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Lawrence Livermore National Laboratory
Lawrence Livermore National Security, LLC Livermore, California 94551

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LLNL
Ground Water Project

2010 Annual Report

Technical Editors

M. Buscheck*
P. McKereghan
M. Dresen*

Contributing Authors

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Environmental Restoration Department

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Acknowledgements

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Summary

In 2010, environmental restoration activities for the Lawrence Livermore National Laboratory (LLNL) Livermore Site Ground Water Project included:

- Removing approximately 54.4 kilograms (kg) of volatile organic compounds (VOCs) from ground water, and 44.5 kg of VOCs from soil vapor (Table Summ-1).
- Maintaining 29 ground water treatment facilities and nine soil vapor treatment facilities.
- Maintaining a network of 93 ground water extraction wells, two ground water injection wells, 17 dual extraction[1] wells, 32 soil vapor extraction wells, and one soil vapor injection well.
- Continuing hydraulic control and treatment of VOCs in ground water along the western and southern margins of the site where concentrations declined or remained stable during the year.
- Installing six dual extraction wells, two ground water extraction wells, three soil vapor extraction wells, and nine monitor wells; conducting extensive direct-push cone penetration testing (CPT) surveys to better delineate the B518 Perched Zone and B511/B419 source areas; and properly sealing 90 obsolete wells in the TFA Vadose Zone Observatory and TF406 Gas Pad areas (Figure 1b).
- Upgrading treatment facilities TFC and TFD-W through ERD's Remediation Evaluation (REVAL) process (Figure 1b).
- Improving Livermore Site treatment facility hours of operation by 22% over 2009.
- Initiating enhanced source area remediation (ESAR) treatability tests at TFE Hotspot (pneumatic fracturing) and TFD Helipad (bioremediation), and preparing for a third treatability test at TFE Eastern Landing Mat (enhanced thermal remediation) (Figure 1b).
- Conducted a mercury soil investigation at former Building 212 and assisted with a soil investigation associated with the RCRA closure of Building 419 (Figure 1b).
- Confirming tritium activities in ground water from all wells remained below the 20,000 picocuries per liter (pCi/L) Maximum Contaminant Level (MCL), and tritium continued to decline by radioactive decay.
- Submitting the 2009 Annual Report, 2010 quarterly reports, and draft focused feasibility study to minimize mixed hazardous and low level radioactive waste from treatment facilities in compliance with regulatory agreements (Bourne et. al., 2010).
- Conducting Neighborhood Meeting to discuss Treatment Facility A (TFA) proposed pipeline extension.

Restoration activities in 2009 at the Livermore Site (Buscheck et. al, 2009) were primarily focused on restoring operations at treatment facilities that were shut down or required repair due to the fiscal year 2008 budget shortfall. In 2010, ERD was able to complete restoring most treatment facility operations to pre-2008 levels or better while beginning to once again evaluate

[1]Extraction of ground water using a downhole pump with concurrent application of vacuum to the well. Ground water and soil vapor are removed in separate pipe manifolds and treated.

technologies that could be used to accelerate clean up of the Livermore Site source areas, and to address the mixed-waste management issue addressed in the Focused Feasibility Study (FFS) (Bourne et. al., 2010). An ESAR bioremediation treatability test was initiated at the TFD Helipad, and the primary field work was completed for the ESAR pneumatic fracturing treatability test. Both treatability tests are scheduled for completion in 2011 while the ESAR thermal heating treatability test at TFE Eastern Landing Mat is scheduled to begin in 2011.

Ground water concentration and hydraulic data indicate subtle but consistent declines in the VOC concentrations and areal extent of the contaminant plumes in 2010. There was little to no evidence in 2010 of measureable contaminant plume migration as a result of treatment facilities shut down in late 2008 and early 2009.

Hydraulic containment along the western and southern boundaries of the site was fully re-established in 2010 and progress was made toward interior plume and source area clean up.

Since remediation began in 1989, nearly 4.1 billion gallons of ground water and about 432 million cubic feet of soil vapor have been treated, removing an estimated 2,876 kg (3.2 tons) of VOCs from the subsurface (Table Summ-2).

Table Summ-1. Summary of 2010 Livermore Site VOC remediation.

Treatment area[a]	Volume of ground water treated (Mgal)[b]	Estimated VOC mass removed from ground water (kg)[c]	Volume of soil vapor treated (Mft^3)[b]	Estimated VOC mass removed from soil vapor (kg)[c]	Estimated VOC mass removed (kg)[c, d]
TFA	101	4.5	na	na	4.5
TFB	28	2.5	na	na	2.5
TFC	36	4.5	na	na	4.5
TFD	70	32.7	21	3.6	36.3
TFE	25	7.4	14	2.3	9.7
TFG	8	0.7	na	na	0.7
TFH	10	2.1	25	38.6	40.7
Totals[d]	278	54.4	60	44.5	98.9

Notes:

Mgal = Millions of gallons.

kg = Kilograms.

Mft^3 = Millions of cubic feet.

na = Not applicable.

[a] **Treatment facilities in each treatment area (refer to Table 1 for abbreviations):**

TFA area: TFA, TFA-E, TFA-W

TFB area: TFB

TFC area: TFC, TFC-E, TFC-SE

TFD area: TFD, TFD-E, TFD-HPD, TFD-S, TFD-SE, TFD-SS, TFD-W, VTFD-ETCS, VTFD-HPD, VTFD-HS

TFE area: TFE-E, TFE-HS, TFE-NW, TFE-SE, TFE-SW, TFE-W, VTFE-ELM, VTFE-HS

TFG area: TFG-1, TFG-N

TFH area: TF406, TF406-NW, VTF406-HS, VTF511, TF518-N, TF518-PZ, VTF518-PZ, TF5475-1, TF5475-2, TF5475-3, VTF5475

TFF started operation in February 1993 for fuel hydrocarbon remediation. In August 1995, the regulatory agencies agreed that the vadose zone remediation was complete, and in October 1996 No Further Action status was granted for fuel hydrocarbons in ground water.

[b] **Volumes and VOC mass are from the sum of individual extraction wells shown in Table 5.**

[c] **VOC mass values are best estimates accounting for measurement uncertainties in both volume and chemical analyses.**

[d] **Rounded numbers.**

Table Summ-2. Summary of cumulative Livermore Site VOC remediation.

Treatment area	Volume of ground water treated (Mgal)[a]	Estimated VOC mass removed from ground water (kg)[b]	Volume of soil vapor treated (Mft^3)[a]	Estimated VOC mass removed from soil vapor (kg)[b]	Estimated VOC mass removed (kg)[b, c]
TFA	1,742	202	na	na	202
TFB	413	77	na	na	77
TFC	435	98	na	na	98
TFD	929	810	79	90	900
TFE	343	208	146	145	353
TFG	71	11	na	na	11
TFH	150	34	207	1,201	1,235
Totals[b]	4,083	1,440	432	1,436	2,876

Notes:

Mgal = Millions of gallons.

kg = Kilograms.

Mft^3 = Millions of cubic feet.

na = Not applicable.

[a] Refer to Table Summ-1 footnote "a" for facilities in each treatment area.

[b] The VOC mass values are best estimates accounting for measurement uncertainties in both volume and chemical analyses.

[c] Rounded numbers.

1. Introduction

This report summarizes the Lawrence Livermore National Laboratory (LLNL) Livermore Site Ground Water Project (GWP) field and regulatory compliance activities, and the remedial action program for calendar year 2010. The field activities section describes ground water monitoring and Enhanced Source Area Remediation (ESAR) activities. The remedial action program section describes treatment facility operations, ground water discharges, remediation performance evaluation, and decision support analysis. The treatment areas, treatment facilities, wells, and locations of significant projects conducted in 2010 at the Livermore Site, are shown on Figures 1 (a, b) and 2 (a, b, c, d). Table 1 defines the treatment facility abbreviations used in this report, Table 2 presents the types and number of wells at the site, Table 3 summarizes treatment facility discharge sampling locations, Table 4 summarizes extraction well performance during 2010, and Table 5 includes a list and rationale for new wells installed in 2010. Acronyms and abbreviations used in this report are defined in Section 6 of this report.

In April 2010, the Remedial Project Managers (RPMs) for the Livermore Site signed a revised Consensus Statement for Environmental Restoration of the Lawrence Livermore National Laboratory Site (McKereghan and Wong, 2010). Table 5 of the Remedial Action Implementation Plan was amended to include 12 new Federal Facility Agreement (FFA) milestones. All 2010 FFA milestones were met early or on schedule.

Details of 2010 treatment facility operations are described further in Section 4.1 of this report.

2. Regulatory Compliance

In 2010, the U.S. Department of Energy (DOE)/LLNL submitted all regulatory documents on schedule. These documents included:

- GWP 2009 Annual Report (Buscheck et al., 2010);
- GWP quarterly self-monitoring reports (Yow and Wong, 2010, 2010a, 2010b, and 2011);
- *Draft Focused Feasibility Study of Methods to Minimize Mixed Hazardous and Low Level Radioactive Waste from Soil Vapor and Ground Water Treatment Facilities at the Lawrence Livermore National Laboratory Site* (Bourne et. al., 2010)**;**

Livermore Site environmental community relations activities in 2010 included:

- Maintaining the Environmental Community Relations website <https://www-envirinfo.llnl.gov/> consisting of project documents and reports, public notices, and other environment-related information**;**
- Supporting Environmental Information Repositories and the Administrative Record**;**
- Disseminating environment-related news releases and internal/external newsletter articles and responding to journalists' inquiries regarding environmental cleanup; and
- Conducting tours of site environmental activities upon request.

General community questions and requests for information were addressed via electronic mail, posted mail or telephone with the assistance of LLNL's Public Affairs Office. In addition, DOE/LLNL met with members of Tri-Valley Communities Against a Radioactive Environment (Tri-Valley CAREs) and their scientific advisor on February 16, July 26, and November 18, 2010, as part of the activities funded by a U.S. Environmental Protection Agency (EPA) Technical Assistance Grant (TAG). In addition, a neighborhood meeting was held on October 7, 2010 and information regarding the planned extension of the TFA Arroyo Seco Pipeline was presented to regulatory agencies, members of Tri-Valley CAREs, community stakeholder groups, and the general public (Figure 1b).

A Consensus Statement for Environmental Restoration of the Lawrence Livermore National Laboratory Site was signed by the RPMs in March 2010 and Table 5 of the Remedial Action Implementation Plan was amended to include 15 new FFA milestones (McKereghan and Wong, 2010). All of these milestones were met early or on schedule.

Five treatment facilities remained off-line, including TFA West, which was shutdown per EPA direction in January 2008 following the conclusion of a one year treatability study (Noyes et al., 2009). The other four facilities were discussed in a Focused Feasibility Study (FFS) document. The Draft FFS for Treatment Facilities TF5475-1, TF5475-3, VTF5475, and TF518 North was submitted to the regulatory agencies on September 13, 2010 (Bourne et. al., 2010). At the request of the EPA, restart of the these facilities through selection and implementation of the proposed alternatives has been put on hold pending the results of ESAR treatability tests being implemented at the Livermore Site and a regional tritium sampling event and hydraulic test to be conducted in early 2011.

3. Field Activities

This section summarizes 2010 ground water monitoring, ESAR treatability tests, and drilling activities, as well as investigations in the Building 212 and Building 419 areas.

3.1. Ground Water Monitoring

During 2010 ground water monitoring activities complied fully with the LLNL Standard Operating Procedures (Goodrich and Lorega, 2009). During 2010, ground water levels were measured quarterly as described below.

3.1.1. Ground Water Level Measurements

In 2010, ground water levels were measured quarterly within a four-week period. These data are complemented by continuous ground water level measurements collected from extraction wells. In 2010, a total of 2,265 ground water levels were manually measured in 591 wells. These data were primarily used to generate the hydraulic capture maps for each extraction well (Figures 3 through 15).

As part of the ERD remediation evaluation (REVAL) process, ground water level measurements were coordinated with treatment facility operations and extraction well hydraulic tests to collect data representative of subsurface conditions, and to define the hydraulic influence of each extraction well.

3.1.2. Ground Water Sampling

As in previous years, LLNL ERD and the LLNL Environmental Functional Area personnel (formerly the Permits and Regulatory Affairs Division) evaluated data quality objectives, analytical results, historical trends, the Cost Effective Sampling (CES) algorithm, and hydraulic data to determine the sampling frequency, chemical analyses, and methods for collecting ground water samples. The samples were analyzed for VOCs, fuel hydrocarbons, polychlorinated biphenyls (PCBs), metals, radionuclides, or combinations thereof depending upon the location.

During 2010, the GWP conducted 653 well sampling events. The samplers were unable to complete 46 (7.0%) sampling events due to various circumstances, e.g., dry wells, inoperable pumps, etc. The methods and numbers of samples collected were:

- Specific-Depth Grab Sampling (SDGS) using the Voss EasyPump: 353 events (54%).
- Three-volume purge using a dedicated electric submersible pump: 71 events (10.9%).
- Low-volume purge: 54 events (8.3%).
- Other methods (bailer, portable electronic submersible pump, etc.): 129 events (19.7%).

Ongoing and significant cost reduction was achieved again in 2010 through the use of SDGS and low-volume purge methods. SDGS is the preferred method for collecting ground water samples, especially at wells where the purge water might contain both VOCs and tritium. The benefits of these methods include:

- Eliminating the need to replace dedicated pumps and related sampling equipment;
- Increasing technician efficiency and reducing sampling time;
- Increasing personnel safety through the use of low voltage equipment; and
- Eliminating collection, treatment, and disposal of more than 50,000 gallons of purge water, including water that would be considered mixed waste due to the presence of both VOCs and tritium.

3.2. Enhanced Source Area Remediation Activities

In 2010, since most Livermore treatment facilities were fully operational, ERD reprioritized a significant portion of its resources to focus on ESAR-related work. ESAR treatability tests were conducted at the TFD Helipad and TFE Hotspot source areas, and preliminary work to prepare for a planned 2011 treatability test was conducted at the TFE Eastern Landing Mat Source Area (Figure 1b). These treatability tests are summarized below.

3.2.1. Source Area Cleanup Technology Evaluation

In 2007, a data evaluation and numerical modeling methodology called the Source Area Cleanup Technology Evaluation (SACTE) analysis was developed by ERD to evaluate potential technologies to accelerate source area cleanup (McNab et al., 2007). ERD resumed this evaluation in 2010 to assist the ESAR field activities discussed below.

3.2.2. TFD Helipad Source Area

In 2010, VTFD Helipad soil vapor and TFD Helipad ground water treatment facilities operated continually while the *in situ* bioremediation (ISB01) facility was under construction. In November 2010, these operating facilities were shut down and an ESAR treatability test was initiated in this source area (Figure 1b). The treatability test is designed to assess the feasibility of *in situ* bioremediation at LLNL, and define optimal design parameters to apply the technology at other LLNL source areas.

The ISB01 facility includes four extraction wells, W-1650, W-1653, W-1655, and W-1657, and one central injection well, W-1552 (Figures 1 and 2e). The extraction and injection well pattern is designed to create a circulation cell that is vertically contained within the HSU-3A/3B hydrostratigraphic unit (HSU) and horizontally contained within the TFD Helipad Source Area. Currently, ground water is being recirculated to establish hydraulic control in the subsurface. In 2011, a dye-tracer injection test will be conducted to define the extent of the area under remediation and to determine travel times between wells. Following this test, a carbon source (sodium lactate) will be injected to stimulate subsurface bioactivity. This is expected to create anaerobic subsurface conditions favorable to the introduction of a dechlorinating microorganism (KB-1). Once the dechlorinating microorganism is introduced, the system will be continually operated until VOC levels are reduced below regulatory limits.

3.2.3. TFE Eastern Landing Mat Source Area

In 2010, VTFE Eastern Landing Mat soil vapor and TFE East ground water treatment facilities operated while source area wells W-1903, W-1909, and W-2305 were being modified for ESAR activities. The TFE Eastern Landing Mat treatability test will evaluate thermally enhanced remediation in the saturated and unsaturated zones by injecting heated air and by heating ground water in some wells, while extracting both soil vapor and ground water in others. In late 2010, the facility was modified to accommodate the extraction, injection, and heating capabilities in the aforementioned three wells (Figure 1b). An injection blower was installed, and the wellheads and the control system for these facilities were modified. Testing and verification of the modified facilities was initiated in 2010 and the treatability test is expected to begin in 2011.

3.2.4. TFE Hotspot Source Area

In October 2010, an ESAR treatability test was conducted at the TFE-Hotspot source area (Figures 1b and 2f) to assess whether pneumatic fracturing could enhance the permeability of low-permeability, silt- and clay-rich source area sediments. Pneumatic fracturing involves the application of high-pressure gas to the subsurface to initiate fracturing in targeted areas. Doing so would accelerate transfer of contaminant mass from the source area by improving the yield of soil vapor and ground water extraction. The treatability test included pneumatically fracturing the vadose and saturated zone in six boreholes at 3-foot intervals between 75 and 105 feet below ground surface (ft bgs) and emplacing an inert sand proppant in the propagated fractures. In addition, two tracer dyes were injected into one fracture borehole in conjunction with the proppant to visually enhance fracture documentation in the field.

ARS Technologies (ARS) of Berkeley, California conducted the pneumatic fracturing. During the pneumatic fracturing activities, ARS deployed six digital bi-axial tiltmeters to record ground movement near each of the injection boreholes during each fracture event. ARS uses these data to plot contour maps of ground displacement at individual intervals. Surface heave rods were also used to visually observe ground surface rise and fall within the fracture zone.

Following pneumatic fracturing, ARS completed two of the six fracture boreholes as 2-inch inside diameter (ID) poly vinyl chloride (PVC) dual extraction wells. The other four fracture boreholes were enlarged to a minimum 9-inch diameter to install 4-inch ID PVC dual extraction wells. All six wells identified as W-2618, W-2619, W-2620A, W-2621, W-2622, and W-2623 (Figure 2f) were screened across the fracture interval (75 to 105 ft bgs).

In addition, six confirmation borings, continuously cored from approximately 72 to 107-ft bgs, were drilled to evaluate the extent, nature, and frequency of propagated fractures. The cores were visually examined, described, and photographed to characterize fracture distribution based on the presence of sand proppant and tracer dyes. In addition, composite samples from all six cores were collected in one-foot intervals between approximately 72 ft bgs and 105 ft bgs and were submitted to the Ozark Underground Laboratory in Protem, Missouri, to analyze for the tracers Fluorescein and Rhodamine WT ™ .

Prior to the pneumatic fracturing, pneumatic testing was conducted in soil vapor extraction wells W-ETS-2008A, W-ETS-2008B, W-ETS-2009, W-ETS-2010A, W-ETS-2010B, and dual extraction well W-2105 (Figure 2d). Hydraulic testing was also conducted in dual extraction well W-2105, extraction well W-2012, and piezometer SIP-ETS-601, before fracturing. These tests will be repeated in 2011 and a comparison of the pre- and post-fracturing data will help quantify any changes in local hydraulic conductivity and storativity, in the hydraulic interconnectivity between wells, and in the improvement of the sediment permeability. W-2012 was damaged during pneumatic fracturing; this well will be sealed and replaced in 2011.

Post-fracturing mass removal rates for TFE Hotspot and VTFE Hotspot will be compared with those recorded prior to pneumatic fracturing to quantify any improvements in mass removal rates. A summary report documenting the results of the test will be prepared once all data from the treatability test has been collected and analyzed.

3.2.5. Trailer 5475 Source Area

No ESAR activities occurred in the Trailer 5475 source area during 2010. The field activities in this source area will resume pending the results of the FFS for TF5475-1, TF5475-2, VTF5475, and TF518 North.

3.3. Drilling Activities

During 2010, 20 new extraction and monitor wells were drilled and constructed at the Livermore Site (Figure 1a and Appendix A). Table 5 includes the well name and rationale for each new well.

Two direct-push cone penetration-testing (CPT) surveys were conducted during 2010 (Figure 1b). The strategy employed in these surveys was to use CPT data to identify zones where samples of water or vapor could be collected, and then sample these zones with direct-push technology. In July and August, borings B-2650 through B-2669 were advanced in the VTF518 Perched Zone area to profile the area lithology and acquire soil vapor samples to help better delineate the VOC source in the area. Attempts were also made to sample perched water, but none was observed in sufficient quantity to sample. In September and October, a second direct-push survey was conducted in the vicinity of former Buildings 514 and 412, and existing Buildings 511, 411, and 419. The objective of the survey was to help identify and delineate the source of the tritium in ground water that has recently been detected in TF518 North and TFE Southwest extraction well influent, and to better delineate the VOC plumes in ground water in this area. The borings associated with this survey were named B-2670 through 2688.

During 2010, a total of 42 wells were sealed at the TF406 Gas Pad area (Appendix A, Figure 1a) using methods fully compliant with the Alameda County Zone 7 Water Agency guidelines. The wells were formerly used to implement or monitor clean up of the Gas Pad fuel hydrocarbon release in the late 1980s and early 1990s and became obsolete. Similarly, 48 obsolete wells were sealed at the TFA Vadose Observatory site, where the former LLNL Earth Sciences Division conducted infiltration studies in the late 1990s (Appendix A, Figure 1a). None of the sealed wells served any useful purpose and were potentially conduits for contamination to enter the subsurface.

3.4. Building 212

Former Building 212 was located in the south-central part of the Livermore Site (Figures 1b and 2g). The building was originally constructed as a drill hall for Naval Air Station Livermore in 1943 and later modified for physics experiments using laser accelerators. During decontamination and demolition of the superstructure in April 2008, free-phase mercury and low-level radiological contamination were discovered. The initial cleanup activities, which consisted of removing soil along the northeast side of the building slab (LLNL, 2009), indicated that contamination remained within the excavated trench below the "stopping points" set forth in the work plan (LLNL, 2008).

Additional work to define the lateral and vertical extent of the mercury was conducted in June 2010 (LLNL, 2010 and 2010a). Soil samples were analyzed onsite using an Ohio Lumex mercury analyzer (RA-915+) with a soil attachment (RP-91C). The investigation employed a phased, "step-out" approach to define the lateral and vertical extent of mercury in soil. The first phase consisted of discrete-depth soil sampling to a depth of 5 ft. If mercury concentrations were above the U.S. EPA Residential Screening Level (SL) of 5.6 milligrams per kilogram (mg/kg), a second phase consisting of adjacent vertical and horizontal "step-out" sampling was conducted to define the extent of mercury.

Soil samples were collected at 45 locations, including seven step-out locations (Figure 2g). No free mercury was encountered and the extent of mercury in soil in the Building 212 area was found to be limited to two areas. The first area, measuring approximately 45 ft x 10 ft, included the eastern 15 ft of the trench excavated in 2008 where free mercury was observed on the northeast side of the building slab. Mercury was detected at 14 and 26 mg/kg, but additional samples to the east confirmed that mercury above the SL does not extend further east than the corner of the building, and no farther than 10 ft north from the edge of the building foundation. The second mercury-impacted area, which is approximately 35 ft x 10 ft, is located west of the former trench and near a former staircase that led into Building 212. In this area, mercury was detected at 8.9 and 5.69 mg/kg at the surface and 1.5 ft, respectively.

Based on the findings of this investigation, all mercury concentrations were below the EPA Industrial SL of 34 mg/kg. Accordingly, no further removal action is planned at this time. A report summarizing the findings of this investigation will be released in 2011.

3.5. Building 419

During September 2010, ERD conducted soil sampling as part of the Resource Conservation and Recovery Act (RCRA) closure plan for Building 419 (EPD, 2009) (Figure 1b). The sampling occurred prior to decontamination and demolition of the Building 419 superstructure in

November and December 2010. The building was constructed during World War II and was used for a variety of industrial purposes, including the treatment of waste containing hazardous and radioactive materials.

The objective of the 2010 drilling program was to investigate hazardous and radioactive waste that may have been released to the subsurface from the building, including leaks from piping and a tank system associated with the building. Twelve vertical boreholes adjacent to the building and six boreholes angled beneath the building were drilled and sampled as part of this initial phase of the investigation. Compounds of concern included mercury and other metals, VOCs, uranium, and tritium. Results of this investigation are pending and will be documented as part of Building 419 RCRA closure report. A second phase of soil sampling, consisting of drilling 28 vertical boreholes through the building slab, will be scheduled when funding for the project becomes available.

4. Summary of Remedial Action Program

This section summarizes the 2010 CERCLA remedial action program activities at the Livermore Site. In 2010, DOE/LLNL maintained 29 ground water treatment facilities in the TFA, TFB, TFC, TFD, TFE, TFG, and TFH areas (Figure 1a and Table 1). The ground water extraction and dual extraction wells produced approximately 278 million gallons of ground water, and the treatment facilities removed an estimated 54.4 kg of VOCs (Table Summ-1, Figure 3, and Table 5). In 2009, the ground water treatment facilities removed approximately 46.3 kg of VOCs. The higher mass removed in 2010 is attributable to the larger number of facilities and extraction wells that operated for longer periods of time as operations were restored after the 2008 budget shortfall. Since remediation began in 1989, nearly 4.1 billion gallons of ground water have been treated, resulting in the removal of an estimated 1,440 kg of VOCs (Table Summ-2 and Figure 3).

In 2010, DOE/LLNL also maintained nine soil vapor treatment facilities in the TFD, TFE, and TFH areas (Figure 1a and Table 1). The soil vapor extraction and dual extraction wells produced approximately 60 million cubic feet of soil vapor, and the treatment facilities removed approximately 44.5 kg of VOCs (Table Summ-1, Figure 3, and Table 5). In 2009, the soil vapor treatment facilities removed approximately 39.4 kg of VOCs. Similar to ground water extraction, the higher mass removed in 2010 through soil vapor extraction is attributable to the larger number of facilities and extraction wells that operated for longer periods of time as operations were restored from 2008 budget shortfall. Since startup, more than 432 million cubic feet of soil vapor has been extracted and treated, removing an estimated 1,436 kg of VOCs (Table Summ-2 and Figure 3) In total, an estimated 2,876 kg (more than 3 tons) of VOCs have been removed from the subsurface beneath the Livermore site and surrounding area since 1989.

Treatment facility performance is evaluated using multiple data sets. Figures 4, 6, 8, 10, 12, and 14 show the estimated hydraulic capture areas in HSUs 1B, 2, 3A, 3B, 4, and 5, respectively, based on ground water elevation data collected during the third quarter 2010. Figures 5, 7, 9, 11, 13, and 15 are isoconcentration maps showing total VOCs above MCLs in the same six HSUs during the third quarter 2010. The estimated hydraulic capture areas for third quarter 2010 have been superimposed on the isoconcentration contour maps to highlight where hydraulic containment of contaminant plumes was achieved during this time period. Contaminant concentration trends (Section 4.3) were also used to evaluate hydraulic capture and treatment facility performance.

4.1. Summary of Treatment Facility Operations

During 2010, 33 Livermore Site treatment facilities (25 ground water and eight vapor, Table 2) operated during most of 2010 and were shut down occasionally for routine maintenance. Two of the ground water treatment facilities, TFC and TFD West, underwent ERD's Remediation Evaluation (REVAL) process (Figure 1a). As a result of the cumulative effect of REVAL activities and increased operational uptime, treatment facility hours of operation improved by 22% over 2009, for the Livermore Site in 2010. Five treatment facilities (TFA West, TF5475-1, TF5475-3, VTF5475, and TF518 North) currently remain shut down due to regulatory concerns or mixed waste issues (McKereghan and Wong, 2009 & Bourne et. al., 2010). These remaining five facilities and their planned restart are described subsequently in this section.

4.1.1. Treatment Facility A Area

Two treatment facilities, TFA and TFA East (Figure 1a), operated in compliance with all permit requirements during 2010.

A third facility, TFA West, remained shut down during 2010 due to regulatory concerns pertaining to the use of the Livermore Water Reclamation Plan (LWRP) for treatment of very low concentrations of VOCs. A year-long treatability test was conducted from 2007 to 2008 to evaluate the effectiveness of ground water extraction and an alternative remedy for cleanup of the uncaptured portion of the HSU 2 plume in the vicinity of offsite well W-404 in the TFA West area (Figure 7). The findings from the treatability test were used as a basis for developing long-term cleanup alternatives for the TFA West area as described in *Treatability Summary and Proposed Cleanup Alternatives for the TFA West Area Report*, submitted to regulators on September 28, 2009 (Noyes et al., 2009). In this report, four treatment alternatives were evaluated for cleanup of VOCs in ground water in the vicinity of well W-404, including:

- A pipeline extension to connect well W-404 to the Arroyo Seco Pipeline (Alternative 1);
- Installation of a granular activated carbon (GAC) system near well W-404 (Alternative 2);
- Installation of a sulfur modified iron (SMI) treatment system near well W-404 (Alternative 3); and
- *In situ* destruction of VOCs by injection of a zero valent iron (ZVI) slurry in the well W-404 area (Alternative 4).

Alternative 1 is consistent with the selected remedy at TFA (U.S. DOE, 1992) and was approved by the regulatory agencies. An addendum to Remedial Design No. 1, which will include details of the pipeline extension to well W-404, will be submitted in 2011.

TFA operated during most of 2010 and was shut down only occasionally for routine maintenance. Notable activities at TFA included:

- In June and July, the facility was shut down periodically for electronic maintenance and the installation of a new cooling unit for the air stripper.

- From mid-October to mid-November, step-drawdown tests were performed on wells W-614 and W-903 to provide a basis for evaluation of long-term well performance and to improve analysis of extraction wellfield performance.
- In mid-November, flow rates in extraction wells (W-109, W-457, W-903 and W-904) along the Arroyo Seco pipeline were adjusted to evaluate the hydraulic influence of these wells on offsite well W-404, screened in HSU 2. The objective of the test was to determine whether hydraulic influence over the W-404 area could be increased through optimization of pumping rates at these extraction wells.
- In mid-December, south wellfield wells W-518 and W-522 were reactivated as part of the TFA REVAL deferred scope of work.

TFA East operated during most of 2010 and was shut down only occasionally for routine maintenance. Notable activities at TFA East included:

- In late June, the treatment facility was down for two days as one of the stacked Shurflow pumps in well W-254 failed and power was connected to the backup pump.
- From late August to mid-September and early November to early December, the facility was shut down due to a faulty flow meter.

4.1.2. Treatment Facility B Area

TFB (Figure 1a) operated in compliance with all permit requirements during 2010. This facility operated during most of 2010 and was shut down occasionally for routine maintenance. As part of the REVAL process, a detailed engineering assessment of this facility was conducted in late 2010 to aid in designing the pipeline extension to recently installed extraction wells W-2501 and W-2502. The two wells are scheduled to be connected to TFB and activated in 2011. The facility was shut down on November 30 and restarted December 14 due to a delay in receiving the ion exchange columns required for wet season operation.

4.1.3. Treatment Facility C Area

All three treatment facilities, TFC, TFC East, and TFC Southeast (Figure 1a), operated in compliance with all permit requirements during 2010.

At the beginning of 2010, TFC remained shut down to upgrade electronic and mechanical equipment under the REVAL process (Figure 1b). Notable activities at TFC included:

- From December 2009 to January 2010, an engineering assessment and associated facility repairs were completed. To improve performance analysis and future operations, several key enhancements were made to the treatment facility and associated extraction wellfield. The improvements included an upgrade to the electronic control system of the treatment facility and converting the power supply for well W-701 to 230 volts. This conversion allows ERD electronic engineering technicians to safely and efficiently conduct operation and maintenance procedures at the well.
- In late January, intermittent operations at the facility began under the REVAL testing and verification phase.
- In late March, continuous operation of the facility and its associated extraction wellfield began under the REVAL testing and verification phase.

- In mid-April, continuous operation of the facility and its associated extraction wellfield began under standard operating procedures.
- The facility was shut down on November 30 and restarted December 14, due to a delay in receiving the ion exchange columns required for wet season operations.
- As part of the TFC REVAL, the sequential step flow rate testing of each extraction well in the TFC wellfield (W-701, W-1015, W-1102, W-1103, W-1104, and W-1116) began in December and will continue into 2011. Analysis of these data provides a basis for evaluating long-term well performance and will be used to improve TFC extraction wellfield performance.

TFC East operated during most of 2010 and was shut down occasionally for routine maintenance. Notable activities at TFC East included:

- The facility was periodically shut down to condition the ion exchange columns necessary for operations of TFC East.
- In mid-May, a new Belsperse (anti-scalant) injection system was installed and placed in service.

TFC Southeast operated during most of 2010 and was shut down only occasionally for routine maintenance and for installation of ion exchange columns necessary for wet season operations.

4.1.4. Treatment Facility D Area

All ten treatment facilities, TFD, TFD East, TFD Helipad, TFD South, TFD Southeast, TFD Southshore, TFD West, VTFD East Traffic Circle (ETC) South, VTFD Helipad, and VTFD Hotspot (Figure 1a), operated in compliance with all permit requirements during 2010.

TFD operated during most of 2010. From late February to late April and late October to mid-November, the facility was shut down to perform maintenance on the air stripper tanks and air stripper blower. In addition, the following modifications were made to the system to allow for some of the treated ground water from TFD to be used for onsite landscaping irrigation.

TFD East operated during most of 2010 and was shut down occasionally for routine maintenance. This facility is scheduled to go through the REVAL process in 2011. In 2010, notable activities at TFD East included well W-2203 (in late May) and well W-1303 (in early October) were reactivated following electrical and mechanical upgrades.

TFD Helipad operated during most of 2010 and was shut down occasionally for routine maintenance and to support the TFD Helipad ESAR *in situ* bioremediation treatability test.

