9601(9).

25. The contamination found at the Site, as identified in the Findings of Fact above, includes "hazardous substances" as defined in Section 101(14) of CERCLA, 42 U.S.C. § 9601(14).

26. Each Respondent is a "person" as defined in Section 101(21) of CERCLA, 42 U.S.C. § 9601(21).

27. Each Respondent is a responsible party as defined in Section 107(a) of CERCLA, 42 U.S.C. § 9607(a), and is subject to this Settlement Agreement under Section 106(a) of CERCLA, 42 U.S.C. § 9606(a). Respondents are jointly and severally liable for performance of response action under the Settlement Agreement and for response costs incurred, and to be incurred, at the Site. Respondents Honeywell International and Lockheed Martin are the former "owners" and/or "operators" of facilities from which there has been a release of hazardous substances, as defined by Section 101(20) of CERCLA, 42 U.S.C. § 9601(20), and within the meaning of Section 107(a)(1) of CERCLA, 42 U.S.C. § 9607(a)(1).

28. The conditions described in the Findings of Fact above constitute an actual or threatened "release" of a hazardous substance from a facility as defined by Section 101(22) of CERCLA, 42 U.S.C. § 9601(22).

VI. SETTLEMENT AGREEMENT AND ORDER

29. Based upon the foregoing Findings of Fact, Conclusions of Law, Determinations, and the Administrative Record for this Site, it is hereby Ordered and Agreed that Respondents shall comply with all provisions of this Settlement Agreement, including, but not limited to, all attachments to this Settlement Agreement and all documents incorporated by reference into this Settlement Agreement.

VII. DESIGNATED PROJECT MANAGER AND COORDINATORS

30. Respondents shall retain one or more contractor(s) to perform the Work and shall notify EPA of the name(s) and qualifications of such contractor(s) within 45 days of the Effective Date. Respondents shall also notify EPA of the name(s) and qualification(s) of any other contractor(s) or subcontractor(s) retained to perform the Work at least 10 days prior to commencement of such Work. EPA retains the right to disapprove of any or all of the contractors and/or subcontractors retained by Respondents. If EPA disapproves of a selected contractor, Respondents shall retain a different contractor and shall notify EPA of that contractor's name and qualifications within 45 days of EPA's disapproval. With respect to any contractor proposed to be Supervising Contractor, Respondents shall demonstrate that the proposed contractor has a quality system that complies with ANSI/ASQC E4-1994, "Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs," (American National Standard, January 5, 1995), by submitting a copy of the proposed contractor's Quality Management Plan (QMP). The QMP should be prepared in accordance with "EPA Requirements for Quality Management Plans (QA/R-2)" (EPA/240/B-01/002, March 2001) or equivalent documentation as determined by EPA. EPA will issue a notice of disapproval or an authorization to proceed. Any decision not to require submission of the contractor's QMP should be documented in a memorandum from EPA's Project Manager and Regional Quality Assurance personnel to the Site file.

31. Within 10 days after the Effective Date, Respondents shall designate a Project Coordinator who shall be responsible for administration of all actions by Respondents required by this Settlement Agreement and shall submit to EPA the designated Project Coordinator's name, address, telephone number, and qualifications. To the greatest extent possible, the Project Coordinator shall be present on-site or readily available during site work. EPA retains the right to disapprove of the designated Project Coordinator. If EPA disapproves of the designated Project Coordinator, Respondents shall retain a different Project Coordinator and shall notify EPA of that person's name, address, telephone number, and qualifications within 30 days following EPA's disapproval. Receipt by Respondents' Project Coordinator of any notice or communication from EPA relating to this Settlement Agreement shall constitute receipt by all Respondents.

a. Documents to be submitted to the Respondent Honeywell International Inc. shall be sent to Mr. Benny DeHghi, Remediation Manager – Health, Safety, Environment & Remediation, Honeywell International Inc., M/S 23-21-80, 2525 West 190th Street, Torrance, California 90504-6002 [(310) 512-2296; benny.dehghi@honeywell.com].

b. Documents to be submitted to the Respondent Lockheed Martin Corporation shall be sent to C. Douglas Goins, Assistant General Counsel, Lockheed Martin Corporation, 6801 Rockledge Drive, Bethesda, Maryland, 20917 [(301) 214-3402; doug.goins@lmco.com].

32. EPA has designated Kelly Manheimer of the Region IX Site Cleanup Branch as its Project Manager. Except as otherwise provided in this Settlement Agreement, Respondents shall direct all submissions required by this Settlement Agreement to the Project Manager at 75 Hawthorne Street, SFD-7-1, San Francisco, California 94105 [(415) 972-3290; manheimer.kelly@epa.gov].

33. EPA's Project Manager shall have the authority lawfully vested in a Remedial Project Manager ("RPM") and On-Scene Coordinator ("OSC") by the NCP. In addition, EPA's Project Manager shall have the authority, consistent with the NCP, to halt any Work required by this Settlement Agreement and to take any necessary response action when the Project Manager determines that conditions at the Site may present an immediate endangerment to public health, welfare, or the environment. The absence of the EPA Project Manager from the area under study pursuant to this Settlement Agreement shall not be cause for the stoppage or delay of Work.

34. EPA and Respondents shall have the right, subject to Paragraph 31, to change their respective designated Project Coordinator and Project Manager. Respondents shall notify EPA 10 days before such a change is made. The initial notification may be made orally, but shall be promptly followed by a written notice.

VIII. WORK TO BE PERFORMED

35. Respondents shall perform all action necessary to implement the Statement of Work.

36. <u>Work Plan and Implementation</u>

a. Within 30 days after EPA's approval of the Supervising Contractor, Respondents shall submit to EPA and the State a work plan for the design of the Remedial Action at the NHOU ("Remedial Design Work Plan" or "RD Work Plan"). The RD Work Plan shall provide for design of the remedy set forth in the ROD, in accordance with the SOW and for achievement of the Performance Standards and other requirements set forth in the ROD, this Settlement Agreement, and/or the SOW. Upon its approval by EPA pursuant to Section IX (EPA Approval of Plans and Other Submissions), the RD Work Plan shall be incorporated into and enforceable under this Settlement Agreement.

b. The RD Work Plan shall include plans and schedules for implementation of all remedial design and pre-design tasks identified in the SOW, including, but not limited to, plans and schedules for the completion of a: (1) Health and Safety Plan; (2) Sampling and Analysis Plan; (3) Remedial Design Quality Assurance Project Plan (RD QAPP), in accordance with Section VII (Quality Assurance, Sampling and Data Analysis)); (4) Groundwater Monitoring Plan; (5) preliminary design submission; (6) an intermediate design submission; (7) a data evaluation report; and (8) a pre-final/final design submission (if required - see SOW section 2.1.1). Respondents shall also propose in the RD Work Plan whether they plan to implement the design and construction utilizing the design/bid/build or design/build process for EPA's approval (see section 2.1.1 of the SOW).

c. Upon approval of the RD Work Plan by EPA pursuant to Section IX, (EPA Approval of Plans and Other Submissions), after a reasonable opportunity for review and comment by the State, and submission of the Health and Safety Plan for all field activities to EPA and the State, Respondents shall implement the RD Work Plan. Respondents shall submit to EPA and the State all plans, reports, and other deliverables required under the approved RD Work Plan in accordance with the approved schedule for review. Unless otherwise directed by EPA, Respondents shall not commence further Remedial Design activities at the NHOU prior to approval of the RD Work Plan.

d. The preliminary design submission shall include, at a minimum, the following: (1) design criteria; (2) results of additional field sampling and pre-design work; (3) project delivery strategy; (4) preliminary plans, drawings and sketches; (5) required specifications in outline form; and (6) preliminary construction schedule.

e. The intermediate design submission shall be a continuation and expansion of the preliminary design.

f. The pre-final/final design submission shall include, at a minimum, the following: (1) final plans and specifications (if the Design/Bid/Build process is approved; not required for the Design/Build process); (2) Construction Quality Assurance Project Plan ("CQAPP"); (3) Field Sampling Plan (directed at measuring progress towards meeting Performance Standards); and (4) Contingency Plan. The CQAPP, which shall detail the approach to quality assurance during construction activities at the NHOU, shall specify a quality assurance official, independent of the Supervising Contractor or Project Coordinator, to conduct a quality assurance program during the construction phase of the project.

g. Health and Safety Plan. As approved in the Remedial Design Work Plan, Respondents shall prepare and submit to EPA for review and comment a plan that ensures the protection of the public health and safety during performance of on-Site work under this Order. This plan shall be prepared in accordance with EPA's Standard Operating Safety Guide (PUB 9285.1-03, PB 92-963414, June 1992). In addition, the plan shall comply with all currently applicable Occupational Safety and Health Administration ("OSHA") regulations found at 29 C.F.R. Part 1910.

If EPA determines that it is appropriate, the plan shall also include contingency planning. Respondents shall incorporate all changes to the plan recommended by EPA and shall implement the plan during the pendency of the removal action.

37. Respondents shall conduct all work in accordance with the SOW, the ROD, CERCLA, the NCP, and all applicable EPA guidance. EPA's Project Manager shall use his or her best efforts to inform Respondents if new or revised guidances may apply to the Work.

38. Respondents shall perform the tasks and submit the deliverables that the SOW sets forth. EPA will approve, approve with conditions, modify, or disapprove each deliverable that Respondents submit under this Settlement Agreement and the SOW, pursuant to Section IX (EPA Approval of Plans and Other Submissions). Each deliverable must include all listed items as well as items that the RD Work Plan indicates Respondents shall prepare and submit to EPA for review and approval.

39. Upon EPA's approval, this Settlement Agreement incorporates any reports, plans, specifications, schedules, and attachments that this Settlement Agreement or the SOW requires. With the exception of extensions that EPA allows in writing or certain provisions within Section XVII of this Settlement Agreement (*Force Majeure*), any non-compliance with such EPA-approved reports, plans, specifications, schedules, and attachments shall be considered a violation of this Settlement Agreement and will subject Respondents to stipulated penalties in accordance with Section XVIII of this Settlement Agreement (Stipulated Penalties).

40. If any unanticipated or changed circumstances exist at the NHOU that may significantly affect the Work or schedule, Respondents shall notify the EPA Project Manager by telephone and email within 72 hours of discovery of such circumstances. Such notification is in addition to any notification required by Section XVII (*Force Majeure*).

41. If EPA determines that additional tasks, including, but not limited to, additional investigatory work or engineering evaluation, are necessary to complete the Work, EPA shall notify Respondents in writing. Respondents shall submit a work plan to EPA for the completion of such additional tasks within 30 days of receipt of such notice, or such longer time as EPA agrees. The work plan shall be completed in accordance with the same standards, specifications, and requirements of other deliverables pursuant to this Settlement Agreement. EPA will review and comment on, as well as approve, approve with conditions, modify, or disapprove the work plan pursuant to Section IX (EPA Approval of Plans and Other Submissions). Upon approval or approval with modifications of the work plan, Respondents shall implement the additional work in accordance with the schedule of the approved work plan. Failure to comply with this Subsection, including, but not limited to, failure to submit a satisfactory work

plan, shall subject Respondents to stipulated penalties as set forth in Section XVIII (Stipulated Penalties).

42. Quality Assurance and Sampling

Respondents shall use quality assurance, quality control, and chain of custody procedures for all design, compliance, and monitoring samples in accordance with "EPA Requirements for Quality Assurance Project Plans (QA/R5)" (EPA/240/B-01/003, March 2001, reissued May 2006), "Guidance for Quality Assurance Project Plans (QA/G-5)" (EPA/240/R-02/009, December 2002), and subsequent amendments to such guidelines upon notification by EPA to Respondents of such amendment. Amended guidelines shall apply only to procedures conducted after such notification. Respondents shall only use laboratories that have a documented Quality System that complies with ANSI/ASQC E-4 1994, "Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs" (American National Standard, January 5, 1995), and "EPA Requirements for Quality Management Plans (QA/R-2)" (EPA/240/B-01/002, March 2001), or equivalent documentation as determined by EPA. Upon request by EPA, Respondents shall have such a laboratory analyze samples submitted by EPA for QA monitoring. Respondents shall provide to EPA the QA/QC procedures followed by all sampling teams and laboratories performing data collection and/or analysis.

a. Upon request, Respondents shall allow EPA or its authorized representatives to take split or duplicate samples. Respondents shall notify EPA not less than 28 days in advance of any sample collection activity unless shorter notice is agreed to by EPA. In addition, EPA shall have the right to take any additional samples that EPA deems necessary. Upon request, EPA shall allow Respondents to take split or duplicate samples of any samples it takes as part of EPA's oversight of Respondents' implementation of the Work.

b. Respondents shall, as specified in Attachment 2 to the SOW, summarize and submit to EPA copies of the results of all sampling and/or tests or other data obtained or generated by or on behalf of Respondents with respect to the NHOU and/or the implementation of this Settlement Agreement unless EPA agrees otherwise.

c. Respondents shall report all communications that they have with local, state, or other federal authorities related to the Remedial Design Work in the monthly progress reports.

d. If, at any time during the Remedial Design process, Respondents become aware of the need for additional data beyond the scope of the approved Work Plans, Respondents shall have an affirmative obligation to submit to EPA's Project Manager, within 30 days, a memorandum documenting the need for additional data.

e. Notwithstanding any provision of this Settlement Agreement, the United States retains all of its information gathering and inspection authorities and rights, including enforcement actions related thereto, under CERCLA, RCRA, and any other applicable statutes or regulations.

43. EPA may prepare a community relations plan, in accordance with EPA guidance and the NCP. As requested by EPA, Respondents shall provide information supporting EPA's community relations plan and shall participate in the preparation of such information for dissemination to the public and in public meetings that may be held or sponsored by EPA to explain activities at, or concerning, the Site, as further described in the SOW.

44. Emergency Response and Notification of Releases

a. If any action or occurrence during the performance of the Work causes or threatens a release of Waste Material at the NHOU that constitutes an emergency situation or may present an immediate threat to public health or welfare or the environment, Respondents shall immediately take all appropriate action to prevent, abate, or minimize such release or threat of release, and shall immediately notify the EPA's Project Manager, or, if the Project Manager is unavailable, EPA's Alternate Project Manager. If neither of these persons is available, Respondents shall notify the Duty Officer in EPA Region IX's Emergency Response, Preparedness, and Prevention Branch, at (800) 300-2193. Respondents shall take such actions in consultation with EPA's Project Manager or other available authorized EPA officer and in accordance with all applicable provisions of the Health and Safety Plans, the Contingency Plans, and any other applicable plans or documents developed pursuant to the SOW. In the event that Respondents fail to take appropriate response action as required by this Section, and EPA takes such action instead, Respondents shall reimburse EPA all costs of the response action not inconsistent with the NCP under Section XV (Payment of Response Costs).

b. In addition, in the event of any release of a hazardous substance from the Site, Respondents shall immediately notify the National Response Center at (800) 424-8802. Respondents shall submit a written report to EPA within 7 days after each release, setting forth the events that occurred and the measures taken, or to be taken, to mitigate any release or endangerment caused or threatened by the release and to prevent the reoccurrence of such a release. This reporting requirement is in addition to, and not in lieu of, reporting under Section 103(c) of CERCLA, 42 U.S.C. § 9603(c), and Section 304 of the Emergency Planning and Community Right-To-Know Act of 1986, 42 U.S.C. § 11004, *et seq.*

IX. EPA APPROVAL OF PLANS AND OTHER SUBMISSIONS

45. After review of any plan, report, or other item that is required to be submitted for approval pursuant to this Settlement Agreement, in a notice to Respondents, EPA shall: (a) approve, in whole or in part, the submission; (b) approve the submission upon specified conditions; (c) modify the submission to cure the deficiencies; (d) disapprove, in whole or in part, the submission, directing that Respondents

modify the submission; or (e) any combination of the above. However, EPA shall not modify a submission without first providing Respondents at least one notice of deficiency and an opportunity to cure within 15 days, except where to do so would cause serious disruption to the Work or where previous submission(s) have been disapproved due to material defects.

46. In the event of approval, approval upon conditions, or modification by EPA, pursuant to Subparagraph 45(a), (b), (c), or (e), Respondents shall proceed to take any action required by the plan, report, or other deliverable, as approved or modified by EPA subject only to their right to invoke the Dispute Resolution procedures set forth in Section XVI (Dispute Resolution) with respect to the modifications or conditions made by EPA. Following EPA approval or modification of a submission or portion thereof, Respondents shall not thereafter alter or amend such submission or portion thereof unless directed by EPA. In the event that EPA modifies the submission to cure the deficiencies pursuant to Subparagraph 45(c) and the submission had a material defect, EPA retains the right to seek stipulated penalties, as provided in Section XVIII (Stipulated Penalties).

47. Resubmission

a. Upon receipt of a notice of disapproval, Respondents shall, within 15 days or such longer time as specified by EPA in such notice, correct the deficiencies and resubmit the plan, report, or other deliverable for approval. Any stipulated penalties applicable to the submission, as provided in Section XVIII, shall accrue during the 15-day period or otherwise specified period but shall not be payable unless the resubmission is disapproved or modified due to a material defect as provided in Paragraphs 48 and 49.

b. Notwithstanding the receipt of a notice of disapproval, Respondents shall proceed to take any action required by any non-deficient portion of the submission, unless otherwise directed by EPA. Implementation of any non-deficient portion of a submission shall not relieve Respondents of any liability for stipulated penalties under Section XVIII (Stipulated Penalties).

c. Respondents shall not proceed further with any subsequent activities or tasks until receiving EPA approval, approval on condition, or modification of the RD Work Plan, the Preliminary Design, the Intermediate Design, the Prefinal Design, the Groundwater Monitoring Plan, and the Sampling and Analysis Plan. While awaiting EPA approval, approval on condition, or modification of this deliverable, Respondents shall proceed with all other tasks and activities that may be conducted independently of this deliverable, in accordance with the schedule set forth under this Settlement Agreement.

d. For all remaining deliverables not listed above in Subparagraph 47(c), Respondents shall proceed with all subsequent tasks, activities, and deliverables without awaiting EPA approval on the submitted deliverable. EPA reserves the right to stop Respondents from proceeding further, either temporarily or permanently, on any task, activity, or deliverable at any point.

48. If EPA disapproves a resubmitted plan, report, or other deliverable, or portion thereof, EPA may again direct Respondents to correct the deficiencies. EPA shall also retain the right to modify or develop the plan, report, or other deliverable. Respondents shall implement any such plan, report, or deliverable as corrected, modified, or developed by EPA, subject only to Respondents' right to invoke the procedures set forth in Section XVI (Dispute Resolution).

49. If upon resubmission, a plan, report, or other deliverable is disapproved or modified by EPA due to a material defect, Respondents shall be deemed to have failed to submit such plan, report, or other deliverable timely and adequately, unless Respondents invoke the dispute resolution procedures in accordance with Section XVI (Dispute Resolution) and EPA's action is revoked or substantially modified pursuant to a Dispute Resolution decision issued by EPA or superseded by an agreement reached pursuant to that Section. The provisions of Section XVI (Dispute Resolution) and Section XVIII (Stipulated Penalties) shall govern the implementation of the Work and accrual and payment of any stipulated penalties during Dispute Resolution. If EPA's disapproval or modification is not otherwise revoked, substantially modified, or superseded as a result of a decision or agreement reached pursuant to the Dispute Resolution process set forth in Section XVI, stipulated penalties shall accrue for such violation from the date on which the initial submission was originally required, as provided in Section XVIII.

50. In the event that EPA takes over some of the tasks, Respondents shall incorporate and integrate information supplied by EPA into the final reports.

51. All plans, reports, and other deliverables submitted to EPA under this Settlement Agreement shall, upon approval or modification by EPA, be incorporated into and enforceable under this Settlement Agreement. In the event EPA approves or modifies a portion of a plan, report, or other deliverable submitted to EPA under this Settlement Agreement, the approved or modified portion shall be incorporated into and become enforceable under this Settlement Agreement.

X. PROGRESS REPORTS

52. Reporting

a. Respondents shall submit written monthly progress reports to EPA on the 10^{th} day of each month beginning after the receipt of EPA's approval of the RD Work Plan until termination of this Settlement Agreement, unless otherwise directed in writing by EPA's Project Manager. These reports shall: (a) describe the actions that have been taken toward achieving compliance with this Settlement Agreement during the previous month; (b) include a summary of all results of sampling and tests and all other data received or generated by Respondents or their contractors or agents in the previous month; (c) identify all plans, reports, and other deliverables required by this Settlement Agreement completed and submitted during the previous month; (d) describe all actions, including, but not limited to, data collection and implementation of work plans, which are scheduled for the next six weeks; (e) include information regarding percentage of completion, unresolved delays encountered or anticipated that may affect the future schedule for implementation of the Work, and a description of efforts made to mitigate those delays or anticipated delays; (f) include any modifications to the work plans or other schedules that Respondents have proposed to EPA or that have been approved by EPA; and (g) describe all activities undertaken in support of the Community Relations Plan during the previous month and those to be undertaken in the next six weeks.

b. Respondents shall submit copies of all plans, reports, data and other deliverables required by this Settlement Agreement as specified in Attachment 2 of the SOW.

53. Final Report. Within 45 days after completion of all Work required by this Settlement Agreement, Respondents shall submit for EPA review and approval a final report summarizing the actions taken to comply with this Settlement Agreement. The final report shall conform, at a minimum, with the requirements set forth in Section 300.165 of the NCP entitled "OSC Reports." The final report shall include the following certification signed by a person(s) who supervised or directed the preparation of that report:

To the best of my knowledge, after thorough investigation, I certify that the information contained in, or accompanying, this submission is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

XI. SITE ACCESS AND INSTITUTIONAL CONTROLS

54. If any Respondent owns or controls property within the boundaries of the Site, or any other property where access is needed to implement this Settlement Agreement, or where land/water use controls are necessary to implement this Settlement Agreement, such Respondent shall, commencing on the Effective Date, provide EPA, the State, and its/their representatives, including contractors, with access at all reasonable times to such property in order to conduct any activity related to this Settlement Agreement. Commencing on the Effective Date, such Respondents shall not use real property that they own or control, in any manner that EPA determines will pose an unacceptable risk to human health or to the environment due to exposure to Waste Materials or interfere with or adversely affect the implementation, integrity, or protectiveness of the Remedial Action. If required by the Work, the land/water use restrictions shall include, but not be limited to: installation of drinking water wells. Respondents who own or control property within the boundaries of the Site shall, at least 30 days prior to the conveyance of any interest in real property within the boundaries of the Site, give written notice to the transferee that the property is subject to this Settlement

Agreement and written notice to EPA and the State of the proposed conveyance, including the name and address of the transferee. Respondents who own or control property within the boundaries of the Site also agree to require that their successors comply with the immediately preceding sentence, this Section, and Section XII (Access to Information). The activities related to this Settlement Agreement include, but are not limited to:

1. Monitoring the Work;

2. Verifying any data or information submitted to the United States;

3. Conducting investigations regarding contamination at or near the NHOU;

4. Obtaining samples;

5. Assessing the need for, planning, or implementing additional response actions at or near the NHOU;

6. Assessing implementation of quality assurance and quality control practices as defined in the approved Quality Assurance Project Plans;

7. Implementing the Work pursuant to the conditions set forth in Paragraph 92 (Work Takeover);

8. Inspecting and copying records, operating logs, contracts, or other documents maintained or generated by Respondents or their agents, consistent with Section XII (Access to Information);

9. Assessing Respondents' compliance with the Settlement Agreement;

10. Determining whether the NHOU or other real property is being used in a manner that is prohibited or restricted, or that may need to be prohibited or restricted under the Settlement Agreement; and

11. Implementing, monitoring, maintaining, reporting on, and enforcing any Institutional Controls.

55. If any real property where access and/or land/water use restrictions are needed, is owned or controlled by persons other than any Respondent, Respondents shall use best efforts to secure from such persons:

a. An agreement to provide access thereto for the United States, the State, and Respondents, and their representatives, contractors and subcontractors, to conduct any activity regarding the Settlement Agreement including, but not limited to, the activities listed in Paragraph 54; and

b. An agreement, enforceable by Respondents, the State, and the United States, to refrain from using the real property owned or controlled by such persons, in any manner that EPA determines will pose an unacceptable risk to human health or to the environment due to exposure to Waste Materials or interfere with or adversely affect the implementation, integrity, or protectiveness of the Remedial Action. The agreement shall include, but not be limited to, the land/water use restrictions listed in Paragraph 54.

56. For purposes of Paragraphs 54 and 55, "best efforts" includes the payment of reasonable sums of money to obtain access, an agreement to restrict land/water use, a proprietary control, and/or an agreement to release or subordinate a prior lien or encumbrance. If, within 45 days of the Effective Date, Respondents have not obtained agreements to provide access or restrict land/water use as required by Paragraph 54 and 55, Respondents shall promptly notify the United States in writing, and shall include in that notification a summary of the steps that Respondents have taken to attempt to comply with Paragraph 54 or 55. The United States may, as it deems appropriate, assist Respondents in obtaining access or agreements to restrict land/water use. Respondents shall reimburse the United States under Section XV (Payments for Response Costs), for all costs incurred, direct or indirect, by the United States in obtaining such access or agreements to restrict land/water use, including, but not limited to, the cost of attorney time and the amount of monetary consideration paid or just compensation.

57. If EPA determines that Institutional Controls in the form of state or local laws, regulations, ordinances, zoning restrictions, or other governmental controls are needed, Respondents shall cooperate with EPA's efforts to secure and ensure compliance with such governmental controls.

58. Notwithstanding any provision of this Settlement Agreement, the United States and the State retain all of their access authorities and rights, as well as all of their rights to require Institutional Controls, including enforcement authorities related thereto, under CERCLA, RCRA, and any other applicable statute or regulations.

59. If Respondents cannot obtain access agreements, EPA may obtain access for Respondents, perform those tasks or activities with EPA contractors, or terminate the Settlement Agreement. If EPA performs those tasks or activities with EPA contractors and does not terminate the Settlement Agreement, Respondents shall perform all other activities not requiring access to that site and shall reimburse EPA for all costs incurred in performing such activities. Respondents shall integrate the results of any such tasks undertaken by EPA into its reports and deliverables.

XII. ACCESS TO INFORMATION

60. Respondents shall provide to EPA and the State, upon request, copies of all documents and information within their possession or control or that of their contractors or agents relating to the implementation of this Settlement Agreement, including, but not limited to, sampling, analysis, chain of custody records, manifests, trucking logs, receipts, reports, sample traffic routing, correspondence,

or other documents or information related to the Work. Respondents shall also make available to EPA and the State, for purposes of investigation, information gathering, or testimony, their employees, agents, or representatives with knowledge of relevant facts concerning the performance of the Work.

61. Respondents may assert business confidentiality claims covering part or all of the documents or information submitted to EPA and the State under this Settlement Agreement to the extent permitted by and in accordance with Section 104(e)(7) of CERCLA, 42 U.S.C. § 9604(e)(7), and 40 C.F.R. § 2.203(b). Documents or information determined to be confidential by EPA will be afforded the protection specified in 40 C.F.R. Part 2, Subpart B. If no claim of confidentiality accompanies documents or information when it is submitted to EPA and the State, or if EPA has notified Respondents that the documents or information are not confidential under the standards of Section 104(e)(7) of CERCLA or 40 C.F.R. Part 2, Subpart B, the public may be given access to such documents or information without further notice to Respondents. Respondents shall segregate and clearly identify all documents or information submitted under this Settlement Agreement for which Respondents assert business confidentiality claims.

62. Respondents may assert that certain documents, records, and other information are privileged under the attorney-client privilege or any other privilege recognized by federal law. If the Respondents assert such a privilege in lieu of providing documents, they shall provide EPA and the State with the following: a) the title of the document, record, or information; b) the date of the document, record, or information; c) the name and title of the author of the document, record, or information; d) the name and title of each addressee and recipient; e) a description of the contents of the document, record, or information; and f) the privilege asserted by Respondents. However, no documents, reports or other information created or generated pursuant to the requirements of this Settlement Agreement shall be withheld on the grounds that they are privileged.

63. No claim of confidentiality shall be made with respect to any data, including, but not limited to, all sampling, analytical, monitoring, hydrogeologic, scientific, chemical, or engineering data, or any other documents or information evidencing conditions at, or around, the Site.

XIII. RECORD RETENTION

64. During the pendency of this Settlement Agreement and until 10 years after the Respondents' receipt of EPA's notification that work has been completed, each Respondent shall preserve and retain all non-identical copies of documents, records, and other information (including documents, records, or other information in electronic form) now in its possession or control or which come into its possession or control that relate in any manner to the performance of the Work or the liability of any person under CERCLA with respect to the Site, regardless of any corporate retention policy to the contrary. Until 10 years after notification that work has been completed, Respondents shall also instruct their

contractors and agents to preserve all documents, records, and other information of whatever kind, nature, or description relating to performance of the Work.

65. At the conclusion of this document retention period, Respondents shall notify EPA and the State at least 90 days prior to the destruction of any such documents, records, or other information and, upon request by EPA or the State, Respondents shall deliver any such documents, records, or other information to EPA or the State. Respondents may assert that certain documents, records, and other information are privileged under the attorney-client privilege or any other privilege recognized by federal law. If Respondents assert such a privilege, they shall provide EPA with the following: (a) the title of the document, record, or other information; (b) the date of the document, record, or other information; (c) the name and title of the author of the document, record, or other information; (d) the name and title of each addressee and recipient; (e) a description of the subject of the document, record, or other information; and (f) the privilege asserted by Respondents. However, no documents, records, or other information created or generated pursuant to the requirements of this Settlement Agreement shall be withheld on the grounds that they are privileged.

66. Each Respondent hereby certifies individually that to the best of its knowledge and belief, after thorough inquiry, it has not altered, mutilated, discarded, destroyed, or otherwise disposed of any records, documents, or other information (other than identical copies) relating to its potential liability regarding the Site since notification of potential liability by EPA or the State or the filing of suit against it regarding the NHOU, and that it has fully complied with any and all EPA requests for information pursuant to Sections 104(e) and 122(e) of CERCLA, 42 U.S.C. §§ 9604(e) and 9622(e), and Section 3007 of RCRA, 42 U.S.C. § 6927.

XIV. COMPLIANCE WITH OTHER LAWS

67. Respondents shall undertake all action that this Settlement Agreement requires in accordance with the requirements of all applicable local, state, and federal laws and regulations, unless an exemption from such requirements is specifically provided by law or in this Settlement Agreement. The activities conducted pursuant to this Settlement Agreement, if approved by EPA, shall be considered consistent with the NCP.

68. Except as provided in Section 121(e) of CERCLA, 42 U.S.C. § 9621(e), and the NCP, no permit shall be required for any portion of the Work conducted entirely on-site. Where any portion of the Work requires a federal or state permit or approval, Respondents shall submit timely applications and take all other actions necessary to obtain and to comply with all such permits or approvals.

69. This Settlement Agreement is not, and shall not be construed to be, a permit issued pursuant to any federal or state statute or regulation.

XV. PAYMENT OF RESPONSE COSTS

70. Payment for Future Response Costs

a. Respondents shall pay EPA all Future Response Costs not inconsistent with the NCP. On a periodic basis, but at least one year after the Effective Date, EPA will send Respondents a bill requiring payment that includes an EPA cost summary, which includes direct and indirect costs incurred by EPA and its contractors. Respondents shall make all payments within 45 days of receipt of each bill requiring payment, except as otherwise provided in Paragraph 72.

b. Respondents shall make all payments by a certified or cashier's check or checks made payable to "EPA Hazardous Substance Superfund," referencing the name and address of the party/parties making payment, the Site name, the EPA Region and Site/Spill ID Number 09N1, and the EPA docket number for this action. Respondents shall send the check(s) to:

U.S. Environmental Protection Agency
Superfund Payments
Cincinnati Finance Center
PO Box 979076
St. Louis, Missouri 63197-9000

The payment may instead by made by Electronic Funds Transfer ("EFT" or "wire transfer") in accordance with instructions provided to Respondent in the first bill for response costs.

c. At the time of payment, Respondents shall send notice that payment has been made to Kelly Manheimer at 75 Hawthorne Street SFD-7-1, San Francisco, California 94105. This notice will include copies of the transmittal letter and the check.

d. The total amount to be paid by Respondents pursuant to Subparagraph 70.a shall be deposited in the NHOU Special Account within the EPA Hazardous Substance Superfund to be retained and used to conduct or finance response actions at or in connection with the Site, or to be transferred by EPA to the EPA Hazardous Substance Superfund.

71. In the event that the payments for Future Response Costs are not made within 45 days of Respondents' receipt of a bill, Respondents shall pay Interest on the unpaid balance. The Interest on Future Response Costs shall begin to accrue on the date of the bill and shall continue to accrue until the date of payment. Payments of Interest made under this Paragraph shall be in addition to such other remedies or sanctions available to the United States by virtue of Respondents' failure to make timely payments under this Section, including but not limited to, payment of stipulated penalties pursuant to Section XVIII.

72. Respondents may contest payment of any Future Response Costs billed under Paragraph 70, if they determine that EPA has made an accounting error, or if they believe EPA incurred excess costs as a direct result of an EPA action that was inconsistent with the NCP. Such objection shall be made in writing within 45 days of receipt of the bill and must be sent to the EPA Project Manager. Any such objection shall specifically identify the contested Future Response Costs and the basis for objection. In the event of an objection, Respondents shall within the 45-day period pay all uncontested Future Response Costs to EPA in the manner described in Paragraph 70. Simultaneously, Respondents shall establish an interest-bearing escrow account in a federally-insured bank duly chartered in the State of California and remit to that escrow account funds equivalent to the amount of the contested Future Response Costs. Respondents shall send to the EPA Project Manager a copy of the transmittal letter and check paying the uncontested Future Response Costs, and a copy of the correspondence that establishes and funds the escrow account, including, but not limited to, information containing the identity of the bank and bank account under which the escrow account is established as well as a bank statement showing the initial balance of the escrow account. Simultaneously with establishment of the escrow account, Respondents shall initiate the Dispute Resolution procedures in Section XVI (Dispute Resolution). If EPA prevails in the dispute, within 15 days of the resolution of the dispute, Respondents shall pay the sums due (with accrued interest) to EPA in the manner described in Paragraph 70. If Respondents prevail concerning any aspect of the contested costs, Respondents shall pay that portion of the costs (plus associated accrued interest) for which they did not prevail to EPA in the manner described in Paragraph 70. Respondents shall be disbursed any balance of the escrow account. The dispute resolution procedures set forth in this Paragraph in conjunction with the procedures set forth in Section XVI (Dispute Resolution) shall be the exclusive mechanisms for resolving disputes regarding Respondents' obligation to reimburse EPA for its Future Response Costs.

XVI. DISPUTE RESOLUTION

73. Unless this Settlement Agreement expressly provides otherwise, the dispute resolution procedures of this Section shall be the exclusive mechanism for resolving disputes arising under this Settlement Agreement. The Parties shall attempt to resolve any disagreements concerning this Settlement Agreement expeditiously and informally.

