Groundwater
Pre-Design Activities Report
Union Pacific Railroad Yard
Sacramento, California

Prepared *for*

Union Pacific Railroad Company

UNION PACIFIC

By

Dames & Moore

June 1995

GROUNDWATER
PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

DAMES & MOORE

SAC153.08

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June 20, 1995

Mr. James L. Tjosvold, P.E. Branch Chief
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Region 1, Department of Toxic Substances Control
California Environmental Protection Agency
10151 Croyden Way, Suite 3
Sacramento, CA 95827

Attention: Mr. Jose Salcedo

Re: Groundwater Pre-Design Activities Report
Union Pacific Railroad Yard
Sacramento, California
Dames & Moore Project No. 00173-080-044

Dear Mr. Salcedo:

At the request of the Union Pacific Railroad Company (UPRR), Dames & Moore is forwarding to you the enclosed Report for Groundwater Pre-Design Activities at the above-referenced site. Presented in the report are the following:

- results of additional off-site groundwater characterization;
- capture zone evaluation of the on-site groundwater Interim Remedial Measures (IRM);
- results of aquifer parameter evaluations;
- results of groundwater modeling; and
- recommendations for expanding the current groundwater IRM extraction well field.

Dames & Moore would like to schedule a meeting to discuss the contents of this report at your earliest convenience. We will contact you to schedule this proposed meeting within the next several days.

SAC153.08

If you have any questions or require any clarification, please contact Jim Brake at (916) 387-7530.

Sincerely,

DAMES & MOORE

for Mark Eisen
Project Hydrogeologist

Jim Brake, R.G.
Project Manager

John Fawcett, P.E.
Senior Engineer

Enclosure

SAC153.08

DISTRIBUTION LIST: **UNION PACIFIC RAILROAD YARD**
SACRAMENTO, CALIFORNIA
PROJECT NUMBER 00173-080-044

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1.0 INTRODUCTION

Presented in this report are the results of pre-remedial action design activities for groundwater operable unit GW-1 (GW-1) and groundwater operable unit GW-2 (GW-2) at the Union Pacific Railroad Yard, Sacramento, California (Figure 1). Pre-design activities were performed in response to comments provided by the California EPA, Department of Toxic Substances Control (DTSC) on the Revised Draft Remedial Action Plan (Dames & Moore, 1993b). Pre-design activities were conducted in accordance with the DTSC-approved Pre-Remedial Action Design Activities Groundwater Operable Unit GW-1 Work Plan (Dames & Moore, 1994c). This report provides conclusions and recommendations from groundwater pre-design activities, including the rationale and approach for expanding the GW-1 groundwater remedy.

1.1 BACKGROUND

GW-1 and GW-2 are defined as groundwater that has been impacted by chlorinated volatile organic compounds (VOC) and, to a lesser extent, by nickel at concentrations exceeding State or Federal maximum concentration limits (MCL) for drinking water (Dames & Moore, 1994a). GW-1 is further defined as groundwater containing aromatic compounds exceeding MCLs. GW-1 and GW-2 are shown in Figure 2. GW-1 extends from the Central Fill Area in the inactive portion of the railyard approximately 5,200 feet to the southeast. GW-2 extends from the former Maintenance Shop Area in the inactive portion of the railyard approximately 700 feet to the southeast.

Groundwater investigations were begun at the site in 1987. Groundwater impacts have been evaluated using a combination of quarterly monitoring well sampling and Hydropunch (HP) in situ groundwater sampling. A combination of test pits, soil borings, borehole geophysics, and cone penetration testing (CPT) has been used to evaluate site stratigraphy. To date, a total of 116 soil borings have been drilled on- and off-site; 46 of these soil borings were completed as groundwater monitoring wells, 11 as piezometers, and 5 as soil vapor extraction wells. From 1990 to 1994, a total of 113 CPT exploratory holes were completed and 219 HP samples collected and analyzed. Groundwater monitoring well, piezometer, and CPT/HP exploratory hole locations are shown on Figure 3.

Interim remedial measures (IRM) have been implemented for the on-site portion of GW-1 and GW-2. The GW-1 IRM extraction wells and treatment system have been in operation since April 1993. Groundwater is being extracted from first hydrostratigraphic zone (HSZ) wells MW-4 and MW-32 at flow rates of approximately 20 and 13 gallons per minute (gpm), respectively. The GW-2 groundwater extraction system began operating in October 1994. Groundwater is being extracted from GW-2 in first HSZ well EW-1 at a flow rate of 10 gpm. Extraction well locations are shown in Figure 3.

1.2 PURPOSE AND OBJECTIVE

The purpose of GW-1 and GW-2 pre-remedial action design activities were to gather additional data and conduct evaluations required for the design of the GW-1 and GW-2 groundwater remedy, mandated by the Draft Remedial Action Plan (Dames & Moore, 1994a). In developing the scope of the pre-remedial action design activities, several objectives were identified. The objectives included:

- Further evaluation of the off-site extent of GW-1;
- Evaluation of the effectiveness of the on-site GW-1 and GW-2 groundwater IRM;
- Further assessment of aquifer characteristics in the first and second HSZs, both on- and off-site; and
- Evaluation of optimal extraction well field scenarios and associated flow rates for groundwater remedial design.

1.3 REPORT FORMAT

Section 2.0 presents a summary of previous groundwater investigation results. Section 3.0 summarizes field investigation methodology for the pre-remedial action design activities. Section 4.0 presents a discussion of field investigation data analyses and results. Section 5.0 summarizes the groundwater modeling approach, model development, model calibration, and the results of predictive groundwater flow and transport simulations. Section 6.0 presents conclusions drawn from the results of groundwater pre-design activities and recommendations for expanding the current groundwater remedy. References cited in the report are listed in Section 7.0.

2.0 PREVIOUS GROUNDWATER INVESTIGATIONS

Previous investigations of the lateral and vertical extent of VOC impacts in GW-1 and GW-2, both on- and off-site, have demonstrated that groundwater is contained in three separate and relatively distinct water-bearing geologic units, or hydrostratigraphic zones (HSZ). Each HSZ is defined by a stratigraphic layer of saturated, relatively permeable sediment (sand and silt) separated from other HSZs by less permeable sediment (silt and clay mixtures). Groundwater tends to flow laterally to the southeast within each HSZ, although some degree of vertical flow as leakage between the HSZs has been demonstrated. Drilling of borings for well installation, exploratory soil borings, and CPTs have shown that the first HSZ extends from first groundwater encountered, approximately 25 to 30 feet below ground surface (bgs) to approximately 55 feet bgs. The second HSZ extends from approximately 70 to 80 feet bgs, and the third HSZ extends from approximately 115 to 125 feet bgs. A more detailed description of the stratigraphy is presented in Section 4.0.

Previous investigations of VOC impacts in groundwater consisted of CPT combined with in situ groundwater sample collection using a HP tool and groundwater monitoring well installation, sampling, and analysis. On-site impacts to groundwater were initially evaluated using groundwater monitoring wells. Results indicated VOC impacts to groundwater had migrated off-site. Subsequently, several CPT/HP programs were performed to delineate the off-site lateral and vertical extent of VOC impacts in GW-1 (Figure 3). Off-site groundwater monitoring wells were then installed in locations based on the results of analysis of HP samples. The wells were installed both to confirm the results of the CPT/HP investigations, and to enable continued monitoring of VOC concentrations in the off-site portion of GW-1.

A brief summary of previous investigations and their results is provided below. The investigations are relative to each HSZ targeted.

2.1 PREVIOUS FIRST HSZ INVESTIGATIONS

The initial evaluation of VOC impacts to the first HSZ was completed with the installation of 30 on-site first HSZ groundwater monitoring wells, between 1987 and 1990 (Dames & Moore, 1991b). Groundwater analytical results from monitoring well samples indicated that groundwater beneath the site contained chlorinated VOCs and, to a lesser extent, aromatic VOCs. Additionally, results indicated chlorinated VOC impacts to groundwater had migrated off-site to the southeast.

During 1990, a total of 61 CPT exploratory holes were completed and 120 HP in situ groundwater samples collected at off-site locations to assess the lateral extent of off-site groundwater impacts in the first HSZ (Dames & Moore 1990a and 1991a). Results indicated that chlorinated VOC impacts to groundwater occurred in the first HSZ along a plume approximately 400 feet wide, extending approximately 3,200 feet off-site to 18th Avenue. Results were used to position five off-site first HSZ groundwater monitoring wells (MW-34, MW-35, MW-36, MW-38, and MW-39) installed in 1991 (Dames & Moore 1991c and 1992a).

During 1991, two CPT exploratory holes were completed and 14 HP in situ groundwater samples collected in the Central Fill Area of the site to further assess the source area of chlorinated VOCs in groundwater (Dames & Moore, 1991c). HP groundwater analytical results indicated the source area of chlorinated VOC impacts appears to be the Central Fill Area of the site. Two groundwater monitoring wells (MW-42 and MW-43) were installed in this area.

In November 1991, an on-site first HSZ aquifer pumping test was completed to evaluate aquifer characteristics (Dames & Moore, 1992b). During the test, monitoring well MW-4 was pumped at a constant rate of 60 gpm for 72 hours, and water levels were recorded in several nearby monitoring wells. Drawdown data was used to estimate hydraulic conductivity *(K)* and storativity *(S)* of the first HSZ. First HSZ estimates of approximately 250 ft/day and 0.07 were calculated for *K* and *S*, respectively.

In 1992, groundwater flow modeling was used to design the on-site GW-1 groundwater IRM extraction well field (Dames & Moore, 1992d). Aquifer pumping test data, and existing hydrogeologic data from past investigation activities, were used as model input. Model results indicated that further off-site migration of GW-1 first HSZ VOC impacts could be prevented by extracting groundwater from on-site monitoring wells MW-4 and MW-32. Operations of the GW-1 IRM began in April 1993.

In 1993, the groundwater flow model used for GW-1 extraction well field design was modified to evaluate groundwater extraction well field design for first HSZ VOC impacts in GW-2 (Dames & Moore, 1994d). Model results indicated that one extraction well operating in the southeast corner of the site could prevent further off-site migration of VOC impacts. Extraction well EW-1 was installed in the southeast corner of the site and began operations in October 1994.

2.2 PREVIOUS SECOND HSZ INVESTIGATION

The initial evaluation of VOC impacts to the second HSZ consisted of the installation of three on-site second HSZ groundwater monitoring wells (MW-12, MW-27, and MW-28), between 1989 and 1990 (Dames & Moore, 1991b). Laboratory analytical results indicated groundwater within the second HSZ contained chlorinated VOCs, and that impacts had migrated off-site. In 1991, two additional second HSZ groundwater monitoring wells (MW-37 and MW-40) were installed and sampled to further evaluate off-site second HSZ impacts (Dames & Moore, 1991c and 1992a). Results indicated groundwater impacts to the second HSZ had migrated south of Sutterville Road.

In 1992, 18 CPT exploratory holes were completed and 18 HP in situ groundwater samples collected to further assess the off-site extent of VOCs in the second HSZ (Dames & Moore, 1992c). Results indicated the lateral extent of impacts to the second HSZ did not extend beyond the area of first HSZ impacts. Groundwater monitoring well MW-44 was installed based on the results of analyses of HP samples collected off-site in the second HSZ. This well was installed in the second HSZ on Arlington Avenue, along the south side of the Sacramento Children's Home (Figure 3). Relatively low concentrations of VOCs were reported for samples collected from MW-44, as compared to results from MW-37, the nearest upgradient second HSZ monitoring well.

2.3 PREVIOUS THIRD HSZ INVESTIGATION

Previous investigation of the third HSZ consisted of installation and monitoring of groundwater monitoring well MW-41 (Figure 3). This was done to assess whether VOC impacts in the second HSZ had leaked to the third HSZ. The location of this well, near the former Oil House Area of the site, was selected based on results of monitoring of first and second HSZ wells in this area. Some of these wells had the highest concentrations of VOCs on the site. Since monitoring of MW-41 began in June 1991, VOCs have never been detected in samples from this well (Dames & Moore, 1995a).

3.0 FIELD INVESTIGATION ACTIVITIES

This section presents a discussion of the field activities completed as part of groundwater pre-design activities. Field activities were conducted in accordance with the Groundwater Pre-Remedial Action Design Activities Work Plan (Dames & Moore, 1994c). These activities include additional off-site groundwater characterization, IRM capture zone evaluation, and aquifer pumping tests. A detailed discussion of field procedures followed during this investigation is provided in standard operating procedures (SOPs) presented in Appendix A.

3.1 ADDITIONAL CHARACTERIZATION OF OFF-SITE GROUNDWATER OPERABLE UNIT GW-1

This section describes the investigation activities performed to delineate the downgradient extent of VOCs in the first and second HSZs and to further assess whether VOCs may have impacted the third HSZ. Activities performed for this investigation included:

- A CPT/HP investigation in the first HSZ, downgradient of first HSZ well MW-39;
- Installation and monitoring of first HSZ well MW-45, based on the results of the first HSZ CPT/HP investigation;
- Installation and monitoring of second HSZ well MW-46, downgradient of second HSZ well MW-44; and
- Installation and monitoring of third HSZ well MW-47, downgradient of third HSZ well MW-41.

Investigation activities performed are described below.

3.1.1 Off-Site CPT/HP Investigation

This portion of the off-site groundwater investigation consisted of performing two series of CPT and HP sample collections in the first HSZ. The purpose of this investigation was to delineate the downgradient extent of VOC impacts in the first HSZ. These data would then be used to select a location for a first HSZ groundwater monitoring well near the downgradient edge of the plume.

The first series of CPT/HP consisted of 8 CPTs and 15 HPs along 19th Avenue at the locations shown on Figure 4. The CPT/HP locations were intended to form a line across the axis of GW-1, roughly perpendicular to the southeasterly groundwater flow direction. These locations were chosen for the first series of CPT/HP because 19th Avenue is the first street downgradient of MW-39 which, prior to this investigation, was the furthest-downgradient monitoring point in the first HSZ. The second series of CPT/HP consisted of 5 CPTs and 10 HPs collected on 21st Avenue (downgradient of 19th Avenue).

Prior to collecting HP samples, a CPT was performed in each of the HP sampling locations. Each CPT produced a stratigraphic log representing the grain size of the material penetrated by the CPT tool. These stratigraphic data were used to select the most appropriate depths from which to collect HP samples. Because of the interlayered nature of the stratigraphy in the first HSZ, two stratigraphic intervals within the first HSZ were selected for sampling in each location. The intervals selected were the two that appeared on the CPT stratigraphic log to be the most permeable. Collecting HP samples from two separate stratigraphic intervals within the first HSZ in each location was intended to ensure that representative first HSZ samples were collected.

Each HP sample was submitted to D&M Laboratories of Petaluma, California for analysis by EPA Method 601 on a "24-hour rush" turnaround basis. Samples were analyzed on a rush basis so that the locations of each day's CPT and HP sample locations could be based on the previous day's results. The results of chemical analysis of HP samples are presented in Section 4.0.

A detailed description of the CPT/HP methodology is presented in Appendix A. CPT logs are included in Appendix B. The CPT/HP locations were surveyed by a California-licensed surveyor.

3.1.2 Off-Site Monitoring Well Installation

Three off-site monitoring wells were installed during 1994 to further evaluate off-site groundwater impacts. Well locations are provided on Figure 3 and well completion details are provided in Table 1. A detailed description of field procedures is presented in SOPs provided in Appendix A. Boring and well completion logs are provided in Appendix B.

3.1.2.1 First HSZ Groundwater Monitoring Well

Monitoring well MW-45 was installed on 19th Avenue (Figure 3) based on the results of analysis of HP samples collected beneath 19th and 21st Avenues (Section 4.0). The objective of installing this well was to confirm the results of analysis of HP samples and to allow continued monitoring of VOC concentrations near the downgradient edge of the GW-1 plume in the first HSZ. The well was installed near the locations of the two HPs on 19th Avenue that had the most detections and highest concentrations of VOCs (HP-107 and HP-108, Figure 4).

MW-45 was installed using hollow stem auger drilling techniques. The screen interval of MW-45 is from 31.5 to 46.5 feet bgs (Table 1). Approximately five feet of well screen was installed above, and ten feet below the water table, as measured during drilling and installation of this well. The location and elevation of the well head was surveyed by a California-licensed surveyor following completion of the well.

Monitoring well MW-45 was sampled in July and November 1994, and January 1995. Samples collected from this well were analyzed for VOCs by EPA Method 601. Results of monitoring of MW-45 (and MW-39 for comparison) are presented in Section 4.0.

3.1.2.2 Second HSZ Groundwater Monitoring Well

Groundwater monitoring well MW-46 was installed in the second HSZ, adjacent to MW-39 on 18th Avenue (Figure 3). The objective of installing this well was to enable monitoring of VOC concentrations near the downgradient edge of the GW-1 plume in the second HSZ. The location of this well was selected based on concentrations of VOCs reported for samples collected from the previously furthest downgradient second HSZ well (MW-44) and HP samples collected in 1992 from the second HSZ beneath 18th Avenue.

MW-46 was installed using the mud-rotary drilling method. The screen interval of MW-46 is from 69.0 to 79.0 feet bgs (Table 1). A conductor casing was installed during construction of this well from the ground surface to immediately beneath the base of the first HSZ to minimize the potential for cross-contamination to occur between the first and second HSZs. Following completion, the well head elevation and location were surveyed by a California-licensed surveyor.

MW-46 was sampled in July and November 1994, and January 1995 during quarterly monitoring of on- and off-site wells. Samples collected from this well were analyzed for VOCs by EPA Method 601. Results of monitoring of MW-46 (and MW-44 for comparison) are presented in Section 4.0.

3.1.2.3 Third HSZ Groundwater Monitoring Well

In their comments on the Revised Draft Remedial Action Plan (Dames & Moore, 1993b), the DTSC expressed a concern that the one existing third HSZ well, MW-41 (Figure 3), could potentially be located upgradient of, and therefore missing, VOC impacts to the third HSZ that could have potentially leaked down from the second HSZ. To address the DTSC's concern, groundwater monitoring well MW-47 was installed in the third HSZ at the northwest corner of the Sacramento Children's Home (Figure 3). The objective of installing this well was to enable monitoring of VOC concentrations in the third HSZ, downgradient of MW-41. This location is approximately 1,300 feet downgradient of MW-41 (Figure 3) and is also downgradient of second HSZ wells that have the highest concentrations of VOCs (MW-37 and MW-40).

Well MW-47 was completed at a total depth of 124 feet bgs and is screened from 114 to 124 feet bgs (Table 1). This well, like MW-41, was installed through two separate conductor casings, one through the first HSZ, and another through the second HSZ, to minimize potential cross-contamination between each HSZ. Following completion, the well head location and elevation were surveyed by a California-licensed surveyor.

MW-47 was sampled as part of quarterly groundwater monitoring of on- and off-site wells during July and November 1994, and January 1995. Samples were submitted to D&M Laboratories for analysis of VOCs by EPA Method 601. The results of analysis of samples collected from MW-47 are presented in Section 4.0.

3.2 ON-SITE IRM CAPTURE ZONE EVALUATION

This section presents a discussion of field activities completed to evaluate GW-1 and GW-2 IRM extraction well field capture zones. The present on-site groundwater extraction and treatment system began operation in April 1993 using GW-1 extraction wells MW-4 and MW-32. In October 1994, GW-2 groundwater extraction well EW-1 was added to the system. This system is considered an IRM (Dames & Moore, 1992d and Dames & Moore, 1994d) and was approved as such by the DTSC. The objective of the IRM extraction well field is to prevent further off-site migration of VOCs in groundwater within the first HSZ of GW-1 and GW-2 (Figure 2). The purpose of the on-site IRM capture zone evaluation was to address the adequacy of the capture zone of the existing extraction well field and to assess if modifications are needed before finalizing the on-site first HSZ GW-1 and GW-2 extraction well field design.

3.2.1 GW-1 IRM Capture Zone Evaluation

An evaluation of the GW-1 IRM capture zone was conducted to determine whether the current extraction well field provides a sufficient capture zone. The scope of this evaluation included the measurement of steady-state drawdown water levels induced by pumping from wells MW-4 and MW-32 and water levels when the wells were not pumping. These water levels were used to construct capture zone maps.

Steady-state drawdown is a measure of the hydraulic influence induced by pumping from a well and can be used to estimate capture zone dimensions. This evaluation of steady-state drawdown was performed by collecting a set of water levels from most on-site wells after hydraulic effects of pumping had reached steady state, then collecting another set of water levels after the pumps were turned off and water levels had recovered to "non-pumping" steady state levels. Steady-state water levels were collected in August 1994 and in February 1995.

In August 1994, water levels were collected from 33 wells over a period of 9 days. To measure water levels more frequently than could be done manually, monitoring wells MW-2, MW-11, MW-13, MW-15 and MW-19 were equipped with pressure transducers and dataloggers for electronic water level monitoring. Barometric pressure was also monitored electronically. Extraction wells MW-4 and MW-32 were run continuously at flow rates of 20 gpm and 13 gpm, respectively, for a 16-day period to allow drawdowns to reach steady-state. Water level trends were monitored manually and electronically for three days prior to shutting off the extraction wells. Datalogger-derived water levels were used to ensure steady-state pumping conditions had been attained. Prior to shutting off the extraction wells, manual water levels were collected from all 33 observation wells. The extraction wells were then shut off and water levels allowed to recover to steady-state, non-pumping levels. Electronically-monitored water levels were used to evaluate when recovery was complete. When recovery was complete, an additional round of water levels was collected.

Steady-state drawdowns were calculated for each well by subtracting steady-state pumping water levels from steady-state, non-pumping water levels. Steady-state drawdown values were used to assess the area over which pumping effects were observed. Steady-state pumping water levels were contoured and used to estimate capture zones for extraction wells MW-4 and MW-32.

In February 1995, steady-state pumping water levels were re-evaluated for confirmation of drawdowns observed in the August 1994 evaluation. Water levels from all monitoring wells, extraction wells and piezometers were collected during a 6-hour period on February 23, 1995. Extraction wells MW-4 and MW-32 had operated continuously for 18 days. Additionally, extraction well EW-1 had operated continuously for 9 days prior to collecting water level measurements. The steady-state drawdown evaluation completed in August 1994 demonstrated that these times are sufficient for development of steady-state pumping conditions. Again, water levels were contoured and used to estimate capture zones for extraction wells MW-4 and MW-32.

3.2.2 GW-2 IRM Capture Zone Evaluation

Water levels in EW-1 were monitored during the week of February 6, 1995 to estimate the size of the capture zone created by this extraction well. EW-1 was shut off for several days prior to testing. EW-1 was then restarted at a flow rate of 8 gpm and water levels were monitored by hand over a period of four days. EW-1 was then shut off and recovery water levels were monitored. Drawdown and recovery data were used to estimate aquifer parameters, transmissivity *(T)* and storativity *(S)* of the first HSZ in this area of the site. Estimates of *T* and *S* were used in an analytical model to estimate the capture zone dimensions.

3.3 AQUIFER PUMPING TESTS

Aquifer pumping tests were conducted in the first and second HSZs, using existing extraction and monitoring wells located both on- and off-site. The purpose of these pumping tests was to provide estimates of aquifer parameters for the first and second HSZ along the site boundary and near the downgradient extent of groundwater impacts. Aquifer parameter estimates were required for groundwater modeling used to design the GW-1 groundwater extraction well field expansion.

Aquifer pumping test activities were partitioned into on-site and off-site aquifer testing. The focus of the on-site tests was the first and second HSZs and the aquitard separating the first and second HSZs. First HSZ extraction well MW-32 and second HSZ monitoring well MW-40 were used for on-site pumping wells. The off-site tests evaluated the effects of pumping in both the first and second HSZs. Monitoring wells MW-38 and MW-44, completed in the first and second HSZs, respectively, were used for off-site pumping wells. Well locations are shown in Figure 3. Existing monitoring wells were used as water level observation wells where possible. To provide additional water level observation stations during pumping tests, piezometers were installed at select locations in the vicinity of each pumping well. Both step drawdown pumping tests and long term constant rate aquifer pumping tests were performed.

Additionally, two short-duration, constant-rate pumping tests were conducted in first HSZ monitoring wells MW-39 and MW-45. The MW-39 and MW-45 tests were performed to further evaluate aquifer parameters in the first HSZ toward the downgradient extent of groundwater impacts. Detailed descriptions of pumping test methodologies are provided in SOPs in Appendix A. Pumping test results are provided in Section 4.0.

3.3.1 Piezometer Installations

Several piezometers were installed both on- and off-site to provide water level observation points during pumping tests. Piezometer locations are shown in Figure 3. Table 1 summarizes piezometer well construction details. Piezometer boring logs and well completion logs are presented in Appendix B. A detailed description of drilling, well installation, and development procedures is provided in SOPs presented in Appendix A.

3.3.1.1 On-Site Piezometer Installations

To evaluate leakage between the first and second HSZ during pumping, a triple-nested piezometer cluster (P-1/P-2A/P-2B) was installed in a single borehole adjacent to first and second HSZ pumping wells MW-32 and MW-40 (Figure 3). Piezometer P-1 is completed in the first HSZ, and piezometer P-2A and P-2B are completed within the aquitard separating the first and second HSZ.

The borehole for this piezometer cluster was advanced using hollow stem auger drilling equipment. Stratigraphy penetrated by the boring was evaluated by observation of continuous core and 3-inch Shelby tube samples. Three Shelby tube soil samples collected within the aquitard were used for laboratory physical testing. Laboratory physical testing consisted of sieve analysis and consolidation testing. The results of the physical tests were used to calculate specific storage of the aquitard material.

Each piezometer was constructed of 1-inch inner diameter stainless steel screen and casing. Piezometer P-1 was completed across the entire first HSZ with a screen interval of 27.5 to 52.5 feet below ground surface (bgs). Piezometer P-2A was completed with a 1-foot screen section near the top of the aquitard between 56 and 57 feet bgs. Piezometer P-2B was completed with a 1-foot screen section near the middle of the aquitard between 64.5 and 65.5 feet bgs. The annular space across each screen interval was backfilled with sand filter pack. The annular space between each screened interval was sealed with bentonite pellets.

Two second HSZ piezometers (P-3 and P-4) were installed to monitor water levels during the on-site second HSZ pumping test (Figure 3). Piezometer P-3 was installed adjacent to second HSZ pumping well MW-40 to provide high resolution drawdown data. Piezometer P-4 was installed on-site just outside the western edge of impacted groundwater within the second HSZ to assess drawdown effects outside the plume boundary and to provide a water level monitoring point for evaluating capture during potential future on-site second HSZ groundwater remediation activities.

Second HSZ piezometers P-3 and P-4 were installed using air rotary casing hammer drilling equipment. Stratigraphy was evaluated by observation of cyclone grab samples. Piezometers were constructed of two-inch diameter schedule 40 PVC screen and casing installed in 8-inch diameter boreholes. Piezometer screen intervals for P-3 and P-4 are 73.5 to 83.5 feet bgs, and 74 to 84 bgs, respectively. Following installation, each piezometer was developed using bailing, surging and pumping techniques. Following completion, the well head elevation and location of each piezometer were surveyed by a California-licensed surveyor.

3.3.1.2 Off-Site Piezometer Installations

Three first HSZ (P-5, P-7, and P-9) and two second HSZ (P-6 and P-8) piezometers were installed in the vicinity of pumping wells MW-38 and MW-44 to provide water level observation stations during off-site aquifer pumping tests (Figure 3). First HSZ piezometer P-5 and second HSZ piezometer P-6 were installed within 15 feet of pumping wells MW-38 and MW-44 to provide high-resolution drawdown data during pumping. First HSZ piezometers P-7 and P-9, and second HSZ piezometer P-8 were installed along the lateral edges of the impacted groundwater plume to assess drawdown effects at the GW-1 boundary and to provide water level monitoring points for evaluating capture during potential future groundwater remediation activities.

Piezometers P-5, P-7, P-8 and P-9 were installed using hollow stem auger drilling equipment. Stratigraphy penetrated by the borings for these piezometers was evaluated by observation of split spoon core samples. Second HSZ piezometer P-6 was installed using air rotary casing hammer drilling equipment, and stratigraphy was evaluated by observation of cyclone grab samples.

Piezometers are constructed of two-inch diameter schedule 40 PVC screens and casings installed in 8-inch diameter boreholes. First HSZ piezometers P-5, P-7, and P-9 are screened from approximately 32 to 49 feet bgs. Second HSZ piezometers P-6 and P-8 are screened from approximately 71 to 79 feet bgs. Following installation, each piezometer was developed using bailing, surging, and pumping techniques. Following completion, the well elevation and location of each piezometer were surveyed by a California licensed surveyor.

3.3.2 Aquifer Pumping Test Set-Up

This section provides a brief description of equipment set-up used for on- and off-site aquifer pumping tests. The set-up for on- and off-site pumping tests are discussed individually.

3.3.2.1 On-Site Aquifer Pumping Test Set-Up

On-site pumping tests were completed using the existing on-site treatment system to regulate pumps and treat groundwater effluent. For the first HSZ pumping test, existing groundwater extraction well MW-32 was used as the pumping well, therefore no modification of the groundwater extraction and treatment system were required to perform this test. For the second HSZ pumping test, groundwater monitoring well MW-40 was used as the pumping well, and a 1-1/2 horse power submersible pump was installed, piped, and wired into the groundwater treatment system. The pump intake was set at 78 feet bgs. An in-line digital flow meter and gate valve were installed at the well head to regulate groundwater flow. The treatment system influent tank was equipped with a water level gauge to calibrate flow rates by measuring the time to fill a portion of the tank.

Pressure transducers connected to dataloggers were installed in select wells to electronically monitor water levels during each pumping test. A list of wells equipped with pressure transducers is provided in Table 2. Additionally, a barometric pressure probe was installed to electronically monitor changes in barometric pressure during each pumping test.

Dataloggers were linked to a computer terminal for real time display of water levels during each pumping test.

3.3.2.2 Off-Site Aquifer Pumping Test Set-Up

The set-up phase for the off-site aquifer pumping tests included:

- Set-up of an office trailer adjacent to the pumping wells;
- Connection to electrical power source for pump and office trailer operations;
- Installation and piping of submersible pumps;
- Set-up the pumping test effluent containment and treatment system;
- Installation of electronic water level monitoring equipment in observation wells; and
- Set-up of site security.

The office trailer was set up to house electronic equipment and conduct in field data analysis. Electrical power was established by modifying existing line power to include 240 Volt service and hooking up an electrical control panel to operate submersible pumps, lighting, and the office trailer.

Pumping wells were equipped with 1-1/2 horse power submersible pumps piped to temporary holding tanks. The pump intakes were set at 47.5 and 75 feet bgs for MW-38 and MW-44, respectively. An in-line digital flow meter and gate valve were installed to regulate discharge rate. Cut off valves were installed to temporarily divert effluent to a 55-gallon drum for flow rate calibration purposes by measuring the time required to fill a portion of the drum.

Two 21,000-gallon tanks were placed adjacent to the pumping wells to temporarily contain pumping test effluent prior to treatment. Two additional 21,000-gallon tanks were placed adjacent to the on-site treatment system. During the pumping tests, effluent was transported between the two sets of tanks by a vacuum truck. The transported groundwater was processed through the on-site groundwater treatment system and discharged to the combined sewer/storm system as part of normal on-site groundwater treatment operations.

Pressure transducers connected to dataloggers were installed in select wells to electronically monitor water levels for each pumping test. A list of wells equipped with pressure transducers is provided in Table 3. Additionally, a barometric pressure probe was installed to electronically monitor changes in barometric pressure during each pumping test. Dataloggers were linked to the computer terminal for real time display of water levels during each pumping test.

Site security measures were taken to minimize the potential for vandalism of equipment and facilities. The area around the pumping well heads, effluent tanks, and office trailer was enclosed with temporary fencing. Additionally, a security guard was posted at the pumping test site to protect equipment and facilities during off hours.

MW-38 and MW-44 short-duration pumping tests were conducted using dedicated sampling pumps. Pressure transducers were installed in each pumping well to monitor water levels. Groundwater effluent was temporarily contained in a portable trailer, transported back to the site, and treated using the on-site groundwater treatment system.

3.3.3 Step Drawdown Pumping Tests

Step drawdown tests were performed in on-site well MW-40 and off-site wells MW-38 and MW-44 prior to each constant rate pumping test. Using a submersible pump and pressure transducers installed in the pumping wells, each well was pumped for a specified period at four different pumping rates (steps) while monitoring changes in water level. The water levels and corresponding times were recorded during each pumping step to allow for analysis in calculating how much drawdown was due to well losses (drawdown due to water passing through the well), how much drawdown was due to formation losses (drawdown due to water passing through the aquifer), and to provide information needed for selection of the appropriate pumping rate for the long-term test. The appropriate pumping rate is that which will affect the largest anticipated zone of influence without pumping the well dry during the test. A step drawdown test was not performed in MW-32 prior to the constant rate pumping test since the maximum sustainable pumping rate of this well has been established through IRM extraction well operations.