TFD South operated during most of 2010 and was shut down occasionally for routine maintenance. As a precautionary measure during drilling of TFD South extraction well W-2601 as described in Section 3.3, the facility was shut down from mid-January to early-February.

TFD Southeast operated during most of 2010 and was shut down occasionally for routine maintenance. A step drawdown test was performed on well W-314 from mid-January to mid-February to provide a basis for evaluating long-term well performance.

TFD Southshore operated during most of 2010 and was shut down occasionally for routine maintenance. Following mechanical upgrades to well W-1603, a step drawdown test was performed on well W-1603 to provide a basis for evaluating long-term well performance. The facility was shut down September 21 after a coupling on the facility's treated water discharge pipe failed. Up to 18,000 gallons of treated water were released to the ground surface. The appropriate repairs were made and the facility was restarted on September 22.

At the beginning of 2010, TFD West remained shut down due to recurring air stripper high water level alarms and for the REVAL process. Notable activities at TFD West included:

- In early February, an engineering assessment and associated facility repairs were completed.
- In late February, intermittent operations at the facility began under the REVAL testing and verification phase.
- From late April to mid-May, extraction well step drawdown tests were performed on wells W-1215, W-1216, and W-1902.

VTFD ETC South operated during most of 2010 and was shut down occasionally for routine maintenance.

VTFD Helipad operated during most of 2010 and was shut down occasionally for routine maintenance and to support the TFD Helipad ESAR *in situ* bioremediation treatability test. On November 24, the facility was shut down to protect the facility blower from damage due to low winter temperatures. The facility was subsequently prepared for long-term storage during the TFD Helipad ESAR *in situ* bioremediation treatability test.

VTFD Hotspot was shut down during most of 2010 due to down-hole ground water pump control issues that occur while operating under an applied vacuum. Consequently, no soil vapor was extracted during this time frame. However, ground water from TFD Hotspot well W-2101 was extracted and treated at TFD, during most of 2010.

During REVAL of TFD West (Figure 1b), step flow rate testing was performed on wells W-1215, W-1216, and W-1902. These test data will provide a basis for evaluating long-term well performance and will be used to improve TFD West extraction wellfield performance. Furthermore, to improve performance analysis and future operations, treatment facility mechanical and electronic upgrades were performed under REVAL to increase data accuracy and reliability.

4.1.5. Treatment Facility E Area

All eight treatment facilities, TFE East, TFE Hotspot, TFE Northwest, TFE Southeast, TFE Southwest, TFE West, VTFE Eastern Landing Mat, and VTFE Hotspot (Figure 1a), operated in compliance with all permit requirements during 2010.

TFE East operated during most of 2010 and was shut down occasionally for routine maintenance and to support the TFE Eastern Landing Mat ESAR field treatability test. Notable activities at TFE East included:

- From early February to early March, the facility was shut down as a precautionary measure during drilling of TFE East extraction well W-2602, as described in Section 3.3.
- From mid-July to mid-November, the facility was shut down intermittently for electronic and mechanical upgrades to support the TFE Eastern Landing Mat ESAR field treatability test.

At the start of 2010, TFE Hotspot was shut down due to pump control problems that arose on December 22, 2009. ERD used this opportunity to perform mechanical and electronic upgrades to aide in the collection of baseline performance data prior to the TFE Hotspot ESAR treatability test. In July 2010, TFE Hotspot was brought online and pre-treatability test performance data was successfully collected. In early October, the facility was shut down and all down-hole equipment in the extraction wells was removed to support the TFE Hotspot ESAR pneumatic fracturing treatability test.

TFE Northwest operated during most of 2010 and was shut down occasionally for routine maintenance. A step-drawdown test was performed on well W-1409 in late June, which will provide a basis for evaluating long-term well performance.

TFE Southeast, TFE Southwest, and TFE West operated during most of 2010 and were shut down occasionally for routine maintenance. Extraction wells W-1520 and W-1522 at TFE Southwest did not operate during 2010 due to the presence of increased tritium activities (up to 11,700 pCi/L, April 2010) in ground water from the two wells. W-1520 and W-1522 will be restarted once a solution to mixed waste management issues has been finalized and implemented.

VTFE Eastern Landing Mat operated during most of 2010 and was shut down occasionally for routine maintenance and to support the TFE Eastern Landing Mat ESAR field treatability test. In mid-July, the facility was shut down for instrumentation and piping modifications to support the TFE Eastern Landing Mat ESAR field treatability test.

VTFE Hotspot operated during most of 2010 and was shut down occasionally for routine maintenance and to support the TFE Hotspot ESAR field treatability test. Notable activities at VTFE Hotspot included:

- In late June, the facility was shut down due to a catastrophic failure of the Nash Elmo blower, which was replaced with a McKenna unit.
- Following the blower replacement in mid July, the facility was operated to collect baseline operational performance data prior to the TFE Hotspot ESAR field treatability test.
- In early October, the facility was shut down to support the TFE Hotspot ESAR pneumatic fracturing treatability test.

4.1.6. Treatment Facility G Area

Two treatment facilities, TFG-1 and TFG North (Figure 1a), operated in compliance with all permit requirements during 2010. Both facilities operated during most of 2010 and were shut down occasionally for routine maintenance.

4.1.7. Treatment Facility H Area

Treatment facilities in the TFH area in the southeast corner of the Livermore Site include those near Buildings 406 and 518, and near Trailer 5475 (Figure 1a). Treatment facility operations in the TFH area are discussed below.

4.1.7.1. Treatment Facilities Near Building 406

Three treatment facilities, TF406, TF406 Northwest, and VTF406 Hotspot (Figure 1a), operated in compliance with all permit requirements during 2010.

TF406, TF406 Northwest, and VTF406 Hotspot, operated during most of 2010 and were shut down occasionally for routine maintenance. As a precautionary measure during well abandonment activities in the former TF406 Gas Pad area, TF406 was shut down occasionally from mid-January to late February. Extraction well GSW-445 was damaged during efforts to remove a dislodged pump and the well was subsequently abandoned (Section 3.3).

4.1.7.2. Treatment Facilities Near Building 518

Three of four treatment facilities near Building 518, TF518 Perched Zone (PZ), VTF518-PZ, and VTF511 (Figure 1a), operated in compliance with all permit requirements during all 2010. The fourth facility, TF518 North, remained offline during 2010 pending resolution of mixed waste management issues.

TF518 North was designed to treat VOC-contaminated ground water from HSU 4 using granular activated carbon (GAC). Tritium was not observed in this area when the facility was designed and became operational in January 2000. However, in January 2007, tritium was detected in a treatment system effluent sample and as a result, the spent GAC required management as a mixed waste.

TF518 North has been shut down since February 20, 2008. In April 2009, a report titled *Resolution of Mixed Waste Management Issues Associated with Operation of Soil Vapor and Ground Water Treatment Facilities at LLNL, Livermore Site* (LLNL, 2009a) was issued which included discussion of the history and possible resolution of mixed waste issues at TF518 North and three other facilities. In September 2009, a letter titled *LLNL Livermore Consensus Statement Schedule* (McKereghan and Wong, 2010) was issued, which proposed September 13, 2010 as the draft submittal date for a FFS. A draft of the FFS was submitted to regulators in 2010.

TF518-PZ and VTF518-PZ operated during most of 2010 and were shut down occasionally for routine maintenance. From late July to early August, both treatment facilities were shut down as a precautionary measure during a CPT survey in the Building 518 perched zone source area.

At the start of 2010, VTF511 remained shut down due to performance issues with the liquid-ring blower. The blower was replaced and testing of the replacement blower began in late January. Testing and verification activities were conducted from January to June and continuous operation of the facility and its associated extraction wellfield began under standard operating procedures in late June.

4.1.7.3. Treatment Facilities Near Trailer 5475

Treatment facilities TF5475-1, TF5475-3, and VTF5475 remained offline during 2010 pending resolution of mixed waste management issues. These facilities have been impacted by tritiated ground water for the same reasons described above for TF518 North.

TF5475-2 operated during most of 2010 and was shut down occasionally for routine maintenance. Notable activities at TF5475-2 include:

- From mid-March to early May, and from mid-May to late June, the facility was shut down due to electrical power upgrades and construction activities in the area that restricted access to the treatment facility.
- In early November, the facility was shut down due to a clogged storm drain at the facility discharge point and did not operate for the remainder of the calendar year.

4.2. Ground Water Discharges

In 2010, LLNL discharged approximately 276 million gallons (Mgal) of treated ground water to the ground surface. Approximately 144 Mgal were discharged to Arroyo Las Positas, 77 Mgal to the West Perimeter Drainage Channel, and 55 Mgal to Arroyo Seco. In addition, approximately 0.003 Mgal of filtered ground water from extraction well W-404 were discharged to the Livermore Water Reclamation Plant during sampling events and 0.15 Mgal of ground water treated at TFD were used for onsite irrigation.

4.3. Remediation Performance Evaluation

In 2010, VOC concentrations decreased or remained unchanged in most Livermore Site ground water plumes. The declines in VOC concentrations discussed below are primarily attributable to active remediation at Livermore Site treatment facilities during the calendar year (Section 4.1). The changes described below are consistent with the longer-term trends described in the 2007 Third Five-Year Review for the LLNL Livermore Site (Berg et al., 2007) that show steady mass removal and cleanup in both offsite and onsite areas.

With the hiatus in pumping that occurred in 2008 and 2009 at many idled facilities, monitoring for possible contaminant plume migration downgradient of these facilities was once again a primary focus of the 2010 remediation performance evaluation. Similar to 2009, no significant westward migration of contaminants was observed during 2010.

Ground water elevation contour maps for each HSU showing estimated capture areas for the third quarter 2010 are presented on Figures 4, 6, 8, 10, 12, and 14. Notable VOC concentration trends and results from the third quarter 2009 through the third quarter 2010 are discussed below and presented on isoconcentration contour maps showing VOCs above MCLs by HSU (Figures 5, 7, 9, 11, 13, and 15). Treatment facilities are shown on Figure 1a. Where available and relevant, concentration data more recent than third quarter 2010 are discussed in the text below.

4.3.1. Hydrostratigraphic Unit 1B

VOC concentrations in HSU 1B declined slightly or remained unchanged along the western margin of the Livermore Site during 2010. TFA monitor well W-1425 (Figure 5) is the only remaining offsite HSU 1B well with VOC concentrations above applicable MCLs (>5 ppb for PCE). PCE concentrations in well W-1425 declined slightly from about 10 parts per billion (ppb) to 8 ppb (August 2009 to October 2010) in response to continued ground water extraction along the TFA Arroyo Seco Pipeline. Again this year, PCE concentrations remained below MCLs at all wells immediately east of Vasco Road (Figure 1a). The highest HSU 1B concentrations in the TFA area remain within its source area, where concentrations at W-1217 showed a slight decrease, from 160 ppb (June 2009) to 140 ppb (November 2010). Elsewhere at TFA, VOC concentrations remained relatively unchanged during 2010.

At TFB, which operated throughout 2010, TCE concentrations continued to decrease in response to pumping. TCE declined in:

- Monitor well W-218, from 25 ppb (September 2009) to 8 ppb (July 2010);
- Monitor well W-419, from 19 ppb (April 2009) to 7 ppb (October 2010); and

- Source area piezometer SIP-141-202, from 54 ppb (March 2009) to 35 ppb (January 2010).

At TFC, which did not operate from December 2009 through March 2010 while facility upgrades were being completed, TCE concentrations in the western part of the TFC area remained relatively unchanged, but increased somewhat in the eastern part. At monitor well W-702, TCE increased from 6 ppb (July 2009) to 23 ppb (November 2010). TCE also increased at SIP-191-002 from 37 ppb (July 2009) to 46 ppb (August 2010). VOC concentrations at these locations are expected to begin declining again now that continuous operations have resumed at TFC. TFC remained operational in 2008 and 2009, and was not shutdown as a result of the 2008 budget shortfall.

At TFC East and TFC Southeast, TCE remained essentially unchanged, and no evidence of westward migration of contaminant plumes was observed. At the TFC Hotspot source area, TCE remained elevated at 320 ppb in monitor well W-1212 (August 2010). A REVAL treatability test involving pneumatic fracturing emplacement of zero valent iron (ZVI) is scheduled for implementation at the TFC Hotspot, in 2011.

As shown on Figures 4 and 5, the HSU 1B contaminant plumes along the western LLNL margin were under full hydraulic containment in the TFA, TFB, TFC and TFC Southeast areas during the third quarter 2010. To the east, contaminant plumes were also hydraulically contained at TFC East, TFG-1, and TFG North.

4.3.2. Hydrostratigraphic Unit 2

VOC concentrations in HSU 2 declined slightly or remained unchanged in most areas along the western LLNL margin during 2010 (Figure 7). At TFA, a net decrease in VOC concentrations was noted in offsite wells, and no westward migration of the PCE plume was observed. PCE concentrations in monitor well W-654 declined from 12 ppb (April 2009) to 8 ppb (May 2010), while concentrations at nearby monitor well W-1424 increased from 11 ppb (April 2009) to 17 ppb (April 2010). PCE in non-operating TFA West extraction well W-404 remained unchanged at 10 ppb. At nearby monitor well W-120, PCE essentially remained unchanged April 2009 to July 2010. East of Vasco Road, PCE in monitor well W-118 decreased from 19 ppb (April 2009) to 5 ppb (April 2010). Throughout the TFA area, VOC concentrations are expected to continue their long-term decline in 2011 in response to continued ground water extraction and treatment operations.

In the TFB area, no significant concentration trends were observed in 2010. TCE in wells W-422 and W-1420 along Vasco Road was monitored closely again throughout 2010. Monthly samples indicate that TCE remained stable at both wells during 2010 (averaging about 12 ppb in monitor well W-422 and 5 ppb in monitor well W-1420). To ensure comprehensive cleanup along the western LLNL Site margin, two new HSU 2 extraction wells, W-2501 and W-2502, are scheduled be connected to TFB and activated in 2011. W-2502, which was completed with multiple screens within HSU 2, should also help equilibrate subsurface pressure changes and stabilize TFB operations during pumping of the HSU 2 remedial wellfield.

In the eastern portion of the site, few changes in HSU 2 concentrations were observed during the year, with the following exceptions. The areal extent of the distal TCE plume emanating from the TFE-ELM source area continued to shrink in response to pumping at TFE-W and TFG-N. TCE concentrations fell in:

- SIP-331-001 from 13 ppb (July 2009) to 7 ppb (June 2010);

- Extraction well W-1409 from 30 ppb (April 2008) to 21 ppb (October 2010); and
- Extraction well W-305 from 48 ppb (July 2009) to 36 (October 2010).

In the TFE-ELM source area, HSU 2 TCE concentrations also continued to decline in response to active pumping. At extraction well W-2305, TCE declined from 1700 ppb (June 2009) to 270 ppb (October 2010), and at extraction well W-1909 from 590 ppb (April 2009) to 360 ppb (September 2010). An ESAR treatability test of subsurface thermal heating is planned for 2011 at TFE-ELM.

In the TFE Hotspot area (Figure 1a), soil vapor extraction (SVE) and ground water extraction treatment facilities were idled for a portion of the year to allow for facility upgrades. Increases in TCE concentrations in this area were observed during the year. TCE increased from 210 ppb (September 2009) to 310 ppb (November 2010) in piezometer SIP-ETS-601, and from 210 ppb (June 2009) to 390 ppb (October 2010) in extraction well W-2105. The fluctuations in concentrations are interpreted to be within the normal range of variability observed annually. In an effort to increase the sustainable yield of extraction wells screened in low-permeability sediments, and to improve access to contaminants trapped in fine-grained source area sediments, an ESAR treatability test involving pneumatic fracturing was conducted at this location during October and November 2010 (Section 3.2.4). If successful, the beginning of an accelerated concentration decline may be observed once treatment facility operations resume in 2011.

In the TFD-SE area, TCE concentrations declined in extraction well W-1404 from 310 ppb (July 2009) to 49 ppb (April 2010) and in extraction well W-1308 from 230 ppb (June 2009) to 130 ppb (October 2010). The apparent concentration decrease is interpreted to be the combined result of ground water extraction and dewatering of HSU 2 in this area.

As shown on Figure 7, the contaminant plumes in the TFA and TFB areas were entirely within the estimated capture areas except at wells W-404 and W-422. Both chemical and hydraulic data suggest that the well W-404 PCE plume continues to be within the stagnation zone of TFA Arroyo Seco pipeline extraction well W-109 (Noyes et al., 2009). The well W-422 area should be completely hydraulically contained once pumping begins at new TFB extraction wells W-2501 and W-2502.

4.3.3. Hydrostratigraphic Unit 3A

During 2010, very little change was observed in the size and location of the contaminant plumes in HSU 3A (Figure 9). However, some changes in VOC concentrations within these plumes were noted. In the TFD-SE area, a consistent decrease in VOC concentrations was observed. TCE declined in:

- Monitor well W-1804-2, from 220 ppb August 2009) to 94 ppb (August 2010);
- Extraction well W-1301, from 440 ppb (July 2009) to 190 ppb (July 2010); and
- Extraction well W-2005, from 220 ppb (July 2009) to 31 ppb (July 2010).

The decrease in TCE concentrations is interpreted to be the combined result of ground water extraction at TFD-E and TFD-SE as well as de-watering of HSU 3A in the TFD-SE area.

A decrease in VOC concentrations was also observed in the area south of Trailer 5475. TCE declined at SIP-ETS 302 (660 ppb in April 2009, to 130 ppb in June 2010), monitor well W-363 (420 ppb in September 2009, to 90 ppb in July 2010), and at monitor well W-206 (490 ppb in July 2009, to 370 ppb in July 2010). These declines are likely attributable to ground water extraction at TFE Hotspot HSU 3A extraction well W-2012. Well W-2012 was damaged during the ESAR pneumatic fracturing treatability test conducted there in 2010 (Section 3.2.4) and is scheduled to be sealed and replaced in 2011.

To the west in the TFA area, carbon tetracholoride along the western site boundary remained unchanged and above its 0.5 ppb MCL (3 ppb in well W-712 throughout the year), and PCE remained slightly above its 5 ppb MCL in monitor well W-310 in TFB (6 ppb in October 2010). A pumping test conducted in 2010 suggests that the leading edge of a very low-concentration PCE plume may now be present in the TFB area. The source of this contaminant plume has not yet been identified, but may be located somewhere to the east.

Figures 8 and 9 show the estimated hydraulic capture areas in HSU 3A during the third quarter 2010. The hydraulic capture areas expanded significantly in the TFD area once hydraulic containment was fully restored in the TFD and TFD Southshore areas in early 2010. An area containing TCE above its MCL in western TFE and eastern TFG remains outside of the hydraulic capture area. Constructed in 2010, monitor well W-2603, installed downgradient of the plume, will be used to monitor any westward movement of the plume, and to determine whether additional treatment will be needed in this area.

4.3.4. Hydrostratigraphic Unit 3B

As with HSU 3A, the size and geometry of the HSU 3B VOC plumes (Figure 11) remained relatively unchanged during 2010. However, concentrations within the plumes did decline in two areas during the year. In the TFD South area, TCE concentrations declined in:

- Monitor well W-1511 from 260 ppb (July 2009) to 210 ppb (August 2010);
- Monitor well W-364 from 85 ppb (July 2009) to 55 (July 2010); and
- Monitor well W-1422 from 52 ppb (July 2009) to 28 ppb (May 2010).

These decreases are attributed to continued ground water extraction and treatment associated with TFD-SS. In the southeastern corner of LLNL, TCE concentrations fell from 100 ppb (July 2009) to 65 ppb (July 2010) in extraction well W-1522, and is thought to be the result of northward migration of the plume towards ground water extraction wells associated with treatment facilities TFD-SS and TFE-W. Pumping at TFE-SW extraction well W-1522 was discontinued in October 2009 due to the presence of elevated tritium activities (2,580 pCi/L measured in October 2009). The well will be restarted once a resolution to the mixed-waste issue has been identified.

As shown on Figures 10 and 11, large portions of the HSU 3B plumes in the TFD, TFE and TFH areas were under hydraulic control in the third quarter 2010. During 2010, the hydraulic containment associated with the TFD and TFD East treatment facilities was fully re-established. The pumping-induced ground water depression associated with active remediation at TFE-W, TFD-S and TFD-SS (Figures 10 and 11) provided additional hydraulic containment over large areas of TFE, TFH, and TFD.

As shown on Figures 11 and 12, an area of the contaminant plume to the west of TFD-SS may remain outside of the interpreted hydraulic capture areas. The concentrations in this area are inferred from older soil data, and are considered to be in an area where ground water gradients have been flattened due to pumping, thereby slowing any potential movement of the plume. The area will continue to be monitored for indications of plume migration to the west.

4.3.5 Hydrostratigraphic Unit 4

Although the position and size of the HSU 4 VOC plumes (Figure 13) was essentially unchanged from 2009, several notable concentration trends were observed during 2010. In extraction well W-1503, located at TFD South, the source area VOC concentration rebound associated with the hiatus in pumping that occurred during 2008 and 2009 (Buscheck et. al., 2010) has now disappeared. TCE in ground water extraction well W-1503, which operated throughout the year, declined from 200 ppb (July 2009) to 75 ppb (July 2010). The latter is similar to concentrations observed prior to the shutdown (e.g., 80 ppb in April 2008).

In the TFD Helipad and TFD-E areas, TFE concentrations increased somewhat in the HSU 4 source area. TCE in monitor well W-1250 increased from 1,700 ppb (August 2009) to 2,000 ppb (August 2010). At monitor well W-1251, TCE increased from 50 ppb (July 2009) to 180 ppb (September 2010). These increases are considered to be within the normal range of concentration fluctuations observed annually.

In the TFE-SW area, TCE increased in non-operating extraction well W-1520 from 60 ppb (July 2009) to 290 ppb (July 2010). This increase may be associated with northward migration of contaminants toward pumping wells at TFE-NW and TFD-S. W-1520 was turned off in February 2009 due to the presence of tritium (2,930 pCi/L in July 2009). Along with extraction well W-1522, well W-1520 will remain off until the mixed-waste issue has been resolved. An investigation to determine the source of the tritium in TF518 North and TFE Southwest influent is in progress.

Figures 12 and 13 show the estimated hydraulic capture areas in HSU 4 during the third quarter 2010. The area under hydraulic containment in HSU 4 has expanded compared to 2009, in the eastern part of the site due to the resumption of pumping at extraction well W-314, in 2010. The pumping-induced ground water depression associated with ground water extraction at TFE-NW, TFD-S and TFD-SS expanded areally during 2010 as HSU 4 became progressively more dewatered due to over drafting. The ground water depression provided additional hydraulic containment in large areas of TFD, TFE, and TFH during 2010.

4.3.6 Hydrostratigraphic Unit 5

The general configuration and location of HSU 5 contaminant plumes in 2010 (Figure 15) remained essentially unchanged from 2009. There were two notable changes in concentrations, however. To the south at TF406, TCE concentrations at the leading edge of the plume emanating from a source to the east declined to its 5 ppb MCL for the first time at W-1519. This is interpreted to be a result of optimized ground water extraction operations at treatment facility TF406 (TF406 underwent the REVAL process in 2008).

At TFD-S, a new HSU 5 ground water extraction well W-2601 was drilled and installed in early 2010. Besides being capable of a significant sustainable yield (over 40 gpm), TCE concentrations were discovered to be on the order of 160 ppb (May 2010). The elevated concentrations indicate that an as-yet unidentified HSU 5 source area is present to the east. Once connected to TFD-S, well W-2601 should provide effective hydraulic containment and treatment for the TCE plume in this area.

Figures 14 and 15 show the estimated hydraulic capture areas in HSU 5 during the third quarter 2010. As shown, a capture area was restored to the extent developed in 2007-2008. It is anticipated that effective hydraulic containment will be re-established at TFD once W-907-2 resumes pumping operations there in 2011.

4.4. Tritium

During 2010, tritium activities in ground water from all wells at the Livermore Site, including those in the Trailer 5475, Building 292, and Building 419 areas (Figure 1a), remained below the US EPA 20,000 pCi/L MCL and continued to decline by radioactive decay. Notable 2010 tritium activities include: 11,700 pCi/L in well W-1520 (HSU 4), 11,600 pCi/L in well W-2205 (HSU 3A), and 9,900 pCi/L in well W-2606, an inclined well that is screened in HSU 2/5 (HSUs 3A, 3B, and 4 are absent in this area) beneath B511 (Figures 13, 9 and 1, respectively). The source of tritium in the Building 511, 419, and 412 areas was the subject of an extensive CPT and hydropunch sampling investigation in September and October (Figure 1b). Tritium activities measured during this investigation were notably higher downgradient of Building 419, with the highest activity of 14,300 pCi/L located near the northeast corner of Building 411 from a depth preliminarily assigned to HSU 3B. A more recent sampling event to establish tritium activity levels in a large number of wells over a relatively short period of time was initiated near the end of December and continued into March 2011. The analytical results of this sampling event and the direct-push sampling project are pending.

4.5. Decision Support Analysis

A variety of decision support tools are used and various analyses are conducted to evaluate the performance of the remediation systems, and to improve the quality, efficiency and consistency of routine tasks. These decision support activities are grouped into four categories:

- the Environmental Information Management System;
- Automated Data Review and Mapping Tools;
- Predictive Analysis Tools; and
- Project Management Tools.

The environmental database, and associated data entry and data review tools are routinely used for work tasks ranging from data entry to report preparation. For example, the treatment facility self-monitoring reporting tool allows facility operators to enter data using a web-based interface, and to automatically generate the resulting reports. Decision support tools were also used extensively during REVAL for each treatment facility, and for ESAR activities.

The next level of decision-support tools consists of sophisticated graphical, statistical and numerical data analysis tools used for remedial performance evaluations. This suite of tools includes the CES algorithm that enables ERD personnel to quickly review concentration trends in wells and make sampling recommendations on a quarterly basis. Another frequently used tool is the Optimized Environmental Restoration Analysis (OPERA) tool. This web-tool enables ERD personnel to quickly view HSU-specific plume maps for each contaminant and compare current conditions with historic distributions. Approximately 10,000 plume maps and 2,300 ground water elevation maps that span the entire 26-year project history are updated each quarter within a matter of hours, using the OPERA tool. The map library was updated quarterly in 2010 with the most recent sampling information available, and the resulting electronic map library is accessed using the OPERA web tool.

The ERD environmental database and the data analysis tools significantly reduce the effort required to develop analytical or numerical models for predictive analyses. Regional-scale flow and transport models were used to evaluate the effectiveness and start order of wells in extraction wellfields. The results of these analyses allowed ERD personnel to prioritize the maintenance and operation of critical facilities to ensure hydraulic containment.

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6. Acronyms and Abbreviations

1,1-DCA	1,1-dichloroethane
1,2-DCA	1,2-dichloroethane
1,1-DCE	1,1-dichloroethylene
1,2-DCE	1,2-dichloroethylene
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CES	cost effective sampling
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
ELM	Eastern Landing Mat
EM	environmental management
EPA	U.S. Environmental Protection Agency
EPD	Environmental Protection Department (Lawrence Livermore National Laboratory)
ERD	Environmental Restoration Department (Lawrence Livermore National Laboratory)
ESAR	Enhanced Source Area Remediation
ESD	Explanation of Significant Differences
ETC	East Traffic Circle

ETCN	East Traffic Circle North
ETCS	East Traffic Circle South
ETS	East Taxi Strip
FFA	Federal Facility Agreement
FFS	Focused Feasibility Study
FY	fiscal year
GAC	granular activated carbon
GTU	GAC treatment unit
GWP	Ground Water Project
HSU	hydrostratigraphic unit
ID	inside diameter
kft^3	thousands of cubic feet
kg	kilogram
kgal	thousands of gallons
LLNL	Lawrence Livermore National Laboratory
LWRP	Livermore Water Reclamation Plant
MCL	maximum contaminant level
Mgal	millions of gallons
MTU	miniature treatment unit
NIF	National Ignition Facility
NNSA	National Nuclear Security Administration
O&M	operations and maintenance
OPERA	optimized environmental restoration analysis
PCB	polychlorinated biphenyl
PCE	perchloroethylene
pCi/L	picocuries per liter
ppb	parts per billion
PSR	phased source remediation
PTU	portable treatment unit
PVC	poly vinyl chloride
REVAL	remediation evaluation (ERD)
ROD	Record of Decision
RPM	Remedial Project Manager
RWQCB	California Regional Water Quality Control Board
SACTE	source area cleanup technology evaluation
SARA	Superfund Amendments and Reauthorization Act
SDGS	specific depth grab sampling
SNL	Sandia National Laboratories

STU	solar treatment unit
SVE	soil vapor extraction
SWPPP	Storm Water Pollution Prevention Plan
TCE	trichloroethylene
TF	treatment facility
VES	vapor extraction system
VOC	volatile organic compound
VTF	soil vapor treatment facility
ZVI	zero valent iron

Figures

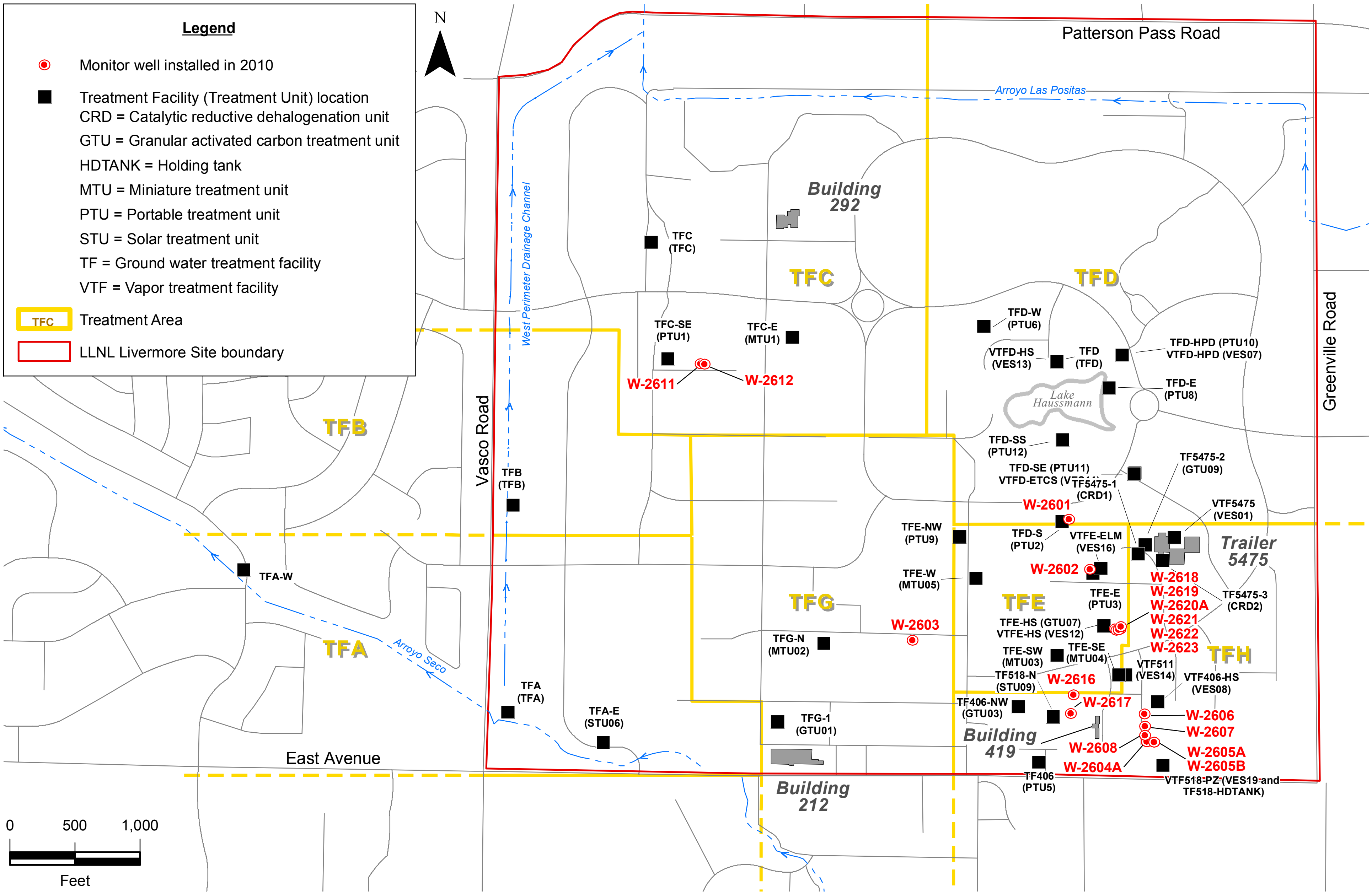

Figure 1a. Livermore Site treatment areas, and location of facilities and wells constructed in 2010.