74. If Respondents object to any EPA action taken pursuant to this Settlement Agreement, including billings for Future Response Costs, they shall notify EPA in writing of their objection(s) within 20 days of such action, unless the objection(s) has/have been resolved informally. EPA and Respondents shall have 30 days from EPA's receipt of Respondents' written objection(s) to resolve the dispute through formal negotiations (the "Negotiation Period"). The Negotiation Period may be extended at the sole discretion of EPA.

75. Any agreement reached by the parties pursuant to this Section shall be in writing and shall, upon signature by both parties, be incorporated into and become an enforceable part of this Settlement Agreement. If the Parties are unable to reach an agreement within the Negotiation Period, an EPA management official at the Division Director level or higher will issue a written decision on the dispute to Respondents. EPA's decision shall be incorporated into and become an enforceable part of this Settlement Agreement. Respondents' obligations under this Settlement Agreement shall not be tolled by submission of any objection for dispute resolution under this Section. Following resolution of the dispute, as provided by this Section, Respondents shall fulfill the requirement that was the subject of the dispute in accordance with the agreement reached or with EPA's decision, whichever occurs. Respondents shall proceed in accordance with EPA's final decision regarding the matter in dispute, regardless of whether Respondents agree with the decision.

XVII. FORCE MAJEURE

76. Respondents agree to perform all requirements of this Settlement Agreement within the time limits established under this Settlement Agreement, unless the performance is delayed by a *force majeure*. For purposes of this Settlement Agreement, a *force majeure* is defined as any event arising from causes beyond the control of Respondents, or of any entity controlled by Respondents, including, but not limited to, their contractors and subcontractors, that delays or prevents performance of any obligation under this Settlement Agreement despite Respondents' best efforts to fulfill the obligation. The requirement that Respondents exercise "best efforts to fulfill the obligation" includes using best efforts to anticipate any potential *force majeure* event: (a) as it is occurring; and (b) following the potential *force majeure* event, such that the delay is minimized to the greatest extent possible. *Force majeure* does not include financial inability to complete the Work or increased cost of performance.

77. If any event occurs or has occurred that may delay the performance of any obligation under this Settlement Agreement, whether or not caused by a *force majeure* event, Respondents shall notify EPA by telephone and by email within 72 hours of when Respondents first knew that the event might cause a delay. Within 10 days thereafter, Respondents shall provide to EPA in writing: an explanation and description of the reasons for the delay; the anticipated duration of the delay; all actions taken or to be taken to prevent or minimize the delay; a schedule for implementation of any measures to be taken to prevent or mitigate the delay or the effect of the delay; Respondents' rationale for attributing such delay to a *force majeure* event if they intend to assert such a claim; and a statement as to whether, in the opinion of Respondents, such event may cause or contribute to an endangerment to public health, welfare, or the environment. Failure to comply with the above requirements shall preclude Respondents from asserting any claim of *force majeure* for that event for the period of time of such failure to comply and for any additional delay caused by such failure. Respondents shall be deemed to know of any circumstance of which Respondents,

any entity controlled by Respondents, or Respondents' contractors knew or should have known.

78. If EPA agrees that the delay or anticipated delay is attributable to a *force majeure* event, the time for performance of the obligations under this Settlement Agreement that are affected by the *force majeure* event will be extended by EPA for such time as is necessary to complete those obligations. An extension of the time for performance of the obligations affected by the *force majeure* event shall not, of itself, extend the time for performance of any other obligation. If EPA does not agree that the delay or anticipated delay has been or will be caused by a *force majeure* event, EPA will notify Respondents in writing of its decision. If EPA agrees that the delay is attributable to a *force majeure* event, EPA will notify Respondents in writing of the length of the extension, if any, for performance of the obligations affected by the *force majeure* event.

XVIII. STIPULATED PENALTIES

79. Respondents shall be liable to EPA for stipulated penalties in the amounts set forth in Paragraphs 80 and 81 for failure to comply with the requirements of this Settlement Agreement specified below, unless excused under Section XVII (*Force Majeure*). "Compliance" by Respondents shall include completion of the activities under this Settlement Agreement, the SOW, or any other plan approved under this Settlement Agreement identified below in accordance with all applicable requirements of law, this Settlement Agreement, the SOW, and any plans or other documents approved by EPA pursuant to this Settlement Agreement and within the specified time schedules established by, and approved under, this Settlement Agreement.

80. Stipulated Penalty Amounts - Work (Including Payments and Excluding Plans, Reports, and Other Deliverables).

a. The following stipulated penalties shall accrue per violation per day for any noncompliance identified in Paragraph 80.b:

Penalty Per Violation Per Day	Period of Noncompliance
$2,000	1st through 14th day
$3,500	15th through 30th day
$7,000	31st day and beyond

b. Compliance Milestones.

1. Timely payment of Future Response Costs.

2. Providing or arranging for access as set forth in Section XI (Site Access and Institutional Controls).

3. Submittal of Remedial Design Work Plan.

4. Submittal of Preliminary Design Report.

5. Submittal of Intermediate Design Report.

81. Stipulated Penalty Amounts - Plans, Reports, and other Deliverables. The following stipulated penalties shall accrue per violation per day for failure to submit timely or adequate reports or other plans or deliverables as otherwise required in this Settlement Agreement and the SOW:

Penalty Per Violation Per Day	Period of Noncompliance
$1,000	1st through 14th day
$2,000	15th through 30th day
$3,000	31st day and beyond

82. In the event that EPA assumes performance of a portion or all of the Work pursuant to Paragraph 92, Respondents shall be liable for a stipulated penalty in the amount of $250,000.

83. All penalties shall begin to accrue on the day after the complete performance is due, or the day a violation occurs, and shall continue to accrue through the final day of the correction of the noncompliance or completion of the activity. However, stipulated penalties shall not accrue: (a) with respect to a deficient submission under Section VIII (Work to be Performed), during the period, if any, beginning on the 31st day after EPA's receipt of such submission until the date that EPA notifies Respondents of any deficiency; and (b) with respect to a decision by the EPA Management Official designated under Paragraph 75 of Section XVI (Dispute Resolution), during the period, if any, beginning on the 21st day after the Negotiation Period begins until the date that the EPA management official issues a final decision regarding such dispute. Nothing herein shall prevent the simultaneous accrual of separate penalties for separate violations of this Settlement Agreement.

84. Following EPA's determination that Respondents have failed to comply with a requirement of this Settlement Agreement, EPA may give Respondents written notification of the failure and describe the noncompliance. EPA may send Respondents a written demand for payment of the penalties. However, penalties shall accrue as provided in the preceding Paragraph regardless of whether EPA has notified Respondents of a violation.

85. Respondent shall pay EPA all penalties accruing under this Section within 45 days of Respondents' receipt from EPA of a demand for payment of the penalties, unless Respondents invoke the dispute resolution procedures under Section XVI (Dispute Resolution). All payments to EPA under this Section shall be paid by

certified or cashier's check(s) made payable to "EPA Hazardous Substances Superfund," and shall be mailed to:

U.S. Environmental Protection Agency
Superfund Payments
Cincinnati Finance Center
PO Box 979076
St. Louis, Missouri 63197-9000

Respondents shall indicate that the payment is for stipulated penalties, and shall reference the EPA Region and Site/Spill ID Number 09N1, the EPA Docket Number 2011-01, and the name and address of the party/parties making payment. Copies of checks paid pursuant to this Section, and any accompanying transmittal letters, shall be sent to EPA as provided in Paragraph 32.

The payment may instead by made by Electronic Funds Transfer ("EFT" or "wire transfer") in accordance with instructions provided to Respondents in the first bill for response costs.

86. The payment of penalties shall not alter in any way Respondents' obligation to complete performance of the Work required under this Settlement Agreement.

87. Penalties shall continue to accrue during any dispute resolution period but need not be paid until 15 days after the dispute is resolved by agreement or by receipt of EPA's decision.

88. If Respondents fail to pay stipulated penalties when due, EPA may institute proceedings to collect the penalties, as well as Interest. Respondents shall pay Interest on the unpaid balance, which shall begin to accrue on the date of demand made pursuant to Paragraph 84. Nothing in this Settlement Agreement shall be construed as prohibiting, altering, or in any way limiting the ability of EPA to seek any other remedies or sanctions available by virtue of Respondents' violation of this Settlement Agreement or of the statutes and regulations upon which it is based, including, but not limited to, penalties pursuant to Sections 106(b) and 122(l) of CERCLA, 42 U.S.C. §§ 9606(b) and 9622(l), and punitive damages pursuant to Section 107(c)(3) of CERCLA, 42 U.S.C. § 9607(c)(3). Provided, however, that EPA shall not seek civil penalties pursuant to Section 106(b) or 122(l) of CERCLA or punitive damages pursuant to Section 107(c)(3) of CERCLA for any violation for which a stipulated penalty is provided herein, except in the case of a willful violation of this Settlement Agreement or in the event that EPA assumes performance of a portion or all of the Work pursuant to Section XX (Reservation of Rights by EPA), Paragraph 90. Notwithstanding any other provision of this Section, EPA may, in its unreviewable discretion, waive any portion of stipulated penalties that have accrued pursuant to this Settlement Agreement.

XIX. COVENANT NOT TO SUE BY EPA

89. In consideration of the actions that Respondents will perform and the payments that Respondents will make under the terms of this Settlement Agreement, and except as otherwise specifically provided in this Settlement Agreement, EPA covenants not to sue or to take administrative action against Respondents pursuant to Sections 106 and 107(a) of CERCLA, 42 U.S.C. §§ 9606 and 9607(a), for the Work and Future Response Costs. This covenant not to sue shall take effect upon the Effective Date and is conditioned upon Respondents' complete and satisfactory performance of all obligations under this Settlement Agreement, including, but not limited to, payment of Future Response Costs pursuant to Section XV. This covenant not to sue extends only to Respondents and does not extend to any other person.

XX. RESERVATION OF RIGHTS BY EPA

90. Except as specifically provided in this Settlement Agreement, nothing herein shall limit the power and authority of EPA or the United States to take, direct, or order all actions necessary to protect public health, welfare, or the environment or to prevent, abate, or minimize an actual or threatened release of hazardous substances, pollutants or contaminants, or hazardous or solid waste on, at, or from the Site. Further, except as specifically provided in this Settlement Agreement, nothing herein shall prevent EPA from seeking legal or equitable relief to enforce the terms of this Settlement Agreement, from taking other legal or equitable action as it deems appropriate and necessary, or from requiring Respondents in the future to perform additional activities pursuant to CERCLA or any other applicable law.

91. The covenant not to sue set forth in Section XIX above does not pertain to any matters other than those expressly identified therein. EPA reserves, and this Settlement Agreement is without prejudice to, all rights against Respondents with respect to all other matters, including, but not limited to:

a. claims based on a failure by Respondents to meet a requirement of this Settlement Agreement;

b. liability for costs not included within the definition of Future Response Costs;

c. liability for performance of response action other than the Work;

d. criminal liability;

e. liability for damages for injury to, destruction of, or loss of natural resources, and for the costs of any natural resource damage assessments;

f. liability arising from the past, present, or future disposal, release, or threat of release of Waste Materials outside of the Site; and

g. liability for costs incurred, or to be incurred, by the Agency for Toxic Substances and Disease Registry related to the Site.

92. Work Takeover. In the event EPA determines that Respondents have ceased implementation of any portion of the Work, are seriously or repeatedly deficient or late in their performance of the Work, or are implementing the Work in a manner that may cause an endangerment to human health or the environment, EPA may assume the performance of any or all portion(s) of the Work as EPA determines necessary. Unless EPA determines that the circumstances require more immediate action on its part, EPA shall give Respondents 30 days notice of its intent to assume the performance of any or all portion(s) of the Work under this Paragraph. Respondents may invoke the procedures set forth in Section XVI (Dispute Resolution) to dispute EPA's determination that takeover of the Work is warranted under this Paragraph. Costs that the United States incurs in performing the Work pursuant to this Paragraph shall be considered Future Response Costs that Respondents shall pay pursuant to Section XV (Payment of Response Costs). Notwithstanding any other provision of this Settlement Agreement, EPA retains all authority and reserves all rights to take any and all response actions authorized by law.

XXI. COVENANT NOT TO SUE BY RESPONDENTS

93. Respondents covenant not to sue and agree not to assert any claims or causes of action against the United States, or its contractors or employees, with respect to the Work, past response actions, Future Response Costs, or this Settlement Agreement, including, but not limited to:

a. any direct or indirect claim for reimbursement from the Hazardous Substance Superfund established by 26 U.S.C. § 9507, based on Sections 106(b)(2), 107, 111, 112, or 113 of CERCLA, 42 U.S.C. §§ 9606(b)(2), 9607, 9611, 9612, or 9613, or any other provision of law;

b. any claim arising out of response actions at, or in connection with, the Site, including any claim under the United States Constitution, the State Constitution, the Tucker Act, 28 U.S.C. § 1491, the Equal Access to Justice Act, 28 U.S.C. § 2412, as amended, or at common law; or

c. any claim against the United States pursuant to Sections 107 and 113 of CERCLA, 42 U.S.C. §§ 9607 and 9613, relating to the Work or payment of Future Response Costs.

Provided, however, that nothing in this Settlement Agreement is intended to alter in any way the rights and obligations of the parties under : (1) the Consent Decree entered January 20, 2000 in the U.S. District Court (Central District of California) in *United States v. Lockheed Martin Corporation et al.* (Consolidated Cases No. 91-4527-MRP and No. 97-4214-MRP) ("the 2000 Consent Decree"); and (2) Settlement Agreement entered September 6, 2000, between the United States, acting through the United States Department of Defense, Defense Contract Management Agency, and Lockheed Martin Corporation addressing discontinued operations, including the San Fernando Valley Superfund Sites ("the 2000 Settlement Agreement").

Subject to the 2000 Consent Decree and the 2000 Settlement Agreement, and specifically (without limitation) the terms thereof respecting the avoidance of any double recovery, nothing in this Settlement Agreement shall be construed as a waiver by Respondents of any rights they may have to include costs incurred due to this Settlement Agreement, which have not been paid or reimbursed by the United States pursuant to the 2000 Consent Decree or any other agreement, in any of their proposals of allowable costs for purposes of costing or pricing pursuant to contracts with the United States. Nothing in the Settlement Agreement shall be construed to create or recognize any such right. The incurrence or payment of any costs by the Respondents pursuant to this Settlement Agreement, or inclusion of such costs in the Respondents' proposals for purpose of costing or pricing of contracts with the United States, does not, in and of itself, render such costs allocable or allowable for Government contracting purposes. For Government contracting purposes, the cost incurred in implementing this Agreement remain subject to the applicable provisions of (1) the Federal Acquisition Regulation ("FAR") and Cost Accounting Standards ("CAS"), (2) agency implementing regulations of FAR, (3) the contract(s) between the Respondents and the United States pursuant to which such costing or pricing proposals are submitted, and (4) any determination by the cognizant Contracting Officer concerning allocability and allowability of such costs, subject to any right of appeal Respondents may have under the applicable contract(s) or the FAR. Notwithstanding any other provision of this Agreement, Respondents agree that they will not claim or include, as allowable costs for purposes of costing or pricing pursuant to contracts with the United States, any amounts they may pay as Stipulated Penalties pursuant to Section XVIII of the Settlement Agreement (Stipulated Penalties), and any such stipulated penalties shall be treated by Respondents as unallowable costs.

94. These covenants not to sue shall not apply in the event the United States brings a cause of action or issues an order pursuant to the reservations set forth in Subparagraphs 91(b), (c), and (e) - (g), but only to the extent that Respondents' claims arise from the same response action, response costs, or damages that the United States is seeking pursuant to the applicable reservation.

95. Respondents reserve, and this Settlement Agreement is without prejudice to, claims against the United States subject to the provisions of Chapter 171 of Title 28 of the United States Code, for money damages for injury or loss of property or personal injury or death caused by the negligent or wrongful act or omission of any employee of the United States while acting within the scope of his office or employment under circumstances where the United States, if a private person, would be liable to the claimant in accordance with the law of the place where the act or omission occurred. However, any such claim shall not include a claim for

any damages caused, in whole or in part, by the act or omission of any person, including any contractor, who is not a federal employee as that term is defined in 28 U.S.C. § 2671; nor shall any such claim include a claim based on EPA's selection of response actions, or the oversight or approval of Respondents' plans or activities. The foregoing applies only to claims that are brought pursuant to any statute other than CERCLA and for which the waiver of sovereign immunity is found in a statute other than CERCLA.

96. Nothing in this Agreement shall be deemed to constitute approval or preauthorization of a claim within the meaning of Section 111 of CERCLA, 42 U.S.C. § 9611, or 40 C.F.R. § 300.700(d).

XXII. OTHER CLAIMS

97. By issuance of this Settlement Agreement, the United States and EPA assume no liability for injuries or damages to persons or property resulting from any acts or omissions of Respondents. The United States or EPA shall not be deemed a party to any contract entered into by Respondents or their directors, officers, employees, agents, successors, representatives, assigns, contractors, or consultants in carrying out actions pursuant to this Settlement Agreement.

98. Except as expressly provided in Section XIX (Covenant Not to Sue by EPA), nothing in this Settlement Agreement constitutes a satisfaction of, or release from, any claim or cause of action against Respondents or any person not a party to this Settlement Agreement, for any liability such person may have under CERCLA, other statutes, or common law, including, but not limited to, any claims of the United States for costs, damages, and interest under Sections 106 and 107 of CERCLA, 42 U.S.C. §§ 9606 and 9607.

99. No action or decision by EPA pursuant to this Settlement Agreement shall give rise to any right to judicial review, except as set forth in Section 113(h) of CERCLA, 42 U.S.C. § 9613(h).

XXIII. CONTRIBUTION

100. Contribution

a. The Parties agree that this Settlement Agreement constitutes an administrative settlement for purposes of Section 113(f)(2) of CERCLA, 42 U.S.C.§ 9613(f)(2), and that Respondents are entitled, as of the Effective Date, to protection from contribution actions or claims as provided by Sections 113(f)(2) and 122(h)(4) of CERCLA, 42 U.S.C. §§ 9613(f)(2) and 9622(h)(4), for "matters addressed" in this Settlement Agreement. The "matters addressed" in this Settlement Agreement are the Work and Future Response Costs.

b. The Parties agree that this Settlement Agreement constitutes an administrative settlement for purposes of Section 113(f)(3)(B) of CERCLA, 42 U.S.C. § 9613(f)(3)(B), pursuant to which Respondents have, as of the Effective Date, resolved their liability to the United States for the Work and Future Response Costs.

c. Nothing in this Settlement Agreement precludes the United States or Respondents from asserting any claims, causes of action, or demands for indemnification, contribution, or cost recovery against any persons not parties to this Settlement Agreement. Nothing herein diminishes the right of the United States, pursuant to Sections 113(f)(2) and (3) of CERCLA, 42 U.S.C. § 9613(f)(2)(3), to pursue any such persons to obtain additional response costs or response action and to enter into settlements that give rise to contribution protection pursuant to Section 113(f)(2).

XXIV. INDEMNIFICATION

101. Respondents shall indemnify, save, and hold harmless the United States, its officials, agents, contractors, subcontractors, employees, and representatives from any and all claims or causes of action arising from, or on account of, negligent or other wrongful acts or omissions of Respondents, their officers, directors, employees, agents, contractors, or subcontractors, in carrying out actions pursuant to this Settlement Agreement. In addition, Respondents agree to pay the United States all costs incurred by the United States, including, but not limited to, attorneys fees and other expenses of litigation and settlement, arising from, or on account of, claims made against the United States based on negligent or other wrongful acts or omissions of Respondents, their officers, directors, employees, agents, contractors, subcontractors, and any persons acting on their behalf or under their control, in carrying out activities pursuant to this Settlement Agreement. The United States shall not be held out as a party to any contract entered into, by, or on behalf of Respondents in carrying out activities pursuant to this Settlement Agreement. Neither Respondents nor any such contractor shall be considered an agent of the United States.

102. The United States shall give Respondents notice of any claim for which the United States plans to seek indemnification pursuant to this Section and shall consult with Respondents prior to settling such claim.

103. Respondents waive all claims against the United States for damages or reimbursement or for set-off of any payments made, or to be made, to the United States, arising from, or on account of, any contract, agreement, or arrangement between any one or more of Respondents and any person for performance of Work on, or relating to, the Site, including, but not limited to, claims on account of construction delays. In addition, Respondents shall indemnify and hold harmless the United States with respect to any and all claims for damages or reimbursement arising from, or on account of, any contract, agreement, or arrangement between any one or more of Respondents and any person for performance of Work on, or relating to, the Site.

XXV. INSURANCE

104. At least 10 days prior to commencing any on-Site Work under this Settlement Agreement, Respondents shall secure and shall maintain for the duration of this Settlement Agreement comprehensive general liability insurance and automobile insurance with limits of two million dollars ($2,000,000), combined single limit, naming the EPA as an additional insured. Within the same period, Respondents shall provide EPA with certificates of such insurance and a copy of each insurance policy. Respondents shall submit such certificates and copies of policies each year on the anniversary of the Effective Date. In addition, for the duration of the Settlement Agreement, Respondents shall satisfy, or shall ensure that their contractors or subcontractors satisfy, all applicable laws and regulations regarding the provision of worker's compensation insurance for all persons performing the Work on behalf of Respondents in furtherance of this Settlement Agreement. If Respondents demonstrate by evidence satisfactory to EPA that any contractor or subcontractor maintains insurance equivalent to that described above, or insurance covering some or all of the same risks but in an equal or lesser amount, then Respondents need provide only that portion of the insurance described above that is not maintained by such contractor or subcontractor.

XXVI. FINANCIAL ASSURANCE

105. Within 30 days of the Effective Date, Respondents shall establish and maintain financial security for the benefit of EPA in the amount of $2.2 million in one or more of the following forms, to secure the full and final completion of Work by Respondents:

a. a surety bond unconditionally guaranteeing payment and/or performance of the Work;

b. one or more irrevocable letters of credit, payable to or at the direction of EPA, issued by financial institution(s) acceptable in all respects to EPA equaling the total estimated cost of the Work;

c. a trust fund administered by a trustee acceptable in all respects to EPA;

d. a policy of insurance issued by an insurance carrier acceptable in all respects to EPA, which ensures the payment and/or performance of the Work;

e. a corporate guarantee to perform the Work provided by one or more parent corporations or subsidiaries of Respondents, or by one or more unrelated corporations that have a substantial business relationship with at least one of Respondents; including a demonstration that any such company satisfies the financial test requirements of 40 C.F.R. Part 264.143(f); and/or

f. a corporate guarantee to perform the Work by one or more of Respondents, including a demonstration that any such Respondent satisfies the requirements of 40 C.F.R. Part 264.143(f). If any Respondent that seeks to make a demonstration pursuant to 40 C.F.R. Part 264.143(f) in order to satisfy the financial assurance requirements of this Section has provided a similar demonstration at other CERCLA or RCRA sites, such Respondent must provide EPA with documentation of the prior demonstration(s) so that EPA can account for the amount of financial assurance already being provided at other sites.

106. Any and all financial assurance instruments provided pursuant to this Section shall be in form and substance satisfactory to EPA, determined in EPA's sole discretion. In the event that EPA determines at any time that the financial assurances provided pursuant to this Section (including, without limitation, the instrument(s) evidencing such assurances) are inadequate, Respondents shall, within 30 days of receipt of notice of EPA's determination, obtain and present to EPA for approval one of the other forms of financial assurance listed in Paragraph 105, above. In addition, if at any time EPA notifies Respondents that the anticipated cost of completing the Work has increased, then, within 30 days of such notification, Respondents shall obtain and present to EPA for approval a revised form of financial assurance (otherwise acceptable under this Section) that reflects such cost increase. Respondents' inability to demonstrate financial ability to complete the Work shall in no way excuse performance of any activities required under this Settlement Agreement.

107. If Respondents seek to ensure completion of the Work through a guarantee pursuant to Subparagraph 105(e) or 105(f) of this Settlement Agreement, Respondents shall: (i) demonstrate to EPA's satisfaction that the guarantor satisfies the requirements of 40 C.F.R. Part 264.143(f); and (ii) resubmit sworn statements conveying the information required by 40 C.F.R. Part 264.143(f) annually, on the anniversary of the Effective Date, to EPA. For the purposes of this Settlement Agreement, wherever 40 C.F.R. Part 264.143(f) references "sum of current closure and post-closure costs estimates and the current plugging and abandonment costs estimates," the current cost estimate of $2.2 million for the Work at the Site shall be used in relevant financial test calculations.

108. If, after the Effective Date, Respondents can show that the estimated cost to complete the remaining Work has diminished below the amount set forth in Paragraph 105 of this Section, Respondents may, on any anniversary date of the Effective Date, or at any other time agreed to by the Parties, reduce the amount of the financial security provided under this Section to the estimated cost of the remaining Work to be performed. Respondents shall submit a proposal for such reduction to EPA, in accordance with the requirements of this Section, and may reduce the amount of the security after receiving written approval from EPA. In the event of a dispute, Respondents may change the form of financial assurance required hereunder only in accordance with a final decision resolving such dispute pursuant to Section XVI (Dispute Resolution).

109. Respondents may change the form of financial assurance provided under this Section at any time, upon notice to and prior written approval by EPA, provided that EPA determines that the new form of assurance meets the requirements of

this Section. In the event of a dispute, Respondents may change the form of financial assurance required hereunder only in accordance with a final decision resolving such dispute pursuant to Section XVI (Dispute Resolution).

XXVII. INTEGRATION/APPENDICES

110. This Settlement Agreement, its appendices, and any deliverables, technical memoranda, specifications, schedules, documents, plans, reports (other than progress reports), etc. that will be developed pursuant to this Settlement Agreement and become incorporated into, and enforceable under, this Settlement Agreement constitute the final, complete, and exclusive agreement and understanding among the Parties with respect to the settlement embodied in this Settlement Agreement. The parties acknowledge that there are no representations, agreements, or understandings relating to the settlement other than those expressly contained in this Settlement Agreement.

111. In the event of a conflict between any provision of this Settlement Agreement and the provisions of any document attached to this Settlement Agreement or submitted or approved pursuant to this Settlement Agreement, the provisions of this Settlement Agreement shall control.

112. The following documents are attached to and incorporated into this Settlement Agreement:

"Appendix A" is the SOW.

"Appendix B" is the ROD.

XXVIII. EFFECTIVE DATE AND SUBSEQUENT MODIFICATION

113. This Settlement Agreement shall be effective 5 days after the Settlement Agreement is signed by the Assistant Director of EPA Region IX's Superfund Division, California Site Cleanup Branch.

114. This Settlement Agreement may be amended by mutual agreement of EPA and Respondents. Amendments shall be in writing and shall be effective when signed by EPA. EPA Project Managers do not have the authority to sign amendments to the Settlement Agreement.

115. No informal advice, guidance, suggestion, or comment by the EPA Project Manager or other EPA representatives regarding reports, plans, specifications, schedules, or any other writing submitted by Respondents shall relieve Respondents of their obligation to obtain any formal approval required by this Settlement Agreement, or to comply with all requirements of this Settlement Agreement, unless it is formally modified.

XXIX. NOTICE OF COMPLETION OF WORK

116. When EPA determines, after EPA's review of the Final Report, that all Work has been fully performed in accordance with the other requirements of this Settlement Agreement, with the exception of any continuing obligations required by this Settlement Agreement, including but not limited to payment of Future Response Costs, EPA will provide written notice to Respondents. If EPA determines that any such Work has not been completed in accordance with this Settlement Agreement, EPA will notify Respondents, provide a list of the deficiencies, and require that Respondents modify the Work Plan if appropriate to correct such deficiencies. Respondents shall implement the modified and approved Work Plan and shall submit the required deliverables. Failure by Respondents to implement the approved modified Work Plan shall be a violation of this Settlement Agreement.

THE UNDERSIGNED SETTLING PARTY enters into this Settlement Agreement in the matter of U.S. EPA CERCLA Docket No. 2011-01, relating to the North Hollywood Operable Unit of the San Fernando Valley Superfund Site, Area 1:

Agreed this 20 day of January, 2011.

For Respondent Honeywell International Inc.

By: ______________________
Benny DeHghi

Title: Remediation Manager – Health, Safety, Environment & Remediation

THE UNDERSIGNED SETTLING PARTY enters into this Settlement Agreement in the matter of U.S. EPA CERCLA Docket No. 2011-01, relating to the North Hollywood Operable Unit of the San Fernando Valley Superfund Site, Area 1:

Agreed this 28th day of January, 2011.

For Respondent Lockheed Martin Corporation

By: David J. C. Constable
David J. C. Constable

Title: Vice President Energy, Environment Safety and Health

It is so ORDERED AND AGREED this 14th day of February, 2011.

BY: Kathleen Salyer DATE: 2/14/11

Kathleen Salyer
Assistant Director, Superfund Division
California Site Cleanup Branch
Region IX
U.S. Environmental Protection Agency

EFFECTIVE DATE: February 21, 2011

Appendix A

Statement of Work
for Remedial Design
of the Second Interim ROD

North Hollywood Operable Unit

San Fernando Valley (Area 1) Superfund Site

Los Angeles County, California

EPA ID: CAD980894893

TABLE OF CONTENTS

Attachments

Acronyms

ARAR	Applicable or Relevant and Appropriate Requirement
AOC	Administrative Order on Consent
CDPH	California Department of Public Health
CFR	Code of Federal Regulations
CQA	Construction Quality Assurance (Plan)
CSI	Construction Specification Institute
COC	contaminant of concern
CSM	Conceptual Site Model
DQO	Data Quality Objective
DTSC	CA Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
FFS	Focused Feasibility Study
FSP	Field Sampling Plan
HASP	Health and Safety Plan
ICIAP	Institutional Controls Implementation and Assurance Plan
LADWP	Los Angeles Department of Water and Power
LCA	Life Cycle Analysis
MCL	Maximum Contaminant Level
NHOU	North Hollywood Operable Unit
O&M	Operation and Maintenance
OU	Operable Unit
PCE	Tetrachloroethylene
QA/QC	Quality Assurance and Quality Control
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
RAOs	Remedial Action Objectives
RD	Remedial Design
ROD	Record of Decision
RWQCB	CA Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SFV	San Fernando Valley
SMP	Site Management Plan
SOW	Statement of Work
TCE	Trichloroethylene
VE	Value Engineering
VOC	Volatile Organic Compounds

1.0 Introduction

This Statement of Work ("SOW") sets forth the activities required to be performed by the Respondents under the Administrative Settlement Agreement and Order on Consent for Remedial Design entered into between the United States and Respondents, dated February 14, 2011, ("AOC"), to conduct pre-design data acquisition and Remedial Design activities associated with the Second Interim Action Record of Decision for the San Fernando Valley ("SFV") (Area 1), North Hollywood Operable Unit ("NHOU") Superfund Site signed by the EPA on September 30, 2009 ("ROD"). The ROD presented the selected second interim remedy for the groundwater within the NHOU. This SOW is Appendix A to the AOC. All terms used in this Statement of Work shall have the same meanings as defined in Section III of the AOC.

1.1 Site Description

The San Fernando Valley (Area 1) Superfund Site was listed on the National Priorities List on June 10, 1986 (Comprehensive Environmental Response, Compensation, and Liability Information System ("CERCLIS") Identification Number CAD980894893).

The NHOU is one of two operable units within the San Fernando Valley (Area 1) Superfund Site. The NHOU comprises approximately 4 square miles of contaminated groundwater underlying an area of mixed industrial, commercial, and residential land use in the community of North Hollywood (a district of the City of Los Angeles). The NHOU is approximately 15 miles north of downtown Los Angeles and immediately west of the City of Burbank, and has approximate boundaries of Sun Valley and Interstate 5 to the North, State Highway 170 and Lankershim Boulevard to the west, the Burbank Airport to the east, and Burbank Boulevard to the south (see Figure 1).

Prior to World War II, most land in the SFV was occupied by farms, orchards, and ranchland. By 1949, after the war, nearly all the land in Burbank and North Hollywood was occupied by housing developments, industrial facilities, retail establishments, and the Burbank Airport. Accompanying these land use changes in the 1940s was a substantial increase in population and groundwater withdrawals from the SFV groundwater basin. In the 1950s, the North Hollywood, Erwin, Whitnall, and Verdugo Well Fields were constructed by the Los Angeles Department of Water and Power ("LADWP") in the North Hollywood area to meet the increasing demand for water. In 1968, groundwater withdrawals from the SFV were reduced to achieve "safe yield" from the basin, and more surface water was imported to the basin from external sources.

In 1979, industrial contamination was found in groundwater in the San Gabriel Valley (to the east of the SFV), prompting the California Department of Public Health ("CDPH"; formerly the California Department of Health Services) to request that all major water providers in the region, including those in the SFV, sample and analyze groundwater for potential industrial contaminants. Trichloroethylene ("TCE") and tetrachloroethylene ("PCE") were consistently detected in a large number of production wells in the SFV at concentrations greater than Federal and State Maximum Contaminant Levels ("MCLs") for drinking water.

TCE and PCE were widely used in the San Fernando Valley starting in the 1940s for dry cleaning and for degreasing machinery. Disposal was not well regulated at that time, and releases from numerous facilities throughout the eastern SFV have resulted in the large plume of groundwater contaminated with volatile organic compounds ("VOCs") that extends from the NHOU to the southeast. To replace wells within the NHOU area contaminated by TCE and PCE, and to provide more operational flexibility for groundwater recharge and pumping in the SFV, LADWP constructed the Rinaldi-Toluca Well Field in 1988 and 1989, and the Tujunga Well Field in 1993 (see Figure 1 in Attachment 1).

1.2 Purpose

The purpose of this SOW is to set forth the requirements for pre-design data acquisition and the Remedial Design ("RD") of the remedy selected in the ROD. The RD is generally defined as those activities to be undertaken by the Respondents to develop the final plans and specifications, general provisions, and specific requirements necessary to implement the ROD. Pre-design data acquisition involves environmental sampling, sample analysis, and data evaluation in support of the RD. The RD will also ensure that the remedy complies with the performance standards set forth in Sections 2.8 and 2.13.2 of the ROD ("Performance Standards"), and other requirements of the ROD and AOC.

The purpose of the Superfund program is to eliminate unacceptable risks to human health and the environment from abandoned hazardous waste sites. In recent years, EPA has taken a more comprehensive view of this purpose, to include life cycle analysis ("LCA") of all the risks posed by the site, and by any resulting remediation efforts. In an effort to describe this approach in more detail, EPA has developed several guidance documents regarding "green remediation" and "greener cleanups," such as Region IX's policy memo, *Greener Cleanups Policy - EPA Region 9.*

1.3 General Requirements

The Respondents shall furnish all necessary and appropriate personnel, materials, and services needed for, or incidental to, performing and completing the Work, as defined below and in Section III of the AOC.

1.3.1 Performance Standards

Respondents shall conduct the RD to achieve the Performance Standards and comply with the provisions and requirements of the ROD, the AOC, and this SOW. Table 6 from the ROD, which identifies the numeric performance standards for the contaminants of concern, is replicated in Attachment 4 to this SOW.