During each step drawdown test, water levels were monitored both electronically and manually. The changes in water level (drawdown) that occurred in pumping wells MW-38, MW-40, and MW-44 during each step drawdown pumping test were input into graphs of drawdown versus time for analysis. Data analysis and results of step drawdown tests are presented in Section 4.3.

3.3.3.1 On-Site Step Drawdown Pumping Tests

The step drawdown test for second HSZ well MW-40 was performed on August 16, 1994. The step drawdown test consisted of four pumping steps lasting 60 minutes per step. Step pumping rates of 12, 19.5, 28, and 37.5 gpm were used. The total time of pumping was 240 minutes.

3.3.3.2 Off-Site Step Drawdown Pumping Tests

The step drawdown test for first HSZ well MW-38 was performed on October 14, 1994. The step drawdown test consisted of four pumping steps lasting 60 minutes per step. Step pumping rates of 20, 26, 32, and 36 gpm were used. During the final step of 36 gpm, the pump began to cavitate causing the pumping rate to fall below 36 gpm. Therefore, the last 60 minutes of the total 240 minutes of pumping was not used for analysis.

The step drawdown test for second HSZ well MW-44 was performed on October 10, 1994. The step drawdown test consisted of four pumping steps lasting 60 minutes each. Step pumping rates of 13, 17, 20, and 25 gpm were used. The total time of pumping was 240 minutes.

3.3.4 Constant Rate Pumping Tests

The objective of the long-term pumping tests was to impose a hydraulic stress on the water-bearing zones in the vicinity of pumping wells by pumping from the wells and lowering water levels in the vicinity. The resulting drawdown data were then used to evaluate the degree of hydraulic communication among wells and the response of the water-bearing zones to pumping. From such tests, calculation of hydraulic characteristics were made for each pumped water-bearing zone. The hydraulic characteristics of particular interest include transmissivity *(T)*, hydraulic conductivity *(K)*, storativity *(S)*, and possibly leakage characteristics. The long-term pumping tests included the three components described below:

- Rest Period — Prior to pumping each well, it is important to monitor static, non-pumping water levels to determine the trend of changes, in water level, if any, and to provide a basis for determining drawdown due to pumping only.
- Pumping Period — The most direct method of testing water-bearing zones over long-term pumping is to pump a single well at a constant rate for a sufficiently period of

time to produce the desired stress in the water-bearing unit and to monitor the resulting change in water levels in observation wells.

- Recovery Period — The period of time immediately following cessation of pumping during which the water levels in the monitored wells rise back to nearly static, non-pumping level. The rate of recovery of water levels with time since pumping stopped provides important data for analysis of hydraulic characteristics.

During each constant-rate pumping test, water levels were monitored both electronically and manually. Changes in water levels were input into graphs of drawdown versus time for analysis. Data analysis and results of constant-rate pumping tests are provided in Section 4.4.

3.3.4.1 On-Site Constant Rate Aquifer Pumping Tests

The MW-32 first HSZ constant rate pumping test was conducted between August 9 and 11, 1994. Background water levels were monitored for 24 hours during the rest period prior to pumping. MW-32 was then pumped at a constant flow rate of 13 gpm for a total of 51 hours. During the test, water levels were monitored in 23 wells listed in Table 2. The test was initially planned for 72 hours. However, the pump inadvertently shut down after 51 hours of pumping. Due to the inadvertent shut down, recovery data was not collected.

The MW-40 second HSZ constant rate pumping test was conducted from August 22 to 25, 1994. Background water levels were monitored for four days during the rest period prior to pumping. MW-40 was then pumped at a constant flow rate of 35 gpm for a total of 72 hours. During the test, water levels were monitored in 23 wells listed in Table 2. During the recovery period, water levels were monitored for 24 hours.

3.3.4.2 Off-Site Constant Rate Aquifer Pumping Tests

The MW-38 first HSZ constant rate pumping test was conducted from October 11 to 13, 1994. Background water levels were monitored for three days during the rest period prior to pumping. MW-40 was pumped at a constant flow rate of 27.6 gpm for a total of 53.5 hours. The duration of the test was initially planned to be 72 hours. However, after 53.5 hours, water levels began to stabilize and the pumping portion of the test was terminated. During the test water levels were monitored in 11 wells listed in Table 3. During the recovery period, water levels were monitored for 24 hours.

The MW-44 second HSZ constant rate pumping test was conducted from October 17 to 21, 1994. Background water levels were monitored for four days during the rest period prior to pumping. MW-44 was pumped at a constant flow rate of 19.8 gpm for a total of 72 hours. During the test water levels were monitored in 9 wells listed in Table 3. During the recovery period, water levels were monitored for 24 hours.

The MW-39 first HSZ short-duration, constant-rate pumping test was conducted on January 19, 1995. MW-39 was pumped at a constant flow rate of 5.8 gpm for a total of 120 minutes. During the test, water levels were monitored electronically and manually in MW-39. Water levels were also monitored during recovery.

The MW-45 first HSZ short-duration, constant-rate pumping test was conducted on January 18, 1995. MW-45 was pumped at a constant flow rate of 3.3 gpm for a total of 126 minutes. During the test, water levels were monitored electronically and manually in MW-45. Water levels were also monitored during recovery.

4.0 DATA ANALYSIS AND RESULTS

This section discusses data analysis and presents results of groundwater pre-design activities leading up to groundwater modeling activities (Section 5.0). Included in this section are discussions of on- and off-site hydrogeology, distribution of groundwater impacts, aquifer testing, and IRM capture zone analysis.

4.1 HYDROGEOLOGY

This section presents a discussion of the current understanding of stratigraphy and groundwater hydrogeology for the site vicinity. Discussions of on-site and off-site stratigraphy were previously presented in the RI/FS Report (Dames & Moore, 1991b), the Addendum RI/FS Report (Dames & Moore, 1991c), the Supplementary Groundwater Investigation Report (Dames & Moore, 1991a), the Additional Off-Site Groundwater Investigation, Second Hydrostratigraphic Zone (Dames & Moore, 1992c), the Additional Characterization of Off-Site Groundwater Operable Unit GW-1 (Dames & Moore, 1995c), and the 1992, 1993, and 1994 Annual Groundwater Monitoring Reports (Dames & Moore, 1993a, 1994b, and 1995a). This section summarizes the discussions of stratigraphy presented in these previous reports, and supplements that information with the results of additional off-site investigation performed in 1994.

4.1.1 Stratigraphy

As presented in the RI/FS Report, the site and surrounding area is underlain by sediments characteristic of flood plain deposits laid down by continuously shifting streams. The subsurface stratigraphy consists of a heterogeneous mixture of clays, silts, and sands. These geologic materials were deposited primarily as either channel deposits (sands) or overbank flood deposits (clays, silts, and fine sands). Due to the nature of this type of deposition, the lateral and vertical extent of each depositional unit differs greatly and is the reason for the heterogeneity of the subsurface stratigraphy. Interpretations of the subsurface stratigraphy are presented in a series of cross-sections (Figures 5 through 12). These cross-sections were developed using data from previous investigation and supplemented with data obtained during additional off-site investigation in 1994.

4.1.1.1 *Unsaturated Zone Stratigraphy*

The unsaturated zone is the interval of fill material and native soil between the ground surface and the water table. The depth to the water table varies seasonally, but is typically encountered approximately 25 bgs. The shallowest unsaturated zone material encountered at the site is a man-emplaced fill layer of variable thickness. The fill material consists primarily of a silty sand imported or disturbed native soil containing demolition debris and other man-made materials. The fill layer varies in thickness from approximately two feet in the southern portion of the site, to 15 feet at the northern extent of Operable Unit S-2 (the Central Fill Area).

Beneath the fill, the native soil of the unsaturated zone consists primarily of silty clay with variable amounts of sand to silty sand. In general, the unsaturated zone soil coarsens downward.

4.1.1.2 *Saturated Zone Stratigraphy*

The shallowest saturated zone material encountered beneath the site is a generally continuous sand layer referred to as the first hydrostratigraphic zone (HSZ) (Figure 5). The first HSZ consists of a fine-to-medium-grained sand to silty sand which coarsens downward to fine gravel and coarse sand lenses toward the base. The base of the first HSZ sand is an erosional surface generally on clay or silty clay.

The sand layer in the first HSZ thins beneath the south end of the site and is thickest (approximately 30 feet) where penetrated by groundwater monitoring well MW-2 in the northern section of the inactive portion of the site (Figure 5). The first HSZ sand layer pinches out to the northeast of MW-2, and is not present at the location of MW-1.

Southeast of the site, the first HSZ sand thickens to approximately 25 feet at the location of groundwater monitoring well pair MW-34/MW-35 and the MW-36/MW-37/MW-47 trio of wells adjacent to Sutterville Road. The first HSZ sand zone thins and finally pinches out just south of Sutterville Road (Figure 5).

Southeast of the pinchout of the first HSZ sand, the first HSZ consists of interbedded sand, silty sand, and silt. The sand layers are typically thinner and are interpreted to be less laterally continuous than the first HSZ sand on-site (Figures 5, 6, 7, 8, and 9). An exception to this is what appears to be a relatively laterally continuous silty sand layer encountered in CPT-98 through CPT-105 beneath 19th Avenue (Figure 7). First HSZ well MW-45 was completed in this sand.

The base of the first HSZ is approximately 50 to 60 feet bgs. Underlying the first HSZ is a relatively low-permeability zone consisting of interbedded silt and silty clay beds. This low-permeability material extends to a depth of approximately 70 feet bgs where the top of the second HSZ is encountered.

The second HSZ consists of interbedded silt, silty sand, and sand with an average combined thickness of approximately 10 feet. The second HSZ is interpreted to be laterally continuous from MW-12 to MW-46 (Figure 5). However, the second HSZ appears to transition from sandy silt to silty clay to the west in some areas (Figure 9).

Relatively low-permeability material consisting of silt, silty clay, and clay underlies the second HSZ to a depth of approximately 90 to 95 feet bgs. This material has a high degree of variation in grain size, but as a unit is lower in permeability than the overlying second HSZ or underlying third HSZ.

The third HSZ has been penetrated by a total of five borings (borings for MW-12, MW-27, MW-28, MW-41, and MW-47). The third HSZ consists of silty sand to sand from approximately 105 to 125 feet bgs and appears to be laterally continuous from MW-12 to MW-47.

4.1.2 Groundwater Hydrogeology

Static water levels in monitoring wells have been measured periodically over the last seven years. Results of water level monitoring indicate that groundwater flow direction and gradient have generally been consistent with the groundwater flow direction to the southeast. The hydraulic gradient for the first HSZ is approximately 0.002 in the northern portion of the site, but increases to approximately 0.003 in the central portion of the site and remains fairly constant to the southeast. Detailed groundwater contour maps for the first and second HSZ for October 1994 are provided in Figures 13 and 14, respectively. October 1994 contours show static (non-pumping) conditions and are typical of conditions observed over the past seven years.

4.2 DISTRIBUTION OF GROUNDWATER IMPACTS

This section provides a summary of the overall distribution of impacts to groundwater both on- and off-site. The distribution of groundwater impacts is described with respect to the source area or upgradient extent of impacts, overall distribution in the first and second HSZs, and the downgradient extent in both HSZs. Detailed descriptions of groundwater sample types, locations, and analysis results can be found in the following documents:

- Hydropunch and Groundwater Investigation Report (Dames & Moore, 1990a);
- RI/FS Report (Dames & Moore, 1991b);
- Supplementary Groundwater Investigation Report (Dames & Moore, 1991a);
- Addendum RI/FS Report (Dames & Moore, 1991c);
- Additional Off-Site Groundwater Investigation Report, Second Hydrostratigraphic Zone (Dames & Moore, 1992c);
- 1992 Annual Groundwater Monitoring Report (Dames & Moore, 1993a);
- 1993 Annual Groundwater Monitoring Report (Dames & Moore, 1994b);
- Additional Characterization of Off-Site Groundwater Operable Unit GW-1 (Dames & Moore, 1995c);
- Development of Remedial Action Objectives for Volatile Organic Compounds in Soil (Dames & Moore, 1995b);
- 1994 Annual Groundwater Monitoring Report (Dames & Moore, 1995a).

The primary constituents of concern in groundwater beneath the site and off-site are chlorinated VOCs. The specific VOCs of concern, because of their concentrations, include 1,1-dichloroethane (DCA), 1,1-dichloroethene (DCE), 1,2-DCA, tetrachloroethene (PCE), and trichloroethene (TCE). Additionally, benzene, toluene, ethylbenzene, and xylenes (BTEX) and total petroleum hydrocarbons (TPH) as gasoline are found in first HSZ groundwater on-site in the former Oil House Area.

Another chlorinated VOC, carbon tetrachloride, has been detected sporadically in samples collected from MW-29 in the vacant lot adjacent to the eastern edge of the site (Figure 3) and in some other off-site wells. The carbon tetrachloride appears to emanate from an off-site source adjacent to the eastern edge of the site. Table 4 provides a complete listing of VOC detections in samples from all on- and off-site wells.

4.2.1 Upgradient Extent/Source Area of Groundwater Impacts

The upgradient extent of chlorinated VOC impacts to groundwater has been demonstrated to be beneath the Central Fill Area of the site between groundwater monitoring wells MW-2 and MW-43 (Figures 15 and 16). This is based on chemical analysis results for samples collected from these wells and in-situ groundwater samples collected in this area. Chemical analysis results for samples collected from MW-2 have consistently been reported as "nondetect" (ND) for VOCs, whereas analysis of samples collected from MW-43, located approximately 200 feet downgradient of MW-2, detected several VOCs (Table 4).

Results of analysis of in-situ groundwater samples collected beneath the Central Fill Area enabled further definition of the upgradient extent of impacts between MW-2 and MW-43 (Dames & Moore, 1991c). Based on these groundwater chemical data and historical site use information, the source area for VOC impacts to groundwater has been determined to be in the immediate vicinity of MW-43.

VOC concentrations in the source area were investigated by performing two soil gas surveys and a soil vapor extraction (SVE) pilot test in the Central Fill Area (Dames & Moore, 1991c and 1995b). The purpose of the soil gas surveys was to test for soil gas concentrations in shallow and deep soil intervals in the source area. Both surveys aided in defining the lateral and vertical distribution of VOCs and to model the potential for impacts to groundwater

The objective of the SVE pilot test was to confirm the presence or absence of VOCs and to evaluate if this remedial technology would be efficient in removing VOCs from the deep unsaturated zone soils in the Central Fill Area from 15 to 25 feet bgs. The results of the SVE pilot test showed that relatively high levels of VOCs are still present in the deepest unsaturated soil and capillary fringe in the source area. The concentrations of VOCs in the capillary fringe suggest that they are likely a continuing source of VOC impacts to groundwater (Dames & Moore, 1995b). This is supported by the fact that VOC concentrations in groundwater samples collected from MW-43, which is screened across the water table and capillary fringe, have remained fairly constant, and typically increase during times of increasing groundwater levels (Dames & Moore, 1995a).

4.2.2 Distribution and Downgradient Extent of First HSZ VOC Impacts

VOC impacts in the first HSZ were demonstrated to extend approximately 5,200 feet downgradient (southeast) of the source area (Figures 15 and 16). The downgradient extent is based on analysis of in-situ groundwater samples collected off-site beneath 19th Avenue and 21st Avenue in 1994 (Dames & Moore, 1995c), and recent groundwater monitoring data (Dames & Moore, 1995a). Results of analysis of in-situ groundwater samples collected from the first HSZ beneath 19th Avenue showed that VOCs typically associated with groundwater operable unit GW-1 are confined to a relatively narrow band at concentrations that only slightly exceed the detection limits of the analytical method (Figure 4). The in-situ sample concentrations were verified by similar concentrations of VOCs reported for samples collected from MW-45 (Table 4 and Figure 4).

In-situ groundwater samples were also collected from the first HSZ beneath 21st Avenue, approximately 600 feet downgradient of 19th Avenue. Only two VOCs, PCE and carbon tetrachloride, were detected in one of the in-situ samples (Figure 4). The detection of PCE is considered to be anomalous and not associated with GW-1 because PCE was not detected in any of the 19th Avenue in-situ groundwater samples or in groundwater monitoring wells downgradient of MW-34 (Dames & Moore, 1995a). MW-34 is located approximately 3,400 feet upgradient of 21st Avenue (Figure 3).

As stated above in Section 4.2, carbon tetrachloride is believed to emanate from a source (or former source) that is located off-site and adjacent to the eastern edge of the site. This is based on the fact that carbon tetrachloride is reported sporadically for samples collected from MW-29 (Table 4), but not for samples collected from on-site wells located upgradient of MW-29. Additionally, carbon tetrachloride is not detected in samples collected from MW-30, which is located immediately adjacent to, but is screened deeper than MW-29. MW-29 is screened across the water table from 26 to 41 feet bgs, whereas MW-30 is screened from 51 to 56 feet bgs at the base of the first HSZ. In addition, carbon tetrachloride has never been detected in samples collected from MW-31, which is located approximately 100 feet downgradient of MW-30 and MW-29 and is also screened at the base of the first HSZ. The fact that carbon tetrachloride is detected in only the shallow first HSZ well, but not the deeper first HSZ wells, suggests that the source of this VOC is upgradient of, but in close proximity to, MW-29.

The next nearest downgradient well with carbon tetrachloride detections is second HSZ well MW-37, which is located approximately 1,200 feet downgradient of MW-29. Samples from first HSZ wells MW-34 and MW-35, located between MW-29 and MW-37, have had no detections of carbon tetrachloride.

Downgradient of MW-37, samples collected from all other first and second HSZ wells have carbon tetrachloride detections with the highest levels found in samples from second HSZ well MW-44 (Table 4). This distribution of carbon tetrachloride detections suggests that the source of carbon tetrachloride upgradient from MW-29 is probably nearly depleted and that the bulk of the carbon tetrachloride is between MW-37 and MW-45. A possible source of the carbon tetrachloride was a former gas station situated in the corner between the eastern site boundary and the northern edge of the vacant lot in which MW-29, MW-30, and MW-31 are located (Figure 4).

The distribution of BTEX and TPH as gasoline appears to be confined to first HSZ groundwater in the former Oil House Area around MW-4, MW-13, and MW-14 (Figure 3). These constituents are not detected in the next furthest downgradient well, MW-29 (Table 4), which suggests that the downgradient extent of these compounds is very limited relative to that of the chlorinated VOCs in GW-1.

4.2.3 Distribution of Second HSZ Impacts

The extent of VOC impacts in the second HSZ has been evaluated by monitoring of seven wells installed in the second HSZ, and collection and analysis of 18 in-situ groundwater samples (Dames & Moore, 1992c and 1995a). Concentrations of VOCs in samples collected from second HSZ wells are typically less than in the first HSZ (Dames & Moore, 1995a). In addition, the extent of VOC impacts to the second HSZ is smaller than that of the first HSZ (Figures 17 and 18). The furthest downgradient second HSZ well with VOC detections is MW-44 (Figures 17 and 18). Monitoring well MW-46, adjacent to MW-39 and downgradient of MW-44, has had only low level detections of carbon tetrachloride and no detections of VOCs associated with GW-1. Therefore, the downgradient extent of VOCs in the second HSZ is believed to be between MW-44 and MW-46.

To evaluate the lateral extent of VOCs in the second HSZ, in-situ groundwater samples were collected outside the lateral extent of the first HSZ (to avoid cross-contamination from the first HSZ to the second) in 1992 (Dames & Moore, 1992c). The results of this investigation suggest that the extent of VOC impacts in the second HSZ do not extend further out from the axis of the GW-1 plume than in the first HSZ.

4.2.4 Third HSZ

Two wells — MW-41 located on-site adjacent to MW-4, MW-12, and MW-13 (Figure 4), and MW-47 located off-site adjacent to MW-36 and MW-37 — have been completed in the third HSZ. No VOC detections have been reported for any samples collected from either well (Table 4). Based on these results, the third HSZ does not appear to have been impacted by VOCs.

4.2.5 Estimate of the Mass of Chlorinated VOCs in Groundwater

A comparison has been made of chlorinated VOC mass in groundwater of the first and second HSZs. The mass calculations are based on average aquifer thicknesses, VOC concentration, distribution (Figures 16 and 18), and the estimated surface area of the impacts. The chlorinated VOC masses were calculated to be 55 pounds in the first HSZ and 6 pounds in the second HSZ. Chlorinated VOC mass calculations are summarized in Table 5. Estimates of chlorinated VOC masses are for pore fluid only and do not account for the adsorbed component in the groundwater system.

4.3 STEP DRAWDOWN AQUIFER PUMPING TESTS

Step drawdown tests were performed in first HSZ well MW-38, and second HSZ wells MW-40 and MW-44 to estimate aquifer-loss and well-loss characteristics of each well, and select flow rates for the subsequent constant rate pumping tests. A discussion of step drawdown test methods is provided in Section 3.3.3. Plots of drawdown versus time were produced for each step test and are provided in Appendix C. Graphical techniques were used to estimate aquifer-loss coefficients *(B)*, and well-loss coefficients *(C)* (Hantush, 1964). Drawdown data for each step was extrapolated out to a time of 10,000 minutes to estimate long term pumping well drawdowns. Arithmetic plots used to estimate *B* and *C* are provided in Appendix C. Estimates of pumping well drawdowns anticipated to result from the constant rate pumping tests were calculated using the relationship:

$$S_w = BQ + CQ^2$$

Where:

S_w	=	total drawdown in the well at time t (10,000 min);
Q	=	pumping rate;
B	=	aquifer-loss coefficient; and
C	=	well-loss coefficient.

The expression CQ^2 represents the component of total drawdown due to turbulent flow well-losses and well inefficiency at a flow rate of Q. The expression BQ represents the component of drawdown due to the water-bearing unit itself, i.e., the natural drawdown, at a flow rate of Q. Well efficiency at a given flow rate can be calculated from the relationship:

$$\text{Well efficiency} = BQ/(CQ^2+BQ) \times 100\%$$

Drawdown estimates at various pumping rates were compared to available drawdowns (the depth of water in a well to the top of the well screen). This comparison was used to select flow rates for the constant rate pumping tests that sufficiently stress the water bearing zone without dewatering the pumping well.

4.3.1 On-Site Step Drawdown Test

A step drawdown test was performed in on-site second HSZ well MW-40. Results of step drawdown analysis for MW-40 are provided in Appendix C, Figures C-25 and C-26. Estimates of aquifer loss and well loss coefficients are 3.13 min/ft^2, and 0.138 min^2/ft^5, respectively. At 35 gpm the predicted drawdown in MW-40 is 17.7 feet and well efficiency is estimated to be 83 %. The available drawdown in MW-40 (depth to top of screen minus depth to water) at the time of the test was 41 feet. A pumping rate of 35 gpm was selected for the constant rate pumping test, which is near the maximum discharge rate for the submersible pump used.

4.3.2 Off-Site Step Drawdown Test

Step drawdown tests were performed in off-site first HSZ well MW-38 and second HSZ well MW-44. Results of step drawdown analysis for MW-38 are provided in Appendix C, Figures C-73 and C-74. Estimates of aquifer loss and well loss coefficients are 1.11 min/ft^2, and 0.068 min^2/ft^5, respectively. The maximum available drawdown for this test was 7.5 feet. This is the level at which the pump began to cavitate during the fourth step of this test. Based on this, a pumping rate of 28 gpm was selected for the constant rate pumping test. At 28 gpm the predicted drawdown in MW-38 is 5.1 feet and well efficiency is estimated to be 82%. Step drawdown test analysis indicated that this flow rate would provide ample protection against pump cavitation during the constant rate pumping test.

During the MW-44 step drawdown test, groundwater levels in MW-44 actually rose as each pumping step progressed. This water level response is indicative of increased well efficiency with pumping (well development). As such, aquifer loss and well loss coefficients could not be evaluated. A flow rate of 20 gpm was selected for the constant rate pumping test based on visual inspection of the drawdown data. During the 20-gpm third step of this test, drawdown in the well was approximately 25 feet after 60 minutes of pumping. The maximum available drawdown at the time of the test was approximately 36 feet.

4.4 CONSTANT RATE AQUIFER PUMPING TESTS

The purpose of the constant rate aquifer pumping tests was to monitor the aquifer's response to pumping and to use the data to estimate aquifer parameters such as transmissivity *(T)*, storativity *(S)*, specific yield (S_y), radius of influence (R_o) and vertical leakance. Estimates of aquifer parameters were used in extraction well field expansion modeling. A discussion of constant rate pumping test methods is provided in Section 3.3.4. This section presents a discussion of data analysis and results.

4.4.1 Data Analysis

Following each constant rate pumping test, graphs of drawdown versus time were produced for pumping wells and observation wells. Graphs were produced for the rest period, pumping period, and recovery period of each test. Additionally, graphs of changes in barometric pressure during rest periods and pumping periods were produced. Graphs for each test are provided in Appendix C.

4.4.1.1 External Effects on Water Levels

Various factors that could potentially effect aquifer pumping test data were considered prior to analysis of the data. These effects included: (1) equipment accuracy; (2) changes in barometric pressure; (3) regional fluctuations in groundwater levels; (4) influences of nearby pumping wells; (5) aquifer boundary effects.

Equipment Accuracy

As a check for equipment accuracy, plots of time versus drawdown data were constructed using pressure transducer water level data and manual water level measurements collected by hand. In general, drawdowns derived from pressure transducer data and hand data were very similar, with the exception of a few wells. Pressure transducer data collected from MW-40 during the MW-32 pumping test was overestimating drawdowns. This discrepancy appears to be the result of transducer drift, and was corrected for using a correction factor estimated from rest period data.

Manual water level data from nested piezometers P-1, P-2A and P-2B appear to have underestimated drawdown compared to pressure transducer water level data. This discrepancy appears to be the result of errors associated with the use of a electronic water level indicator in a small diameter (1-inch) stainless steel casing. If the water level indicator comes in contact with wet metallic casing walls above the water table, a conductivity bridge can be created causing the water level indicator to sound even though it is not submerged.

Drawdowns calculated from manual water levels collected from MW-38 during the MW-44 pumping test consistently were approximately 0.08 feet greater than pressure transducer-derived drawdowns. This inconsistency appears to have resulted from an erroneous initial manual water level reading.

Changes in Barometric Pressure

Site barometric pressure readings were collected simultaneously with electronic water level readings on one of the dataloggers used during each constant rate pumping test. Barometric pressure data was compared to rest period data to evaluate the effects of changing barometric pressure on water levels. Barometric pressure changes during each pumping period were compared to drawdown data to determine if barometric pressure changes during each constant rate pumping test could have significantly effected water levels in observation wells. In general, water level fluctuations caused by barometric pressure changes were minimal and barometric corrections were not required prior to aquifer parameter analysis.

Barometric corrections were applied to drawdown data from select observation wells collected during the on-site second HSZ MW-40 pumping test to evaluate the cause of anomalous increases in drawdown observed during the latter portion of the pumping period. Barometric corrections were made by estimating the barometric efficiency, calculating a barometric correction factor, and subtracting the barometric correction factor from observation well water levels. Barometric efficiency *(Be)* and the barometric correction factor *(Bc)* were calculated from the following relationships:

$$Be = \Delta H(t) / \Delta B(t)$$

$$Bc = Be \times \Delta B(t)$$

where Δ B(t) is the change in barometric pressure at time t, and delta H(t) is the change in head at time *t*.

For second HSZ wells MW-12, MW-28 and P-4, estimates of barometric efficiency are 32%, 35%, and 25%, respectively. Corrected drawdown versus time graphs for these wells are provided in Appendix C, Figures C-42, C-47, and C-60. Barometric corrections had little effect on drawdown curves and did not account for the anomalous increase in drawdown observed in the latter portion of the test.

Regional Fluctuations in Groundwater Levels

To evaluate the effect of regional fluctuations in groundwater levels, water levels were measured daily during each pumping test in background wells located outside the influence of the pumping test. Background groundwater levels monitored in MW-2 during the on-site first HSZ (MW-32) pumping test fluctuated approximately 0.02 feet. Background groundwater levels monitored in MW-37 during the on-site second HSZ (MW-40) pumping test fluctuated approximately 0.06 feet. Background groundwater levels monitored in MW-36 during the off-site first HSZ (MW-38) pumping test fluctuated approximately 0.05 feet. Background groundwater levels monitored in MW-46 during the off-site second HSZ (MW-44) pumping test also fluctuated approximately 0.05 feet. Additionally, inspection of pre-test water levels from most wells show that water levels remained relatively stable during the rest period prior to the constant rate pumping test. Therefore, no corrections for regional water level fluctuations were required.

Influences of Nearby Pumping Wells

Influences from nearby pumping wells were not a factor since there are no known production wells within several miles of the site that extract groundwater from the zones being tested. Additionally, no sudden fluctuations in groundwater levels characteristic of startup or shutdown of interfering pumping wells were observed during the rest period prior to constant rate pumping tests.

Aquifer Boundary Effects

The potential of boundary effects caused by constant head boundaries such as streams and lakes, and impermeable boundaries such as lithologic changes was evaluated for each constant rate pumping test. During a constant rate pumping test, water level response to a boundary will appear as the radius of pumping influence expands into a boundary area. When constant head boundaries are encountered, the drawdown curve will flatten out since a constant supply of groundwater has been reached. When impermeable boundaries are encountered, drawdown curves steepen since the supply of groundwater is restricted.

It is difficult to distinguish constant head boundary effects in a semi-confined water bearing zone (such as the second HSZ) because leakage from adjacent water bearing units produces a similar drawdown effect. However, the nearest constant head source is the Sacramento River approximately 1.5 miles west of the site which is outside the influence of these pumping tests. Impermeable and semi-impermeable boundaries are more easily recognized from drawdown versus time graphs. However, delayed yield effects in unconfined aquifers could mask impermeable boundary effects. The depositional environment of sediments beneath the site (see Section 4.1) suggest semi-impermeable boundaries exist where sand channels pinch out into finer grained overbank deposits.

During the on-site first HSZ (MW-32) constant rate pumping test, drawdowns in observation wells MW-19, MW-20 and MW-31 increased markedly after approximately 400 minutes, as shown in Appendix C, Figures C-12, C-14, and C-16. These breaks in the drawdown curves do not appear to be fully attributable to delayed yield effects. Instead, they may be partially attributed to the effect of the radius of pumping influence reaching the edge of the first HSZ sand channel which acts as a semi-impermeable boundary.

During the on-site second HSZ (MW-40) constant rate pumping test, a similar break in drawdowns occurred in observation wells P-4, MW-12 and MW-28 after approximately 400 minutes of pumping, as shown in Appendix C, Figures C-41, C-46, and C-59. Similar drawdown behavior was observed in piezometer P-8 (Appendix C, Figure C-123) during the off-site second HSZ (MW-44) constant rate pumping test. In both cases, breaks in drawdown curves may be the result of the radius of pumping influence reaching the lateral extent of the second HSZ sands. Data from CPT exploratory holes indicate the second HSZ sands pinch out approximately 150 feet west of second HSZ pumping well MW-44.

4.4.1.2 *Aquifer Parameter Analysis and Results*

Six different techniques were used to analyze data from the constant rate pumping tests. Drawdown data from pumping wells was analyzed using the Cooper-Jacob straight line method to estimate *T* (Cooper and Jacob, 1946). Drawdown data from on-site first HSZ wells, which showed delayed yield effects, was analyzed using the Neuman curve-matching method to estimate *T, S,* and S_y (Neuman, 1972). Drawdown data from second HSZ wells during both second HSZ constant rate pumping tests was evaluated using the Hantush leaky confined aquifer curve-matching method to estimate *T* and *S* (Hantush, 1956). Drawdown data from observation wells, which did not show delayed yield effects (first HSZ pumping tests) or confined leaky effects (second HSZ pumping tests), was analyzed using the Theis curve-matching method to estimate *T* and *S* (Theis, 1935). Distance-drawdown data was analyzed using the Cooper-Jacob distance-drawdown method to evaluate *T, S,* and R_o (Cooper and Jacob, 1946). Recovery data was analyzed using the Theis recovery method to provide an additional estimate of *T* (Theis, 1935).