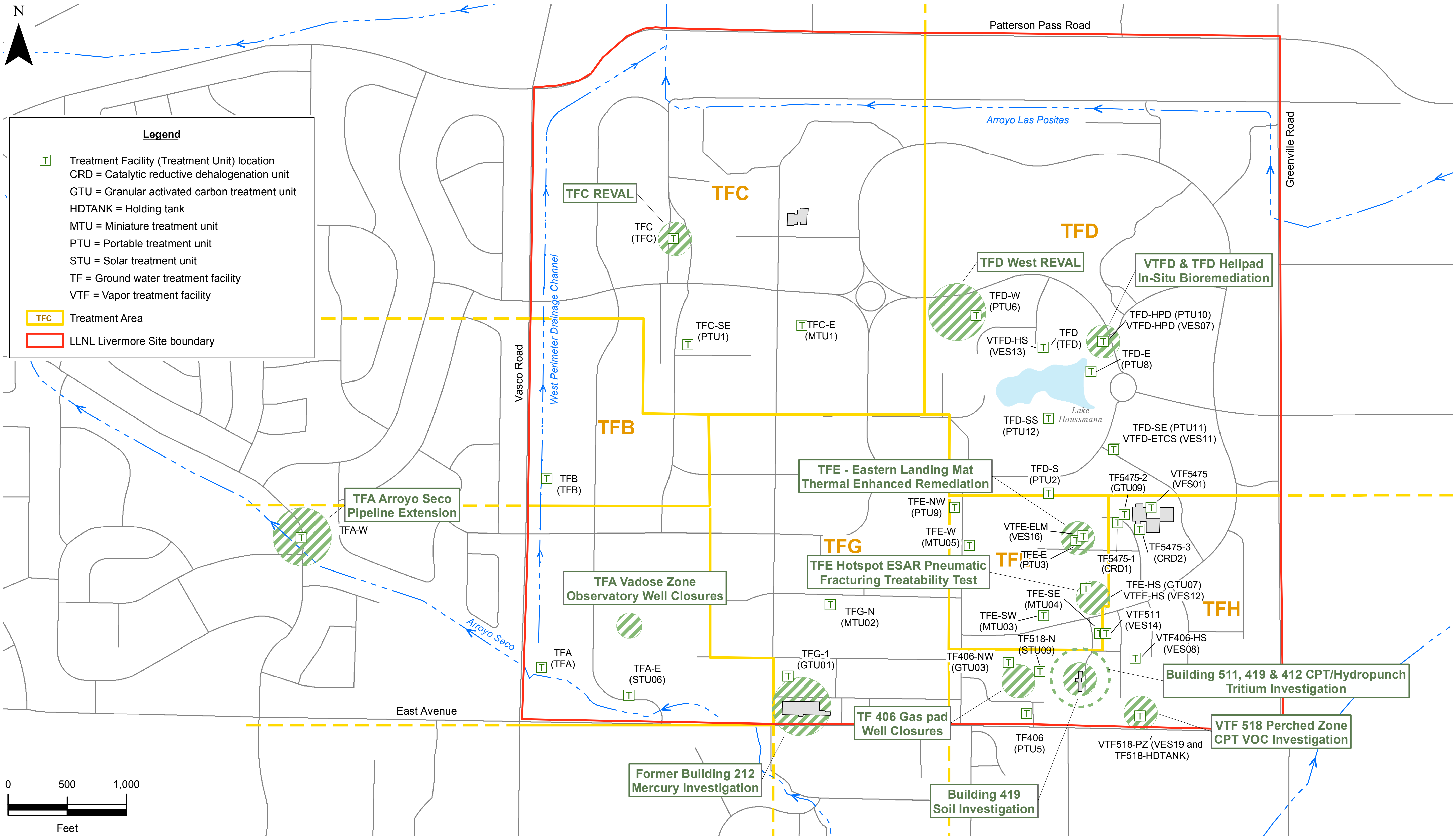

Figure 1b. Livermore Site location map of significant projects conducted in 2010.

Figure 2a. Locations of Livermore Site wells and treatment facilities, December 2010.

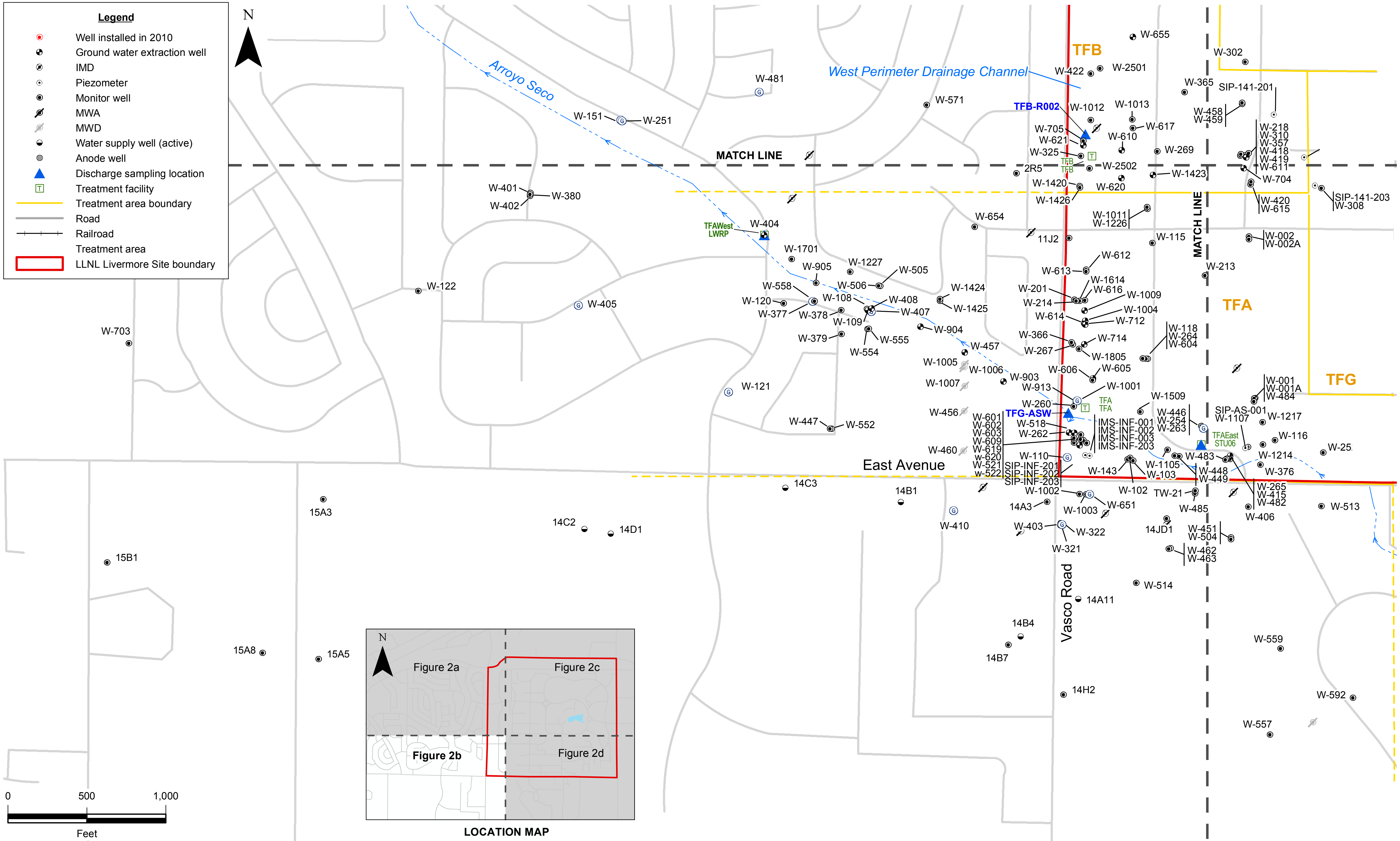

Figure 2b. Locations of Livermore Site wells and treatment facilities, December 2010.

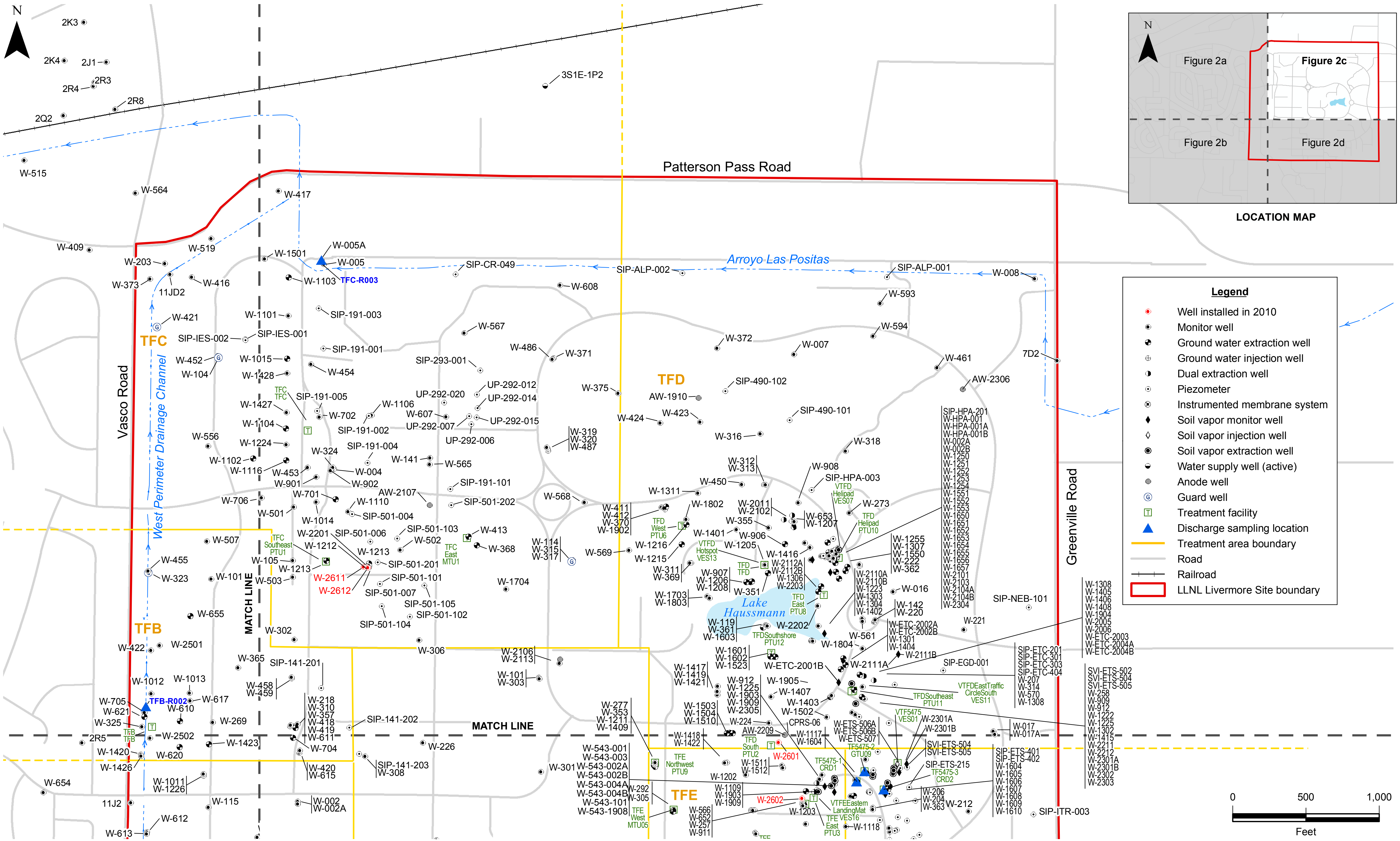

Figure 2c. Locations of Livermore Site wells and treatment facilities, December 2010

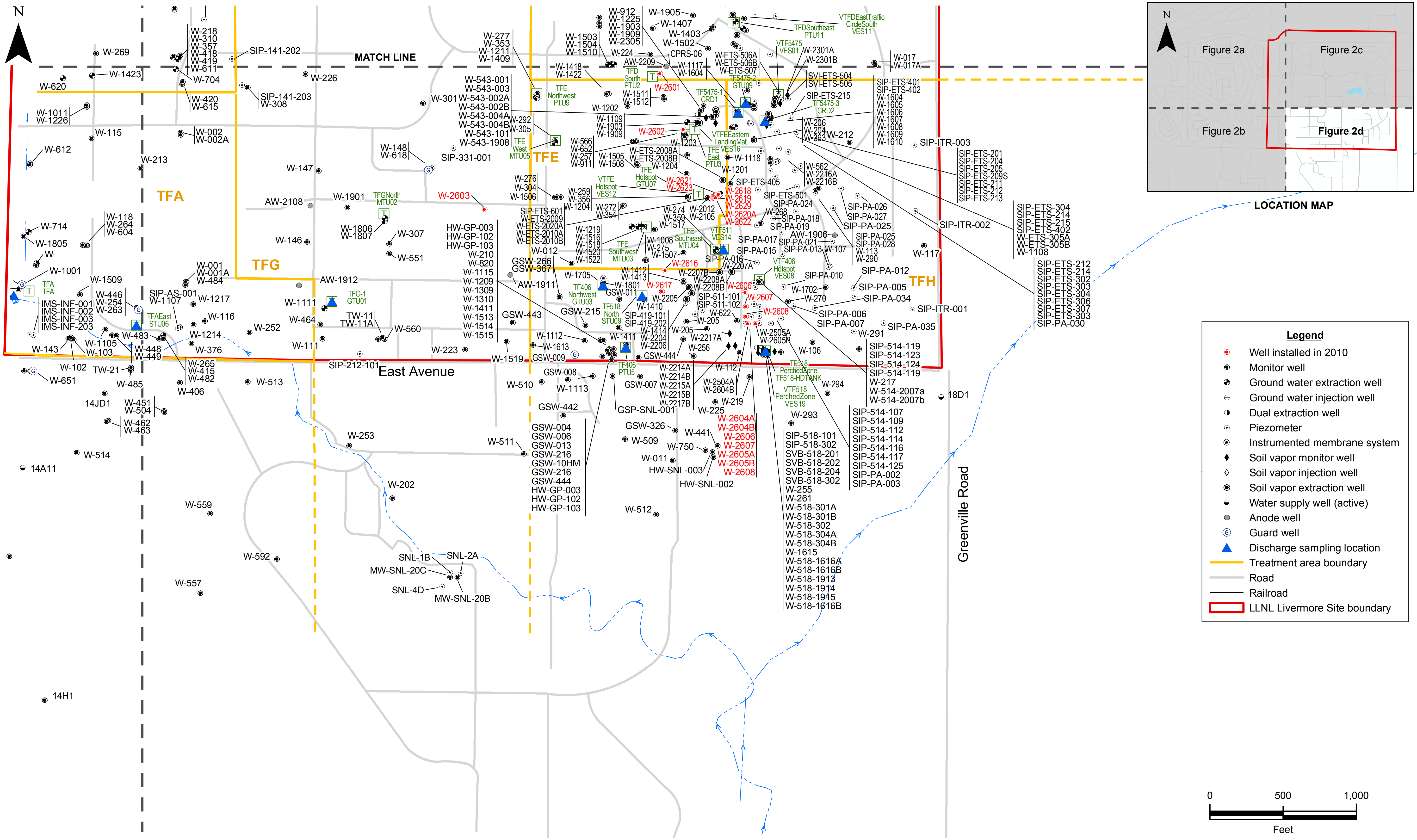

Figure 2d. Locations of Livermore Site wells and treatment facilities, December 2010.

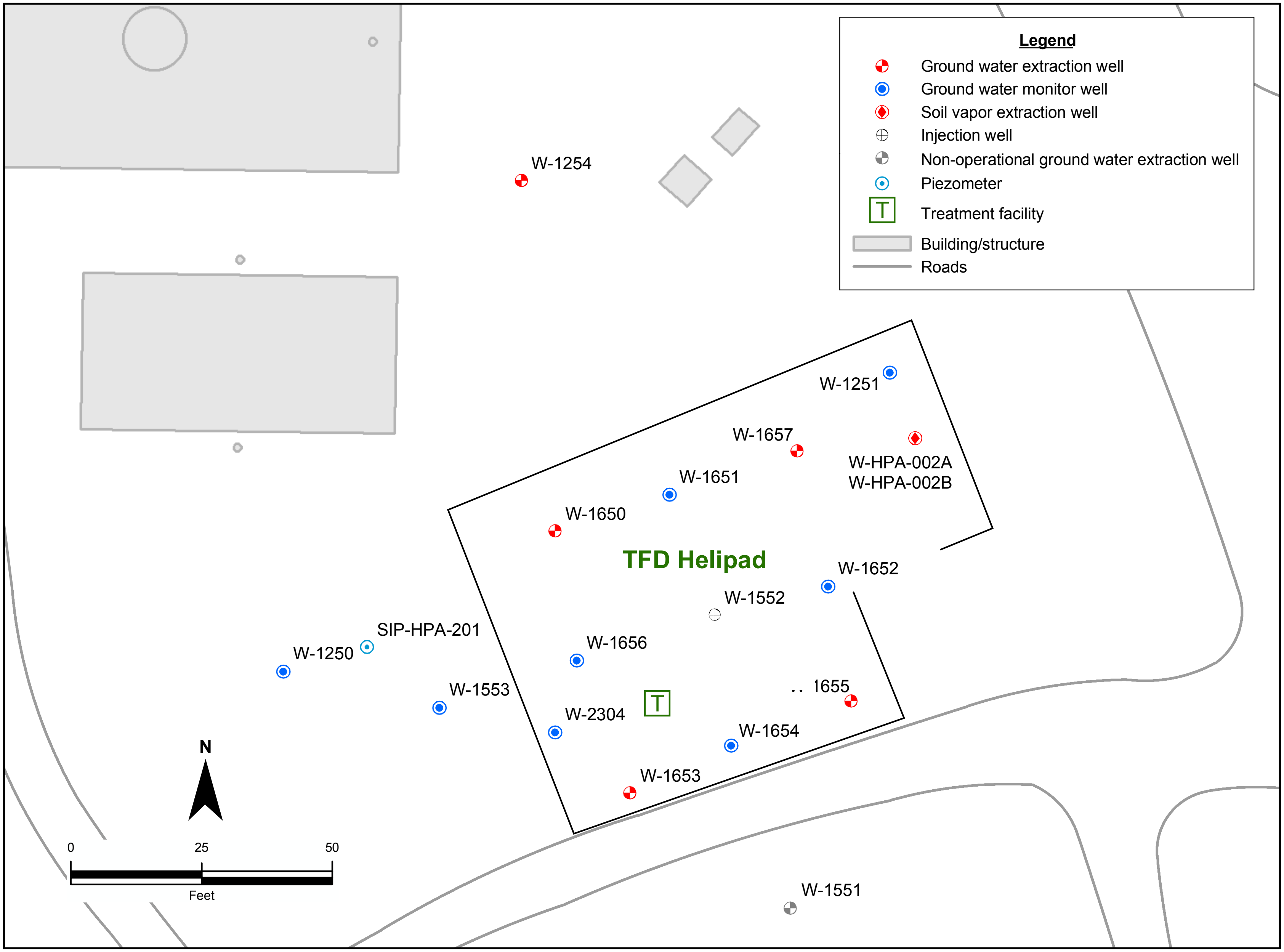

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Figure 2e. Locations of TFD Helipad wells and facilities.

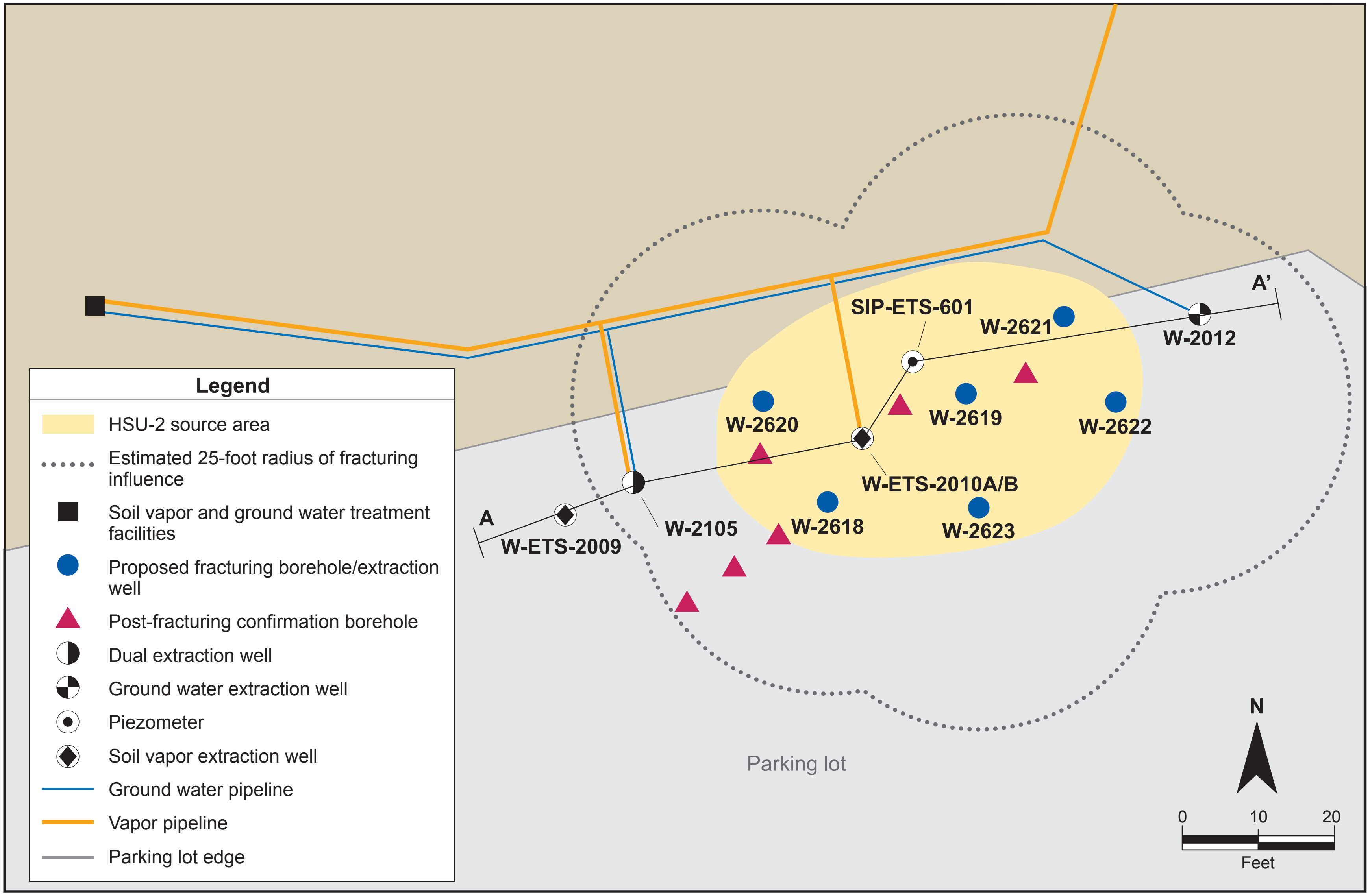

Figure 2f. Locations of the wells in the TFE Hotspot Pneumatic Fracturing Treatability Study Area.

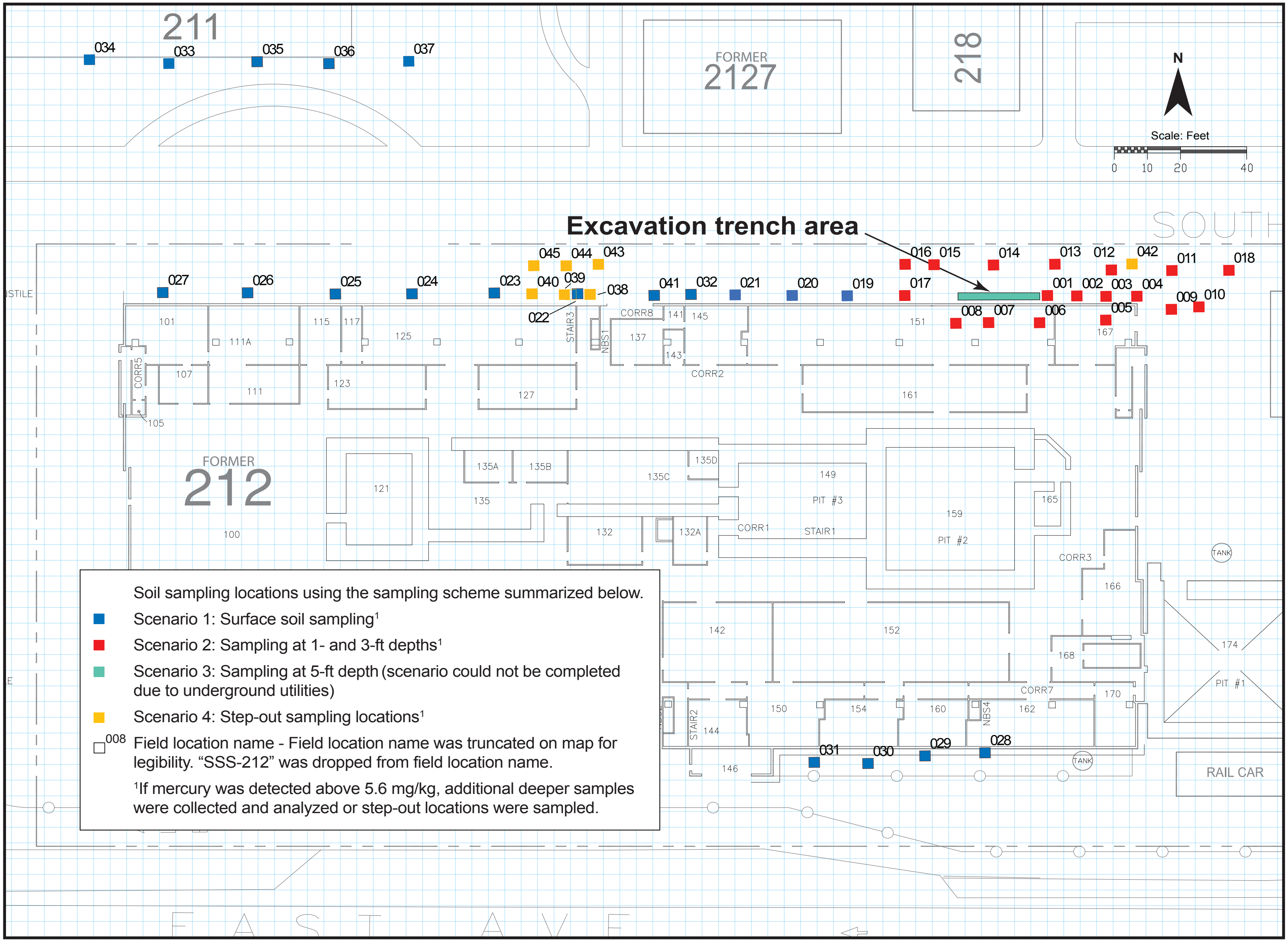

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Figure 2g. Soil sample locations, as part of the mercury investigation in the Building 212 Area, LLNL.

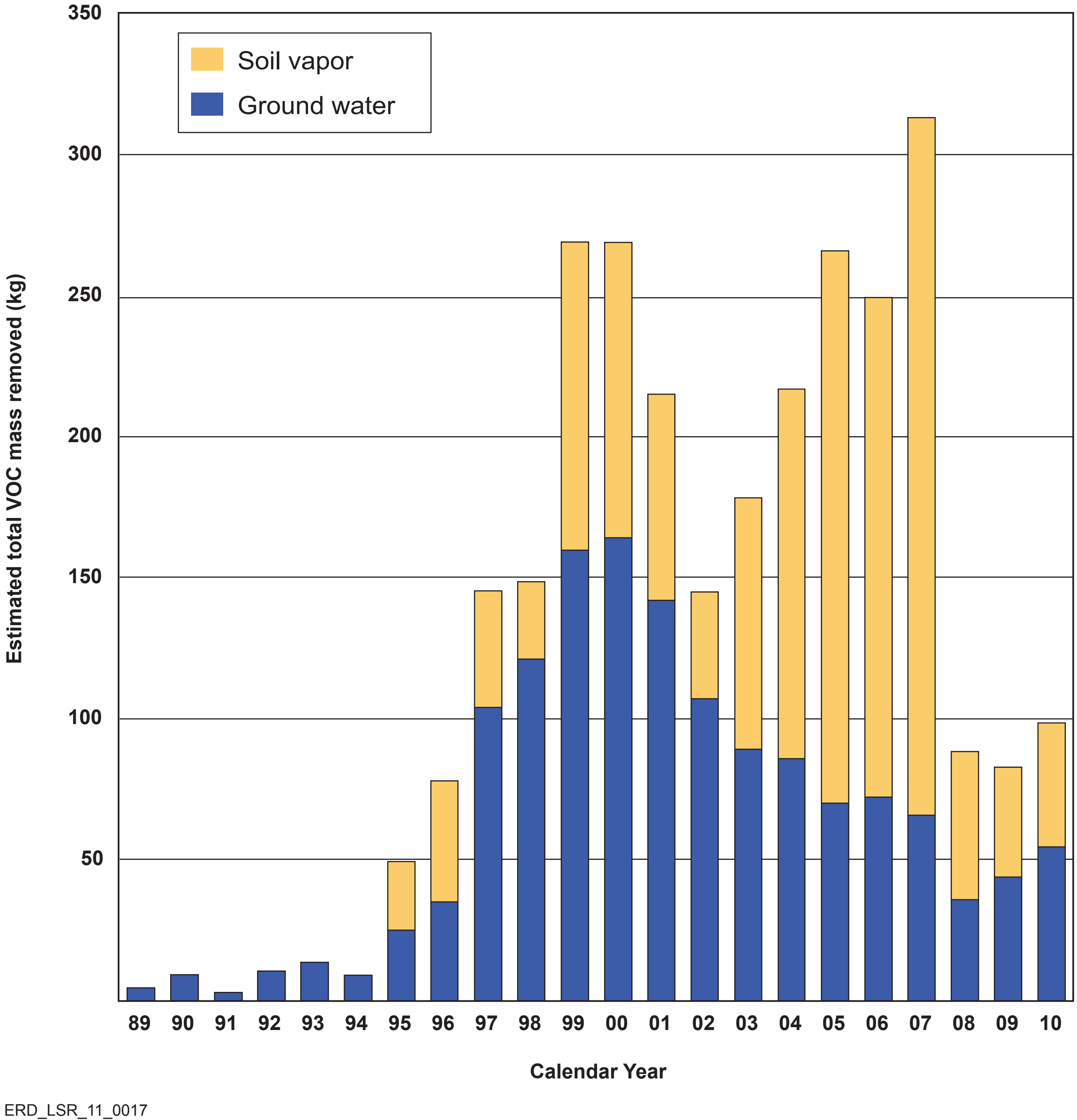

Figure 3. Estimated total VOC mass removed from the Livermore Site subsurface since 1989.

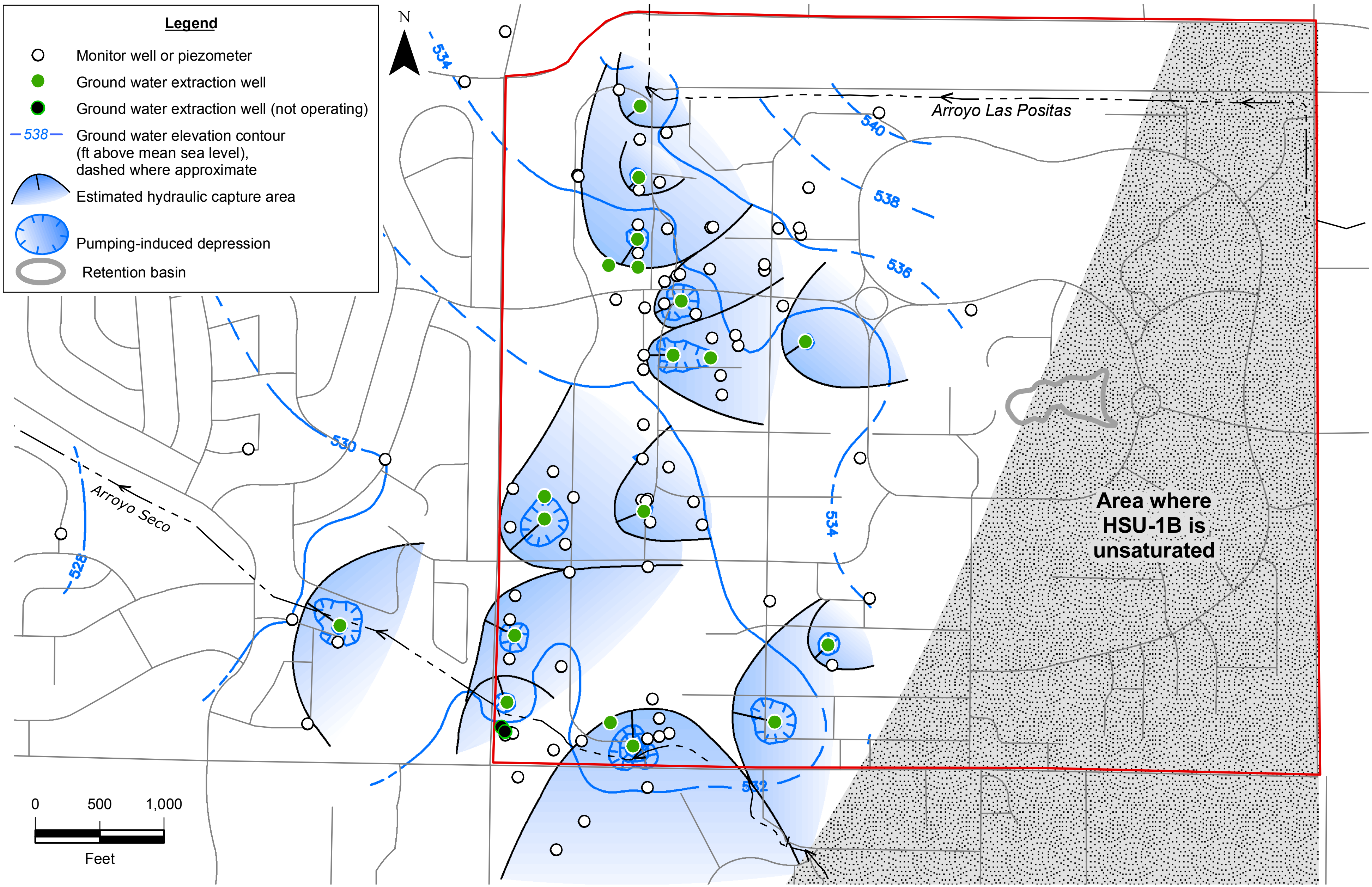

Figure 4. Ground water elevation contour map based on 129 wells completed within HSU 1B showing estimated hydraulic capture areas, LLNL and vicinity, July 2010.