The Remedial Action Objectives ("RAOs") for this action are:

- Prevent exposure to contaminated groundwater, above acceptable risk levels.
- Contain areas of contaminated groundwater that exceed the MCLs and notification levels to the maximum extent practicable.
- Prevent further degradation of water quality at the Rinaldi-Toluca and North Hollywood West production wells by preventing the migration toward these well fields of the more highly contaminated areas of the VOC plume located to the east/southeast.
- Achieve improved hydraulic containment to inhibit horizontal and vertical contaminant migration in groundwater from the more highly contaminated areas and depths of the aquifer to the less contaminated areas and depths of the aquifer, including the southeast portion of the NHOU in the vicinity of the Erwin and Whitnall production well fields.
- Remove contaminant mass from the aquifer.

As stated in the ROD, in some areas of the NHOU, high volume LADWP production wells currently capture part of the VOC plume (i.e., groundwater with VOC concentrations of 5 micrograms per liter ("µg/L") or greater). LADWP relies on these wells (particularly those in the Rinaldi-Toluca and North Hollywood West well fields) to meet its water supply needs and manages their use so as to ensure that drinking water standards are always met. Because these wells will continue to be used, it is not possible for the NHOU system to capture and contain all of the contaminated groundwater. Consequently, one of EPA's objectives is to improve containment of the high concentration areas of the plume to ensure that no further degradation of groundwater quality occurs in the vicinity of the Rinaldi-Toluca and North Hollywood West well fields from those areas.

Additionally, if EPA determines that modifications to the Work specified in this SOW for the RD or in work plans developed pursuant to this SOW are necessary to achieve and maintain the Performance Standards and/or comply with ARARs as set forth in the ROD, EPA may require that such modifications be incorporated into the appropriate work plans developed pursuant to this SOW, as set forth in Paragraph 41 of the AOC.

1.3.2 Items Covered by Work

Respondents shall design a groundwater extraction and treatment system to meet the stated RAOs. The Work required to be performed by the Respondents pursuant to the AOC and this SOW includes, but is not limited to, the following specific components:

Groundwater Monitoring

Approximately 37 new monitoring wells are required to be installed as part of the remedy selected in the ROD; however, Honeywell has already installed 31 new wells. As described in EPA's 2009 Focused Feasibility Study ("FFS") Respondents will install additional monitoring wells as necessary and required by EPA to track the location and movement of groundwater contamination throughout the NHOU to fill data gaps necessary for design. Groundwater monitoring pursuant to this AOC and this SOW shall be conducted to fill data gaps necessary for design and to track the location and movement of groundwater contamination throughout the NHOU for the duration of this AOC. Monitoring shall include continued sampling and analysis of the new and existing monitoring wells within the NHOU, selected facility monitoring wells, LADWP production wells, and extraction wells in the North Hollywood area. Monitoring parameters shall include VOCs, chromium, emerging chemicals, and parameters indicative of geochemical conditions that may affect chromium speciation and transport. Proposed activities associated with groundwater monitoring shall be described in a Groundwater Monitoring Plan (see Section 2.2.3 of this SOW).

Replace Existing Extraction Well NHE-1

The ROD states that replacement of existing extraction well NHE-1 with a deeper well of similar construction is necessary to achieve the required hydraulic containment under the Second Interim Remedy. During pre-design data acquisition (described in Section 4) and design (described in Section 5), existing data and data gathered as part of this SOW will be used to verify the need for and determine the optimal location, depth, and pumping rate of the new NHE-1 extraction well.

Replace or Repair and Modify Existing Extraction Wells NHE-2, NHE-4, and NHE-5

The ROD states that replacement of wells NHE-2, NHE-4, and NHE-5 with deeper wells of similar construction will likely be necessary to achieve the required hydraulic containment of the contaminated groundwater plume. Alternatively, the existing wells could remain active in their present configuration, and a new well with deeper screened intervals could be constructed adjacent to each existing well. During pre-design data acquisition (described in Section 4) and design (described in Section 5), existing data and data gathered as part of this SOW will be used to verify the need for and determine the optimal location, depth, and pumping rate of these three wells.

Wellhead Chromium Treatment at Well NHE-2

The ROD states that wellhead treatment of chromium is required at existing extraction well NHE-2. The ROD also states that ferrous iron reduction with microfiltration is the preferred technology for a wellhead treatment system. Alternatively, an anion-exchange-based treatment process could be installed, if results expected from the pilot tests conducted at the Glendale treatment system in 2010 demonstrate that the process is effective, does not produce excessive NDMA or other problematic constituents, and is otherwise acceptable to the CDPH.

During pre-design data acquisition (described in Section 4) and design (described in Section 5), existing data and data gathered as part of this SOW will be used to confirm the final design for the NHE-2 wellhead treatment system, and determine if any modifications are required.

Honeywell has been developing an approach to treatment and disposal of water extracted from NHOU well NHE-2 pursuant to a Cleanup and Abatement Order issued by the Regional Water Quality Control Board, Los Angeles Region ("Proposed NHE-2 Treatment and Disposal Approach"). Honeywell intends to separately submit a design of the Proposed NHE-2 Treatment and Disposal Approach to EPA for its evaluation as an alternative to the NHE-2 treatment and disposal approach selected by EPA in the ROD.[1]

Wellhead 1,4-Dioxane Treatment at Extraction Well NHE-2

The ROD states that wellhead treatment for 1,4-dioxane is required at extraction well NHE-2. The preferred treatment technology is ultraviolet light and hydrogen-peroxide advanced oxidation process; however, the ROD states that during design, another treatment option may be recommended. During pre-design data acquisition (described in Section 4) and design (described in Section 5), existing data and data gathered as part of this SOW will be used to confirm the final design for the NHE-2 wellhead treatment system, and determine if any modifications are required.

Construct New Extraction Wells

The ROD states that new extraction wells are necessary to further limit contaminant migration and to improve contaminant mass removal. Based on groundwater modeling conducted as part of the FFS, three new wells should be located northwest of the existing NHOU treatment system in locations selected to prevent VOC and chromium migration towards the Rinaldi-Toluca well field and the western portion of the North Hollywood well field. A plan for optimizing the pumping rates of the new

[1] Irrespective of the final treatment and disposal approach selected for well NHE-2, this Section of the SOW – specifically the requirements under the headings *Replace Existing Extraction Well NHE-1; Replace or Repair and Modify Existing Extraction Wells NHE-2, NHE-4, and NHE-5; and Construct New Extraction Well* – requires Respondents to design well NHE-2 in order to achieve (along with the rest of the NHOU extractions well network) the hydraulic containment of the groundwater plume required by the ROD.

NHOU extraction well system shall be developed as part of the design. During pre-design data acquisition (described in Section 4) and design (described in Section 5), existing data and data gathered as part of this SOW will be used to verify the need for and determine the optimal location, depth, and pumping rate of these three wells.

Treatment of VOCs in Extracted Groundwater

The ROD states that expansion of VOC treatment capacity at the NHOU is necessary to treat the volume of groundwater produced by the existing NHOU extraction wells and the proposed additional extraction wells. The ROD states that the existing air stripper shall be refurbished and a second air stripper, similar in capacity to the original, shall be installed and operated in parallel with the existing system. During pre-design data acquisition (described in Section 4) and design (described in Section 5), existing data and data gathered as part of this SOW will be used to verify the need for and determine the degree of VOC treatment capacity expansion necessary. This design may be amended pending consultation with CDPH (see below "Delivery of Treated Groundwater to LADWP").

***Ex Situ* Chromium Treatment for Wells NHE-1, NEW-2, and NEW-3**

The ROD requires that *Ex situ* treatment of chromium (including hexavalent chromium) shall be implemented for the combined flow from at least three extraction wells at the NHOU groundwater treatment facility. During pre-design data acquisition (described in Section 4) and design (described in Section 5), existing data and data gathered as part of this SOW will be used to verify the need for and determine the degree of *Ex situ* treatment of chromium necessary.

Delivery of Treated Groundwater to LADWP

The treated groundwater will be delivered to LADWP for use in its municipal supply system. LADWP, as the water utility, will separately have to prepare, submit, and comply with, the CDPH's *Policy Guidance for Direct Domestic Use of Extremely Impaired Sources*, CDPH Policy Memorandum 97-005 ("CDPH 97-005"). CDPH 97-005 establishes a specific process for the evaluation of, and selection of treatment systems for, impaired water sources before they can be approved for use as drinking water. Respondents shall provide all necessary information and draft submittals, as necessary, to the LADWP in support of this process. To the extent that the CDPH 97-005 requirements are known, they will be considered during implementation of the Work. Data collection necessary to begin the 97-005 process will be conducted by Respondents as necessary to perform the RD. The preparation of the 97-005 permit application is not included in this SOW. Unless otherwise directed by EPA, the remediation system will be designed to meet the standards that were in effect at the time of the ROD.

1.3.3 Guidance and Reference Material

The Respondents shall comply with all guidance issued by EPA for conducting RD and the activities described herein, to the extent deemed appropriate by EPA. A list of primary guidance and reference material is attached (Attachment 3). In all cases, the Respondents shall use the most recently issued guidance, as appropriate.

In addition, Respondents shall implement EPA's *Greener Cleanups Policy - EPA REGION 9***,** issued September 14, 2009. EPA Headquarters is also finalizing additional guidance on its “Superfund Green Remediation Strategy”, which shall be consulted and followed to the extent practicable, and subject to EPA direction.

1.3.4 Communication

The primary EPA contact for activities to be conducted pursuant to this Statement of Work is the EPA Project Coordinator, Kelly Manheimer, (415) 972-3290, manheimer.kelly@epa.gov.

The alternate contact is Fred Schauffler, Chief of California Site Cleanup Section I, (415) 972-3174, schauffler.frederick@epa.gov.

The LADWP contact is Robert McKinney, 213-367-0921, Robert.McKinney@WATER.LADWP.com

The California Department of Toxic Substances Control (“DTSC”) contact is Poonam Acharya, (818) 717-6558, pacharya@dtsc.ca.gov

The CDPH contact is Jeff O’Keefe, (818) 551-2044, jokeefe@cdph.ca.gov.

1.3.5 EPA Oversight

EPA will provide oversight of the Respondents' activities throughout the RD and performance of the Work. EPA will review deliverables to ensure that the RD and all Work correctly identifies and achieves the ROD Performance Standards and other requirements of the ROD, the Consent Decree, and this SOW. Notwithstanding any action by EPA, Respondents remain fully responsible for achieving the Performance Standards and other provisions and requirements of the ROD, the AOC and this SOW. Nothing in the AOC, this SOW, EPA's approval of the RD or any other submission, shall be deemed to constitute a warranty or representation of any kind by EPA that full performance of the RD will achieve the ROD Performance Standards. Respondents' compliance with submissions approved by EPA does not foreclose EPA from seeking additional work to achieve the applicable Performance Standards.

1.3.6 Timeframes, Deliverables Review

The timeframes and deadlines for the submission of each deliverable are listed in Attachment 2. The “EPA Estimated Review Period” specified in Attachment 2 is set by EPA as a goal. EPA will strive to achieve this goal to keep the project on schedule. However, if EPA is unable to meet one or more of these review periods, and deliverables from the Respondents are affected by EPA’s delay, EPA in its discretion will modify the deadlines for those deliverables to reflect such delay.

All deliverables will be submitted for review in accordance with Section IX of the AOC and will either be approved or disapproved by EPA. If EPA disapproves the deliverable and requests modifications, the Respondents shall revise the deliverable and resubmit it to EPA, as provided in Section IX of the AOC. After Respondents’ receipt of EPA comments on any draft document, if any, Respondents shall submit for EPA review and approval a final document within 15 days of receipt of such comments, or other due date as specified in EPA’s comment letter. The Respondents shall submit the major deliverables using a form approved by EPA.

2.0 Project Planning and Support

The purpose of this task is to determine how the site-specific Performance Standards will be satisfied. The following activities shall be performed as part of the project planning and support task:

2.1 Personnel

As required in Section VII of the AOC, Respondents shall notify EPA as noted in Attachment 2 of this SOW of the name, title, and qualifications of the Supervising Contractor that Respondents will retain to perform the Work. Respondents shall also provide EPA with a copy of the Supervising Contractor's Quality Management Plan ("QMP").

Respondents shall demonstrate that the proposed contractor has a quality assurance system that complies with ANSI/ASQC E4-1994, "Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs" (American National Standard, January 5, 1995), by submitting a copy of the proposed contractor's QMP. The QMP should be prepared in accordance with "EPA Requirements for Quality Management Plans (QA/R-2)" (EPA/240/B-01/002, March 2001, reissued May 2006) or equivalent documentation as determined by EPA.

In addition, Respondents shall identify an individual who shall be responsible for ensuring that each phase of the project is reviewed to identify the most sustainable path that is appropriate for the project. Best sustainable practices shall be reviewed for appropriate inclusion, including Leadership in Energy and Environmental Design ("LEED"), LCA, etc. To the extent practicable, all carbon emissions shall be offset, so that the entire project is carbon neutral, or negative, preferably with internally generated credits.

2.2 Develop Site-Specific Plans

The Respondents shall obtain and evaluate existing data and documents pertinent to the implementation of the ROD. This information shall be used to determine pre-design data acquisition activities necessary to support RD implementation.

The Respondents shall prepare and submit for EPA approval the site-specific plans specified in this SOW, in accordance with the approved RD Work Plan (described in Section 5.1 of this SOW). The following describes the site-specific plans that are required.

2.2.1 Health and Safety Plan/Contingency Plan

A site-specific Health and Safety Plan ("HASP") must specify how workers will be protected during any site activities through the identification, evaluation, and control of health and safety hazards. The HASP shall be in conformance with U.S. Occupational Safety and Health Administration requirements in Title 29 of the Code of Federal Regulations ("CFR") (sections 1910 and 1926), and any other applicable requirement(s). The contingency plan portion of the HASP shall specify the actions to be taken to protect the local community in the event of an accident or emergency. EPA will review, but will neither approve nor disapprove, the HASP. Each of Respondents' employees, and contractors, etc., is responsible for ensuring that its workers follow applicable federal and State worker health and safety regulations. Contingency plans shall be posted at a visible location during all field work.

2.2.2 Sampling and Analysis Plan

The Sampling and Analysis Plan ("SAP") shall address sampling and analysis activities associated with the groundwater monitoring activities described in Section 2.2.3 and any additional field activities that the Respondents determine, and EPA approves, are required to implement the Work. The SAP shall include a Quality Assurance Project Plan ("QAPP"), a Field Sampling Plan ("FSP"), and a schedule for implementation of sampling, analysis, and reporting activities. Upon EPA approval of the SAP, the Respondents shall proceed to implement the sampling activities described in the SAP.

- Quality Assurance Project Plan. The QAPP must be prepared in accordance with the *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations*, and with the EPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* and other applicable guidance (see Attachment 3). The QAPP shall describe project objectives, organizational and functional activities, data quality objectives ("DQOs"), and quality assurance and quality control ("QA/QC") protocols that shall be used to achieve the desired DQOs. The DQOs shall, at a minimum, reflect use of analytical methods for obtaining data of sufficient quality to meet National Contingency Plan requirements as identified at 40 CFR 300.435(b). In addition, the QAPP shall address personnel qualifications, sampling procedures, sample custody, analytical procedures, document control procedures, preservation of records (see AOC Section XIII), data reduction, data validation, data management, procedures that will be used to enter, store, correct, manipulate, and analyze data. It shall also include protocols for transferring data to EPA in electronic format, and document management. The QAPP shall provide sufficient detail to demonstrate that:
    - The project technical and data quality objectives are identified;
    - The measurements or data acquisition methods are appropriate for achieving project objectives;
    - Assessment procedures are sufficient for confirming that data of the type and quality needed and expected are obtained; and,
    - Any limitations on the use of the data are identified and documented.

  All analytical data, whether or not validated, shall be submitted to the EPA within 60 calendar days of sample shipment to the laboratory, or 14 days of receipt of analytical results from the laboratory, whichever occurs first. All analytical data shall be validated and submitted to EPA in an approved electronic format within 90 calendar days of the sample shipment to the laboratory. Well construction information shall be submitted to EPA at the completion of the initial sampling activities, or within 90 days after completion of a well, whichever is earlier.

- Field Sampling Plan. The FSP must be in accordance with the regional guidance document *EPA Region IX Sampling and Analysis Plan Guidance and Template* (R9QA/002.1, April, 2000); and other applicable guidance (see Attachment 3). The FSP shall describe sampling objectives, analytical parameters, analytical methods, sampling locations and frequencies, analytical holding times, sampling procedures and equipment, sample preservation, sample packing, QA/QC samples, sample paperwork and chain-of-custody procedures, sample handling and shipping, management of investigation-derived wastes, and planned uses of the data. The FSP must define the sampling and data collection methods that will be used for a project. The FSP shall be written so that a field sampling team unfamiliar with the project would be able to gather the samples and field information required. The FSP shall include a schedule that describes activities that must be completed in advance of sampling, including acquisition of property, access agreements, and arrangements for disposal of investigation-derived waste.

2.2.3 Groundwater Monitoring Plan

Respondents shall submit a Groundwater Monitoring Plan in accordance with the schedule identified in Attachment 2. The groundwater monitoring shall be implemented upon EPA approval of the Groundwater Monitoring Plan.

The Groundwater Monitoring Plan shall be amended as necessary over the life of the activities conducted pursuant to this SOW and the AOC. Considering this:

- Respondents will prepare an initial Groundwater Monitoring Plan coincident with development of the RD Work Plan to describe the identification of existing monitoring wells, LADWP production wells, and extraction wells in the North Hollywood area to be sampled by the Respondents during a coordinated effort with EPA for the purposes of providing a comprehensive set of groundwater level and groundwater quality data on the onset of the 2nd Interim Remedy Design (referred to hereafter as "Baseline Groundwater Monitoring").
- The Groundwater Monitoring Plan will be updated during the design to describe the rationale for the location and depth, and procedures for the installation of additional monitoring wells, if additional monitoring wells are necessary to fill critical data gaps to support the design.
- The Groundwater Monitoring Plan shall be updated during the Final Design to describe existing and proposed monitoring wells, the frequency of sampling, and the analytical parameters necessary for semi-annual monitoring to evaluate the location and movement of groundwater contamination throughout the NHOU and evaluate performance of the interim remedy.

The Groundwater Monitoring Plan shall address the following requirements:

- Data Collection Parameters: specify the locations of monitoring wells, and a sampling and monitoring frequency. It is expected that, initially, selected groundwater monitoring wells will be sampled semi-annually, with the majority being sampled annually.
- Identify monitoring wells, sentinel wells, and compliance wells.
- Contingency Action: the Groundwater Monitoring Plan shall propose contingency plans to be used in the event that sampling results in the sentinel wells located on the edges of the plume indicate unexpected increases in COC concentrations. Contingency actions may include increases in monitoring frequency, installation of additional groundwater monitoring wells in the impacted areas, and/or adjustment of groundwater extraction locations or rates.
- Data Analysis and Reporting: The Groundwater Monitoring Plan shall also describe how the performance data will be analyzed, interpreted, and reported to evaluate compliance with ARARs and the Performance Standards. All data shall be submitted by the deadlines approved in the SAP. Claims of change, difference, or trend in water quality or other parameters (e.g., between observed values and an ARAR or Performance Standard) shall include the use of appropriate statistical concepts and tests.

To the extent practicable, any Respondent that is currently conducting source control work at a facility in the NHOU under RWQCB or DTSC order, or otherwise, shall work with the appropriate oversight agency to coordinate times for groundwater quality and water level sampling to coincide with the area-wide events described herein.

2.2.4 Remedial Design Quality Assurance Project Plan

A RD QAPP shall be submitted to EPA for review and approval. This plan shall describe the quality control activities that Respondents will implement to ensure that the RD is conducted in an effective and compliant manner.

2.3 Project Status Reports and Meetings

2.3.1 Weekly Project Status Update

The Respondents shall prepare and submit weekly electronic Project Status Updates to EPA and DTSC that briefly document the progress and current status of each task required by this SOW and approved RD Work Plan. Each update should consist of a simple tracking form for the tasks, a narrative of problems arising, and description of steps planned or underway to mitigate them. In addition, weekly teleconferences may be scheduled to review the progress during particularly active times, at the discretion of the EPA Project Coordinator. These meetings may be held in person, at the discretion of the EPA Project Coordinator.

2.3.2 Monthly Progress Report

In addition, the Respondents shall prepare and submit written Monthly Progress Reports that:

a) describe the actions which have been taken toward achieving compliance with the requirements of this SOW and the AOC during the previous month;

b) include a summary of all results of sampling and tests and all other data received or generated by Respondents in the previous month;

c) identify all plans, reports, and other deliverables required by this SOW and AOC completed and submitted during the previous month;

d) describe all actions, including, but not limited to, data collection and implementation of work plans, which are scheduled for the next six (6) weeks and provide other information relating to the progress of the design, activities, including, but not limited to, critical path diagrams, Gantt charts and Pert charts;

e) include information regarding percentage of completion, unresolved delays encountered or anticipated that may affect the future schedule for implementation of the work, and a description of efforts made to mitigate those delays or anticipated delays; and,

f) include any modifications to the work plans or other schedules that Respondents have proposed to EPA or that have been approved by EPA.

If requested by EPA, Respondents shall also provide briefings for EPA to discuss the progress of the Work.

2.3.3 Progress Meetings

The Respondents shall consult with EPA during the design process, and shall discuss and obtain approval for critical decisions in meetings and conversations with EPA. Following such meetings and conversations, Respondents shall prepare and submit for EPA approval, draft meeting summary notes within five (5) days of the discussion. Respondents shall document all decisions made and rationale for those decisions. Meeting notes shall include appropriate layout and design drawings or figures used in the meetings. The meeting summary deliverable shall be factual and shall present any technical disputes in an unbiased manner.

2.3.4 Annual Performance Evaluation Report

At the end of each fiscal year (September 30), Respondents shall provide an Annual Performance Evaluation Report. The format and exact content of the updates and reports shall be determined in the RD Work Plan. The Annual Performance Evaluation Reports shall include but not be limited to a review of how the system is working and any recommended changes or modifications to the system, as well as any projected operational timelines.

3.0 Community Involvement Support

The Respondents shall provide community involvement support to EPA throughout the performance of the Work under this AOC consistent with Paragraph 43 of the AOC and in accordance with the *Superfund Community Involvement Handbook*, April 2005. Community involvement support may include the following subtasks:

Fact Sheet Preparation Assistance: The Respondents shall, at EPA's request, assist with the preparation of fact sheets that inform the public about activities related to the remedial design, the schedule for RA, activities to be expected during construction, provisions for responding to emergency releases and spills, and any potential inconveniences such as excess traffic and noise that could affect the community during the RD or RA.

Technical Support: The Respondents shall, at EPA's request, provide technical support for community involvement, which may include providing technical input to news releases, fact sheets, briefing materials, and other community involvement vehicles.

Public Meeting Support: The Respondents shall, at EPA's request, prepare presentation materials and provide logistical support for public meetings and open houses.

Public Notice: The Respondents shall, at EPA's request or as otherwise needed, provide individual notice to residents in the vicinity of areas where work will be performed by the Respondents.

Reporting: The Respondents shall, at the request of EPA, provide verbal status reports concerning the work performed by the Respondents.

Report Copies: The Respondents shall, at the request of EPA, provide extra copies for the public of final deliverables or other documents produced pursuant to this SOW.

4.0 Pre-Design Data Acquisition

Pre-design data acquisition involves environmental sampling, sample analysis, and data evaluation in support of the RD. The planning for this task, including the scheduling, shall be accomplished in accordance with Section 2.2.2 (SAP) and Section 2.2.3 (Groundwater Monitoring Plan) of this SOW, and shall result in the plans and timeframes required to collect the field data. Sample acquisition starts with EPA approval of the SAP and continues on a routine frequency (as defined in the SAP and Groundwater Monitoring Plan) until the Work performed under the AOC is completed.

4.1 Sample Acquisition

The Respondents shall perform the following field activities or combination of activities for sample acquisition in accordance with the EPA-approved SAP:

4.1.1 Mobilization and Demobilization

Provide the necessary personnel, equipment, and materials for mobilization and demobilization to and from the NHOU for the purpose of conducting the sampling program approved in the SAP. Coordinate with and allow EPA to conduct split sampling whenever requested by EPA.

4.1.2 Field Investigation

Conduct environmental sampling / field investigations as described in the EPA-approved SAP.

4.1.3 Sample Analysis

The Respondents shall arrange for and carry out the analysis of environmental samples, collected during the previous task, according to the SAP approved by EPA. The sample analysis task begins with arranging the sample analysis work with a qualified laboratory and after completion of the field sampling program. This task ends with the Respondents verifying that the laboratory has completed the requested analyses and has submitted sample data packages for full third party validation (Region 9 Tier 3) per the frequency defined in the approved monitoring specific QAPP. Normally this would be 20% for routine monitoring.

The Respondents shall demonstrate in advance and to EPA's satisfaction that each laboratory used is qualified to conduct the proposed work and satisfies the requirements specified in Section VII of the AOC. EPA may require that the Respondents submit detailed information to demonstrate that the laboratory is qualified to conduct the work, including information on personnel qualifications, equipment and material specification, and laboratory analyses of performance samples (blank and/or spike samples). In addition, EPA may require submittal of data packages equivalent to those generated by the EPA Contract Laboratory Program. Electronic data deliverables shall be submitted to EPA.

4.2 Analytical Support and Data Validation

The Respondents shall arrange for and carry out third party data validation of the analytical data received from the laboratory during the previous task, according to the approved SAP. For purposes of this SOW, "third party" is defined as any party other than the entity managing or performing the monitoring activities. The data validation task begins with the Respondents transmitting all sample data packages received from the laboratory to the third party for validation in accordance with USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, and USEPA Contract Laboratory Program National Functional Guidelines for Low Concentration Organic Data Review. This task ends with the Respondents providing EPA with data validation reports for the analytical data received from the laboratory.

4.3 Data Evaluation

The Respondents shall organize and evaluate both pre-existing data and data gathered as part of this SOW; such data will be used later in the RD effort. This work shall be performed in accordance with the EPA-approved SAP. The EPA Guidance for Data Quality Assessment, Practical Methods for Data Analysis should also be consulted for this operation.

Specifically, the Respondents shall perform the following activities or combination of activities during the data evaluation effort:

- Baseline Groundwater Monitoring Report

- Building Conditions Assessment Report
- Pre-Design Groundwater Modeling Report
- Treatment Options Evaluation Report

These submittals are described below.

4.3.1 Baseline Groundwater Monitoring Report

A report describing and evaluating the data collected in the initial groundwater sampling event described in Section 2.2.3 of this SOW shall be submitted.

4.3.2 Building Conditions Assessment Report

Pertinent information about the NHOU will be collected and regulatory requirements will be researched to identify and evaluate factors affecting the design. A site visit to the NHOU Central Treatment Facility will be conducted and a Building Conditions Assessment Report prepared.

4.3.3 Pre-Design Groundwater Modeling

Approximately 37 new monitoring wells are required to be installed as part of the interim remedy selected in the ROD. In 2009, Honeywell installed 26 new groundwater monitoring wells throughout the NHOU under oversight by EPA. Information obtained from the installation of these wells is presented in the “Draft NHOU Groundwater Characterization Report, North Hollywood Operable Unit,” dated April 7, 2010. This report currently is being revised to reflect the results of five additional monitoring wells installed during the summer of 2010. The additional data obtained through the installation of these groundwater monitoring wells across the NHOU has provided a more refined understanding of the contaminant plumes, their potential risk to nearby production wellfields, and the possible sources of the contaminants of concern. Consideration of the new data obtained from the 31 new groundwater monitoring wells will be essential to the development of the RD. The new data will be used to refine the planned treatment options.

A Pre-Design Groundwater Modeling Memorandum will incorporate results from the following activities:

- Refining EPA’s SFBFS-B groundwater flow model consistent with the updated hydrogeologic conceptual model. This is expected to consist of subdividing and refining the model layers, particularly in Depth Regions 1 and 2, to improve the model’s accuracy with regard to plume containment by existing and proposed extraction wells. Additional modifications may address variations in the distribution of aquifer properties. The modified model may require recalibration and subsequent validation and sensitivity analysis.
- Refining proposed extraction well locations, depths, and pumping rates using the updated model. These refinements will be made to maximize contaminant removal while minimizing plume spreading.

4.3.4 Treatment Options Memorandum

After completion of the pre-design groundwater modeling, groundwater treatment options will be evaluated considering the target zones, pumping well locations, depths, flow rates, and influent concentrations estimated during the modeling effort. To achieve the RAOs involving containment of high concentration areas of the plume to ensure no further degradation of the groundwater quality occurs in the vicinity of the production wellfields, potential groundwater extraction and treatment scenarios will need to consider:

- Extraction well locations, depths, and pumping rates;
- The efficiency and cost-effectiveness of separate treatment areas that target distinct plumes (if confirmed during the Baseline Groundwater Monitoring);
- The use of wellhead treatment versus centralized treatment; and,
- The need for additional groundwater investigation to assess the risk contaminants pose to wellfields.

This will be a collaborative process that includes consultation with USEPA, LADWP, CDPH, RWQCB, and the Upper Los Angeles River Area (“ULARA”) Watermaster.

4.3.5 Data Usability Evaluation and Field QA/QC

Each submittal will:

- State the criteria used to review and validate data, in an objective and consistent manner.
- Describe how the results obtained from the project or tasks were reconciled with the requirements defined by the data user or decision maker.
- Outline the methods used to analyze the data and determine possible anomalies or departures from assumptions established in the planning phase of data collection.
- Describe the methods used for field QA/QC.

4.3.6 Data Reduction, Tabulation, and Evaluation

Each submittal will:

- Tabulate, evaluate, and interpret the data;
- Present data in an appropriate format for final data tables;
- Design and set up an appropriate database for pertinent information collected that will be used during the performance of the Work;
- Submit electronic database in a format compatible with EPA’s existing database (to enable efficient import into that system); and,
- Submit processed data tables to EPA.

4.3.7 Development of Reports

Respondents shall evaluate and present results in a report, which shall be submitted to EPA for review and approval, within 90 days of the completion of each activity or as specified in Attachment 2. Sufficient information must be provided in this report to enable EPA to assess the adequacy of the work performed.

5.0 Remedial Design

Remedial Design activities shall include the preparation of clear and comprehensive design documents, construction plans and specifications, and other design activities needed to implement the Work and satisfy all Performance Standards set forth in the ROD. All plans and specifications shall be developed in accordance with relevant portions of the EPA Remedial Design/Remedial Action Handbook, and in accordance with the schedule set forth in the approved RD Work Plan.

5.1 Develop RD Work Plan

The Respondents shall submit a draft RD work plan, in accordance with the schedule in Attachment 2. The deliverables and schedule approved by EPA in the final RD Work Plan shall become requirements of this SOW and the AOC.

Design/Construction Approach:

Respondents shall indicate if they are interested in pursuing a conventional design/bid/build strategy, or the design/ build approach to design and construction. The conventional design/bid/build approach is one in which the design is taken to the 100 percent completion level to allow contractor bidding of the construction work. The design/build approach is one in which the design is developed to about the 60 percent completion level followed by subsequent field engineering during construction. EPA will indicate preliminary approval of the approach as part of RD Work Plan approval. The final decision will be made with the approval of the Preliminary Design.

The RD Work Plan shall include the following information:

- Project Description: A statement of the problem and any potential problems posed by the Site and how the objectives of the RD will address these problems. A discussion of the proposed extraction and treatment options to be evaluated and the approach in evaluating the options.
- Background: A background summary setting forth:
  - A brief description of the NHOU including any geographic, physiographic, hydrologic, geologic, demographic, ecological, cultural, or natural resource features that are relevant to the RD.
  - A brief synopsis of the history of the area including a summary of past disposal practices and a description of previous responses that have been conducted by local, state, federal, or private parties at the NHOU.
  - A summary of the existing data including physical and chemical characteristics of the contaminants identified and their distribution among the environmental media at the NHOU.
- Scope of Work: A discussion of the detailed scope of work to be performed during the RD.
- RD Team Organization and Coordination: A discussion and organizational charts for the Respondents' organization, the RD project organization, coordination and communications procedures, and a discussion of the roles and responsibilities of the RD team. The Respondents shall identify any subcontractors it plans to use to accomplish all or part of any task identified.
- RD Project Schedule: The schedule shall include, but not be limited to, all design deliverables listed in Attachment 2 of this SOW.
- Permits, Access and Third Party Agreement(s): Any and all permits, property leases, and/or easements required for implementation of the RD, as well as a discussion of the substantive permit requirements, schedule of permit applications, property acquisitions, and third party agreements. This shall include planning for the CDPH 97-005 process, as

referenced above in Section 1.3.2 of this SOW.

- Site Management: a description of how access, security, management responsibilities, decontamination, and waste disposal are to be handled during RD.
- Sustainability Approach: a thorough description of the process or plans to be implemented by the Respondents to ensure that the entire project is managed in the most sustainable manner possible.
- Data Gap Analysis: an evaluation of existing data and determination of data gaps necessary to be filled prior to design. This will include evaluation of the remaining FFS monitoring wells (those identified in the FFS, not already installed by Honeywell), to determine which are required for design.
- Description of Deliverables: The RD Work Plan shall include plans for the completion of all the deliverables identified below. In addition, the RD Work Plan shall present the technical and management approach to each task to be performed, including: a detailed description of each task; the assumptions used; the identification of any technical uncertainties (with a proposal for the resolution of those uncertainties); the information needed for each task; any information to be produced during and at the conclusion of each task; and a description of the deliverables that will be submitted to EPA. These deliverables include:
    1. Health and Safety Plan/Contingency Plan ("HASP");
    2. Sampling and Analysis Plan ("SAP");
    3. Groundwater Monitoring Plan;
    4. Remedial Design Quality Assurance Project Plan ("RD QAPP");
    5. Monthly Progress Reports;
    6. Data Evaluation Report (if additional data is needed prior to, or during, design – see section 4.5);
    7. Preliminary Design Report (30%);
    8. Pre-Achievement O&M Plan;
    9. Intermediate design report (60%); and,
    10. Prefinal/final design report (if applicable).

The Respondents shall also identify any additional deliverables believed necessary, and include a schedule for the submission of these deliverables.

Hydraulic modeling has been performed on many occasions during the Site history, and most recently for EPA's *Focused Feasibility Study*. The Respondents shall submit to EPA any proposed changes in modeling assumptions, and discuss their effect on recommended extraction rates and well locations. The RD Work Plan shall describe the model calibration approach and assumptions. All models must be calibrated and approved by EPA prior to use. When establishing extraction capture zones, the Respondents shall follow the guidelines described in the EPA guidance document: *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems*.

5.2 Approval of the RD Work Plan

The draft RD Work Plan will be submitted for review in accordance with Sections VIII and IX of the AOC. Respondents shall submit a final RD Work Plan within 30 days of receipt of any EPA comments on the draft RD Work Plan. Upon approval of the final RD Work Plan by EPA, Respondents shall implement the RD.