The computer program Aqtesolv™ was used to assist with aquifer parameter analysis. This program combines statistical parameter estimation methods with interactive graphical curve-matching capabilities. Aquifer parameter estimation using the Jacob straight-line method, Hantush leaky aquifer curve-matching method, Theis confined aquifer curve-matching method, and Theis recovery method were performed using the Aqtesolv™ software. Aquifer parameter estimation using the Neuman delayed yield curve-matching method and Cooper-Jacob distance drawdown method were performed manually. Aqtesolv™ plots are provided in Appendix C.

Results of aquifer parameter analysis for the on-site and off-site constant rate aquifer pumping tests are summarized in Tables 6 and 7. A brief discussion of the results from each constant rate pumping test follows.

On-Site First HSZ Results

During the MW-32 constant rate pumping test, drawdown was observed in 15 of 19 first HSZ observation wells. Additionally, drawdown response was observed in both aquitard piezometers and in all four second HSZ observation wells. Drawdown effects in the second HSZ show that a hydraulic connection exists between the first and second HSZs.

During the on-site first HSZ test, the water level in MW-32 decreased approximately 19.4 feet in response to pumping, while the water level in piezometer P-1 located approximately 24 feet away decreased only 0.62 feet. MW-32 was originally constructed as a monitoring well, then later converted to an extraction well. This well is partially penetrating in the first HSZ with a 5-foot screened interval at the base of the first HSZ. The excessive drawdowns in MW-32 appear to be the result of well inefficiencies caused by a combination of partial penetration effects and inadequate well construction for extraction purposes.

Aquifer parameter analysis was conducted on drawdown data from observation wells MW-18, MW-19, MW-20, MW-31 and P-1 to provide estimates of *T*, *K*, and S_y. Estimates of *T*, *K*, and S_y for the first HSZ range from approximately 1,200 to 10,000 ft^2/day, 55 to 400 ft/day, and 0.018 to 0.02, respectively (Table 6). As discussed in Section 3.3.4.1, recovery data were not collected for this test; therefore, there are no recovery-based aquifer parameter estimates. The distance/drawdown-based estimate of R_O after 1,000 minutes of pumping is 530 feet.

Anomalously low values of *T* and *K* were estimated from analysis of P-1 drawdown data. These lower estimates of *T* and *K* are attributed to a component of vertical flow in the vicinity of P-1 caused by partial penetration pumping effects of MW-32. Although drawdown in P-1 appears small compared to MW-32, it was relatively large, given the distance from MW-32 and pumping rate. The first HSZ is approximately 21 feet thick in this area, and P-1 is approximately 24 feet away from MW-32. Ideally, observation wells and partially penetrating pumping wells should be separated by a minimum distance equivalent to two aquifer thicknesses to avoid the effects of vertical flow in the water bearing zone.

The geometric mean values of the ranges of *T* and *K* values calculated from test results and presented above are approximately 6,650 ft^2/day and 267 ft/d, excluding P-1 data. The specific yield values were generated by applying the Neuman delayed yield method to drawdown curves from MW-19 and MW-20. The average value of S_y is 0.019. Aquifer parameter estimates derived using MW-32 drawdown data are consistent with average values estimated from the MW-4 constant rate pumping test data performed in 1991 (Dames & Moore, 1992b).

On-Site Second HSZ Results

During the MW-40 constant rate pumping test, drawdown was observed in 6 of 8 second HSZ observation wells. Additionally, drawdown response was observed in both aquitard piezometers and in 9 of 12 first HSZ observation wells. Like the results of the first HSZ pumping test, response in the first HSZ wells to pumping in a second HSZ well illustrates the hydraulic connection between the first and second HSZs. The water level in MW-40 decreased approximately 11.5 feet in response to pumping, while the water level in piezometer P-3, located approximately 20 feet away, decreased approximately 4.4 feet. MW-40 is a fully penetrating monitoring well screened across the second HSZ. Results of both the step drawdown test and constant rate pumping test indicate MW-40 well efficiency is sufficient for potential future use as an extraction well.

Aquifer parameter analysis was conducted on drawdown data from observation wells MW-12, MW-28, MW-40, P-3, and P-4 to provide estimates of *T, K,* and *S*. Parameter analysis was also conducted on drawdown data from aquitard wells P-2A and P-2B to provide an estimate of aquitard vertical hydraulic conductivity, the results of which are presented in Section 4.4.1.3. Estimates of *T, K,* and *S* for the second HSZ range from approximately 450 to 4,850 ft^2/day, 41 to 440 ft/day, and 1.7×10^{-5} to 5.1×10^{-5}, respectively (Table 6). The distance/drawdown-based estimate of R_o after 1,000 minutes of pumping is 410 feet. Additionally, analysis of recovery data was performed to provide additional estimates of T and K (Table 6). Recovery-derived *T* and *K* values were generally greater than drawdown-derived estimates and are considered unreliable. Geometric mean values of *T, K,* and *S* calculated from test results (excluding recovery data) are 2,340 ft^2/day, 217 ft/d, and 3.4×10^{-5}, respectively.

Off-Site First HSZ Results

During the MW-38 constant rate pumping test, drawdown was observed in 4 of 6 first HSZ observation wells. Additionally, drawdown response was observed in 3 of 5 second HSZ observation wells, illustrating that the hydraulic connection between the first and second HSZ occurs both on- and off-site. First HSZ response did not show delayed yield effects characteristic of unconfined aquifers.

During the test, the water level in MW-38 decreased approximately 5.4 feet in response to pumping, while the water level in piezometer P-5 located approximately 14.5 feet away decreased approximately 1.6 feet. MW-38 is a fully penetrating monitoring well completed across the first HSZ. Results of both the step drawdown test and constant rate pumping test suggest MW-38 well efficiency is sufficient for potential future use of this well as an extraction well.

Aquifer parameter analysis was conducted on drawdown data from observation wells MW-38, P-5, P-7 and P-9 to provide estimates of *T, K*, and *S*. Estimates of *T, K*, and *S* for the first HSZ off-site range from approximately 3,200 to 5,400 ft^2/day, 320 to 570 ft/day, and 0.0028 to 0.019, respectively (Table 7). The distance/drawdown-based estimate of R_O after 1,000 minutes of pumping is 380 feet. Additionally, analysis of recovery data was performed to provide additional estimates of *T* and *K* (Table 7). Recovery-derived *T* and *K* values were similar to drawdown-derived estimates. Geometric mean values of *T, K*, and *S* calculated from test results are approximately 3,614 ft^2/day, 366 ft/d, and 0.010, respectively.

Estimates of *K* for the first HSZ off-site are higher than anticipated, based on our knowledge of the stratigraphy in this area. Although MW-38 is completed approximately 700 feet south of the pinch-out of the first HSZ sand channel, it appears that MW-38 is screened in an area of locally elevated hydraulic conductivity. As shown in lithologic cross-sections, presented in Figures 5 and 9, MW-38 is screened across primarily silty sand and silt, but also a 4-foot-thick sand lens. Pumping test results suggest that this sand lens is hydraulically productive in the vicinity of MW-38, and demonstrates the heterogeneous character of the first HSZ south of the sand channel.

Aquifer parameters for the first HSZ south of the sand channel were also evaluated by conducting constant-rate pumping tests in wells EW-1, MW-39 and MW-45. A description of the MW-39 and MW-45 tests is provided in Section 3.3.4 and a description of the EW-1 constant rate pumping test is provided in Section 3.2.1. Drawdown and recovery data from MW-39, MW-45, and EW-1 were used to estimate *T* and *K* at each location (Table 7). The average values of *T* and *K* from drawdown and recovery data for MW-39 are 288 ft^2/day and 29 ft/day, respectively. The average values of *T* and *K* from drawdown and recovery data for MW-45 are 1180 ft^2/day and 118 ft/day, respectively. The average values of *T* and *K* from drawdown and recovery data for EW-1 are 897 ft^2/day and 43 ft/day, respectively.

To provide an estimate of hydraulic conductivity which is representative of average hydrogeologic conditions south of the first HSZ sand channel, the mean values of the results from the MW-38, MW-39, MW-45 and EW-1 constant rate pumping test were calculated. The geometric mean *K* value for the four tests is 86 ft/day.

Off-Site Second HSZ Results

During the MW-44 constant rate pumping test, drawdown was observed in 3 of 5 second HSZ observation wells and 4 of 4 first HSZ observation wells.

During the test, the water level in MW-44 decreased approximately 24 feet in response to pumping, while the water levels in piezometer P-3 located approximately 20 feet away decreased approximately 2.8 feet. MW-44 is a fully penetrating monitoring well screened across the second HSZ. Results of both the step drawdown test and constant rate pumping test suggest that the well efficiency of MW-44 is sufficient for potential future use of this well as an extraction well.

Aquifer parameter analysis was conducted on drawdown data from the pumping well and observation wells P-6 and P-7 to provide estimates of *T*, *K*, and *S*. Estimates of *T*, *K*, and *S* for the second HSZ range from approximately 176 to 925 ft^2/day, 18 to 77 ft/day, and 0.00041 to 0.00045, respectively (Table 7). The distance/drawdown-based estimate of R_o after 1,000 minutes of pumping is 230 feet. Additionally, analysis of recovery data was completed to provide additional estimates of *T* and *K* (Table 7). Recovery-derived *T* and K values were generally greater than drawdown-derived estimates and are considered unreliable. Geometric mean values of *T*, *K*, and *S* calculated from test results (excluding recovery data) are 469 ft^2/day, 49 ft/d, and 0.00043, respectively.

4.4.1.3 Aquitard Parameter Analysis Results

An evaluation was conducted to estimate the vertical hydraulic conductivity of the aquitard between the first and second HSZs. Aquifer pumping tests performed at the site demonstrated that leakage between the first, second and third HSZs effects the radius of pumping influence and capture zone width. Therefore, an estimate of aquitard vertical conductivity is an important parameter for extraction well field design modeling. The Neuman-Witherspoon ratio method (Neuman and Witherspoon, 1972) for estimating vertical hydraulic conductivity of a leaky aquitard was used for this evaluation.

Drawdown data derived from monitoring water levels in piezometer nest P-1/P-2A/P-2B and piezometer P-3, during the MW-40 constant rate pumping test, were used for this evaluation. A description of the installation of piezometers P-1/P-2A/P-2B and P-3 is presented in Section 3.3.1. Data acquisition for this evaluation was discussed in Section 3.3.2. Time-drawdown plots for P-1, P-2A, P-2B, and P-3 are provided in Appendix C, Figure C-138.

Aquitard Specific Storage Estimate

To estimate aquitard parameters using the Neuman-Witherspoon ratio method, an estimate of specific storage *(S_s')* of the aquitard was required. Laboratory physical testing of three aquitard soil samples was performed to estimate S_s'. Results of laboratory physical testing are presented in Table 8, and laboratory reports are provided in Appendix D. The S_s' of an aquifer is estimated from consolidation test data by the following relationship:

$$S_s'(ft^{-1}) = 30.48\left[\frac{A_v}{1 + e}\right]$$

A_v = the coefficient of compressibility in cm^2/g determined from consolidation tests
e = the void ratio

The average value of S_s' from the three consolidation tests is 8.64×10^{-5}/ft.

Aquitard Vertical Hydraulic Conductivity Estimate

The ratio of the drawdown in the aquitard to drawdown in the aquifer, at the same radial distance from the pumping well, can be used to evaluate the hydraulic properties of the aquitard. The Neuman-Witherspoon ratio method evaluates the drawdown ratio early in the pumping period when aquitard drawdowns result from aquitard storage release. Drawdowns occurring after the time when water level response extends through the aquitard into the overlying water-bearing zone ($t_{critcal}$), are not the result of aquitard storage release and are therefore ignored. Using the ratio method, the vertical hydraulic conductivity *(K')* of the aquitard can be estimated. A brief description of the solution technique follows.

The ratio of drawdown within the aquitard *(s')* to drawdown within the aquifer *(s)* at equal distance from the pumping well is calculated. At time t, the ratio s'/s and the dimensionless parameter t_d are calculated from the relationship:

$$t_d = \frac{Kt}{S_s r^2}$$

K = the hydraulic conductivity of the pumped aquifer
S_s = the specific storage of the pumped aquifer
t = the elapsed pumping time
r = the radial distance to the pumping well

Using the type curves which relate variations of s'/s versus t_d' for various values of t_d, an estimate of t_d' is provided. Curves are shown in Appendix C, Figure C-139. K' is then estimated using the relationship:

$$K' = \frac{S_s' Z^2 t_d'}{t}$$

S_s' = the specific storage of the aquitard
Z = the vertical distance from the top of the aquifer to the aquitard observation point

The process is repeated for several values of t less than $t_{critical}$, and the average K' value is calculated.

Piezometers completed in the first HSZ (P-1), aquitard (P-2A), and second HSZ (P-3) and at equal distances from the pumping well (MW-40) were monitored during the second HSZ constant rate pumping test. At a time of 10 minutes, response was observed in first HSZ piezometer P-1, therefore, drawdown data after 10 minutes were ignored. Using the ratio method, K' was calculated at elapsed times of 5, 6, 7, 8, 9 and 10 minutes. Calculations are summarized in Table 9. An average estimated K' of 0.33 ft/day was calculated for the aquitard.

Uncertainties in the calculated values of K' presented above exist as a result of apparent inconsistencies noted in the drawdown data. The primary inconsistency is the delayed response to second HSZ pumping observed in drawdown data collected from aquitard piezometer P-2B, completed near the base of the aquitard. Piezometer P-2A, completed near the top of the aquitard responded after approximately 2 minutes of pumping, while piezometer P-2B did not respond until after approximately 40 minutes of pumping. First HSZ piezometer P-1 responded after approximately 10 minutes of pumping.

This discrepancy in response times may be the result of installation difficulties encountered with P-2A. Borehole wall conductivity in the screened interval of P-2B may have been reduced due to smearing effects from repeated attempts to remove slough material during drilling. An alternative explanation for the discrepancy in piezometer response is the possibility of a short circuiting hydraulic effect adjacent to the pumping well. In this scenario, a higher conductivity pathway may exist between the first and second HSZ which is not hydraulically connected with the screened interval of P-2B. The presence of such a pathway could enable drawdown response near the top of the aquitard and in the first HSZ to occur sooner than drawdown response near the base of the aquitard.

4.5 GROUNDWATER IRM PERFORMANCE

This section presents a discussion of GW-1 and GW-2 groundwater IRM performance. A discussion of data analysis and results of GW-1 and GW-2 IRM capture zone evaluations is included. Additionally, a discussion of mass removal of VOCs from groundwater for GW-1 and GW-2 is presented.

4.5.1 Groundwater IRM Capture Zones

This section presents data analysis and results of GW-1 and GW-2 capture zone evaluations discussed in Section 3.2.

4.5.1.1 GW-1 IRM Capture Zone

Groundwater levels were measured in several on- and off-site wells and piezometers in August 1994 and February 1995 and used to construct groundwater elevation contour maps for the first HSZ. The water levels are representative of steady-state pumping conditions during MW-4 and MW-32 extraction well operations. These groundwater elevations are provided in Tables 10 and 11, and the corresponding groundwater elevation contours are provided in Figures 19 and 20. A discussion of the methods used to assess steady state conditions is provided in Section 3.2.1.

In some areas along the eastern side of the GW-1 plume, there are no wells in which to monitor water levels. To supplement existing water level data with water level data for the areas with no wells, the concept of mirror image wells was used. This concept assumes water level response to MW-4 and MW-32 extraction is symmetrical across an axis. This axis of symmetry is defined as a groundwater flow line which intersects both extraction wells. This is considered a valid approach at this site because extensive groundwater monitoring over the past seven years has demonstrated that the groundwater flow direction and gradient remain relatively constant across the axis of the plume. Additionally, groundwater monitoring has demonstrated that a groundwater flow line approximately bisects both MW-4 and MW-32. Using this concept, water levels from actual wells west of the axis were projected an equal distance across the axis of symmetry. Groundwater levels from actual wells and mirror image wells were then used to construct a contour map of steady-state groundwater elevations created by extraction from MW-4 and MW-32.

The groundwater elevation contours maps developed for steady-state pumping conditions in August 1994 and February 1995 were used to estimate the capture zone boundary using the groundwater flow concepts. The GW-1 capture zone boundaries for MW-4 and MW-32 are presented in Figures 19 and 20 for August 1994 and February 1995, respectively. The groundwater flow lines show that the width of the GW-1 IRM capture zone is approximately 400 feet wide, 300 feet upgradient of extraction well MW-32, and expands to approximately 650 feet wide, 300 feet upgradient of extraction well MW-4. The groundwater flow lines shown in Figures 19 and 20 indicate that full capture of the on-site portion of GW-1 in the first HSZ is being attained.

4.5.1.2 GW-2 IRM Capture Zone

Drawdown and recovery data collected from extraction well EW-1 during a constant rate pumping test were used to estimate aquifer properties *T* and *K*. Drawdown and recovery data from EW-1 were evaluated using the Cooper-Jacob straight line method and Theis recovery method, respectively. Results are presented in Table 6.

Aqtesolv™ graphs of drawdown and recovery data are provide in Appendix C, Figures C-134 and C-136. Using both methods the average *T* is 897 ft/day. The thickness of the first HSZ in this area of the site is approximately 21 feet, leading to an estimated K of 43 feet/day.

An estimate of the capture zone for EW-1 was provided using the analytical flow model QuickFlow™. Model input is as follows:

Input Parameter	Value
Hydraulic Conductivity	45 ft/day
Aquifer Thickness	21 ft
Hydraulic Gradient	0.0025
Bottom Elevation of Aquifer	-30 ft
Water Table Elevation	-9 ft
Porosity	0.30
EW-1 Pumping Rate	10 gpm

Figure 11 shows an estimate of the EW-1 capture zone at steady state based on QuickFlow™ results. The capture zone appears to cover most of the GW-2 plume. A small portion of the downgradient portion of the plume extends beyond the capture zone. However, the majority of the plume with concentrations of 1,1-DCE exceeding the RAO (MCL) of 6 μg/L, appears to be covered by the capture zone created by EW-1 pumping at 10 gpm.

4.5.2 Groundwater IRM Mass Removal

Since GW-1 groundwater extraction wells began operations in April 1993, an estimated 14.3 million and 8.7 million gallons of groundwater have been removed from extraction wells MW-4 and MW-32, respectively (Table 12). Based on these volumes and the concentrations of VOCs in each well, a combined amount of 11.1 pounds of chlorinated VOCs is estimated to have been removed from extraction wells MW-4 and MW-32 (Table 13). In addition, approximately 20.2 pounds of BTEX, and 62.0 pounds of TPH as gasoline is estimated to have been removed from extraction well MW-4. The current mass removal rate of chlorinated VOCs for MW-4 and MW-32 is estimated to be approximately 2.6 and 1.6 pounds/year, respectively. The current mass removal rate of aromatic compounds and TPH-gasoline for MW-4 is 2.0 and 11.6 pounds per year, respectively. The estimated mass of chlorinated VOCs in GW-1 (pore fluid fraction) in the first HSZ is 48 pounds.

Since GW-2 groundwater extraction well EW-1 began operations October 1994, an estimated 1.4 million gallons of groundwater have been removed (Table 12). Approximately 0.20 pounds of chlorinated VOCs is estimated to have been removed (Table 13), and the current chlorinated VOC mass removal rate is approximately 0.88 pounds/year. The estimated mass of chlorinated VOCs in GW-2 (pore fluid fraction) in the first HSZ is 6 pounds.

5.0 GROUNDWATER MODELING

This section describes the process of development of the numerical model; provides the justification for model construction; describes the procedures used to calibrate the numerical model; and presents results of sensitivity analyses, and predictive simulations.

5.1 PURPOSE AND OBJECTIVES

The culmination of the pre-design site activities was the development of a comprehensive understanding of the groundwater regime both on- and off-site. The purpose of developing this understanding was to enable the design and operation of an efficient groundwater remediation scheme that will prevent further migration of existing impacts, and cost-effectively remediate impacted groundwater in the first and second HSZ, both on- and off-site. To prevent further migration and to effectively remediate groundwater impacts requires some type of hydraulic control over groundwater flow (e.g., groundwater extraction and/or injection). To evaluate groundwater extraction and injection scenarios that effectively prevent further migration of groundwater impacts and still allow for efficient and effective groundwater remediation, a numerical groundwater flow model and contaminant transport model was used.

The specific objectives of using a numerical groundwater flow and transport model were:

- Design an extraction well field to capture VOC-impacted groundwater within the first and second HSZs at the site boundary and near the toe of the plume;
- Estimate extraction flow rates for design of an off-site treatment system;
- Evaluate benefits of adding extraction wells along the plume axis; and
- Evaluate the hydraulic effects of injecting treated water.

5.2 FLOW MODEL DESCRIPTION

A numerical flow model was developed based on data collected from previous investigations, coupled with the information obtained from the pre-design site activities described in the previous sections. This section describes the steps of flow model development which include conceptual model development and model calibration. The numerical flow model was then used to evaluate and select the optimal groundwater pumping and injection scenarios.

5.2.1 Conceptual Model

The numerical model MODFLOW was used to simulate groundwater flow. MODFLOW is a well-documented groundwater flow code developed by the United States Geological Survey (USGS) (McDonald and Harbaugh, 1988), and has been used to simulate groundwater flow at numerous sites throughout California. MODFLOW's code uses a finite difference method to solve the flow equation to obtain hydraulic head distribution under hydraulic stresses (pumping and injection). The particle tracking program MODPATH (Pollack, 1994) was used to estimate capture zone boundaries. MODPATH is used as a post-processing program designed to work with MODFLOW output to compute particle paths for water moving through the simulated groundwater system.

The first step in developing the numerical flow model was to define the geologic and hydrologic system to be simulated. Section 4.0 describes the physical groundwater system interpreted to exist both on- and off-site. To represent this groundwater regime, a three-dimensional irregular grid was developed. The irregular grid was adopted to maximize resolution in the area of the plume. In the vertical dimension, an irregular mesh was developed to account for the variable thickness and change in elevation of the various stratigraphic layers. One of the principle grid directions is oriented parallel to the general groundwater flow direction, with the VOC plume in the first HSZ in the center of the model domain. Figure 21 shows a map of the model grid and its relation to the site.

The numerical model uses three layers to simulate the groundwater hydrology of the site. Layer 1 of the model represents the first HSZ, layer 2 of the model represents the second HSZ, and layer 3 of the model represents the third HSZ. The low-permeability zones (aquitards) that separate the first and second, and second and third HSZs are simulated by using a lower vertical conductance term. The vertical conductance term is a function of the thickness and vertical hydraulic conductivity of the aquitards between the HSZs.

Boundary conditions for the flow model include constant head boundaries on the up- and down-gradient ends of the model and no flow boundaries along the sides. Constant head elevations were set to simulate the gradient observed within the flow model domain. No-flow boundaries were set parallel to the direction of groundwater.

The water levels measured during October 1994 were used as the steady state base condition (Figures 13 and 14). Groundwater elevations have varied by about five feet since water level measurements began in 1987. Water levels typically change about one to two feet per year and usually change less than 0.5 feet over one month's time. October 1994 groundwater elevations were used as the base condition since they represent the most recent static (non-pumping) water levels measured on the site. The gradient represented by October 1994 water levels is typical of what has been measured across the model domain over the last seven years. In addition, the gradient across the site and between HSZs has been consistent, regardless of the water level changes observed over the last seven years.

Flow model parameters were based on hydrogeologic data collected during the remedial investigation and from pre-design activities (Section 4.0). Table 14 lists the parameters incorporated into the model. Hydraulic conductivity *(K)* and storativity *(S)* values for the first HSZ are based on data from pumping tests conducted in wells MW-4, MW-32, EW-1, MW-38, MW-39, and MW-45. The distribution of *K* and *S* throughout the modeled domain, as shown in Figure 22, is primarily based on the stratigraphy presented in Section 4.0. Note that the model is divided into two areas based on hydraulic conductivity. Wells MW-4 and MW-32 are screened within the first HSZ sand channel that is typically encountered beneath the site, but pinches out south of the site near Sutterville Road. Wells EW-1, MW-38, MW-39, and MW-45 are screened in interfingering layers of sand, silt, and clay that are predominant in the first HSZ south of pinchout of the sand channel. The geometric mean of *K* values derived from the pumping tests performed in MW-4 and MW-32 was used to represent the material within the sand channel, while the geometric mean of *K* values derived from the pumping tests performed in EW-1, MW-38, MW-39, and MW-45 was used to represent the material outside the sand channel. Where data on the presence (or absence) of the sand channel was lacking, the contact between the two material types was extrapolated to the edges of the modeled domain. Values of *K* and *S* for the second HSZ are based on the results of pumping tests performed in wells MW-40 and MW-44. The distribution of *K* within the second HSZ, as shown in Figure 23, illustrates the different values *obtained* on-site (MW-40) and off-site (MW-44). The two values were both extrapolated to the edges of the model domain into areas where data were not available.

The vertical hydraulic conductivity used to calculate vertical leakance between the first and second HSZ is based on evaluations completed during the on-site (MW-40) pumping test (see Section 4.4.1). This value was extrapolated across the model domain. Vertical conductivity between the second and third HSZ was not evaluated. However, the lithology between the second and third HSZ is similar to that separating the first and second HSZ; therefore, the same vertical conductivity was used.

No pumping test data were available for the third HSZ; however, based on soil samples collected during drilling, the lithologies of the second and third HSZs are very similar. Therefore, similar values of K and S for layers 2 and 3 were input into the model. In addition, published values relating to K to soil type (Bear, 1972) were reviewed to further support the selection of K and S for the third layer.

Top and bottom elevations of the three HSZs are based on the cross-sections presented in Section 4.1. The cross-sections are interpretations of data collected from installation of monitoring wells and CPTs. Bottom elevations for layers 1 and 2 are shown in Figures 24 and 25. The top elevation of layer 2 is shown in Figure 26. The top of layer 1 is undefined since it is modeled as an unconfined layer. The top and bottom elevations of layer 3 are based on two points (data from MW-41 and MW-47) and is therefore held constant throughout the model domain. As shown in Figures 15 through 18, the majority of the field data is centered along the plume axis. As a result, the top and bottom elevations vary as constrained by available data in the area centered around the plume axis , and constant values are extrapolated to the edges of the model domain where data are lacking.

5.2.2 Model Calibration

The model was calibrated to assumed steady-state conditions. Calibration was performed by comparing simulated water levels computed by the numerical model, with actual water levels measured in the field. The difference between simulated and actual water levels is termed "the residual." Residuals were then compared to appropriate calibration targets. Calibration criteria for residuals were set at two percent of the change in head from the upgradient end to the downgradient end of the model domain, which is approximately 17 feet. Two percent of the change in head is 0.34 feet.

Simulated water levels were compared to water levels measured in October 1994. October 1994 water levels were used as calibration targets because they represent the most recent set of water levels not affected by pumping for the on-site IRM and, as described above, are representative of the water level distribution observed over the last seven years. Target wells were selected to represent water levels in both on-and off-site wells and within all three HSZs. Calibration was accomplished by trial and error by changing model parameter values (K and/or top and bottom elevations) and/or boundary conditions (constant heads) in sequential model simulations to minimize residuals.

Calibration targets are listed in Table 15. A total of 26 wells were used, 17 in the first HSZ, 7 in the second HSZ, and 2 in the third HSZ. First HSZ calibration targets were chosen to provide a distribution across the site. All second and third HSZ wells were used as calibration targets. All but two of the target wells are within the calibration target of $\pm$0.34 feet, first HSZ well MW-35 (-0.36 feet), and third HSZ well MW-47 (-1.08 feet). The absolute residual mean, which provides a measure of the average total error, is approximately 0.15, 0.10, and 0.54 for the first HSZ, second HSZ, and third HSZ calibration targets, respectively.

Plots of actual versus simulated water levels are included in Figures 27 and 28 for the first and second HSZs, respectively. These figures show that simulated water levels are relatively close to actual water levels for the entire range of groundwater elevations across the model domain.

Differences between first and second HSZ water levels measured in the field show a consistent downward gradient between the first and second HSZs. These differences were evaluated in the numerical model and are summarized in Table 16. As the table shows, even though the magnitude of the differences between simulated and actual water levels varies with location, the model simulates a downward gradient between the first and second HSZs across the model domain, except between downgradient wells MW-39 and MW-46.

5.3 TRANSPORT MODEL DESCRIPTION

Data collected during previous investigations, coupled with data generated during previous modeling efforts (Dames & Moore, 1991b) and published hydrogeologic parameter values were incorporated into a numerical transport model. The numerical transport model was used to further evaluate groundwater pumping scenarios and to optimize the groundwater extraction well field design.

5.3.1 Conceptual Model

The numerical model MT3D was used to simulate contaminant transport. MT3D is a proprietary program (S.S. Papadapolus and Associates, 1990) developed with support from the U.S. Environmental Protection Agency, that uses a modular structure similar to MODFLOW. The modular structure of MT3D allows independent evaluation of advection, the transport parameter, dispersion, chemical reaction (adsorption and/or decay), and sink or source mixing. The transport model and flow model are related, in that MT3D requires output from the flow model (MODFLOW) to conduct simulations.

Transport parameters evaluated in this report include porosity, sorption, dispersivities, time since release of impacts, and concentration of impacts during release. Some of these parameters such as porosity and sorption could be estimated using available field data. Other parameters, such as dispersivities, are unknown, but may be estimated using values published in literature, while parameters such as time of release and initial concentration, are unknown and difficult to estimate.

Porosity values *(n)* input into the transport model were based on values obtained from soil samples collected from four wells (MW-2, MW-4, MW-7, and MW-8). The samples ranged in depth from 40 to 55 feet and the range of values measured from the four samples was 0.35 to 0.41. The effective porosity of the material and the value input into the model was assumed to be 80% of the measured porosity. This assumption was used to produce a conservative estimate of *n*. The porosity values measured from soil samples are representative of material in the first HSZ within the sand channel. No porosity values are available for the second and third HSZ; however, since the material type for samples collected in the first HSZ (within the sand channel), the second HSZ, and the third HSZ are similar, similar porosity values were used. In addition, no porosity values were measured in material found outside the sand channel within the first HSZ. This material is generally finer-grained than the sand channel, suggesting a slightly higher porosity (Bouwer, 1979). However, since the effective porosity of the material within the first HSZ outside the sand channel is unknown, the on-site measured values were extrapolated throughout the model domain.

Sorption is defined as the adhesion of solutes in groundwater to the surface of soil particles with which they come into contact. Sorption is represented by the retardation factor *(R)*. The retardation factor is a function of aquifer porosity *(n)*, soil bulk density (p_b), and contaminant partitioning coefficient *(Kd)*. The partitioning coefficient is a function of the fraction of organic carbon in the soil (f_{oc}) and the proportionality constant characteristic of the chemical (K_{oc}) (Freeze and Cherry, 1979; Anderson and Woessner, 1992).

The retardation factor used in the model was initially estimated using the following equation:

$$R = 1 + (P_b / n) K_d$$

where:

R =	Retardation Factor
P_b =	Bulk Density
n =	Porosity; and
K_d =	Distribution Coefficient (equal to $f_{oc} \times K_{oc}$)

Bulk density values of 1.6 g/cm^3 were determined from previous investigations along with an F_{oc} of 0.0007 (Dames & Moore, 1995b). The bulk density and f_{oc} values were obtained from samples collected at a depth of approximately 20 feet bgs, and represent the deepest samples for which this information was obtained. A K_{ow} of 65 was used based on values reported in Montgomery and Welcom, 1990, for 1,1-DCE. A value of 0.3 was used for n. Using these values results in an estimate of R equal to 1.24. This estimate of R was initially used in the model in all three layers throughout the model domain. This assumption is supported by the similarity of soil type between the three HSZs and is consistent with holding parameters constant throughout the model domain where data are absent.

Dispersion is the process by which a solute flowing in groundwater is mixed with unimpacted groundwater and is reduced in concentration. Dispersion is represented by a dispersivity value. Dispersivities used in the transport model were based on values published in the literature, values used in previous modeling work at the site (Dames & Moore, 1991b), and sensitivity of the model to changes in dispersivity. Fetter (1988) reports values of longitudinal dispersivities ranging from three feet for homogeneous materials, to 200 feet in alluvial sediments. Values of three feet were used in previous modeling efforts focused in the sand channel. Values similar to these were used for the three layers in the model.

Transport modeling involved the evaluation of one constituent, 1,1-DCE. Evaluating one constituent simplifies the modeling process by eliminating the complexity of multiple solute fronts and the different retardation and transformation processes that affect each one. 1,1-DCE was chosen as the constituent to model because of the chlorinated VOCs associated with the plume, it is the most widespread, and is found in the highest concentration.