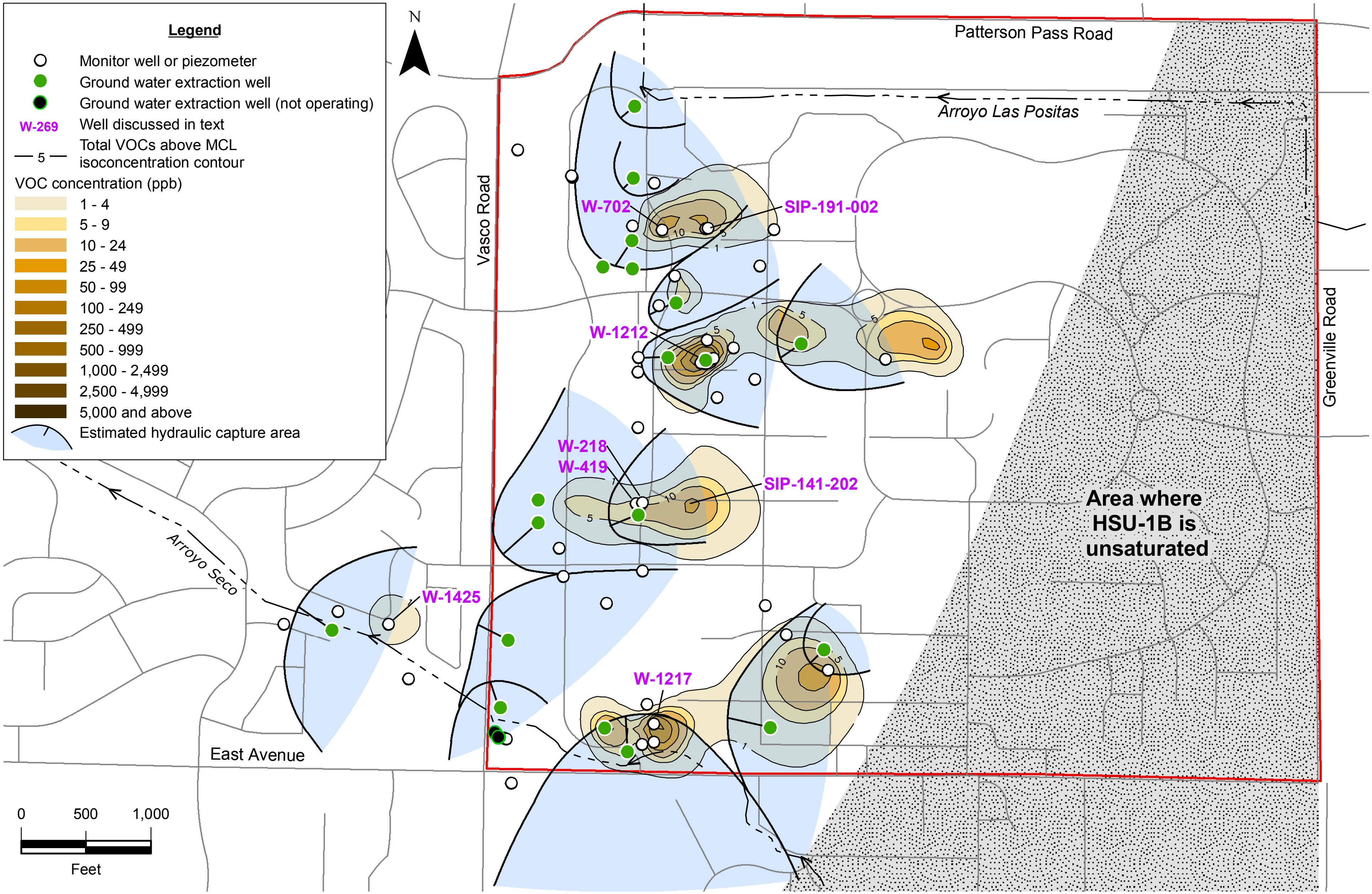

Figure 5. Isoconcentration contour map of total VOCs above MCLs from 129 wells completed within HSU 1B, third quarter 2010 (or the next most recent data), and supplemented with soil chemistry data from 40 borehole locations.

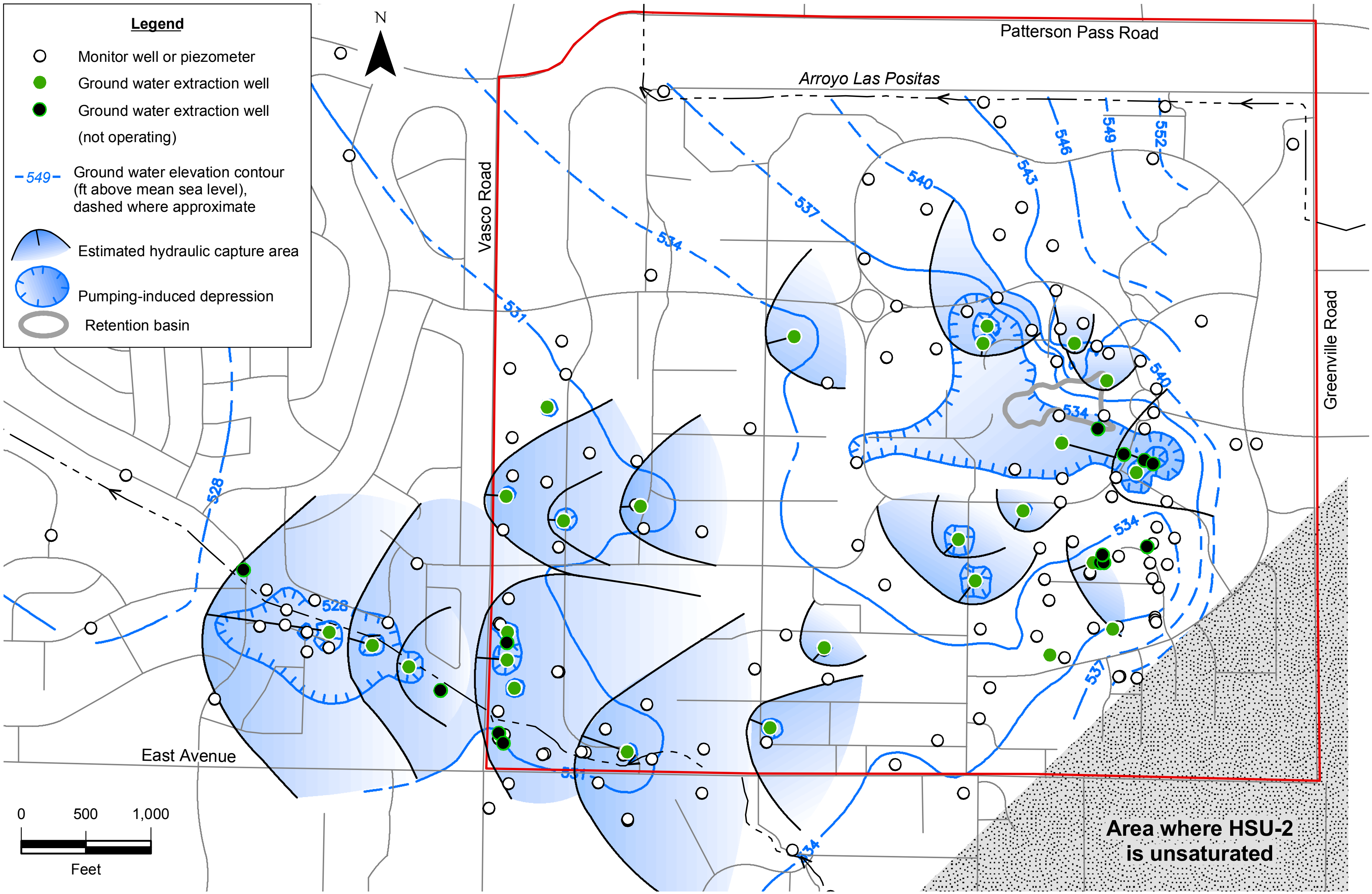

Figure 6. Ground water elevation contour map based on 197 wells completed within HSU 2 showing estimated hydraulic capture areas, LLNL and vicinity, July 2010.

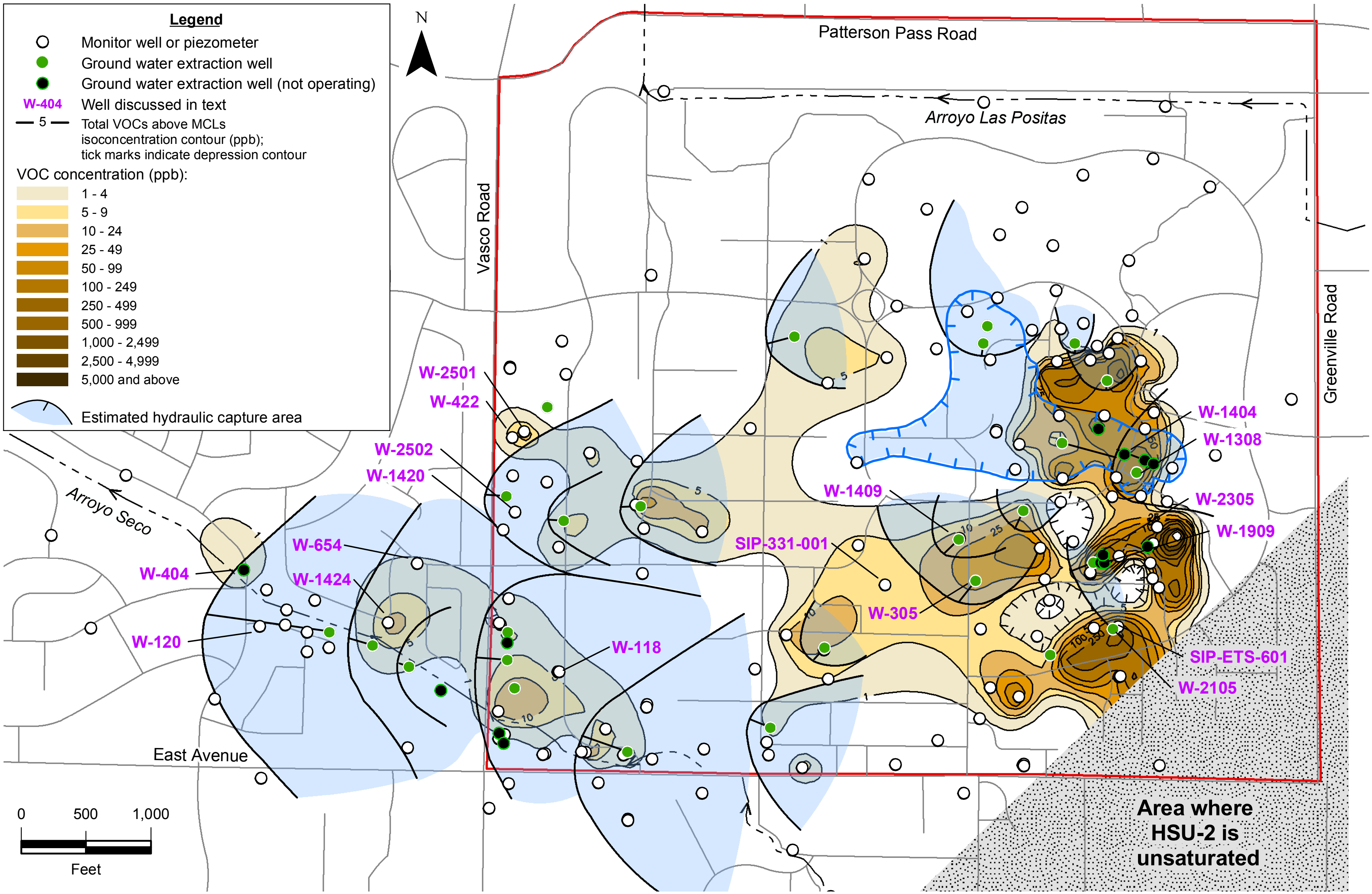

Figure 7. Isoconcentration contour map of total VOCs above MCLs from 197 wells completed within HSU 2, third quarter 2010 (or the next most recent data), and supplemented with soil chemistry data from 94 borehole locations.

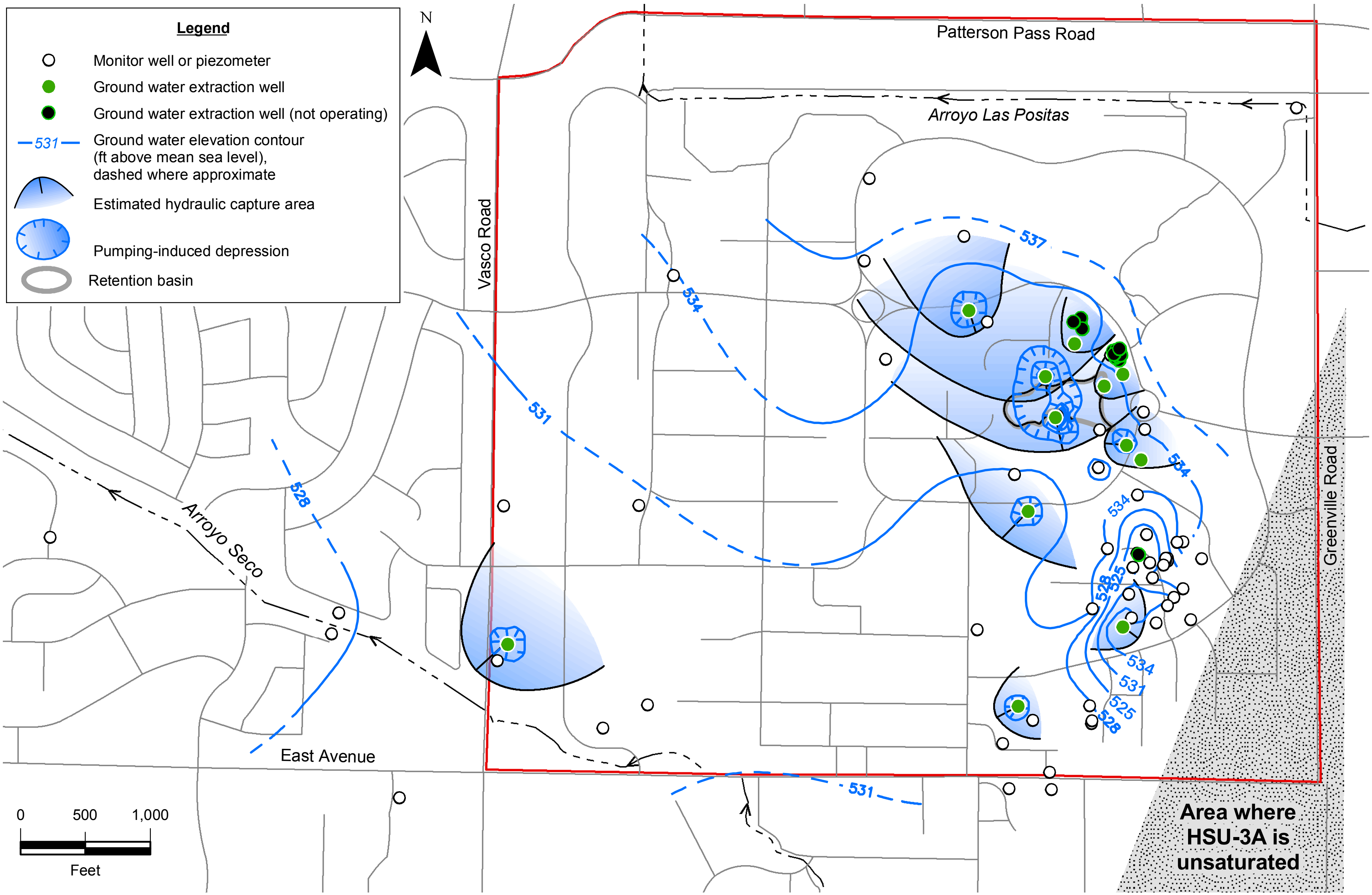

Figure 8. Ground water elevation contour map based on 112 wells completed within HSU 3A showing estimated hydraulic capture areas, LLNL and vicinity, July 2010.

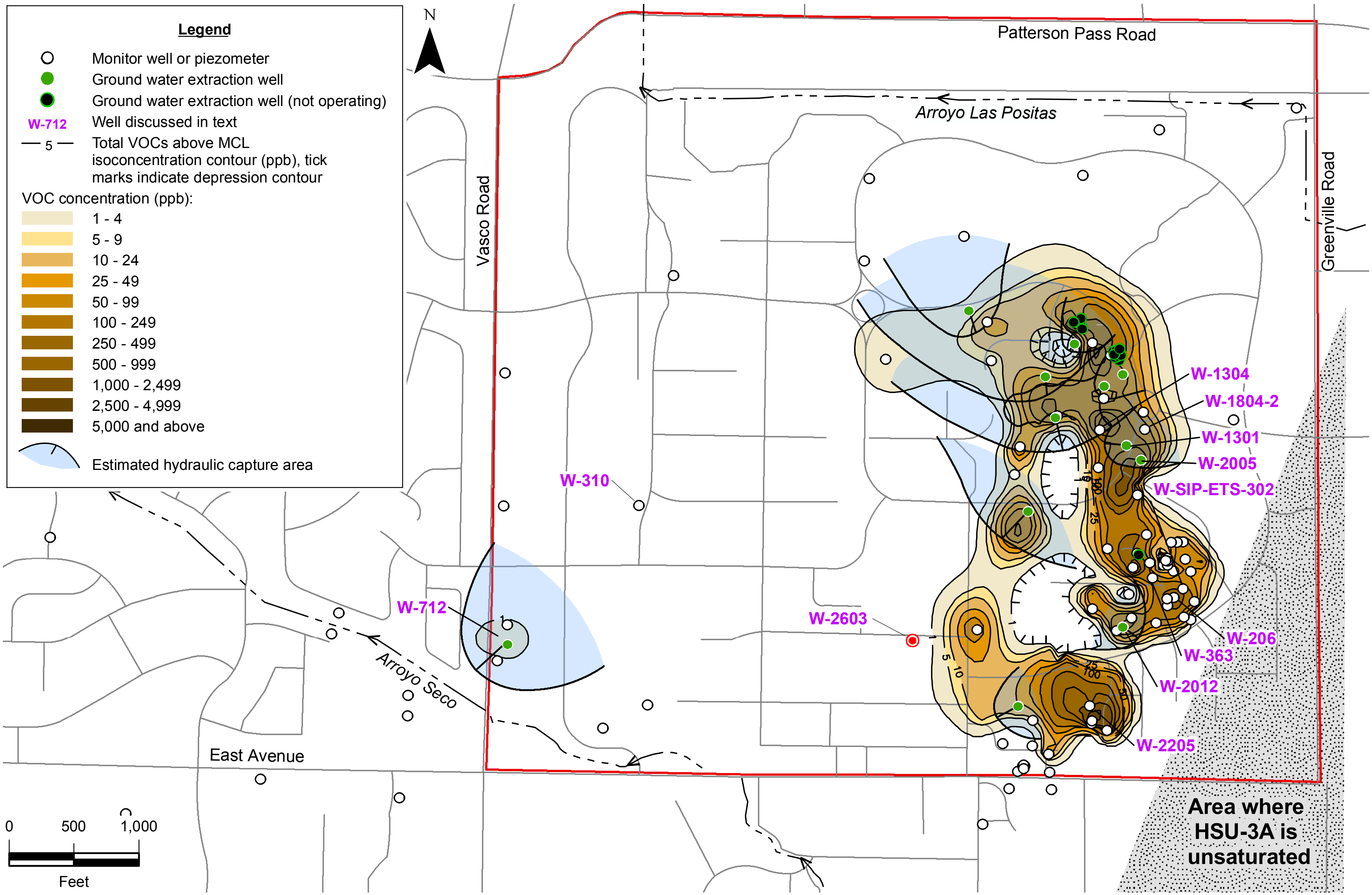

Figure 9. Isoconcentration contour map of total VOCs above MCLs from 112 wells completed within HSU 3A, third quarter 2010 (or the next most recent data), and supplemented with soil chemistry data from 144 borehole locations.

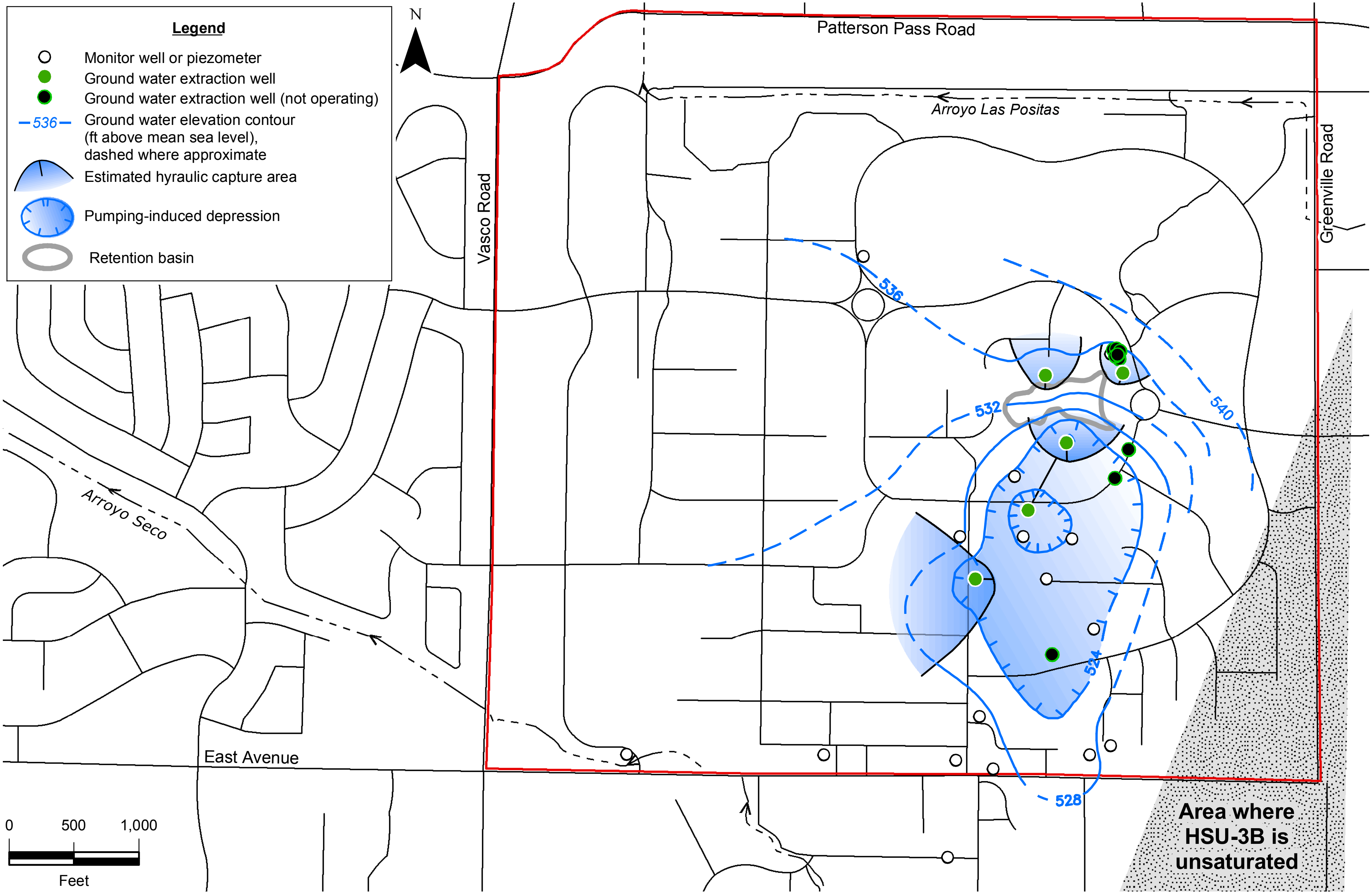

Figure 10. Ground water elevation contour map based on 40 wells completed within HSU 3B showing estimated hydraulic capture areas, LLNL and vicinity, July 2010.

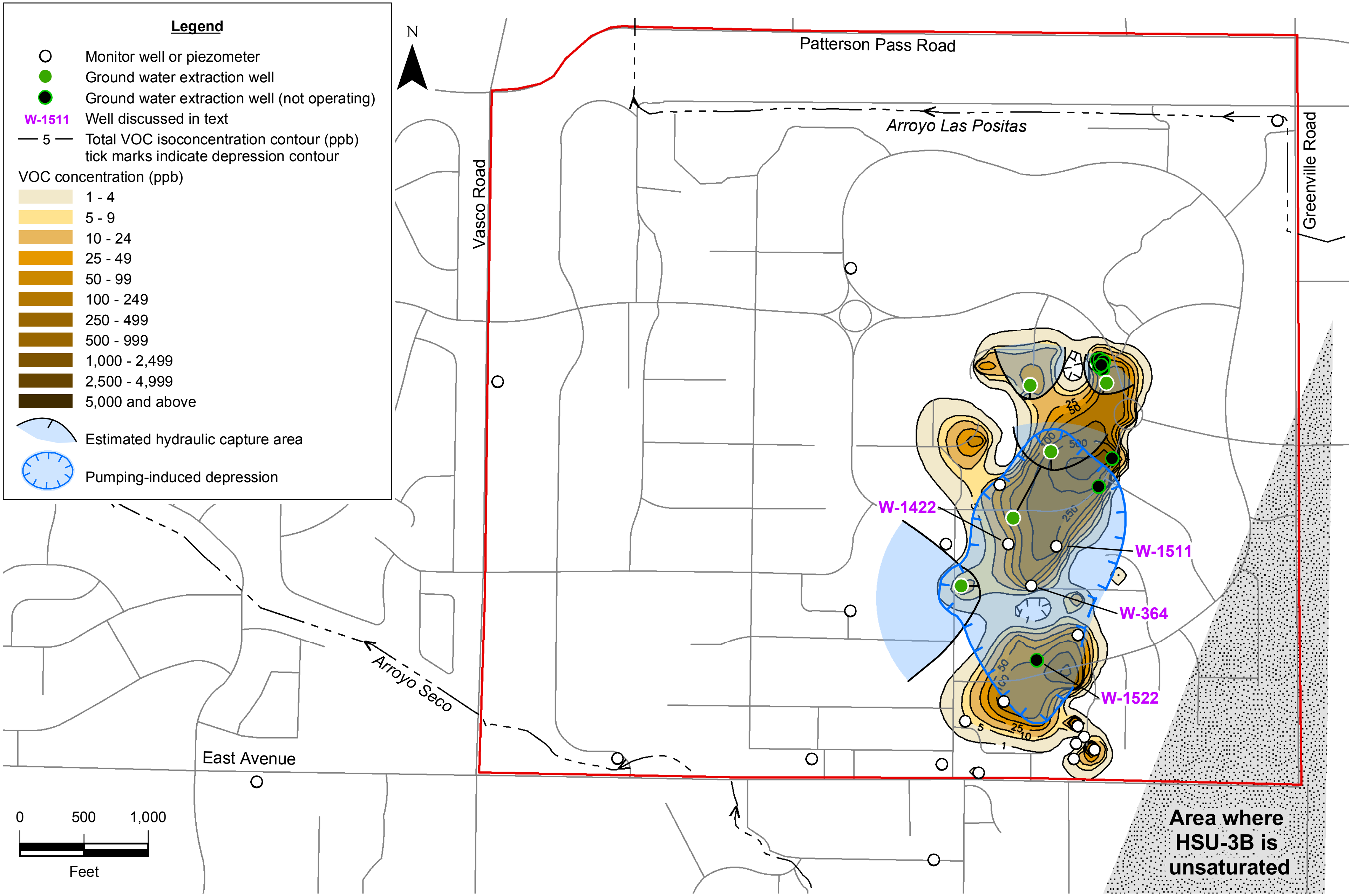

Figure 11. Isoconcentration contour map of total VOCs above MCLs from 40 wells completed within HSU 3B, third quarter 2010 (or the next most recent data), and supplemented with soil chemistry data from 109 borehole locations.

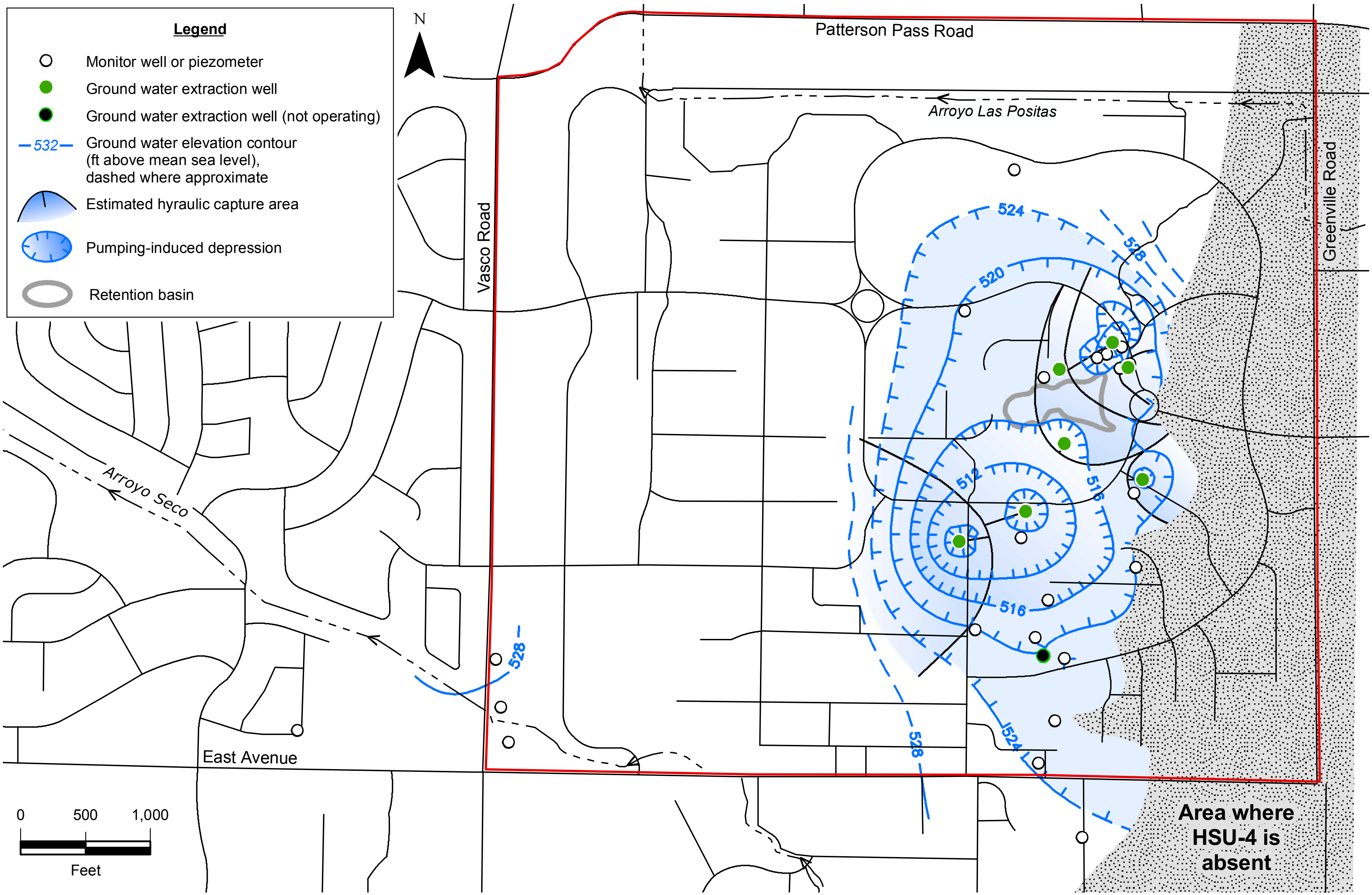

Figure 12. Ground water elevation contour map based on 42 wells completed within HSU 4 showing estimated hydraulic capture areas, LLNL and vicinity, July 2010.