5.3 Preliminary Design

The Respondents shall conduct Preliminary Design activities in accordance with the RD Work Plan and Attachment 2 of this SOW. The components that constitute the Preliminary Design are described below and shall be submitted to EPA for review and approval in accordance with Sections VI and X of the AOC, unless otherwise provided herein. Preliminary Design begins with the initial design and ends with the completion of approximately 30 percent of the design effort. The Respondents shall include the following components in the Preliminary Design:

5.3.1 Design/Construction Approach

If EPA preliminarily approved the design/build approach with the approval of the RD Work Plan, Respondents shall include a final request to perform design/build for any or all of the design and construction with the Preliminary Design. The Preliminary Design will then outline the approach to contracting and quality control in a more thorough manner.

5.3.2 Preliminary Design Report

A Preliminary Design Report will be prepared that includes the design criteria, delivery plan and schedule, construction schedule, specifications outline, preliminary drawings and specifications, the basis of design, easement and access requirements, and value engineering, as described below. The Pre-Design Groundwater Modeling and Treatment Options Memorandum will be appended to the Preliminary Design Report.

5.3.3 Design Criteria

The Design Criteria shall define in detail the technical parameters upon which the design will be based. Specifically, the Design Criteria shall include the preliminary design assumptions and parameters, including, as appropriate:

- Waste characterization;
- Volume and types of each medium requiring treatment;
- Assumed treatment plant influent quality over the design life of the treatment system(s), with a description of the methodology used to develop the estimate (including discussion of the likelihood and magnitude of short-term and long-term changes in influent concentrations);
- Treatment schemes (including all media and byproducts), rates, and required qualities of waste streams (i.e., input and output rates, influent and effluent qualities, potential air emissions, etc.);
- Filtration, disinfection, corrosion control, or other treatment requirements in addition to removal of site contaminants;
- Delivery locations, rates, and pressures for the treated groundwater, and other conveyance system assumptions for supplying treated groundwater;
- Description of how the design will achieve Performance Standards;
- Long-term operation and maintenance (“O&M”) and performance monitoring requirements;

- An LCA evaluation for all components of the system and a method for minimizing or offsetting impacts, including all carbon emissions;
- Preliminary demonstration of plume capture, consistent with EPA's guidance: *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems;*
- All ARARs, pertinent codes, and standards to be complied with; and,
- Technical factors of importance to the design and construction including use of currently accepted environmental control measures, constructability of the design, end-use of land, and use of currently acceptable construction practices and techniques.

5.3.4 Preliminary Delivery Plan and Schedule

The Delivery Plan and Schedule shall describe how the Remedial Action is to be delivered, how contracting shall be done, the contracting strategy (conventional 100 percent design-bid-build versus design-build), the organizational structure, communication strategy, etc. The schedule shall include an evaluation of a phased approach to expedite the Remedial Action. The contracting strategy shall be carefully described.

For a conventional design-bid-build approach, all four phases of design including Preliminary Design (approximately 30 percent design completion), Intermediate Design (approximate 60 percent completion), Prefinal Design (approximately 90 percent completion) and Final Design (100 percent completion) shall be required to facilitate bidding of the construction work and commencement of the construction work itself. In addition, as-built drawings shall be required at the end of construction.

5.3.5 Preliminary Construction Schedule

A preliminary Remedial Action schedule appropriate to the size and complexity of the project shall be included in the Preliminary Design.

5.3.6 Specifications Outline

The general specifications outline shall include all specification sections to be used. The format and organization shall be consistent with the Construction Specification Institute ("CSI") format.

5.3.7 Preliminary Drawings and Specifications

The drawings and schematics shall reflect organization and clarity. This submittal shall include the following:

- An outline or listing of the drawings and schematics;
- Facility representations including a process flow diagram and a preliminary piping and instrumentation diagram;
- A general arrangement diagram; and,
- Site drawings, consisting of engineering drawings submitted in 11-inch x 17-inch sheets (or larger with approval from the EPA Project Coordinator).

5.3.8 Basis of Design

The Basis of Design shall include a detailed description of the evaluations conducted to select the design approach. It shall include a Summary and Detailed Justification of Assumptions, which shall include:

- Calculations supporting the assumptions;
- Detailed evaluation of how all ARARs will be met;
- Model input files (to the extent that the design is based upon modeled results);
- A plan for minimizing environmental and public impacts; and,
- A plan for satisfying any permitting requirements, including a status update of the progress of the CDPH 97-005 process.

5.3.9 Easement and Access Requirements

The potential need for land acquisition for access, or any other access or easement issues or requirements shall be identified.

5.3.10 Value Engineering Screening (Optional)

The Respondents may choose to perform Value Engineering ("VE") screening that shall include an evaluation of cost and function relationships, concentrating on high-cost areas. The VE screening shall be performed by an independent Value Engineering group. An "Independent Value Engineering group" is defined as any qualified party other than the individuals that performed the design. However, as necessary, selected individuals from the design team may also participate in the VE screening. The outcome of the screening shall be a recommendation for or against a full-scale VE study based on the potential for cost savings as a result of design changes. VE screening can be performed at the discretion of the Respondents. However, any decisions made as a result of any VE effort that could impact the design of the interim remedy shall be submitted to EPA for approval.

5.4 Intermediate Design

The Respondents shall conduct Intermediate Design activities in accordance with the RD Work Plan and the requirements identified below. Intermediate Design activities shall include the preparation of clear and comprehensive design documents, construction plans and specifications, and other design activities needed to implement the work and satisfy all Performance Standards set forth in the ROD. All plans and specifications shall be developed in accordance with relevant portions of the EPA Remedial Design/Remedial Action Handbook, and in accordance with the schedule set forth in the approved RD Work Plan, and Attachment 2 of this SOW.

The components that constitute the Intermediate Design are described below and shall be submitted to EPA for review and approval in accordance with Sections VIII and IX of the AOC and Attachment 2 to this SOW. Intermediate Design begins with completion of the Preliminary Design and ends with the completion of approximately 60 percent of the design effort. The level of the Intermediate Design may vary, depending on whether the Respondents propose and EPA approves, to complete the project on a design/bid/build or design/build basis. The Intermediate Design shall address all prior EPA comments on the Preliminary Design, or provide a memorandum explaining why specific comments were not incorporated or addressed.

The Respondents shall include in the Intermediate Design, at a minimum, the following components:

5.4.1 Update of Construction Schedule

The schedule for implementation of the Remedial Action shall identify the timing for initiation and completion of all major construction activities. The schedule shall specifically identify duration for completion of the project and major milestones.

5.4.2 Intermediate Specifications

Plans and specifications shall conform to acceptable standards and shall be formatted in accordance with CSI requirements. Plans and specifications shall include preliminary specifications for construction, installation, site preparation, and fieldwork associated with the remediation system implementation.

5.4.3 Intermediate Drawings

Intermediate Drawings shall include an outline or listing of all of the drawings anticipated to be required for the remediation system construction. The Intermediate Drawings package shall include facility representations containing a process flow diagram, a piping and instrumentation diagram with a control logic table, and continuations and expansions of drawings submitted with the preliminary plans and specifications. The Intermediate Drawings shall also include engineering drawings for grading/paving, foundation, extraction wells and wellheads, piping, electrical, structural, mechanical, instrumentation, and monitoring systems, as appropriate.

5.4.4 Revised Basis of Design

The revised Basis of Design shall include a revised summary of the evaluations conducted to select the design approach. This summary shall include any additions made to the Basis of Design, as presented in the Preliminary Design.

5.4.5 Remedial Action Contracting Strategy

The contracting strategy shall describe the management approach for procuring the Remedial Action contractor, including procurement methods, phasing alternatives, and contractor and equipment availability concerns. It shall identify the specific procurement process proposed; i.e. design/build or design/bid/build.

5.4.6 Updated Identification of Easement and Access Requirements

The need for land acquisitions for access and easement requirements shall be updated, as appropriate, as part of the Intermediate Design.

5.4.7 Identification of the Projected O&M Requirements and Annual Costs

The Respondents shall identify the projected O&M requirements, including performance monitoring as initially established in the Groundwater Monitoring Plan, and develop an estimate of the annual O&M costs.

5.4.8 VE Study and Report Recommendations

If recommended by the preliminary VE screening, the VE Study shall be conducted and the report prepared and submitted by an independent Value Engineering group. However, any decisions made as a result of any VE effort that could affect the design of the interim remedy shall be submitted to EPA for approval. This task is optional, and shall be done at the discretion of the Respondents.

5.5 Prefinal and Final Design

The Respondents shall conduct Prefinal and Final Design activities in accordance with the RD Work Plan and the approved schedule.

- These design activities shall be performed if the construction approach uses a conventional design/bid/build strategy in which the design is taken to the 100 percent completion level to allow contractor bidding of the construction work. If a design/build approach is utilized in which the design is developed to about the 60 percent completion level followed by subsequent field engineering during construction, then prefinal and final design activities would not be required. In this case, the as-built drawings will serve as the final design drawings. In addition, the 60 percent design package shall be revised to fully address all EPA comments on the Preliminary and Intermediate Design submittals and re-submitted for EPA approval.

The following discussion and requirements would be applicable if the design/bid/build approach is approved, and prefinal and final design activities are performed.

5.5.1 Prefinal Design

The Prefinal Design shall fully address all comments made on the Preliminary and Intermediate design submissions, and, if not previously addressed, be accompanied by a memorandum indicating how the comments were incorporated into the Prefinal Design. The Prefinal Design submittal shall include an updated capital and O&M cost estimate, reproducible drawings and specifications, and a complete set of construction drawings in one-half-size reduction (11-inch by 17-inch size).

The components and deliverables that constitute the Prefinal and Final Design are described below and shall be submitted to EPA for review and approval in accordance with Section IX of the AOC, and Attachment 2 to this SOW. The Prefinal Design shall clearly show any modifications to the design resulting from the Intermediate Design review. EPA will review the Prefinal Design in accordance with Section IX of the AOC.

5.5.2 Final Design

Within 30 days after EPA approves the Prefinal Design, Respondents shall submit all Final Design deliverables to EPA. All Final Design documents shall be approved and stamped by a Professional Engineer registered in California. EPA approval of the Final Design, including the Final Draft Pre-Achievement O&M Plan and the Final Construction Quality Assurance Plan, is required before initiating the RA, unless specifically authorized otherwise by EPA.

The Respondents shall include the following components in the Prefinal and Final Designs:

5.5.3 Specifications

A complete set of construction specifications shall be submitted at the prefinal stage. All specifications shall conform to CSI format. If the Value Engineering study is conducted, the VE report recommendations that have been approved by EPA shall be incorporated into the Prefinal Design specifications. The specifications must be consistent with the technical requirements of all ARARs and must meet all ARARs, Performance Standards, and other provisions and requirements of the ROD, the AOC, and the SOW. Any offsite response activities shall be in compliance with Section 121(d)(3) of CERCLA, 42 U.S.C. Section 9621(d)(3), 40 C.F.R. 300.440, and other applicable guidance. Before submitting the project specifications, the Respondents shall coordinate and cross-check the specifications and drawings.

5.5.4 Drawings

A complete set of construction drawings shall be submitted in the 11-inch x 17-inch size. Value Engineering report recommendations (submitted as part of the Intermediate Design) that have been approved by EPA shall be incorporated into the Prefinal Design drawings.

5.5.5 Basis of Design

A Basis of Design that incorporates any changes made since the Intermediate Design shall be submitted.

5.5.6 Delivery Plan and Schedule

The Delivery Plan shall incorporate any changes made since the Preliminary Delivery Plan and Schedule. The Final Design should also include the timing and duration of major construction activities and operational milestones identified in this SOW.

5.5.7 Report of VE Modifications

A Report of VE Modifications shall be submitted that describes the changes made to the final designs as a result of the VE Study and Recommendations, if conducted.

5.6 Operation and Maintenance Plan

Respondents shall submit a draft Pre-Achievement O&M Plan for EPA's review, in accordance with Attachment 2 of this SOW. Once approved by EPA, this document will be considered the Final Pre-Achievement O&M Plan.

"Pre-Achievement O&M" shall mean all operation and maintenance activities required for the Remedial Action to achieve Performance Standards, as provided under the Pre-Achievement O&M Plan approved by EPA and the SOW. Pre-Achievement O&M includes all O&M activities to be conducted until Performance Standards are met. The O&M Plan shall describe, among other things, the compliance monitoring that will be conducted to measure the performance of the system in achieving and maintaining the Performance Standards described in the ROD. At a minimum, the Pre-Achievement O&M Plan shall include the following:

5.6.1 Description of Equipment

A description of equipment including: the equipment identification numbers; identification and description of monitoring components; maintenance needs and schedules of site equipment; material requirements; anticipated equipment replacement for significant components; and a list of recommended spare parts.

5.6.2 Description of O&M

A description of routine and emergency O&M tasks, including startup and shutdown procedures, prescribed treatment or operation conditions, and schedule for each O&M task. In addition, a description of provisions for remote monitoring and control, operator training and certification requirements, staffing needs, and related requirements.

5.6.3 Description of Potential Operating Problems

A description and analysis of potential operating problems, including common and/or anticipated remedies with a description of the system monitoring implemented to track these operational problems. In addition, a useful-life analysis of significant components and replacement costs shall be included in this Pre-Achievement O&M Plan.

5.6.4 Compliance Monitoring Sampling and Analysis Plan

A description of the compliance monitoring strategy and tasks, location of the points of compliance monitoring, required data collection, and a description of required laboratory tests and their validation and interpretation. (See Section 2.2.3, Sampling and Analysis Plan and the Groundwater Monitoring Plan, for more information). It shall also include criteria for determining when the Performance Standards have been met as well as other indicators of system performance and/or maintenance (e.g., parameters to be monitored to determine timing for activated carbon replacement, etc.).

5.6.5 Waste Disposal

A description of the plans for the proper disposal of materials used and wastes generated during the O&M periods (e.g., wastewater from the treatment process including process blowoff water from the wells, spent treatment media, protective clothing, and disposable equipment). These provisions shall be consistent with the off-site disposal requirements of Superfund Amendments and Reauthorization Act, the Resource Conservation and Recovery Act, and applicable state laws. The Respondents, their authorized representative, or another party acceptable to the EPA shall be identified as the generator of wastes for the purpose of regulatory or policy compliance.

5.6.6 Health and Safety Plan for O&M

A description of precautions and necessary equipment to protect site personnel shall be included. The HASP shall be in conformance with U.S. Occupational Safety and Health Administration requirements in Title 29 of the CFR, sections 1910 and 1926.

5.6.7 Records and Reporting Mechanisms

A description of records and reporting mechanisms including, as appropriate, performance monitoring results, daily operating logs, preventative maintenance logs, laboratory records, records for operating costs, mechanism for reporting emergencies, and personnel and maintenance records.

Attachment 1: Site Map

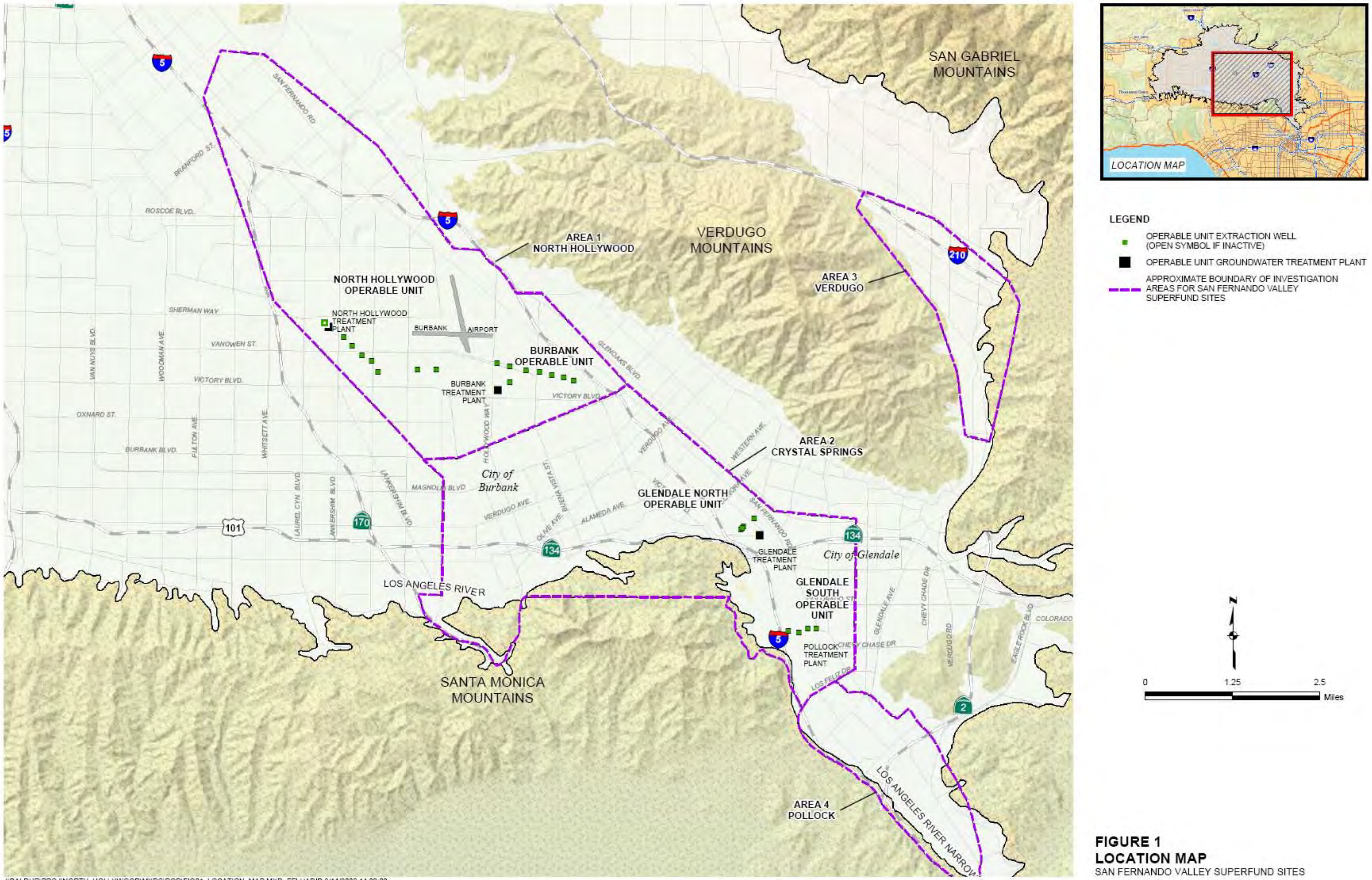


FIGURE 1
LOCATION MAP
SAN FERNANDO VALLEY SUPERFUND SITES

Attachment 2: Summary of Deliverables

Ref SOW Section	Deliverable	No. of copies [1]	Due [2]	EPA Estimated Review period [3]
2.1	Selection of Supervising Contractor and Sustainability Manager	Email	January 30, 2011	7 days
2.1	QMP for Supervising Contractor	Email	February 11, 2011	7 days
Communications				
2.3.1	Project Status Updates	email to EPA and DTSC	Weekly, or as approved in Work Plans (starting after submittal of draft RD Work Plan)	N/A
2.3.2	Monthly Progress Reports	Electronic via email	10th day of each month (starting after submittal of draft RD Work Plan)	7 days
2.3.3	Progress Meeting Notes	Email	Within 5 days of each meeting	N/A
2.3.4	Annual Performance Evaluation Report		Annually, by September 30th	21 days
Design and Action				
5.1	Draft RD Work Plan	Electronic only	30 days after EPA's approval of the Supervising Contractor	30 days
5.2	Final RD Work Plan		15 days after receipt of any EPA comments on the draft RD Work Plan	10 days
2.2.1	Health And Safety Plan/Contingency Plan	Electronic only	As approved in RD Work Plan	21 days
2.2.2	Sampling & Analysis Plan		As approved in RD Work Plan	30 days
2.2.2	Analytical Data	Electronic only	See section 2.2.2 (QAPP bullet)	
2.2.3	Initial Groundwater Monitoring Plan		Coincident with RD Work Plan	30 days
2.2.4	Remedial Design Quality Assurance Project Plan	Electronic only	as approved in RD Work Plan	30 days
4.5.3	Data Evaluation Report	Electronic only	90 days after completion of each monitoring event	21 days
5.3	Building Conditions Assessment	Electronic only	Coincident with RD Work Plan development	Not applicable
	Pre-Design Groundwater Modeling Memorandum		120 days after EPA approval of the RD Work Plan	30 days
	Treatment Options Memorandum		90 days after completion of the Pre-Design Groundwater Modeling Memorandum	30 days

Ref SOW Section	Deliverable	No. of copies [1]	Due [2]	EPA Estimated Review period [3]
	Preliminary Design		130 days after completion of the Treatment Options Memorandum	30 days
5.4	Intermediate Design		90 days after EPA approval of the Preliminary Design	30 days
5.5	Prefinal Design		90 days after EPA approval of the Intermediate Design	30 days
5.6	Draft Pre-Achievement O&M Plan		With the Prefinal Design	30 days
5.5	Final Design		30 days after EPA approves the Prefinal Design	30 days
5.6	Final Draft Pre-Achievement O&M Plan	Electronic only	15 days after EPA comments on the draft Plan	21 days

[1] Unless otherwise indicated, four (4) hard copies shall be provided: one (1) copy sent to USEPA, one (1) copy sent to EPA’s contractor, one (1) copy sent to LADWP, and one (1) copy sent to DTSC. Four (4) electronic copies (on compact disc) also shall be provided - one (1) copy to EPA, one (1) copy to EPA’s contractor, one (1) copy sent to LADWP, and one (1) copy to DTSC.

[2] All deliverables set forth in Attachment 2 will be reviewed and approved by EPA in accordance with Section IX of the AOC. If EPA disapproves a deliverable and requests modifications pursuant to Section IX of the AOC, the Respondents shall revise the deliverable and resubmit it to EPA within the timeframe specified in Section IX of the AOC.

[3] The “EPA Estimated Review Period” specified herein is set by EPA as a goal. EPA will strive to achieve this goal to keep the project on schedule. However, if EPA is unable to meet one or more of these review periods, and deliverables from the Respondents are affected by EPA’s delay, the deadlines for those deliverables will reflect such delay.

Attachment 3: Primary Guidance and Resources

The following list, although not comprehensive, consists of many of the regulations and guidance documents that apply to the RD/RA process:

1) *Greener Cleanups Policy - EPA REGION 9***,** issued September 14, 2009; found at: http://www.epa.gov/region09/climatechange/green-sites.html.
2) *Superfund Green Remediation Strategy*, draft dated August 2009, http://www.epa.gov/superfund/greenremediation/sf-gr-strategy.pdf.
3) *CERCLA Compliance with Other Laws Plan*, Two Volumes, U.S. EPA, Office of Emergency and Remedial Response, August 1988 (DRAFT), OSWER Directive No. 9234.1-01 and -02.
4) *Superfund Community Involvement Handbook*, U.S. EPA, Office of Solid Waste and Emergency Response, April 2005, EPA-540-K-05-003.
5) *EPA Guidance on Systematic Planning Using the Data Quality Objectives Proce*ss (EPA QA/G-4, 2006).
6) Federal Acquisition Regulation, Washington, DC: U.S. Government Printing Office (revised periodically).
7) *Guidance on Expediting Remedial Design and Remedial Actions*, EPA/540/G-90/006, August 1990.
8) *Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites*, U.S. EPA Office of Emergency and Remedial Response (DRAFT), OSWER Directive No. 9283.1-2.
9) *Guide to Management of Investigation-Derived Wastes*, U.S. EPA, Office of Solid Waste and Emergency Response, Publication 9345.3-03FS, January 1992.
10) *Interim Guidance on Compliance with Applicable of Relevant and Appropriate Requirements*, U.S. EPA, Office of Emergency and Remedial Response, July 9, 1987, OSWER Directive No. 9234.0-05.
11) *Institutional Controls: A Guide to Implementing, Monitoring and Enforcing Institutional Controls at Superfund, Brownfields, Federal Facility, UST and RCRA Corrective Action Cleanups*, (Draft), February 2003, OSWER 9355.0-89, EPA 540-R-04-002, http://www.epa.gov/superfund/action/ic/guide/index.htm
12) National Oil and Hazardous Substances Pollution Contingency Plan; Final Rule, Federal Register 40 CFR Part 300, March 8, 1990.
13) *Permits and Permit Equivalency Processes for CERCLA On-Site Response Actions*, February 19, 1992, OSWER Directive 9355.7-03.
14) *Quality in the Constructed Project: A Guideline for Owners, Designers and Constructors, Volume 1, Preliminary Edition for Trial Use and Comment*, American Society of Civil Engineers, May 1988.
15) *Remedial Design/Remedial Action (RD/RA) Handbook*, U.S. EPA, Office of Solid Waste and Emergency Response (OSWER), 9355.0-04B, EPA 540/R-95/059, June 1995.

16) *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations,* U.S. EPA, EPA/240/B-01/003, March 2001, Reissued May 2006.

17) *Guidance for Quality Assurance Project Plans,* U.S. EPA, EPA/240/R-02/009, December 2002.

18) *Scoping the Remedial Design* (Fact Sheet), February 1995, OSWER Publ. 9355-5-21 FS.

19) Standards for the Construction Industry, Code of Federal Regulations, Title 29, Part 1926, Occupational Health and Safety Administration.

20) Standards for General Industry, Code of Federal Regulations, Title 29, Part 1910, Occupational Health and Safety Administration.

21) *Superfund Guidance on EPA Oversight of Remedial Designs and Remedial Actions Performed by Potentially Responsible Parties,* April 1990, EPA/540/G-90/001.

22) *Value Engineering* (Fact Sheet), U.S. EPA, Office of Solid Waste and Emergency Response, Publication 9355.5-03FS, May 1990.

23) *USEPA Contract Laboratory Program National Functional Guidelines for Low Concentration Organic Data Review*, EPA-540-R-00-006, June 2001.

24) *USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review*, EPA-540-R-08-01, June 2008.

25) *Policy Guidance for Direct Domestic Use of Extremely Impaired Sources,* CDPH Policy Memorandum 97-005

26) *Focused Feasibility Study, North Hollywood Operable Unit, San Fernando Valley Area 1 Superfund Site*, EPA, prepared by CH2MHILL, July 2009

27) *American National Standards Practices for Respiratory Protection*. American National Standards Institute Z88.2-1980, March 11, 1981.

28) *A Compendium of Superfund Field Operations Methods*, Two Volumes, USEPA, Office of Emergency and Remedial Response, EPA/540/P-87/001a, August 1987, OSWER Directive No. 9355.0-14.

29) *Data Quality Objectives for Remedial Response Activities*, USEPA, Office of Emergency and Remedial Response and Office of Waste Programs Enforcement, EPA/540/G-87/003, March 1987, OSWER Directive No. 9335.0-7B.

30) *Engineering Support Branch Standard Operating Procedures and Quality Assurance Plan*, USEPA Region IV, Environmental Services Division, April 1, 1986 (revised periodically).

31) *NIOSH Plan of Analytical Methods*, 2nd edition. Volumes I-VII for the 3rd edition, Volumes I and II, National Institute of Occupational Safety and Health.

32) *Occupational Safety and Health Guidance Plan for Hazardous Waste Site Activities*, National Institute of Occupational Safety and Health/Occupational Health and Safety Administration/United States Coast Guard/Environmental Protection Agency, October 1985.

33) *Superfund Remedial Design and Remedial Action Guidance*, USEPA, Office of Emergency and Remedial Response, June 1986, OSWER Directive No. 9355.0-4A.

34) *EPA Region IX Sampling and Analysis Plan Guidance and Template* (R9QA/002.1, April, 2000).

35) *Draft: Region 9 Superfund Data Evaluation/Validation Guidance,* USEPA, Quality Assurance Office, R9QA/006.1, December 2001.

36) *Methods for Monitoring Pump and Treat Performance,* USEPA, Office of Research and Development, June 1994 (EPA 600/R-94/123).

37) *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems*, EPA, January 2008 (EPA/600/R-08/003).

38) *Operation and Maintenance in the Superfund Program,* EPA, May 2001, (OSWER 9200.1-37FS, EPA 540-F-01-004).

39) *Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs* (American National Standard, January 5, 1995), ANSI/ASQC E4-1994.

40) *EPA Requirements for Quality Management Plans (QA/R-2)*, EPA/240/B-01/002, March 2001, reissued May 2006.

41) *EPA Guidance for Data Quality Assessment, Practical Methods for Data Analysis* (EPA QA/G-9, 1998).

Attachment 4: Performance Standards for COCs

Table 6. Performance Standards for COCs in Extracted and Treated Groundwater (from ROD)

Contaminant of Concern	Federal MCL (µg/L)	California MCL (µg/L)	CDPH Notification Level (µg/L)	Basis for Performance Standard	Performance Standard (µg/L)[a]
TCE	5	5	None	Federal MCL	5
PCE	5	5	None	Federal MCL	5
1,1-DCA	5	5	None	Federal MCL	5
1,2-DCA	0.5	0.5	None	Federal MCL	0.5
1,1-DCE	6	6	None	Federal MCL	6
cis-1,2-DCE	6	6	None	Federal MCL	6
1,1,2-TCA	5	5	None	Federal MCL	5
Carbon tetrachloride	0.5	0.5	None	Federal MCL	0.5
Methylene Chloride	5	5	None	Federal MCL	5
Total Chromium	100	50	None	California MCL	50
Hexavalent Chromium	None[b]	None[b,c]	None	See footnote "d"	5[d]
Perchlorate	None	6	None	California MCL	6
TCP	None	None	0.005	CDPH notification level	0.005
1,4-dioxane	None	None	3	CDPH notification level	3
NDMA	None	None	0.01	CDPH notification level	0.01

Notes:

[a] The CDPH permitting process may require lower concentrations in the treated effluent.

[b] Federal and state MCLs specific to hexavalent chromium have not been established; therefore, the state MCL for total chromium currently is applied to hexavalent chromium.

[c] A PHG for hexavalent chromium is currently under development by OEHHA. Following development of a PHG, a state MCL specific to hexavalent chromium may be established.

[d] Based on discussions with LADWP, it is EPA's understanding that LADWP will continue to use a voluntary cleanup level of 5 µg/L for hexavalent chromium for water it will accept for use in its water supply system. Consequently, under the drinking water end use option, chromium treatment at the NHOU will be needed so that LADWP's voluntary cleanup level of 5 µg/L can be met.

APPENDIX H

RESPONSES TO EPA COMMENTS ON THE
DRAFT DATA GAP ANALYSIS, NORTH HOLLYWOOD OPERABLE UNIT SECOND INTERIM REMEDY, GROUNDWATER REMEDIATION SYSTEM DESIGN
(DATED FEBRUARY 21, 2012)
(INCLUDING THE REVISED NHOU PROJECT SCHEDULE)

14 March 2012

Mr. Matt Salazar
U.S. Environmental Protection Agency
75 Hawthorne Street
San Francisco, CA 94105

Re: AMEC Responses to EPA Comments (dated February 21, 2012)
Draft Data Gap Analysis, North Hollywood Operable Unit, Second Interim Remedy, Groundwater Remediation Design

Dear Mr. Salazar:

This letter has been prepared to respond to final comments to the *Draft Data Gap Analysis, North Hollywood Operable Unit Second Interim Remedy, Groundwater Remediation System Design* (AMEC, October 31, 2011), provided by the EPA in a letter dated February 21, 2012. A response follows each comment generated either by the EPA or its contractor (CH2M Hill), the Los Angeles Department of Water and Power (LAWDWP), the Regional Water Quality Control Board, Los Angeles (RWQCB-LA), or the Upper Los Angeles River Area (ULARA) Watermaster). As requested, the revised NHOU project schedule (Attachment A) illustrates our phased approach to completing the Pre-Design Investigation and remaining AOC scope items necessary to design the Second Interim Remedy such that RAOs and CDPH 97-0005 requirements can be met.

GENERAL COMMENTS

<u>CH2M HILL and EPA</u>

1. In consideration of the updated conceptual site model, new groundwater quality data obtained since the time of the NHOU Focused Feasibility Study (FFS), and regulatory changes (i.e. a new notification level for 1,4-dioxane), the Draft Data Gaps Analysis (DDGA) concludes that RD for the NHOU Second Interim Remedy cannot proceed until a number of “critical” data gaps have been filled. However, It appears to us that some of the “critical” data gaps may be impossible to fill (e.g. accurate forecasts of future municipal pumping rates), while other listed “critical” data gaps would not have a major impact on RD, and others could potentially be filled (at least for the purposes of RD) using available data and relatively inexpensive methods of analysis (e.g. determining hydraulic parameters of the A and B zones by equipping existing wells with pressure transducers and monitoring the responses to changes in pumping rates).

AMEC response: AMEC’s revised project schedule conveys our intent to balance the competing objectives of quickly proceeding with the remedial design and obtaining sufficient data to ensure design compliance with RAOs and CDPH 97-005 requirements. Filling critical data gaps is not intended to remove all uncertainty (that is not possible). Rather, we recognize that many fundamental aspects of groundwater flow and

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distribution of COCs in the NHOU study area have not yet been reasonably addressed and additional data are thus required to ensure the remedial design will be able to achieve the Second Interim Remedy RAOs.

The revised project schedule (Attachment A) includes two parallel tracks to be performed concurrently. A Pre-Design Investigation is proposed to include a field program and data evaluation, consistent with Section 4 of the AOC scope of work, that will proceed concurrently with other AOC scope items (e.g., RD QAPP, Building Conditions Assessment) that are either not dependent upon findings from the Pre-Design Investigation or can be adjusted as needed in subsequent AOC scope item deliverables (e.g., Preliminary Design Report). The Pre-Design Groundwater Modeling Memorandum and Treatment Options Memorandum will be initiated during the Pre-Design Investigation and completed based on collected data.

Pre-Design Investigation tasks are segmented into Phases 1 and 2. Phase 2 is intended to allow for the collection of additional data deemed necessary to meet RAOs following completion of Phase 1. If the Phase 1 Pre-Design Investigation sufficiently addresses critical data gaps, the Preliminary Design Report would be submitted in third quarter, 2013 rather than in the fourth quarter 2012 as indicated in the Final RD Work Plan. The additional nine months includes the almost three extra months spent by EPA to review the draft Data Gap Analysis (one month had been scheduled) and additional time associated with reviewing the draft RD Work Plan. Note that the revised NHOU project schedule (dated March 14, 2012) will replace the final RD Work Plan project schedule and the schedule in Appendix A of the AOC.

2. We agree with the statement in Section 4.5.4, that “additional capture does appear to be needed (both deeper and over a larger area than is apparently capable by the existing NHOU extraction well field)”; however, the purpose of the new extraction wells was not necessarily to provide capture under “normal” (as far as any scenario is normal) LA DWP pumping scenarios, but to protect the LA DWP production wells under the maximum pumping conditions provided by LA DWP for the FFS. As an alternative to delaying RD until all of the outlying data gaps are filled, design of specific, immediate improvements in key areas (i.e. modifying or rehabilitating wells NHE-2 through NHE-5 as discussed in the Proposed Plan and ROD, together with upgrading the treatment system to treat emerging contaminants), could proceed immediately, while outlying data gaps are filled and the options for the new extraction wells can be more fully evaluated.