Initial conditions for the transport model were based on the contaminant distribution of 1,1-DCE, as discussed in Section 4.2. Using the current contaminant distribution eliminates the need to explicitly know the release times and concentration of constituents. The initial 1,1-DCE concentration input for the first and second HSZ are shown in Figures 29 and 30, respectively. Simulations use the current plume configuration to evaluate capture zones and extraction well field design. Release times and concentrations are discussed further in the transport model development subsection 5.3.2.

5.3.2 Transport Model Development

Due to the limitations of available data to simulate contaminant transport, the transport model focused on evaluation of the parameters that govern transport at the site and how they may affect movement of contaminants induced by an extraction well field. The current data interpretation of the distribution of 1,1-DCE in the first and second HSZs was input into the model to evaluate contaminant transport and plume capture. Two parameters affecting transport of 1,1-DCE, dispersivities and retardation, were then revised separately in subsequent simulations. This evaluation was completed to develop an understanding of the processes that affect contaminant transport at the site. The focus of this evaluation was to assess which parameter dominates simulated transport (i.e., advection, dispersion, or retardation), and how the parameters interact.

The transport model was evaluated in step-wise fashion. The first step was to simulate a point source release over time near the downgradient side of well MW-2 using advection transport only and then compare the predicted contaminant distribution with the actual plume. This step confirms the accuracy of the flow field simulated by the flow model (does the predicted plume follow the same flow path as the actual plume) and also produces the initial understanding of the transport parameters that may be affecting contaminant transport at the site.

Once an advective transport simulation was completed, more complexity was introduced into the model by including dispersion. This step included inputting dispersion into the model and evaluating the change in plume morphology compared to the change in the advective simulation results. Model stability and plume morphology were evaluated after initial simulations to see the effects when dispersivity were raised above initial inputs for longitudinal dispersivity (α_L of 3 feet). Large values of longitudinal dispersivity (α_L greater than 10 feet) resulted in model instability and a plume shape that did not match the plume observed in the field. Values of dispersivities lower than 3 feet resulted in more stable model runs and a simulated plume shape similar to that observed in the field. Dispersivity values which produced a simulated plume shape consistent with field data are listed in Table 14. Lower values of dispersivity are used in layer 2 (Table 14) where layer thickness becomes relatively small. Slightly higher values were used in layers 1 and 3. The values in layer 1 coincide with those used in earlier modeling efforts (Dames & Moore, 1991b). Once dispersivities were evaluated, sorption was added to the transport model.

Using a value of retardation due to sorption *(R)* of 1.24 results in transport rates of approximately 400 feet per year. The simulated plume develops to the size of the actual plume in simulation times of 10 years. Groundwater velocities at the site are estimated to be about 250 feet per year (based on gradient and porosity). Using the relationship where K_d is a function of f_{oc} and *K*oc is commonly found in the literature; however, the EPA (1989) reported that for values of f_{oc} less than 0.001, a condition found at the site, sorption of neutral organics onto mineral phases may cause important errors in the estimate of *R*. Therefore, using the relationship of $K_c = f_{oc} K_{oc}$ may underestimate the value of *R*. This is supported by the results of a twenty-year simulation in which a plume that is similar in shape to the actual plume is created using *R* equal to 2.5. Based on available historical data, a 20-year release scenario appears reasonable. Using values of *R* greater than 2.5 resulted in simulated plumes where the center of mass stayed close to the source and did not show the distribution of the actual plume.

To formally calibrate the transport model, additional information regarding time of release, initial concentration, source area/groundwater interaction, and chemical transport parameters is required. Due to a lack of verifiable contaminant input data, the flow model was not formally calibrated. However, at this stage of development, the transport model appears to be producing results consistent with field observations.

Once the model was producing a plume similar in characteristics (length, width, and concentration distribution) to that observed in the field (assuming a 20-year constant release point source near well MW-2), the current contaminant distribution in both the first and second HSZs was input for predictive simulations. Although the transport model was not formally calibrated, results of transport predictive simulations were used to check predictive flow simulation results and provide limited input on extraction well placement. The predictive simulations were conducted to evaluate extraction well flow rates and locations required to effect plume capture.

5.4 MODEL SIMULATIONS

The purpose of conducting the predictive simulations was to develop an extraction well field to (1) prevent migration in both the first and second HSZs, and (2) effectively remove groundwater for treatment. Predictive simulations are based mainly on flow model and particle tracking results, supplemented with transport model estimates. Particle tracking was used to estimate capture zone boundaries for predictive simulation. Capture zone boundaries were estimated using particle tracking simulations to assess the starting locations of particles captured by each extraction well. Although the transport model has not been formally calibrated, it has been used to estimate relative removal times for different extraction well scenarios. For each scenario, it is assumed that the source of VOCs to groundwater was contained or removed. Predictive simulations focused on using existing wells. Simulations started with existing groundwater extraction conditions and progressively added more wells to the network.

The first predictive simulation was selected to simulate GW-1 and GW-2 IRM groundwater extraction conditions. First HSZ extraction wells MW-4, MW-32, and EW-1 were pumped at their operation flow rate of 20, 13, and 10 gpm, respectively. The particle tracking capture zone-based boundaries of the simulated flow field are shown in Figure 31. Capture zone dimensions for MW-4, MW-32, and EW-1 from this simulation are similar to the results of the GW-1 and GW-2 IRM capture zone evaluations presented in Section 4.4.

The second predictive simulation included pumping from first HSZ well MW-39 and second HSZ well MW-44 with the purpose of hydraulically controlling the downgradient area of the plume. Next, first HSZ well MW-38 was added to enhance the mass removal rate of off-site first HSZ groundwater impacts. MW-38 is located at an area of known elevated VOC concentrations. An additional simulation added second HSZ well MW-40 to simulate on-site hydraulic containment of second HSZ impacts. The final simulation included first HSZ wells MW-36 and MW-42, located along the axis of the VOC plume, to evaluate enhancement of mass removal rates. Well locations relative to the VOC plume are shown in Figures 15 through 18.

Based on the results of predictive simulations, the recommended extraction well field consists of a total of seven extraction wells as follows:

On-Site

- Wells MW-4, and MW-32 are used to capture first HSZ on-site GW-1 groundwater impacts;
- MW-40 is used to capture second HSZ on-site GW-1 groundwater impacts; and
- EW-1 is used to capture GW-2 groundwater impacts.

Off-Site

- MW-39 is used to prevent further migration of groundwater impacts off-site near the downgradient end of the plume in the first HSZ;
- Similarly, well MW-44 is used to prevent further migration of impacts off-site near the downgradient end of the plume in the second HSZ; and
- MW-38 is used to remove mass from the interior of the plume in the first HSZ.

Extraction well locations and estimated capture zones boundaries are shown in Figures 32 and 33. Wells are pumped at a rate of 10 to 20 gpm, depending on location. Table 17 lists proposed extraction wells and their associated flow rate. The recommended number of wells is based on the ability of the extraction well field to attain capture, and relative time to remove impacted groundwater in relation to the number of extraction wells in operation. Figure 34 is a plot of number of extraction wells versus relative predicted time for each scenario to reach the 1,1-DCE remedial action objective of 6 ppb in groundwater. It was developed by reviewing the results of different transport simulations discussed above. As the figure indicates, there appears to be a point where an increase in the number of extraction wells does not appreciably reduce the time to remove impacted groundwater.

Simulations were conducted to evaluate the effect of injection of water into the first HSZ on the groundwater flow field. Reinjection is a potential cost-effective alternative to the current approach, which is discharge to an on-site sanitary sewer.

Model simulations were performed to evaluate the effect on water levels and plume movement when injecting upgradient of the plume on-site, and when injecting near the toe of the plume off-site. Results of on-site injection simulations suggest that injection of water upgradient of the plume does not affect the capture zone, nor does it affect the flow field in such a way as to render the extraction wells ineffective (i.e., increase the gradient or change direction of flow). The model results indicate that on-site injection of treated groundwater offers no significant advantages to shortening the time needed to remediate groundwater. Therefore, the decision to use injection on-site should be based on economics and technical constructibility issues. Off-site injection of water near the toe of the plume can affect the flow field if injection is performed too close to the plume. Simulation results suggest injection in the first HSZ must occur no closer than 800 to 1,000 feet away to minimize influence on the plume. As with on-site injection, off-site injection of treated groundwater appears to offer no advantages in terms of shortening the time for remediation. The advantages and disadvantages of pursuing injection as a treated water discharge option should be evaluated as part of the final remedial design strategy for the on-site and off-site remediation system.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The conclusions based on groundwater predesign activities are as follows:

- Based on analysis results for HP in situ water samples and groundwater monitoring well samples, the downgradient extent of VOC impacts to first HSZ groundwater originating from the site appears to extend approximately 5,200 feet downgradient from the source area of GW-1 (Central Fill Area) to 19th Avenue;

- Based on analysis results for groundwater monitoring well samples collected from MW-46, the downgradient extent of VOC impacts to second HSZ groundwater originating from the site appears to extend downgradient to a point between MW-44 and MW-46;

- Based on groundwater analytical results for samples collected from MW-41 and MW-47, the third HSZ has not been impacted by VOCs;

- The total mass of chlorinated VOCs in both first HSZ and second HSZ groundwater impacted is estimated to be 55 and 6 pounds, respectively;

- Monitoring information indicates that the GW-1 groundwater IRM is accomplishing the objective of capturing on-site first HSZ groundwater impacts, preventing further off-site migration within the first HSZ;

- To date, the GW-1 groundwater IRM extraction system has removed an estimated 23 million gallons of water, 11 pounds of chlorinated VOCs, 20.2 pounds of BTEX and 62.0 pounds of TPH as gasoline. The system is currently removing chlorinated VOCs at an estimated rate of 4.2 pounds per year, BTEX at 2.0 pounds per year, and TPH as gasoline at 11.6 pounds per year;

- To date, the GW-2 groundwater IRM extraction system has removed an estimated 1.4 million gallons of water and 0.2 pounds of chlorinated VOCs, and is currently removing VOCs at an estimated rate of 0.9 pounds per year.

- Groundwater modeling results indicate that VOC impacts to groundwater originating from the site will be effectively addressed by continued operation of on-site first HSZ extraction wells EW-1, MW-4 and MW-32, supplemented by on-site second HSZ extraction well MW-40, off-site first HSZ extraction wells MW-38 and MW-39, and off-site second HSZ extraction well MW-44.

The recommendations based on groundwater predesign activities are as follows:

- Replace the on-site, partially-penetrating monitoring/extraction well MW-32 with a fully-penetrating extraction well adjacent to the current location to increase pumping efficiency in this location;

- Expand the current on-site GW-1/GW-2 IRM system to include on-site second HSZ well MW-40 and upgrade the status of the system from on-site first HSZ groundwater IRM to on-site first and second HSZ groundwater remedy;

- Implement the off-site extraction well field expansion scenario which includes extracting groundwater from off-site first HSZ wells MW-38 and MW-39, and off-site second HSZ well MW-44;

- Replace off-site partially-penetrating first HSZ monitoring well MW-39 with a fully-penetrating, first HSZ extraction well adjacent to MW-39.

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TABLES

TABLE 1
SUMMARY OF WELL CONSTRUCTION DETAILS
GROUNDWARE PRE-DESIGN ACTIVITIES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Date Completed	Ground Elev. (feet MSLD)	Top of Casing Elev.[A] (feet MSLD)	Completed Depth (feet)	Boring Diam. (inches)	Well Casing Diam. (inches)	Screened Interval (feet bgs)	Filter Pack Interval (feet bgs)	Dedicated Pump Intake (feet bgs)
AS-1	07/05/94	—	23.39	46.25	8	2	39.5-44.5	38-46.25	—
EW-1**	06/03/94	23.90	24.44	51.0	12	4	25-50	23-51	44
MP-1A	07/08/94	—	24.04	45.0	12	1	19-27	17-27	—
MP-1B	07/08/94	—	24.04	45.0	12	1	31.36	29-36	—
MP-1C	07/08/94	—	24.04	45.0	12	1	40-45	38-45	—
MP-2A	07/12/94	—	22.88	46.5	12	1	19-27	17-27	—
MP-2B	07/12/94	—	22.88	46.5	12	1	31-36	29-36	—
MP-2C	07/12/94	—	22.88	46.5	12	1	40-45	38-45	—
MW-1	01/20/88	17.15	18.67	46.0	12	4	15-35	12-46	—
MW-2	01/25/88	21.93	23.62	66.0	12	4	37-57	34-66	46.7
MW-3	01/23/88	15.22	16.76	31.0	12	4	15-25	13-31	—
MW-4*	02/03/88	24.68	26.17	60.0	12	4	34-54	30.5-57	—
MW-5	02/09/88	24.60	28.00	51.0	12	4	37-47	31.5-51	—
MW-6	02/15/88	24.63	26.50	54.0	12	4	30-50	26.5-54	—
MW-7	01/29/88	24.78	26.29	46.0	12	4	33-43	29-46	38.6
MW-8	02/06/88	24.85	26.66	59.5	12	4	37.5-52.5	28-59	—
MW-11	08/09/89	23.9	26.29	56.0	12	4	50-55	48-56	52.26
MW-12	08/30/89	25.5	28.37	82.0	10.5[B]	4	69-79	67-82	74.0
MW-13	08/16/89	25.8	27.88	45.0	12	4	26-41	24-43	38.5
MW-14	08/17/89	26.8	29.21	58.0	12	4	52.5-57.5	49.5-58	54.9
MW-15	08/21/89	25.1	27.32	44.0	12	4	26-41	24-41	—
MW-16	08/23/89	25.1	27.37	57.5	12	4	51.8-56.8	49.8-57.5	54.4
MW-17	09/12/89	25.2	27.55	45.0	12	4	26.5-41.5	24-43	—
MW-18	09/13/89	25.1	27.64	57.5	12	4	52-57	50-57.5	54.7
MW-19	09/08/89	24.5	27.05	42.0	12	4	26-41	24-42	—
MW-20	09/11/89	24.7	27.15	59.0	12	4	52-57	50-59	54.6
MW-21	08/31/89	24.3	26.46	40.0	12	4	24-39	22-40	—
MW-22	09/06/89	24.8	27.35	52.5	12	4	45.5-50.5	43.5-52.5	—
MW-23	08/28/89	24.5	26.68	42.0	12	4	25.5-40.5	23.5-42	—

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TABLE 1 (continued)
SUMMARY OF WELL CONSTRUCTION DETAILS
GROUNDWATER PRE-DESIGN ACTIVITIES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Date Completed	Ground Elev. (feet MSLD)	Top of Casing Elev.[A] (feet MSLD)	Completed Depth (feet)	Boring Diam. (inches)	Well Casing Diam. (inches)	Screened Interval (feet bgs)	Filter Pack Interval (feet bgs)	Dedicated Pump Intake (feet bgs)
MW-24	08/30/89	24.9	27.13	45.0	12	4	34-39	32-45	—
MW-25	08/03/89	23.7	26.13	41.5	12	4	26-41	24-41.5	—
MW-26	08/04/89	23.7	26.04	50.0	12	4	38-43	35-44	40.6
MW-27	09/07/89	23.8	26.53	73.0	10.5[B]	4	56.5-66.5	54.5-70	61.5
MW-28	02/07/90	25.15	25.14	85.0	12[B]	4	69.0-79.0	65.6-80.5	74.7
MW-29	01/22/90	25.24	25.22	42.0	12	4	26.0-41.0	24.0-42.0	39.1
MW-30	01/24/90	26.19	25.16	57.0	12	4	51.0-56.0	49.0-57.0	53.9
MW-31	04/26/90	25.34	25.28	54.5	12	4	49.0-54.0	47.0-54.5	51.7
MW-32*	04/24/90	25.02	24.96	57.0	12	4	51.5-56.5	49.5-57.0	—
MW-33	04/27/90	23.8	25.46	39.0	12	4	23.5-38.5	21.5-39.0	35.7
MW-34	5/22/91	24.5	24.45	62.0	10	4	56-61	55-62	59.0
MW-35	5/22/91	24.5	24.51	44.0	10	4	27-42	25-44	39.5
MW-36	11/15/91	25.4	25.36	49.0	10	4	33.5-48.5	31-49	42.6
MW-37	11/21/91	25.4	25.43	86.0	10[B]	4	75-85	73-86	79.9
MW-38	11/15/91	26.2	26.27	49.0	10	4	36-48.5	34-49	45.0
MW-39	5/21/91	24.4	24.41	49.0	10	4	33-48	31-49.5	44.5
MW-40	5/20/91	25.0	25.06	83.0	10[B]	4	72.5-82.5	71.5-83	77.5
MW-41	5/15/91	25.2	27.48	115.5	10[B]	4	104.5-114.5	103.5-115.5	109.6
MW-42	5/23/91	21.7	23.62	37.0	10	4	20.5-35.5	18.5-37	33.0
MW-43	5/23/91	21.2	22.82	37.0	10	4	20-35	18-37	31.3
MW-44	10/14/92	26.1	26.25	81.0	10[B]	4	73.5-78.5	72.5-81	76.0
MW-45	06/07/94	23.01	23.01	48.0	12	4	31.5-46.5	29-48	40.2
MW-46	06/09/94	24.25	24.25	82.0	8.75	4	69-79	67.5-82	72.8
MW-47	06/25/94	25.69	25.69	126.0	8.75	4	114-124	111-126	118.2
MW-48	05/31/94	—	24.21	36.5	12	4	19.5-34.5	18-36.5	—
P-1	06/10/94	—	28.64	65.7	12	1	27.5-52.5	25-53.5	—
P-2A	06/10/94	—	28.64	65.7	12	1	56.25-57.25	55.4-58.1	—

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TABLE 1 (continued)
SUMMARY OF WELL CONSTRUCTION DETAILS
GROUNDWATER PRE-DESIGN ACTIVITIES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Date Completed	Ground Elev. (feet MSLD)	Top of Casing Elev.[A] (feet MSLD)	Completed Depth (feet)	Boring Diam. (inches)	Well Casing Diam. (inches)	Screened Interval (feet bgs)	Filter Pack Interval (feet bgs)	Dedicated Pump Intake (feet bgs)
P-2B	06/10/94	—	28.64	65.7	12	1	64.7-65.7	63.5-65.7	—
P-3	06/21/94	25.36	25.36	85.9	9.5	2	73.5-83.5	69-84.9	—
P-4	06/22/94	—	26.83	86.0	9.5	2	74-84	70-86	—
P-5	06/13/94	26.05	26.05	50.0	8	2	34-49	32-50	—
P-6	06/20/94	26.08	26.08	82.0	9.5	2	71-79	69.2-82	—
P-7	10/06/94	25.5	25.5	49.5	8	2	32.5-49.5	30-49.5	—
P-8	10/05/94	25.88	25.88	80.0	8	2	71.5-78.5	67.7-80	—
P-9	10/06/94	27.24	27.24	49.0	8	2	34-49	30.5-49	—
P-10	06/01/94	—	26.09	36.5	12	4	20.5-35.5	18.5-36.5	—
P-11	06/02/94	—	23.93	34.0	12	4	18-33	16-34	—

TABLE 1 (continued)
SUMMARY OF WELL CONSTRUCTION DETAILS
GROUNDWATER PRE-DESIGN ACTIVITIES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Date Completed	Ground Elev. (feet MSLD)	Top of Casing Elev.[A] (feet MSLD)	Completed Depth (feet)	Boring Diam. (inches)	Well Casing Diam. (inches)	Screened Interval (feet bgs)	Filter Pack Interval (feet bgs)	Dedicated Pump Intake (feet bgs)
SVE-1	07/06/94	—	22.66	31.5	8	2	14.5-29.5	13-31.5	—
SVE-2	07/07/94	—	22.36	30.0	8	2	14.5-29.5	13-30	—
SVE-3	07/06/94	—	23.13	31.5	8	2	14.5-29.5	13-31.5	—
SVE-4	07/08/94	—	23.83	30.0	8	2	14.5-29.5	13-30	—
SVE-5	07/11/94	—	25.87	34.0	8	2	17.5-32.5	16-34	—

A Measured from stand pipe rim or surface vault rim.
B Direct mud rotary drilled.
— Indicates dedicated pump not installed in well.
* Began operation as groundwater IRM extraction well in April 1993.
* Began operation as groundwater IRM extraction well in October 1994.
MSLD Mean Sea Level Datum.

TABLE 2
OBSERVATION WELLS
ON-SITE AQUIFER PUMPING TESTS
GROUNDWATER PRE-DESIGN ACTIVITIES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	HSZ Completed	Screen Interval	Manual (M) and/or Electronic (E) Water Levels	
			First HSZ MW-32 Pumping Test	Second HSZ MW-40 Pumping Test
MW-2	1	37-57	M	M
MW-7	1	33-43	M	M
MW-8	1	37.5-52.5	M	M
MW-12	2	69-79	—	M & E
MW-15	1	26-41	M	—
MW-17	1	26.5-41.5	M	—
MW-18	1	52-57	M & E	M & E
MW-19	1	26-41	M & E	—
MW-20	1	52-57	M & E	M & E
MW-22	1	45.5-50-5	M	M
MW-27	2	56.5-66.5	—	M & E
MW-28	2	69-79	M	M & E
MW-29	1	26-41	M	M
MW-30	1	51.56	M	M
MW-31	1	49-54	M & E	M & E
MW-32	1	51.5-56.5	M	M
MW-34	1	56-61	M	M
MW-35	1	27-42	M	—
MW-37	2	75.85	—	M
MW-40	2	72.5-82.5	M & E	M & E
MW-42	1	20.5-35.5	M	M
MW-44	2	73.5-78.5	—	M
P-1	1	27.5-52.5	M & E	M & E
P-2A	Aquitard	56.3-57.3	M & E	M & E
P-2B	Aquitard	64.7-65.7	M & E	M & E
P-3	2	73.5-83.5	M & E	M & E
P-4	2	74-84	M & E	M & E

TABLE 3
OBSERVATION WELLS
OFF-SITE AQUIFER PUMPING TESTS
GROUNDWATER PRE-DESIGN ACTIVITIES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	HSZ Completed	Screen Interval	Manual (M) or Electronic (E) Water Levels	
			First HSZ MW-38 Pumping Test	Second HSU MW-44 Pumping Test
MW-36	1	33.5-48.5	M	—
MW-37	2	7.5-8.5	M	M
MW-38	1	36-48.5	M & E	M & E
MW-39	1	33-48	M	—
MW-44	2	73.5-78.5	M & E	M & E
MW-46	2	69-79	M	M
P-5	1	34-49	M & E	M & E
P-6	2	71-79	M & E	M & E
P-7	1	32.5-49.5	M & E	M & E
P-8	2	71.5-78.5	M & E	M & E
P-9	1	34-49	M & E	M & E

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

	Date	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
Well	Sampled	1(1)	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-01	03/03/88	—	—	—	—	—	—	—	—	—	0.8	—	—	—	—	—	NA	—
	09/20/89	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	—
	05/10/90	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	09/05/90	—	—	—	—	—	—	—	—	—	1.0	—	—	—	—	—	NA	—
	01/21/91	—	—	—	—	—	—	—	—	—	0.80	—	—	—	NA	NA	NA	—
	01/29/92	—	—	—	—	—	—	—	—	—	1.7	—	—	—	NA	NA	NA	—
	07/09/93	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	—
	01/17/94	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
MW-02	03/03/88	—	—	—	—	—	—	—	—	—	0.6	—	—	—	280	—	NA	—
	09/20/89	—	1.4	—	—	—	—	—	—	—	—	—	—	—	—	50*	NA	—
	05/17/90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	—
	09/11/90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	—
	01/22/91	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	04/22/91	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	08/01/91	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	11/07/91	8.4	1.2	8.3	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	02/07/92	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	05/26/92	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	08/25/92	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	10/20/92	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	01/19/93	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	04/07/93	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	07/01/93	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	—
	09/21/93	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	01/05/94	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	04/12/94	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	07/05/94	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	10/25/94	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	01/13/95	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
MW-03	03/03/88	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	—
	09/20/89	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	—
	05/10/90	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	09/05/90	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	01/22/91	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	08/01/91	—	—	—	—	—	—	—	—	NA	—	—	—	—	NA	NA	NA	—
	01/29/92	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	07/09/93	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	—
	01/17/94	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—

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TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988–1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Date Sampled	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
		1(1)	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-04	03/03/88	11	4.5	6	1.5	22	—	12	130	42	—	—	—	—	1100	300	NA	—
	09/20/89	210	—	—	—	—	—	7.1	—	120	—	—	—	—	—	3000	NA	—
	02/15/90	190	3.5	7.5	2.1	5.3	—	12	250	46	—	—	5.7	—	NA	NA	NA	—
	05/23/90	130	4.9	2.1	6.3	4.1	—	5.8	5.5	45	—	—	4.9	—	—	650	NA	—
	09/18/90	98	4.1	2.7	4.3	2.4	—	6	30	38	—	—	4.5	—	—	—	NA	—
	02/05/91	17	—	—	—	1.2	—	6	45	16	—	—	4.2	—	NA	NA	NA	—
	05/01/91	580	—	24	12	—	—	11	15	93	—	—	0.89	—	NA	NA	NA	—
	08/14/91	—	0.6	13	2.5	—	—	13	27	—	—	—	1.4	—	NA	NA	NA	—
	11/07/91	1200	26	8.7	26	—	—	19	40	—	—	—	—	—	NA	NA	NA	—
	01/28/92	940	12	3.4	18	0.6	—	12	16	170	—	—	1.4	—	NA	NA	NA	—
	05/29/92	210	7.5	9.3	6.7	2.4	—	15	110	20	—	—	7.8	—	NA	NA	NA	—
	08/26/92	230	2.4	1.7	4.1	1.3	—	14	120	13	—	1.3	8.6	—	NA	NA	NA	—
	10/20/92	260	—	—	—	—	—	—	32	—	—	—	—	—	NA	NA	NA	—
	01/20/93	180	5.6	4.2	8.9	—	—	7.5	73	12	—	—	5.0	—	NA	NA	NA	—
	04/17/93	350	35	93	18	1.3	—	8.8	37	20	—	—	6.1	—	NA	2,300	NA	—
	04/18/93	200	19	46	10	1.4	—	5.8	44	14	—	0.82	4.8	—	NA	980	NA	—
	04/23/93	160	16	32	8.4	1.4	—	5.0	39	9.2	—	—	3.8	—	NA	—	NA	—
	04/30/93	200	22	37	7.6	1.5	—	5.0	62	—	—	—	4.5	—	NA	NA	NA	—
	05/06/93	200	30	30	9.7	1.4	—	4.8	42	10	—	—	3.9	—	NA	1,100	NA	—
	05/14/93	220	26	45	7.3	—	—	5.7	46	9.2	—	—	4.6	—	NA	1,200	NA	—
	06/17/93	270	40	50	9.7	1.4	—	5.2	66	7.9	—	—	3.2	—	NA	1,400	NA	—
	07/12/93	210	23	28	7.1	1.2	—	4.5	55	6.0	—	—	—	—	NA	910	NA	—
	08/03/93	170	27	31	9.2	1.3	—	4.5	64	5.7	—	—	2.9	—	NA	NA	NA	—
	09/10/93	110	7.5	—	—	1.3	—	4.5	53	3.5	—	0.82	3.0	—	NA	630	NA	—
	09/24/93	93	8.7	—	—	—	—	—	42	—	—	—	—	—	NA	NA	NA	—
	10/07/93	150	19	—	—	1.8	—	5.8	69	5.4	—	1.1	4.3	—	NA	520	NA	—
	11/08/93	110	15	21	5.1	1.6	—	5.0	65	4.4	—	1.2	3.7	—	NA	750	NA	—
	01/14/94	110	14	19	4.4	1.3	—	4.6	52	3.4	—	1.1	2.9	—	NA	510	NA	—
	02/11/94	110	14	17	4.3	1.8	—	4.6	64	4.6	—	1.5	3.0	—	—	330	—	—
	03/02/94	110	13	16	4.0	1.2	—	3.9	41	3.3	—	1.4	2.6	—	—	580	—	—
	04/07/94	120	14	19	3.7	1.5	—	3.6	53	2.7	—	1.3	2.7	—	NA	660	NA	—
	05/05/94	61	6.9	8.6	2.2	0.66	—	3.3	37	2.9	—	1.0	2.4	—	—	380	—	—
	06/08/94	75	—	—	—	—	—	2.9	37	1.8	—	0.88	2.1	—	—	415	—	—
	07/08/94	88	12	13	3.6	1.1	—	3.2	39	—	—	1.0	—	—	NA	150	NA	—
	09/14/94	84	11	17	3.5	—	—	2.4	38	2.1	—	0.70	1.6	—	—	310	—	—
	10/10/94	110	12	15	7.4	1.3	—	2.4	39	2.5	—	1.2	2.8	—	—	430	—	—
	11/08/94	96	13	17	4.5	0.62	—	3.8	33	3.3	—	1.1	2.6	—	—	—	—	—
	12/07/94	94	12	16	4.5	1.0	—	3.4	33	2.9	—	1.4	2.5	—	—	—	—	—

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Date Sampled	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
		1(1)	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-05	03/04/88	—	—	—	—	—	—	—	—	—	4.9	—	—	—	—	—	NA	—
	09/20/89	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	NA	—
	05/17/90	—	—	—	—	—	—	—	—	—	2.6	—	—	—	—	—	NA	—
	09/12/90	—	—	—	—	—	—	—	—	—	2.3	—	—	—	—	—	NA	—
	08/12/91	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	01/28/92	—	—	—	—	—	—	—	—	—	1.2	—	—	—	NA	NA	NA	—
	01/22/93	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	01/17/94	—	—	—	—	—	—	—	—	—	2.1	—	—	—	NA	NA	NA	—
MW-06	03/04/88	—	—	—	—	—	—	—	—	—	0.6	—	—	—	—	—	NA	—
	09/20/89	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	—
	05/17/90	—	—	—	—	—	—	—	—	—	1.5	—	—	—	NA	NA	NA	—
	09/11/90	—	—	—	—	—	—	—	—	—	2.0	—	—	—	—	—	NA	—
	08/12/91	—	—	—	—	—	—	—	—	—	6.2	—	—	—	NA	NA	NA	—
	01/28/92	—	—	—	—	—	—	—	—	—	2.1	—	—	—	NA	NA	NA	—
	08/28/92	—	—	—	—	—	—	—	—	—	0.85	—	—	—	NA	NA	NA	—
	01/22/93	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	07/09/93	—	—	—	—	—	—	—	—	—	1.6	—	—	—	—	—	NA	—
	01/17/94	—	—	—	—	—	—	—	—	—	1.8	—	—	—	NA	NA	NA	—
MW-07	03/04/88	—	—	—	—	25	—	15	17	1.6	1.9	—	1.0	—	—	—	NA	—
	09/15/89	—	—	—	—	26	—	15	0.5	3.1	1.1	—	1.1	—	—	50	NA	—
	02/07/90	—	—	—	—	11	—	9.9	58	—	2.6	—	0.6	—	NA	NA	NA	—
	05/17/90	—	—	—	—	9.7	—	9.2	8.1	—	3	—	—	—	—	—	NA	—
	09/07/90	—	—	—	—	6.4	—	6.1	19	—	2.5	—	—	—	—	—	NA	—
	01/30/91	NA	NA	NA	NA	5.1	—	4.3	15	—	2.6	—	—	—	NA	NA	NA	—
	04/26/91	NA	NA	NA	NA	4.6	—	4.5	11	—	3.0	—	—	—	NA	NA	NA	—
	08/07/91	—	—	—	—	8.1	—	12	28	—	4.1	—	—	—	NA	NA	NA	—
	02/07/92	—	—	—	—	7.2	—	12	32	—	4.9	—	—	—	NA	NA	NA	—
	06/02/92	—	—	—	—	4.2	—	6.8	21	—	4.1	—	—	—	NA	NA	NA	—
	08/31/92	—	—	—	—	5.2	—	8.5	39	—	4.5	—	—	—	NA	NA	NA	—
	10/23/92	—	—	—	—	3.7	—	5.9	21	—	4.7	—	—	—	NA	NA	NA	—
	01/29/93	—	—	—	—	1.4	—	3.6	9.6	—	1.8	—	—	—	NA	NA	NA	—
	04/14/93	NA	NA	NA	NA	1.9	—	3.7	9.8	—	4.0	—	—	—	NA	NA	NA	—
	07/07/93	—	—	—	—	0.93	—	2.9	11	—	3.3	—	—	—	NA	NA	NA	—
	09/24/93	NA	NA	NA	NA	—	—	—	3.4	—	2.1	—	—	—	NA	NA	NA	—
	01/10/94	—	—	—	—	—	—	1.3	6.2	—	2.2	—	—	—	NA	NA	NA	—
	04/14/94	NA	NA	NA	NA	—	—	0.59	3.7	—	2.4	—	—	—	NA	NA	NA	—
	07/21/94	NA	NA	NA	NA	—	—	0.71	NA	NA	2.1	—	—	—	NA	NA	NA	—
	11/02/94	—	—	—	—	—	—	0.62	5.4	—	2.0	—	—	—	—	—	—	—
	02/04/95	NA	NA	NA	NA	—	—	1.50	8.3	—	1.1	1.8	—	—	NA	NA	NA	—
	02/04/95	NA	NA	NA	NA	—	—	1.30	7.8	—	0.87	7.0	—	—	NA	NA	NA	—