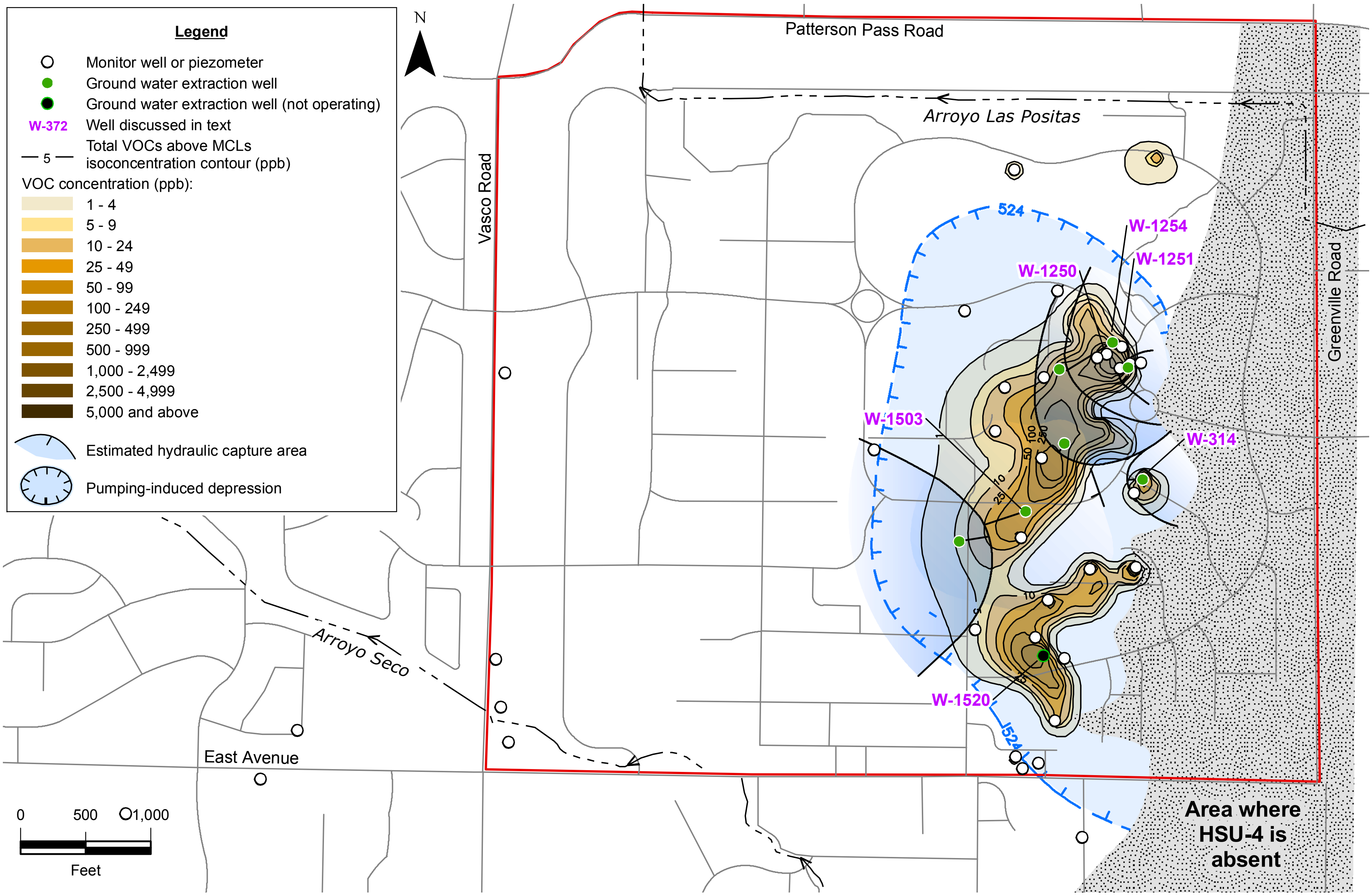

Figure 13. Isoconcentration contour map of total VOCs above MCLs from 42 wells completed within HSU 4, third quarter 2010 (or the next most recent data), and supplemented with soil chemistry data from 57 borehole locations.

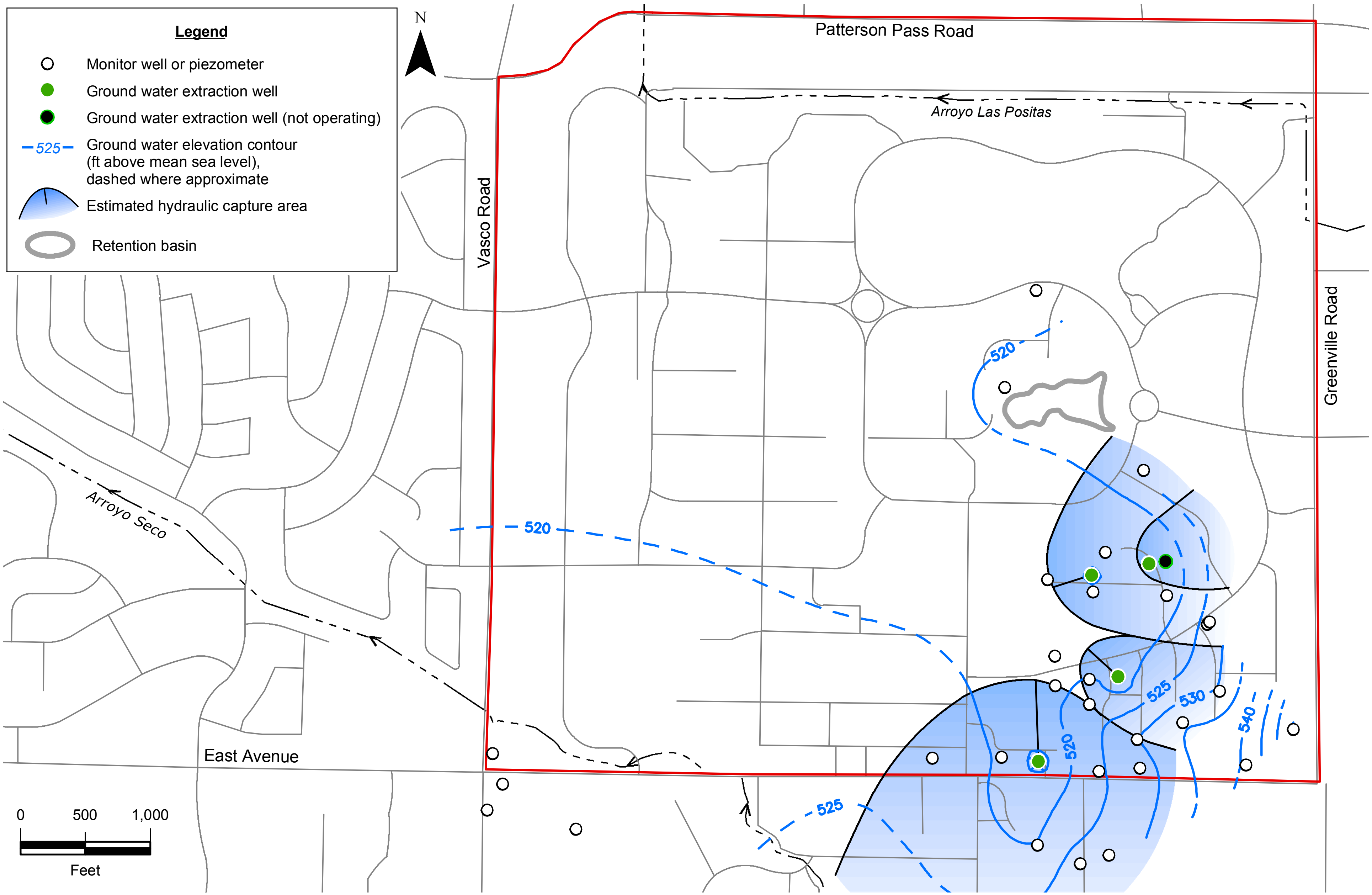

Figure 14. Ground water elevation contour map based on 60 wells completed within HSU 5 showing estimated hydraulic capture areas, LLNL and vicinity, July 2010.

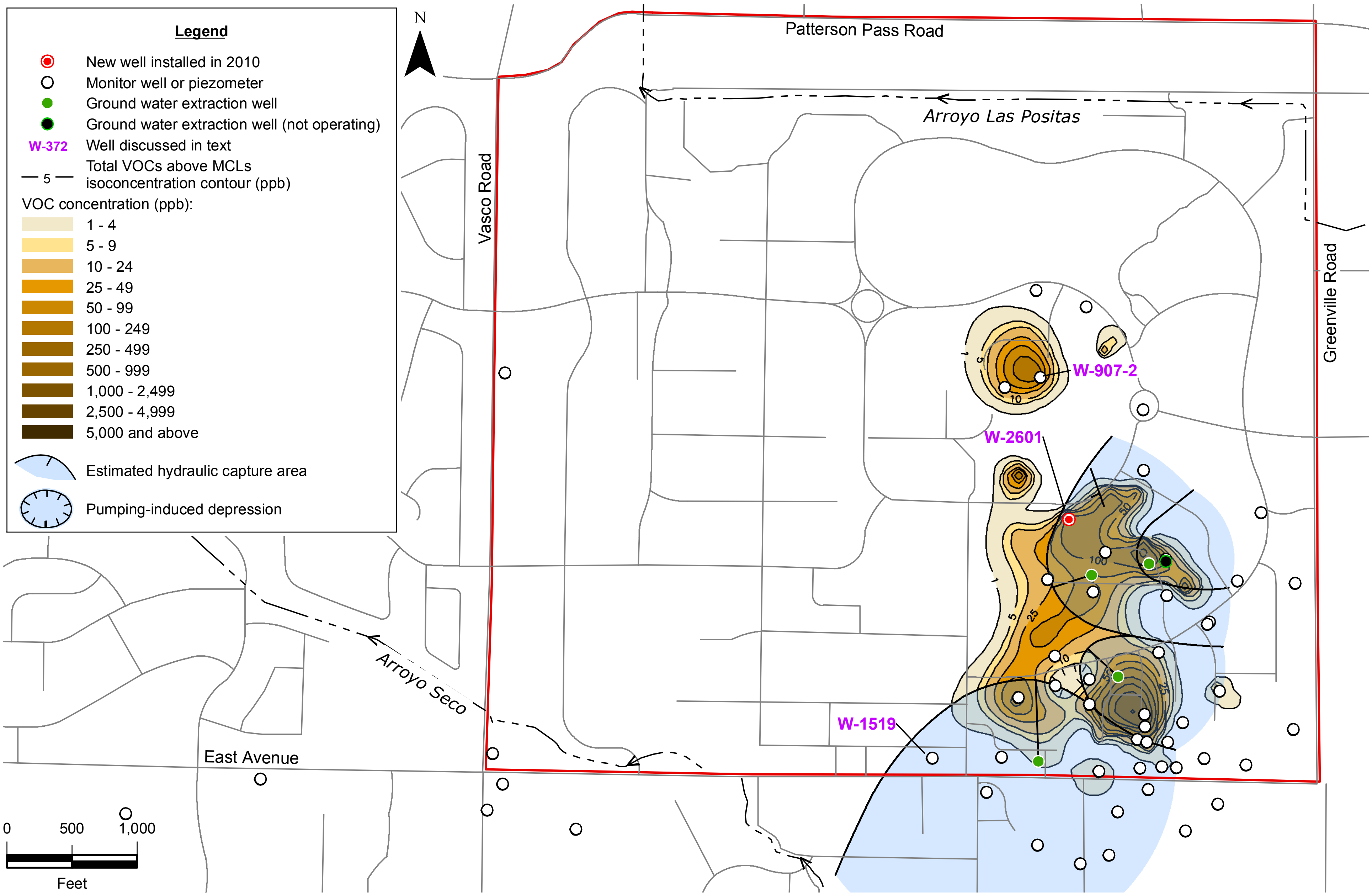

Figure 15. Isoconcentration contour map of total VOCs above MCLs from 60 wells completed within HSU 5, third quarter 2010 (or the next most recent data), and supplemented with soil chemistry data from 95 borehole locations.

Tables

Table 1. Livermore Site treatment facility abbreviations.

Treatment facility	Abbreviation
TFA	TFA
TFA East	TFA-E
TFA West	TFA-W
TFB	TFB
TFC	TFC
TFC East	TFC-E
TFC Southeast	TFC-SE
TFD	TFD
TFD East	TFD-E
TFD Helipad	TFD-HPD
TFD South	TFD-S
TFD Southeast	TFD-SE
TFD Southshore	TFD-SS
TFD West	TFD-W
VTFD East Traffic Circle South	VTFD-ETCS
VTFD Helipad	VTFD-HPD
VTFD Hotspot	VTFD-HS
TFE East	TFE-E
TFE Hotspot	TFE-HS
TFE Northwest	TFE-NW
TFE Southeast	TFE-SE
TFE Southwest	TFE-SW
TFE West	TFE-W
VTFE Eastern Landing Mat	VTFE-ELM
VTFE Hotspot	VTFE-HS
TFG-1	TFG-1
TFG North	TFG-N
TF406	TF406
TF406 Northwest	TF406-NW
VTF406 Hotspot	VTF406-HS
VTF511	VTF511
TF518 North	TF518-N
TF518 Perched Zone	TF518-PZ
VTF518 Perched Zone	VTF518-PZ
TF5475-1	TF5475-1
TF5475-2	TF5475-2
TF5475-3	TF5475-3
VTF5475	VTF5475

Notes:

TF = Ground water treatment facility.

VTF = Soil vapor treatment facility.

Table 2. Types and numbers of Livermore Site wells.

Well type	Number of wells
Anode wells (cathodic protection)[1]	9
Dual Extraction[2]	17
Ground Water Extraction	93
Ground Water Injection	2
Ground Water Monitor[a]	411
Ground Water Guard	20
Instrumented Membrane System	1
Piezometer	112
Soil Vapor Extraction	32
Soil Vapor Injection	1
Soil Vapor Monitor	41
Total	739

Notes:

The number of Livermore Site wells is current through the end of December 2010.

Table 5 lists extraction wells and Table A-1 of Appendix A summarizes construction information for all wells.

[a] **Does not include 35 offsite private or agency wells that are occasionally monitored by ERD.**

[1] **Protect metallic objects in contact with the ground with electrolytic corrosion.**

[2] **Extraction of ground water using a downhole pump with concurrent application of vacuum to the well. Ground water and soil vapor are removed in separate pipe manifolds and treated.**

Table 3. Summary of treatment facility discharge sampling locations.

Treatment facility		Discharge sampling location
TFA	TFA	Arroyo Seco (TFG-ASW) and West Perimeter Drainage Channel (TFB-R002)
	TFA East	Arroyo Seco (TFG-ASW)
	TFA West[a]	Livermore Water Reclamation Plant (TFA-W-E)
TFB	TFB	West Perimeter Drainage Channel (TFB-R002)
TFC	TFC	Arroyo Las Positas (TFC-R003)
	TFC East	Arroyo Las Positas (TFC-R003)
	TFC Southeast	Arroyo Las Positas (TFC-R003)
TFD	TFD	Arroyo Las Positas (TFC-R003)
	TFD East	Arroyo Las Positas (TFC-R003)
	TFD Helipad	Arroyo Las Positas (TFC-R003)
	TFD South	Arroyo Las Positas (TFC-R003)
	TFD Southeast	Arroyo Las Positas (TFC-R003)
	TFD Southshore	Arroyo Las Positas (TFC-R003)
	TFD West	Arroyo Las Positas (TFC-R003)
	VTFD East Traffic Circle South	Treated vapor to atmosphere
	VTFD Helipad	Treated vapor to atmosphere
	VTFD Hotspot	Treated vapor to atmosphere
TFE	TFE East	Arroyo Las Positas (TFC-R003)
	TFE Hotspot	Arroyo Las Positas (TFC-R003)
	TFE Northwest	Arroyo Las Positas (TFC-R003)
	TFE Southeast	Arroyo Las Positas (TFC-R003)
	TFE Southwest	Arroyo Las Positas (TFC-R003)
	TFE West	Arroyo Las Positas (TFC-R003)
	VTFE Eastern Landing Mat	Treated vapor to atmosphere
	VTFE Hotspot	Treated vapor to atmosphere
TFG	TFG-1	Arroyo Seco (TFG-ASW)
	TFG North	Arroyo Las Positas (TFC-R003)
TFH	TF406	Arroyo Las Positas (TFC-R003)
	TF406 Northwest	Arroyo Las Positas (TFC-R003)
	VTF406 Hotspot	Treated vapor to atmosphere
	VTF511	Treated vapor to atmosphere
	TF518 North	Arroyo Las Positas (TFC-R003)
	TF518 Perched Zone	Tankered to TF406 Northwest
	VTF518 Perched Zone	Treated vapor to atmosphere
	TF5475-1	CRD-1 injection (W-1302)
	TF5475-2	Arroyo Las Positas (TFC-R003)
	TF5475-3	CRD-2 injection (W-1610)
	VTF5475	Injection (SVI-ETS-505)

Notes:

[a] **Ground water from TFA West was shut down on January 14, 2008 per direction of the regulators over concern about using the Livermore Water Reclamation Plant (LWRP) for final treatment.**

Table 4. 2010 Livermore Site performance summary.

HSU	Extraction well	Volume of ground water treated (kgal)	Estimated VOC mass removed from ground water (kg)	Volume of soil vapor treated (kft^3)	Estimated VOC mass removed from soil vapor (kg)
		Treatment Facility A (TFA)			
1B	W-262	<1	<0.01	-	-
1B	W-408	12,439	0.03	-	-
1B	W-1001	1,652	0	-	-
1B	W-1004	5,589	0.08	-	-
1B/2	W-415	18,230	1.22	-	-
2	W-109	14,305	0.14	-	-
2	W-457	2,477	0.13	-	-
2	W-518	152	0.01	-	-
2	W-522	259	0.01	-	-
2	W-605	4,226	0.31	-	-
2	W-614	2,481	0.06	-	-
2	W-714	3,926	0.16	-	-
2	W-903	2,310	0.04	-	-
2	W-904	17,264	0.79	-	-
2	W-1009	11,733	1.25	-	-
3A	W-712	3,504	0.24	-	-
		Treatment Facility A East (TFA-E)			
1B	W-254	325	0.05	-	-
		Treatment Facility A West (TFA-W)			
2	W-404	3.4	<0.01	-	-
		Treatment Facility B (TFB)			
1B	W-610	3,438	0.11	-	-
1B	W-620	2,289	0.11	-	-
1B	W-704	8,596	1.25	-	-
2	W-357	2,994	0.55	-	-
2	W-621	3,568	0.10	-	-
2	W-655	4,156	0.11	-	-
2	W-1423	2,471	0.23	-	-

Table 4. 2010 Livermore Site performance summary. (Continued)

HSU	Extraction well	Volume of ground water treated (kgal)	Estimated VOC mass removed from ground water (kg)	Volume of soil vapor treated (kft^3)	Estimated VOC mass removed from soil vapor (kg)
		Treatment Facility C (TFC)			
1B	W-701	4,295	0.75	-	-
1B	W-1015	1,359	0.05	-	-
1B	W-1102	1,125	0.03	-	-
1B	W-1103	716	<0.01	-	-
1B	W-1104	9,479	0.48	-	-
1B	W-1116	505	0.03	-	-
		Treatment Facility C East (TFC-E)			
1B	W-368	2,411	0.50	-	-
2	W-413	5,475	0.88	-	-
		Treatment Facility C Southeast (TFC-SE)			
1B	W-1213	3,988	0.57	-	-
1B	W-2201	6,177	1.22	-	-
		Treatment Facility D (TFD)		**Vapor Treatment Facility D Hotspot (VTFD-HS)**	
2/3A	W-906	1,223	0.02	-	-
3A	W-653	15	0.07	16	<0.01
3A	W-2011	0	0	0	0
3A	W-2101	73	0.10	5.6	<0.01
3A	W-2102	0	0	0	0
3A/3B	W-1208	9,063	4.06	-	-
4	W-351	463	0.34	-	-
4	W-1206	1,329	0.17	-	-
5	W-907-2	0	0	-	-
		Treatment Facility D East (TFD-E)			
2	W-1303	398	0.33	-	-
2	W-1306	112	0.05	-	-
2	W-1404	58	0.03	-	-

Table 4. 2010 Livermore Site performance summary. (Continued)

HSU	Extraction well	Volume of ground water treated (kgal)	Estimated VOC mass removed from ground water (kg)	Volume of soil vapor treated (kft^3)	Estimated VOC mass removed from soil vapor (kg)
		Treatment Facility D East (TFD-E) (continued)			
3A	W-1301	474	0.65	-	-
3A	W-1550	461	0.37	-	-
3A	W-2203	207	0.13	-	-
3B	W-2006	2.2	0.01	-	-
4	W-1253	0	0	-	-
4	W-1255	0	0	-	-
4	W-1307	2,844	0.32	-	-
		Treatment Facility D Helipad (TFD-HPD)		**Vapor Treatment Facility D Helipad (VTFD-HPD)**	
1B	W-HPA-002A	-	-	8,241	0.70
2	W-HPA-002B	-	-	0	0
2/3A	W-1655	0	0	0	0
2/3A/3B	W-1651	0	0	0	0
3A	W-1551	0	0	-	-
3A	W-1552	0	0	0	0
3A	W-1650	0	0	0	0
3A	W-1653	0	0	0	0
3A	W-1654	0	0	0	0
3A	W-1656	0	0	0	0
3A/3B	W-1652	0	0	0	0
3A/3B	W-1657	0	0	0	0
4	W-1254	6,783	1.47	-	-
		Treatment Facility D South (TFD-S)			
2	W-1510	3,494	0.39	-	-
3A/3B	W-1504	3,600	1.59	-	-
4	W-1503	7,721	3.18	-	-

Table 4. 2010 Livermore Site performance summary. (Continued)

HSU	Extraction well	Volume of ground water treated (kgal)	Estimated VOC mass removed from ground water (kg)	Volume of soil vapor treated (kft^3)	Estimated VOC mass removed from soil vapor (kg)
		Treatment Facility D Southeast (TFD-SE)		**Vapor Treatment Facility D East Traffic Circle South (VTFD-ETCS)**	
1B	W-ETC-2003	-	-	7,177	0.52
1B/2	W-ETC-2004A	-	-	2,699	0.31
2	W-ETC-2004B	-	-	2,924	2.10
2	W-1308	1,455	1.57	-	-
2	W-1904	0	0	0	0
2	SIP-ETC-201	0	0	0	0
3A	W-2005	101	0.03	-	-
3B	W-1403	355	0.76	-	-
4	W-314	4,571	3.12	-	-
		Treatment Facility D Southshore (TFD-SS)			
2	W-1602	2,300	0.20	-	-
3A	W-1603	6,184	5.56	-	-
3B	W-1601	441	0.68	-	-
4	W-1523	3,008	3.60	-	-
		Treatment Facility D West (TFD-W)			
2	W-1215	3,342	0.53	-	-
2	W-1216	3,330	0.81	-	-
3A	W-1902	6,501	2.54	-	-
		Treatment Facility E East (TFE-E)		**Vapor Treatment Facility E Eastern Landing Mat (VTFE-ELM)**	
1B	W-543-1908	-	-	0	0
2	W-543-001	-	-	0	0
2	W-543-003	-	-	5,507	0.90
2	W-1109	830	1.12	-	-
2	W-1903	26	0.01	<1	<0.01
2	W-1909	0	0	2.3	<0.01
2	W-2305	88	0.16	<1	<0.01
5	W-566	3,013	0.81	-	-

Table 4. 2010 Livermore Site performance summary. (Continued)

HSU	Extraction well	Volume of ground water treated (kgal)	Estimated VOC mass removed from ground water (kg)	Volume of soil vapor treated (kft^3)	Estimated VOC mass removed from soil vapor (kg)
		Treatment Facility E Hotspot (TFE-HS)		**Vapor Treatment Facility E Hotspot (VTFE-HS)**	
1B	W-ETS-2008A	-	-	2,336	0.05
1B/2	W-ETS-2010A	-	-	2,326	0.08
2	W-ETS-2008B	-	-	1,927	1.13
2	W-ETS-2009	-	-	<1	<0.01
2	W-ETS-2010B	-	-	92	0.02
2	W-2105	1.3	<0.01	1,607	0.18
3A	W-2012	303	0.33	-	-
		Treatment Facility E Northwest (TFE-NW)			
2	W-1409	692	0.06	-	-
4	W-1211	7,752	0.44	-	-
		Treatment Facility E Southeast (TFE-SE)			
5	W-359	4,201	2.91	-	-
		Treatment Facility E Southwest (TFE-SW)			
2	W-1518	885	0.06	-	-
3B	W-1522	<1	<0.01	-	-
4	W-1520	<1	<0.01	-	-
		Treatment Facility E West (TFE-W)			
2	W-305	4,410	1.16	-	-
3B	W-292	2,966	0.32	-	-
		Treatment Facility G-1 (TFG-1)			
1B/2	W-1111	4,321	0.33	-	-

Table 4. 2010 Livermore Site performance summary. (Continued)

HSU	Extraction well	Volume of ground water treated (kgal)	Estimated VOC mass removed from ground water (kg)	Volume of soil vapor treated (kft³)	Estimated VOC mass removed from soil vapor (kg)
		Treatment Facility G North (TFG-N)			
1B	W-1806	1,362	0.10	-	-
2	W-1807	2,400	0.27	-	-
		Treatment Facility 406 (TF406)			
4	W-1309	<1	<0.01	-	-
4	GSW-445	0	0	-	-
5	W-1310	6,836	0.20	-	-
		Treatment Facility 406 Northwest (TF406-NW)			
3A	W-1801	1,919	0.28	-	-
				Vapor Treatment Facility 406 Hotspot (VTF406-HS)	
1B/2	W-514-2007A	-	-	2,444	0.31
2/5	W-514-2007B	-	-	5,063	3.22
5	W-217	-	-	10,048	7.43
				Vapor Treatment Facility 511 (VTF511)	
1B	W-2207A	-	-	0	0
2	W-274	-	-	0	0
2	W-1517	-	-	0	0
2	W-2204	-	-	0	0
2	W-2206	-	-	0	0
2	W-2207B	-	-	3,268	14.32
2	W-2208A	-	-	0	0
2	W-2208B	-	-	2,456	5.28
2	W-2205	-	-	0	0

Table 4. 2010 Livermore Site performance summary. (Continued)

HSU	Extraction well	Volume of ground water treated (kgal)	Estimated VOC mass removed from ground water (kg)	Volume of soil vapor treated (kft^3)	Estimated VOC mass removed from soil vapor (kg)
		Treatment Facility 518 North (TF518-N)			
4	W-1410	0	0	-	-
		Treatment Facility 518 Perched Zone (TF518-PZ)		**Vapor Treatment Facility 518 Perched Zone (VTF518-PZ)**	
1B	W-518-1914	0	0	0	0
1B/2	W-1615	2.0	<0.01	1,737	4.10
2	W-518-1913	0	0	0	0
2	W-518-1915	<1	0.01	251	3.99
2	SVB-518-201	0	0	0	0
2	SVB-518-204	0	0	0	0
		Treatment Facility 5475-1 (TF5475-1)			
3A	W-1302-2	0	0	-	-
		Treatment Facility 5475-2 (TF5475-2)			
2	W-1415	<1	<0.01	-	-
5	W-1108	1,133	1.63	-	-
		Treatment Facility 5475-3 (TF5475-3)			
3A	W-1605	0	0	-	-
3A	W-1608	0	0	-	-
4	W-1604	0	0	-	-
5	W-1609	0	0	-	-

Table 4. 2010 Livermore Site performance summary. (Continued)

HSU	Extraction well	Volume of ground water treated (kgal)	Estimated VOC mass removed from ground water (kg)	Volume of soil vapor treated (kft^3)	Estimated VOC mass removed from soil vapor (kg)
				Vapor Treatment Facility 5475 (VTF5475)	
1B/2	W-ETS-507	-	-	0	0
2	W-2211	-	-	0	0
2	W-2302	-	-	0	0
2	W-2303	-	-	0	0
2	SVI-ETS-504	-	-	0	0
3A	W-1605	-	-	0	0
3A	W-1608	-	-	0	0
3A	W-2212	-	-	0	0

Notes:

- = Not applicable.

HSU = Hydrostratigraphic Unit.

kg = Kilogram.

kgal = Thousands at gallons.

kft^3 = Thousands of cubic feet.

VOC = Volatile Organic Compound.

Table 5. Livermore Site wells installed in 2010.

Well number	Location	Purpose
W-2601	TFD-S	Ground water extraction well to hydraulically contain and treat a HSU 5 TCE plume emanating from the east
W-2602	TFE-E	Ground water extraction well to hydraulically contain and treat a HSU 4 TCE plume emanating from the east
W-2603	TFE	Monitor well positioned to intersect the leading edge of a HSU 3A plume originating in the B419 area
W-2604A & B	Former Building 514 area	Monitor wells screened in HSU 2 and 2/5 to delineate VOC source
W-2605A & B	Former Building 514 area	Monitor wells screened in HSU 1B and 2/5 to delineate VOC source
W-2606	Building 511	Angled dual extraction well screened in HSU 2/5 beneath Building 511 to treat TCE source
W-2607	Building 511	Angled soil vapor extraction well screened in HSU 2/5 beneath Building 511 to treat TCE source
W-2608	Building 511	Angled soil vapor extraction well screened in HSU 2/5 beneath Building 511 to treat TCE source
W-2611	TFC Hotspot	Performance monitor well screened in HSU 1B as part of the ESAR treatability test scheduled for 2011
W-2612	TFC Hotspot	Performance monitor well screened in HSU 1B as part of the ESAR treatability test scheduled for 2011
W-2616	TF-518 North	Monitor well screened in HSU 4 to identify tritium source impacting TF518 North and TFE Southwest
W-2617	TF-518 North	Monitor well screened in HSU 3B to identify tritium source impacting TF518 North and TFE Southwest
W-2618	TFE Hotspot	Dual extraction well screened in HSU 2 as part of the ESAR pneumatic fracturing treatability test
W-2619	TFE Hotspot	Dual extraction well screened in HSU 2 as part of the ESAR pneumatic fracturing treatability test
W-2620A	TFE Hotspot	Dual extraction well screened in HSU 2 as part of the ESAR pneumatic fracturing treatability test
W-2621	TFE Hotspot	Dual extraction well screened in HSU 2 as part of the ESAR pneumatic fracturing treatability test
W-2622	TFE Hotspot	Dual extraction well screened in HSU 2 as part of the ESAR pneumatic fracturing treatability test
W-2623	TFE Hotspot	Dual extraction well screened in HSU 2 as part of the ESAR pneumatic fracturing treatability test

Appendix A

Well Construction and Closure Data

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
W-001	GW Monitor	21-Oct-80	122.5	116	1	95-100	1B	6
					2	104-114	2	6
W-001A	GW Monitor	12-Apr-84	180	156	1	145-156	2	5.3
W-002	GW Monitor	29-Aug-80	102.5	101	1	86-101	1B	2.8
W-002A	GW Monitor	2-Apr-84	185	164	1	150-164	2	9.3
W-004	GW Monitor	28-Jul-80	92	92	1	75-90	1B	7
W-005	GW Monitor	24-Oct-80	93.5	90	1	56-71	1B	7
					2	81-86	1B	7
W-005A	GW Monitor	9-Apr-84	115	105	1	95-105	2	11.5
W-007	GW Monitor	3-Oct-80	110.5	100	1	76-81	2	1.5
					2	88-98	3A	1.5
W-008	GW Monitor	14-May-81	110	105	1	72-77	3A	7
					2	92-102	3B	7
W-011	GW Monitor	3-Jun-81	252	191	1	136-141	5	8.5
					2	177-187	5	8.5
W-012	GW Monitor	14-Aug-80	115.8	115	1	99-114	2	5
W-016	GW Monitor	30-Oct-80	122.7	119	1	NA	NA	NA
W-017	GW Monitor	8-Oct-80	114	109	1	94-109	5	0.4
W-017A	GW Monitor	20-May-81	181.4	160	1	127-132	7	5.5
					2	147-157	7	5.5
W-101	GW Monitor	25-Jan-85	77	72	1	62-72	1B	2
W-102	GW Monitor	14-Feb-85	396.5	171.5	1	151.5-171.5	2	6.6
W-103	GW Monitor	14-Feb-85	96	89.5	1	79.5-89.5	1B	6.2
W-104	GW Monitor	21-Feb-85	61.5	56.5	1	38.75-56.5	1B	3.1
W-105	GW Monitor	26-Feb-85	69	62	1	42-62	1B	1
W-106	GW Monitor	6-Mar-85	144	134.5	1	127.5-134.5	5	0.3
W-107	GW Monitor	13-Mar-85	128	122	1	115-122	5	2.5
W-108	GW Monitor	21-Mar-85	113.5	69	1	57-69	1A	13
W-109	GW Extraction	2-Apr-85	289	147	1	137-147	2	13
W-110	GW Monitor	26-Apr-85	371	365	1	340-365	5	16
W-111	GW Monitor	2-May-85	122	117	1	97-117	2	3.4
W-112	GW Monitor	10-May-85	129	123.5	1	111-123.5	5	3.5
W-113	GW Monitor	16-May-85	124	115	1	100-115	5	0.4
W-114	GW Monitor	23-May-85	70.5	66	1	51-63	1B	0.5
W-115	GW Monitor	3-Jun-85	106	95	1	88-95	1B	5.4