AMEC response: Our response addresses the two components of this comment: (A) the perceived need for additional extraction wells to the west, and (B) the second addressing the suggestions to proceed with immediate improvements in parallel with filling other data gaps.

(A) As stated in the ROD, page 2-39:

> “…certain groundwater pumping scenarios acceptable to the Watermaster could interfere with the effectiveness of the Second Interim Remedy. In order to address this issue, an additional [Institutional Control] is necessary, wherein EPA and LADWP work together to develop and implement a groundwater management plan that would protect the effectiveness and integrity of the NHOU

remedy while being consistent with LADWP's drinking water production requirements."

To our knowledge, the ULARA Watermaster has not indicated whether the "maximum pumping conditions" considered in the FFS are acceptable, but we are aware that several recent ULARA Watermaster reports refer to a Stipulated Agreement that includes the Cities of Los Angeles, Burbank, and Glendale, that is intended to reduce municipal pumping and restore San Fernando Valley storage capacity to 1968 levels.

As discussed in the Data Gap Analysis report, the lower projected pumping rates called for by the Stipulated Agreement present a significant deviation from conditions assumed as part of the FFS, including the perceived need to install additional extraction wells to intercept contamination that is assumed will migrate westward toward the Rinaldi-Toluca well field. Deviations such as this underscore the need for the Groundwater Management Plan, which should include specific and reasonable minimum/maximum groundwater elevations.

Development of the Groundwater Management Plan, as a required Institutional Control in the ROD, is thus a critical element of the Second Interim Remedy. The protectiveness of the Second Interim Remedy could be severely compromised if the Groundwater Management Plan is not established in coordination with the system design.

(B) As discussed in the response to the previous comment, the Second Interim Remedy project schedule has been revised (Attachment A) to proceed with a Phase 1 Pre-Design Investigation and components of the remedial design in parallel where possible. Recommendations have been revised such that the need for additional data, potentially including the collection of groundwater samples or installing monitoring well(s), will be considered following completion of the Phase 1 Pre-Design Investigation.

Regarding the suggestion to immediately upgrade the treatment system, the Second Interim Remedy cannot be designed to achieve RAOs and comply with CDPH 97-005 requirements until the Pre-Design Investigation has been performed and critical data gaps have been filled. Proceeding with the remedial design before evaluating these data would be premature for at least the following reasons:

- The radius of influence and capture area of each existing NHE well has not yet been delineated and simulation results have not been verified. Proceeding with the remedial design before uncertainty regarding spatial variation in A-Zone/B-Zone hydraulic parameters within the NHE well field and groundwater flow directions/gradients has been resolved would preclude AMEC from performing a data-driven capture zone analysis. Such an analysis is necessary to comply with CDPH 97-005 requirements and to meet RAOs.
- Because the extent of elevated COCs has not yet been delineated (i.e., target capture zones have not been identified), particularly to the west of the NHOU extraction well field, the flow rate necessary to establish capture as required by the RAOs cannot yet be determined. Proceeding with the remedial design could result in an under-designed system that may not be easily upgraded or modified after-the-fact (particularly regarding chromium treatment) and may not meet RAOs.

- Deepening NHOU extraction wells will likely result in a different influent chemistry, potentially with higher COC concentrations as observed at NH-C18, NH-C19, and NH-C21. Hydraulic and analytical data from our recommended NHE piezometer couplets are intended to establish the necessary depth of NHE extraction wells and better estimate influent water quality. These data are needed to design a treatment system that will comply with CDPH's 97-005 requirements.
- Because necessary influent flow rates and deep A-Zone COC concentrations cannot be accurately anticipated without filling critical data gaps, it cannot be determined what components of the existing NHOU treatment system will remain viable or will need to be replaced. These data are needed to complete the Treatment Options Memorandum.

Note that the revised recommendations include video inspection and, if deemed necessary, redevelopment of the NHOU extraction wells where aquifer testing will be performed. Results from these well inspections will be used to consider what, if any, redevelopment actions may be warranted at other NHOU extraction wells.

As noted in our responses to several comments below, recommendations included in the Data Gap Analysis are intended to fill critical data gaps as needed to ensure that the remedial design will be able to achieve Second Interim Remedy RAOs.

Regional Board

3. The work plan should present geologic cross-sections to allow the reader to view the contaminant plumes in the A- and B-zones as presented in the work plan.

AMEC response: The Data Gap Analysis includes six detailed geologic cross-sections (Figures 4-2a-f). However, insufficient depth-discrete analytical data exist to illustrate the vertical distribution of COC mass along these transects. As discussed in Section 4.5, most COC mass appears to be associated with the shallower "A-Zone" unit, which is clearly illustrated on the six cross-section figures.

4. The work plan should collect analytical data to develop Stiff diagrams to help determine groundwater flow.

AMEC response: Although previous investigations have evaluated groundwater chemical signatures based on major ion proportions, results were not based on depth-discrete groundwater samples. The Pre-Design Investigation findings report will consider whether the A-Zone and B-Zone have distinct groundwater chemical signatures and illustrate them using Stiff, Piper, or other appropriate graphical method(s).

LADWP

5. LADWP requested that the design for the Second Interim Remedy should have extraction wells in both the shallow and deep zone to prevent further migration of contaminants toward LADWP production wells. The vertical migration of contaminants from shallow to deeper aquifer zones is apparent at monitoring well NH-CO3, and in the recently installed (by Honeywell) additional "Remedial Investigation" (RI) monitoring wells. Also, the EPA annual basinwide plume maps for the deep zone clearly shows contaminants over a wide area that includes LADWP production wells. Most LADWP production wells extract groundwater from the deep zone, which

contains elevated levels of contaminants. In addition, the large fluctuations in the water table, especially declines, make it impossible to maintain contaminant capture from the shallow zone only. For all of these reasons, extraction from both the shallow and deep zones should be implemented in the Second Interim Remedy.

AMEC response: As discussed during the December 12, 2011 Stakeholder meeting, the need to hydraulically capture COC mass within or below the B-Zone (i.e., the deep zone) must be based on depth-discrete groundwater quality data and aquifer hydraulic properties. If additional data support our conceptual model (namely, that most COC mass remains in the shallower A-Zone), then the remedial design should proceed with the objective of preventing that mass from further downward migration. As such, the Second Interim Remedy must account for pumping interference between municipal production wells and NHOU extraction wells operation within and below the A-Zone (where NHOU capture is anticipated to occur). Extracting groundwater from the B-Zone should only proceed where COC concentrations are sufficiently elevated to warrant hydraulic capture; otherwise, downward vertical gradients will be increased and COC mass in the A-Zone will be induced to migrate farther downward.

AMEC recognizes that LADWP production wells are located within the areas of elevated COC concentrations and that many of these production wells produce (or produced) water that does not comply with CDPH requirements. We also acknowledge that results from packer tests performed by LADWP demonstrated that preventing groundwater from entering through perforation zones in the A-Zone significantly lowered COC concentrations to 1/50th of concentrations when pumping from the A-Zone was allowed (i.e., no packers). These test results are consistent with depth-discrete analytical data at RI wells recently installed by Honeywell. The appropriate and optimal depths to extend NHOU extraction wells cannot be determined until additional depth-discrete data have been collected, as is recommended in the final Data Gap Analysis report, to verify our conceptual site model.

6. LADWP would like implementation of the Second Interim Remedy to be performed in parallel with the additional investigation for the Second Interim Remedy. Design and implementation of the Second Interim Remedy should occur as soon as possible without any delay to contain the high concentrations of contaminants and prevent their further migration to LADWP wells. We need to keep in mind this is not a final remedy. Any further investigation to improve the performance of the Second Interim Remedy can be done simultaneously.

AMEC response: See our response to general comments #1 and #2. The revised project schedule includes (Attachment A) parallel tracks to expedite closure of critical data gaps and to proceed with the remedial design such that RAOs and CDPH 97-005 requirements can be met, as stipulated in the AOC.

Development of a Groundwater Management Plan between the LADWP and EPA remains a critical element of the Second Interim Remedy to ensure that future pumping at nearby municipal well fields will be acceptable to the ULARA Watermaster and will not interfere with or adversely affect the implementation, integrity, or protectiveness of the Second Interim Remedy.

7. LADWP's goal is to serve the water that is treated by the Second Interim Remedy. The design for the Second Interim Remedy should ensure that the treated groundwater complies with the California Department of Public Health (CDPH) regulations for both the regulated and unregulated constituents.

AMEC response: Comment acknowledged. Groundwater treatment criteria are included, directly and by reference, in the Second Interim Remedy AOC.

ULARA Watermaster

8. The ULARA Watermaster wants to reiterate the general comments made at the recent "all hands" meeting. Specifically, the cleanup and remediation of the groundwater contamination described in the AMEC Draft report must be performed expeditiously. Many purveyor wells and various aquifers have been adversely impacted; numerous purveyor wells are not able to be actively pumped and the well owners must substitute their pumping rights by purchasing costly imported water for use in their respective service areas.

AMEC response: Comment acknowledged. Our revised project schedule (Attachment A) incorporates acquisition of field data to fill critical data gaps and recommendations have been revised to expedite delivery of the Preliminary Design Report (see our response to general comments #1 and #2).

9. Whereas some additional subsurface exploration, additional E-log correlation and additional down-well testing for groundwater sampling may be needed, it is vital that efficient and effective groundwater remediation be performed to remove the contaminant mass and to contain the continued downgradient flow.

AMEC response: Comment acknowledged. Critical data gaps must be filled to ensure that the remedial design is able to achieve Second Interim Remedy RAOs and comply with CDPH 97-005 requirements. We intend to design an NHOU remedy that can efficiently and effectively remove and inhibit further migration of COC mass.

10. Water wells in some of the local active wellfields are old and were constructed by the archaic cable tool drilling method. Hence, these wells have no sanitary seals, the perforations tend to start at relatively shallow depths, and there are no geologic logs or electric logs (E-logs) for these wells.

AMEC response: Comment acknowledged. We will continue to collaborate with the ULARA Watermaster to further refine our NHOU and SFB conceptual site model. See also our response to general comment #13.

11. Numerous water wells in the wellfields have long and continuous perforated intervals and when the well is pumped the discharge rate and water quality represents the wellblend or inflow from all perforated zones. At least some recovery/extraction wells have a long and continuous section of perforations, coupled with the fact that most contamination occurs in the shallower portions of the saturated zones, means that the "efficiency" of contaminant mass removal is likely low.

AMEC response: Comment acknowledged. New NHOU extraction wells will target COC mass within the A-Zone (and in the B-Zone, if necessary) such that the Second Interim Remedy achieves and maintains a high mass removal efficiency.

12. Unfortunately, there is a paucity of spinner log surveys (dynamic flow tests) to help define the percentage of groundwater inflow from the different perforated intervals in each well; there is also a lack of depth-discrete groundwater sampling under pumping conditions in the wells. These 2 types of tests would help define the relative inflow rates and groundwater quality entering each zone of perforations under pumping conditions. There is also a paucity or absence of static spinner surveys in the water wells and in monitoring wells with more than one screened section. Hence, it is not known, under non-pumping conditions, whether groundwater moves upward or downward inside most/all of these well casings. It is expected that there could be a downward flow in some/many of these wells and monitoring wells under non-pumping conditions.

AMEC response: Comment acknowledged. We anticipate that vertical flow measurements from inactive LADWP production wells will be used to evaluate our stated concerns regarding passive vertical conduits present throughout the elevated COC concentration areas in the NHOU. The first of the proposed tasks is included in the Phase 1 Pre-Design Investigation; the remaining tasks are scheduled to occur thereafter.

13. Some water wells are inactive, or even abandoned (capped), but not thoroughly and properly destroyed. Each such inactive and/or abandoned, non-pumping well is essentially a vertical conduit for groundwater flow (e.g., see NH-9).

AMEC response: Comment acknowledged. See our response to the previous general comment. Inactive production wells acting as vertical conduits should be properly destroyed or fitted with packers by LADWP to prevent further COC migration into deeper aquifers and contributions to groundwater quality impacts at active production wells.

MAJOR COMMENTS

CH2M HILL and EPA

1. Page xiv: "The revised CSM suggests several AOC scope items may need to be revised." – please clarify this statement: which items? How revised? Based on what reasoning?

AMEC response: Each AOC scope item is discussed with respect to critical data gaps in Section 5.3 of the draft Data Gap Analysis. Implementing recommendations included in Section 6 are intended to generate data to close critical data gaps and propose revisions to the AOC scope items that will be included in a findings report following completion of the proposed Pre-Design Investigation. The text has been revised to include a reference to Section 5.

2. Page 3-20, Section 3.2.5, first (partial) paragraph at top of page: We agree that the correction factor applied to vertical data for well measuring point elevations is appropriate (to correct for changes in the vertical datum) to estimate comparable approximate water levels. However, resurveying wells that have not been surveyed in

10 or more years would provide the added benefit of accounting for land subsidence (common in basins with thick alluvial fill) or other changes in wellhead elevation.

AMEC response: The application of a correction factor to convert water level data to a common datum assumes that there has been no significant change in the absolute elevation of a well reference point. As stated in the Data Gap Analysis, the datum correction applied for contouring purposed in the Data Gap Analysis in no way resolves additional elevation correction(s) that can only be addressed by surveying these and other wells with respect to the NAVD88 datum. Once the newer datum standard (NAVD88) is applied, the layer contact elevations in the groundwater model must also be adjusted in addition to modifications to the model to incorporate the A- and B-Zone interpretations. The model must be based on consistent groundwater elevations and geologic contact elevations.

3. Page 3-21, 3.2.6.3: The characterization of the facilities in the MWH report as "known" sources is a bit misleading. EPA has not approved this report and has not endorsed those findings. Honeywell and MWH report that the facilities are known to have releases, but this does not necessarily translate into a "known" source of contamination to the NHOU. Please clarify this in the text.

AMEC response: The MWH Report (April 7, 2010) describes facilities that have "known releases of the COCs to soil and/or groundwater, and facilities with the potential to have released COCs based on the type, timeframe, and duration of operations, and information on waste generation and handling practices." This same statement was included in the final version of that report (September 29, 2011), which was reviewed and commented on by the EPA. Whether or not releases at these source areas have contributed to groundwater contamination in the NHOU is the crux of data gap #4 (page 5-14, draft Data Gap Analysis). Additional depth-discrete analytical and hydraulic parameter data are needed to assess the capture of COC mass that may originate from suspected sources in the NHOU (that have not yet been investigated) and to meet RAOs and comply with CDPH 97-005 requirements.

4. Page 4-4, Section 4.1.3, first full paragraph: Important conjecture is provided in this paragraph regarding how geologically and geophysically distinct and extensive the AA and BB groups are within the basin-fill deposits of the San Fernando Basin (SFB). It would be helpful if more data were provided in the analysis to support the concept that these units are hydraulically distinct from each other, and their extents shown on a map.

AMEC response: Existing geologic and geophysical data presented in the DGA clearly distinguish the A-Zone from the B-Zone (see Section 4.1, draft Data Gap Analysis) and are used to define each unit on geologic cross-sections illustrated on Figures 4-2(a-f). Recommendations to collect depth-discrete groundwater samples from existing wells (Section 6, draft Data Gap Analysis) and to perform zone-specific aquifer tests are intended to clarify the hydraulic distinction (including groundwater quality) between the A-Zone and B-Zone and to close data gap #1 (page 5-14, draft Data Gap Analysis).

5. Page 4-8, Section 4.4.1, first (partial) paragraph: The last sentence in this paragraph seems to imply that FFS-proposed deepening of some of the existing NHOU extraction wells is in response to forecasted decreases in groundwater levels

associated with the "maximum pumping scenario" assumed by LADWP. However, the primary reason that some of the NHOU extraction wells were assumed in the FFS to require deepening was that they commonly were incapable of producing groundwater at design rates, due to actual (not forecast) groundwater level declines. Furthermore, it should be noted that under the forecasted maximum pumping scenario in the FFS, highly contaminated groundwater underlying the former Bendix facility is projected to flow toward the southernmost Rinaldi-Toluca production wells. This is the primary reason for assuming three new extraction wells would be required between the former Bendix facility and the Rinaldi-Toluca well field in the FFS and ROD.

AMEC response: As stated in our response to general comment #2, installing additional remedial groundwater extraction wells without first establishing how the SFB would be pumped by the LADWP could severely compromise the Second Interim Remedy. The Groundwater Management Plan remains a critical component of the Second Interim Remedy to ensure that, in this case, LADWP pumping does not interfere with or adversely affect the implementation, integrity, or protectiveness of the Remedial Action. To our knowledge, the ULARA Watermaster has not indicated whether the "maximum pumping scenario" that was assumed in the FFS would be acceptable or consistent with the Stipulated Agreement signed by the Cities of Los Angeles, Burbank, and Glendale.

Under the proposed worst-case (dry conditions) future use scenario (which was the basis for recommendations for extraction well modification/replacement), model simulations suggest that the water table will drop significantly, including to below the screen intervals of several of the existing NHE wells. Hence, if this were to occur, the need for deepening of these wells would have been apparent.

Note that current groundwater elevations are similar to those observed when the existing NHOU extraction wells were designed; their inability to establish designed flow rates suggests that a factor other than groundwater level declines must be accounted for. Such factors may include lower hydraulic conductivity values, well screen corrosion or scaling, or improper well construction. New recommendations in Section 6.1.3 of the final Data Gap Analysis have been included to better assess poor extraction well performance and to design appropriate replacement and/or additional wells to meet Second Interim Remedy RAOs. The proposed piezometer couplets described therein are consistent with our discussions at a meeting on December 12, 2011 with the EPA and Stakeholders.

The FFS groundwater model did not use currently available well packages (such as FWL4 or FWL5) that account for well efficiency. It was also calibrated, in part, to groundwater elevations observed at monitoring wells with reference points surveyed to multiple elevation datums that differ by up to 3 feet. Recommendations in the final Data Gap Analysis are intended to resolve both issues by performing aquifer tests at NHE wells and correcting survey elevation issues at monitoring wells throughout the NHOU study area. The groundwater model will be revised based, in part, on findings from these actions and will be presented in the Pre-Design Groundwater Modeling Memorandum to identify necessary modifications to the NHOU extraction well field to achieve Second Interim Remedy RAOs.

This comment is specifically addressed by modifying the sentence in question to reflect that potential dewatering provided a partial rationale for deepening existing extraction wells and installing additional extraction wells.

6. Page 4-13, Section 4.5.1.1, first bullet: Please refer to a figure or report that supports the statement that "elevated concentrations beneath the former Bendix facility appear to be captured by NHOU extraction wells NHE-2 (primarily) and NHE-3…" Currently, this statement appears to be unsubstantiated. And what is meant by the last sentence in this bullet point, "Wells within this area are consistent with those associated with the presumed NHE-2 capture area?"

AMEC response: Groundwater elevation data indicate that flow beneath the former Bendix facility is toward both NHE-2 and NHE-3. Capture of groundwater from beneath the former Bendix facility is illustrated on Figure 4-11 of the FFS (CH2M Hill, 2009), which depicts forward particle pathlines under simulated current pumping conditions. However, we agree that insufficient empirical data exist to verify the size and shape of the capture zones associated with these wells. As such, recommendations in the final Data Gap Analysis now include the installation of piezometer couplets adjacent to several NHOU extraction wells (see Sections 6.1.2c and 6.1.3a) and aquifer testing at the same extraction wells. This approach is consistent with our discussion on December 12, 2011 with the EPA and Stakeholders and is intended to expedite closure of critical data gaps and to proceed with the remedial design.

The last sentence in this bullet has been deleted.

7. Page 4-13, Section 4.5.1.1, third bullet: What is the basis of the statement "Elevated concentrations at NHE-4 and NH-C10-280 appear discontinuous from higher concentrations closer to the former Bendix facility?" Is there a figure or report that can be referenced to support this claim?

AMEC response: As contoured on Figure 4-7a, lower TCE concentrations separate these wells from higher concentrations beneath the former Bendix facility. This is particularly true of the 100 μg/L TCE concentration observed at NH-C10-280. Based on FFS modeling results (see Figure 4-11 therein), these wells are expected to be hydraulically isolated from the former Bendix facility due to upgradient capture by NHE-2 and NHE-3. Additional depth-discrete sampling recommended in the draft Data Gap Analysis (Section 6.1.1) is intended to be used to further delineate COC distribution and consider other potential sources in this area.

8. Page 4-14, Section 4.5.1.1, first paragraph: It is unclear where or why data are insufficient to delineate the 50 μg/L contour boundary northwest of Target Area 3. Perhaps this area could be illustrated on a map. Why are no wells proposed in this area to sufficiently delineate this contour?

AMEC response: The closest well upgradient to LC1-CW06 is approximately 2,000 feet to the northwest. The disparity in TCE concentrations (3.7 μg/L at NH-C24-305 versus 1,240 μg/L at LC1-CW06) represents a significant data gap. Depth-discrete groundwater samples are proposed to be collected from NH-C24-305 to further evaluate the vertical distribution of COC mass northwest of Target Area 3.

Monitoring wells proposed in the draft Data Gap Analysis (location E) were intended to further delineate the westward extent of Target Area 3. Recommendations in the final Data Gap Analysis have been revised to consider the need for additional information, potentially including a monitoring well at or near location E, following completion of the Phase 1 Pre-Design Investigation. This and potentially other wells may be installed, or additional groundwater samples collected from existing wells, as part of the Phase 2 Pre-Design Investigation if it was determined that additional data were needed to achieve Second Interim Remedy RAOs. A piezometer couplet is currently recommended to be installed adjacent to NHE-7 (among others) to estimate the radius of influence of this well (and possibly that of NHE-8) and to assess the need to improve hydraulic capture of Target Area 3.

9. Page 4-17, Section 4.5.2, third full paragraph: The ROD requirement for installing up to three new extraction wells northwest of the current NHOU extraction well field is to prevent the Rinaldi-Toluca wells from withdrawing highly contaminated groundwater from under the former Bendix facility, in the event that the forecasted maximum pumping scenario would occur as assumed by LADWP. Current conditions, which are the focus of this paragraph, have little bearing on the potential transport of contaminants from the former Bendix facility to the Rinaldi-Toluca well field under the assumed maximum pumping scenario.

AMEC response: This paragraph was not intended to indicate that the proposed three new extraction wells would not lessen the potential for migration of contaminated groundwater from beneath former Bendix to the more southerly Rinaldi-Toluca wells. Rather, it recognizes that potential sources exist up-gradient and cross-gradient of the Rinaldi-Toluca well field that, regardless of what might be present at the former Bendix site, could further degrade water quality at the Rinaldi-Toluca wells upon their resumed operation. As stated in our response to general comment #2, the Groundwater Management Plan was intended to establish an important institutional control that would prevent municipal pumping from interfering with or adversely affecting the implementation, integrity, or protectiveness of the Second Interim Remedy. The potential need for additional extraction wells will be assessed as part of the Pre-Design Groundwater Modeling Memorandum.

10. Page 4-22, Section 4.5.4, first (partial) paragraph at top of page: We agree with the statement in this paragraph that “additional capture does appear to be needed (both deeper and over a larger area than is apparently capable by the existing NHOU extraction well field), but specifically within the A-Zone,” assuming that AMEC’s conjecture regarding hydrogeologic distinction of their newly proposed A- and B-Zones can be supported by data.

AMEC response: Comment acknowledged.

11. Page 4-31, section 4.7.3.2, last bullet: This bullet does not specify a specific data gap, nor a reason why the statements made in this bullet point are critical for RD. In addition, what are the “many other known and suspected source areas” for hexavalent chromium (in addition to the former Bendix facility)? What is the relative importance of the known hexavalent chromium concentrations at and migrating off-site from the former Bendix facility, compared to concentrations elsewhere in the NHOU, for remedial design? Based on the maps presented in the Draft Data Gap

Analysis, the majority of the dissolved hexavalent chromium in the NHOU appears to emanate from the former Bendix facility.

AMEC response: This bullet acknowledges ongoing chromium source investigations and investigations not yet started; insufficient information regarding the potential contribution from several facilities in this area represents a data gap. We are aware of the EPA's revised list of potential source properties (as of March 6, 2012), several of which could be chrome sources (see Table 3-8). Contribution from one or more facilities is indicated by the presence of hexavalent chromium at wells NH-C18 and NH-C21, which are cross-gradient to the former Bendix facility and are located opposite the NHOU extraction well field. Several potential sources are described in Section 3.2.6. Not accounting for possible contributions from these sources or for the apparently deeper COC distribution (as indicated by depth-discrete analytical data from NH-C18 and NH-C21) could lead to under-designing the Second Interim Remedy and an inability to meet RAOs.

12. Page 4-32, Section 4.7.3.4: The characterization of the 45 "known" sources identified by USEPA and PRPs is misleading. EPA has only identified 10 known sources to date. Please clarify this.

AMEC response: As presented by EPA at a PRP meeting on March 8, 2012, EPA has identified 10 known source properties and 23 potential source properties. These properties are summarized on Table 3-8 and illustrated on Figure 3-8 in the Final Data Gap Analysis report and the report text has been revised accordingly. Potential source properties include those where the EPA has reason to suspect that one or more sources at each location/property may have led to contamination. However, insufficient information exists to determine whether the facility(s) has significantly contributed to soil and/or groundwater contamination. Given the location of these potential source properties (see Figure 3-8), and the lack of remediation action at each, potential contamination emanating from one or more location presents additional risk to designing the Second Interim Remedy to meet RAOs and comply with CDPH 97-005 requirements.

13. Page 4-32, Section 4.7.3.4, last paragraph: The last sentence of this paragraph states that "The new NHOU treatment system will not achieve RAOs if the lateral and vertical extent of COCs is not delineated first." Please clarify which RAOs would not be met, or delete this sentence. It seems that most RAOs for this interim remedy would be met, even if the lower concentration margins of the plume were not completely and confidently delineated prior to RD. A greater concern is that further delay in improving the existing NHOU extraction and treatment system will allow migration of known areas of highly contaminated groundwater farther away from existing extraction wells, making future achievement of RAOs more difficult.

AMEC response: The ROD specifies in Section 2.8 (Remedial Action Objectives) (see page 2-19) that "The Second Interim Remedy for the NHOU is intended to achieve the following Remedial Action Objectives (RAOs)…", which are reproduced in Section 2.2 of the Data Gap Analysis. This language makes it clear that meeting only "most" of the Second Interim Remedy RAOs would be unacceptable.

In particular, preventing further degradation of water quality at the Rinaldi-Toluca and North Hollywood (west) production wells, as required by RAO #3, cannot be met without further delineating the COC mass that has already impacted these wells. As described in the Data Gap Analysis report, even if westward-induced migration of COCs beneath the former Bendix facility was prevented from impacting these well fields, it appears that contamination from other sources would continue to degrade groundwater quality. Consequently, the Second Interim Remedy will fail to meet RAOs unless the design captures all COC mass that could impact water quality at these production wells.

Regarding the comment that “further delay…will allow migration…farther away from existing extraction wells…”, note that AMEC is equally concerned that higher COC concentrations not yet delineated will continue to migrate (possibly unmonitored) and may further impact groundwater quality at LADWP production wells that are to be protected by the Second Interim Remedy, as specified in the AOC.

We note that this comment suggests that achieving Second Interim Remedy RAOs is intended for the Final Remedy (or subsequent interim remedy), rather than the Second Interim Remedy itself. This presents a quandary that the Respondents are not able to resolve without EPA clarifying its intended goals of the Second Interim Remedy. We suggest that the EPA and Respondents meet to develop a solution that is consistent with the clarified goals.

Note that the project schedule has been revised to proceed with Remedial Design components, including the Pre-Design Groundwater Modeling Memorandum, in parallel with Pre-Design Investigation actions to the extent possible. Findings from this investigation are intended to fill critical data gaps to meet RAOs and improve NHOU groundwater quality consistent with the Second Interim Remedy ROD. Implementing recommendations will apply lessons learned from the original treatment system design and are intended to mitigate performance issues observed since NHOU operations began in 1989.

14. Page 4-33, Section 4.7.4, third paragraph on page: This paragraph states that “Because COC mass resides within the A-Zone, however, deepening extraction well screens such that they capture groundwater from in the B-Zone would induce deeper COC mass migration where groundwater quality is generally high.” Based on the updated conceptual site model presented earlier in the Draft Data Gap Analysis, it appears reasonable to extract groundwater only from the A-Zone, assuming an updated groundwater flow model is developed and predictive model runs conducted that support such a change from the ROD and FFS. As noted in the paragraph, additional extraction wells may be necessary to achieve the same degree of capture as modeled in the FFS.

AMEC response: Comment acknowledged. Note that recommendations are intended to generate empirical data upon which the Second Interim Design will be based, in addition to, enhanced modeling results (rather than solely upon modeling results). The potential need for additional extraction wells will be evaluated in the Pre-Design Groundwater Modeling Memorandum.

15. Page 5-2, Section 5.2.2, bullet point at bottom of page: We agree that additional investigation in the area south and southwest from the former Bendix facility, near

wells NH-C18, NH-C19, and NH-C21 is important. Figures in the Draft Data Gaps Analysis and in Honeywell's quarterly monitoring reports for the former Bendix facility suggest that the chromium and TCE plumes migrating offsite from the former Bendix facility may extend to, and perhaps southwest from, monitoring wells NH-C18 and NH-C21. Currently, the southern and southwestern extents of these plumes are poorly delineated. These wells were recommended in the FFS to improve delineation of the plume extents southwest of the former Bendix facility and the NHOU extraction wells, with the caveat that additional investigation may be necessary if COC concentrations were elevated (which they are). However, groundwater flow modeling for the FFS indicated that contaminated groundwater in this area would be captured under the preferred alternative for the Second Interim Remedy. Therefore, it does not appear that delaying remedial design until further plume delineation is completed would help to meet the RAOs for the Second Interim Remedy. We recommend that complete delineation of the VOC, chromium, and 1,4-dioxane plumes extending from the former Bendix facility be conducted in parallel with remedial design; if necessary, the extraction network can be expanded or modified at a later date to ensure capture and treatment of contaminated groundwater in the area of monitoring wells NH-C18 and NH-C21. We also agree that additional investigation of VOC plume depths and extents in the area south and southeast (downgradient) from the Lockheed facility, in the area of wells NHE-7 and NHE-8, is important, although again should not be considered so critical as to be the cause of a significant delay in implementation of increased NHOU extraction pumping. As noted in the FFS, failure to capture some of the VOCs in this area was expected and is considered a tolerable limitation of the Second Interim Remedy.

AMEC response: As correctly noted in minor comment #12, concentration contours generated by the ordinary kriging algorithm do not account for groundwater flow directions or pumping patterns. Thus, figures in the Data Gap Analysis do not suggest that chromium and TCE plumes have migrated southwest from the former Bendix facility to NH-C18, NH-C19, and NH-C21. As stated in Sections 4.5.1.1 and 4.5.1.4, these wells are cross-gradient from the former Bendix facility and opposite the NHOU extraction well field but are downgradient from several known or suspected potential source areas to the northwest. Hydraulic capture of groundwater in this area will be further evaluated as part of the Pre-Design Groundwater Modeling Memorandum.

Regarding groundwater flow directions indicated in quarterly groundwater reports for the former Bendix facility, groundwater flow direction rose diagrams prepared and evaluated by MWH (see MWH memo in Attachment B) illustrate that groundwater most often flows toward the south or southeast. Flow towards to the southwest has only infrequently been observed and likely does not result in significant and/or consistent COC mass migration in that direction. AMEC agrees with the assessment included in Attachment B.

Regarding the EPA's anticipated effectiveness of their proposed NEW-1, -2, and -3 extraction wells with respect to wells NH-C18, NH-C19, and NH-C21, simulation results illustrated in the FFS indicate that capture of groundwater in this area would only occur under the "maximum pumping scenario". Even then, only groundwater near NH-C19 clearly lies within the simulated NEW-1 capture area (see FFS Figure 4-17). Under forecast average pumping conditions, capture by the NEW extraction wells would not include groundwater at NH-C18, NH-C19, or NH-C21 (see FFS Figure 4-15).

The FFS also concludes that, under forecast average conditions, *"The only portion of [the 50 µg/L VOC] target volume that escapes capture by the extraction wells is within the isolated 50 µg/L contour located adjacent to the Rinaldi-Toluca Well Field, at the Hewitt Landfill. This target volume is poorly delineated at present and will require further investigation prior to development of a containment or remediation strategy."* Elevated concentrations of TCE and 1,4-dioxane in groundwater samples collected from NH-C09 (subsequent to the FFS) support the need for further investigating the area upgradient of NH-C19 prior to developing the Second Interim Remedy.

In the interest of expediting the remedial design, the need for additional data (potentially including monitoring wells at locations C and D) will be assessed following completion of the Phase 1 Pre-Design Investigation. Note that expansion of the extraction well network to include the areas necessary to meet the RAOs later during this Remedial Design process may not be possible (e.g., if the additional capture requires a flow rate that exceeds the Second Interim Remedy treatment system capacity). As indicated in our response to major comment #13, we suggest meeting with the EPA to discuss how to comply with RAOs and to clarify the EPA's intended objectives for the Second Interim Remedy.

We disagree with the statement that failure to capture some of the VOC plume near NHE-7 and NHE-8 is a tolerable limitation of the Second Interim Remedy. Regardless of what is stated in the FFS, design of the Second Interim Remedy is intended to meet RAOs specified in the AOC (see response to major comment #13), of which, one is to *"Achieve improved hydraulic containment to inhibit horizontal and vertical contaminant migration in groundwater from the more highly contaminated areas and depths of the aquifer to the less contaminated areas and depths of the aquifer, <u>including the southeast portion of the NHOU</u> in the vicinity of the Erwin and Whitnall production well fields"* (emphasis added). Not improving hydraulic capture near NHE-7 and NHE-8 would directly violate this Second Interim Remedy RAO unless clarification is provided by EPA.

As noted in other responses, the final Data Gap Analysis recommendations have been revised to include the installation of a piezometer couplet adjacent to NHE-7 to further delineate the vertical extent of COCs in this area and to support an aquifer test to estimate the NHE-7 capture area (and perhaps that of NHE-8 as well).

16. Page 5-3, Section 5.2.3, second paragraph: To clarify, wells NHE-1 and the proposed three new extraction wells in the FFS are intended to intercept highly contaminated groundwater forecasted to be drawn from the former Bendix facility toward the southern Rinaldi-Toluca wells assuming LADWP implementation of the maximum pumping scenario. These wells were not "intended to compete with much larger-capacity production wells" as described in the Draft Data Gap Analysis. Regarding the statement that "little data exist to calibrate this (SFBFS) model at a site-specific scale appropriate to the NHOU area, particularly concerning vertical discretization," we recommend development of a site-specific model that incorporates the key features of the updated conceptual site model, calibrating it to the extent possible with available data, and evaluating where additional data are needed at that point. A significant quantity of data from numerous monitoring wells are available now in the NHOU area—it is difficult to judge whether these data are insufficient for model calibration without knowing the details of the new site-specific model.