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Date	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
	Sampled	1(1)	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-08	03/03/88	—	—	—	—	—	—	0.9	—	—	—	0.8	—	—	—	—	NA	—
	09/20/89	—	2.5	—	—	—	—	—	—	—	—	1.5	—	—	—	—	NA	—
	05/23/90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	—
	09/13/90	—	—	—	—	0.6	—	—	3.8	—	—	—	—	—	—	—	NA	—
	01/30/91	NA	NA	NA	NA	—	—	—	1.8	—	—	—	—	—	NA	NA	NA	—
	04/26/91	NA	NA	NA	NA	—	—	—	1.8	—	—	3.2	—	—	NA	NA	NA	—
	08/12/91	—	—	—	—	—	—	—	9.6	—	—	21.0	—	—	NA	NA	NA	—
	11/11/91	NA	NA	NA	NA	0.7	—	—	2.5	—	—	5.3	—	—	NA	NA	NA	—
	01/28/92	—	—	—	—	—	—	—	1.8	—	—	8.8	—	—	NA	NA	NA	—
	08/28/92	—	—	—	—	—	—	—	0.71	—	—	—	7.1	—	NA	NA	NA	—
	01/27/93	—	—	—	—	—	—	—	0.61	—	—	3.7	—	—	NA	NA	NA	—
	07/08/93	NA	NA	NA	NA	—	—	—	—	—	—	4.8	—	—	NA	—	NA	—
	01/17/94	—	—	—	—	—	—	—	—	—	0.60	2.8	—	—	NA	NA	NA	—
	07/05/94	NA	NA	NA	NA	—	—	—	—	—	—	3.1Uz	—	—	NA	NA	NA	—
	01/25/95	NA	NA	NA	NA	—	—	—	—	—	—	3.0	—	—	NA	NA	NA	—
MW-11	09/06/89	—	6.0	—	—	—	—	0.8	—	—	5.1	—	1.7	—	600	120	NA	—
	02/15/90	—	—	—	—	—	—	—	8.3	—	0.6	—	0.5	—	NA	NA	NA	—
	05/18/90	—	—	—	—	—	—	3.2	—	—	—	0.7	4.2	—	—	—	NA	—
	09/17/90	—	—	—	—	1.7	—	6.2	18	—	—	—	2.4	—	—	—	NA	—
	01/30/91	NA	NA	NA	NA	2.8	—	16	46	—	—	—	2.5	—	NA	NA	NA	—
	04/26/91	NA	NA	NA	NA	4.5	—	19	62	—	—	—	3.5	—	NA	NA	NA	—
	08/15/91	—	—	—	—	1.8	—	11	—	—	—	—	2.0	—	NA	NA	NA	—
	11/07/91	NA	NA	NA	NA	1.0	—	7.2	9.9	0.6	—	—	1.1	—	NA	NA	NA	—
	01/27/92	—	—	—	—	1.5	—	11	110	—	—	0.7	3.0	—	NA	NA	NA	—
	06/02/92	—	—	—	—	1.5	0.5	7.6	54	—	—	—	3.8	—	NA	NA	NA	—
	08/26/92	—	—	—	—	0.72	—	8.0	57	—	—	1.3	4.3	—	NA	NA	NA	—
	10/20/92	—	—	—	—	0.51	—	4.7	37	—	—	0.68	2.6	—	NA	NA	NA	—
	01/14/93	—	—	—	—	—	—	2.5	54	—	—	—	2.2	—	NA	NA	NA	—
	04/09/93	NA	NA	NA	NA	0.95	—	2.9	27	—	—	—	2.8	—	NA	NA	NA	—
	07/02/93	—	—	—	—	0.71	—	3.5	45	—	—	0.65	2.9	—	NA	NA	NA	—
	09/24/93	NA	NA	NA	NA	—	—	1.7	20	—	—	0.54	1.3	—	NA	NA	NA	—
	01/05/94	—	—	—	—	—	—	1.7	15	—	—	—	1.7	—	NA	NA	NA	—
	04/13/94	NA	NA	NA	NA	—	—	2.4	18	—	—	—	1.5	—	NA	NA	NA	—
	07/05/94	NA	NA	NA	NA	—	—	1.90Jh	14Jh	—	—	—	1.6Jh	—	NA	NA	NA	—
	10/26/94	—	—	—	—	—	—	0.72	8.6	—	—	—	0.70	—	—	—	—	—
	01/16/95	NA	NA	NA	NA	—	—	—	12.0	—	—	—	3	—	NA	NA	NA	—

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

	Date	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
Well	Sampled	1(1)	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-12	09/11/89	—	2.2	—	—	—	—	1.3	—	—	6.4	—	4	—	—	70	NA	—
	10/13/89	0.8	—	—	—	—	—	4.9	26.3	—	4.5	—	5.7	—	NA	NA	NA	—
	02/15/90	—	—	—	—	—	—	9.6	62	—	1.4	—	9	—	NA	NA	NA	—
	05/22/90	—	—	—	—	—	—	9.2	1.4	—	0.6	—	9	—	—	—	NA	—
	09/18/90	—	—	—	—	0.88	—	10	24	—	—	—	12	—	—	—	NA	—
	02/04/91	—	—	—	—	—	—	15	47	—	—	—	14	—	NA	NA	NA	—
	05/01/91	NA	NA	NA	NA	—	—	12	52	—	—	—	15	—	NA	NA	NA	—
	08/15/91	—	0.6	—	—	0.7	—	13	27	—	—	—	15	—	NA	NA	NA	—
	11/07/91	—	—	—	—	1.4	—	15	28	—	—	—	13	—	NA	NA	NA	—
	01/28/92	0.6	—	—	—	0.8	—	23	120	—	—	0.6	19	—	NA	NA	NA	—
	06/01/92	—	—	—	—	0.8	—	19	61	—	—	—	11	—	NA	NA	NA	—
	08/26/92	—	—	—	—	0.64	—	31	94	—	—	0.93	16	—	NA	NA	NA	—
	10/26/92	—	—	—	—	—	—	26	97	—	—	—	14	—	NA	NA	NA	—
	01/20/93	—	—	—	—	0.60	—	21	78	—	—	—	9.1	—	NA	NA	NA	—
	04/13/93++	700	52	88	47	—	—	23	52	19	—	—	13	—	NA	NA	NA	—
	07/02/93	—	—	—	—	—	—	12.0	30.0	—	—	—	4.7	—	NA	NA	NA	—
	09/22/93	—	—	—	—	—	—	11	42	—	—	—	2.5	—	NA	NA	NA	—
	01/07/94	—	—	—	—	—	—	12	45	—	—	—	—	—	NA	NA	NA	—
	04/13/94	—	—	—	—	—	—	16	42	—	—	—	2.1	—	NA	NA	NA	—
	07/05/94	—	—	—	—	—	—	14Jh	38Jh	—	—	—	3.0Jh	—	NA	NA	NA	—
	10/29/94	—	—	—	—	—	—	12	35	—	—	—	3.6	—	—	—	—	—
	01/23/95	—	—	—	—	—	—	14.0	40.0	—	—	—	4.8	—	NA	NA	NA	—

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

	Date	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
Well	Sampled	1[1]	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-13	09/13/89	5,700	343	147	—	—	0.8	13.2	—	360	—	—	0.6	—	3100	51000	NA	—
	11/02/89	6,700	210	88	50	—	—	20	24	270	—	—	—	—	NA	NA	NA	—
	02/15/90	10,500	400	1600	150	—	—	40	55	200	—	—	—	—	NA	NA	NA	—
	05/25/90	12,000	250	530	1200	—	—	35	1.8	250	—	—	—	—	2400	46000	NA	—
	09/18/90	7,300	310	620	410	—	—	27	15	210	—	—	—	—	—	12000	NA	—
	02/05/91	10,000	390	600	—	0.6	—	36	25	96	—	—	—	—	NA	NA	NA	—
	04/30/91	7,900	260	520	340	0.5	—	17	14	120	—	—	—	—	NA	NA	NA	—
	08/07/91	11,000	440	760	450	1.1	—	24	9.6	108	—	—	1.5	—	NA	NA	NA	—
	11/07/91	41,000	1,600	3,900	180	—	—	160	210	—	—	—	—	—	NA	NA	NA	—
	02/07/92	11,000	630	1,300	780	—	—	34	31	—	—	5.6	—	—	NA	NA	NA	—
	06/04/92	9900	380	500	570	—	—	35	18	160	—	—	—	—	NA	NA	NA	—
	08/26/92	13,000	340	780	520	—	—	39	13	180	—	—	0.8	—	NA	NA	NA	—
	10/27/92	9,600	330	740	500	—	—	34	13.	170	—	—	0.91	—	NA	NA	NA	—
	01/20/93	7,300	290	520	340	—	—	46	8.8	150	—	—	—	—	NA	NA	NA	—
	04/13/93	7,500	340	600	330	—	—	30	8.7	130	—	—	0.68	—	NA	NA	NA	—
	07/02/93	4,900	230	360	290	—	—	26	66	89	—	—	—	—	NA	NA	NA	—
	09/22/93	3,800	66	110	190	—	—	21	27	81	—	—	6.5	—	NA	NA	NA	—
	01/07/94	4,100	180	280	250	—	—	27	100	73	—	—	16	—	NA	NA	NA	—
	04/13/94	2,200	67	79	130	—	—	40	140	61	—	—	22	—	NA	NA	NA	—
	07/05/94	1,800Jh	43Jh	36Jh	120Jh	—	—	48Jh	78Jh	57Jh	—	—	11Jh	—	NA	NA	NA	—
	10/29/94	2,200	100	96	130	—	—	40	99	39	—	—	—	—	—	—	—	—
	01/30/95	2,600	99.0	170.0	180.0	—	—	24	89	32	—	—	12	—	NA	NA	NA	—
MW-14	09/13/89	—	12.3	—	—	22	7.1	9.4	15.1	3.7	2.5	—	5.6	—	—	100	NA	—
	11/02/89	—	—	—	—	20	6.3	9.3	75	7.7	2.5	—	4.7	—	NA	NA	NA	—
	02/15/90	3.6	—	0.6	—	8.9	1.1	9.6	380	1.0	—	—	8.0	—	NA	NA	NA	—
	05/22/90	2.2	—	—	—	4.1	—	5.8	11	1.4	—	—	5.9	—	—	—	NA	—
	09/18/90	—	—	—	—	2.3	—	5.0	47	—	—	—	5.7	—	—	—	NA	—
	02/04/91	—	—	—	—	1.3	—	4.4	47	—	—	—	6.2	—	NA	NA	NA	—
	05/01/91	—	—	—	—	0.88	—	3.1	18	—	—	—	4.9	—	NA	NA	NA	—
	08/14/91	0.7	—	—	—	1.6	—	4.8	50	—	—	0.6	9.7	—	NA	NA	NA	—
	11/22/91	—	—	—	—	1.9	—	6.3	150	1.5	—	—	5.6	—	NA	NA	NA	—
	02/07/92	—	—	—	—	3.1	—	12	100	—	0.5	0.6	9.4	—	NA	NA	NA	—
	06/01/92	15	—	—	—	5.1	0.7	28	120	3.7	0.8	—	10	—	NA	NA	NA	—
	08/27/92	—	—	—	—	3.3	—	43	142	—	—	—	12	—	NA	NA	NA	—
	10/26/92	—	—	—	—	—	—	36	200	—	—	—	13	—	NA	NA	NA	—
	01/20/93	—	—	—	—	1.7	—	20	140	—	—	0.8	7	—	NA	NA	NA	—
	04/13/93	1.5	—	—	—	1.8	0.59	12	99	—	—	0.65	7.9	—	NA	NA	NA	—
	07/02/93	8.7	—	—	—	—	—	2.1	36.0	—	—	—	0.85	—	NA	NA	NA	—
	09/22/93	0.79	—	—	—	1.0	0.61	7.7	80	0.50	—	1.1	6.0	—	NA	NA	NA	—
	01/07/94	—	—	—	—	—	—	—	42	—	—	—	—	—	NA	NA	NA	—
	04/13/94	0.63	—	—	—	0.58	—	4.9	44	—	—	—	7.8	—	NA	NA	NA	—
	07/05/94	1.6Jh	—	—	—	0.94Jh	—	3.50Jh	28.00Jh	—	—	—	5.50Jh	—	NA	NA	NA	—
	01/30/95	—	—	—	—	0.68	—	14	66	—	—	—	4.8	—	NA	NA	NA	—
	01/30/95	—	—	—	—	0.98	—	17	69	—	—	—	5.5	—	NA	NA	NA	—

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Date Sampled	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
		1(1)	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-15	09/07/89	—	—	—	—	—	—	—	—	—	—	2.2	—	—	—	—	NA	—
	02/07/90	—	—	—	—	0.5	—	—	5.8	—	—	2.8	—	—	NA	NA	NA	—
	05/16/90	—	—	—	—	—	—	—	—	—	—	3.5	—	—	NA	NA	NA	—
	09/14/90	—	—	—	—	1.1	—	—	0.58	—	—	6.2	—	—	—	—	NA	—
	01/24/91	NA	NA	NA	NA	0.7	—	—	1.2	—	—	—	6.8	—	NA	NA	NA	—
	04/25/91	NA	NA	NA	NA	0.53	—	—	0.82	—	—	—	6.7	—	NA	NA	NA	—
	08/05/91	—	—	—	—	—	—	—	—	—	—	7.8	—	—	NA	NA	NA	—
	11/05/91	NA	NA	NA	NA	1.3	—	—	2.1	—	—	12	—	—	NA	NA	NA	—
	01/30/92	—	—	—	—	—	—	—	1.6	—	—	10	—	—	NA	NA	NA	—
	08/27/92	—	—	—	—	—	—	—	—	—	—	10	—	—	NA	NA	NA	—
	01/25/93	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	07/09/93	—	—	—	—	—	—	—	—	—	—	5.8	—	—	NA	NA	NA	—
	01/17/94	—	—	—	—	—	—	—	—	—	—	3.4	—	—	NA	NA	NA	—
	07/05/94	NA	NA	NA	NA	—	—	—	—	—	0.54Jh	2.4UJh	—	—	NA	NA	NA	—
	01/25/95	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
MW-16	09/07/89	—	3.9	—	—	0.8	—	0.7	—	—	0.5	—	—	—	—	—	NA	—
	02/07/90	—	—	—	—	2	—	1.8	29	—	—	—	—	—	NA	NA	NA	—
	05/16/90	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	09/14/90	—	—	—	—	1.3	—	—	2.3	—	—	—	—	—	—	—	NA	—
	01/24/91	NA	NA	NA	NA	—	—	—	2.6	—	—	—	—	—	NA	NA	NA	—
	04/25/91	NA	NA	NA	NA	0.83	—	—	2.8	—	—	—	—	—	NA	NA	NA	—
	08/13/91	—	—	—	—	1.5	—	—	8.3	—	—	—	—	—	NA	NA	NA	—
	11/07/91	NA	NA	NA	NA	1.6	—	—	5.7	—	—	—	—	—	NA	NA	NA	—
	01/30/92	—	—	—	—	0.6	—	—	9.0	—	—	—	—	—	NA	NA	NA	—
	06/04/92	—	—	—	—	1.9	—	—	2.7	—	—	—	—	—	NA	NA	NA	—
	08/27/92	—	—	—	—	—	—	—	3.9	—	—	—	—	—	NA	NA	NA	—
	10/23/92	—	—	—	—	0.81	—	—	3.2	—	—	—	—	—	NA	NA	NA	—
	01/21/93	—	—	—	—	—	—	—	2.6	—	—	—	—	—	NA	NA	NA	—
	04/12/93	NA	NA	NA	NA	0.64	—	—	—	—	—	—	—	—	NA	NA	NA	—
	06/29/93	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	09/23/93	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	01/06/94	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	04/14/94	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	07/05/94	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	10/26/94	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	01/17/95	NA	NA	NA	NA	—	—	—	—	—	0.55	—	—	—	NA	NA	NA	—

SAC21A3.WK1

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

	Date	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
Well	Sampled	1[(1)]	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-17	09/21/89	—	1.3	—	—	1.1	—	0.5	—	—	2.6	—	0.7	—	—	—	NA	—
	02/07/90	—	—	—	—	0.8	—	0.6	36	—	—	—	0.5	—	NA	NA	NA	—
	05/18/90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	—
	09/13/90	—	—	—	—	—	—	—	4.0	—	—	—	—	—	—	—	NA	—
	01/25/91	—	—	—	—	—	—	—	3.0	—	—	—	—	—	NA	NA	NA	—
	04/29/91	—	—	—	—	—	—	—	3.8	—	—	—	—	—	NA	NA	NA	—
	08/06/91	—	—	—	—	—	—	—	3.7	—	—	—	—	—	NA	NA	NA	—
	11/05/91	NA	NA	NA	NA	0.6	—	—	2.8	—	—	—	—	—	NA	NA	NA	—
	01/30/92	—	—	—	—	—	—	—	1.2	—	—	—	—	—	NA	NA	NA	—
	08/27/92	—	—	—	—	—	—	—	0.8	—	—	—	—	—	NA	NA	NA	—
	01/25/93	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	07/09/93	—	—	—	—	—	—	—	1.0	—	—	—	—	—	NA	NA	NA	—
	01/17/94	—	—	—	—	—	—	—	0.61	—	—	1.1	—	—	NA	NA	NA	—
	06/30/94	NA	NA	NA	NA	—	—	—	—	—	—	1.3Uz	—	—	NA	NA	NA	—
	02/04/95	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
MW-18	09/21/89	—	1.3	—	—	1.9	0.8	3.4	0.5	—	1.5	—	9.4	—	—	50	NA	—
	11/02/89	—	—	—	—	6.9	1.0	7.8	92	—	0.5	—	13	—	NA	NA	NA	—
	02/07/90	—	—	—	—	4	—	4.8	230	—	—	—	8.1	—	NA	NA	NA	—
	05/18/90	—	—	—	—	2.4	—	2.8	3.2	—	—	1.0	10	—	—	—	NA	—
	09/13/90	—	—	—	—	3.3	—	3.9	19	—	—	—	4.4	—	—	—	NA	—
	01/25/91	—	—	—	—	0.90	—	1.4	22	—	—	—	2.9	—	NA	NA	NA	—
	04/29/91	—	—	—	—	0.94	—	1.1	20	—	—	—	2.3	—	NA	NA	NA	—
	08/13/91	—	—	—	—	1.5	—	1.2	18	—	—	—	3.8	—	NA	NA	NA	—
	11/05/91	NA	NA	NA	NA	2.2	3.8	2.0	18	—	—	—	—	—	NA	NA	NA	—
	01/30/92	—	—	—	—	1.0	—	0.8	25	—	—	—	2.8	—	NA	NA	NA	—
	06/01/92	—	—	—	—	1.4	—	0.6	13	—	—	—	2.2	—	NA	NA	NA	—
	08/27/92	—	—	—	—	0.94	—	—	16	—	—	—	3.2	—	NA	NA	NA	—
	10/26/92	—	—	—	—	2.6	—	—	—	—	—	—	3.0	—	NA	NA	NA	—
	01/21/93	—	—	—	—	0.77	—	—	14	—	—	—	1.6	—	NA	NA	NA	—
	04/14/93	NA	NA	NA	NA	1.3	—	—	12	—	—	—	1.5	—	NA	NA	NA	—
	06/30/93	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	09/24/93	NA	NA	NA	NA	—	—	—	5.4	—	—	—	—	—	NA	NA	NA	—
	01/06/94	—	—	—	—	—	—	—	5.2	—	—	—	0.68	—	NA	NA	NA	—
	04/14/94	NA	NA	NA	NA	—	—	—	3.7	—	—	—	0.52	—	NA	NA	NA	—
	06/30/94	NA	NA	NA	NA	—	—	—	2.8	—	—	—	0.50	—	NA	NA	NA	—
	10/26/94	—	—	—	—	—	—	—	2.7	—	—	—	—	—	—	—	—	—
	01/17/95	NA	NA	NA	NA	—	—	—	3.3	—	—	—	—	—	NA	NA	NA	—

SAC21A3.WK1

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

	Date	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
Well	Sampled	1(1)	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-19	09/14/89	—	—	—	—	—	—	—	—	—	0.9	1	—	—	—	—	NA	—
	05/18/90	—	—	—	—	—	—	—	—	—	—	1.4	—	—	NA	NA	NA	—
	09/07/90	—	—	—	—	—	—	—	6.8	—	—	1.5	—	—	—	—	NA	—
	01/24/91	NA	NA	NA	NA	—	—	—	5.9	—	—	—	1.7	—	NA	NA	NA	—
	04/29/91	NA	NA	NA	NA	—	—	—	4.2	—	—	—	1.9	—	NA	NA	NA	—
	08/05/91	—	—	—	—	—	—	—	2.4	—	—	3.2	—	—	NA	NA	NA	—
	11/11/91	NA	NA	NA	NA	—	—	—	3.7	—	—	2.8	—	—	NA	NA	NA	—
	01/30/92	—	—	—	—	—	—	—	2.9	—	—	3.6	—	—	NA	NA	NA	—
	08/28/92	—	—	—	—	—	—	—	1.5	—	—	2.0	—	—	NA	NA	NA	—
	01/25/93	—	—	—	—	—	—	—	8.9	—	—	1.5	—	—	NA	NA	NA	—
	07/09/93	—	—	—	—	—	—	—	5.9	—	—	0.8	—	—	NA	NA	NA	—
	01/16/94	—	—	—	—	—	—	—	7.1	—	—	—	—	—	NA	NA	NA	—
	06/30/94	NA	NA	NA	NA	—	—	—	9.3	—	0.95	—	—	—	NA	NA	NA	—
	01/25/95	NA	NA	NA	NA	—	—	—	9.7	—	—	—	—	—	NA	NA	NA	—
MW-20	09/14/89	—	—	—	—	0.7	—	—	—	—	—	—	—	—	—	—	NA	—
	05/14/90	—	—	—	—	1.4	—	0.9	—	—	—	—	—	—	NA	NA	NA	—
	09/07/90	—	—	—	—	0.92	—	—	9.6	—	—	—	—	—	—	—	NA	—
	01/24/91	NA	NA	NA	NA	—	—	—	9.8	—	—	—	—	—	NA	NA	NA	—
	04/29/91	NA	NA	NA	NA	—	—	—	8.9	—	—	—	—	—	NA	NA	NA	—
	08/14/91	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	11/11/91	NA	NA	NA	NA	0.7	—	—	11	—	—	—	—	—	NA	NA	NA	—
	01/30/92	—	—	—	—	0.6	—	—	11	—	—	—	—	—	NA	NA	NA	—
	06/02/92	—	—	—	—	0.8	—	—	7.2	—	—	—	—	—	NA	NA	NA	—
	08/28/92	—	—	—	—	—	—	—	8.3	—	—	—	—	—	NA	NA	NA	—
	10/23/92	—	—	—	—	—	—	—	7.3	—	—	—	—	—	NA	NA	NA	—
	01/25/93	—	—	—	—	—	—	—	4.0	—	—	—	—	—	NA	NA	NA	—
	04/13/93	NA	NA	NA	NA	—	—	—	3.5	—	—	—	—	—	NA	NA	NA	—
	06/29/93	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	09/24/93	NA	NA	NA	NA	—	—	—	0.51	—	—	—	—	—	NA	NA	NA	—
	01/06/94	—	—	—	—	—	—	—	0.66	—	—	—	—	—	NA	NA	NA	—
	04/14/94	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	06/30/94	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	10/26/94	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	01/17/95	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Date	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
	Sampled	1(1)	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-21	09/08/89	—	—	—	—	—	—	—	—	—	1.6	—	—	—	—	—	NA	—
	05/15/90	—	—	—	—	—	—	0.6	—	—	4.2	—	—	—	NA	NA	NA	—
	09/07/90	—	—	—	—	—	—	—	2.1	—	1.9	—	—	—	—	—	NA	—
	01/23/91	NA	NA	NA	NA	—	—	—	0.8	—	2.4	—	—	—	NA	NA	NA	—
	04/25/91	NA	NA	NA	NA	—	—	—	4.7	—	2.5	—	—	—	NA	NA	NA	—
	08/07/91	—	—	—	—	—	—	—	0.9	—	5.1	—	—	—	NA	NA	NA	—
	11/11/91	NA	NA	NA	NA	—	—	—	—	—	4.8	—	—	—	NA	NA	NA	—
	01/30/92	—	—	—	—	—	—	—	2.7	—	5.1	—	—	—	NA	NA	NA	—
	08/28/92	—	—	—	—	—	—	—	0.6	—	4.0	—	—	—	NA	NA	NA	—
	01/29/93	—	—	—	—	—	—	—	1.3	—	2.0	—	—	—	NA	NA	NA	—
	07/08/93	NA	NA	NA	NA	—	—	—	—	—	2.4	—	—	—	NA	NA	NA	—
	01/16/94	—	—	—	—	—	—	1.0	6.1	—	1.4	—	—	—	NA	NA	NA	—
	07/07/94	NA	NA	NA	NA	—	—	—	1.9	—	2.2	—	—	—	NA	NA	NA	—
	02/04/95	NA	NA	NA	NA	—	—	1.4	15.0	—	—	3.0	—	—	NA	NA	NA	—
MW-22	09/08/89	—	—	—	—	—	—	—	—	—	3.0	—	—	—	—	—	NA	—
	02/07/90	—	—	—	—	—	—	—	—	—	0.9	—	—	—	NA	NA	NA	—
	05/15/90	—	—	—	—	—	—	—	—	—	5.0	—	—	—	NA	NA	NA	—
	09/07/90	—	—	—	—	—	—	—	—	—	2.6	—	—	—	—	—	NA	—
	01/23/91	NA	NA	NA	NA	—	—	—	—	—	5.2	—	—	—	NA	NA	NA	—
	04/25/91	NA	NA	NA	NA	—	—	—	—	—	4.8	—	—	—	NA	NA	NA	—
	08/14/91	—	—	—	—	—	—	—	—	—	3.9	—	—	—	NA	NA	NA	—
	01/30/92	—	—	—	—	—	—	—	—	—	5.8	—	—	—	NA	NA	NA	—
	01/29/93	—	—	—	—	—	—	—	—	—	1.5	—	—	—	NA	NA	NA	—
	01/16/94	—	—	—	—	—	—	—	—	—	2.0	—	—	—	NA	NA	NA	—
MW-23	09/08/89	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	—
	05/15/90	—	—	—	—	—	—	1.3	—	—	10	—	—	—	NA	NA	NA	—
	09/06/90	—	—	—	—	—	—	0.88	0.5	—	4.2	—	—	—	—	—	NA	—
	04/23/91	NA	NA	NA	NA	—	—	—	0.67	—	3.0	—	—	—	NA	NA	NA	—
	08/02/91	—	—	—	—	—	—	—	—	—	3.1	—	—	—	NA	NA	NA	—
	11/11/91	NA	NA	NA	NA	—	—	—	—	—	4.6	0.7	—	—	NA	NA	NA	—
	01/24/92	—	—	—	—	—	—	—	—	—	2.8	—	—	—	NA	NA	NA	—
	08/28/92	—	—	—	—	—	—	1.2	—	—	4.5	—	—	—	NA	NA	NA	—
	01/22/93	—	—	—	—	—	—	—	—	—	2.2	—	—	—	NA	NA	NA	—
	07/08/93	NA	NA	NA	NA	—	—	—	—	—	2.0	—	—	—	NA	—	NA	—
	01/16/94	—	—	—	—	—	—	0.54	—	—	2.0	—	—	—	NA	NA	NA	—
	07/13/94	NA	NA	NA	NA	—	—	0.71	0.76	—	1.5	—	—	—	NA	NA	NA	—
	02/04/95	NA	NA	NA	NA	—	—	—	—	—	—	2.7	—	—	NA	NA	NA	—
MW-24	09/08/89	—	—	—	—	—	—	—	—	—	2.8	—	—	—	—	—	NA	—
	05/15/90	—	—	—	—	—	—	—	—	—	11	—	—	—	NA	NA	NA	—
	09/06/90	—	—	—	—	—	—	—	—	—	4.1	—	—	—	—	—	NA	—
	09/06/90	—	—	—	—	—	—	—	—	—	4.1	—	—	—	—	—	NA	—
	08/11/91	—	—	—	—	—	—	—	—	—	3.2	—	—	—	NA	NA	NA	—
	01/24/92	—	—	—	—	—	—	—	—	—	2.5	—	—	—	NA	NA	NA	—
	01/22/93	—	—	—	—	—	—	—	—	—	1.7	—	—	—	NA	NA	NA	—
	01/16/94	—	—	—	—	—	—	—	—	—	0.90	—	—	—	NA	NA	NA	—
	02/04/95	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Date	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
	Sampled	1(1)	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-25	09/11/89	—	4.1	—	—	—	—	1.0	—	—	0.9	—	—	—	—	—	NA	—
	02/07/90	—	—	—	—	—	—	1.3	7.6	—	1.1	—	—	—	NA	NA	NA	—
	05/16/90	—	—	—	—	—	—	1.3	—	—	1.1	—	—	—	—	—	NA	—
	09/12/90	—	—	—	—	—	—	1.5	3.1	—	1.3	—	—	—	—	—	NA	—
	01/29/91	NA	NA	NA	NA	—	—	1.3	2.3	—	1.1	—	—	—	NA	NA	NA	—
	04/24/91	NA	NA	NA	NA	—	—	2.1	2.5	—	1.4	—	—	—	NA	NA	NA	—
	08/02/91	—	—	—	—	0.6	—	3.0	5.8	—	1.6	—	—	—	NA	NA	NA	—
	01/23/92	—	—	—	—	2.1	—	6.9	8.7	—	2.2	—	—	—	NA	NA	NA	—
	09/01/92	—	—	—	—	4.4	—	14	22	—	2.8	—	0.65	—	NA	NA	NA	—
	01/27/93	—	—	—	—	2.2	—	10	6.3	0.77	1.6	—	—	—	NA	NA	NA	—
	07/08/93	NA	NA	NA	NA	2.8	—	12	—	—	2.4	—	—	—	NA	—	NA	—
	01/16/94	—	—	—	—	1.3	—	5.9	6.3	—	1.5	—	—	—	NA	NA	NA	—
	07/07/94	NA	NA	NA	NA	1.00	—	4.8	6.1	—	1.8	—	—	—	NA	NA	NA	—
	01/25/95	NA	NA	NA	NA	—	—	5.1	6.7	—	3.1	—	—	—	NA	NA	NA	—
MW-26	09/11/89	—	—	—	—	—	—	1.0	—	—	2.6	—	—	—	—	50	NA	—
	02/07/90	—	—	—	—	—	—	3.2	14	—	1.3	—	—	—	NA	NA	NA	—
	05/16/90	—	—	—	—	—	—	1.6	—	—	1.1	—	—	—	—	—	NA	—
	09/12/90	—	—	—	—	—	—	2.1	5	—	1.6	—	—	—	—	—	NA	—
	01/29/91	NA	NA	NA	NA	—	—	1.6	3.6	—	1.0	—	—	—	NA	NA	NA	—
	04/24/91	NA	NA	NA	NA	—	—	2.4	3.4	—	1.4	—	—	—	NA	NA	NA	—
	08/13/91	—	—	—	—	0.6	—	4.0	8.1	—	1.5	—	—	—	NA	NA	NA	—
	01/27/92	—	1.4	—	—	1.1	—	4.8	5.1	—	2.0	—	—	—	NA	NA	NA	—
	06/04/92	—	—	—	—	4.4	—	8.6	8.2	0.6	2.7	—	—	—	NA	NA	NA	—
	09/01/92	—	—	—	—	3.7	—	12	19	—	3.6	—	—	—	NA	NA	NA	—
	10/23/92	—	—	—	—	2.4	—	10	9.4	—	3.1	—	—	—	NA	NA	NA	—
	01/28/93	—	—	—	—	3.2	—	13	15	0.9	2.5	—	—	—	NA	NA	NA	—
	04/08/93	—	—	—	—	3.9	—	13	9.1	0.78	2.9	—	—	—	NA	NA	NA	—
	07/07/93	—	—	—	—	3.3	—	14	14	—	2.3	—	—	—	NA	NA	NA	—
	09/23/93	NA	NA	NA	NA	3.0	—	9.4	15	3.6	1.9	—	—	—	NA	NA	NA	—
	01/10/94	—	—	—	—	2.6	—	11	15	0.70	2.0	—	—	—	NA	NA	NA	—
	04/14/94	NA	NA	NA	NA	1.9	—	10	16	—	2.4	—	—	—	NA	NA	NA	—
	07/07/94	NA	NA	NA	NA	1.4	—	6.6	9.3	—	2.3	—	—	—	NA	NA	NA	—
	10/29/94	—	—	—	—	1.1	—	7.1	12	—	1.9	—	—	—	—	—	—	—
	01/17/95	NA	NA	NA	NA	1.4	—	8.2	12	—	3.5	—	—	—	NA	NA	NA	—