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
W-116	GW Monitor	14-Jun-85	181	92.6	1	86-91	1B	0.3
W-117	GW Monitor	27-Jun-85	202	150.1	1	138-148	7	6
W-118	GW Monitor	19-Jul-85	206.5	110	1	99-110	2	10
W-119	GW Monitor	2-Aug-85	139	102.5	1	87.5-102.5	2	9
W-120	GW Monitor	19-Aug-85	195	153	1	147-153	2	3.5
W-121	GW Monitor	23-Aug-85	194	171	1	159-171	2	6
W-122	GW Monitor	17-Aug-85	189	132	1	125-132	2	13.4
W-123	GW Monitor	1-Oct-85	174	47.7	1	37.3-47.7	1A	6
W-141	GW Monitor	23-Mar-85	61.5	60	1	45-60	1B	0.5
W-142	GW Monitor	29-Mar-85	74.2	72	1	62-72	2	0.5
W-143	GW Monitor	12-Apr-85	130	126	1	121-126	2	6
W-146	GW Monitor	16-Jul-85	225	125	1	115-125	2	9.4
W-147	GW Monitor	26-Jul-85	137	87	1	77-87	1B	0.5
W-148	GW Monitor	8-Aug-85	152	98	1	83-98	1B	0.5
W-151	GW Monitor	30-Sep-85	247	158	1	148.5-157.5	2	8
W-201	GW Monitor	17-Oct-85	211	161	1	151-161	2	14
W-202	GW Monitor	7-Nov-85	191	109	1	99-109	2	0.4
W-203	GW Monitor	15-Nov-85	87	41	1	31-41	1A	5
W-204	GW Monitor	22-Nov-85	160	110	1	100-110	2	2.5
W-205	GW Monitor	9-Dec-85	180	117	1	107-117	3B	0.3
W-206	GW Monitor	19-Dec-85	188	118	1	106-118	3A	NA
W-207	GW Monitor	24-Jan-86	150	85	1	69-85	2	0.4
W-210	GW Monitor	11-Mar-86	176	113	1	108-113	3B	0.3
W-212	GW Monitor	28-Mar-86	183	136	1	124-136	5	1.3
W-213	GW Monitor	4-Apr-86	174	100	1	94-100	1B	4
W-214	GW Monitor	11-Apr-86	146	141.5	1	134-141.5	2	18
W-217	SV Extraction	20-May-86	200	112.5	1	98.5-112.5	5	0.3
W-218	GW Monitor	30-May-86	201	71	1	64.5-71	1B	10
W-219	GW Monitor	13-Jun-86	214	148	1	141-148	5	4.5
W-220	GW Monitor	25-Jun-86	196	92.5	1	82.5-92.5	2	0.4
W-221	GW Monitor	7-Jul-86	178	95	1	82-95	3A	2
W-222	GW Monitor	17-Jul-86	197	83	1	63-83	2	15
W-223	GW Monitor	15-Aug-86	202	153	1	146-153	2	4.2
W-224	GW Monitor	26-Aug-86	199	88	1	78-88	2	8.1
W-225	GW Monitor	9-Sep-86	238	166	1	152-166	5	4.2

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
W-226	GW Monitor	25-Sep-86	173	86	1	71-86	1B	0.5
W-251	GW Monitor	3-Oct-85	50	47.5	1	35.5-47.5	1A	7.9
W-252	GW Monitor	18-Oct-85	197	126	1	108-126	2	6
W-253	GW Monitor	30-Oct-85	180	128	1	112.5-128	2	2.3
W-254	GW Extraction	21-Nov-85	277	89	1	82-89	1B	2
W-255	GW Monitor	5-Dec-85	187	124	1	115-124	5	10
W-256	GW Monitor	19-Dec-85	187	137	1	132-137	5	6
W-257	GW Monitor	15-Jan-86	197	96.5	1	82.5-96.5	2	0.5
W-258	GW Monitor	31-Jan-86	157	121.5	1	116.5-121.5	3A	NA
W-259	GW Monitor	7-Feb-86	200	99	1	93.5-99	2	0.3
W-260	GW Monitor	27-Feb-86	215	151	1	141-151	2	5.1
W-261	GW Monitor	12-Mar-86	225	118.5	1	109-118.5	5	0.5
W-262	GW Extraction	20-Mar-86	256	100	1	91-100	1B	12
W-263	GW Monitor	7-Apr-86	146	130	1	123-130	2	3
W-264	GW Monitor	14-Apr-86	170	151	1	141-151	2	15
W-265	GW Monitor	25-Apr-86	216	211	1	205-211	3B	2.5
W-267	GW Monitor	27-May-86	196	179	1	172.5-179	3A	3.3
W-268	GW Monitor	4-Jun-86	213	150.5	1	138-150.5	5	6
W-269	GW Monitor	16-Jun-86	185	92	1	79-92	1B	6.8
W-270	GW Monitor	26-Jun-86	185	127	1	113-127	5	0.3
W-271	GW Monitor	7-Jul-86	201	112	1	105-112	2	7.2
W-272	GW Monitor	18-Jul-86	226	110	1	95-110	2	1.3
W-273	GW Monitor	11-Aug-86	203	84	1	64-84	2	3.4
W-274	Dual Extraction	21-Aug-86	217	95	1	90-95	2	NA
W-275	GW Monitor	5-Sep-86	262	184	1	179-184	5	5.9
W-276	GW Monitor	17-Sep-86	267	170	1	153.5-169.5	3A	12
W-277	GW Monitor	3-Oct-86	254	169	1	163-169	3B	6
W-290	GW Monitor	8-Jul-86	181	126	1	119.5-126	5	0.3
W-291	GW Monitor	24-Jul-86	194	137	1	127-137	5	0.3
W-292	GW Extraction	10-Aug-86	250	184.5	1	176-184.5	3B	NA
W-293	GW Monitor	27-Aug-86	229	155	1	145-155	5	5
W-294	GW Monitor	15-Sep-86	251	139	1	122-139	5	6
W-301	GW Monitor	7-Oct-86	203	141	1	136-141	2	10
W-302	GW Monitor	22-Oct-86	191	83.5	1	78-83.5	1B	2
W-303	GW Monitor	28-Oct-86	197	128	1	124-128	2	24

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
W-304	GW Monitor	12-Nov-86	207	200	1	195-200	4	0.7
W-305	GW Extraction	18-Nov-86	146	138	1	128-138	2	16.2
W-306	GW Monitor	4-Dec-86	207	110	1	98-110	2	8.3
W-307	GW Monitor	15-Dec-86	214	102	1	93-102	1B	1.4
W-308	GW Monitor	13-Jan-87	194	113	1	107-113	2	2.4
W-310	GW Monitor	4-Feb-87	202	184.5	1	176.5-184.5	3A	20
W-311	GW Monitor	20-Feb-87	226.5	147.5	1	134.5-147.5	3A	NA
W-312	GW Monitor	5-Mar-87	224.5	168	1	160-168	4	16.7
W-313	GW Monitor	12-Mar-87	99	85	1	80-85	2	7.8
W-314	GW Extraction	20-Mar-87	228	142	1	129-142	4	19
W-315	GW Monitor	3-Apr-87	215	156	1	141-156	3A	15
W-316	GW Monitor	15-Apr-87	196	72	1	68-71	2	7
W-317	GW Monitor	20-Apr-87	100	95	1	88-95	2	14
W-318	GW Monitor	28-Apr-87	200	81	1	74-81	2	6
W-319	GW Monitor	5-May-87	198	125	1	119-125	3A	15
W-320	GW Monitor	11-May-87	106	99	1	94-99	2	5
W-321	GW Monitor	29-May-87	356	321.5	1	305-321.5	5	17
W-322	GW Monitor	1-Jul-87	565.5	152	1	142-152	2	8
W-323	GW Monitor	4-Aug-87	200	127	1	122-127	2	5.6
W-324	GW Monitor	17-Aug-87	219	189	1	184-189	3A	15
W-325	GW Monitor	28-Aug-87	312	170	1	158-170	3A	10
W-351	GW Extraction	17-Oct-86	191	152	1	146-152	4	6.5
W-353	GW Monitor	12-Nov-86	205	101	1	95.5-101	2	2.4
W-354	GW Monitor	24-Nov-86	185	179	1	163-179	4/5	17.6
W-355	GW Monitor	5-Dec-86	202	107	1	102-107	2	1.7
W-356	GW Monitor	18-Dec-86	237	137	1	133-137	3B	5
W-357	GW Extraction	12-Jan-87	197	123	1	107-123	2	13.6
W-359	GW Extraction	10-Feb-87	195	150.5	1	138-150.5	5	5
W-361	GW Monitor	5-Mar-87	257	135	1	125-135	3A	6
W-362	GW Monitor	13-Mar-87	151	145	1	131-145	4	15
W-363	GW Monitor	24-Mar-87	195	129	1	117-129	3A	6
W-364	GW Monitor	31-Mar-87	195	165	1	155-165	3B	6.5
W-365	GW Monitor	9-Apr-87	187	125	1	120-125	2	10
W-366	GW Monitor	20-Apr-87	273	251	1	240-251	4	17.6
W-368	GW Extraction	6-May-87	206	78	1	70-78	1B	3.5

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
W-369	GW Monitor	14-May-87	204	113	1	107-113	2	7
W-370	GW Monitor	29-May-87	286	208	1	196.5-208	4	10
W-371	GW Monitor	12-Jun-87	233	162	1	155-162	3A	5
W-372	GW Monitor	25-Jun-87	218	152.5	1	147.5-152.5	4	7.5
W-373	GW Monitor	6-Jul-87	178	99	1	89-99	1B	9
W-375	GW Monitor	29-Jul-87	223	71	1	65-71	2	0.4
W-376	GW Monitor	27-Aug-87	249	172	1	162-172	2	4
W-377	GW Monitor	4-Sep-87	159	144	1	141.5-144	2	0.5
W-378	GW Monitor	9-Sep-87	155	150	1	146-150	2	0.5
W-379	GW Monitor	14-Sep-87	155	150	1	146-150	2	0.5
W-380	GW Monitor	1-Oct-87	195	182	1	170-182	3A	9.1
W-401	GW Monitor	5-Nov-87	159	153	1	109-153	2	18
W-402	GW Monitor	13-Oct-87	104	102	1	92-102	1B	20
W-403	GW Monitor	16-Nov-87	585	495	1	485-495	7	15
W-404	GW Extraction	4-Dec-87	245	158	1	150-158	2	20
W-405	GW Monitor	4-Jan-88	244	162	1	132-162	2	20
W-406	GW Monitor	20-Jan-88	213	94	1	79-84	1B	5
W-407	GW Monitor	4-Feb-88	215	205	1	192-205	3A	10
W-408	GW Extraction	16-Feb-88	131	122.5	1	103-122.5	1B	20
W-409	GW Monitor	7-Mar-88	272	78	1	71-78	1B	20
W-410	GW Monitor	30-Mar-88	369	205	1	193-205	3A	16
W-411	GW Monitor	12-Apr-88	192	138	1	131-138	2	20
W-412	GW Monitor	18-Apr-88	104	74	1	67-74	1B	4
W-413	GW Extraction	28-Apr-88	163	115	1	100-115	2	12
W-415	GW Extraction	12-Aug-88	205	183.7	1	79-179	1B/2	50
W-416	GW Monitor	10-Jun-88	152	80.5	1	72-80.5	1B	20
W-417	GW Monitor	20-Jun-88	152	60	1	51-60	1B	5
W-418	GW Monitor	24-Jun-88	124	124	1	108-118	2	0.5
W-419	GW Monitor	29-Jun-88	82	82	1	62.5-75.5	1B	0.5
W-420	GW Monitor	26-Jul-88	127	111	1	105-111	2	4
W-421	GW Monitor	23-Aug-88	181	90	1	75-90	1B	5
W-422	GW Monitor	2-Sep-88	203	139.5	1	133-139.5	2	9
W-423	GW Monitor	9-Sep-88	308	118	1	106-118	2	19
W-424	GW Monitor	4-Oct-88	208	144	1	137-144	3A	6
W-441	GW Monitor	14-Oct-87	250	144	1	135-144	5	3

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
W-446	GW Monitor	18-Dec-87	202	196	1	186-196	3A	0.5
W-447	GW Monitor	05-Feb-88	353	274	1	256-274	4	8
W-448	GW Monitor	17-Feb-88	235	127.5	1	120.5-127.5	2	20
W-449	GW Monitor	7-Mar-88	172	165	1	152-165	2	6
W-450	GW Monitor	21-Mar-88	300	200	1	193-200	5	6
W-451	GW Monitor	6-Apr-88	202	112	1	106-112	2	3
W-452	GW Monitor	15-Apr-88	210	79.5	1	64-79.5	1B	7
W-453	GW Monitor	27-Apr-88	185	130	1	121-130	2	8
W-454	GW Monitor	9-May-88	196	83	1	73-83	1B	3
W-455	GW Monitor	19-May-88	184	162.5	1	148-162.5	2	5
W-457	GW Extraction	22-Jun-88	289	149.5	1	130-149.5	2	20
W-458	GW Monitor	30-Jun-88	212.5	116	1	108-116	2	2
W-459	GW Monitor	20-Jul-88	76	73	1	59.5-73	1B	0.5
W-461	GW Monitor	16-Aug-88	133	50.5	1	41.5-50.5	2	0.5
W-462	GW Monitor	12-Sep-88	385	337	1	331-336.5	5	10
W-463	GW Monitor	16-Sep-88	93	92.8	1	87-92.5	1B	20
W-464	GW Monitor	30-Sep-88	253	104.5	1	96-104.5	2	7
W-481	GW Monitor	4-Nov-87	224.5	105	1	100-105	1B	2
W-482	GW Monitor	15-Jan-88	218	170	1	165-170	2	0.5
W-483	GW Monitor	26-Jan-88	140	130	1	115-130	2	0.5
W-484	GW Monitor	11-Feb-88	255	188	1	185-188	3A	0.5
W-485	GW Monitor	25-Feb-88	249	157	1	151-157	2	0.5
W-486	GW Monitor	11-Mar-88	167	110	1	100-108	2	6
W-487	GW Monitor	17-Mar-88	180	151	1	148-151	3B	5
W-501	GW Monitor	13-Oct-88	174	92	1	84-92	1B	6
W-502	GW Monitor	25-Oct-88	158	59	1	55-59	1B	0.5
W-503	GW Monitor	2-Nov-88	187	80	1	74-80	1B	2
W-504	GW Monitor	21-Nov-88	358	167	1	157-167	2	8
W-505	GW Monitor	15-Dec-88	278	180	1	167-180	2/3A	18
W-506	GW Monitor	22-Dec-88	120	115	1	101-115	1B	9
W-507	GW Monitor	18-Jan-89	158	139	1	129-139	2	15
W-508	GW Monitor	17-Feb-89	316	306	1	287-305	7	18
W-509	GW Monitor	3-Mar-89	305	184	1	179-184	5	2
W-510	GW Monitor	15-Mar-89	300	119.1	1	111-119	2	0.5
W-511	GW Monitor	31-Mar-89	316	176	1	167-176	3B	2

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
W-512	GW Monitor	13-Apr-89	261	176.5	1	166-176	5	2.5
W-513	GW Monitor	26-Apr-89	259	115	1	102-115	2	1
W-514	GW Monitor	17-May-89	386	115.5	1	92-115.5	1B	2
W-515	GW Monitor	30-May-89	211	78	1	68-78	1B	3
W-516	GW Monitor	9-Jun-89	203	119	1	114-119	2	10
W-517	GW Monitor	20-Jun-89	215	88.2	1	80-88	1B	8
W-518	GW Extraction	8-Aug-89	251	139.3	1	131-139	2	6.7
W-519	GW Monitor	14-Aug-89	186.5	80.6	1	60-80.5	1B	20
W-520	GW Extraction	30-Aug-89	160	101.5	1	94-101.5	1B	10
W-521	GW Monitor	13-Sep-89	166	95.4	1	86-95	1B	1.5
W-522	GW Extraction	5-Oct-89	145.5	141.5	1	134-141.5	2	16
W-551	GW Monitor	18-Oct-88	308	155.5	1	151-155.5	2	9
W-552	GW Monitor	25-Oct-88	70.5	64.5	1	48.5-64	1B	15
W-553	GW Monitor	3-Nov-88	186	106.5	1	99-106.5	2	2
W-554	GW Monitor	22-Nov-88	239	141.5	1	126.5-141.4	2	15
W-555	GW Monitor	5-Dec-88	122	116.5	1	102.5-116.5	1B	14.5
W-556	GW Monitor	15-Dec-88	192	81.5	1	76-81.5	1B	15
W-557	GW Monitor	22-Dec-88	122.5	118	1	102-118	2	10
W-558	GW Monitor	17-Jan-89	117	110.5	1	101-110.5	1B	20.5
W-559	GW Monitor	24-Jan-89	105	100	1	93-100	1B	1.2
W-560	GW Monitor	7-Feb-89	263	206.5	1	201-206.5	3B	5
W-561	GW Monitor	23-Feb-89	180	152	1	143-152	5	1
W-562	GW Monitor	8-Mar-89	263	158.5	1	145-158	5	1.5
W-563	GW Monitor	17-Mar-89	192	105.5	1	95-105	2	8
W-564	GW Monitor	30-Mar-89	184	85	1	79.5-85	1B	3.5
W-565	GW Monitor	6-Apr-89	177	82.5	1	75-82.5	1B	15
W-566	GW Extraction	19-Apr-89	317	207.5	1	197-207	5	15
W-567	GW Monitor	27-Apr-89	194	61.5	1	51-61	1B	10.5
W-568	GW Monitor	5-Jun-89	156	101	1	97-101	2	10
W-569	GW Monitor	16-May-89	215	109.5	1	101-109.5	2	3
W-570	GW Monitor	9-Jun-89	180	175	1	161-175	5	2
W-571	GW Monitor	15-Jun-89	223.5	107.5	1	102-107	1B	20
W-592	GW Monitor	12-Dec-88	136.5	113	1	101-112	2	1.2
W-593	GW Monitor	6-Feb-89	159	92.5	1	82-92.5	3A	2.1
W-594	GW Monitor	27-Feb-89	156	61	1	55-61	2	0.5

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
W-601	GW Extraction	13-Oct-89	146	96	1	88-96	1B	12
W-602	GW Extraction	6-Nov-89	268	100.2	1	90-100	1B	11
W-603	GW Extraction	15-Nov-89	150	147	1	141-147	2	6
W-604	GW Monitor	27-Nov-89	111	83	1	76-82	1B	0.4
W-605	GW Extraction	8-Dec-89	246	136	1	130-136	2	5
W-606	GW Monitor	21-Dec-89	145	89	1	73-89	1B	0.4
W-607	GW Monitor	24-Jan-90	186	55.1	1	49-55	1B	2
W-608	GW Monitor	7-Feb-90	162	66.3	1	55-66	1B	2
W-609	GW Extraction	21-Feb-90	120	112	1	104-112	2	3
W-610	GW Extraction	16-Mar-90	453	84.5	1	69-84.5	1B	5
W-611	GW Monitor	4-Apr-90	161	98	1	87.5-98	1B	3
W-612	GW Monitor	19-Apr-90	222	137	1	126-136	2	10
W-613	GW Monitor	2-May-90	93	88	1	81.5-88	1B	4.5
W-614	GW Extraction	18-May-90	262	123	1	100-123	2	6
W-615	GW Monitor	1-Jun-90	121	99.3	1	91-99	1B	5
W-616	GW Monitor	14-Jun-90	255	188	1	178-188	3A	4
W-617	GW Monitor	26-Jun-90	200	110	1	103-110	2	3
W-618	GW Monitor	17-Jul-90	357	205	1	201-205	3B	3
W-619	GW Monitor	7-Aug-90	330	252	1	232-252	3B/4	20
W-620	GW Extraction	30-Aug-90	206	88.5	1	75-88.5	1B	6
W-621	GW Extraction	9-Sep-90	149	120	1	113-120	2	3.5
W-622	GW Monitor	28-Sep-90	206	112.25	1	104-112	5	0.3
W-651	GW Monitor	22-Feb-90	155	89	1	82-89	1B	0.4
W-652	GW Monitor	15-Mar-90	318	256	1	245-256	7	2
W-653	Dual Extraction	29-Mar-90	225	128	1	122-128	3A	1
W-654	GW Monitor	11-Apr-90	240	158	1	140-158	2	20
W-655	GW Extraction	25-Apr-90	193	130	1	121-129.5	2	15
W-701	GW Extraction	10-Oct-90	159	86	1	74-86	1B	14
W-702	GW Monitor	24-Oct-90	180.5	95	1	77-95	1B	4
W-703	GW Monitor	3-Dec-90	586	325	1	298-325	5	NA
W-704	GW Extraction	2-Feb-91	135	107	1	67-76	1B	20
					2	88-97	1B	20
W-705	GW Monitor	26-Dec-90	126	90	1	77-90	1B	1
W-706	GW Monitor	25-Jan-91	178	85	1	71-85	1B	NA
W-712	GW Extraction	28-Aug-91	200	185.5	1	170-185.5	3A	8

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
W-714	GW Extraction	5-Dec-91	128.5	128	1	107-128	2	NA
W-750	GW Monitor	10-Apr-91	152	150	1	130-150	5	NA
W-901	GW Monitor	24-Feb-93	97.8	88	1	80-83	1B	1
W-902	GW Monitor	22-Jan-93	95.5	88	1	80-83	1B	1
W-903	GW Extraction	28-Apr-93	223	145	1	132-140	2	20
W-904	GW Extraction	6-May-93	212	154	1	121-133	2	30
					2	140-149	2	30
W-905	GW Monitor	7-Apr-93	221	144.5	1	134-144	2	3.5
W-906	GW Extraction	23-Jul-93	200	132	1	58-132	2/3A	8
W-907	GW Extraction	3-Aug-93	239	222	1	172.7-188.7	4	40
					2	204.5-215	5	40
W-908	GW Monitor	17-Aug-93	239	197	1	180-197	5/6	0.4
W-909	GW Monitor	11-Nov-93	252	113.5	1	80.5-113.5	2	2.5
W-911	GW Monitor	20-Sep-93	180	113.65	1	73.65-108.65	2	1.5
W-912	GW Monitor	7-Sep-93	239	174	1	168-174	5	3.5
W-913	GW Monitor	24-Nov-93	454	255	1	235-255	4	30
W-1001	GW Extraction	15-Dec-93	105	92	1	85-92	1B	1.5
W-1002	GW Monitor	12-Nov-93	293	260	1	246-260	5	20
W-1003	GW Monitor	2-Feb-94	184	147	1	140-147	2	1.5
W-1004	GW Extraction	23-Feb-94	100	97	1	71-91	1B	5
W-1008	GW Monitor	13-Apr-94	246	238	1	229.5-238	7	9.5
W-1009	GW Extraction	27-Apr-94	191	140	1	134-140	2	25
W-1010	GW Monitor	24-May-94	463	142	1	130-142	2	25
W-1011	GW Monitor	6-Jun-94	106	89	1	75-89	1B	2
W-1012	GW Monitor	20-Jun-94	161	117	1	96-112	2	2.5
W-1013	GW Monitor	29-Jun-94	147	73	1	65-73	1B	1.5
W-1014	GW Monitor	12-Jul-94	99	89	1	65-89	1B	30
W-1015	GW Extraction	10-Aug-94	437	94	1	84-94	1B	25
W-1101	GW Monitor	10-Nov-94	200	79	1	76-79	1B	1
W-1102	GW Extraction	29-Nov-94	163	95.6	1	76-94	1B	11
W-1103	GW Extraction	15-Dec-94	200	82	1	70-82	1B	4.5
W-1104	GW Extraction	18-Jan-95	165	99.3	1	77-87	1B	35
					2	92-98	1B	35
W-1105	GW Monitor	18-Jan-95	105	93	1	78-93	1B	3.75
W-1106	GW Monitor	17-Jan-95	245	86	1	76-85	1B	17.5

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
W-1107	GW Monitor	6-Mar-95	199.5	93	1	74-88	1B	1.5
W-1108	GW Extraction	17-Mar-95	250	156	1	142-156	5	22.5
W-1109	GW Extraction	11-Apr-95	121	113	1	94-113	2	6.5
W-1110	GW Monitor	4-Apr-95	252	92.9	1	68-92	1B	NA
W-1111	GW Extraction	1-June-95	152	129	1	88-108	1B/2	NA
					2	120-124	2	NA
W-1112	GW Monitor	28-Jun-95	263	210	1	201-210	5	NA
W-1113	GW Monitor	12-Jul-95	260	214	1	204-214	5	NA
W-1115	GW Monitor	12-Oct-95	126.5	118	1	108-118	3A	0.5
W-1116	GW Extraction	17-Aug-95	214.8	101	1	72-98	1B	NA
W-1117	GW Monitor	21-Aug-96	154	132.2	1	122-132	3A	1
W-1118	GW Monitor	27-Sep-95	225	125	1	115-125	3A	NA
W-1201	GW Monitor	18-Oct-95	225	133	1	125-133	3A	1
W-1202	GW Monitor	25-Oct-95	99.3	99	1	83-99	2	5
W-1203	GW Monitor	7-Nov- 95	224	206.2	1	196-206	5	18
W-1204	GW Monitor	20-Nov-95	225	126.2	1	118-126	3A	2.5
W-1205	GW Monitor	27-Nov-95	91	82	1	72-82	2	1
W-1206	GW Extraction	6-Dec-95	220	191	1	174-186	4	40
W-1207	GW Monitor	13-Dec-95	92	90	1	70-90	2	1
W-1208	GW Extraction	9-Jan-96	166	163	1	135-163	3A/3B	40
W-1209	GW Monitor	26-Jan-96	210	164	1	148-164	4	3
W-1210	GW Monitor	12-Feb-96	250	223	1	213-223	5	3
W-1211	GW Extraction	5-Mar-96	273	205	1	185-200	4	25
W-1212	GW Monitor	19-Mar-96	150	75	1	52-75	1B	3
W-1213	GW Extraction	2-Apr-96	129	76	1	64-76	1B	5
W-1214	GW Monitor	22-Apr-96	180	100	1	80-100	1B	2
W-1215	GW Extraction	17-Apr-96	175	120	1	108-118	2	8.5
W-1216	GW Extraction	7-May-96	200	124	1	94-124	2	14
W-1217	GW Monitor	15-May-96	182	98.5	1	78-98	1B	0.25
W-1219	GW Monitor	4-Jun-96	201	142	1	138-142	4	0.18
W-1222	GW Monitor	26-Jun-96	175	125.2	1	115-125	3A	6
W-1223	GW Monitor	23-Jul-96	175	102	1	87-97	2	4
W-1224	GW Monitor	5-Sep-96	125	104.5	1	99-104	1B	4.3
W-1225	GW Monitor	14-Aug-96	150	121.2	1	113-121	3A	2
W-1226	GW Monitor	6-Aug-96	155	126.5	1	116-126	2	1

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
W-1227	GW Monitor	9-Oct-96	200	134	1	126-134	2	11
W-1250	GW Monitor	7-Jun-96	210	200.3	1	130-135	4	0.25
W-1251	GW Monitor	3-Jul-96	210	200.3	1	134-139	4	1.3
W-1252	GW Monitor	25-Jul-96	208	202.3	1	135-140	4	0.15
W-1253	GW Extraction	15-Aug-96	206	200.3	1	127-132	4	0.15
W-1254	GW Extraction	28-Aug-96	210	200	1	131-141	4	26
W-1255	GW Extraction	27-Aug-96	208	200.7	1	124-129	4	0.2
W-1301	GW Extraction	4-Dec-96	180	120.3	1	112-120	3A	15
W-1302	GW Extraction	21-Jan-97	145	138.9	1	116.5-121.2	3A	7.5
					2	125.8-133.8	3A	7.5
W-1303	GW Extraction	6-Feb-97	199.5	107	1	78-102	2	10
W-1304	GW Monitor	20-Feb-97	149.5	125	1	120-125	3A	0.75
W-1306	GW Extraction	6-May-97	200	106	1	81-101	2	3.3
W-1307	GW Extraction	2-Jul-97	150	141	1	126-136	4	20
W-1308	GW Extraction	22-Jul-97	154	116	1	81-111	2	7
W-1309	GW Extraction	11-Aug-97	220	157	1	142-152	4	6
W-1310	GW Extraction	15-Sep-97	220	198	1	173-193	5	28
W-1311	GW Monitor	1-Oct-97	150	120.5	1	100-120	2	14
W-1401	GW Monitor	21-Oct-97	254	120	1	105-120	2	7.8
W-1402	GW Monitor	6-Nov-97	135	112	1	102-112	3A	4.1
W-1403	GW Extraction	13-Nov-97	175	142.5	1	132-142	3B	5
W-1404	GW Extraction	24-Nov-97	162	97.7	1	87-97	2	3.1
W-1405	GW Monitor	24-Nov-97	100	97.8	1	87-97	2	4.5
W-1406	GW Monitor	15-Dec-97	201	150	1	139.2-149.2	4	9.2
W-1407	GW Monitor	18-Dec-97	224	118	1	105-118	2	2
W-1408	GW Monitor	12-Jan-98	134	128	1	118-128	3A	3.8
W-1409	GW Extraction	23-Jan-98	143	140	1	80-135	2	13
W-1410	GW Extraction	19-Feb-98	208.5	131.1	1	126-131	4	9
W-1411	GW Monitor	4-Feb-98	133	128.1	1	114-128	3A	10.6
W-1412	GW Monitor	11-Mar-98	201	108	1	92-107	3A	1
W-1413	GW Monitor	26-Mar-98	163.5	163.5	1	147-157	5	1
W-1414	GW Monitor	31-Mar-98	128	107.5	1	97-107	3A	0.018
W-1415	GW Extraction	15-Apr-98	182	104.72	1	74.5-104.5	2	2
W-1416	GW Monitor	2-Jun-98	194.5	105	1	85-100	2	10.8
W-1417	GW Monitor	23-Apr-98	225	155	1	130-150	3A	8.9

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
W-1418	GW Monitor	5-May-98	252.5	190	1	176-190	4	9
W-1419	GW Monitor	13-May-98	175	115.5	1	90-110	2	4.45
W-1420	GW Monitor	17-Jun-98	175.5	112.5	1	102-112	2	20
W-1421	GW Monitor	28-May-98	230	172	1	157-167	3B	2.1
W-1422	GW Monitor	14-May-98	173.5	169.1	1	162-169	3B	11
W-1423	GW Extraction	2-Jul-98	175	134.5	1	99.5-109.5	2	22.4
					2	119.5-129.5	2	22.4
W-1424	GW Monitor	13-Aug-98	225.3	146	1	126-146	2	6.2
W-1425	GW Monitor	26-Aug-98	115	100.5	1	88.5-100.5	1B	1
W-1426	GW Monitor	3-Sep-98	89	85	1	70-85	1B	10
W-1427	GW Monitor	7-Sep-98	104	80.2	1	70-80	1B	17.7
W-1428	GW Monitor	29-Sep-98	104	78.2	1	63-78	1B	30
W-1501	GW Monitor	12-Oct-98	126.1	88	1	72-88	1B	7.5
W-1502	GW Monitor	27-Oct-98	204	98.7	1	88-98	2	1.7
W-1503	GW Extraction	16-Nov-98	234	181.5	1	171-181	4	24
W-1504	GW Extraction	14-Dec-98	165.2	162.5	1	140-160.4	3A/3B	21.7
W-1505	GW Monitor	20-Jan-99	276	184.5	1	174-184	4	10
W-1506	GW Monitor	3-Feb-99	160	120.5	1	110-120	2	3
W-1507	GW Monitor	19-Feb-99	201.5	169.5	1	159-169	5	0.5
W-1508	GW Monitor	3-Mar-99	135	128.5	1	118-128	2	0.75
W-1509	GW Monitor	24-Mar-99	175	88.5	1	73-88	1B	8
W-1510	GW Extraction	9-Apr-99	114.5	113.5	1	93-113	2	5
W-1511	GW Monitor	27-Apr-99	229	146	1	138-146	3B	15
W-1512	GW Monitor	3-May-99	100	100	1	88-98	2	0.5
W-1513	GW Monitor	11-May-99	122	120	1	108-120	2/3A	NA
W-1514	GW Monitor	24-May-99	127.5	126	1	103-121	2/3A	6.5
W-1515	GW Monitor	8-Jun-99	130	121.5	1	102-120	2/3A	3
W-1516	GW Monitor	17-Jun-99	204.5	200.25	1	188-200	5	17
W-1517	Dual Extraction	6-Jun-99	154	122.4	1	87-97	2	0.1
W-1518	GW Extraction	8-Jul-99	184	115	1	84-107	2	3
W-1519	GW Monitor	3-Aug-99	245	238	1	222-237	5	30
W-1520	GW Extraction	27-Jul-99	178.3	173	1	160-168	4	3.5
W-1522	GW Extraction	11-Aug-99	169	161	1	141-156	3B	9
W-1523	GW Extraction	7-Sep-99	216	172.3	1	164-172	4	15
W-1550	GW Extraction	24-Jun-99	200	130	1	98-125	3A	10

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
W-1551	GW Extraction	15-Jul-99	153	129	1	93-124	3A	10.5
W-1552	Dual Extraction	24-Jun-99	153.5	130	1	97.2-124.5	3A	2
W-1553	GW Monitor	17-Aug-99	153	130	1	98-125	3A/3B	1
W-1601	GW Extraction	13-Oct-99	169	160	1	150-155	3B	2.7
W-1602	GW Extraction	2-Nov-99	115.5	110.7	1	80-90	2	8
W-1603	GW Extraction	16-Nov-99	144	140	1	130-135	3A	71.2
W-1604	GW Extraction	2-Dec-99	194	148.7	1	138-148	4	8
W-1605	Dual Extraction	7-Mar-00	120.5	112	1	90-107	3A	NA
W-1606	SV Monitor	27-Jan-00	175	112	1	90-107	3A	NA
W-1607	SV Monitor	10-Feb-00	155.4	112	1	90-107	3A	0.1
W-1608	Dual Extraction	28-Feb-00	155	112	1	90-107	3A	NA
W-1609	GW Extraction	17-Apr-00	155	135	1	110-130	5	0.1
W-1610	GW Injection	4-May-00	155.3	135	1	110-130	5	0.5
W-1613	GW Monitor	27-Apr-00	219	173.4	1	168.4-173.4	3B	NA
W-1614	GW Monitor	18-May-00	100	89.8	1	79-89	1B	3
W-1615	Dual Extraction	15-Aug-00	55	48	1	15-48	1B/2	NA
W-1650	Dual Extraction	19-Jan-00	145	126	1	96-121	3A	2
W-1651	Dual Extraction	27-Jan-00	145	129	1	94-124	2/3A/3B	1
W-1652	Dual Extraction	9-Feb-00	145	127	1	92-122	3A/3B	0.5
W-1653	Dual Extraction	24-Feb-00	144	124	1	94-119	3A	1.2
W-1654	Dual Extraction	25-Feb-00	146.5	128	1	93-123	3A	1
W-1655	Dual Extraction	8-Mar-00	145	125	1	90-120	2/3A	0.5
W-1656	Dual Extraction	14-Mar-00	145	125.3	1	95.1-120.1	3A	5
W-1657	Dual Extraction	23-Mar-00	145	128	1	95-123	3A/3B	0.5
W-1701	GW Monitor	3-Jul-01	185	180.8	1	140-155	2	15
					2	165-175	2	15
W-1702	GW Monitor	15-Jun-01	15	14.25	1	4-13	2	NA
W-1703	GW Monitor	23-Aug-01	358	341.5	1	331-341	LL	22.6
W-1704	GW Monitor	19-Sep-01	240	118.8	1	98-118	2	2
W-1705	FLUTe	16-Oct-01	225	208.8	1	93-103	2	5
					2	123-128	3A	5
					3	138-143	3B	5
					4	203-208	5	5
W-1801	GW Extraction	18-Mar-02	143	134.4	1	124-134	3A	5
W-1802	GW Monitor	2-Apr-02	175	162.2	1	147-157	3A	NA