AMEC response: Our use of the word “compete” is semantic; according to FFS simulations, groundwater not captured by these three extraction wells might otherwise be drawn back to the Rinaldi-Toluca wells. As discussed in our response to general comment #2, the Rinaldi-Toluca well field should not be operated such that it could interfere with or adversely affect the implementation, integrity, or protectiveness of the Second Interim Remedy. The Groundwater Management Plan is intended to provide a critical institutional control to protect the effectiveness and integrity of the NHOU remedy while being consistent with LADWP’s drinking water production requirements.

As discussed in other responses to comments, and in agreement with the recommendation, a revised groundwater model will be used to aid in the determination of the location and pumping rates of extraction wells that may be needed to protect the Rinaldi-Toluca well field. However, note that our conclusion regarding the limited existing data available to calibrate the SFBFS model would also apply to a site-specific model. Empirical data collected as part of the Pre-Design Investigation, including new depth-discrete groundwater quality data, will form the primary basis to revise the conceptual site model and the numerical flow model. The revised numerical model will then be primarily used to evaluate various pumping scenarios and to perform capture analyses.

Data gaps identified in the draft Data Gap Analysis took into account the data available from existing monitoring wells and concluded that these data are insufficient for model calibration. Recommendations provided therein are intended to close these data gaps and proceed with the remedial design.

17. Page 5-3, Section 5.2.3, bottom (partial) paragraph: Again, it should be noted that the new extraction wells in the FFS were proposed to intercept potential migration of highly contaminated groundwater from the former Bendix facility to the southern Rinaldi-Toluca wells under LADWP’s maximum pumping scenario. If new modeling indicates that such future migration is unlikely to impact the Rinaldi-Toluca wells, then that evaluation should be discussed in the Pre-Design Groundwater Modeling Memorandum.

AMEC response: Results of our revised model will be discussed in the Pre-Design Groundwater Modeling Memorandum. Regarding the FFS conclusion that additional extraction wells are needed to protect the Rinaldi-Toluca well field, please refer to our response to general comment #2.

18. Page 5-4, Section 5.2.4, second paragraph: As noted in the FFS, the Second Interim Remedy is acknowledged to incompletely capture contaminated groundwater in the area downgradient from wells NHE-7 and NHE-8. Our recommendation is to proceed with the RD effort consistent with the goals of the FFS, Proposed Plan, and ROD, which focus on improving hydraulic containment in the western part of the NHOU extraction well network (wells NHE-1 through NHE-6). Complete delineation of the VOC plume south and east of wells NHE-7 and NHE-8 should not be considered a critical data gap for RD of the Second Interim Remedy; however, further investigation in this area is important, and should continue in parallel with RD and remedy implementation.

AMEC response: As indicated in our response to major comment #15, we strongly disagree with this comment. The AOC specifies that the Second Interim Remedy shall, in part, “achieve improved hydraulic containment to inhibit horizontal and vertical contamination…including the southeast portion of the NHOU…”.

We also disagree with the statement that the ROD focuses on the western port of the NHOU extraction well network. As stated in the ROD, Appendix A (page A-4):

> **Technical Comment #15:** FFS alternative 4 does not address other well fields besides Rinaldi-Toluca.
>
> **EPA Response:** Alternative 4a (the preferred alternative in the FFS and Proposed Plan) addresses contamination currently impacting, or expected to impact, the North Hollywood (East and West branches), Whitnall, and Erwin well fields, in the same manner as the Rinaldi-Toluca well field. The improved containment of highly contaminated groundwater in the vicinity of the existing NHOU extraction and treatment system, as well as the additional groundwater investigation planned in the NHOU, are expected to reduce impacts to these [i.e., Erwin and Whitnall] well fields or provide sufficient data to plan future remedial measures, if necessary, to protect these well fields.

Our recommendation in the final Data Gap Analysis to install a piezometer couplet adjacent to NHE-7 is not intended to completely delineate the VOC plume south of this area. Rather, analytical and hydraulic data from these piezometers are intended to further delineate the vertical extent of COC mass and to verify the need for additional hydraulic capture in this area to comply with the AOC.

19. Page 5-5, Section 5.2.5, second paragraph: A revised site-specific groundwater flow model based on the new conceptual site model (described in the Draft Data Gap Analysis) should be used to adjust planned depths of new and existing extraction wells, as part of the RD process. The FFS and ROD allow for modification of depths, locations, and numbers of extraction wells, based on data collected during the RD, to more efficiently and effectively achieve the RAOs of the Second Interim Remedy. It should be noted that past and future changes in groundwater levels in the basin (greater than 100 feet in the NHOU area) resulting from regional groundwater recharge and discharge from the basin, are likely to be significant factors in vertical spread of contamination in the eastern SFV, perhaps more than screen depths of the NHOU extraction wells.

AMEC response: The revised groundwater model presented in the Pre-Design Groundwater Modeling Memorandum is anticipated to benefit significantly from the additional empirical data to be collected as part of the Pre-Design Investigation. Predictive simulations will account for historical groundwater elevation fluctuations between 460 and 520 feet MSL (see Data Gap Analysis Figure 4-5) and possible municipal pumping scenarios to the extent that such scenarios can be anticipated. Note that data gap #5 is expected to be resolved, in part, by information anticipated to comprise the Groundwater Management Plan.

20. Page 5-7, Section 5.3.2, first full paragraph: Please provide a reference or figure that explains the basis for the statement *"Deepening NHE-1…could induce COC mass to migrate upgradient from the former Bendix facility."*

AMEC response: Available groundwater elevation data suggest that NHE-1 is located cross-gradient and upgradient from the former Bendix facility (see Figures 3-7a and 3-7b). Pumping from wells at or near the NHE-1 location would lower groundwater elevations upgradient from NHE-2 and would induce flow to the west/northwest (i.e., upgradient). Expanding the NHOU capture to this area must be based on empirical data that is not yet available, which is the basis of our recommendations. Possible extraction well configurations and capture scenarios will be included in the Pre-Design Groundwater Modeling Memorandum. As noted in our response to general comment #2, installing additional extraction wells in this area to prevent migration towards increased future pumping at the Rinaldi-Toluca well field is not consistent with the institutional controls stipulated in the AOC.

21. Page 5-8, 5.3.4: Although Honeywell has agreed in principle to design and implement the NHE-2 treatment system, the AOC is not yet finalized (although it may be by the time this Data Gap report is finalized). If the AOC is not finalized, the treatment of water extracted from NHE-2 shall be included as work under this RD AOC. Please clarify this in the text, if the AOC is not signed before the final is due.

AMEC response: The text has been revised to state that the Second Interim Remedy design will include flow and water quality from NHE-2 unless EPA approves the former Bendix facility AOC prior to our submittal of the Preliminary Design Report.

22. Page 5-8, Section 5.3.5, second paragraph: See our comments above regarding the new extraction wells.

AMEC response: See our responses to major comments #2, #16, and #17.

23. Page 5-14, Section 5.6, bullet list of critical data gaps:

    i. *Incomplete understanding of the hydraulic parameters specific to the A-Zone and B-Zone:* Hydraulic parameters of the A-Zone and B-Zone can be estimated during modeling associated with the RD effort. If specific aquifer-property data gaps arise during model development, then recommendations should be provided in the Pre-Design Groundwater Modeling Memorandum.

AMEC response: Comment acknowledged. The Pre-Design Groundwater Modeling Memorandum will account for additional hydraulic parameter data to be collected as part of the Pre-Design Investigation. Should development of the new model give rise to additional data gaps, additional recommendations will be included in the Pre-Design Groundwater Modeling Memorandum.

    ii. *Need projections of pumping and recharge volumes beyond year 2015*: A complete and accurate forecast of future pumping and recharge in the basin may never be available, simply because there are many unknowns regarding future water supply demands and availability. For RD of the Second Interim Remedy, we recommend that AMEC contact LADWP and the Watermaster to determine if their future projections are substantially different from what they provided for the

FFS. If so, we see no conceptual problem with updating the groundwater flow model with the new information and proceeding with RD. Review of historical water levels should provide an indication of what might be expected in the next 10 to 30 years. In addition, a comparison of past pumping projections versus the actual pumping conducted would be useful to indicate how reliable the pumping projections actually are as an indicator for future pumping.

AMEC response: Comment acknowledged. See our response to general comment #2 regarding the need for the ULARA Watermaster to determine the acceptability of pumping rates as they pertain to complying with the intended Groundwater Management Plan (institutional control) as stipulated by the AOC.

iii. *Performance monitoring wells needed to demonstrate size and shape of existing NHOU extraction well capture area, and evaluate well efficiency changes:* Performance monitoring wells should certainly be installed when the Second Interim Remedy is constructed. Different degrees of capture and extraction well configurations would be best analyzed using a model, and sensitivity analysis should be conducted to evaluate uncertainty of input parameters. Regarding the lack of drawdown measurements at each extraction well to evaluate efficiency declines and the need for rehabilitation, those data simply don't exist, as noted in the Draft Data Gap Analysis. So although this is a data gap, we don't see how it is relevant or actionable.

AMEC response: It is because performance monitoring wells and drawdown measurements do not exist to support accurate assessment of the current system performance that the recommendation was made to install the performance monitoring wells and implement drawdown monitoring. These wells will provide critical groundwater elevation data (groundwater elevations in active extraction wells are of little value for interpreting groundwater flow unless well efficiency values and past/recent pumping patterns are also known). Data from these wells will also be used to assess groundwater flow and quality conditions and the capture efficiency of extraction wells to verify assumptions comprising the current conceptual site model and numerical model.

Revised recommendations include installing piezometer couplets adjacent to select NHOU extraction wells and performing aquifer tests prior to completing the Pre-Design Groundwater Modeling Memorandum. Testing at these wells will provide empirical data that will support an improved numerical model and a remedial design that will more effectively and efficiently achieve Second Interim Remedy RAOs.

iv. *Existing numerical groundwater flow model is not sufficiently structured or discretized vertically for RD:* Agreed, the model should be updated, and a Predesign Groundwater Modeling Memorandum prepared. This was planned as part of the RD process.

AMEC response: Comment acknowledged.

v. *Vertical conduits have not been sufficiently evaluated to quantify the volume of groundwater and COC mass induced to depths below the A-Zone:* Please explain why this is critical to evaluate before designing the Second Interim Remedy. If increased pumping occurs in Depth Region 1 (or the A-Zone) under the Second Interim Remedy, downward hydraulic gradients between the A- and

B-Zones would be expected to decrease (or upward gradients increase) in the areas with the highest contaminant concentrations. Certainly the proposed additional pumping contemplated under the Second Interim Remedy, with some of the adjustments to screened intervals discussed in the Draft Data Gaps Analysis, would likely have a significant beneficial impact on this assumed problem.

AMEC response: The significant beneficial impact anticipated of the Second Interim Remedy design may be overwhelmed by future municipal pumping unless the potential changes in groundwater flow direction and COC mass migration patterns in response to vertical conduits at inactive production wells is better understood and quantified. Deep zone pressure changes induced by relatively distant production wells can be translated to the shallow zone via inactive production wells/conduits within the areas of elevated COC concentrations in the NHOU study area.

The recommended actions are to determine which wells, in areas of elevated concentration, may allow for significant vertical conduits and to quantify the magnitude of induced vertical groundwater and COC migration through these conduits. Once this information is available, an informed decision can be made to either packer off the well or, as the ULARA Watermaster has suggested, to properly abandon the well and permanently eliminate the pathway. As such, addressing vertical conduits throughout the NHOU area must be recognized as a critical element of the Second Interim Remedy remedial design and is intended to be accounted for with the revised groundwater model.

24. Page 5-15, Section 5.6, first paragraph: The first sentence states that “Not resolving each critical data gap before designing the Second Interim Remedy will cause a system failure with respect to achieving the RAOs.” As noted in several of our comments above, we disagree that filling all of the data gaps noted above is critical prior to remedial design. It is likely that as more data are collected, and this is true of any remediation system, adjustments and optimization will be necessary to ensure that RAOs are achieved to the extent practicable. In this case, where an improved interim remedy is proposed (as opposed to a final remedy for site cleanup), we believe that expedited action would have a net beneficial effect on hydraulic containment of contaminated groundwater, even if some data gaps must be filled during or after the remedial design process.

AMEC response: Data Gap Analysis recommendations are not intended to fill all data gaps; we fully recognize that uncertainty exists, and is to be considered in all remedial designs. Rather, our recommendations are intended to fill critical data gaps necessary to achieve Second Interim Remedy RAOs and to comply with CDPH 97-005 requirements.

25. Page 6-1, Section 6.1.1, Bullet 2 (Recommendation to collect depth discrete samples from NHE-1 and NH-10): Similar to the previous comment, the proposed sampling effort would be relatively easy and inexpensive (compared to construction of new monitoring wells). This effort could be conducted relatively quickly without delaying the RD.

AMEC response: Comment acknowledged.

26. Page 6-2, Section 6.1.1, Bullet 4 (Recommendation to obtain quarterly groundwater level measurements from monitoring wells): This effort would be very easy and inexpensive, but might require substantial time depending on how many quarters of data are perceived as being required. These data could be collected throughout the RD process.

AMEC response: Comment acknowledged. The revised project schedule illustrates that four quarterly events for at least one year will be integrated with anticipated field work and completion of remaining AOC scope items. Remedial design actions, including preparation of the Pre-Design Groundwater Modeling Memorandum, will proceed concurrently with several of these and other monitoring events.

27. Page 6-2, Section 6.1.1, Bullet 5 (Recommendation to collect groundwater samples and vertical flow logs from selected RI monitoring wells, to evaluate vertical flow): If most of additional remedial pumping under the Second Interim Remedy would occur in the A-Zone, then vertical gradients would decrease, rather than increase. We don't see how this is a critical data gap to resolve before RD, but agree it would be helpful to resolve during RD.

AMEC response: See our response to major comment 23(v).

28. Page 6-2, Section 6.1.1, Bullet 6 (Recommendation to review and adjust survey points for monitoring wells): This action would be helpful, inexpensive, and relatively easy to do. We don't see that it's a critical data gap to resolve before RD, but recommend proceeding concurrent with RD. As noted in previous comments, we recommend resurveying the wells that have not been surveyed in the past 10 years, also during RD.

AMEC response: Accurate groundwater elevations rely upon the assurance that all depth-to-water measurements are referenced to the same vertical survey datum and are critical to properly calculate groundwater flow directions and gradients. By extension, a common vertical survey datum is necessary to meaningfully calibrate groundwater flow models and to demonstrate hydraulic capture, particularly where gradients are very low.

29. Page 6-2, Section 6.1.2, Bullets 1 and 2 (Recommendation to perform slug tests at selected monitoring wells): We feel it would be more expedient and yield equal (or better) results than slug testing to analyze aquifer properties using an updated groundwater flow model or use deconvolution methods (which may require setting pressure transducers down these wells for a period of several months). This effort could be conducted during, rather than before, construction of the updated flow model, as part of the RD process.

AMEC response: Deconvolution methods fundamentally require either a known source(s) of groundwater elevation change (e.g., operations and discharge rates of active production wells throughout the NHOU study area) or that a probabilistic approach be used in lieu of this information. A major variable associated with this approach in the case of the San Fernando Valley is that zone-dependent (i.e., depth-discrete) discharge rates from the many municipal wells are not known and, in fact, are directly dependent upon the spatial distribution of hydraulic parameters that we are attempting to measure. Performing slug tests at various monitoring wells and aquifer tests at NHOU extraction wells is intended to provide empirical data that may validate assumptions regarding absolute aquifer hydraulic parameter and their spatial variation, specifically within the A-Zone.

30. Page 6-3, Section 6.1.4, Bullets 2 through 4 (Collaboration with LADWP to modify selected production wells): The points made in these bullets are good ideas, but we fail to see how they are critical prior to RD.

AMEC response: Current data are insufficient to accurately assess current system performance, including the potential impact of degraded extraction well efficiencies on groundwater capture. Successfully repurposing existing production wells as part of the remedy to capture elevated COC mass within the A-Zone could greatly expedite the NHOU Remedial Action and reduce associated capital cost. Even if modified production wells are not brought back into service, identifying and removing those that represent vertical conduits that significantly interfere with NHOU extraction will expedite achievement of the Second Interim Remedy RAOs. Note that bullet 1 is associated with the remedial design and, as such, will be completed as part of the Phase 1 Pre-Design Investigation.

<u>ULARA Watermaster</u>

31. In many of the wells, no well or pump rehabilitation has been undertaken for years; perforations are likely plugged to varying degrees. Thus, no one knows from what depth the groundwater is actually entering the well under pumping conditions. Recovery and extraction wells (and their pumps) should be subjected to regular periods of O&M.

AMEC response: Comment acknowledged. We are currently reviewing historical LADWP records and will incorporate our findings in the Building Conditions Assessment memorandum. Lessons learned, including those learned during the proposed NHOU extraction well aquifer tests, will be applied to the Preliminary Design Report. Note that the Phase 1 Pre-Design Investigation includes video inspection and, if deemed necessary, redevelopment of select NHOU extraction wells to evaluate, in part, whether well deterioration has contributed to performance below their designed specifications.

32. There is some discussion of replacing NH EX-1; however, it is reported by AMEC that no one seems to know why this well has low production and a low specific capacity, even though it is perforated in essentially the same zones as other NH EX wells, and it is not located too distant from these other wells. Watermaster review of available data reveals NH EX-1 was drilled using bentonite mud (direct rotary) methods. Furthermore, because it was drilled in the late-1980's, one needs to be aware that a mud dispersant commonly used at that time was sodium acid pyrophosphate (SAPP). A major drawback, and one that became known by the early-to mid-1990's, was that SAPP was a nutrient and caused a rapid and large scale buildup of bacterial slimes/growths (biofilm) in wells. Also, it is highly likely that remnant bentonite from drilling is still in the well and gravel pack. Before spending a lot of money to replace NH EX-1, consider conducting an initial video log, followed by wire brushing, and bailing sediment fill, and then conducting superchlorination and the use of Aquaclear PDF or a similar mud dispersant that is not a nutrient.

AMEC response: Comment acknowledged.

33. Different extraction/recovery and/or wellfield wells have different perforation intervals and these various perforation intervals are in separate aquifer zones. Fortunately, AMEC has provided its interpretation of their independent correlation of resistivity signatures on numerous available E-logs (see AMEC Cross Sections A-A' through F-F'); these correlations are considered to be more "accurate" and more objectively-based, relative to the interpretations of drillers' logs and/or limited geologic logs that were used by prior investigators (JMM and CH2MHILL) to provide their original definitions of model layers in the eastern portion of the San Fernando Valley. Prior to finalizing these newly-proposed AMEC model layers, the Watermaster recommends that AMEC meet to gain consensus of E-log correlations from well to well in the area (certain zones, like the "B" zone on the AMEC cross sections, are acceptably correlated but certain other zones, could be revised). This meeting should also include EPA representatives.

AMEC response: Comment acknowledged. We agree that further consensus on the conceptual model is needed and look forward to an opportunity to meet with key stakeholders, perhaps following completion of our recommended Pre-Design Investigation.

MINOR COMMENTS

CH2M HILL and EPA comments

1. Page x, Section ES.1, fourth paragraph: The first sentence of this paragraph includes the statement "…however, the extraction wells were prone to dewatering…" Not all of the extraction wells are prone to dewatering. It is recommended that this phrase be changed to "…however, some of the extraction wells commonly produce less than 300 gpm…"

AMEC response: The final Data Gap Analysis now states that "…some of the extraction wells have been unable to sustain their anticipated flow rate…"

2. Page xi, Section ES.2, second bullet in top half of page: The word "concentration" between "maximum" and "levels" should be changed to "contaminant."

AMEC response: Text has been revised accordingly.

3. Page xii, Section ES.3: Three out of five of the bullet points in this section describe data gaps, rather than the conceptual site model. It would be helpful if more of the conceptual site model were summarized in this section.

AMEC response: Text has been revised accordingly.

4. Page xii, Section ES.3, second and fifth bullets: These bullets do not describe the refined NHOU conceptual site model (the title of this section); rather, they describe data gaps and uncertainties. This section would flow more logically if the second and fifth bullets were separated from the other three (which do relate to the conceptual site model), and had a distinct introductory statement.

AMEC response: Text has been revised accordingly.

5. Page xii, Section ES.3, third bullet: This bullet should be modified to clarify that recent data indicate that groundwater flow is to southeast below the Hewitt Pit and former Bendix facility. At various times in the past, available data have indicated or suggested other directions of groundwater flow beneath these facilities, specifically to the northeast below Hewitt Pit, and to the southwest below the former Bendix facility.

AMEC response: Text has been modified to specify the December 2010 monitoring event upon which this statement is based. An additional statement now acknowledges historical groundwater flow patterns that are, albeit, based on fewer data than those collected in December 2010.

6. Page 3-7, Section 3.1.2.2, first paragraph: The third sentence states that "…releases from many facilities occurred throughout the eastern SFV," referring to industrial waste discharges in the 1940s and 1950s. Please provide a reference or data to support that statement.

AMEC response: A citation to the original Groundwater Management Plan (LADWP, 1983) is now included.

7. Page 3-22, 3.2.6.4, last paragraph, last sentence: Please add the word "potential" as follows: "Table 3-8 lists the potential source areas…"

AMEC response: Text has been modified accordingly.

8. Page 3-23, Section 3.2.7, third paragraph (below bullets): The first sentence of this paragraph states that "Wells with maximum TCE, 1,4-dioxane, and hexavalent chromium concentrations are hydraulically contained by former Bendix facility onsite extraction wells." Please provide a reference to a figure (perhaps in another report) that illustrates where the maximum TCE, 1,4-dioxane, and hexavalent chromium concentrations occur, and their relation to the onsite extraction wells. April 2011 data provided in Honeywell's Second Quarter 2011 monitoring report for the former Bendix facility indicates that the maximum TCE concentration was detected at well GW-19A, which appears to be outside the containment zone of onsite extraction wells.

AMEC response: This sentence has been modified to acknowledge additional hydraulic capture by NHE-2. Note that Attachment C (prepared by MWH as part of discussions with the Regional Water Quality Control Board on December 20, 2011) illustrates August 2011 analytical data that suggest the elevated TCE concentrations observed at GW-19A may originate from a source(s) north/northwest of the former Bendix facility. This illustration is consistent with AMEC findings discussed in the Data Gap Analysis.

9. Page 4-3, Section 4.1.3, fifth (partial) paragraph at bottom of page: The first sentence of this paragraph states that "Stratified groundwater quality is suggestive of multiple hydrostratigraphic units, however hydraulically similar they may be otherwise." It should be noted that depth-varying contaminant concentrations (stratified groundwater quality) could also result from vertical anisotropy within a single hydrostratigraphic unit, horizontal or upward hydraulic gradients, or changing

redox potential with increasing depth (affecting geochemical properties or biodegradation rates).

AMEC response: Depth-dependent groundwater quality can result from many possible conditions that may act independently of, or in concert with, one another. Few data exist to address this issue, which is the crux of our recommendation: to collect depth-discrete groundwater samples (i.e., A-Zone versus B-Zone) from existing monitoring wells, and to install piezometer couplets to obtain depth-discrete aquifer hydraulic data and geologic materials that may drive reduction/oxidation potentials.

10. Page 4-4, Section 4.2, third paragraph: The second sentence of this paragraph states that "This degree of modification suggests the model is insensitive to moderate variations in hydraulic conductivity" (increasing hydraulic conductivity by 50 percent). We would suggest first that a 50 percent change in hydraulic conductivity is minor, not moderate (hydraulic conductivity of alluvial deposits can vary by an order of magnitude or more as a result of a subtle change in grain size distribution). Secondly, the 50% change in model hydraulic conductivity resulted in notable improvement in calibration statistics, indicating the model is not "insensitive" to hydraulic conductivity.

AMEC response: AMEC performed a detailed sensitivity analysis on the FFS model. We found that varying the hydraulic conductivity in individual hydraulic conductivity zones had little or no significant effect on the residual statistics or the apparent groundwater flow directions in the model. However, changing all hydraulic conductivity zone values within a layer by the same factor did produce appreciable effects in the residual statistics. We were most concerned that, because the model did not appear to be sensitive to individual hydraulic conductivity zone values, individual values could significantly vary without negatively affecting the residual statistics of the model. Although the model residuals may be rather insensitive, the projected rates needed to establish a defined capture zone would be quite sensitive. Merely doubling the hydraulic conductivity throughout an extensive NHOU area may not measurably alter the model calibration, but would double the estimated pumping rate needed to maintain capture. From this standpoint, empirical data are essential to reasonably estimate NHOU area hydraulic conductivity values.

11. Page 4-5, Section 4.3.1, second paragraph: The second sentence of this paragraph states that "Groundwater beneath the northern landfills (including the Penrose, Strathern, Newberry and Tujunga Pit) flows to the southwest toward the southern portion of the Rinaldi-Toluca production well field." The hydraulic gradient shown on Figure 3-7b does not suggest a flow direction from these landfills toward the Rinaldi-Toluca well field. We suggest clarifying this statement appropriately.

AMEC response: Text has been modified to specify the associated December 2010 monitoring event (Figure 3-7a), and additional text acknowledge that a more southward flow direction was observed in April 2011 (Figure 3-7b), albeit based on fewer data points than the December 2010 event. Data from both events suggest that groundwater flow is toward the southeast downgradient of the former Bendix facility and former Lockheed Martin facilities.

12. Page 4-11, Section 4.5.1, fifth paragraph: The ordinary kriging method used for contouring the data in the Draft Data Gaps Analysis is suitable for the intended purpose, but does not account for the known effects of groundwater flow and transport on contaminant distribution. There is not a practical (cost effective and more accurate) alternative to using the ordinary kriging method. However, it should be recognized that this approach is purely statistical, rather than deterministic, and will tend to result in higher estimated concentrations up- and cross-gradient from sources than would be expected to actually occur.

AMEC response: As stated in the previous paragraph in Section 4.5.1, *"The resulting COC distribution maps thus do not represent "plume maps" because they are mathematical constructs meant to account for data values and locations rather than interpret COC patterns based on groundwater flow and source considerations. The method does not account for groundwater flow directions, pumping patterns, or uncharacterized known/suspected source areas."*

13. Page 4-26, Section 4.6.2, fourth full paragraph: The reason that mass removal at NHE-7 is greater than at NHE-2 may be due to the significantly larger volume of water extracted at NHE-7 over the years. This possibility should be explored and mentioned in this paragraph.

AMEC response: Comment acknowledged. Text has been added to account for the relationship between mass removal and sustained discharge rates at each well.

14. Page 4-27, Section 4.7.1, first paragraph: This paragraph notes that "Various subunits have been identified within the SFB based on geophysical signatures and lithology, but in general, many of the identified units are difficult to correlate across the SFB without use of down-hole geophysical data." Given the fact that the basin-fill consists of alluvial and fluvial deposits, influenced by significant tectonic activity and multiple sources of basin fill materials (four different mountain ranges immediately adjacent to the eastern SFV), it seems likely that many of the subunits would have limited extent. In other words, one might not expect many, or any, lithologic subunits to be capable of being correlated across the SFB.

AMEC response: Comment acknowledged. See our response to major comment #33.

15. Page 4-28, Section 4.7.1, second paragraph: This section notes that past low-flow sampling may only provide representative concentration data for the depth of the sample. However, MWH conducted low-flow sampling at various depths at select monitoring wells at the former Bendix facility approximately five years ago, to determine whether there was significant variability with depth. Those results should be reviewed and used to update this section, before stating that collection of additional depth-specific samples from within a single well screen interval would be a critical data gap.

AMEC response: Review of the multiple depth-discrete data from monitoring wells at the former Bendix facility indicates relatively homogenous groundwater quality conditions within the A-Zone where the majority of sampling was performed. Vertical groundwater quality and flow profiles to be collected from both shallow and deep screens at the NH-C19 and NH-C23 locations are intended to further evaluate conditions west of the former Bendix facility.

16. Page 5-3, Section 5.2.2, second bullet: Hexavalent chromium concentrations are shown on Figures 4-10a/b of the Draft Data Gap Analysis rather than Figures 4-9a/b, as indicated in the bullet. More importantly, there are some confusing statements in this comment that should be clarified. First, based on Figure 4-10a, the highest hexavalent chromium concentration in this area appears to occur at well NH-C18, not wells NH-C19 and NH-C21. Based on the plume delineations depicted on Figures 4-10a/b, as well as in Honeywell's monitoring quarterly monitoring reports for the former Bendix facility, the historically dominant direction of chromium plume migration has been south and southwest, toward wells NH-C18 and NH-C21, despite recent groundwater level contours indicating that these wells are "cross-gradient" from the Honeywell facility.

AMEC response: The figure reference has been corrected. To clarify, the text does not refer to the "highest" hexavalent concentrations, rather to elevated concentrations at NH-C19 and NH-C21. As stated in minor comment #12 and in our response to minor comment #12, the distribution of hexavalent chromium on Figure 4-10a does not account for groundwater flow directions, rather is a mathematical construct meant to account for data values and locations rather than interpret COC patterns based on groundwater flow and source considerations. However, groundwater elevations contoured on Figure 3-7a (December 2010) and Figure 3-7b (April 2011) illustrate that cluster monitoring wells NH-C18, NH-C19, and NH-C21 are all cross-gradient to the former Bendix facility (at least at those times).

The statement that the "historically dominant direction of chromium plume migration has been to the south and southwest" is incorrect. There is no evidence to suggest that a southwest gradient has been historically dominant in this area. Rather, rose diagrams in Attachment B (see our response to major comment #15) illustrate that the predominant groundwater flow direction has been to the south and southeast.

17. Page 5-5, section 5.3.1: Honeywell installed 31 wells; however, five of them were not identified in the EPA's Focused Feasibility Study – leaving 11 of the original FFS wells that have not been installed (list below). However, please note that there is no specific requirement in the AOC that these wells be installed as part of the remedial design – our agreement was only that they would be installed if information from them is required for design.

Category	EPA Well ID	Comments
i. Sentinel Well	B2-2	Sentinel wells for RT
ii. Sentinel Well	B-3-2	Sentinel Wells for RT
iii. Sentinel Well	B4-2	Sentinel wells for RT
iv. Remedy Selection	C2-2	Delineate Lockheed plume at depth
v. Remedy Selection	C2-3	Delineate Lockheed plume at depth
vi. Sentinel Well	C3-1	Monitoring NHOU/BOU Boundary
vii. Sentinel Well	C3-2	Monitoring NHOU/BOU Boundary
viii. Sentinel Well	E2-2	Delineate southern hot spot potentially approaching Whitnall wells
ix. Sentinel Well	E2-3	Delineate southern hot spot potentially approaching Whitnall wells

x. Sentinel Well	F2-2	Sentinel well for NH-west production well field
xi. Sentinel Well	G1-1	Sentinel well for R-T well field (may not be necessary due to depth to gw)

AMEC response: Comment acknowledged. Our recommendation to install monitoring well couplets A through E has been revised to allow for additional data collection as described in other recommendations. Pending our evaluation of Phase 1 Pre-Design Investigation findings, well locations proposed in the FFS will also be considered for installation during Phase 2, if additional data are necessary.

18. Page 5-6, Section 5.3.1, first (partial) paragraph at top of page: See our comment above regarding depth-specific (low-flow) sampling.

AMEC response: Comment acknowledged. See our response to minor comment #15.

19. Page 5-6, Section 5.3.1, third full paragraph: See our comment above regarding surveying.

AMEC response: Comment acknowledged. See our responses to major comments #2, #6, and #28.

20. Page 5-8, Section 5.3.5, third paragraph: Please explain the statement: “Given significant uncertainty…there appears to be little potential for COCs to migrate westward.” It is not clear how significant uncertainty can lead to such a firm conclusion about contaminant migration.

AMEC response: Text has been revised to clarify the point that contamination impacts to the southern Rinaldi-Toluca wells appear to originate from a source or sources either in the northern portion of the NHOU study area or near the Hewitt Pit (or both), rather than the former Bendix facility. Regardless of how groundwater flow directions may change should pumping resume at these municipal wells, proposed NEW-1, -2, and -3 extraction wells would not prevent migration of COC mass to the Rinaldi-Toluca wells apparently emanating from known and suspected potential sources north and west of the former Bendix facility.

21. Page 5-10, 5.4, 4th bullet: Strike “(contamination concentration at or below acceptable risk levels)”.

AMEC response: Text has been revised to read as “Delivery of treated groundwater to LADWP that meets or exceeds state and federal drinking water quality requirements”.

22. Figure 4-2f: The screened interval shown for well NHE-1 appears to be deeper than indicated by well construction data. Please verify that the screened interval for this well is depicted accurately on the cross section shown on Figure 4-2f.

AMEC response: Figure 4-2f has been revised to correctly illustrate the screen depth of NHOU extraction well NHE-1.

ULARA Watermaster

23. In many water wells in the area, the depth setting for the pump intake is either not known accurately or not known at all. In these or other wells, the pump intake is either directly opposite a section of perforated casing or is set below the top of the uppermost perforations; cascading water conditions may occur in some of these wells. Whenever cascading water conditions occur in a well, volatilization of VOCs will take place.

AMEC response: Comment acknowledged. Pump settings will be a key point of discussions with LADWP should collaborative meetings occur as recommended. Insufficient data exist to determine if this issue also pertains to NHOU extraction wells.

24. One way to help minimize problems related to the natural decline in pump efficiency and cascading water conditions as water levels decline in the area is to use variable frequency drive (vfd) pumps in all recovery/extraction wells.

AMEC response: Comment acknowledged. Variable-drive pumps and other mechanisms will be considered as part of the Preliminary Design to maintain operations under various groundwater elevation conditions.

25. Table 3-2 on Rainfall uses the term "Delta Average", but the definition was not clear nor the use of this term for the analyses. If rainfall is to be used for trend analyses of static water levels in wells over time, then the use of a curve of the accumulated departure of rainfall is a more viable tool.

AMEC response: The footnotes indicate that the "Delta" is the difference between the annual precipitation for the specified year and the average annual rainfall over the period of the data. The table was meant to account for only the variability of rainfall over the years 1995/1996 through 2009/2010, rather than to present a trend analysis. These data are illustrated graphically for years 1987 to present on Figure 4-4.

Regional Board (none provided)

26. ES, Page xiv: ES-5: 3rd bullet makes reference to suspected sources. What was used as the basis to conclude that there are suspected sources. Perhaps a reference to Section 3.2.6 could be added.

AMEC response: Known and suspected potential source areas have been identified by EPA and NHOU PRPs in separate investigations. References to these investigations are now included in this bullet.

27. ES, Page xiv: ES-5, 4th bullet makes reference to groundwater elevation differences between ULARA Watermaster and USEPA FFS. What created these differences and which one is more accurate and representative? Were different calculations, models, or assumptions, etc. used? The different groundwater elevations for future work could have a significant impact on pumping rates (i.e., LADWP) to be used in the NHOU for contamination plume containment.