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Date Sampled	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
		1(1)	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-27	09/15/89	—	—	—	—	—	—	—	—	—	5.5	—	—	—	—	—	NA	—
	05/21/90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	—
	09/17/90	—	—	—	—	—	—	—	0.99	—	1.1	—	—	—	—	—	NA	—
	01/29/91	NA	NA	NA	NA	—	—	—	—	—	0.7	—	—	—	NA	NA	NA	—
	04/24/91	NA	NA	NA	NA	—	—	—	1.1	—	1.4	—	—	—	NA	NA	NA	—
	08/13/91	—	—	—	—	—	—	—	—	—	0.9	—	—	—	NA	NA	NA	—
	01/23/92	—	—	—	—	—	—	—	0.83	—	1.3	—	—	—	NA	NA	NA	—
	09/01/92	—	—	—	—	—	—	—	—	—	3.0	—	—	—	NA	NA	NA	—
	01/28/93	—	—	—	—	—	—	—	—	—	1.7	—	—	—	NA	NA	NA	—
	07/08/93	NA	NA	NA	NA	—	—	—	—	—	3.1	—	—	—	NA	—	NA	—
	01/16/94	—	—	—	—	—	—	0.76	1.1	—	2.4	—	—	—	NA	NA	NA	—
	07/07/94	NA	NA	NA	NA	—	—	2.2Js	2.4Js	—	2.2Js	—	—	—	NA	NA	NA	—
	01/23/95	NA	NA	NA	NA	—	—	3	4.7	—	3.4	—	—	—	NA	NA	NA	—
MW-28	02/15/90	—	—	—	—	—	—	5.8	1	—	0.7	—	—	—	NA	—	NA	—
	05/21/90	—	—	—	—	—	—	9.5	—	—	—	—	—	—	—	—	NA	—
	09/19/90	—	—	—	—	—	—	9	4	—	—	—	—	—	—	—	NA	—
	02/01/91	—	—	—	—	—	—	13	4.3	—	—	—	—	—	NA	NA	NA	—
	04/30/91	—	—	—	—	—	—	8.1	3.9	—	—	—	—	—	NA	NA	NA	—
	08/13/91	—	—	—	—	—	—	13	—	—	—	—	—	—	NA	NA	NA	—
	11/05/91	—	—	—	—	—	—	14	9.4	—	—	—	—	—	NA	NA	NA	—
	01/30/92	—	—	—	—	—	—	17	24	—	—	—	—	—	NA	NA	NA	—
	05/28/92	—	—	—	—	—	—	9.5	6.0	—	—	—	—	—	NA	NA	NA	—
	08/31/92	—	—	—	—	—	—	20	31	—	—	—	—	—	NA	NA	NA	—
	10/22/92	—	—	—	—	—	—	18	21	—	—	—	—	—	NA	NA	NA	—
	01/13/93	—	—	—	—	—	—	13	22	—	—	—	—	—	NA	NA	NA	—
	04/12/93	—	—	—	—	—	—	12	11	—	—	—	—	—	NA	NA	NA	—
	06/30/93	—	—	—	—	—	—	4.1	—	—	—	—	—	—	NA	NA	NA	—
	09/28/93	—	—	—	—	—	—	8.6	8.7	—	—	—	—	—	NA	NA	NA	—
	01/11/94	—	—	—	—	—	—	5.9	4.2	—	—	—	—	—	NA	NA	NA	—
	04/25/94	—	—	—	—	—	—	10	17	—	—	—	—	—	NA	NA	NA	—
	07/01/94	—	—	—	—	—	—	4.6	4.2	—	—	—	—	—	NA	NA	NA	—
	10/31/94	—	—	—	—	—	—	6.3	7.0	—	—	—	—	—	—	—	—	—
	01/20/95	—	—	—	—	—	—	9	—	14	—	—	—	—	NA	NA	NA	—

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Date Sampled	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
		1(1)	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-29	02/15/90	—	—	—	—	8.5	—	10	190	22	1.8	—	0.9	—	NA	50	NA	—
	04/23/90	—	—	—	—	5.0	—	14	72	16	1.2	—	0.87	—	NA	NA	NA	—
	05/25/90	6.2	—	—	—	4.6	—	4.1	8.6	14	—	—	—	—	—	—	NA	—
	09/06/90	—	—	—	—	3.2	—	4.4	38	11	1.3	—	0.76	1.3	—	—	NA	—
	02/01/91	—	—	—	—	—	—	1.9	33	4.7	—	—	—	—	NA	NA	NA	—
	04/30/91	—	—	—	—	—	—	2.4	16	6.6	0.57	—	—	0.68	NA	NA	NA	—
	08/07/91	—	—	—	—	1.3	—	4.5	29	11	0.9	—	0.9	1.0	NA	NA	NA	—
	11/05/91	—	—	—	—	1.4	—	3.7	21	7.1	1.0	—	0.8	1.1	NA	NA	NA	—
	01/30/92	—	—	—	—	0.7	—	2.0	26	5.2	1.2	—	0.7	1.5	NA	NA	NA	—
	05/29/92	—	—	—	—	1.1	—	4.3	19	—	0.8	—	1.2	—	NA	NA	NA	—
	08/31/92	—	—	—	—	0.91	—	3.9	27	7.9	1.3	—	0.8	—	NA	NA	NA	—
	10/22/92	—	—	—	—	0.87	—	2.3	18	6.1	0.56	—	—	—	NA	NA	NA	—
	01/14/93	—	—	—	—	—	—	1.1	13	3.2	—	—	—	—			NA	—
	04/12/93	—	—	—	—	—	—	1.2	5.0	3.0	—	—	0.51	—	NA	NA	NA	—
	06/30/93	—	—	—	—	—	—	—	—	2.3	—	—	—	—	NA	NA	NA	—
	09/28/93	—	—	—	—	—	—	0.81	8.8	2.6	—	—	0.66	—	NA	NA	NA	—
	01/11/94	—	—	—	—	—	—	0.73	7.9	2.3	—	—	0.68	—	NA	NA	NA	—
	04/25/94	—	—	—	—	—	—	1.1	9.0	2.7	2.0	—	—	1.6	NA	NA	NA	—
	07/01/94	—	—	—	—	—	—	0.73	3.6	1.6	4.0	—	0.59	3.7	NA	NA	NA	—
	10/31/94	—	—	—	—	—	—	—	3.4	1.5	1.7	—	—	1.3	—	—	—	—
	01/20/95	—	—	—	—	—	—	0.87	5	2.5	1.9	—	0.54	1.9	NA	NA	NA	—
MW-30	02/15/90	—	—	—	—	4.5	2.3	18	820	—	1.5	—	4.8	—	NA	60	NA	—
	04/23/90	1.1	—	—	—	30.0	—	12	470	31	—	—	8.2	—	NA	NA	NA	—
	05/24/90	2.4	—	—	—	22.0	3	19	48	4.8	1.1	—	6.8	—	—	60	NA	—
	09/05/90	1.2	—	—	—	14.0	—	11	150	—	—	—	—	—	—	—	NA	—
	02/04/91	—	—	—	—	6.3	—	8.2	160	—	—	—	—	—	NA	NA	NA	—
	04/30/91	—	—	—	—	5.9	—	9.0	75	—	—	—	—	—	NA	NA	NA	—
	08/15/91	—	—	—	—	4.4	—	6.8	84	—	—	—	6.4	—	NA	NA	NA	—
	11/05/91	—	—	—	—	8.5	—	11	88	—	—	—	9.4	—	NA	NA	NA	—
	01/31/92	—	—	—	—	1.8	—	7.0	140	—	—	0.8	8.0	—	NA	NA	NA	—
	05/28/92	—	—	—	—	3.0	—	10	61	—	—	—	9.5	—	NA	NA	NA	—
	08/31/92	—	—	—	—	6.9	—	14	130	—	—	—	10	—	NA	NA	NA	—
	10/22/92	—	—	—	—	3.3	—	17	116	—	—	—	10	—	NA	NA	NA	—
	01/14/93	—	—	—	—	1.3	—	6.2	93	—	—	—	6.3	—	NA	NA	NA	—
	04/12/93	—	—	—	—	1.9	—	8.7	46	—	—	—	8.1	—	NA	NA	NA	—
	07/06/93	—	—	—	—	1.3	—	8.6	78	—	—	—	7.2	—	NA	NA	NA	—
	09/28/93	—	—	—	—	—	—	12	99	—	—	—	6.4	—	NA	NA	NA	—
	01/10/94	—	—	—	—	—	—	7.7	99	—	—	—	6.5	—	NA	NA	NA	—
	04/25/94	—	—	—	—	1.4	—	4.9	66	—	—	—	8.6	—	NA	NA	NA	—
	07/01/94	—	—	—	—	0.67	—	3.3	44	—	—	—	7.7	—	NA	NA	NA	—
	10/31/94	—	—	—	—	—	—	2.0	45	—	—	—	8.3	—	—	—	—	—
	01/27/95	—	—	—	—	1.2	—	2.0	31	—	—	—	.86	—	NA	NA	NA	—

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

	Date	B	T	X	E	1,1,1–TCA	1,1,2–TCA	1,1–DCA	1,1–DCE	1,2–DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
Well	Sampled	1(1)	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-31	05/24/90	1.1	—	—	—	39	2.7	22	54	0.6	1.7	—	10	—	—	60	NA	—
	09/19/90	0.63	—	—	—	20	—	15	160	—	—	—	7.6	—	—	—	NA	—
	02/01/91	—	—	—	—	—	—	7.6	150	—	—	—	—	—	NA	NA	NA	—
	05/01/91	—	—	—	—	5.9	—	12	110	—	—	—	7.3	—	NA	NA	NA	—
	08/15/91	—	—	—	—	6.2	—	10	120	—	—	—	6.6	—	NA	NA	NA	—
	11/22/91	—	—	—	—	6.3	—	17	140	—	—	0.62	9.3	—	NA	NA	NA	—
	01/31/91	—	—	—	—	4.3	0.6	16	310	—	0.6	1.1	12	—	NA	NA	NA	—
	05/28/92	—	—	—	—	3.5	—	10	130	—	—	—	12	—	NA	NA	NA	—
	08/31/92	—	—	—	—	5.5	—	9.6	170	—	—	—	10	—	NA	NA	NA	—
	10/21/92	—	—	—	—	—	—	7.5	121	—	—	—	11	—	NA	NA	NA	—
	01/21/93	—	—	—	—	2.1	—	8.5	82	—	—	—	12	—	NA	NA	NA	—
	04/12/93	—	—	—	—	1.7	—	4.2	46	—	—	—	8.2	—	NA	NA	NA	—
	07/07/93	—	—	—	—	1.7	—	5.3	43	—	—	0.71	14	—	NA	NA	NA	—
	09/28/93	—	—	—	—	—	—	—	50	—	—	—	—	—	NA	NA	NA	—
	01/11/94	—	—	—	—	—	—	—	54	—	—	—	7.8	—	NA	NA	NA	—
	04/26/94	—	—	—	—	0.65	—	2.5	53	—	—	0.89	11	—	NA	NA	NA	—
	07/01/94	—	—	—	—	0.50	—	1.6	40	—	—	—	9	—	NA	NA	NA	—
	10/31/94	—	—	—	—	0.78	—	2.0	40	—	—	—	11	—	—	—	—	—
	01/20/95	—	—	—	—	0.95	—	1.4	34	—	—	0.71	11	—	NA	NA	NA	—

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Date Sampled	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
		1[(1)]	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-32	05/24/90	—	—	—	—	20	0.9	21	45	—	0.9	0.6	13	—	—	60	NA	—
	09/19/90	—	—	—	—	15	—	18	180	—	—	—	11	—	—	—	NA	—
	02/01/91	—	—	—	—	—	—	6.1	130	—	—	—	5.0	—	NA	NA	NA	—
	05/01/91	—	—	—	—	6.4	—	11	160	—	—	—	11	—	NA	NA	NA	—
	08/16/91	—	—	—	—	5.2	—	7.5	140	—	—	—	8.8	—	NA	NA	NA	—
	11/22/91	—	—	—	—	4.0	—	7.4	88	—	—	—	8.9	—	NA	NA	NA	—
	01/29/92	—	—	—	—	3.3	—	8.7	240	—	—	0.9	16	—	NA	NA	NA	—
	05/29/92	—	—	—	—	3.9	—	8.6	90	—	—	—	15	—	NA	NA	NA	—
	09/04/92	—	—	—	—	—	—	7.1	155	—	—	—	11	—	NA	NA	NA	—
	10/22/92	—	—	—	—	—	—	—	96	—	—	—	11	—	NA	NA	NA	—
	01/26/93	—	—	—	—	1.2	—	4.5	58	—	—	—	8.9	—	NA	NA	NA	—
	04/15/93	—	—	—	—	2	—	3.1	47	—	—	—	9.6	—	NA	—	NA	—
	04/18/93	—	—	—	—	1.4	—	2.8	37	—	—	0.5	6.5	—	NA	—	NA	—
	04/23/93	—	—	—	—	1.6	—	3.1	40	—	—	—	6.9	—	NA	—	NA	—
	04/30/93	—	—	—	—	1.3	—	3.2	45	—	—	—	6.7	—	NA	NA	NA	—
	05/16/93	—	—	—	—	1.3	—	3.8	45	—	—	—	7.3	—	NA	—	NA	—
	05/14/93	—	—	—	—	—	—	3.6	44	—	—	—	6.9	—	NA	—	NA	—
	06/17/93	—	—	—	—	—	—	3.1	43	—	—	—	7.4	—	NA	—	NA	—
	07/12/93	—	—	—	—	0.72	—	2.6	46	—	—	—	5.9	—	NA	—	NA	—
	08/03/93	—	—	—	—	—	—	2.7	44	—	—	—	5.3	—	NA	—	NA	—
	09/10/93	—	—	—	—	0.90	—	2.8	38	—	—	—	5.1	—	NA	—	NA	—
	09/27/93	NA	NA	NA	NA	—	1.3	4.0	43	—	—	4.6	7.5	—	NA	NA	NA	—
	10/07/93	—	—	—	—	1.3	—	4.2	52	0.60	—	—	7.2	—	NA	—	NA	—
	11/08/93	—	—	—	—	1.4	—	4.0	49	0.70	—	—	7.2	—	NA	—	NA	—
	01/14/94	—	—	—	—	—	—	—	44	—	—	—	—	—	—	NA	NA	—
	02/11/94	—	—	—	—	1.4	—	4.5	58	0.53	—	0.53	7.4	—	—	—	—	—
	03/02/94	—	—	—	—	1.2	—	4.3	41	0.70	—	—	7.2	—	—	—	—	—
	04/07/94	—	—	—	—	1.2	—	4.0	52	—	—	—	6.8	—	NA	—	NA	—
	05/05/94	—	—	—	—	0.67	—	3.7	33	—	—	—	6.5	—	—	—	—	—
	06/08/94	—	—	—	—	0.81	—	4.0	39	0.65	—	—	6.2	—	—	—	—	—
	07/08/94	—	—	—	—	1.0	—	3.8	44	0.98	—	—	4.9	—	NA	—	NA	—
	09/14/94	—	—	—	—	0.50	—	0.80	19	—	—	—	4.10	—	—	—	—	—
	10/10/94	—	—	—	—	0.86	—	2.0	26	—		—	6.3	—	—	—	—	—
	11/08/94	—	—	—	—	—	—	1.4	25	—	—	—	5.4	—	—	—	—	—
	12/07/94	—	—	—	—	0.93	—	4.2	39	—	—	—	6.5	—	—	—	—	—

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Date Sampled	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
		1(1)	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-33	05/18/90	—	—	—	—	17	—	8.1	38	—	—	—	1.4	—	—	—	NA	—
	09/14/90	—	—	—	—	10	—	—	120	—	—	—	—	—	—	—	NA	—
	01/30/91	—	—	—	—	3.4	—	2.0	31	—	—	—	—	—	NA	NA	NA	—
	04/30/91	—	—	—	—	2.4	—	2.1	33	—	—	—	—	—	NA	NA	NA	—
	08/07/91	—	—	—	—	6.7	—	5.4	85	—	—	—	1.0	—	NA	NA	NA	—
	11/05/91	—	—	—	—	8.1	—	6.2	100	—	—	—	—	—	NA	NA	NA	—
	01/24/92	—	—	—	—	3.0	—	2.7	97	—	—	—	—	—	NA	NA	NA	—
	06/02/92	—	—	—	—	4.4	—	4.6	95	—	—	—	0.8	—	NA	NA	NA	—
	08/26/92	—	—	—	—	3.4	—	7.0	170	—	—	—	1.6	—	NA	NA	NA	—
	10/20/92	—	—	—	—	4.1	—	2.6	131	—	—	—	—	—	NA	NA	NA	—
	01/14/93	—	—	—	—	—	—	—	6.1	—	—	—	—	—	NA	NA	NA	—
	04/09/93	NA	NA	NA	NA	—	—	—	7.6	—	—	—	—	—	NA	NA	NA	—
	07/02/93	—	—	—	—	2.1	—	3.3	110	—	—	—	—	—	NA	NA	NA	—
	09/22/93	NA	NA	NA	NA	2.1	—	3.5	92	—	—	—	—	—	NA	NA	NA	—
	01/06/94	—	—	—	—	1.5	—	2.5	75	—	—	—	0.58	—	NA	NA	NA	—
	04/13/94	NA	NA	NA	NA	1.3	—	2.5	75	—	—	—	0.60	—	NA	NA	NA	—
	07/05/94	NA	NA	NA	NA	1.4Jh	NA	2.2Jh	87Jh	—	—	—	0.69Jh	—	NA	NA	NA	—
	10/26/94	—	—	—	—	0.67	—	1.60	66	—	—	—	—	—	—	—	—	—
	01/16/95	NA	NA	NA	NA	—	—	—	4.1	—	—	—	—	—	NA	NA	NA	—
MW-34	07/02/91	—	—	—	—	17	1.3	17.0	470	—	1.2	—	15	—	NA	NA	NA	—
	08/16/91	—	—	—	—	24	—	20.0	510	—	—	—	—	—	NA	NA	NA	—
	12/12/91	0.9	—	—	—	18	1.1	28.0	318	1.7	2.3	1.4	26	—	NA	NA	NA	—
	01/23/92	—	—	—	—	19	4.9	25.0	370	2.3	1.7	0.86	20	—	NA	NA	NA	—
	06/03/92	—	—	—	—	11	1.2	21	270	0.6	1.2	—	24	—	NA	NA	NA	—
	09/01/92	—	—	—	—	13	—	25	480	—	—	—	30	—	NA	NA	NA	—
	10/26/92	—	—	—	—	—	—	—	380	—	—	—	31	—	NA	NA	NA	—
	01/21/93	—	—	—	—	1.3	—	3.3	68	—	—	—	5.6	—	NA	NA	NA	—
	04/09/93	NA	NA	NA	NA	3.9	—	9.2	94	—	—	—	15	—	NA	NA	NA	—
	07/07/93	—	—	—	—	4.1	0.64	13	190	—	—	0.75	24	—	NA	NA	NA	—
	09/28/93	NA	NA	NA	NA	2.7	—	9.4	130	—	—	0.53	18	—	NA	NA	NA	—
	01/12/94	—	—	—	—	2.2 UJF	—	8.7	120	—	—	0.54	17UJF	—	NA	NA	NA	—
	04/26/94	NA	NA	NA	NA	1.4	—	6.2	120	—	—	0.84	16	—	NA	NA	NA	—
	07/20/94	NA	NA	NA	NA	1.3	—	5.9	86	—	—	—	17	—	NA	NA	NA	—
	11/01/94	—	—	—	—	1.5	—	5.4	86	—	—	0.52	15	—	—	—	—	—
	02/01/95	NA	NA	NA	NA	—	—	3.4	47	—	—	—	12	—	NA	NA	NA	—

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Date Sampled	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
		1(1)	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-35	07/02/91	—	—	—	—	6.8	—	4.8	220	—	0.7	—	3.8	—	NA	NA	NA	—
	08/08/91	—	—	—	—	40	—	41	880	—	—	—	19	—	NA	NA	NA	—
	12/12/91	—	—	—	—	2.6	—	2.8	92	—	1.9	0.7	2.6	—	NA	NA	NA	—
	01/23/92	—	—	—	—	5.4	—	5.8	140	—	1.0	—	3.9	—	NA	NA	NA	—
	06/01/92	—	—	—	—	2.4	—	2.4	49	—	0.8	—	4.8	—	NA	NA	NA	—
	09/01/92	—	—	—	—	5.8	—	—	135	—	—	—	—	—	NA	NA	NA	—
	10/26/92	—	—	—	—	—	—	—	94	—	—	—	5.8	—	NA	NA	NA	—
	01/21/93	—	—	—	—	1.3	—	2.8	58	—	—	—	3.7	—	NA	NA	NA	—
	04/09/93	NA	NA	NA	NA	1.2	—	1.2	36	—	—	—	2.7	—	NA	NA	NA	—
	07/07/93	—	—	—	—	1.2	—	1.5	45	—	—	—	4.7	—	NA	NA	NA	—
	09/28/93	NA	NA	NA	NA	0.72	—	0.78	32	—	—	—	3.0	—	NA	NA	NA	—
	01/12/94	—	—	—	—	0.66	—	0.52	27	—	—	—	3.1	—	NA	NA	NA	—
	04/26/94	NA	NA	NA	NA	—	—	—	10	—	—	—	2.2	—	NA	NA	NA	—
	07/20/94	NA	NA	NA	NA	—	—	—	7.6	—	—	—	2.0	—	NA	NA	NA	—
	11/01/94	—	—	—	—	—	—	—	3.6	—	—	—	1.5	—	—	—	—	—
	02/01/95	NA	NA	NA	NA	—	—	—	3.0	—	—	—	—	—	NA	NA	NA	—
MW-36	12/12/91	—	—	—	—	15	—	12	290	1.6	3.4	0.7	8.8	1.4	NA	NA	NA	—
	01/23/92	0.53	1.4	—	—	21	3.0	13	330	2.7	2.6	—	8.9	—	NA	NA	NA	—
	06/01/92	—	—	—	—	12	—	9.6	180	0.7	2.0	—	8.3	—	NA	NA	NA	—
	09/04/92	—	—	—	—	14	—	—	210	—	—	—	—	—	NA	NA	NA	—
	10/21/92	—	—	—	—	—	—	—	110	—	—	—	—	—	NA	NA	NA	—
	01/27/93	—	—	—	—	4.5	—	5.0	110	1.1	0.66	—	5.8	—	NA	NA	NA	—
	04/13/93	NA	NA	NA	NA	4.4	—	4.2	75	—	0.92	—	5.6	—	NA	NA	NA	—
	07/07/93	—	—	—	—	2.6	—	3.5	60	—	1.0	—	5.1	—	NA	NA	NA	—
	09/28/93	NA	NA	NA	NA	—	—	—	53	—	—	—	—	—	NA	NA	NA	—
	01/12/94	—	—	—	—	—	—	—	110	—	—	—	5.8	—	NA	NA	NA	—
	04/26/94	NA	NA	NA	NA	1.2	—	2.0	76	—	—	—	4.5	—	NA	NA	NA	—
	07/20/94	NA	NA	NA	NA	0.96	—	1.8	42	—	—	—	4.4	—	NA	NA	NA	—
	11/04/94	—	—	—	—	—	—	0.51	30	—	—	—	1.9	—	—	—	—	—
	01/30/95	NA	NA	NA	NA	—	—	1.4	53	—	—	—	4.0	—	NA	NA	NA	—
	01/30/95	NA	NA	NA	NA	—	—	2.4	48	—	—	—	5.9	—	NA	NA	NA	—
	01/31/95	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

	Date	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
Well	Sampled	1(1)	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-37	12/12/91	—	—	—	—	1.0	—	3.6	9.3	7.1	4.6	0.6	0.6	1.3	NA	NA	NA	—
	01/23/92	—	—	—	—	—	—	4.4	8.5	9.7	3.1	—	—	1.8	NA	NA	NA	—
	06/01/92	—	—	—	—	—	—	2.6	6.0	6.2	3.8	—	0.5	1.5	NA	NA	NA	—
	09/04/92	—	—	—	—	0.95	—	3.6	16	7.4	4.2	—	—	1.4	NA	NA	NA	—
	10/21/92	—	—	—	—	1.1	—	2.9	13	4.9	2.5	—	—	0.84	NA	NA	NA	—
	01/27/93	—	—	—	—	—	—	2.7	9.2	5.5	2.3	—	—	0.61	NA	NA	NA	—
	04/13/93	NA	NA	NA	NA	—	—	2.9	8.0	6.5	3.9	—	—	0.99	NA	NA	NA	—
	07/07/93	—	—	—	—	—	—	2.8	7.9	5.8	3.1	—	—	0.78	NA	NA	NA	—
	09/28/93	NA	NA	NA	NA	0.55	—	3.2	16	5.8	2.8	—	0.50	0.84	NA	NA	NA	—
	01/12/94	—	—	—	—	—	—	3.7	20	6.2	2.4	—	0.57	0.61	NA	NA	NA	—
	04/26/94	NA	NA	NA	NA	—	—	3.1	20	7.7	2.5	—	—	0.55	NA	NA	NA	—
	07/20/94	NA	NA	NA	NA	0.51	—	4.3	31	7.2	2.7	—	0.75	0.57	NA	NA	NA	—
	11/04/94	—	—	—	—	—	—	5.0	40	9.5	2.5	—	0.98	—	—	—	—	—
	01/30/95	NA	NA	NA	NA	—	—	3.1	27	4.0	1.9	—	—	—	NA	NA	NA	—
	01/31/95	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-38	12/12/91	—	—	—	—	13	—	9.1	260	4.0	4.2	—	8.6	2.2	NA	NA	NA	—
	01/24/92	—	—	—	—	11	—	5.7	250	2.7	2.8	—	5.7	1.3	NA	NA	NA	—
	06/03/92	—	—	—	—	14	—	8.6	150	2.2	3.6	—	8.7	1.9	NA	NA	NA	—
	09/04/92	—	—	—	—	21	—	—	350	—	—	—	—	—	NA	NA	NA	—
	10/27/92	—	—	—	—	22	—	13	230	—	—	—	14	—	NA	NA	NA	—
	01/26/93	—	—	—	—	10	—	7.3	140	1.7	2.4	—	7.7	1.3	NA	NA	NA	—
	04/09/93	NA	NA	NA	NA	9.4	—	7.1	84	1.3	3.4	—	6.3	1.3	NA	NA	NA	—
	07/06/93	—	—	—	—	4.5	—	2.9	140	0.52	1.3	—	4.2	0.76	NA	NA	NA	—
	09/27/93	NA	NA	NA	NA	8.0	—	—	130	—	—	—	—	—	NA	NA	NA	—
	01/10/94	—	—	—	—	—	—	—	120	—	—	—	—	—	NA	NA	NA	—
	04/15/94	NA	NA	NA	NA	6.2	—	6.6	130	0.89	2.1 J	—	7.7	0.85	NA	NA	NA	—
	07/14/94	NA	NA	NA	NA	4.7	—	5.8	130	0.68	1.9	—	7.4	0.86	NA	NA	NA	—
	11/01/94	—	—	—	—	3.5	—	4.9	150	0.54	1.6	—	6.3	1.0	—	—	—	—
	01/24/95	NA	NA	NA	NA	—	4.0	6.1	140	—	2.2	—	7.3	—	NA	NA	NA	—
MW-39	06/28/91	—	—	—	—	0.6	—	—	0.7	2.9	4.0	—	—	1.8	NA	NA	NA	—
	08/06/91	—	—	—	—	0.6	—	1.0	1.0	2.1	3.3	—	—	2.4	NA	NA	NA	—
	12/12/91	—	—	—	—	1.0	—	1.2	3.2	2.5	4.9	0.6	—	2.4	NA	NA	NA	—
	01/24/92	—	—	—	—	0.7	—	0.8	4.1	1.6	3.1	—	—	1.4	NA	NA	NA	—
	06/03/92	—	—	—	—	1.1	—	1.3	4.1	1.6	3.1	—	—	2.0	NA	NA	NA	—
	09/04/92	—	—	—	—	1.6	—	1.7	12	1.8	4.2	—	—	2.8	NA	NA	NA	—
	10/21/92	—	—	—	—	1.6	—	1.2	7.7	—	2.3	—	—	1.8	NA	NA	NA	—
	01/27/93	—	—	—	—	1.4	—	1.6	11	1.6	2.7	—	—	1.9	NA	NA	NA	—
	04/09/93	NA	NA	NA	NA	1.7	—	1.5	10	1.1	2.7	—	0.63	1.7	NA	NA	NA	—
	07/06/93	—	—	—	—	1.4	—	1.5	18	0.92	2.0	—	—	1.4	NA	NA	NA	—
	09/27/93	NA	NA	NA	NA	2.0	—	2.0	20	0.95	2.5	—	0.73	1.4	NA	NA	NA	—
	01/12/94	—	—	—	—	2.3	—	2.6	34	1.3	2.5	—	1.1	1.6	NA	NA	NA	—
	04/15/94	NA	NA	NA	NA	2.5	—	2.8	34	1.2	2.6 JC	—	1.4	1.8	NA	NA	NA	—
	07/14/94	NA	NA	NA	NA	2.4	—	3.0	41	1.0	2.5	—	1.5	1.5	NA	NA	NA	—
	11/02/94	—	—	—	—	2.9	—	3.3	64	0.91	2.5	—	2.3	1.8	—	—	—	—
	01/19/95	—	—	—	—	2.9	—	4.1	70	1.7	2.9	—	2.5	1.6	NA	NA	NA	—

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988–1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

	Date	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
Well	Sampled	1(1)	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-40	06/28/91	—	—	—	—	4.0	—	19	110	—	—	—	46	—	NA	NA	NA	—
	08/15/91	—	—	—	—	3.8	—	15	140	—	—	—	30	—	NA	NA	NA	—
	11/22/91	—	—	—	—	2.4	—	12	95	—	—	—	27	—	NA	NA	NA	—
	01/29/92	—	—	—	—	4.2	—	25	190	—	0.6	—	40	—	NA	NA	NA	—
	05/29/92	—	—	—	—	5.2	—	25	170	—	0.6	—	38	—	NA	NA	NA	—
	08/31/92	—	—	—	—	8.4	—	35	370	—	—	—	52	—	NA	NA	NA	—
	10/22/92	—	—	—	—	6.9	—	—	220	29	—	—	49	—	NA	NA	NA	—
	01/26/93	—	—	—	—	3.3	—	27	170	—	—	—	32	—	NA	NA	NA	—
	04/13/93	NA	NA	NA	NA	3.7	—	26	120	—	—	—	38	—	NA	NA	NA	—
	07/15/93	NA	NA	NA	NA	1.7	—	17	110	—	—	—	16	—	NA	NA	NA	—
	09/27/93	NA	NA	NA	NA	—	—	15	120	—	—	16	—	—	NA	NA	NA	—
	01/11/94	—	—	—	—	—	—	11	100	—	—	—	12	—	NA	NA	NA	—
	04/25/94	NA	NA	NA	NA	0.87	—	11	120	—	—	—	13	—	NA	NA	NA	—
	06/30/94	NA	NA	NA	NA	0.81	—	10	93	—	—	—	12	—	NA	NA	NA	—
	11/01/94	—	—	—	—	1.8	—	17	160	—	—	—	21	—	—	—	—	—
	01/24/95	NA	NA	NA	NA	—	—	16	160	—	—	—	17	—	NA	NA	NA	—
MW-41	06/28/91	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	08/12/91	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	11/05/91	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	01/31/92	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	05/26/92	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	08/25/92	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	10/20/92	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	01/20/93	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	06/30/93	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	09/22/93	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	01/07/94	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	04/13/94	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	07/05/94	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	10/26/94	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	01/23/95	NA	NA	NA	NA	—	—	—	—	—	—	—	—	—	NA	NA	NA	—