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
W-1803	GW Monitor	24-Apr-02	245	240.8	1	175-185	4	15
					2	225-235	5	15
W-1804	GW Monitor	22-May-02	155	110.8	1	80-95	3A	0.5
					2	100-105	3B	0.5
W-1805	GW Monitor	20-Aug-02	110	100.8	1	70-80	1B	6
					2	85-95	1B	6
W-1806	GW Extraction	12-Sep-02	260	106.2	1	80.7-101.2	1B	3
W-1807	GW Extraction	7-Oct-02	165	130	1	115-125	2	10
W-1901	GW Monitor	31-Oct-02	175	127	1	92-97	1B	7
					2	107-122	2	7
W-1902	GW Extraction	21-Nov-02	175	165	1	140-145	3A	20
					2	150-160	3A	20
W-1903	Dual Extraction	16-Dec-02	120	109	1	84-104	2	0.5
W-1904	Dual Extraction	23-Jan-03	120	101	1	75-100	2	0.5
W-1905	GW Monitor	20-May-03	210	123.5	1	103-113	3A	2.5
					2	118-123	3A	2.5
W-1909	Air Inlet	24-Jun-03	110	106.35	1	86-106	2	1.5
W-2005	GW Extraction	3-Feb-04	160	125	1	109-119	3A	2
W-2006	GW Extraction	24-Feb-04	160	132.5	1	122-132	3B	NA
W-2011	Dual Extraction	29-Feb-04	155	116.3	1	106-116	3A	0.3
W-2012	GW Extraction	21-Oct-04	155	136.6	1	111-116	3A	4
					2	126-131	3A	4
W-2101	Dual Extraction	18-Nov-04	160	135.3	1	110-130	3A	0.25
W-2102	Dual Extraction	14-Dec-04	160	138.35	1	118-133	3A	0.33
W-2103	GW Monitor	18-Jan-05	160	133.35	1	113-128	3A	0.5
W-2104A	SV Monitor	8-Feb-05	80	45.5	1	30-45	1B	NA
W-2104B	SV Monitor	8-Feb-05	80	72.55	1	52-72	2	NA
W-2105	Dual Extraction	9-Mar-05	126	115.33	1	90-110	2	0.25
W-2110A	SV Monitor	14-Jun-05	100	58.49	1	38-58	1B/2	NA
W-2110B	SV Monitor	14-Jun-05	100	85.49	1	65-85	2	NA
W-2111A	SV Monitor	22-Jun-05	90	40.3	1	25-40	1B	NA
W-2111B	SV Monitor	22-Jun-05	90	75.3	1	60-75	2	NA
W-2112A	SV Monitor	28-Jun-05	100	58.49	1	38-58	1B/2	NA
W-2112B	SV Monitor	28-Jun-05	100	78.49	1	68-78	2	NA
W-2113	GW Monitor	21-Jul-05	220	201.5	1	190.5-200.5	4	9

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Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
W-2201	GW Extraction	26-Jan-06	130	98.8	1	43.4-53.4	1B	12
					2	73.4-93.4	1B	12
W-2202	GW Monitor	15-Dec-05	140	122.25	1	102-107	3A	0.4
					2	112-117	3A	0.4
W-2203	GW Extraction	10-Jan-06	136.5	131.4	1	121-126	3A	1
W-2204	SV Extraction	26-Jan-06	120	111.38	1	41-66	2	0.1
					2	71-76	2	0.1
					3	91-106	2/3A	0.1
W-2205	SV Extraction	3-Apr-06	127	125.4	1	40-65	2	NA
					2	70-80	2	NA
					3	90-120	2/3A	NA
W-2206	SV Extraction	16-Feb-06	91.5	78.05	1	40-75	2	NA
W-2207A	SV Extraction	9-Mar-06	103	60.41	1	25-35	1B	NA
					2	45-60	1B	NA
W-2207B	SV Extraction	9-Mar-06	103	100.4	1	65-95	2	NA
W-2208A	SV Extraction	30-Mar-06	104	71.38	1	36-66	2	0.1
W-2208B	SV Extraction	30-Mar-06	104	95.63	1	75.2-95.2	2	0.25
W-2211	SV Extraction	30-May-06	106.5	105.3	1	75-105	2	NA
W-2212	SV Extraction	6-Jun-06	115.4	115.4	1	90-115	3A	1
W-2214A	SV Monitor	24-Jul-06	135	39.3	1	6-39	1B/2	NA
W-2214B	SV Monitor	24-Jul-06	135	88.3	1	48-83	2	NA
W-2215A	SV Monitor	9-Aug-06	121.5	82.4	1	47-82	2	NA
W-2215B	SV Monitor	9-Aug-06	121.5	120.5	1	100-120	5	NA
W-2216A	SV Monitor	18-Sep-06	131.5	65.4	1	40-65	2	NA
W-2216B	GW Monitor	18-Sep-06	131.5	126.4	1	106-121	3A	0.2
W-2217A	SV Monitor	12-Oct-06	131.5	48.4	1	18-48	2	NA
W-2217B	SV Monitor	12-Oct-06	131.5	95.4	1	55-75	5	NA
					2	85-95	5	NA
W-2301A	SV Monitor	31-Oct-06	121	57.4	1	32-57	2	NA
W-2301B	SV Monitor	31-Oct-06	121	94.8	1	64.5-94.5	2/3A	NA
W-2302	SV Extraction	1-Feb-07	130	107.3	1	82-102	2	0.1
W-2303	SV Extraction	14-Feb-07	100	79.8	1	45-74.5	2	NA
W-2304	GW Monitor	19-Dec-06	130	124.3	1	114-119	3A	0.15
W-2305	Dual Extraction	23-Jan-07	115	108.3	1	83-103	2	0.5
W-2501	GW Extraction	9-Dec-09	175	144.2	1	128-133	2	15

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Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
W-2502	GW Extraction	28-Dec-09	177	164	1	101-106	2	15
					2	116-126	2	15
					3	143-153	2	15
W-2601	GW Extraction	2-Feb-10	225	220.1	1	179-189	5	20
					2	195-211	5	20
W-2602	GW Extraction	3-Mar-10	175	162.6	1	152-157	4	1
W-2603	GW Monitor	17-Mar-10	251	189.1	1	179-183.9	3A	3.4
W-2604A	GW Monitor	5-Apr-10	130	60.5	1	35-55	2	0.02
W-2604B	GW Monitor	5-Apr-10	130	100.9	1	65-95	2/5	0.03
W-2605A	GW Monitor	14-Apr-10	125	58.2	1	23-53	1B/2	NA
W-2605B	GW Monitor	14-Apr-10	125	110.3	2	70-105	2/5	0.16
W-2606 (a)	GW Extraction	28-Apr-10	113.1	112.6	1	59.9-110.3	2/5	NA
W-2607 (a)	GW Extraction	11-May-10	120.2	104.1	1	50.9-101.8	2/5	NA
W-2608 (a)	GW Extraction	27-May-10	160.1	82.1	1	31.1-80.6	2/5	NA
W-2611	GW Monitor	13-Jul-10	90	75.2	1	50-75	1B	1.66
W-2612	GW Monitor	21-Jul-10	137	73.8	1	43.8-73.5	1B	0.22
W-2616	GW Monitor	12-Aug-10	187	145.4	1	130-140.5	4	0.09
W-2617	GW Monitor	24-Aug-10	177	127.2	1	117-121.9	3B	0.04
W-2618	GW Monitor	29-Oct-10	111	103.8	1	77.3-103.3	2	NA
W-2619	GW Monitor	1-Nov-10	110	105.5	1	75-105	2	NA
W-2620A	GW Monitor	11-Oct-10	110	105.3	1	75-105	2	NA
W-2621	GW Monitor	12-Oct-10	110	105.2	1	75-105	2	NA
W-2622	GW Monitor	20-Oct-10	111	105.2	1	75-105	2	NA
W-2623	GW Monitor	24-Oct-10	111	105.2	1	75-105	2	NA
SIP-141-201	Piezometer	2-Feb-96	77	74.2	1	57-74	1B	0.5
SIP-141-202	Piezometer	12-Feb-96	80	74	1	64-74	1B	0.5
SIP-141-203	Piezometer	20-Feb-96	87	83	1	72-83	1B	NA
SIP-191-001	Piezometer	1-Aug-94	50	NA	1	NA	1A	NA
SIP-191-002	Piezometer	21-Apr-94	66	61	1	45-61	1B	NA
SIP-191-003	Piezometer	26-Apr-94	50.5	45	1	35-45	1B	NA
SIP-191-004	Piezometer	15-Jul-94	57.5	NA	1	47.5-53.5	1B	NA
SIP-191-005	Piezometer	4-May-94	54	48	1	42-48	1A	NA
SIP-191-101	Piezometer	18-Nov-94	68.5	64	1	58-64	1B	NA
SIP-212-101	Piezometer	14-Mar-96	94	90.5	1	87-90.5	2	NA
SIP-293-001	Piezometer	5-Dec-90	56.5	50	1	45-50	1B	NA

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Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
SIP-331-001	Piezometer	21-Sep-95	122	116.5	1	106.5-116.5	2	NA
SIP-419-101	Piezometer	8-Sep-95	127	123	1	112-123	3B	NA
SIP-419-202	Piezometer	6-Mar-96	110	106.5	1	97-106.5	3A	NA
SIP-490-101	Piezometer	1-Nov-95	60	58	1	53-56	2	NA
SIP-490-102	Piezometer	8-Nov-95	75	73.5	1	53.5-73.5	2	0.5
SIP-501-004	Piezometer	20-Oct-92	60	56.9	1	48.5-56.9	1B	NA
SIP-501-006	Piezometer	11-Nov-92	59.5	56	1	50-56	1B	NA
SIP-501-007	Piezometer	16-Nov-92	64	59	1	53-59	1B	NA
SIP-501-101	Piezometer	10-May-94	77.5	73	1	69-73	1B	NA
SIP-501-102	Piezometer	16-May-94	77	73	1	67-73	1B	NA
SIP-501-103	Piezometer	20-May-94	63	57.5	1	51-57.5	1B	NA
SIP-501-104	Piezometer	15-Jul-94	67	62	1	50-62	1B	NA
SIP-501-105	Piezometer	1-Sep-94	73	68	1	63-68	1B	NA
SIP-501-201	Piezometer	29-Nov-94	65	58.5	1	54-58.5	1B	NA
SIP-501-202	Piezometer	1-Jul-95	70	64.5	1	58-64.5	1B	NA
SIP-511-101	Piezometer	25-Jan-96	110	106.7	1	100-106.7	3A	0.5
SIP-511-102	Piezometer	2-Apr-96	114	110	1	108-110	3B	0.5
SIP-514-107	Piezometer	3-Jan-90	21.5	17	1	9-17	1B	NA
SIP-514-109	Piezometer	5-Jan-90	21.5	21.5	1	7-21.5	1B	NA
SIP-514-112	Piezometer	8-Jan-90	21.5	18	1	7-18	1B	NA
SIP-514-114	Piezometer	9-Jan-90	21.5	17	1	4-17	1B	NA
SIP-514-116	Piezometer	10-Jan-90	21.5	17	1	7-17	1B	NA
SIP-514-117	Piezometer	11-Jan-90	21.5	17.5	1	6-17.5	1B	NA
SIP-514-119	Piezometer	12-Jan-90	21.5	16	1	5-16	1B	NA
SIP-514-123	Piezometer	17-Jan-90	26.5	23	1	11.5-23	1B	NA
SIP-514-124	Piezometer	17-Jan-90	21.5	17	1	6-17	1B	NA
SIP-514-125	Piezometer	19-Jan-90	21.5	15	1	6-15	1B	NA
SIP-514-126	Piezometer	18-Jan-90	26.5	21.5	1	4-21.5	1B	NA
W-514-2007A	SV Extraction	18-Mar-04	110	45.5	1	15-45	1B/2	NA
W-514-2007B	SV Extraction	18-Mar-04	110	102.5	1	72-102	2/5	NA
SIP-518-101	Piezometer	20-Sep-90	125	61	1	55-61	2	NA
SVB-518-201	Dual Extraction	3-Mar-93	59.8	50	1	34-50	2	NA
SVB-518-202	SV Monitor	3-Nov-93	120.6	73.7	1	19-73.7	1B/2	NA
SIP-518-203	Piezometer	21-Oct-93	132.1	127	1	121-127	5	NA
SVB-518-204	Dual Extraction	5-Nov-93	121.5	50	1	24-46	2	NA

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Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
SVB-518-302	GW Monitor	22-Jun-95	104.5	39.5	1	11-39	NA	NA
W-518-1914	Dual Extraction	9-Oct-03	18	16	1	5.5-15.5	1B	NA
W-518-1915	Dual Extraction	15-Oct-93	104.5	41	1	30.5-40.5	2	NA
W-543-001	SV Extraction	25-Feb-03	71.5	67.5	1	52-67	2	NA
W-543-002A	SV Monitor	10-Mar-03	96	65.4	1	45-65	2	NA
W-543-002B	SV Monitor	10-Mar-03	96	82.5	1	72-82	2	NA
W-543-003	SV Extraction	20-Mar-03	95	80	1	69-79	2	NA
W-543-004A	SV Monitor	27-Mar-03	95	64.5	1	49-64	2	NA
W-543-004B	SV Monitor	27-Mar-03	95	80.5	1	70-80	2	NA
SIP-543-101	Piezometer	1-Jul-95	111	104	1	93-103	2	NA
W-543-1908	SV Extraction	12-Jun-03	40.8	40.4	1	20-40	1B	9
SIP-ALP-001	Piezometer	3-May-90	66.5	60	1	45-60	2	NA
SIP-ALP-002	Piezometer	7-May-90	62	57.5	1	47.5-57.5	2	NA
SIP-AS-001	Piezometer	30-Apr-90	100.5	90.5	1	81-90.5	1B	NA
SIP-CR-049	Piezometer	26-Feb-90	41.5	40	1	36-40	1B	NA
SIP-EGD-001	Piezometer	16-Oct-90	101.5	85	1	75-85	2	NA
SIP-ETC-201	Dual Extraction	26-Mar-96	106	100	1	80-100	2	0.5
SIP-ETC-301	Piezometer	9-Apr-99	102	NA	1	NA	NA	NA
SIP-ETC-303	Piezometer	24-May-99	111	88	1	82-88	2	NA
W-ETC-2001A	SV Monitor	10-Nov-03	95	23.5	1	18-23	1B	NA
W-ETC-2001B	SV Monitor	10-Nov-03	95	88.5	1	78-88	2	NA
W-ETC-2002A	SV Monitor	25-Nov-03	95	64.5	1	34-64	1B/2	NA
W-ETC-2002B	SV Monitor	25-Nov-03	95	85.5	1	75-85	2	NA
W-ETC-2003	SV Extraction	9-Dec-03	95	45.5	1	20-45	1B	NA
W-ETC-2004A	SV Extraction	17-Dec-03	95	53.5	1	28-53	1B/2	NA
W-ETC-2004B	SV Extraction	17-Dec-03	95	88.5	1	63-68	2	NA
SIP-ETS-201	Piezometer	5-Feb-91	95	90	1	85-90	3A	NA
SIP-ETS-204	Piezometer	7-May-91	102.5	97	1	87-97	3A	NA
SIP-ETS-205	Piezometer	20-Jun-91	103	95	1	89.5-95	3A	NA
SIP-ETS-209	Piezometer	25-Jul-91	96.6	90.5	1	79.5-89.8	2	NA
SIP-ETS-211	Piezometer	6-Aug-91	103	98.5	1	95-98.5	3A	NA
SIP-ETS-212	Piezometer	14-Aug-91	106.5	102.5	1	97.5-102.25	2	NA
SIP-ETS-213	Piezometer	15-Nov-91	118.5	116.5	1	108.5-116.5	3A	NA
SIP-ETS-214	Piezometer	22-Nov-91	101	101	1	86-101	3A	NA
SIP-ETS-215	Piezometer	3-Dec-91	94.5	94.5	1	84.5-94.5	3A	NA

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Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
SIP-ETS-302	Piezometer	30-Mar-92	117.4	113	1	97-113	3A	NA
SIP-ETS-303	Piezometer	2-Apr-92	110.7	102	1	95-102	3A	NA
SIP-ETS-304	Piezometer	27-Aug-92	100	97	1	90-97	3A	NA
SIP-ETS-306	Piezometer	11-Sep-92	101	93	1	80.5-93	3A	NA
SIP-ETS-307	Piezometer	8-Dec-92	105.5	NA	NA	NA	NA	NA
SIP-ETS-401	Piezometer	2-Aug-95	122	122	1	116-121	3A	NA
SIP-ETS-402	Piezometer	8-Aug-95	110	110	1	97-107	2	NA
SIP-ETS-404	Piezometer	22-Aug-95	99	99	1	83.5-95.5	2	NA
SIP-ETS-405	Piezometer	29-Aug-95	126	126	1	114.5-123	3A	NA
SIP-ETS-501	Piezometer	16-Nov-95	110	106.5	1	100-106.5	3A	NA
SIP-ETS-502	Piezometer	5-Dec-95	95	88	1	80-88	2	NA
SVI-ETS-504	SV Extraction	9-Jul-96	76.5	67	1	42-67	2	NA
SVI-ETS-505	SV Injection	18-Jul-96	80	77.5	1	45-75	2	NA
W-ETS-305A	SV Monitor	30-May-07	80.5	50	1	14.7-49.7	1B/2	NA
W-ETS-305B	SV Monitor	30-May-07	85	79.7	1	59.3-79.3	2	NA
W-ETS-506A	SV Monitor	29-May-07	75	37.5	1	17.1-37.1	1B/2	NA
W-ETS-506B	SV Monitor	29-May-07	75	63.3	1	43-63	2	NA
W-ETS-507	SV Extraction	27-Apr-96	75	65.5	1	25.1-65.1	1B/2	NA
SIP-ETS-601	Piezometer	7-Jun-99	115.5	104.8	1	98.3-104.8	2	NA
W-ETS-2008A	SV Extraction	7-Apr-04	110	40.5	1	20-40	1B	NA
W-ETS-2008B	SV Extraction	7-Apr-04	110	85.5	1	50-85	2	NA
W-ETS-2009(a)	SV Extraction	3-May-04	103	79.5	1	54-79	2	NA
W-ETS-2010A	SV Extraction	19-May-04	110.3	70.5	1	35-70	1B/2	NA
W-ETS-2010B	SV Extraction	19-May-04	110.3	100.5	1	80-100	2	NA
SIP-HPA-001	Piezometer	20-Apr-90	92.75	75	1	65-75	2	NA
W-HPA-001A	SV Monitor	15-Apr-03	80	45.5	1	30-45	1B	NA
W-HPA-001B	SV Monitor	15-Apr-03	80	73.5	1	63-73	2	NA
W-HPA-002A	SV Extraction	29-Apr-03	80	43	1	32.5-42.5	1B	NA
W-HPA-002B	SV Extraction	29-Apr-03	80	72.5	1	52-72	2	NA
SIP-HPA-003	Piezometer	19-Apr-90	91.5	66	1	61-66	2	NA
SIP-HPA-201	Piezometer	14-May-96	97.5	76	1	71-76	2	NA
SIP-IES-001	Piezometer	16-Sep-92	50	46.5	1	44-46.5	1B	NA
SIP-IES-002	Piezometer	5-Oct-92	41.5	39.2	1	33-39.2	1A	NA
IMS-INF-001	IMS	NA	67	NA	1	NA	NA	NA
IMS-INF-002	IMS	NA	67	NA	1	NA	NA	NA

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
IMS-INF-003	IMS	NA	67	NA	1	NA	NA	NA
SIP-INF-201	Piezometer	1-Jul-98	87.4	86.5	1	66-86.5	NA	35
SIP-INF-202	Piezometer	1-Jul-98	87	85.5	1	65.5-85.5	NA	0.5
IMS-INF-203	IMS	NA	63	63	1	NA	NA	NA
SIP-ITR-001	Piezometer	19-Apr-91	121.5	115	1	105-115	5	NA
SIP-ITR-002	Piezometer	2-Apr-91	100	84	1	79-84	5	NA
SIP-ITR-003	Piezometer	25-Apr-91	121.5	106	1	98.66-106	5	NA
SIP-NEB-101	Piezometer	23-Sep-92	68.7	66	1	57-66	2	NA
SIP-PA-002	Piezometer	29-Jan-90	16.5	16.5	1	4-16.5	1B	NA
SIP-PA-003	Piezometer	26-Jan-90	18	14	1	4-14	1B	NA
SIP-PA-005	Piezometer	4-Jan-90	11.5	8	1	3-8	1B	NA
SIP-PA-006	Piezometer	4-Jan-90	13.5	12	1	5-12	1B	NA
SIP-PA-007	Piezometer	4-Jan-90	11.5	5	1	1-5	1B	NA
SIP-PA-010	Piezometer	25-Jan-90	11.5	9	1	3-9	1B	NA
SIP-PA-012	Piezometer	29-Jan-90	11.5	9	1	2-9	1B	NA
SIP-PA-013	Piezometer	24-Jan-90	16.5	13	1	8-13	1B	NA
SIP-PA-015	Piezometer	25-Jan-90	21.5	17.5	1	2-17.5	1B	NA
SIP-PA-016	Piezometer	24-Jan-90	11.5	11.5	1	7-11.5	1B	NA
SIP-PA-017	Piezometer	24-Jan-90	16.5	14	1	7-14	1B	NA
SIP-PA-018	Piezometer	25-Jan-90	11.5	8	1	6-8	1B	NA
SIP-PA-019	Piezometer	26-Jan-90	16.5	12	1	2-12	1B	NA
SIP-PA-021	Piezometer	23-Jan-90	11.5	10	1	2-10	1B	NA
SIP-PA-024	Piezometer	23-Jan-90	16.5	15	1	5-15	1B	NA
SIP-PA-025	Piezometer	23-Jan-90	11.5	7	1	4-7	1B	NA
SIP-PA-026	Piezometer	29-Jan-90	11.5	10	1	2-10	1B	NA
SIP-PA-027	Piezometer	29-Jan-90	8.5	7	1	2-7	1B	NA
SIP-PA-028	Piezometer	23-Jan-90	11	8	1	5-8	1B	NA
SIP-PA-029	Piezometer	22-Jan-90	11.5	7	1	5-7	1B	NA
SIP-PA-030	Piezometer	24-Jan-90	11.5	8	1	4-8	1B	NA
SIP-PA-034	Piezometer	4-Jan-90	6.5	5	1	3-5	1B	NA
SIP-PA-035	Piezometer	4-Jan-90	11.5	11.5	1	6.5-11.5	1B	NA
TW-11	GW Monitor	9-Jun-81	112.5	107	1	97-107	2	NA
TW-11A	GW Monitor	16-Mar-84	163	160	1	133-160	2	6
TW-21	GW Monitor	12-Jun-81	111.5	95	1	85-95	1B	3
UP-292-006	Piezometer	7-Jan-91	74	57.5	1	47.5-57.5	1B	NA

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
UP-292-007	Piezometer	7-Jan-91	71	56	1	46-56	1B	NA
UP-292-012	Piezometer	29-Jan-92	67.7	60	1	45-60	1B	NA
UP-292-014	Piezometer	29-Jan-92	66	66	1	50-60	1B	NA
UP-292-015	Piezometer	29-Jan-92	61.5	61.5	1	49.5-60.5	1B	NA
UP-292-020	Piezometer	3-Feb-93	68.5	68.5	1	56.5-64	1B	NA
GSB-811	NA	NA	140.1	NA	NA	NA	NA	NA
GSW-003	GW Monitor	7-Feb-85	115	105	1	85-105	2	NA
GSW-004	GW Monitor	22-Feb-85	112	106	1	86-106	2	NA
GSW-006	GW Monitor	28-Feb-86	212	137	1	121-137	3A	11
GSW-007	GW Monitor	14-Mar-86	176.5	123.4	1	110.8-123.4	3A	5
GSW-008	GW Monitor	1-Apr-86	176	133	1	127.5-133	3A	2
GSW-009	GW Monitor	14-Apr-86	197.5	152.5	1	147-152.5	3B	5
GSW-011	GW Monitor	7-May-86	182.5	126	1	116-126	3A	5
GSW-013	GW Monitor	27-Jun-86	198	134.5	1	125-134.5	3A	NA
GSW-215	GW Monitor	22-Apr-86	214	133.5	1	127-133.5	3A	6
GSW-216	GW Monitor	9-May-86	193	120.5	1	110.5-120.5	3A	7
GSW-266	GW Monitor	8-May-86	220	166	1	159-166	3B	3
GSW-326	GW Monitor	2-Oct-87	230	134	1	129-134	4	NA
GSW-367	GW Monitor	29-Apr-87	159	124	1	114-124	2	7
GSW-442	GW Monitor	27-Oct-87	270	145	1	138-145	3A	1
GSW-443	GW Monitor	9-Nov-87	291	141	1	123-141	2	5
GSW-444	GW Monitor	20-Nov-87	278	120	1	110-120	3B	NA
HW-GP-003	GW Monitor	18-May-92	119	119	NA	NA	NA	NA
HW-GP-102	GW Monitor	24-Jan-95	140	142.5	1	70-132.5	NA	NA
HW-GP-103	GW Monitor	24-Jan-95	138	141.5	1	71.5-131.5	NA	NA
GSP-SNL-001	Piezometer	10-Jan-92	147	131	1	99-104	NA	NA
					2	118-131	NA	NA
MW-508	NA	NA	NA	NA	NA	NA	NA	NA
MW-NLF-1	GW Monitor	13-Mar-91	26	NA	1	NA	NA	NA
MW-NLF-2	GW Monitor	13-Mar-91	NA	NA	1	NA	NA	NA
MW-NLF-3	GW Monitor	13-Mar-91	20	NA	1	NA	NA	NA
MW-NLF-4	GW Monitor	13-Mar-91	26	NA	1	NA	NA	NA
MW-NLF-20	GW Monitor	NA	NA	NA	1	NA	NA	NA
MW-NLF-21	GW Monitor	NA	NA	NA	1	NA	NA	NA
MW-NLF-22	GW Monitor	NA	NA	NA	1	NA	NA	NA

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
					2	118-131	NA	NA
SNL-1B	Piezometer	NA	NA	NA	1	NA	NA	NA
SNL-2A	Piezometer	NA	NA	NA	1	NA	NA	NA
SNL-4D	Piezometer	NA	NA	NA	1	NA	NA	NA
MW-SNL-20B	GW Monitor	28-Jun-84	140	140	1	90-105	NA	NA
MW-SNL-20C	GW Monitor	16-Jul-84	165	156	1	140-155	NA	NA
11C1	GW Monitor	8-Jun-76	68	66	1	56.2-61.2	1B	1
11J2	GW Monitor	26-Apr-79	112	112	1	90-92	1B	5
					2	102-108	2	5
14A3	GW Monitor	7-Dec-77	110	110	1	100-105	1B	NA
14B1	Water-supply (pumping)	13-Aug-59	300	300	1	146-149	2	NA
					2	192-195	3A	NA
					3	209-213	3A	NA
14B4	Water-supply (pumping)	1-Aug-60	260	260	1	143-148	2	NA
					2	155-159	2	NA
					3	186-189	3A	NA
					4	205-215	3A	NA
					5	245-250	4	NA
14B7	GW Monitor	25-Aug-87	NA	NA	NA	NA	NA	NA
14C2	Water-supply (pumping)	7-Jan-88	217	NA	1	135-150	2	NA
14C3	Water-supply (pumping)	19-Jan-88	405	NA	1	160-388	2/3A/ 3B/4/5	NA
14H1	GW Monitor	21-Dec-83	NA	288	1	0-288	NA	NA
14H2	GW Monitor	28-Aug-87	NA	NA	NA	NA	NA	NA
14JD1	GW Monitor	NA	NA	NA	NA	NA	NA	NA
14K1	GW Monitor	NA	372	361	1	153-157	NA	NA
					2	193-202	NA	NA
					3	217-251	NA	NA
					4	279-290	NA	NA
					5	300-336	NA	NA
					6	345-349	NA	NA
					7	354-361	NA	NA
15B1	GW Monitor	24-Jun-49	423	NA	NA	NA	NA	NA
18D1	Water-supply (pumping)	20-Apr-84	NA	NA	1	NA	7	12

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well	Well type	Date Completed	Borehole depth (ft)	Casing depth (ft)	Screen position	Screen interval (ft)	HSU	Initial flow rate (gpm)
2J2	GW Monitor	4-Jan-90	NA	NA	1	NA	NA	NA
2K3	GW Monitor	6-Mar-91	35	NA	1	NA	NA	NA
2K4	GW Monitor	6-Mar-91	35	NA	1	NA	1B	NA
2Q2	GW Monitor	6-Mar-91	40	NA	1	NA	1B	NA
2R3	GW Monitor	5-Mar-91	37	NA	1	NA	1B	NA
2R4	GW Monitor	5-Mar-91	37	NA	1	NA	NA	NA
2R8	GW Monitor	6-Mar-91	40	NA	1	NA	1B	NA
3S1E-1P2	Water-supply (pumping)	7-Oct-60	144	NA	NA	NA	NA	NA
3S2E-16B1	Water-supply (pumping)	1-Jul-44	410	410	1	140-235	NA	NA
					2	275-287	NA	NA
					3	304-320	NA	NA
					4	333-338	NA	NA
					5	347-352	NA	NA
					6	380-390	NA	NA
3S2E-16C1	Water-supply (pumping)	18-Feb-58	584	580	1	288-298	NA	950
					2	316-327	NA	950
					3	347-353	NA	950
					4	432-454	NA	950
					5	517-523	NA	950
3S2E-7C2	Water-supply (pumping)	NA	NA	49	1	39-44	NA	NA
3S2E-8P1	Water-supply (pumping)	NA	NA	273	1	122-263	NA	NA
3S2E-9Q1	Water-supply (pumping)	13-Jan-60	576	516	1	180-492	NA	510
7D2	GW Monitor	7-Jun-76	74	72	1	63-68	3A	NA
AW-1906	Anode Well	17-Jun-03	270	258	NA	NA	NA	NA
AW-1910	Anode Well	23-Jul-03	270	258	NA	NA	NA	NA
AW-1911	Anode Well	NA	290	NA	NA	NA	NA	NA
AW-1912	Anode Well	28-Aug-03	280	258	NA	NA	NA	NA
AW-2106	Anode Well	11-Apr-05	290	257.5	NA	NA	NA	NA
AW-2107	Anode Well	4-May-05	290	NA	NA	NA	NA	NA
AW-2108	Anode Well	2-Jun-05	290	258	NA	NA	NA	NA
AW-2306	Anode Well	31-Aug-07	280	261	NA	NA	NA	NA

Notes and footnotes appear on the following page.

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Notes.

ft = Feet.
gpm = Gallons per minute.
GW = Ground Water.
HSU = Hydrostratigraphic Units.
IMS = Instrumented Membrane Systems.
NA = Not available.
SV = Soil Vapor.

In wells with more than one screen, the screen positions are numbered consecutively downward within a single well. Well numbers ending in A and B, indicate two wells installations in the same borehole. The "A" refers to the shallow well and "B" refers to the deeper well.

Hydrostratigraphic Units (HSUs) are numbered consecutively downward from ground surface. An HSU is defined as sediments that are grouped together based on their hydrogeologic and contaminant transport properties. The permeable layers within an HSU are considered to be in good hydraulic communication, whereas permeable layers in different HSUs are considered to be
in poor hydraulic communication. HSU contacts are interpreted and are periodically revised based on new data.

Well numbers were changed in December 1988 to be consistent with Alameda County Flood Control and Water Conservation District, Zone 7 well identification. Well number changes made on this table are:

4A6 ------> 14H2
18D81 ------> 18D1
14A84 ------> 14A11

Wells installed for the Dynamic Underground Stripping Demonstration Project include extraction wells (GEW series), injection wells (GIW series), gasoline spill piezometer (GSP series), and heating wells (HW series).

A FLUTe liner was installed to monitor ground water chemistry in multiple HSUs. Instrumented Membrane Systems were installed in the vadose zone to measure moisture content, pressure, temperature, and VOCs.

Piezometer SVI-518-303 was drilled out and replaced by SVW-518-1915.

(a) Wells W-2606, W-2607, and W-2608 were drilled at an angle 45 degrees from vertical; depths shown are true vertical depth.

(b) Well W-ETS-2009 was drilled at an angle 20 degrees from vertical; depths shown are true vertical depth.