AMEC response: This issue is discussed in Sections 3.1.1.4 (SFB Management) and 5.5 (Groundwater Flow Model Memorandum Data Gaps). Note that the more recent pumping rate projections do not represent independent projections developed by the

ULARA Watermaster; rather, these projections were produced by the cities of Los Angeles, Burbank, and Glendale and were provided to the ULARA Watermaster to comply with SFB adjudication requirements. We agree with the concern regarding how future pumping rates will impact NHOU remediation and had anticipated that the Groundwater Management Plan to be developed by the LADWP and EPA would partially address this issue. Please refer to our response to general comment #2 regarding the original intent of developing a Groundwater Management Plan as an institutional control to the Second Interim Remedy.

28. Section 1.1, Page 1-1, Bullet D: Has LADWP provided these pumping rates and how will the differences in calculated groundwater elevations affect the "Data Gap Analysis (DGA)?"

AMEC response: LADWP provides pumping rates to the ULARA Watermaster to comply with adjudication requirements. The revised groundwater flow model to be developed as part of the Second Interim Remedy design will be based on reasonable long-term projections in an attempt to account for a variety of groundwater elevation conditions. This issue will likely persist with significant uncertainty until a Groundwater Management Plan is developed by EPA and the LADWP consistent with the AOC (Section XI "Site Access and Institutional Controls", paragraph 55(b)).

Should you have questions regarding our responses to EPA comments, please feel free to call me at (510) 628-3222 to discuss.

Sincerely,
AMEC Engineering & Infrastructure, Inc.

Michael Taraszki, PG, CHG, PMP
Project Manager

Robert Hartwell, PE
Engineering Manager

For Robert Hartwell
with permission

Attachments:

A Revised NHOU Project Schedule

B MWH Memo and Groundwater Flow Direction Rose Diagrams (March 13, 2012)

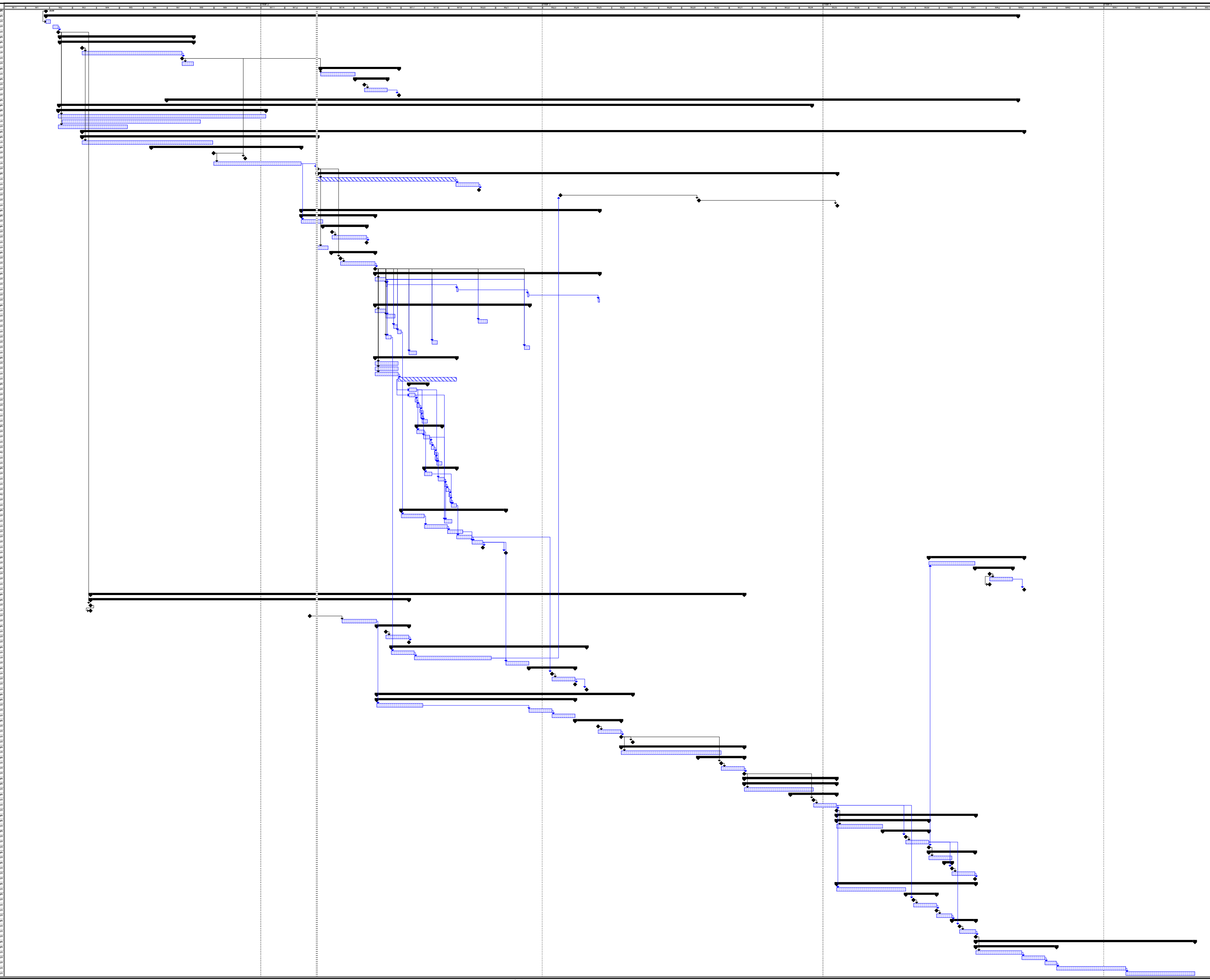
C MWH Figure Prepared for Regional Water Quality Control Board, December 20, 2011

D EPA Comments on the *Draft Data Gap Analysis, North Hollywood Operable Unit Second Interim Remedy, Groundwater Remediation System Design (February 21, 2012)*

ATTACHMENT A

REVISED NHOU PROJECT SCHEDULE

ID	Predecessors	Task Name	Duration
1		EPA APPROVAL OF SUPERVISING CONTRACTOR (NOTICE-TO-PROCEED)	0 days
2		TASK 1 - PROJECT MANAGEMENT	1264 days
3	1SS	Prepare Quality Management Plan	6 days
5	4	EPA Review	7 days
6	5	EPA Approves QMP	0 days
7		Prepare Remedial Design Work Plan, HASP, and RD QAPP	174 days
8		Review Process	174 days
14	13	Submit Draft RD Work Plan to EPA	0 days
15	14	EPA Review	130 days
16	15	Submit Final RD Work Plan to EPA	0 days
17	16	EPA Review of Final RD Work Plan	15 days
18		Prepare RD QAPP per RD Work Plan	102 days
19	16FS+180 days	Draft RD QAPP	45 days
20		Review Process	42 days
24	23	Submit Draft RD QAPP to EPA	0 days
25	24	EPA Review	30 days
26	25FS+15 days	Submit Final RD QAPP	0 days
27		Prepare Monthly Progress Reports and Annual Performance Evaluations	1107 days
70		Conduct Weekly and Monthly Teleconference Calls with LMC/HW Team and USEPA	979 days
213		TASK 2 - DATA AND DOCUMENT MANAGEMENT	270 days
214	6	Data Management	270 days
215		Geospatial Data Dissemination and Aggregation	180 days
216	6	e-Document Solution (SharePoint)	90 days
217		TASK 3 - GROUNDWATER CHARACTERIZATION	1225 days
218		Data Gap Analysis Report	306 days
219	14	Draft Data Gap Analysis Memorandum	170 days
220		Review Process	195 days
227	226	Submit Draft Data Gap Analysis Report to EPA	0 days
228	16FS+60 days,227	Collaboration Meeting #1 with USEPA, LADWP, CDPH, and RWQCB	0 days
229	227	EPA Review	114 days
230	229FS+21 days	Submit Final Data Gap Analysis and revised project schedule to EPA	0 days
231		Groundwater Management Plan	676 days
232	230	EPA, LADWP, and Watermaster deliberations	180 days
233	232	AMEC review of draft GMMP	30 days
234	233	Submit comments on draft GMMP to EPA and LADWP	0 days
235	335FS+90 days	Collaboration Meeting #2 with USEPA, LADWP, ULARA W/M, CDPH, and RWQCB	0 days
236	235FS+180 days	Collaboration Meeting #3 with USEPA, LADWP, ULARA W/M, CDPH, and RWQCB	0 days
237	236FS+180 days	Collaboration Meeting #4 with USEPA, LADWP, CDPH, ULARA W/M, and RWQCB	0 days
238		Pre-Design Investigation - Phase 1	388 days
239		Sampling and Analysis Plan (SAP) and Work Plan	96 days
240	229	Develop Draft SAP (including QAPP) and HASP	28 days
241		Review Process	57 days
245	244	Submit Draft SAP + HASP to EPA	0 days
246	245	EPA Review	45 days
247	246	EPA Approves SAP + HASP	0 days
248	230	Develop Phase 1 Work Plan (including FSP)	14 days
249		Review Process	57 days
253	252,230FS+30 days	Submit Phase 1 Work Plan to EPA	0 days
254	253	EPA Review	45 days
255	254	EPA Approves Phase 1 Work Plan	0 days
256		Groundwater Elevation Measurements	292 days
257	255	Access agreements with well owners	14 days
258	257,255	First Quarterly Event	2 days
259	258FS+90 days	Second Quarterly Event	2 days
260	259FS+90 days	Third Quarterly Event	2 days
261	260FS+90 days	Fourth Quarterly Event	2 days
262		Depth-Discrete Groundwater Sampling	201 days
263	255	Access agreement with well owners	14 days
264	257,255	First Semi-annual event (A-Zone and B-Zone monitoring wells)	12 days
265	257FS+120 days,255	Second Semi-annual event (A-Zone and B-Zone monitoring wells)	12 days
266	257FS+10 days,255	Depth-discrete Sampling at and near NHE-1	5 days
267	257FS+15 days,255	Vertical Groundwater Quality Profiles	5 days
268	257,255	Surveying	7 days
269	257FS+60 days,255	First semiannual spinner logging event	7 days
270	257FS+180 days,255	Second semiannual spinner logging event	7 days
271	257FS+30 days,255	Slug Testing	10 days
272		NHE Piezometers/Aquifer Tests	106 days
273	255	LADPH well instllation permits (develop applications and obtain permits)	30 days
274	255	Access Agreements and LADWP Coordination (drilling, rehabilitation, and aquifer testing)	30 days
275	255	Communication planning with EPA	30 days
276	275	Execute Communication Plan	76 days
277		NHE-3 Location	24 days
278	276SS+14 days	Inspect/Rehabilitate NHE-3	10 days
279	276SS+14 days	Drill deep borehole/collect soil samples	8 days
280	279	Construct deep piezometer	2 days
281	280	Drill shallow borehole	4 days
282	281	Construct shallow piezometer	1 day
283	282	Develop shallow and deep piezometers	2 days
284	283,278	Perform NHE-3 Aquifer Test	7 days
285		NHE-5 Location	33 days
286	278	Inspect/Rehabilitate NHE-5	10 days
287	282FS+4 days	Drill deep borehole/collect soil samples	8 days
288	287	Construct deep piezometer	2 days
289	288	Drill shallow borehole	4 days
290	289	Construct shallow piezometer	1 day
291	290	Develop shallow and deep piezometers	2 days
292	291,278	Perform NHE-5 Aquifer Test (temporary pump)	7 days
293		NHE-7 Location	42 days
294	286	Inspect/Rehabilitate NHE-7	10 days
295	290FS+4 days	Drill deep borehole/collect soil samples	8 days
296	295	Construct deep piezometer	2 days
297	296	Drill shallow borehole	4 days
298	297	Construct shallow piezometer	1 day
299	298	Develop shallow and deep piezometers	2 days
300	299,294	Perform NHE-7 Aquifer Test	7 days
301		Pre-Design Investigation (Phase 1) Findings Memorandum	136 days
302	267	Laboratory Analysis (Groundwater Samples)	30 days
303	295,279,287	Laboratory Analysis (Soil Samples)	10 days
304	302	Third Party Analytical Data Validation (Groundwater Samples)	30 days
305	304	Analytical Data Evaluation	20 days
306	300	Geologic/Hydraulic Data Evaluation	20 days
307	306,305	Summarize Phase 1 Findings (Groundwater Modeling Memorandum Appendix)	14 days
308	307	Assess need for Phase 2	0 days
309	307FS+30 days	Meet with EPA to discuss Phase 1 Pre-Design Investigation and assessment findings	0 days
310		Groundwater Monitoring Plan and SAP	124 days
311	385	Final Design Update of Groundwater Monitoring Plan	60 days
312		Review Process	49 days
316	315	Submit Draft Groundwater Monitoring Plan and SAP to EPA	0 days
317	316	EPA Review	30 days
318	316	EPA Approves Groundwater Monitoring Plan and SAP	0 days
319	317FS+15 days	Submit Final Groundwater Modeling Plan and SAP	0 days
320		TASK 4 - PRELIMINARY DESIGN	850 days
321		Building Conditions Assessment	414 days
322	6FS+32 days	NHOU LTF Site Visit	0 days
323	322	Develop Building Conditions Assessment Report	180 days
324		Submit LADWP Data Request	0 days
325	324FS+42 days	Finalize Draft Building Conditions Assessment Report	40 days
326		Review Process	42 days
330	329	Submit Draft Building Conditions Assessment to EPA	0 days
331	330	EPA Review	30 days
332	331	EPA Approves Building Conditions Assessment	0 days
333		Predesign Groundwater Modeling Memorandum (no Phase 2)	234 days
334	269	Refine SVFB FFS Model	30 days
335	334	Site Model Simulations	100 days
336	335,307FS+30 days	Develop Administrative Draft Groundwater Modeling Memorandum	30 days
337		Review Process	60 days
341	340,309FS+60 days	Submit Draft Groundwater Modeling Memorandum to EPA	0 days
342	341	EPA Review	30 days
343	342	EPA Approves Pre-Design Groundwater Modeling Memorandum	0 days
344	343FS+15 days	Submit Final Groundwater Modeling Memorandum	0 days
345		Treatment Options Memorandum	335 days
346		Internal development	256 days
347	325	Evaluate potential treatment technologies	60 days
348	336,347	Evaluate potential NHOU extraction well scenarios (rates and concentration ranges)	30 days
349	348	Develop draft Treatment Options Memorandum	30 days
350		Review Process	60 days
353	352	Submit Draft Treatment Options Memorandum to EPA	0 days
354	353	EPA Review	30 days
355	354	EPA Approves Treatment Options Memorandum	0 days
356	355FS+15 days	Submit Final Treatment Options Memorandum	0 days
357		Preliminary Design Report (30%)	160 days
358	356	Internal Development	130 days
359		Review Process	60 days
363	362,356FS+130 days	Submit Draft Preliminary Design Report to EPA	0 days
364	363	EPA Review	30 days
365	364	EPA Approves Preliminary Design Report	0 days
[illegible]		TASK 5 - INTERMEDIATE DESIGN (60%)	120 days
[illegible]		Intermediate Design Package	120 days
[illegible]	[illegible]	Internal Development	90 days
[illegible]		Review Process	60 days
[illegible]	[illegible]	Submit Intermediate Design Report to EPA	0 days
[illegible]	[illegible]	EPA Review	30 days
[illegible]	[illegible]	EPA Approves Intermediate Design Report	0 days
[illegible]		TASK 6 - PRE-FINAL AND FINAL DESIGN	185 days
[illegible]		Pre-Final Design Package (90%)	120 days
[illegible]	[illegible]	Internal Development	90 days
[illegible]		Review Process	60 days
[illegible]	[illegible]	Submit Pre-Final Design Report to EPA	0 days
[illegible]	[illegible]	EPA Review	30 days
[illegible]	[illegible]	EPA Approves Pre-Final Design Report	0 days
[illegible]		Final Design Package (100%)	60 days
[illegible]	[illegible]	Internal Development	30 days
[illegible]		Review Process	30 days
[illegible]	[illegible]	Submit Final Design Report to EPA	0 days
[illegible]	[illegible]	EPA Review	30 days
[illegible]	[illegible]	EPA Approves Final Design Report	0 days
[illegible]		Pre-Achievement O&M Plans	185 days
[illegible]	[illegible]	Draft Pre-Achievement O&M Plan	90 days
[illegible]		Review Process	40 days
[illegible]	[illegible]	Submit Draft Pre-Achievement O&M Plan to EPA	0 days
[illegible]	[illegible]	EPA Review	30 days
[illegible]	[illegible]	EPA Approves Draft Pre-Achievement O&M Plan	0 days
[illegible]	[illegible]	Develop Final Pre-Achievement O&M Plan	20 days
[illegible]		Review Process	31 days
[illegible]	[illegible]	Submit Final Pre-Achievement O&M Plan to EPA	0 days
[illegible]	[illegible]	EPA Review	21 days
[illegible]	[illegible]	EPA Approves Final Pre-Achievement O&M Plan	0 days
[illegible]		TASK 7 - ENGINEERING SERVICES DURING BIDDING AND CONSTRUCTION	295 days
[illegible]		Construction Management Plan	105 days
[illegible]	[illegible]	Draft	60 days
[illegible]	[illegible]	Review	30 days
[illegible]	[illegible]	Final	15 days
[illegible]	[illegible]	Office-based Services During Construction	90 days
[illegible]	[illegible]	Assist LMC/HW and Contractor with Start-up and Testing	90 days



ATTACHMENT B

MWH MEMO AND GROUNDWATER FLOW DIRECTION ROSE DIAGRAMS (March 13, 2012)

TECHNICAL MEMORANDUM

TO: Don Walsh **DATE:** March 13, 2012

FROM: Craig Altare

SUBJECT: Historic Groundwater Flow Directions in the Vicinity of the Former Bendix Facility, North Hollywood, California

Historic groundwater flow directions in Depth Region 1 at the former Bendix facility were evaluated using: (1) flow directions based on groundwater modeling for the period from Fall 1981 to Fall 2008 and (2) groundwater elevation maps prepared between May 2006 and July 2011. These evaluations are described below.

The first source for historic flow direction information was the San Fernando Basin Feasibility Study version B (SFBFS-B) groundwater model. CH2M Hill provided MWH with a copy of the SFBFS-B model in 2007. The SFBFS-B model simulates groundwater flow in the San Fernando Valley from Water Years 1981 through 2006. MWH extended the SFBFS-B model period to include pumping and spreading data for 1968 to 1981, and from 2006 to 2009. The model uses a quarterly stress period and outputs for each stress period were loaded into the Groundwater Vistas graphical user interface (Environmental Simulations, Inc.). Groundwater flow direction in Depth Region 1 (model layer 1) was recorded for each stress period at four locations corresponding to (1) at the former Bendix facility, (2) approximately 3,000 feet west of the former Bendix facility, (3) approximately 1,400 feet south-southwest of the former Bendix facility, and (4) approximately 1,100 feet east of the former Bendix facility (Figure 1). Flow directions were compiled and the directional frequencies were plotted on Rose diagrams (Figure 1). Model results for the period prior to 1981 were not included for this analysis because flow directions were generally stable, in part because the Rinaldi-Toluca Well Field was not operational.

As shown in Figure 1, groundwater flow direction at the former Bendix facility has been predominantly southeast and south-southeast since 1981 and relatively few quarters have flow directions with a westerly flow component. Locations east of and southwest of the former Bendix facility show strong southeast and south-southeast historical flow directions. Flow directions at the location approximately 0.7 miles west of the former Bendix facility show more variability. This location is approximately 1,600 feet south of the Rinaldi-Toluca Well Field and 2,500 feet northeast of the western portion of the North Hollywood Well Field. Pumping from the two Los Angeles Department of Water and Power (LADWP) operated well fields is the likely cause of the variable groundwater flow direction at this location.

In addition to the model, flow direction was interpreted based on groundwater elevation contour maps prepared for submittal to the Regional Water Quality Control Board (RWQCB) between May 2006 and July 2011. Groundwater flow direction on the contour maps was interpreted at a location corresponding to monitoring well GW-18, which was chosen because it is not located in close proximity to the on-site extraction and infiltration system. Flow directions were compiled and plotted on a rose diagram (Figure 2), which indicated that the predominant direction of groundwater flow from 2006 to 2011 was south to southeast. Flows had a westerly component in only 22 percent of the monitoring events.

Groundwater elevation information evaluated for this memorandum supports the conclusion that flow directions at the former Bendix facility predominantly ranged from southeast to south-southeast since 1981, and that recent flow directions are oriented more to the south. This information suggests that the dominant flow direction for advective transport of solutes would be southeast to south of the former Bendix facility.

Attachments: Figures 1 and 2

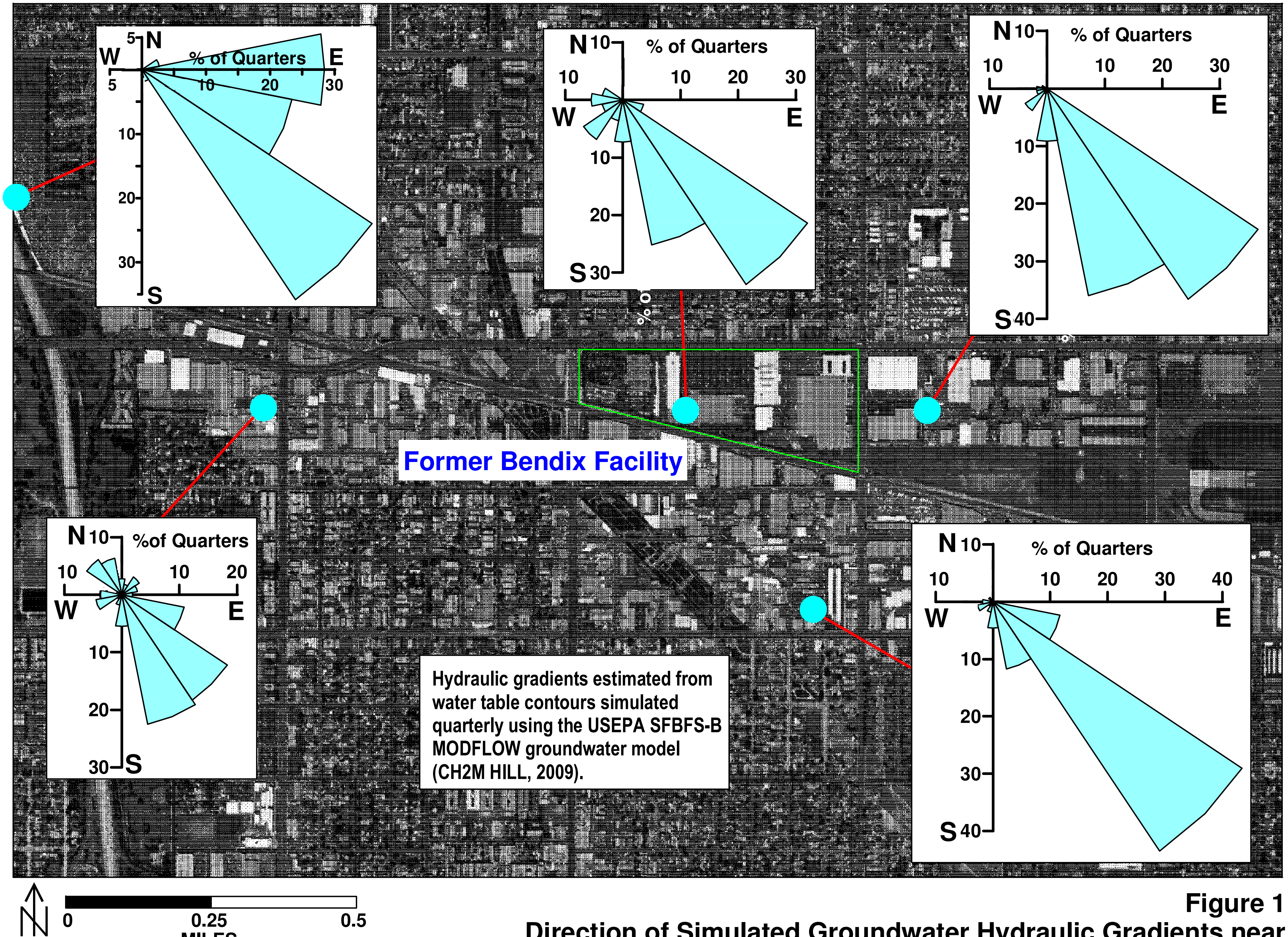


Figure 1
Direction of Simulated Groundwater Hydraulic Gradients near Former Bendix Facility, Autumn 1981 to Autumn 2008

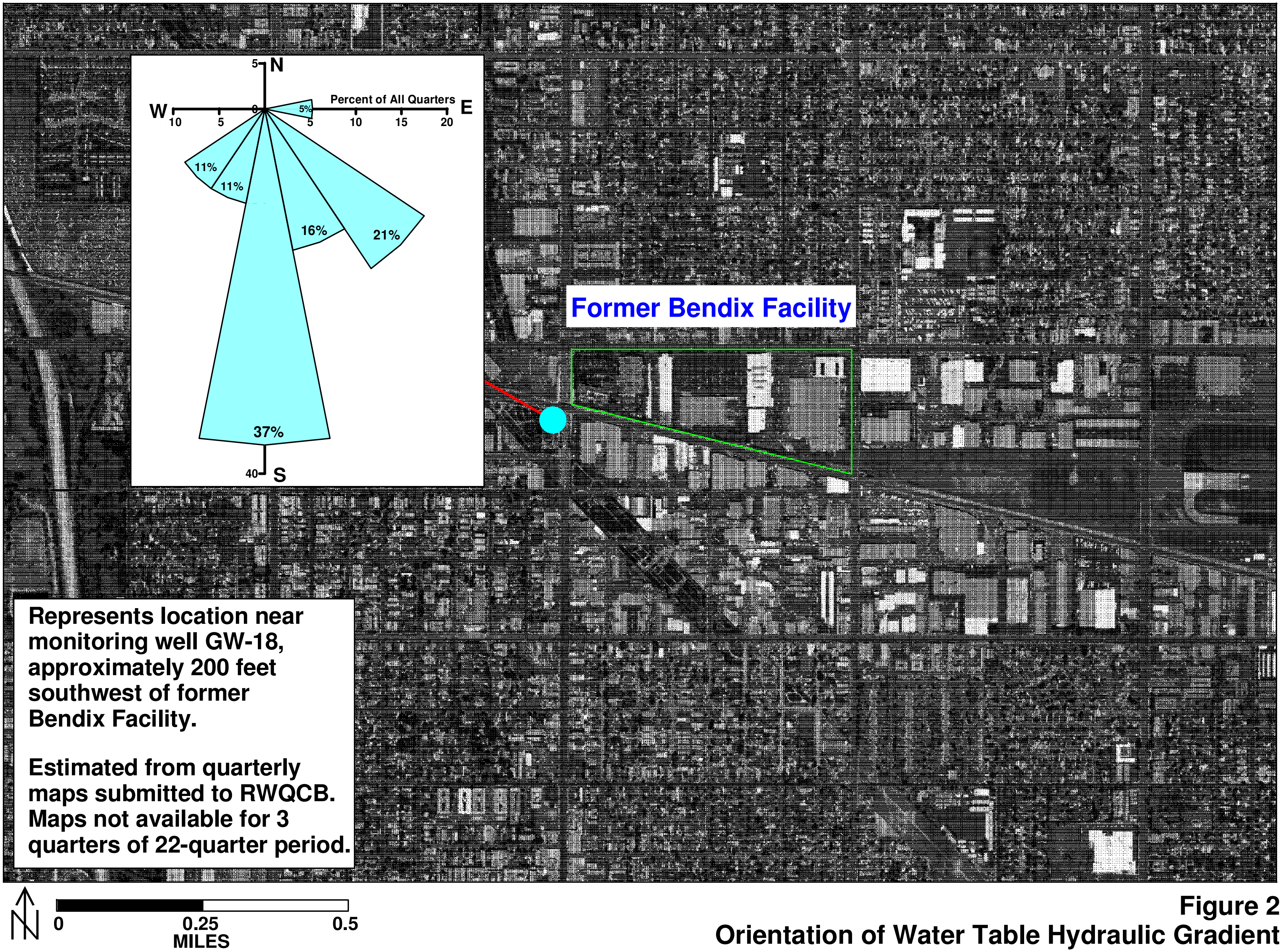
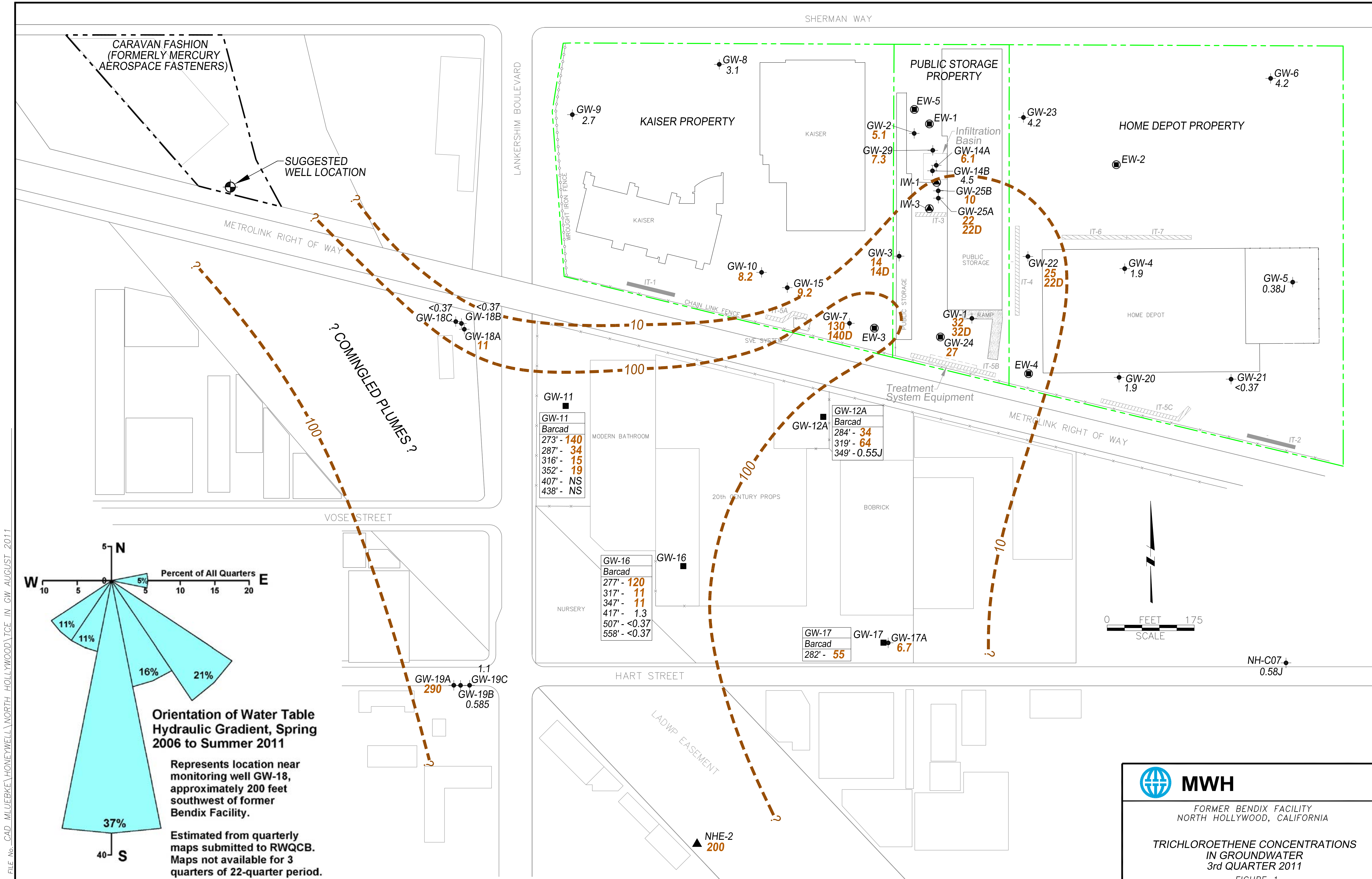


Figure 2
Orientation of Water Table Hydraulic Gradient
Spring 2006 to Summer 2011

ATTACHMENT C

MWH FIGURE PREPARED FOR REGIONAL WATER QUALITY CONTROL BOARD, DECEMBER 20, 2011


SHERMAN WAY
CARAVAN FASHION (FORMERLY MERCURY AEROSPACE FASTENERS)
SUGGESTED WELL LOCATION
LANKERSHIM BOULEVARD
METROLINK RIGHT OF WAY
KAISER PROPERTY
PUBLIC STORAGE PROPERTY
HOME DEPOT PROPERTY
KAISER
PUBLIC STORAGE
HOME DEPOT
Infiltration Basin
Treatment System Equipment
CHAIN LINK FENCE
SVE SYSTEM
WROUGHT IRON FENCE
? COMINGLED PLUMES ?
GW-8 3.1
GW-9 2.7
GW-6 4.2
GW-23 4.2
EW-5
EW-1
EW-2
EW-3
EW-4
GW-2 5.1
GW-29 7.3
GW-14A 6.1
GW-14B 4.5
IW-1
IW-3
GW-25B 10
GW-25A 22 22D
GW-3 14 14D
GW-10 8.2
GW-15 9.2
GW-7 130 140D
GW-1 32 32D
GW-24 27
GW-22 25 22D
GW-4 1.9
GW-5 0.38J
GW-20 1.9
GW-21 <0.37
GW-18C <0.37
GW-18B <0.37
GW-18A 11
GW-11
GW-11 Barcad: 273' - 140; 287' - 34; 316' - 15; 352' - 19; 407' - NS; 438' - NS
GW-12A
GW-12A Barcad: 284' - 34; 319' - 64; 349' - 0.55J
GW-16
GW-16 Barcad: 277' - 120; 317' - 11; 347' - 11; 417' - 1.3; 507' - <0.37; 558' - <0.37
GW-17
GW-17 Barcad: 282' - 55
GW-17A 6.7
GW-19A 290
GW-19C 1.1
GW-19B 0.585
NH-C07 0.58J
NHE-2 200
10
100
?
IT-1
IT-2
IT-3
IT-4
IT-5A
IT-5B
IT-5C
IT-6
IT-7
RAMP
MODERN BATHROOM
20th CENTURY PROPS
BOBRICK
NURSERY
VOSE STREET
HART STREET
LADWP EASEMENT
0 FEET 175
SCALE
N
S
W
E
Percent of All Quarters
5% 11% 11% 16% 21% 37%
Orientation of Water Table Hydraulic Gradient, Spring 2006 to Summer 2011
Represents location near monitoring well GW-18, approximately 200 feet southwest of former Bendix Facility.
Estimated from quarterly maps submitted to RWQCB. Maps not available for 3 quarters of 22-quarter period.
MWH
FORMER BENDIX FACILITY
NORTH HOLLYWOOD, CALIFORNIA
TRICHLOROETHENE CONCENTRATIONS IN GROUNDWATER 3rd QUARTER 2011
FIGURE 1
FILE No. CAD MLUEBKE\HONEYWELL\NORTH HOLLYWOOD\TCE IN GW AUGUST 2011

ATTACHMENT D

EPA COMMENTS ON THE
***"DRAFT DATA GAP ANALYSIS, NORTH HOLLYWOOD OPERABLE UNIT SECOND INTERIM REMEDY, GROUNDWATER REMEDIATION SYSTEM DESIGN,"* (FEBRUARY 21, 2012)**

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

February 21, 2012

Michael Taraszki
AMEC
for Honeywell and Lockheed
1330 Broadway Street, Ste 1702
Oakland, CA 94612

Re: EPA Comments on "*Draft Data Gap Analysis, North Hollywood Operable Unit Second Interim Remedy, Groundwater Remediation System Design*," prepared by AMEC, dated October 31, 2011

Dear Mr. Taraszki:

EPA has reviewed the above-referenced document, and provides the following comments in the attached file. These comments should be addressed and resubmitted with the Final Data Gap Analysis, which is due **March 14**, 2012.