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Date Sampled	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
		1[(1)]	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-42	06/28/91	—	—	—	—	11	—	110	340	—	2.0	—	4.0	—	NA	NA	NA	—
	08/08/91	6.3	—	—	—	42.0	8.1	370	1500	—	8.7	—	19.0	—	NA	NA	NA	—
	11/07/91	1.2	—	—	—	6.9	1.9	69	270	—	1.4	1.1	3.9	—	NA	NA	NA	—
	02/07/92	1.6	—	—	—	8.7	2.2	100	480	0.7	2.5	1.6	5.5	—	NA	NA	NA	—
	06/04/92	3.3	—	—	—	7.0	2.6	80	220	0.9	2.0	3.4	5.8	—	NA	NA	NA	—
	08/25/92	1.2	—	—	—	5.5	2.6	110	260	1.6	1.9	4.2	7.2	—	NA	NA	NA	—
	10/27/92	—	—	—	—	—	—	110	340	—	—	28	—	—	NA	NA	NA	—
	01/19/93	—	—	—	—	5.3	1.2	60	180	—	1.1	3.0	4.3	—	NA	NA	NA	—
	04/08/93	—	—	—	—	5.9	1.7	44	95	0.54	1.4	2.9	3.8	—	NA	NA	NA	—
	07/01/93	0.72	—	—	—	3.1	0.89	50	120	—	0.76	2.7	—	—	NA	NA	NA	—
	09/21/93	—	—	—	—	3.5	1.1	45	120	—	0.80	2.6	—	—	NA	NA	NA	—
	01/05/94	0.51	—	—	—	4.3	1.8	54	130	—	0.84	4.0	3.2	—	NA	NA	NA	—
	04/12/94	0.54	—	—	—	4.5	1.8	50	120	—	0.90	4.8	3.6	—	NA	NA	NA	—
	07/07/94	—	—	—	—	3.1	1.7	46	92	—	0.78	3.3	2.6	—	NA	NA	NA	—
	10/26/94	0.70	—	—	—	2.8	0.88	89	50	—	—	3.6	2.3	—	—	—	—	—
	01/13/95	0.65	—	—	—	4.3	2.9	61	110	—	1.1	5.2	3.5	—	NA	NA	NA	—
MW-43	06/28/91	—	—	—	—	—	—	330	33	—	—	—	—	—	NA	NA	NA	—
	08/16/91	—	—	—	—	—	—	200	21	—	—	—	—	—	NA	NA	NA	—
	11/07/91	—	—	—	—	—	2.0	170	30	1.9	—	0.6	2.5	—	NA	NA	NA	5.6
	02/07/92	—	—	—	—	0.7	2.2	220	45	2.3	—	1.4	4.3	—	NA	NA	NA	7.4
	06/02/92	—	—	—	—	—	2.5	210	32	2.5	—	—	4.7	—	NA	NA	NA	10.0
	08/25/92	0.6	—	—	—	—	1.9	260	—	2.0	—	1.1	5.4	—	NA	NA	NA	7.9
	10/22/92	—	—	—	—	—	—	240	28	—	—	—	—	—	NA	NA	NA	—
	01/19/93	—	—	—	—	—	1.0	110	24	1.1	—	0.9	2.8	—	NA	NA	NA	—
	04/08/93	—	—	—	—	—	3.3	210	33	3.2	—	1.0	4.9	—	NA	NA	NA	5.7
	07/01/93	—	—	—	—	—	—	—	25	—	—	—	—	—	NA	NA	NA	11.0
	09/21/93	0.70	—	—	—	—	2.8	220	23	2.8	—	0.98	—	—	NA	NA	NA	—
	01/05/94	—	—	—	—	—	1.0	290	25	—	—	—	3.7	—	NA	NA	NA	7.6
	04/12/94	0.55	—	—	—	—	4.3	310	43	3.9	—	1.3	7.4	—	NA	NA	NA	10.0
	07/13/94	—	—	—	—	—	3.3	260	37	2.9	—	1.0	6.2	—	NA	NA	NA	8.1
	10/26/94	0.52	—	—	—	—	2.1	200	15	2.2	—	1.4	6.4	—	—	—	—	9.2
	01/13/95	—	—	—	—	—	2.1	150	17	2.3	—	—	4.3	—	NA	NA	NA	3.8
MW-44	10/27/92	—	—	—	—	—	—	0.69	2.0	4.3	7.2	—	—	9.6	NA	NA	NA	—
	01/26/93	—	—	—	—	—	—	—	0.96	1.9	3.6	—	—	4.1	NA	NA	NA	—
	04/09/93	NA	NA	NA	NA	—	—	—	0.79	2.5	5.1	—	—	5.3	NA	NA	NA	—
	07/06/93	—	—	—	—	—	—	—	—	2.4	3.6	—	—	5.6	NA	NA	NA	—
	09/27/93	NA	NA	NA	NA	—	—	—	1.2	2.4	4.4	4.5	—	5.9	NA	NA	NA	—
	01/10/94	—	—	—	—	—	—	—	0.77	2.1	3.6	—	—	3.9	NA	NA	NA	—
	04/15/94	NA	NA	NA	NA	—	—	—	1.1	2.5	4.4 JC	—	—	6.1	NA	NA	NA	—
	07/14/94	NA	NA	NA	NA	—	—	—	1.2	1.9	4.0	—	—	4.9	NA	NA	NA	—
	11/01/94	—	—	—	—	—	—	—	—	1.7	2.8	—	—	5.1	—	—	—	—
	01/24/95	NA	NA	NA	NA	—	—	—	—	—	3.6	—	—	4.7	NA	NA	NA	—

TABLE 4
SUMMARY MONITORING WELL GROUNDWATER ANALYTICAL RESULTS, 1988 – 1995
AROMATIC AND VOLATILE ORGANIC COMPOUNDS (ug/l)
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Date	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Chloroform	PCE	TCE	CCL_4	TPH	TPH/Gas	TPH/D	Vinyl Chloride
	Sampled	1(1)	1000	1,750	680	200	32	5	6	0.5	100	5	5	0.5	NE	NE	NE	0.5
MW-45	07/20/94	—	—	—	—	—	—	—	—	0.55	2.2	—	—	1.3	NA	NA	NA	—
	11/02/94	—	—	—	—	—	—	—	—	0.76	1.7	—	—	1.4	—	—	—	—
	01/18/95	—	—	—	—	—	—	—	—	—	2.2	—	—	1.4	NA	NA	NA	—
MW-46	07/20/94	—	—	—	—	—	—	—	—	—	2.6	—	—	0.89	NA	NA	NA	—
	11/01/94	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	11/02/94	—	—	—	—	—	—	—	—	—	2.2	—	—	0.79	—	—	—	—
	01/24/95	—	—	—	—	—	—	—	—	—	3.1	—	—	—	NA	NA	NA	—
MW-47	07/21/94	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	11/94/94	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	01/30/95	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	01/30/95	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	NA	NA	—
	01/31/95	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-48	07/21/94	—	—	—	—	—	—	—	—	—	—	—	—	—	NA	—	—	—
	11/03/94	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	02/08/95	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	—	430	NA

(1) – Values in shaded row are drinking water Maximum Contaminant Levels (MCL) established by DHS or EPA, whichever is more stringent.
NE – Not Established
\+ – Detections of Benzene, Toluene, and Xylene appear to be due to field contamination. Analysis of duplicate sample showed no detections.
++ – Detections of Benzene, Toluene, Xylene, and Ethylbenzene appear to be due to field contamination.
Analysis of samples from other monitoring rounds were mostly non–detection for these constituents.
-- – Not Detected.
NA – Not Analyzed.
* – At or near detection limits.
UJf,UJh,Jc,Uz,Jh – See Table 8 for key to data qualifiers.

B – Benzene
T – Toluene
X – Xylene
E – Ethylbenzene
TCA – Trichloroethane
DCA – Dichloroethane
DCE – Dichloroethene
PCE – Tetrachloroethene
CCL_4 – Carbon Tetrachloride
TPH – Total Petroleum Hydrocarbons
TPH/gas – Total Petroleum Hydrocarbon as gasoline
TPH/D – Total Petroleum Hydrocarbon as diesel

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TABLE 5
ESTIMATE OF CHLORINATED VOLATILE ORGANIC COMPOUND MASS IN GROUNDWATER
GROUNDWATER PRE-DESIGN ACTIVITIES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Total CVOCs — First Zone

	Surface Area(1) (sq. ft.)	Aquifer Thickness (ft.)	Volume of Impacted Aquifer (cu. ft.)	Porosity	Volume of Impacted Pore Fluid (liters)	Concentration (μg/L)	Mass CVOC in Groundwater(2) (lbs.)
ND	8.308×10^5	20	1.662×10^7	0.3	1.412×10^8	5	1.56
10	6.316×10^5	20	1.263×10^7	0.3	1.073×10^8	30	7.08
50	4.163×10^5	20	8.326×10^6	0.3	7.073×10^7	75	11.70
100	3.216×10^5	20	6.432×10^6	0.3	5.464×10^7	150	18.00
200	1.115×10^5	20	2.231×10^6	0.3	1.895×10^7	250	10.43
300	1.546×10^4	20	3.092×10^5	0.3	2.627×10^6	350	2.02
400	2.450×10^4	20	4.899×10^5	0.3	1.462×10^6	450	4.11
Totals:	**2.352×10^6**		**4.704×10^7**		**3.996×10^8**		**54.9**

Total CVOCs — Second Zone

	Surface Area(1) (sq. ft.)	Aquifer Thickness (ft.)	Volume of Impacted Aquifer (cu. ft.)	Porosity	Volume of Impacted Pore Fluid (liters)	Concentration (μg/L)	Mass CVOC in Groundwater(2) (lbs)
ND	6.070×10^5	10	6.070×10^6	0.3	5.156×10^7	5	0.57
10	3.935×10^5	10	3.935×10^6	0.3	3.343×10^7	30	2.20
50	1.586×10^5	10	1.586×10^6	0.3	1.347×10^7	75	2.22
100	4.853×10^4	10	4.853×10^5	0.3	4.123×10^6	110	0.99
Totals:	**1.208×10^6**		**1.208×10^7**		**1.026×10^8**		**5.98**

Notes: (1) Surface area estimates based on total chlorinated VOC maps presented in Figures 16 and 18.
(2) Volume estimate only accounts for chlorinated VOCs in pore fluid and does not account for asorbed component.

TABLE 6
ON-SITE AQUIFER PUMPING TEST RESULTS
GROUNDWATER PREDESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Pumping Well and Pumping Parameters	Observation Well	Zone	Distance From Pumping Well (feet)	Zone Thickness (feet)	Manual (M) or Electronic (E) Measurements	Response Observed	Maximum Drawdown (feet)	Evaluation of Drawdown (D) or Recovery (R) Data	Method of Analysis	T(s) (ft^2/day)	Hydraulic Conductivity (ft/day)	S
Pumping Well MW-32	MW-2		2129.6	38.9	M	no	--	D	--	--	--	--
1st HSZ	MW-7		476.4	13.4	M	yes	0.05	D	--	--	--	--
Q=13 gpm	MW-8		303.5	36.9	M	yes	0.08	D	--	--	--	--
	MW-15		510.1	25.2	M	yes	0.05	D	--	--	--	--
Pump On: 08/09/94 12:00	MW-17		273.4	24.7	M	yes	0.06	D	--	--	--	--
Pump Off: 08/11/94 16:40	MW-18		250.5	24.7	E	yes	0.15	D	Theis	5,740	232.0	0.02
Duration Pumped = 3160 min	MW-19		121.1	25.2	E	yes	0.23	D	Theis	9,063	359.6	0.004
									Neuman	4,426	175.6	0.020 (4)
	MW-20		137.8	25.0	E	yes	0.21	D	Theis	9,912	397.3	0.005
									Neuman	5,690	228.1	0.018 (4)
	MW-22	1st HSZ	736.3	18.8	M	yes	0.08	D	--	--	--	--
	MW-29		272.7	24.7	M	yes	0.16	D	--	--	--	--
	MW-30		264.6	24.7	M	yes	0.08	D	--	--	--	--
	MW-31		287.6	21.9	E	yes	0.21	D	Theis	5,977	272.4	0.0018
	MW-32		--	21.5	M	yes	19.35	D	--	--	--	--
	MW-34		328.3	28.2	M	yes	0.09	D	--	--	--	--
	MW-35		334.5	28.1	M	yes	0.08	D	--	--	--	--
	MW-42		1371.4	?	M	no	--	D	--	--	--	--
	P-1		24.4	21.4	E	yes	0.62	D	Neuman	1,171	54.7	0.16
									Dist. vs. Dradown	2,292	104.2	0.013
									MEAN PARAMETER VALUE (1)	6,648	267	0.019 (2)
	P-2A	Aquitard	24.4	18	E	yes	0.62	D	--	--	--	0.0016 (3)
	P-2B		24.4		E	yes	0.66					
Note: During this test the pump	MW-28		256.3	16	M	yes	0.13	D	--	--	--	--
inadvertently shut off. Due to	MW-40	2nd HSZ	10.4	11.5	E	yes	0.18	D	--	--	--	--
the pump failure no recovery	P-3		29.9	11	E	yes	0.21	D	--	--	--	--
data was collected	P-4		198.5	6.5	M	yes	0.09	D	--	--	--	--
Pumping Well EW-1	EW-1		--	21	M	yes	3.35	D	Cooper-Jacob	914	43.5	--
1st HSZ, Q = 8 gpm								R	Theis Recovery	879	41.9	--
Pump On: 02/09/95 11:17	MW-25	1st HSZ	346.9	15	M	no		D	--	--	--	--
Pump Off: 02/13/95 08:54	MW-26		340.0	15	E	no		D	--	--	--	--
Duration Pumped = 5617 min												

(1) Mean parameter values for T and K are the geometric mean of Theis and Neuman solutions for MW-18, MW-19, MW-20 and MW-31. Estimates of T and K for P-1 were anomolously low and were therefore excluded.
(2) Mean specific yield value calculated from MW-19 and MW-20 Nueman solutions.
(3) Based on consolidation test results.
(4) Values are specific yields based on Neuman Type B curve matching.
(5) Mean parameter values for T and K are the geometric mean of Theis and Neuman solutions for MW-12, MW-28, MW-40, P-3 and P-4.
(6) Mean parameter values for T and K are the geometric mean of Theis, Theis Recovery, Distance-Drawdown and Cooper-Jacob solutions for MW-38, P-5, P-7 and P-9.
(7) Mean parameter values for T and K are the geometric mean of the Hantush solution and the Distance-Drawdown solution for P-6 and P-8.

TABLE 6 (Continued)
ON-SITE AQUIFER PUMPING TEST RESULTS
GROUNDWATER PREDESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Pumping Well and Pumping Parameters	Observation Well	Zone	Distance From Pumping Well (feet)	Zone Thickness (feet)	Manual (M) or Electronic (E) Measurements	Response Observed	Maximum Drawdown (feet)	Evaluation of Drawdown (D) or Recovery (R) Data	Method of Analysis	T(s) (ft^2/day)	Hydraulic Conductivity (ft/d)	S
Pumping Well MW-40	MW-2		2132.9	32.5	M	no	--	D	--	--	--	--
2nd HSZ	MW-7		466.1	11	M	yes	0.23	D	--	--	--	--
Q=35 gpm	MW-8		299.7	23.5	M	yes	0.27	D	--	--	--	--
Pump On: 08/22/94 10:00	MW-18		250.8	25	E	yes	0.3	D	--	--	--	--
Pump Off: 08/25/94 11:00	MW-20		127.5	30	E	yes	0.36	D	--	--	--	--
Duration Pumped = 4380 min	MW-22	1st HSZ	360.0	23	M	yes	0.27	D	--	--	--	--
	MW-30		270.0	30	M	yes	0.4	D	--	--	--	--
	MW-31		284.7	26.5	E	yes	0.3	D	--	--	--	--
	MW-32		10.4	29	M	yes	0.63	D	--	--	--	--
	MW-34		328.0	35	M	?	--	D	--	--	--	--
	MW-42		1375.0	?	M	?	--	D	--	--	--	--
	P-1		19.6	28	E	yes	0.45	D	--	--	--	--
	P-2A	Aquitard	19.6	18	E	yes	1.14	D	Neuman and Witherspoon	--	0.33	0.0016 (3)
	P-2B		19.6		E	yes	0.47					
	MW-12		554.6	11	E	yes	0.27	D	Hantush	4,855	441.4	0.00051
								R	Theis Recovery	15,610	1419.1	--
	MW-27		533.3	5	E	yes	0.17	D	--	--	--	--
	MW-28	2nd HSZ	262.2	16	E	yes	0.55	D	Hantush	1,630	101.9	0.00038
								R	Theis Recovery	13,801	862.6	--
	MW-37		1010.8	7	M	no	--	D	--	--	--	--
	MW-40		--	11.5	E	yes	17.7	D	Cooper-Jacob	7,022	610.6	--
								R	Theis Recovery	1,689	146.9	--
	MW-44		1809	7.5	M	no	--	D	--	--	--	--
	P-3		19.6	11	E	yes	4.43	D	Hantush	450	40.9	0.00017
								R	Theis Recovery	11,854	1077.6	--
	P-4		190.2	6.5	E	yes	0.61	D	Hantush	2,808	432.0	0.00041
								R	Theis Recovery	10,730	1650.8	--
									Dist. vs. Drawdown	796	69.2	0.02
								MEAN PARAMETER VALUE (5)		2,340	217	0.00034

(1) Mean parameter values for T and K are the geometric mean of Theis and Neuman solutions for MW-18, MW-19, MW-20 and MW-31. Estimates of T and K for P-1 were anomolously low and were therefore excluded.
(2) Mean specific yield value calculated from MW-19 and MW-20 Nueman solutions.
(3) Based on consolidation test results.
(4) Values are specific yields based on Neuman Type B curve matching.
(5) Mean parameter values for T and K are the geometric mean of Theis and Neuman solutions for MW-12, MW-28, MW-40, P-3 and P-4.
(6) Mean parameter values for T and K are the geometric mean of Theis, Theis Recovery, Distance-Drawdown and Cooper-Jacob solutions for MW-38, P-5, P-7 and P-9.
(7) Mean parameter values for T and K are the geometric mean of the Hantush solution and the Distance-Drawdown solution for P-6 and P-8.

TABLE 7
OFF-SITE AQUIFER PUMPING TEST RESULTS
GROUNDWATER PREDESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Pumping Well and Pumping Parameters	Observation Well	Zone	Distance From Pumping Well (feet)	Zone Thickness (feet)	Manual (M) or Electronic (E) Measurements	Response Observed	Maximum DRAWDOWN (feet)	Evaluation of Drawdown (D) or Recovery (R) Data	Method of Analysis	T(s) (ft^2/day)	Hydraulic Conductivity (ft/d)	S
Pumping Well MW-38	MW-36		859.9	14	M	no	--	D	--	--	--	--
1st HSZ	MW-38		--	9	E	yes	5.41	D	Cooper-Jacob	3,208	356.4	--
Q=27.6 gpm								R	Theis Recovery	2,678	297.6	--
Pump On: 10/17/94 12:00	MW-39		778.5	10	M	?	--	D	--	--	--	--
Pump Off: 10/20/94 11:00	P-5	1st HSZ	14.5	10	E	yes	1.57	D	Theis	3,185	318.5	0.0028
Duration Pumped = 4320 min								R	Theis Recovery	2,750	275.0	--
	P-7		215.4	11	E	yes	0.40	D	Theis	4,037	367.0	0.019
								R	Theis Recovery	5,367	487.9	--
	P-9		216.0	9.5	E	yes	0.38	D	Theis	5,414	569.9	0.019
								R	Theis Recovery	5,680	597.9	--
									Dist. vs. Drawdown	2,100	210.0	0.023
								MEAN PARAMETER VALUE (6)		3,614	366	0.010
	MW-37		854.2	6.5	M	no	--	D	--	--	--	--
	MW-44		14.8	7.5	E	yes	0.22	D	--	--	--	--
	MW-46	2nd HSZ	784	10	M	no	--	D	--	--	--	--
	P-6		21.0	7.5	E	yes	0.24	D	--	--	--	--
	P-8		211.4	12	E	yes	0.19	D	--	--	--	--
1st HSZ Pumping Well MW-39	MW-39	1st HSZ	--	10	M	yes	3.55	D	Cooper-Jacob	468	46.8	--
Q=5.8 gpm; Duration = 120 min								R	Theis Recovery	109	10.9	--
1st HSZ Pumping Well MW-45	MW-45	1st HSZ	--	10	M	yes	0.5	D	Cooper-Jacob	1266	126.6	--
Q=3.3 gpm; Duration = 126 min								R	Theis Recovery	1098	109.8	--
Pumping Well MW-44	MW-38		14.8	9	E	yes	0.14	D	--	--	--	--
2nd HSZ	P-5	1st HSZ	15.0	10	E	yes	0.14	D	--	--	--	--
Q=19.8 gpm	P-7		202.0	11	E	yes	0.12	D	--	--	--	--
Pump On: 10/11/94 10:00	P-9		230.8	9.5	E	yes	0.11	D	--	--	--	--
Pump Off: 10/13/94 15:30	MW-37		851.2	6.5	M	no	--	D	--	--	--	--
Duration Pumped = 3150 min	MW-44		--	7.5	E	yes	23.95	D	Cooper-Jacob	176	17.6	--
								R	Theis Recovery	6,708	670.8	--
	MW-46	2nd HSZ	790.9	10	M	no	--	D	--	--	--	--
	P-6		14.9	7.5	E	yes	2.75	D	Hantush	169	22.5	0.00045
								R	Theis Recovery	300	40.0	
	P-8		197.7	12	E	yes	0.29	D	Hantush	925	77.1	0.00041
								R	Theis Recovery	4,176	348.0	
									Dist. vs. Drawdown	662	66.2	0.0046
								MEAN PARAMETER VALUE (7)		469	49	0.00043

(1) Mean parameter values for T and K are the geometric mean of Theis and Neuman solutions for MW-18, MW-19, MW-20 and MW-31. Estimates of T and K for P-1 were anomolously low and were therefore excluded.
(2) Mean specific yield value calculated from MW-19 and MW-20 Nueman solutions.
(3) Based on consolidation test results.
(4) Values are specific yields based on Neuman Type B curve matching.
(5) Mean parameter values for T and K are the geometric mean of Theis and Neuman solutions for MW-12, MW-28, MW-40, P-3 and P-4.
(6) Mean parameter values for T and K are the geometric mean of Theis, Theis Recovery, Distance-Drawdown and Cooper-Jacob solutions for MW-38, P-5, P-7 and P-9.
(7) Mean parameter values for T and K are the geometric mean of the Hantush solution and the Distance-Drawdown solution for P-6 and P-8.

TABLE 8
SUMMARY OF SOILS PHYSICAL TESTING RESULTS
GROUNDWATER PRE-DESIGN ACTIVITIES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Sample Location	Depth (ft)	USCS Soil Classification	Moisture Content (%)	Void Ratio	Specific Gravity	Porosity (%)	Coefficient of Compressibility (cm^2/gm)	Storage Coefficient[1] (ft^{-1})	Laboratory Hydraulic Conductivity (ft/day)
P-2	56.5	CL	27.1	0.717	2.514	41.8	7.19×10^{-6}	1.28×10^{-4}	3.9×10^{-4}
P-2	60.5	ML	23.2	0.659	2.585	39.7	4.0×10^{-6}	7.35×10^{-5}	4.4×10^{-4}
P-2	64	ML	19.5	0.585	2.621	36.9	3.02×10^{-6}	5.81×10^{-5}	2.5×10^{-3}
Averages			23.3	0.653	2.573	39.5	4.74×10^{-6}	8.64×10^{-5}	1.1×10^{-3}

(1) Storage Coefficient (FT^{-1}) = $30.48 \left[\frac{a_v}{1+e} \right]$

where:

a_v = coefficient of compressibility (cm^2/gm).
e = void ratio.

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TABLE 9
VERTICAL HYDRAULIC CONDUCTIVITY CALCULATION FOR THE AQUITARD BETWEEN THE FIRST AND SECOND HSZS
GROUNDWATER PRE-DESIGN ACTIVITIES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Time (min)	P-3 Drawdown (s in ft)	P-2A Drawdown (s' in ft)	s'/s	td	td'	K' (ft/day)
5	3.63	0.051	0.014	63.5	0.09	0.41
6	3.69	0.061	0.017	76.1	0.10	0.36
7	3.76	0.072	0.019	88.8	0.10	0.32
8	3.80	0.083	0.022	101.5	0.11	0.31
9	3.83	0.098	0.025	114.2	0.12	0.30
10	3.85	0.112	0.029	126.9	0.13	0.29
					Average K'	0.33

Notes:

r = 19.6 feet	distance between MW-40 and P-2A/P-3
K = 217 ft/day	second HSZ hydraulic conductivity geometric mean of MW-40 pumping test results.
S = 0.00034	second HSZ storativity (geometric mean of MW-40 results)
b = 11 feet	second HSZ aquifer thickness
S_s = 0.000039 ft^{-1}	second HSZ specific storage
A = 13.5 feet	vertical distance from top of second HSZ to P-2B
S_s' =0.0000864 ft^{-1}	aquitard specific storage

TABLE 10
CAPTURE ZONE EVALUATION
GROUNDWATER ELEVATION DATA — AUGUST 1994
(elevations in feet mean sea level datum)
GROUNDWATER PRE-DESIGN ACTIVITIES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Date	MW-2	MW-7	MW-8	MW-11	MW-12	MW-13	MW-14	MW-15	MW-16	MW-17	MW-18
08/01/94	-3.14	-6.96	-6.47	-5.40	-5.91	-6.37	-6.29	-6.03	-6.09	-6.43	-6.50
08/03/94	-3.15	-6.92	-6.46	-5.39	-5.91	-6.36	-6.37	-6.02	-6.08	-6.42	-6.49
08/04/94	-3.17	-7.00	-6.50	-5.42	-5.95	-6.38	-6.31	-6.06	-6.10	-6.46	-6.53
08/05/94	-3.16	-6.87	-6.28	-5.15	-5.71	-5.66	-5.71	-5.73	-5.73	-6.16	-6.24
08/08/94	-3.16	-6.80	-6.21	-5.06	-5.66	-5.54	—	—	-5.61	-6.04	-6.11
08/09/94	-3.19	-6.86	-6.25	—	—	-5.56	—	-5.66	-5.64	-6.07	-6.16
Steady State Drawdown(1)	0.01	0.20	0.29	0.36	0.29	0.84	—	0.40	0.49	0.42	0.42

Date	MW-19	MW-20	MW-21	MW-22	MW-28	MW-29	MW-30	MW-31	MW-32	MW-33	MW-34
08/01/94	-7.08	-7.10	-6.63	-6.62	-6.49	-6.46	-6.47	-6.66	-25.31	-5.42	-7.50
08/03/94	-7.07	-7.09	-6.62	-6.62	—	—	—	—	-27.49	-5.42	-7.50
08/04/94	-7.12	-7.13	-6.67	-6.66	-6.55	-6.43	-6.54	-6.68	-26.61	-5.43	-7.57
08/05/95	-6.84	-6.88	-6.49	-6.47	-6.35	-6.19	-6.20	-6.39	—	-5.15	-7.43
08/08/94	-6.76	-6.78	-6.42	-6.41	-6.31	—	-6.07	—	-7.01	-5.07	-7.36
08/09/94	-6.80	-6.85	-6.47	-6.45	-6.33	-6.06	-6.15	-6.28	—	—	-7.39
Steady State Drawdown(1)	0.36	0.35	0.25	0.25	0.24	0.37	0.47	0.40	19.60	0.36	0.21

Date	MW-35	MW-40	MW-41	MW-42	MW-43	P-1	P-2A	P-2B	P-3	P-4	SVE-5
08/01/94	-7.51	-7.08	-5.87	-4.28	-3.41	-7.40	-7.42	-7.38	-7.08	-6.79	—
08/03/94	-7.52	-7.08	-5.86	-4.28	-3.41	-7.42	-7.42	-7.39	-7.08	-6.79	—
08/04/94	-7.57	-7.13	-5.9	-4.29	-3.44	-7.45	-7.47	-7.45	-7.12	-6.83	-5.99
08/05/94	-7.44	-6.86	-5.7	-4.24	-3.42	-6.76	-6.78	-6.91	-6.86	-6.65	-5.45
08/08/94	—	-6.80	-5.66	-4.20	-3.41	-6.67	-6.69	-6.69	-6.82	-6.60	-5.31
08/09/94	-7.41	-6.85	—	-4.24	—	-6.71	-6.73	-6.67	-6.86	-6.64	—
Steady State Drawdown(1)	0.16	0.33	0.24	0.09	0.03	0.78	0.78	0.76	0.30	0.23	0.68

— Not Measured

(1) Based on the difference between water levels collected on 08/04/94 prior to shutting extraction wells MW-4 and MW-32 off and water levels collected on 08/08/94 after water levels recovered from puping.

TABLE 11
CAPTURE ZONE EVALUATION
GROUNDWATER ELEVATION DATA — FEBRUARY 1995
(elevations in feet mean sea level datum)
GROUNDWATER PRE-DESIGN ACTIVITIES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Date	EW-1	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-11	MW-12
02/23/95	-9.85	0.58	0.72	1.06	-6.32	-2.31	-2.69	-4.06	-3.39	-2	-2.77

Date	MW-13	MW-14	MW-15	MW-16	MW-17	MW-18	MW-19	MW-20	MW-21	MW-22	MW-23
02/23/95	-3.09	-3.03	-2.79	-2.81	-3.34	-3.41	-4.26	-4.26	-3.62	-3.62	-3.15

Date	MW-24	MW-25	MW-26	MW-27	MW-28	MW-29	MW-30	MW-31	MW-32	MW-33	MW-34
02/23/95	-3.09	-4.72	-4.72	-4.74	-3.55	-3.36	-3.37	-3.58	-24.29	-1.88	-4.89

Date	MW-35	MW-36	MW-37	MW-38	MW-39	MW-40	MW-41	MW-42	MW-43	MW-44	MW-45
02/23/95	-4.93	-6.43	-6.74	-9.25	-11.27	-4.28	-2.75	-0.65	0.41	-9.41	-13.11

Date	MW-46	MW-47	MW-48	P-1	P-2A	P-2B	P-3	P-4	P-5	P-6	P-7
02/23/95	-15.4	-7.92	1.28	-4.54	-4.56	-3.95	-4.26	-3.89	-9.36	-9.47	-8.98

Date	P-8	P-9	P-10	P-11	SVE-4	SVE-5
02/23/95	-9.15	-9.47	0.95	0.99	-0.26	-2.6

TABLE 12
GW-1 AND GW-2 IRM EXTRACTED GROUNDWATER VOLUMES AND CONCENTRATION ESTIMATES
GROUNDWATER PREDESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

MW-4, VOLUME OF GROUNDWATER (gallons) AND CONCENTRATIONS (ug/L)															
DATE	METER READING	VOLUME (gallons)	B	T	X	E	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	1,2-DCE	TCE	PCE	TPH GAS	NI
04/30/93	408,940	490,728 *	350	35	93	18	1.3	8.8	37.0	20	ND	6.1	ND	2300	8.9
05/30/93	904,090	594,180 *	200	30	30	9.7	1.4	4.8	42	10	ND	3.9	ND	1100	7.1
06/30/93	1,432,420	633,996 *	270	40	50	9.7	1.4	5.2	66	7.9	ND	3.2	ND	1400	14
07/30/93	2,186,740	905,184 *	210	23	28	7.1	1.2	4.5	55	6	ND	ND	ND	ND	6.7
09/01/93	2,800,480	736,488 *	170	27	31	9.2	1.3	4.5	64	5.7	ND	2.9	ND	--	10
09/28/93	3,216,150	498,804 *	110	7.5	ND	ND	1.3	4.5	53	3.5	ND	3.0	0.82	630	12
11/01/93	3,790,600	689,340 *	150	19	ND	ND	1.8	5.8	69	5.4	ND	4.3	1.1	520	8
11/30/93	4,297,920	608,784 *	110	15	21	5.1	1.6	5.0	65	4.4	ND	3.7	1.2	750	7.8
12/29/93	4,617,270	383,220 *	110	15	21	5.1	1.6	5.0	65	4.4	ND	3.7	1.2	ND	16
01/31/94	5,174,748	696,848 *	110	14	19	4.4	1.3	4.6	52	3.4	ND	2.9	1.1	510	7.8
02/28/94	5,675,860	626,390 *	110	14	17	4.3	1.8	4.6	64	4.6	ND	3	1.5	330	13
03/31/94	6,258,818	728,698 *	110	13	16	4	1.2	3.9	41	3.3	ND	2.6	1.4	580	24
04/28/94	6,727,750	586,165 *	120	14	19	3.7	1.5	3.6	53	2.7	ND	2.7	1.3	660	9.6
05/31/94	7,289,670	702,400 *	61	6.9	8.6	2.2	0.66	3.3	37	2.9	ND	2.4	1	380	6
06/30/94	7,987,090	871,775 *	75	ND	ND	ND	ND	2.9	37	1.8	ND	2.1	0.88	415	ND
07/27/94	8,425,570	754,813 *	88	12	13	3.6	1.1	3.2	39	ND	ND	ND	1	150	8
09/30/94	9,038,230	559,113 *	84	11	17	3.5	ND	2.4	38	2.1	ND	1.6	0.7	310	17
10/31/94	9,328,450	362,775 *	110	12	15	7.4	1.3	2.4	39	2.5	ND	2.8	1.2	430	25
11/29/94	10,076,280	747,830	96	13	17	4.5	0.62	3.8	33	3.3	ND	2.6	1.1	470	22
12/31/94	10,954,540	878,260	94	12	16	4.5	1	3.4	33	2.9	ND	2.5	1.4	430	30
01/27/95	11,258,010	303,470	84	13	15	4.6	ND	4.3	46	ND	ND	2.8	2.1	340	24
02/28/95	11,816,030	558,020	68	11	19	3.4	ND	3.1	40	2.3	ND	2.5	ND	430	8
03/31/95	12,158,060	342,030	39	7.5	11	2.0	ND	2.5	33	1.4	ND	2.4	1.1	340	ND
TOTALS		14,259,311													

* A correction factor of 1.2 times was applied to the volumes through October 1994 for incorrect meter calibration.