The attached comments are comprehensive, and represent the combined input from the following agencies/firms, in addition to EPA:

- the Los Angeles Department of Water and Power (LADWP)
- the Upper Los Angeles River Area (ULARA) Watermaster
- the Los Angeles Regional Water Quality Control Board (Regional Board)
- CH2M HILL, consultant to EPA

Please include a separate letter which addresses each of the general and major comments specifically, and indicates how the responses to the comments have been incorporated into the final. In addition, please include an updated project schedule, which clearly identifies the phasing of the investigation work to be completed, as well as the remainder of the SOW deliverables.

The Sampling and Analysis Plan, the Quality Assurance Project Plan, and the Health and Safety Plan for the data gap investigation are due by April 1, 2012.

Please let me know if you have any questions.

Sincerely,

Kelly S Manheimer

Kelly Manheimer
EPA Project Manager

The comments are organized as follows:

- "General Comments," including introductory statements from the commenters on the overall methods and conclusions of the Draft Data Gap Analysis;
- "Major Comments," including concerns, questions, or recommendations that could have a significant impact on conclusions and recommendations section of the Draft Data Gap Analysis; and,
- "Minor Comments," including issues noted by the commenters that should be relatively easy to address by AMEC in a final version of the Data Gap Analysis.

We have not commented on typographical or grammatical errors except where such errors may lead to confusion on technical issues.

General Comments

CH2M HILL and EPA

1. In consideration of the updated conceptual site model, new groundwater quality data obtained since the time of the NHOU Focused Feasibility Study (FFS), and regulatory changes (i.e. a new notification level for 1,4-dioxane), the Draft Data Gaps Analysis (DDGA) concludes that RD for the NHOU Second Interim Remedy cannot proceed until a number of "critical" data gaps have been filled. However, It appears to us that some of the "critical" data gaps may be impossible to fill (e.g. accurate forecasts of future municipal pumping rates), while other listed "critical" data gaps would not have a major impact on RD, and others could potentially be filled (at least for the purposes of RD) using available data and relatively inexpensive methods of analysis (e.g. determining hydraulic parameters of the A and B zones by equipping existing wells with pressure transducers and monitoring the responses to changes in pumping rates).
2. We agree with the statement in Section 4.5.4, that "additional capture does appear to be needed (both deeper and over a larger area than is apparently capable by the existing NHOU extraction well field)"; however, the purpose of the new extraction wells was not necessarily to provide capture under "normal" (as far as any scenario is normal) LA DWP pumping scenarios, but to protect the LA DWP production wells under the maximum pumping conditions provided by LA DWP for the FFS. As an alternative to delaying RD until all of the outlying data gaps are filled, design of specific, immediate improvements in key areas (i.e. modifying or rehabilitating wells NHE-2 through NHE-5 as discussed in the Proposed Plan and ROD, together with upgrading the treatment system to treat emerging contaminants), could proceed immediately, while outlying data gaps are filled and the options for the new extraction wells can be more fully evaluated.

Regional Board

3. The work plan should present geologic cross-sections to allow the reader to view the contaminant plumes in the A- and B-zones as presented in the work plan.
4. The work plan should collect analytical data to develop Stiff diagrams to help determine groundwater flow.

LADWP

5. LADWP requested that the design for the Second Interim Remedy should have extraction wells in both the shallow and deep zone to prevent further migration of contaminants toward LADWP production wells. The vertical migration of

contaminants from shallow to deeper aquifer zones is apparent at monitoring well NH-CO3, and in the recently installed (by Honeywell) additional “Remedial Investigation” (RI) monitoring wells. Also, the EPA annual basinwide plume maps for the deep zone clearly shows contaminants over a wide area that includes LADWP production wells. Most LADWP production wells extract groundwater from the deep zone, which contains elevated levels of contaminants. In addition, the large fluctuations in the water table, especially declines, make it impossible to maintain contaminant capture from the shallow zone only. For all of these reasons, extraction from both the shallow and deep zones should be implemented in the Second Interim Remedy.

6. LADWP would like implementation of the Second Interim Remedy to be performed in parallel with the additional investigation for the Second Interim Remedy. Design and implementation of the Second Interim Remedy should occur as soon as possible without any delay to contain the high concentrations of contaminants and prevent their further migration to LADWP wells. We need to keep in mind this is not a final remedy. Any further investigation to improve the performance of the Second Interim Remedy can be done simultaneously.

7. LADWP’s goal is to serve the water that is treated by the Second Interim Remedy. The design for the Second Interim Remedy should ensure that the treated groundwater complies with the California Department of Public Health (CDPH) regulations for both the regulated and unregulated constituents.

ULARA Watermaster

8. The ULARA Watermaster wants to reiterate the general comments made at the recent “all hands” meeting. Specifically, the cleanup and remediation of the groundwater contamination described in the AMEC Draft report must be performed expeditiously. Many purveyor wells and various aquifers have been adversely impacted; numerous purveyor wells are not able to be actively pumped and the well owners must substitute their pumping rights by purchasing costly imported water for use in their respective service areas.

9. Whereas some additional subsurface exploration, additional E-log correlation and additional down-well testing for groundwater sampling may be needed, it is vital that efficient and effective groundwater remediation be performed to remove the contaminant mass and to contain the continued downgradient flow.

10. Water wells in some of the local active wellfields are old and were constructed by the archaic cable tool drilling method. Hence, these wells have no sanitary seals, the perforations tend to start at relatively shallow depths, and there are no geologic logs or electric logs (E-logs) for these wells.

11. Numerous water wells in the wellfields have long and continuous perforated intervals and when the well is pumped the discharge rate and water quality represents the wellblend or inflow from all perforated zones. At least some recovery/extraction wells have a long and continuous section of perforations, coupled with the fact that most contamination occurs in the shallower portions of the saturated zones, means that the “efficiency” of contaminant mass removal is likely low.

12. Unfortunately, there is a paucity of spinner log surveys (dynamic flow tests) to help define the percentage of groundwater inflow from the different perforated intervals in each well; there is also a lack of depth-discrete groundwater sampling under pumping conditions in the wells. These 2 types of tests would help define the relative

inflow rates and groundwater quality entering each zone of perforations under pumping conditions. There is also a paucity or absence of static spinner surveys in the water wells and in monitoring wells with more than one screened section. Hence, it is not known, under non-pumping conditions, whether groundwater moves upward or downward inside most/all of these well casings. It is expected that there could be a downward flow in some/many of these wells and monitoring wells under non-pumping conditions.

13. Some water wells are inactive, or even abandoned (capped), but not thoroughly and properly destroyed. Each such inactive and/or abandoned, non-pumping well is essentially a vertical conduit for groundwater flow (e.g., see NH-9).

Major Comments

CH2M HILL and EPA

1. Page xiv: "The revised CSM suggests several AOC scope items may need to be revised." – please clarify this statement: which items? How revised? Based on what reasoning?
2. Page 3-20, Section 3.2.5, first (partial) paragraph at top of page: We agree that the correction factor applied to vertical data for well measuring point elevations is appropriate (to correct for changes in the vertical datum) to estimate comparable approximate water levels. However, resurveying wells that have not been surveyed in 10 or more years would provide the added benefit of accounting for land subsidence (common in basins with thick alluvial fill) or other changes in wellhead elevation.
3. Page 3-21, 3.2.6.3: The characterization of the facilities in the MWH report as "known" sources is a bit misleading. EPA has not approved this report and has not endorsed those findings. Honeywell and MWH report that the facilities are known to have releases, but this does not necessarily translate into a "known" *source* of contamination to the NHOU. Please clarify this in the text.
4. Page 4-4, Section 4.1.3, first full paragraph: Important conjecture is provided in this paragraph regarding how geologically and geophysically distinct and extensive the AA and BB groups are within the basin-fill deposits of the San Fernando Basin (SFB). It would be helpful if more data were provided in the analysis to support the concept that these units are hydraulically distinct from each other, and their extents shown on a map.
5. Page 4-8, Section 4.4.1, first (partial) paragraph: The last sentence in this paragraph seems to imply that FFS-proposed deepening of some of the existing NHOU extraction wells is in response to forecasted decreases in groundwater levels associated with the "maximum pumping scenario" assumed by LADWP. However, the primary reason that some of the NHOU extraction wells were assumed in the FFS to require deepening was that they commonly were incapable of producing groundwater at design rates, due to actual (not forecast) groundwater level declines. Furthermore, it should be noted that under the forecasted maximum pumping scenario in the FFS, highly contaminated groundwater underlying the former Bendix facility is projected to flow toward the southernmost Rinaldi-Toluca production wells. This is the primary reason for assuming three new extraction wells would be required between the former Bendix facility and the Rinaldi-Toluca well field in the FFS and ROD.

6. Page 4-13, Section 4.5.1.1, first bullet: Please refer to a figure or report that supports the statement that “elevated concentrations beneath the former Bendix facility appear to be captured by NHOU extraction wells NHE-2 (primarily) and NHE-3…” Currently, this statement appears to be unsubstantiated. And what is meant by the last sentence in this bullet point, “Wells within this area are consistent with those associated with the presumed NHE-2 capture area?”

7. Page 4-13, Section 4.5.1.1, third bullet: What is the basis of the statement “Elevated concentrations at NHE-4 and NH-C10-280 appear discontinuous from higher concentrations closer to the former Bendix facility?” Is there a figure or report that can be referenced to support this claim?

8. Page 4-14, Section 4.5.1.1, first paragraph: It is unclear where or why data are insufficient to delineate the 50 µg/L contour boundary northwest of Target Area 3. Perhaps this area could be illustrated on a map. Why are no wells proposed in this area to sufficiently delineate this contour?

9. Page 4-17, Section 4.5.2, third full paragraph: The ROD requirement for installing up to three new extraction wells northwest of the current NHOU extraction well field is to prevent the Rinaldi-Toluca wells from withdrawing highly contaminated groundwater from under the former Bendix facility, in the event that the forecasted maximum pumping scenario would occur as assumed by LADWP. Current conditions, which are the focus of this paragraph, have little bearing on the potential transport of contaminants from the former Bendix facility to the Rinaldi-Toluca well field under the assumed maximum pumping scenario.

10. Page 4-22, Section 4.5.4, first (partial) paragraph at top of page: We agree with the statement in this paragraph that “additional capture does appear to be needed (both deeper and over a larger area than is apparently capable by the existing NHOU extraction well field), but specifically within the A-Zone,” assuming that AMEC’s conjecture regarding hydrogeologic distinction of their newly proposed A- and B-Zones can be supported by data.

11. Page 4-31, section 4.7.3.2, last bullet: This bullet does not specify a specific data gap, nor a reason why the statements made in this bullet point are critical for RD. In addition, what are the “many other known and suspected source areas” for hexavalent chromium (in addition to the former Bendix facility)? What is the relative importance of the known hexavalent chromium concentrations at and migrating off-site from the former Bendix facility, compared to concentrations elsewhere in the NHOU, for remedial design? Based on the maps presented in the Draft Data Gap Analysis, the majority of the dissolved hexavalent chromium in the NHOU appears to emanate from the former Bendix facility.

12. Page 4-32, Section 4.7.3.4: The characterization of the 45 “known” sources identified by USEPA and PRPs is misleading. EPA has only identified 10 known sources to date. Please clarify this.

13. Page 4-32, Section 4.7.3.4, last paragraph: The last sentence of this paragraph states that “The new NHOU treatment system will not achieve RAOs if the lateral and vertical extent of COCs is not delineated first.” Please clarify which RAOs would not be met, or delete this sentence. It seems that most RAOs for this interim remedy would be met, even if the lower concentration margins of the plume were not completely and confidently delineated prior to RD. A greater concern is that further delay in improving the existing NHOU extraction and treatment system will allow

migration of known areas of highly contaminated groundwater farther away from existing extraction wells, making future achievement of RAOs more difficult.

14. Page 4-33, Section 4.7.4, third paragraph on page: This paragraph states that "Because COC mass resides within the A-Zone, however, deepening extraction well screens such that they capture groundwater from in the B-Zone would induce deeper COC mass migration where groundwater quality is generally high." Based on the updated conceptual site model presented earlier in the Draft Data Gap Analysis, it appears reasonable to extract groundwater only from the A-Zone, assuming an updated groundwater flow model is developed and predictive model runs conducted that support such a change from the ROD and FFS. As noted in the paragraph, additional extraction wells may be necessary to achieve the same degree of capture as modeled in the FFS.

15. Page 5-2, Section 5.2.2, bullet point at bottom of page: We agree that additional investigation in the area south and southwest from the former Bendix facility, near wells NH-C18, NH-C19, and NH-C21 is important. Figures in the Draft Data Gaps Analysis and in Honeywell's quarterly monitoring reports for the former Bendix facility suggest that the chromium and TCE plumes migrating offsite from the former Bendix facility may extend to, and perhaps southwest from, monitoring wells NH-C18 and NH-C21. Currently, the southern and southwestern extents of these plumes are poorly delineated. These wells were recommended in the FFS to improve delineation of the plume extents southwest of the former Bendix facility and the NHOU extraction wells, with the caveat that additional investigation may be necessary if COC concentrations were elevated (which they are). However, groundwater flow modeling for the FFS indicated that contaminated groundwater in this area would be captured under the preferred alternative for the Second Interim Remedy. Therefore, it does not appear that delaying remedial design until further plume delineation is completed would help to meet the RAOs for the Second Interim Remedy. We recommend that complete delineation of the VOC, chromium, and 1,4-dioxane plumes extending from the former Bendix facility be conducted in parallel with remedial design; if necessary, the extraction network can be expanded or modified at a later date to ensure capture and treatment of contaminated groundwater in the area of monitoring wells NH-C18 and NH-C21. We also agree that additional investigation of VOC plume depths and extents in the area south and southeast (downgradient) from the Lockheed facility, in the area of wells NHE-7 and NHE-8, is important, although again should not be considered so critical as to be the cause of a significant delay in implementation of increased NHOU extraction pumping. As noted in the FFS, failure to capture some of the VOCs in this area was expected and is considered a tolerable limitation of the Second Interim Remedy.

16. Page 5-3, Section 5.2.3, second paragraph: To clarify, wells NHE-1 and the proposed three new extraction wells in the FFS are intended to intercept highly contaminated groundwater forecasted to be drawn from the former Bendix facility toward the southern Rinaldi-Toluca wells assuming LADWP implementation of the maximum pumping scenario. These wells were not "intended to compete with much larger-capacity production wells" as described in the Draft Data Gap Analysis. Regarding the statement that "little data exist to calibrate this (SFBFS) model at a site-specific scale appropriate to the NHOU area, particularly concerning vertical discretization," we recommend development of a site-specific model that incorporates the key features of the updated conceptual site model, calibrating it to the extent possible with available data, and evaluating where additional data are needed at that point. A significant quantity of data from numerous monitoring wells

are available now in the NHOU area—it is difficult to judge whether these data are insufficient for model calibration without knowing the details of the new site-specific model.

17. Page 5-3, Section 5.2.3, bottom (partial) paragraph: Again, it should be noted that the new extraction wells in the FFS were proposed to intercept potential migration of highly contaminated groundwater from the former Bendix facility to the southern Rinaldi-Toluca wells under LADWP's maximum pumping scenario. If new modeling indicates that such future migration is unlikely to impact the Rinaldi-Toluca wells, then that evaluation should be discussed in the Pre-Design Groundwater Modeling Memorandum.

18. Page 5-4, Section 5.2.4, second paragraph: As noted in the FFS, the Second Interim Remedy is acknowledged to incompletely capture contaminated groundwater in the area downgradient from wells NHE-7 and NHE-8. Our recommendation is to proceed with the RD effort consistent with the goals of the FFS, Proposed Plan, and ROD, which focus on improving hydraulic containment in the western part of the NHOU extraction well network (wells NHE-1 through NHE-6). Complete delineation of the VOC plume south and east of wells NHE-7 and NHE-8 should not be considered a critical data gap for RD of the Second Interim Remedy; however, further investigation in this area is important, and should continue in parallel with RD and remedy implementation.

19. Page 5-5, Section 5.2.5, second paragraph: A revised site-specific groundwater flow model based on the new conceptual site model (described in the Draft Data Gap Analysis) should be used to adjust planned depths of new and existing extraction wells, as part of the RD process. The FFS and ROD allow for modification of depths, locations, and numbers of extraction wells, based on data collected during the RD, to more efficiently and effectively achieve the RAOs of the Second Interim Remedy. It should be noted that past and future changes in groundwater levels in the basin (greater than 100 feet in the NHOU area) resulting from regional groundwater recharge and discharge from the basin, are likely to be significant factors in vertical spread of contamination in the eastern SFV, perhaps more than screen depths of the NHOU extraction wells.

20. Page 5-7, Section 5.3.2, first full paragraph: Please provide a reference or figure that explains the basis for the statement "Deepening NHE-1…could induce COC mass to migrate upgradient from the former Bendix facility."

21. Page 5-8, 5.3.4: Although Honeywell has agreed in principle to design and implement the NHE-2 treatment system, the AOC is not yet finalized (although it may be by the time this Data Gap report is finalized). If the AOC is not finalized, the treatment of water extracted from NHE-2 shall be included as work under this RD AOC. Please clarify this in the text, if the AOC is not signed before the final is due.

22. Page 5-8, Section 5.3.5, second paragraph: See our comments above regarding the new extraction wells.

23. Page 5-14, Section 5.6, bullet list of critical data gaps:

    i. *Incomplete understanding of the hydraulic parameters specific to the A-Zone and B-Zone:* Hydraulic parameters of the A-Zone and B-Zone can be estimated during modeling associated with the RD effort. If specific aquifer-property data gaps arise during model development, then recommendations should be provided in the Pre-Design Groundwater Modeling Memorandum.

ii. *Need projections of pumping and recharge volumes beyond year 2015:* A complete and accurate forecast of future pumping and recharge in the basin may never be available, simply because there are many unknowns regarding future water supply demands and availability. For RD of the Second Interim Remedy, we recommend that AMEC contact LADWP and the Watermaster to determine if their future projections are substantially different from what they provided for the FFS. If so, we see no conceptual problem with updating the groundwater flow model with the new information and proceeding with RD. Review of historical water levels should provide an indication of what might be expected in the next 10 to 30 years. In addition, a comparison of past pumping projections versus the actual pumping conducted would be useful to indicate how reliable the pumping projections actually are as an indicator for future pumping.

iii. *Performance monitoring wells needed to demonstrate size and shape of existing NHOU extraction well capture area, and evaluate well efficiency changes:* Performance monitoring wells should certainly be installed when the Second Interim Remedy is constructed. Different degrees of capture and extraction well configurations would be best analyzed using a model, and sensitivity analysis should be conducted to evaluate uncertainty of input parameters. Regarding the lack of drawdown measurements at each extraction well to evaluate efficiency declines and the need for rehabilitation, those data simply don't exist, as noted in the Draft Data Gap Analysis. So although this is a data gap, we don't see how it is relevant or actionable.

iv. *Existing numerical groundwater flow model is not sufficiently structured or discretized vertically for RD:* Agreed, the model should be updated, and a Predesign Groundwater Modeling Memorandum prepared. This was planned as part of the RD process.

v. *Vertical conduits have not been sufficiently evaluated to quantify the volume of groundwater and COC mass induced to depths below the A-Zone:* Please explain why this is critical to evaluate before designing the Second Interim Remedy. If increased pumping occurs in Depth Region 1 (or the A-Zone) under the Second Interim Remedy, downward hydraulic gradients between the A- and B-Zones would be expected to decrease (or upward gradients increase) in the areas with the highest contaminant concentrations. Certainly the proposed additional pumping contemplated under the Second Interim Remedy, with some of the adjustments to screened intervals discussed in the Draft Data Gaps Analysis, would likely have a significant beneficial impact on this assumed problem.

24. Page 5-15, Section 5.6, first paragraph: The first sentence states that "Not resolving each critical data gap before designing the Second Interim Remedy will cause a system failure with respect to achieving the RAOs." As noted in several of our comments above, we disagree that filling all of the data gaps noted above is critical prior to remedial design. It is likely that as more data are collected, and this is true of any remediation system, adjustments and optimization will be necessary to ensure that RAOs are achieved to the extent practicable. In this case, where an improved interim remedy is proposed (as opposed to a final remedy for site cleanup), we believe that expedited action would have a net beneficial effect on hydraulic containment of contaminated groundwater, even if some data gaps must be filled during or after the remedial design process.

25. Page 6-1, Section 6.1.1, Bullet 2 (Recommendation to collect depth discrete samples from NHE-1 and NH-10): Similar to the previous comment, the proposed sampling effort would be relatively easy and inexpensive (compared to construction of new monitoring wells). This effort could be conducted relatively quickly without delaying the RD.

26. Page 6-2, Section 6.1.1, Bullet 4 (Recommendation to obtain quarterly groundwater level measurements from monitoring wells): This effort would be very easy and inexpensive, but might require substantial time depending on how many quarters of data are perceived as being required. These data could be collected throughout the RD process.

27. Page 6-2, Section 6.1.1, Bullet 5 (Recommendation to collect groundwater samples and vertical flow logs from selected RI monitoring wells, to evaluate vertical flow): If most of additional remedial pumping under the Second Interim Remedy would occur in the A-Zone, then vertical gradients would decrease, rather than increase. We don't see how this is a critical data gap to resolve before RD, but agree it would be helpful to resolve during RD.

28. Page 6-2, Section 6.1.1, Bullet 6 (Recommendation to review and adjust survey points for monitoring wells): This action would be helpful, inexpensive, and relatively easy to do. We don't see that it's a critical data gap to resolve before RD, but recommend proceeding concurrent with RD. As noted in previous comments, we recommend resurveying the wells that have not been surveyed in the past 10 years, also during RD.

29. Page 6-2, Section 6.1.2, Bullets 1 and 2 (Recommendation to perform slug tests at selected monitoring wells): We feel it would be more expedient and yield equal (or better) results than slug testing to analyze aquifer properties using an updated groundwater flow model or use deconvolution methods (which may require setting pressure transducers down these wells for a period of several months). This effort could be conducted during, rather than before, construction of the updated flow model, as part of the RD process.

30. Page 6-3, Section 6.1.4, Bullets 2 through 4 (Collaboration with LADWP to modify selected production wells): The points made in these bullets are good ideas, but we fail to see how they are critical prior to RD.

ULARA Watermaster

31. In many of the wells, no well or pump rehabilitation has been undertaken for years; perforations are likely plugged to varying degrees. Thus, no one knows from what depth the groundwater is actually entering the well under pumping conditions. Recovery and extraction wells (and their pumps) should be subjected to regular periods of O&M.

32. There is some discussion of replacing NH EX-1; however, it is reported by AMEC that no one seems to know why this well has low production and a low specific capacity, even though it is perforated in essentially the same zones as other NH EX wells, and it is not located too distant from these other wells. Watermaster review of available data reveals NH EX-1 was drilled using bentonite mud (direct rotary) methods. Furthermore, because it was drilled in the late-1980's, one needs to be aware that a mud dispersant commonly used at that time was sodium acid pyrophosphate (SAPP). A major drawback, and one that became known by the early-to mid-1990's, was that SAPP was a nutrient and caused a rapid and large

scale buildup of bacterial slimes/growths (biofilm) in wells. Also, it is highly likely that remnant bentonite from drilling is still in the well and gravel pack. Before spending a lot of money to replace NH EX-1, consider conducting an initial video log, followed by wire brushing, and bailing sediment fill, and then conducting superchlorination and the use of Aquaclear PDF or a similar mud dispersant that is not a nutrient.

33. Different extraction/recovery and/or wellfield wells have different perforation intervals and these various perforation intervals are in separate aquifer zones. Fortunately, AMEC has provided its interpretation of their independent correlation of resistivity signatures on numerous available E-logs (see AMEC Cross Sections A-A' through F-F'); these correlations are considered to be more "accurate" and more objectively-based, relative to the interpretations of drillers' logs and/or limited geologic logs that were used by prior investigators (JMM and CH2MHILL) to provide their original definitions of model layers in the eastern portion of the San Fernando Valley. Prior to finalizing these newly-proposed AMEC model layers, the Watermaster recommends that AMEC meet to gain consensus of E-log correlations from well to well in the area (certain zones, like the "B" zone on the AMEC cross sections, are acceptably correlated but certain other zones, could be revised). This meeting should also include EPA representatives.

Minor Comments

CH2M HILL and EPA comments

1. Page x, Section ES.1, fourth paragraph: The first sentence of this paragraph includes the statement "…however, the extraction wells were prone to dewatering…" Not all of the extraction wells are prone to dewatering. It is recommended that this phrase be changed to "…however, some of the extraction wells commonly produce less than 300 gpm…"
2. Page xi, Section ES.2, second bullet in top half of page: The word "concentration" between "maximum" and "levels" should be changed to "contaminant."
3. Page xii, Section ES.3: Three out of five of the bullet points in this section describe data gaps, rather than the conceptual site model. It would be helpful if more of the conceptual site model were summarized in this section.
4. Page xii, Section ES.3, second and fifth bullets: These bullets do not describe the refined NHOU conceptual site model (the title of this section); rather, they describe data gaps and uncertainties. This section would flow more logically if the second and fifth bullets were separated from the other three (which do relate to the conceptual site model), and had a distinct introductory statement.
5. Page xii, Section ES.3, third bullet: This bullet should be modified to clarify that *recent data indicate* that groundwater flow is to southeast below the Hewitt Pit and former Bendix facility. At various times in the past, available data have indicated or suggested other directions of groundwater flow beneath these facilities, specifically to the northeast below Hewitt Pit, and to the southwest below the former Bendix facility.
6. Page 3-7, Section 3.1.2.2, first paragraph: The third sentence states that "…releases from many facilities occurred throughout the eastern SFV," referring to industrial waste discharges in the 1940s and 1950s. Please provide a reference or data to support that statement.
7. Page 3-22, 3.2.6.4, last paragraph, last sentence: Please add the word "potential" as follows: "Table 3-8 lists the *potential* source areas…"

8. Page 3-23, Section 3.2.7, third paragraph (below bullets): The first sentence of this paragraph states that "Wells with maximum TCE, 1,4-dioxane, and hexavalent chromium concentrations are hydraulically contained by former Bendix facility onsite extraction wells." Please provide a reference to a figure (perhaps in another report) that illustrates where the maximum TCE, 1,4-dioxane, and hexavalent chromium concentrations occur, and their relation to the onsite extraction wells. April 2011 data provided in Honeywell's Second Quarter 2011 monitoring report for the former Bendix facility indicates that the maximum TCE concentration was detected at well GW-19A, which appears to be outside the containment zone of onsite extraction wells.

9. Page 4-3, Section 4.1.3, fifth (partial) paragraph at bottom of page: The first sentence of this paragraph states that "Stratified groundwater quality is suggestive of multiple hydrostratigraphic units, however hydraulically similar they may be otherwise." It should be noted that depth-varying contaminant concentrations (stratified groundwater quality) could also result from vertical anisotropy within a single hydrostratigraphic unit, horizontal or upward hydraulic gradients, or changing redox potential with increasing depth (affecting geochemical properties or biodegradation rates).

10. Page 4-4, Section 4.2, third paragraph: The second sentence of this paragraph states that "This degree of modification suggests the model is insensitive to moderate variations in hydraulic conductivity" (increasing hydraulic conductivity by 50 percent). We would suggest first that a 50 percent change in hydraulic conductivity is minor, not moderate (hydraulic conductivity of alluvial deposits can vary by an order of magnitude or more as a result of a subtle change in grain size distribution). Secondly, the 50% change in model hydraulic conductivity resulted in notable improvement in calibration statistics, indicating the model is not "insensitive" to hydraulic conductivity.

11. Page 4-5, Section 4.3.1, second paragraph: The second sentence of this paragraph states that "Groundwater beneath the northern landfills (including the Penrose, Strathern, Newberry and Tujunga Pit) flows to the southwest toward the southern portion of the Rinaldi-Toluca production well field." The hydraulic gradient shown on Figure 3-7b does not suggest a flow direction from these landfills toward the Rinaldi-Toluca well field. We suggest clarifying this statement appropriately.

12. Page 4-11, Section 4.5.1, fifth paragraph: The ordinary kriging method used for contouring the data in the Draft Data Gaps Analysis is suitable for the intended purpose, but does not account for the known effects of groundwater flow and transport on contaminant distribution. There is not a practical (cost effective and more accurate) alternative to using the ordinary kriging method. However, it should be recognized that this approach is purely statistical, rather than deterministic, and will tend to result in higher estimated concentrations up- and cross-gradient from sources than would be expected to actually occur.

13. Page 4-26, Section 4.6.2, fourth full paragraph: The reason that mass removal at NHE-7 is greater than at NHE-2 may be due to the significantly larger volume of water extracted at NHE-7 over the years. This possibility should be explored and mentioned in this paragraph.

14. Page 4-27, Section 4.7.1, first paragraph: This paragraph notes that "Various subunits have been identified within the SFB based on geophysical signatures and lithology, but in general, many of the identified units are difficult to correlate across

the SFB without use of down-hole geophysical data." Given the fact that the basin-fill consists of alluvial and fluvial deposits, influenced by significant tectonic activity and multiple sources of basin fill materials (four different mountain ranges immediately adjacent to the eastern SFV), it seems likely that many of the subunits would have limited extent. In other words, one might not expect many, or any, lithologic subunits to be capable of being correlated across the SFB.

15. Page 4-28, Section 4.7.1, second paragraph: This section notes that past low-flow sampling may only provide representative concentration data for the depth of the sample. However, MWH conducted low-flow sampling at various depths at select monitoring wells at the former Bendix facility approximately five years ago, to determine whether there was significant variability with depth. Those results should be reviewed and used to update this section, before stating that collection of additional depth-specific samples from within a single well screen interval would be a critical data gap.

16. Page 5-3, Section 5.2.2, second bullet: Hexavalent chromium concentrations are shown on Figures 4-10a/b of the Draft Data Gap Analysis rather than Figures 4-9a/b, as indicated in the bullet. More importantly, there are some confusing statements in this comment that should be clarified. First, based on Figure 4-10a, the highest hexavalent chromium concentration in this area appears to occur at well NH-C18, not wells NH-C19 and NH-C21. Based on the plume delineations depicted on Figures 4-10a/b, as well as in Honeywell's monitoring quarterly monitoring reports for the former Bendix facility, the historically dominant direction of chromium plume migration has been south and southwest, toward wells NH-C18 and NH-C21, despite recent groundwater level contours indicating that these wells are "cross-gradient" from the Honeywell facility.

17. Page 5-5, section 5.3.1: Honeywell installed 31 wells; however, five of them were not identified in the EPA's Focused Feasibility Study – leaving 11 of the original FFS wells that have not been installed (list below). However, please note that there is no specific requirement in the AOC that these wells be installed as part of the remedial design – our agreement was only that they would be installed if information from them is required for design.

Category	EPA Well ID	Comments
i. Sentinel Well	B2-2	Sentinel wells for RT
ii. Sentinel Well	B-3-2	Sentinel Wells for RT
iii. Sentinel Well	B4-2	Sentinel wells for RT
iv. Remedy Selection	C2-2	Delineate Lockheed plume at depth
v. Remedy Selection	C2-3	Delineate Lockheed plume at depth
vi. Sentinel Well	C3-1	Monitoring NHOU/BOU Boundary
vii. Sentinel Well	C3-2	Monitoring NHOU/BOU Boundary
viii. Sentinel Well	E2-2	Delineate southern hot spot potentially approaching Whitnall wells
ix. Sentinel Well	E2-3	Delineate southern hot spot potentially approaching Whitnall wells
x. Sentinel Well	F2-2	Sentinel well for NH-west production well field
xi. Sentinel Well	G1-1	Sentinel well for R-T well field (may not be necessary due to depth to gw)

18. Page 5-6, Section 5.3.1, first (partial) paragraph at top of page: See our comment above regarding depth-specific (low-flow) sampling.

19. Page 5-6, Section 5.3.1, third full paragraph: See our comment above regarding surveying.

20. Page 5-8, Section 5.3.5, third paragraph: Please explain the statement: "Given significant uncertainty…there appears to be little potential for COCs to migrate westward." It is not clear how significant uncertainty can lead to such a firm conclusion about contaminant migration.

21. Page 5-10, 5.4, 4th bullet: Strike "(contamination concentration at or below acceptable risk levels)".

22. Figure 4-2f: The screened interval shown for well NHE-1 appears to be deeper than indicated by well construction data. Please verify that the screened interval for this well is depicted accurately on the cross section shown on Figure 4-2f.

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23. In many water wells in the area, the depth setting for the pump intake is either not known accurately or not known at all. In these or other wells, the pump intake is either directly opposite a section of perforated casing or is set below the top of the uppermost perforations; cascading water conditions may occur in some of these wells. Whenever cascading water conditions occur in a well, volatilization of VOCs will take place.

24. One way to help minimize problems related to the natural decline in pump efficiency and cascading water conditions as water levels decline in the area is to use variable frequency drive (vfd) pumps in all recovery/extraction wells.

25. Table 3-2 on Rainfall uses the term "Delta Average", but the definition was not clear nor the use of this term for the analyses. If rainfall is to be used for trend analyses of static water levels in wells over time, then the use of a curve of the accumulated departure of rainfall is a more viable tool.

Regional Board (none provided)

26. ES, Page xiv: ES-5: 3rd bullet makes reference to suspected sources. What was used as the basis to conclude that there are suspected sources. Perhaps a reference to Section 3.2.6 could be added.

27. ES, Page xiv: ES-5, 4th bullet makes reference to groundwater elevation differences between ULARA Watermaster and USEPA FFS. What created these differences and which one is more accurate and representative? Were different calculations, models, or assumptions, etc. used? The different groundwater elevations for future work could have a significant impact on pumping rates (i.e., LADWP) to be used in the NHOU for contamination plume containment.

28. Section 1.1, Page 1-1, Bullet D: Has LADWP provided these pumping rates and how will the differences in calculated groundwater elevations affect the "Data Gap Analysis (DGA)?"