TABLE 12 (cont.)
GW-1 AND GW-2 IRM EXTRACTED GROUNDWATER VOLUMES AND CONCENTRATION ESTIMATES
GROUNDWATER PREDESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

MW-32, VOLUME OF GROUNDWATER (gallons) AND CONCENTRATIONS (ug/L)															
DATE	METER READING	VOLUME (gallons)	B	T	X	E	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	1,2-DCE	TCE	PCE	TPH GAS	Ni
04/30/93	299,450	284,478 *	ND	ND	ND	ND	2.0	3.1	47	ND	ND	9.6	ND	ND	21
05/30/93	694,720	375,507 *	ND	ND	ND	ND	1.3	3.8	45	ND	ND	7.3	ND	ND	17
06/30/93	1,163,590	445,427 *	ND	ND	ND	ND	ND	3.1	43	ND	ND	7.4	ND	ND	150
07/30/93	1,838,120	640,804 *	ND	ND	ND	ND	0.72	2.6	46	ND	ND	5.9	ND	ND	20
09/01/93	2,403,580	537,187 *	ND	ND	ND	ND	ND	2.7	44	ND	ND	5.3	ND	ND	23
09/28/93	2,785,580	362,900 *	ND	ND	ND	ND	0.90	2.8	38	ND	ND	5.1	ND	ND	24
11/01/93	3,316,890	504,745 *	ND	ND	ND	ND	1.3	4.2	52	0.6	ND	7.2	ND	ND	20
11/30/93	3,847,310	503,899 *	ND	ND	ND	ND	1.4	4.0	49	0.7	ND	7.2	ND	ND	20
12/29/93	4,110,330	249,869 *	ND	ND	ND	ND	1.4	4.0	49	0.7	ND	7.2	ND	ND	23
01/31/94	4,532,690	401,242 *	ND	ND	ND	ND	ND	ND	44	ND	ND	ND	ND	ND	18
02/28/94	4,858,540	309,558 *	ND	ND	ND	ND	1.4	4.5	58	0.53	ND	7.4	0.53	ND	20
03/31/94	5,256,060	377,644 *	ND	ND	ND	ND	1.2	4.3	41	0.7	ND	7.2	ND	ND	21
04/28/94	5,594,290	321,319 *	ND	ND	ND	ND	1.2	4	52	ND	ND	6.8	ND	ND	18
05/31/94	6,011,890	396,720 *	ND	ND	ND	ND	0.67	3.7	33	ND	ND	6.5	ND	ND	18
06/30/94	6,572,560	532,637 *	ND	ND	ND	ND	0.81	4	39	0.65	ND	6.2	ND	ND	15
07/27/94	6,910,870	440,154 *	ND	ND	ND	ND	1	3.8	44	0.98	ND	4.9	ND	ND	17
09/30/94	7,208,970	164,436 *	ND	ND	ND	ND	0.5	0.8	19	ND	ND	4.1	ND	ND	16
10/31/94	7,258,090	46,664 *	ND	ND	ND	ND	0.86	2	26	ND	ND	6.3	ND	ND	18
11/29/94	7,550,130	292,040	ND	ND	ND	ND	ND	1.4	25	ND	ND	5.4	ND	ND	14
12/31/94	8,132,490	582,360	ND	ND	ND	ND	0.93	4.2	39	ND	ND	6.5	ND	ND	22
01/27/95	8,351,680	219,190	ND	ND	ND	ND	ND	4.9	51	ND	ND	6.9	ND	ND	30
02/28/95	8,774,170	422,490	ND	ND	ND	ND	ND	3.1	31	ND	ND	6.9	ND	ND	19
03/31/95	9,135,130	360,960	ND	ND	ND	ND	ND	3.5	34	ND	ND	6.7	ND	ND	17
TOTALS		8,772,230													

* A correction factor of 0.95 times was applied to the volumes through October 1994 for incorrect meter calibration.

TABLE 12 (cont.)
GW-1 AND GW-2 IRM EXTRACTED GROUNDWATER VOLUMES AND CONCENTRATION ESTIMATES
GROUNDWATER PREDESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

EW-1, VOLUME OF GROUNDWATER (gallons) AND CONCENTRATIONS (ug/L)															
DATE	METER READING	VOLUME (gallons)	B	T	X	E	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	1,2-DCE	TCE	PCE	TPH GAS	NI
11/29/94	340,600	340,600	ND	ND	ND	ND	ND	7.8	13	ND	ND	ND	ND	ND	ND
12/31/94	770,260	429,660	ND	ND	ND	ND	ND	6.1	11	ND	ND	ND	ND	ND	ND
01/27/95	938,620	168,360	ND	ND	ND	ND	ND	5.3	10.0	ND	ND	ND	ND	ND	ND
02/28/95	1,173,730	235,110	--	--	--	--	ND	5.0	10.0	ND	ND	ND	ND	ND	ND
03/31/95	1,432,120	258,390	ND	ND	ND	ND	ND	4.5	9.2	ND	ND	ND	ND	ND	ND
TOTALS		1,432,120													

TABLE 13
GW-1 AND GW-2 IRM GROUNDWATER EXTRACTION MASS REMOVAL ESTIMATES
GROUNDWATER PREDESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD
SACRAMENTO, CALIFORNIA

MW-4, MASS REMOVED, IN POUNDS													
DATE	B	T	X	E	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	1,2-DCE	TCE	PCE	TPH GAS	NI
04/30/93	1.43	0.14	0.38	0.07	0.005	0.04	0.15	0.082	0.00	0.02	0.000	9.42	0.04
05/30/93	0.99	0.15	0.15	0.05	0.007	0.02	0.21	0.050	0.00	0.02	0.000	5.45	0.04
06/30/93	1.43	0.21	0.26	0.05	0.007	0.03	0.35	0.042	0.00	0.02	0.000	7.41	0.07
07/30/93	1.59	0.17	0.21	0.05	0.009	0.03	0.42	0.045	0.00	0.00	0.000	0.00	0.05
09/01/93	1.04	0.17	0.19	0.06	0.008	0.03	0.39	0.035	0.00	0.02	0.000	0.00	0.06
09/28/93	0.46	0.03	0.00	0.00	0.005	0.02	0.22	0.015	0.00	0.01	0.003	2.62	0.05
11/01/93	0.86	0.11	0.00	0.00	0.010	0.03	0.40	0.031	0.00	0.02	0.006	2.99	0.05
11/30/93	0.56	0.08	0.11	0.03	0.008	0.03	0.33	0.022	0.00	0.02	0.006	3.81	0.04
12/29/93	0.35	0.05	0.07	0.02	0.005	0.02	0.21	0.014	0.00	0.01	0.004	0.00	0.05
01/31/94	0.64	0.08	0.11	0.03	0.008	0.03	0.30	0.020	0.00	0.02	0.006	2.97	0.05
02/28/94	0.58	0.07	0.09	0.02	0.009	0.02	0.33	0.024	0.00	0.02	0.008	1.73	0.07
03/31/94	0.67	0.08	0.10	0.02	0.007	0.02	0.25	0.020	0.00	0.02	0.009	3.53	0.15
04/28/94	0.59	0.07	0.09	0.02	0.007	0.02	0.26	0.013	0.00	0.01	0.006	3.23	0.05
05/31/94	0.36	0.04	0.05	0.01	0.004	0.02	0.22	0.017	0.00	0.01	0.006	2.23	0.04
06/30/94	0.55	0.00	0.00	0.00	0.000	0.02	0.27	0.013	0.00	0.02	0.006	3.02	0.00
07/27/94	0.55	0.08	0.08	0.02	0.007	0.02	0.25	0.000	0.00	0.00	0.006	0.94	0.05
09/30/94	0.39	0.05	0.08	0.02	0.000	0.01	0.18	0.010	0.00	0.01	0.003	1.45	0.08
10/31/94	0.33	0.04	0.05	0.02	0.004	0.01	0.12	0.008	0.00	0.01	0.004	1.30	0.08
11/29/94	0.60	0.08	0.11	0.03	0.004	0.02	0.21	0.021	0.00	0.02	0.007	2.93	0.14
12/31/94	0.69	0.09	0.12	0.03	0.007	0.02	0.24	0.021	0.00	0.02	0.010	3.15	0.22
01/27/95	0.21	0.03	0.04	0.01	0.000	0.01	0.12	0.000	0.00	0.01	0.005	0.86	0.06
02/28/95	0.32	0.05	0.09	0.02	0.000	0.01	0.19	0.011	0.00	0.01	0.000	2.00	0.04
03/31/95	0.11	0.02	0.03	0.01	0.000	0.01	0.09	0.004	0.00	0.01	0.003	0.97	0.00
TOTALS	15.30	1.89	2.40	0.58	0.123	0.49	5.69	0.517	0.00	0.31	0.100	62.01	1.45

TOTAL BTEX 20.17 TOTAL CVOCs 7.24

Note: Mass removal estimates based on metered discharge volumes and periodic chemical analysis of extracted groundwater as summarized in Table 12.

TABLE 13 (cont.)
GW-1 AND GW-2 IRM GROUNDWATER EXTRACTION MASS REMOVAL ESTIMATES
GROUNDWATER PREDESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD
SACRAMENTO, CALIFORNIA

MW-32, MASS REMOVED, IN POUNDS													
DATE	B	T	X	E	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	1,2-DCE	TCE	PCE	TPH GAS	NI
04/30/93	0.00	0.00	0.00	0.00	0.005	0.01	0.11	0.000	0.00	0.02	0.000	0.00	0.05
05/30/93	0.00	0.00	0.00	0.00	0.004	0.01	0.14	0.000	0.00	0.02	0.000	0.00	0.05
06/30/93	0.00	0.00	0.00	0.00	0.000	0.01	0.16	0.000	0.00	0.03	0.000	0.00	0.56
07/30/93	0.00	0.00	0.00	0.00	0.004	0.01	0.25	0.000	0.00	0.03	0.000	0.00	0.11
09/01/93	0.00	0.00	0.00	0.00	0.000	0.01	0.20	0.000	0.00	0.02	0.000	0.00	0.10
09/28/93	0.00	0.00	0.00	0.00	0.003	0.01	0.12	0.000	0.00	0.02	0.000	0.00	0.07
11/01/93	0.00	0.00	0.00	0.00	0.005	0.02	0.22	0.003	0.00	0.03	0.000	0.00	0.08
11/30/93	0.00	0.00	0.00	0.00	0.006	0.02	0.21	0.003	0.00	0.03	0.000	0.00	0.08
12/29/93	0.00	0.00	0.00	0.00	0.003	0.01	0.10	0.001	0.00	0.02	0.000	0.00	0.05
01/31/94	0.00	0.00	0.00	0.00	0.000	0.00	0.15	0.000	0.00	0.00	0.000	0.00	0.06
02/28/94	0.00	0.00	0.00	0.00	0.004	0.01	0.15	0.001	0.00	0.02	0.001	0.00	0.05
03/31/94	0.00	0.00	0.00	0.00	0.004	0.01	0.13	0.002	0.00	0.02	0.000	0.00	0.07
04/28/94	0.00	0.00	0.00	0.00	0.003	0.01	0.14	0.000	0.00	0.02	0.000	0.00	0.05
05/31/94	0.00	0.00	0.00	0.00	0.002	0.01	0.11	0.000	0.00	0.02	0.000	0.00	0.06
06/30/94	0.00	0.00	0.00	0.00	0.004	0.02	0.17	0.003	0.00	0.03	0.000	0.00	0.07
07/27/94	0.00	0.00	0.00	0.00	0.004	0.01	0.16	0.004	0.00	0.02	0.000	0.00	0.06
09/30/94	0.00	0.00	0.00	0.00	0.001	0.00	0.03	0.000	0.00	0.01	0.000	0.00	0.02
10/31/94	0.00	0.00	0.00	0.00	0.000	0.00	0.01	0.000	0.00	0.00	0.000	0.00	0.01
11/29/94	0.00	0.00	0.00	0.00	0.000	0.00	0.06	0.000	0.00	0.01	0.000	0.00	0.03
12/31/94	0.00	0.00	0.00	0.00	0.005	0.02	0.19	0.000	0.00	0.03	0.000	0.00	0.11
01/27/95	0.00	0.00	0.00	0.00	0.000	0.01	0.09	0.000	0.00	0.01	0.000	0.00	0.05
02/28/95	0.00	0.00	0.00	0.00	0.000	0.01	0.11	0.000	0.00	0.02	0.000	0.00	0.07
03/31/95	0.00	0.00	0.00	0.00	0.000	0.01	0.10	0.000	0.00	0.02	0.000	0.00	0.05
TOTALS	0.00	0.00	0.00	0.00	0.055	0.24	3.10	0.017	0.00	0.46	0.001	0.00	1.92

TOTAL BTEX 0.00

TOTAL CVOCs 3.87

Note: Mass removal estimates based on metered discharge volumes and periodic chemical analysis of extracted groundwater as summarized in Table 12.

TABLE 13 (cont.)
GW-1 AND GW-2 IRM GROUNDWATER EXTRACTION MASS REMOVAL ESTIMATES
GROUNDWATER PREDESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD
SACRAMENTO, CALIFORNIA

EW-1, MASS REMOVED, IN POUNDS													
DATE	B	T	X	E	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	1,2-DCE	TCE	PCE	TPH GAS	NI
11/29/94	0.00	0.00	0.00	0.00	0.000	0.02	0.04	0.000	0.00	0.00	0.000	0.00	0.00
12/31/94	0.00	0.00	0.00	0.00	0.000	0.02	0.04	0.000	0.00	0.00	0.000	0.00	0.00
01/27/95	0.00	0.00	0.00	0.00	0.000	0.01	0.01	0.000	0.00	0.00	0.000	0.00	0.00
02/28/95	0.00	0.00	0.00	0.00	0.000	0.01	0.02	0.000	0.00	0.00	0.000	0.00	0.00
03/31/95	0.00	0.00	0.00	0.00	0.000	0.01	0.02	0.000	0.00	0.00	0.000	0.00	0.00
TOTALS	0.00	0.00	0.00	0.00	0.000	0.07	0.13	0.000	0.00	0.00	0.000	0.00	0.00

TOTAL BTEX 0.00

TOTAL CVOCs 0.20

Note: Mass removal estimates based on metered discharge volumes and periodic chemical analysis of extracted groundwater as summarized in Table 12.

TABLE 14
MODEL PARAMETERIZATION
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Parameter	Layer		
	1	2	3
Hydraulic Conductivity (K_X) (ft/day) [1]	91-250	80-200	300
Storage Coefficient (S)	0.03	0.0004	0.0004
Top Elevations (ft) [2]	N/A	-43 to -53	-70
Bottom Elevations (ft) [3]	-23 to -41	-51 to -59	-90
Porosity (n)	0.3	0.3	0.3
Retardation Factor (R)	2.5	2.5	2.5
Longitudinal Dispersivity (α_L) [4]	2 - 4	0.5	1
Transverse Dispersivity Ratio ($\alpha_{Y,Z}:\alpha_L$)	1:10	1:10	1:10
Initial Concentrations ($\mu g/L$) [5]	0 - 100	0 - 50	0
Vertical Hydraulic Conductivity Ratio ($K_X:K_Z$)	10:1	10:1	10:1

Notes:

(1) For distribution of hydraulic conductivity in Layers 1 and 2, see Figures 21 and 24, respectively.
(2) For distribution of top elevations in Layers 2 and 3, see Figure 25.
(3) For distribution of bottom elevation in Layers 1 and 2, see Figures 22 and 26, respectively.
(4) Longitudinal dispersivities in Layer 1 are distributed as K in Figure 21.
(5) For distribution of initial concentrations in Layers 1 and 2, see Figures 23 and 27, respectively.

TABLE 15
CALIBRATION TARGETS
COMPARISON OF SIMULATED AND ACTUAL GROUNDWATER ELEVATIONS
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well Name	Hydrostrati-graphic Zone	Actual Head (ft)	Simulated Head (ft)	Residual (ft)
MW-2	1	-3.81	-3.93	0.12
MW-3		-4.02	-4.35	0.33
MW-5		-6.21	-6.32	0.11
MW-7		-7.50	-7.32	-0.18
MW-13		-6.29	-6.24	-0.05
MW-15		-6.34	-6.38	0.04
MW-19		-7.47	-7.18	-0.29
MW-16		-8.00	-7.72	-0.28
MW-30		-6.81	-6.72	-0.09
MW-35		-8.06	-7.70	-0.36
MW-36		-9.23	-9.10	-0.13
MW-38		-11.60	-11.43	0.25
MW-39		-13.18	-13.43	0.25
MW-42		-4.97	-4.97	0.00
MW-45		-14.79	-14.88	0.09
MW-48		-3.34	-3.40	0.06
SVE-5		-6.09	-6.08	-0.01
MW-12	2	-6.41	-6.45	0.04
MW-27		-7.99	-7.94	-0.05
MW-28		-7.03	-6.95	-0.08
MW-37		-9.52	-9.34	-0.18
MW-40		-7.49	-7.34	-0.15
MW-44		-11.64	-11.48	-0.16
MW-46		-13.38	-13.43	0.05
MW-41	3	-6.40	-6.41	0.01
MW-47		-10.58	-9.50	-1.08

TABLE 16
COMPARISON OF SIMULATED AND ACTUAL WATER ELEVATIONS
FIRST AND SECOND HSZs
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

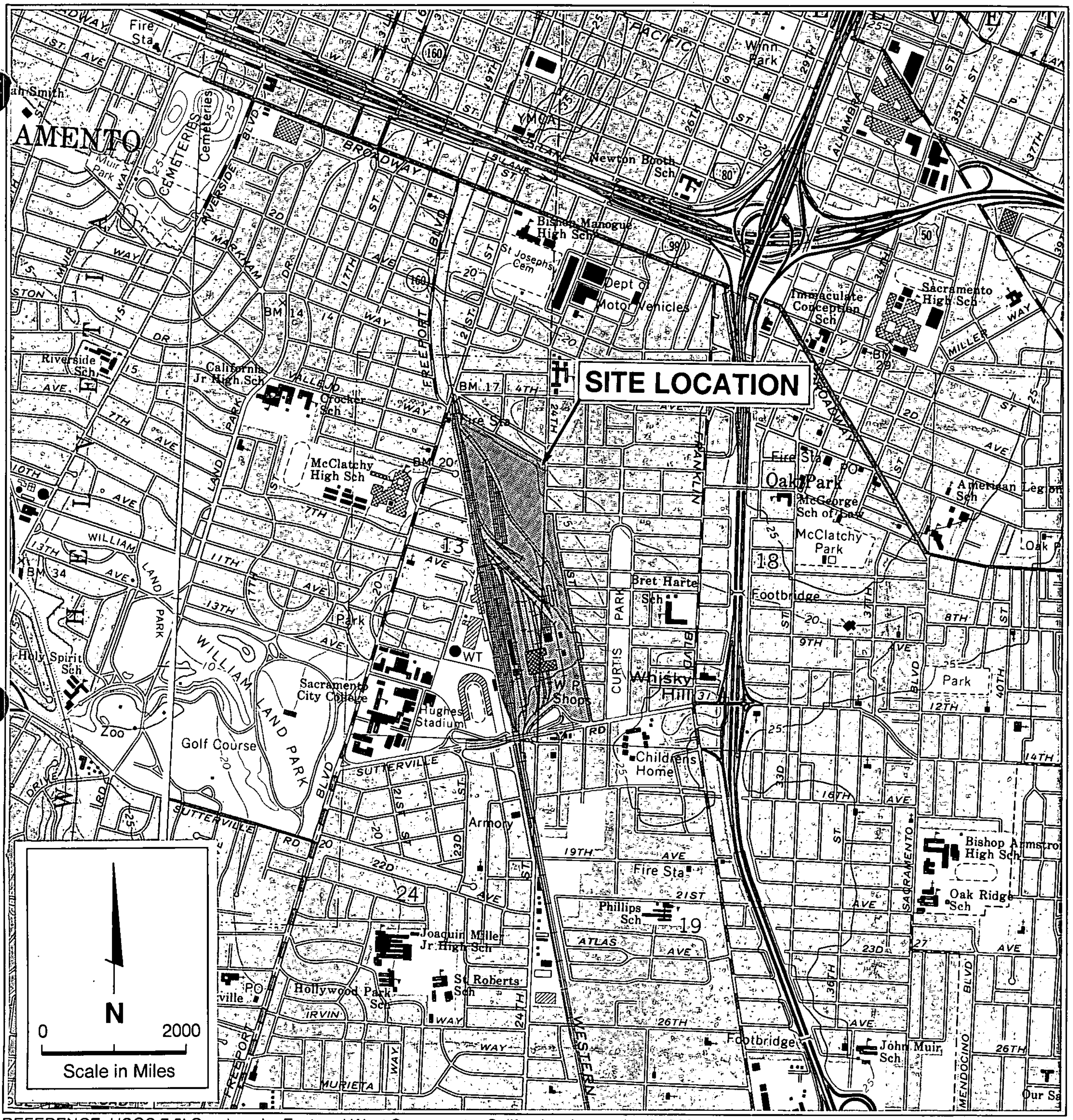
Layer	Well	Water Elevations (ft)		Elevation Difference [1] (ft)		Residual (ft)
		Actual	Simulated	Actual	Simulated	
1	MW-13	-6.29	-6.24	-0.12	-0.19	+0.07
2	MW-12	-6.41	-6.45			
1	MW-26	-8.00	-7.72	+0.01	-0.22	+0.23
2	MW-27	-7.99	-7.94			
1	MW-30	-6.81	-6.72	-0.22	-0.23	+0.01
2	MW-28	-7.03	-6.95			
1	MW-36	-9.23	-9.10	-0.19	-0.24	+0.05
2	MW-37	-9.52	-9.34			
1	MW-38	-11.60	-11.43	-0.04	-0.05	+0.01
2	MW-44	-11.64	-11.48			
1	MW-39	-13.18	-13.43	-0.20	0.00	-0.20
2	MW-46	-13.38	-13.43			

(1) Difference in groundwater elevation between the first and second HSZs.

TABLE 17
PROPOSED EXTRACTION WELLS
GROUNDWATER PRE-DESIGN ACTIVITIES REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Well	Hydrostratigraphic Zone	Flow Rate (gpm)	Comment
EW-1	1	10	Control Toe of GW-2
MW-4	1	20	On-Site GW-1
MW-32	1	15	On-Site GW-1
MW-40	2	10	On-Site GW-1
MW-39	1	10	Control Toe of GW-1
MW-38	1	10	Off-Site GW-1
MW-44	2	15	Control Toe of GW-2

FIGURES



REFERENCE: USGS 7.5' Quadrangle; East and West Sacramento, California, photorevised 1980.

SITE VICINITY MAP

Groundwater Pre-Design Activities Report
Union Pacific Railroad Yard
Sacramento, California

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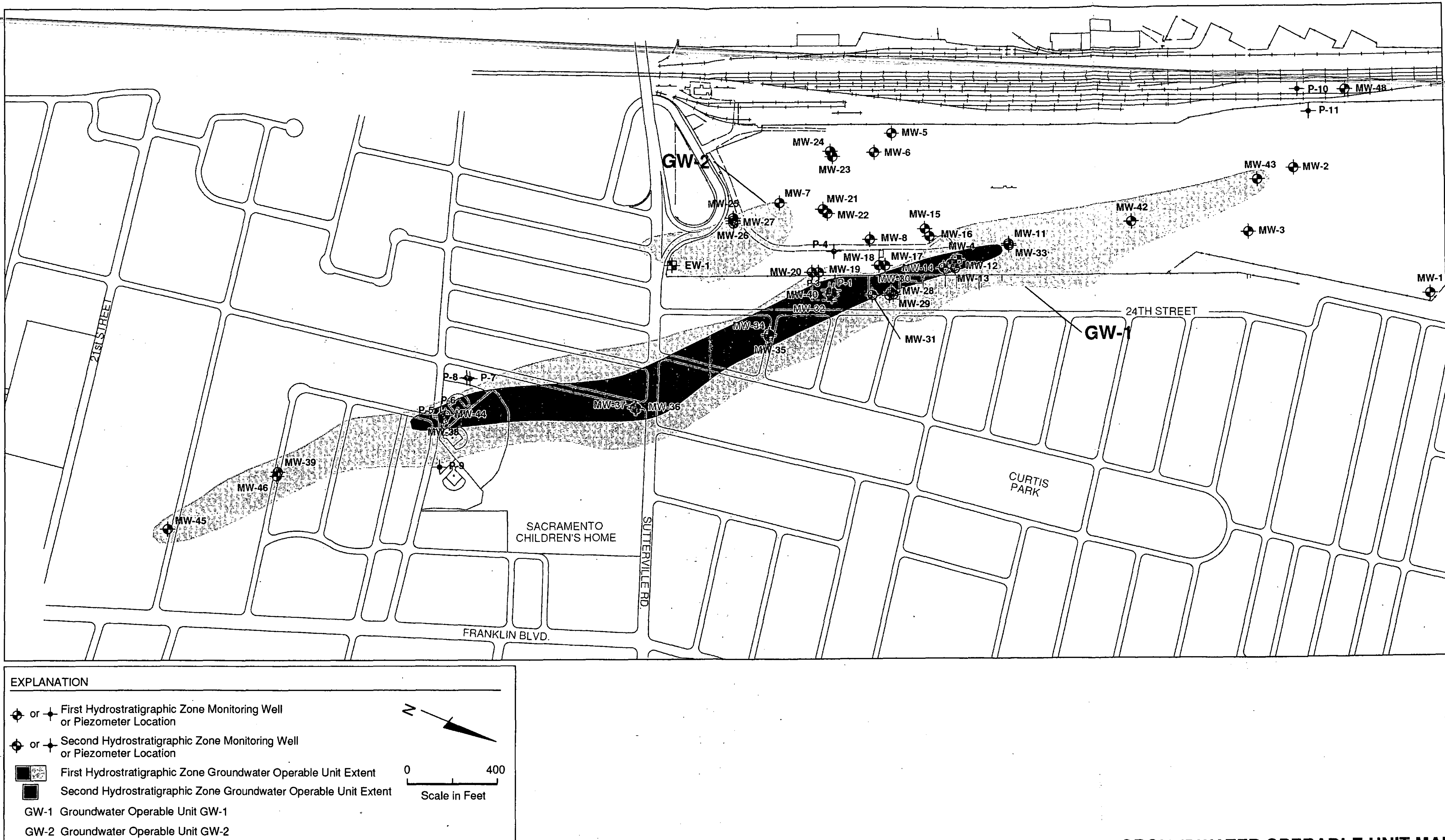
FIGURE 1



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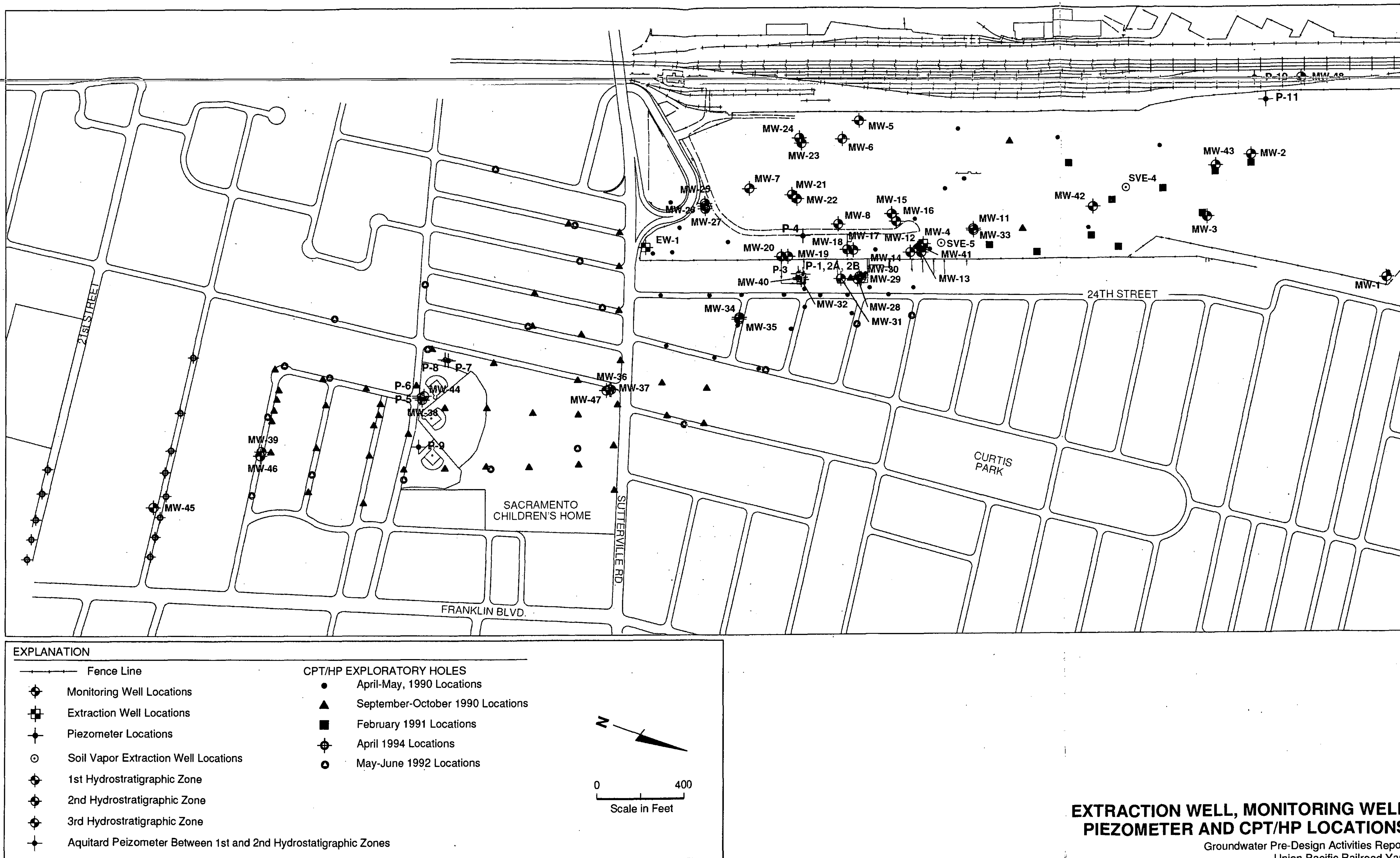
GROUNDWATER OPERABLE UNIT MAP

Groundwater Pre-Design Activities Report
Union Pacific Railroad Yard
Sacramento, California

FIGURE 2



EXTRACTION WELL, MONITORING WELL PIEZOMETER AND CPT/HP LOCATIONS

Groundwater Pre-Design Activities Report
Union Pacific Railroad Yard
Sacramento, California

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FIGURE 3