Table A-2. Well closure data, LLNL Livermore Site and vicinity, Livermore, California.

Well number	Well type	Date installed	Borehole depth (ft)	Casing depth (ft)	Screen interval(s) (ft)	HSU monitored	Closure date
11A1	Other non-LLNL	8-Jun-76	66	64.7	54.7-59.7	NA	18-Aug-88
11BA[a]	Other non-LLNL	2-Mar-87	NA	NA	NA	NA	10-Jun-87
11H1	Other non-LLNL	4-Nov-41	NA	519	157-161	2/3A/4/5/6/7	31-Oct-88
					169-177		
					224-228		
					243-245		
					254-256		
					306-314		
					319-327		
					339-342		
					414-419		
					424-431		
					477-479		
11H4	Other non-LLNL	5-Apr-60	272	272	166-170	3/4/5	7-Oct-88
					174-176		
					183-185		
					200-202		
					211-214		
					224-230		
					250-252		
					260-265		
11J1	Other non-LLNL	1-Jan-41	160	160	NA	2	3-Aug-88
11J4	Other non-LLNL	1-Jan-65	NA	NA	NA	NA	11-Oct-88
11K1	Other non-LLNL	6-Jan-42	621	621	247-255	4/5/6	26-Sep-88
					272-276		
					297-304		
					322-339		
					554-557		
					580-602		
11K2	Other non-LLNL	NA	NA	232	NA	NA	3-Oct-88
11Q2	Other non-LLNL	20-Dec-83	NA	264	NA	NA	16-Aug-88
11Q3	Other non-LLNL	20-Dec-83	NA	120	NA	NA	10-Aug-88
11Q6	Other non-LLNL	20-Dec-83	NA	280	NA	NA	11-Jan-89
11R3	Other non-LLNL	8-May-61	140	117	NA	NA	3-Sep-85
11R4	Other non-LLNL	28-Oct-58	268	NA	165-177	NA	3-Sep-85
					252-258		
11R5	Other non-LLNL	19-Dec-83	NA	NA	NA	NA	26-Jul-85

Table A-2. Well closure data, LLNL Livermore Site and vicinity, Livermore, California.

Well number	Well type	Date installed	Borehole depth (ft)	Casing depth (ft)	Screen interval(s) (ft)	HSU monitored	Closure date
12M1	Other non-LLNL	12-Sep-42	702	702	375-378		15-Apr-84
					420-426		
					452-473		
					560-564		
					609-621		
					626-657		
12N1	Other non-LLNL	14-Apr-42	702	NA	392-399	7	24-Jan-89
					478-483		
					492-496		
					514-518		
					527-536		
					666-670		
					678-681		
13D1	Other non-LLNL	29-Oct-56	402	400	200-400	3B/4/5/6	23-Aug-88
14A1	Other non-LLNL	12-Jul-43	246	227	102-107		13-Sep-88
					113-119		
					144-148		
					176-179		
					188-190		
					192-194		
					219-222		
					223-227		
14A2	Other non-LLNL	15-Nov-56	229	229	122-130	2/3A	12-Sep-88
					140-150		
					160-180		
14A4	Other non-LLNL	15-Jun-59	252	248	167-170	3/4	29-Aug-88
					175-179		
					192-202		
					235-246		
14A8	Other non-LLNL	NA	NA	86	NA	NA	22-Jul-88
14B2	Other non-LLNL	22-Aug-56	312	312	185-312	3A/3B/4/5	11-Nov-88
14B8	Other non-LLNL	3-May-88	385	306	NA	NA	NA
14C1	Other non-LLNL	31-Jul-91	523	NA	NA	2/3A/4	NA
1N1	Other non-LLNL	15-Jan-88	600	600	427-442	7	21-Oct-88
					450-453		
					465-469		
					500-515		
					575-588		
3S2E01P2	Other non-LLNL	7-Oct-60	144	144	124-144	NA	22-May-86

Table A-2. Well closure data, LLNL Livermore Site and vicinity, Livermore, California.

Well number	Well type	Date installed	Borehole depth (ft)	Casing depth (ft)	Screen interval(s) (ft)	HSU monitored	Closure date
2R9 (11A5)	Other non-LLNL	NA	NA	NA	NA	NA	19-Jul-88
HW-GP-001	Monitor	16-Apr-92	120	113	NA	NA	25-Jan-10
HW-GP-002	Monitor	12-Jan-95	120	117	NA	NA	20-Jan-10
HW-GP-104	Monitor	24-Jan-95	138	142.2	72.2-132.5	NA	21-Jan-10
HW-GP-105	Monitor	24-Jan-95	138	142.2	72.2-132.5	NA	20-Jan-10
GEW-710	Monitor	23-Sep-91	159	158	94-137	3A/3B	22-Feb-10
GEW-711	Extraction	24-May-91	167.5	157	94-137	3A/3B	16-Jun-92
GEW-808	Monitor	5-Jun-92	150	150	50-140	2/3A	18-Feb-10
GEW-816	Monitor	4-Aug-92	161.7	150	50-140	2/3A	22-Feb-10
GIW-813	Monitor	5-Aug-92	140.7	127	67-87	2	17-Feb-10
					89-99	2	
					120-127	2/3A	
GIW-814	Monitor	5-Aug-92	149.6	141	86.5-106.5	2	17-Feb-10
					110-120	2	
					121-141	2/3A	
GIW-815	Monitor	5-Aug-92	143	137.5	77-97	2	17-Feb-10
					102-112	2/3A	
					112.8-132.5	3A	
GIW-817	Monitor	NA	121	NA	NA	NA	NA
GIW-818	Monitor	5-Aug-92	150	140	82-102	2	20-Jan-10
					120-140	3A/3B	
GIW-819	Monitor	5-Aug-92	150	141	78.6-98.6	2	27-Jan-10
					108-118	2/3A	
GIW-820	Monitor	5-Aug-92	143.3	141	85-105	2	25-Jan-10
					112-132	3A	
GSB-014	NA	NA	141	NA	NA	NA	23-Feb-10
GSB-804	NA	NA	145.5	NA	NA	NA	19-Jan-10
GSB-807	NA	NA	151.8	NA	NA	NA	21-Jan-10
	NA	NA	151.8	NA	NA	NA	21-Jan-10
GSW-001	Monitor	5-Feb-85	112	109	85-106	2	6-Jun-86
GSW-001A	Monitor	12-Jun-86	208	133	115-133	3A	NA
GSW-002	Monitor	14-Feb-85	113	107	87-107	2	NA
GSW-005	Monitor	19-Mar-85	110	104	94-104	2	9-Sep-10
GSW-010	Monitor	29-Apr-86	205.5	127.5	114-127.5	3A	28-Jan-98
GSW-012	Monitor	27-May-86	205	191	186.5-191	5	25-Jan-10
GSW-014	Monitor	17-Jul-86	141	NA	NA	NA	1-Nov-92
GSW-015	Monitor	14-Aug-87	148	145	20.5-28	1B/2/3A	18-Feb-10
					38-44		
					50-56		

Table A-2. Well closure data, LLNL Livermore Site and vicinity, Livermore, California.

Well number	Well type	Date installed	Borehole depth (ft)	Casing depth (ft)	Screen interval(s) (ft)	HSU monitored	Closure date
					60-64		
					68-73		
					77-83		
					95-105		
					120-130		
GSW-016	Monitor	19-Oct-87	146	145	23-28	1B	18-Feb-10
					38-43	1B	
					50-55	2	
					61-66	2	
					78-83	2	
					95-105	2	
					120-130	3A	
GSW-020	Monitor	18-May-84	134	101.3	95-101.3	2	3-Sep-87
GSW-208	Monitor	6-Feb-86	211	123	108-118	3A	NA
GSW-209	Monitor	27-Feb-86	204	135.2	112.8-132.8	3A	9-Sep-10
GSW-403-6	Monitor	11-May-84	138	100	90-110	2	21-Jan-10
GSW-445	Extraction	9-Dec-87	319	161	155-161	4	9-Sep-10
IMS-518-1616	IMS	16-Aug-00	55	NA	3-3.5	NA	31-May-07
					8-8.5		
					13-13.5		
					18-18.5		
					23-23.5		
					28-28.5		
					33.33.5		
					38-38.5		
					48-48.5		
S-14-7	NA	NA	40	NA	NA	NA	24-Feb-10
SEA-518-301	SEAMIST	22-Jun-95	102.6	39.3	1	NA	4-Jun-07
SEA-518-304	SEAMIST	11-Sep-95	104.5	NA	1	NA	31-May-07
SEA-ETS-305	SEAMIST	2-Sep-92	85	NA	1	NA	30-May-07
SEA-ETS-506	SEAMIST	24-Jul-96	75	75	NA	1B/2	29-May-07
SEA-ETS-507	SEAMIST	30-Jul-96	75	75	7-8	1B/2	27-Apr-06
					20-21	1B/2	
					25-26	1B/2	
					32-33	1B/2	
					38-39	1B/2	
					47-48	1B/2	
					52-53	1B/2	
					59-60	1B/2	

Table A-2. Well closure data, LLNL Livermore Site and vicinity, Livermore, California.

Well number	Well type	Date installed	Borehole depth (ft)	Casing depth (ft)	Screen interval(s) (ft)	HSU monitored	Closure date
SIB-INF-001	NA	NA	67	66.8	NA	NA	7-Jan-10
SIB-INF-002	NA	NA	67	66.4	NA	NA	7-Jan-10
SIB-INF-003	NA	NA	67	66	NA	NA	7-Jan-10
SIB-INF-008	NA	NA	92	91.9	NA	NA	6-Jan-10
SIB-INF-009	NA	NA	92	92	NA	NA	6-Jan-10
SIB-INF-010	NA	NA	95	81.8	NA	NA	6-Jan-10
SIB-INF-012	NA	NA	16	11.2	NA	NA	7-Jan-10
SIB-INF-103	NA	NA	103.5	91.5	NA	NA	6-Jan-10
SIB-INF-104	NA	NA	92	91.7	NA	NA	6-Jan-10
SIB-INF-201	NA	NA	87.4	85.7	NA	NA	6-Jan-10
SIB-INF-203	NA	NA	63	62.7	NA	NA	7-Jan-10
SIB-INF-301	Piezometer	NA	NA	95	NA	NA	21-Dec-09
SIP-INF-011	Monitor	Apr-97	93.4	92	NA	NA	23-Dec-09
SIP-INF-101	Piezometer	NA	NA	95	NA	NA	23-Dec-09
SIP-INF-102	Piezometer	NA	NA	90	NA	NA	23-Dec-09
SIP-INF-202	Piezometer	NA	NA	85	NA	NA	23-Dec-09
SIP-INF-302	Monitor	Mar-95	NA	89	NA	NA	23-Dec-09
SIB-INF-001	NA	NA	67	66.8	NA	NA	7-Jan-10
SIP-419-201	Piezometer	29-Feb-96	126	107	97-107	3A/3B	NA
SIP-490-101	Piezometer	1-Nov-95	59	56	53–56	2	21-Dec-95
SIP-514-101	Piezometer	28-Dec-89	26	22	7-22	1B	3-Sep-96
SVB-518-303	Monitor	29-Jun-95	104.5	40	6-40	1B/2	15-Oct-03
SIP-ETC-302	Piezometer	22-Apr-99	104	89.4	79–89	2	26-Apr-99
SIP-ETS-105	Piezometer	11-Dec-90	110	103	87-103	3A	6-Dec-93
SIP-ETS-207	Piezometer	11-Jul-91	103	98.5	89.75-98.5	3A	5-Jan-00
SIP-HPA-102	Piezometer	8-Dec-94	76	72	67-72	2	9-Apr-02
SIP-HPA-103	Piezometer	1-Mar-95	77	73.5	67-72.5	2	9-Apr-02
SIP-INF-011	NA	NA	NA	92	NA	NA	23-Dec-09
SIP-INF-202	NA	NA	NA	85	NA	NA	23-Dec-09
SIP-INF-301	NA	NA	NA	95	NA	NA	23-Dec-09
SIP-INF-302	NA	NA	NA	89	NA	NA	23-Dec-09
SVB-GP-001	NA	NA	20	NA	NA	NA	22-Feb-10
SVB-GP-002	NA	NA	20	NA	NA	NA	23-Feb-10
SVB-GP-006	NA	NA	30	NA	NA	NA	2-Sep-10
SVB-GP-008	NA	NA	20	NA	NA	NA	23-Feb-10
SVB-GP-008A	NA	NA	90.1	NA	NA	NA	24-Feb-10
SVB-GP-009	NA	NA	30	NA	NA	NA	2-Sep-10
SVB-GP-010	NA	NA	30	NA	NA	NA	2-Sep-10
SVB-GP-012	NA	NA	51	NA	NA	NA	2-Sep-10

Table A-2. Well closure data, LLNL Livermore Site and vicinity, Livermore, California.

Well number	Well type	Date installed	Borehole depth (ft)	Casing depth (ft)	Screen interval(s) (ft)	HSU monitored	Closure date
SVB-GP-013	NA	NA	89	NA	NA	NA	24-Feb-10
TOM-001	Tomography	NA	NA	52	NA	NA	17-Dec-09
TOM-002	Tomography	NA	NA	55	NA	NA	17-Dec-09
TOM-003	Tomography	NA	NA	55	NA	NA	17-Dec-09
TOM-004	Tomography	NA	NA	54.6	NA	NA	17-Dec-09
TOM-005	Tomography	NA	NA	55	NA	NA	16-Dec-09
TOM-006	Tomography	NA	NA	55	NA	NA	16-Dec-09
TOM-007	Tomography	NA	NA	55	NA	NA	23-Dec-09
UP-292-001	Piezometer	7-Jan-91	54.5	49.5	44.5-49.5	1B	25-Sep-95
W-010A	Monitor	8-Sep-80	110.7	110	85-95	2	26-Feb-02
					100-105		
W-014A	Monitor	26-Aug-80	112.8	109	NA	2	11-Dec-87
					NA	2	
					NA	2	
W-015	Monitor	17-Nov-80	285	267	239-265	7	13-May-88
W-018	Monitor	22-Aug-80	161	152	80-90	2	11-Nov-85
					100-105	2	
					112-117	3A	
					128-133	5	
					143-152	5	
W-019	Monitor	19-Sep-80	164.8	161	147-157	7	22-Jun-06
W-149	Monitor	23-Aug-85	201	169	161-169	2	3-Sep-96
W-150	Monitor	13-Sep-85	212	162	157-162	2	11-Apr-90
W-211	Monitor	19-Mar-86	215.5	193	183-193	7	13-Jun-02
W-352	Monitor	29-Oct-86	235	201	181-201	4	5-Jan-98
W-358	Monitor	4-Feb-87	248	239	230-239	7	13-Apr-94
W-360	Monitor	24-Feb-87	260	204.5	181.5-204.5	4	26-Feb-02
W-414	Monitor	20-May-88	179	74	69.5-74	2	26-Feb-02
W-456	Monitor	9-Jun-88	343	180.5	172-180.5	3A	15-Nov-00
W-460	Monitor	22-Jul-88	361	140.5	135-140.5	2	15-Nov-00
W-508	Monitor	17-Feb-89	316	306	287-305	7	NA
W-591	Monitor	29-Nov-88	112	107.5	97-107.5	2	18-Apr-06
W-1005	Monitor	14-Mar-94	192	110	98-110	1B	13-Nov-00
W-1006	Monitor	10-Mar-94	154	149	141-149	2	14-Nov-00
W-1007	Monitor	31-Mar-94	199.5	182	172-182	3A	14-Nov-00
W-1114	Monitor	7-Aug-95	223	205	177-200	5	23-Apr-97
W-1218	Monitor	29-May-96	240	145.5	127-145	3A	27-Feb-02
W-1220	Monitor	12-Jun-96	120	117	90-112	2	27-Feb-02
W-1221	Monitor	1-Jul-96	220	172	162-172	4	28-Feb-02

Table A-2. Well closure data, LLNL Livermore Site and vicinity, Livermore, California.

Well number	Well type	Date installed	Borehole depth (ft)	Casing depth (ft)	Screen interval(s) (ft)	HSU monitored	Closure date
TEP-GP-001	Dynamic Stripping	15-Jan-92	165	160.5	NA	NA	25-Jan-10
				117	107-117	2/3A	
				160.5	NA	NA	
TEP-GP-002	Dynamic Stripping	24-Jun-92	161.4	NA	102-112.5	2/3A	25-Feb-10
				133	122-133	3A	
				161	NA	NA	
TEP-GP-003	Dynamic Stripping	28-Jan-92	161	129.5	124.5-129.5	3A	13-Feb-93
				161	NA	NA	
TEP-GP-004	Dynamic Stripping	5-Feb-92	161	106	96-106	2	13-Feb-93
				134	124-134	3A	
				161	NA	NA	
TEP-GP-005	Dynamic Stripping	18-Feb-92	161	124.5	114.5-124.5	3A	25-Jan-10
				161	NA	NA	
TEP-GP-006	Dynamic Stripping	26-Feb-92	161	127	107-127	2/3A	16-Feb-10
				161	NA	NA	
TEP-GP-007	Dynamic Stripping	13-Mar-92	161	125.5	115.5-125.5	3A	13-Feb-93
				161	NA	NA	
TEP-GP-008	Dynamic Stripping	3-Mar-92	161	110	100-110	2	13-Feb-93
				129	119-129	3A	
				161	NA	NA	
TEP-GP-009	Dynamic Stripping	6-May-92	161.7	107	98-107	2	20-Jan-10
				130.5	120.5-130.5	3A	
				161	NA	NA	
TEP-GP-010	Dynamic Stripping	24-Mar-92	161	124.5	114.5-124.5	3A	21-Jan-10
				161	NA	NA	
TEP-GP-011	Dynamic Stripping	7-Apr-92	161	108	98-108	2	13-Feb-93
				161	NA	NA	
TEP-GP-106	Dynamic Stripping	21-Sep-93	137.5	135.5	NA	NA	NA
CPRS-02	Anode Well	NA	290	NA	NA	NA	
CPRS-03 (B482)	Anode Well	NA	180	NA	NA	NA	26-Sep-03
CPRS-06 (B543)	Anode Well	NA	NA	NA	NA	NA	29-Aug-06
CPS-1-325CT (B323)	Anode Well	24-Feb-77	290	NA	NA	NA	30-Oct-03
CPS-622	Anode Well	14-Feb-77	290	NA	NA	NA	15-Jan-04
CPS SC-5	Anode Well	NA	290	NA	NA	NA	21-Jul-05
W-1218	Monitor	29-May-96	240	145.5	127-145	3A	27-Feb-02
W-1220	Monitor	12-Jun-96	120	117	90-112	2	27-Feb-02
W-1221	Monitor	1-Jul-96	220	172	162-172	4	20-Feb-02

Notes appear on the following page.

Table A-2. (Cont.). Well closure data, LLNL Livermore Site and vicinity, Livermore, California.

Notes:

ft =	**Feet.**
HSU =	**Hydrostratigraphic unit.**
NA =	**Not available.**

Well numbers were changed in December 1988 to be consistent with Alameda County Flood Control and Water. Conservation District, Zone 7 well identification. Well number changes made on this table are:

11J81 ------>	**11J4**
11R81 ------>	**11R5**
11Q81 ------>	**11Q6**
13D81 ------>	**13D1**
14A81 ------>	**14A1**
14A82 ------>	**14A2**
14A83 ------>	**14A4**

Well 11A5 was renamed 2R9 by the Alameda County Flood Control and Water Conservation District, Zone 7 in November 1997. Well 11A5 now applies to monitor well W-409.

"Other non-LLNL" refers to agricultural, private or agency wells.

Piezometer SVI-518-303 was drilled out and replaced by well SVW-518-1915.

Temperature monitoring wells (TEP series) consist of a blank fiberglass 2-in. inside diameter (ID) casing instrumented with geophysical sensors. The blank fiberglass casing has no screened interval. Some boreholes also had one or two 1-inch piezometers installed adjacent to the blank casing. Therefore, the casing depths with accompanying screened intervals refer to the piezometers.

[a] **Well 11BA not recognized by Alameda County Flood Control and Water Conservation District, Zone 7.**

Appendix B

Hydraulic Test Results

Table B-1. Results of hydraulic tests[a].

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-001	1-Dec-83	Drawdown	5.7	2,000	110	Fair
W-001	23-Jan-85	Drawdown	7.1	3,100	170	Good
W-001A	22-Jan-85	Drawdown	1.4	190	19	Good
W-002	1-Dec-83	Slug	NA	110	34	Poor
W-002A	24-Jan-85	Drawdown	10.3	2,700	200	Good
W-004	1-Dec-83	Drawdown	3.3	63	13	Good
W-005	1-Dec-83	Drawdown	4.3	110	20	Good
W-005	24-Jan-85	Drawdown	7.9	1,100	210	Fair
W-005A	23-Jan-85	Drawdown	13.0	1,300	130	Poor
W-007	1-Dec-83	Slug	NA	43	14	Fair
W-008	1-Dec-83	Drawdown	2.9	29	4.9	Fair
W-011	1-Dec-83	Drawdown	4.1	130	15	Good
W-017	1-Dec-83	Slug	NA	38	2.5	Good
W-017	21-Feb-86	Slug	NA	85	5.7	Good
W-018	1-Dec-83	Drawdown	2.6	20	2.7	Poor
W-102	25-Mar-86	Drawdown	6.4	1,100	76	Good
W-102	5-Sep-86	Drawdown	24.0	770	53	Good
W-102	15-Sep-86	Longterm	27.5	4,200	290	Good
W-103	25-Apr-86	Drawdown	6.7	15,000	1,500	Good
W-104	3-Mar-88	Drawdown	5.4	1,200	170	Fair
W-104	25-Mar-88	Drawdown	3.3	450	45	Fair
W-105	6-Apr-87	Drawdown	0.8	73	7.3	Fair
W-106	19-Feb-86	Slug	NA	7.4	1.3	Excel
W-107	17-Jun-85	Drawdown	1.0	94	9.4	Poor
W-108	29-Oct-85	Drawdown	7.9	750	63	Poor
W-109	5-Mar-86	Drawdown	8.1	3,200	530	Good
W-109	4-Sep-87	Drawdown	20.0	1,600	270	Good
W-109	29-Sep-87	Longterm	11.6	130	22	Fair
W-109	16-Oct-87	Drawdown	8.0	2,300	380	Fair
W-110	18-Jun-85	Drawdown	5.0	1,300	130	Good
W-111	13-Jun-85	Drawdown	1.0	370	37	Good
W-111	21-Nov-85	Drawdown	1.0	370	37	Good
W-112	18-Nov-86	Drawdown	13.4	2,100	170	Fair
W-112	15-Dec-86	Longterm	13.2	3,100	260	Fair
W-112	5-Nov-96	Longterm	13.7	3,300	260	Fair
W-113	17-Apr-86	Slug	NA	7.4	1.2	Excel
W-115	5-Mar-86	Drawdown	1.1	180	30	Good
W-116	24-Dec-85	Slug	NA	37	7.5	Good

Table B-1. Results of hydraulic tests[a].

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-117	20-Feb-86	Slug	NA	2	0.4	Good
W-118	18-Sep-85	Drawdown	16	1,200	120	Poor
W-118	27-Sep-85	Drawdown	13	1,900	190	Poor
W-118	5-Mar-86	Drawdown	10.0	2,100	230	Good
W-119	8-Aug-85	Drawdown	2.0	1,600	110	Good
W-120	22-Apr-86	Drawdown	1.1	23	5.6	Poor
W-121	10-Sep-85	Drawdown	2.0	120	7.5	Good
W-121	23-Sep-85	Drawdown	4.0	23	1.5	Excel
W-121	14-Oct-85	Drawdown	3.0	34	2.2	Excel
W-121	15-Oct-85	Drawdown	4.5	45	3.0	Excel
W-122	28-Oct-85	Drawdown	10.8	490	49	Good
W-123	28-Oct-85	Drawdown	5.8	40	4.4	Poor
W-142	3-Mar-88	Slug	NA	2,600	330	Excel
W-143	3-Mar-88	Slug	NA	1,200	240	Excel
W-149	9-Sep-85	Drawdown	4.0	120	19	Good
W-149	11-Sep-85	Drawdown	8.0	95	16	Excel
W-149	11-Oct-85	Drawdown	4.8	58	9.7	Excel
W-149	11-Oct-85	Drawdown	7.0	70	12	Good
W-150	2-Oct-85	Drawdown	3.1	640	210	Fair
W-150	3-Oct-85	Drawdown	6.0	720	240	Fair
W-150	10-Oct-85	Drawdown	8.8	630	210	Fair
W-150	10-Oct-85	Drawdown	12.0	620	210	Fair
W-151	28-Oct-85	Drawdown	5.8	550	61	Poor
W-201	5-Mar-86	Drawdown	10.0	740	86	Excel
W-203	2-Mar-88	Drawdown	6.6	1,100	110	Good
W-204	23-Jan-86	Drawdown	1.9	100	15	Fair
W-205	14-Feb-86	Slug	NA	5.9	1.9	Good
W-205	18-Feb-86	Slug	NA	5.9	1.9	Good
W-206	14-Apr-86	Slug	NA	120	11	Good
W-206	27-Sep-93	Drawdown	0.19	3.0	0.20	Fair
W-206	18-Oct-93	Drawdown	0.3	4.0	0.30	Fair
W-207	2-Mar-88	Slug	NA	380	32	Excel
W-210	9-Jun-86	Slug	NA	0.6	0.1	Good
W-211	22-Oct-86	Drawdown	2.9	37	12	Fair
W-211	8-Dec-86	Longterm	1.0	44	15	Fair
W-211	16-Sep-97	Longterm	1.1	14	1.4	Good
W-212	12-May-86	Drawdown	0.8	18	3.1	Poor
W-213	22-Apr-86	Drawdown	3.8	190	38	Good

Table B-1. Results of hydraulic tests[a].

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-214	7-Oct-86	Longterm	27.6	2,300	350	Good
W-217	15-Jul-86	Slug	NA	750	120	Good
W-218	17-Jun-86	Drawdown	11.7	6,400	1,100	Good
W-218	12-Nov-86	Longterm	7.7	4,000	670	Good
W-219	15-Jul-86	Drawdown	4.3	620	76	Good
W-219	23-Feb-87	Longterm	5.2	66	8.0	Fair
W-220	21-Aug-86	Slug	NA	28	5.5	Excel
W-221	5-Aug-86	Drawdown	2.1	120	16	Fair
W-222	12-Aug-86	Drawdown	16.0	1,700	160	Excel
W-222	8-Mar-85	Longterm	7.7	1,100	180	Good
W-223	27-Aug-86	Drawdown	4.0	510	110	Good
W-224	28-Oct-86	Drawdown	7.6	3,600	400	Excel
W-225	23-Oct-86	Drawdown	4.0	85	11	Good
W-225	12-Jan-87	Longterm	2.0	62	8.5	Fair
W-226	31-Mar-87	Slug	NA	1,700	160	Fair
W-252	4-Nov-85	Drawdown	4.0	920	50	Fair
W-252	19-Nov-85	Drawdown	5.6	800	43	Fair
W-254	27-Jan-86	Drawdown	4.2	340	38	Fair
W-254	27-Feb-86	Drawdown	3.2	370	41	Good
W-255	21-Jan-86	Drawdown	5.0	2,800	250	Fair
W-255	21-Jan-86	Drawdown	6.0	2,000	180	Fair
W-255	6-Jan-87	Longterm	2.0	400	36	Fair
W-256	11-Apr-86	Slug	NA	11	5.5	Good
W-257	15-Apr-86	Slug	NA	120	24	Good
W-258	5-Jun-86	Slug	NA	35	9.0	Excel
W-258	29-Oct-86	Slug	NA	32	8.0	Good
W-259	26-Mar-88	Slug	NA	15	5.0	Good
W-260	25-Mar-86	Drawdown	3.0	140	22	Good
W-260	1-Oct-86	Longterm	1.4	120	18	Good
W-261	27-May-86	Slug	0.0	7	2.3	Excel
W-262	11-Apr-86	Drawdown	12.5	2,000	250	Excel
W-262	23-Sep-86	Longterm	22.0	2,750	340	Good
W-262	27-Apr-87	Longterm	23.1	6,800	810	Good
W-263	22-Apr-86	Drawdown	1.2	37	7.4	Poor
W-263	4-Nov-86	Longterm	1.8	76	15	Excel
W-264	7-May-86	Drawdown	8.1	930	100	Good
W-264	29-Oct-86	Longterm	23.0	480	50	Good
W-265	19-May-86	Drawdown	0.7	180	34	Fair

Table B-1. Results of hydraulic tests[a].

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-267	2-Jun-86	Drawdown	0.5	420	85	Poor
W-268	14-Nov-86	Drawdown	5.0	230	18	Good
W-269	14-Jul-86	Drawdown	5.0	570	95	Good
W-270	30-Dec-86	Slug	NA	14	2.0	Good
W-271	4-Aug-86	Drawdown	5.5	340	76	Fair
W-272	19-Aug-86	Drawdown	0.8	150	30	Fair
W-273	27-Aug-86	Drawdown	3.2	600	90	Good
W-274	25-Mar-85	Slug	NA	38	7.6	Fair
W-274	2-Feb-99	Slug	NA	10	2	Fair
W-275	30-Oct-86	Drawdown	7.0	730	150	Fair
W-275	2-Mar-87	Longterm	5.5	830	170	Fair
W-276	21-Nov-86	Drawdown	13.0	960	110	Good
W-276	04-May-87	Longterm	24.0	2,700	300	Fair
W-277	3-Nov-86	Drawdown	0.9	74	25	Fair
W-290	5-Jan-87	Slug	NA	14	4.0	Excel
W-291	27-Jan-87	Slug	NA	25	7.1	Fair
W-292	28-Aug-86	Drawdown	6.0	400	56	Excel
W-294	29-Dec-86	Drawdown	5.3	5,300	29	Fair
W-294	29-Dec-86	Drawdown	5.9	5,400	300	Good
W-301	30-Oct-86	Drawdown	6.0	460	100	Good
W-302	18-Nov-86	Drawdown	1.0	100	27	Good
W-302	18-Nov-86	Drawdown	2.0	76	21	Fair
W-303	12-Nov-86	Drawdown	11.1	210	70	Good
W-304	13-Mar-87	Drawdown	0.9	74	25	Fair
W-305	26-Nov-86	Drawdown	19.0	720	72	Excel
W-305	18-May-87	Longterm	20.1	640	64	Excel
W-306	31-Mar-87	Drawdown	9.5	270	68	Good
W-307	26-Mar-87	Drawdown	0.9	66	33	Fair
W-308	4-Dec-87	Drawdown	2.6	27	5.4	Good
W-310	17-Feb-87	Drawdown	6.7	58	850	Good
W-310	29-Jul-2010	Drawdone	6.0	170	24	Fair
W-311	19-Mar-87	Drawdown	9.8	130	12	Good
W-311	17-Nov-87	Longterm	9.9	370	26	Good
W-312	27-Mar-87	Drawdown	20.5	1,800	300	Poor
W-312	3-Nov-87	Longterm	18.8	1,700	280	Good
W-313	25-Mar-87	Drawdown	7.9	3,000	600	Good
W-313	5-Oct-87	Longterm	9.6	3,400	680	Good
W-314	10-Apr-87	Drawdown	26.4	2,900	390	Good

Table B-1. Results of hydraulic tests[a].

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-314	13-Jul-87	Longterm	13.6	2,500	330	Fair
W-314	14-Oct-97	Longterm	12	1,400	100	Fair
W-315	9-Apr-87	Drawdown	15.4	150	11	Good
W-315	5-Jan-85	Longterm	24.5	571	41	Excel
W-316	4-May-87	Drawdown	7.8	1,400	280	Good
W-317	12-May-87	Drawdown	12.1	300	43	Fair
W-317	15-Dec-87	Longterm	8.2	120	17.1	Good
W-318	7-Aug-87	Slug	NA	120	16	Good
W-319	29-Jul-87	Drawdown	48.0	7,200	1,500	Good
W-320	15-May-87	Drawdown	1.8	58	17	Fair
W-320	15-May-87	Drawdown	3.0	22	3.7	Fair
W-320	26-Jun-87	Drawdown	2.1	49	14	Fair
W-321	28-Jul-87	Drawdown	40.0	6,600	450	Good
W-322	3-Aug-87	Drawdown	3.1	85	15	Good
W-323	11-Aug-87	Drawdown	3.4	205	59	Good
W-324	10-Sep-87	Drawdown	6.6	200	50	Good
W-325	10-Sep-87	Drawdown	6.0	160	13	Excel
W-351	12-Nov-86	Drawdown	5.7	27	14	Poor
W-351	20-Jun-09	Step	2.7	200	34	Good
W-352	30-Dec-86	Drawdown	20.0	280	14	Good
W-352	7-Jul-87	Longterm	19.5	120	6.0	Excel
W-353	20-Nov-86	Drawdown	2.1	60	17	Good
W-354	30-Dec-86	Drawdown	17.6	2,000	220	Fair
W-354	30-Dec-86	Drawdown	18.0	2,400	260	Good
W-354	20-Apr-87	Longterm	17.8	310	34	Good
W-355	29-Dec-86	Drawdown	2.1	19	5.0	Fair
W-356	17-Mar-87	Drawdown	5.7	180	59	Good
W-356	16-Jul-96	Longterm	4.9	230	57	Poor
W-357	18-Feb-87	Drawdown	15.0	1,300	110	Good
W-357	21-Jul-87	Longterm	9.2	210	18	Good
W-358	18-Mar-87	Drawdown	9.2	210	32	Excel
W-359	9-Mar-87	Longterm	19.0	2,800	290	Fair
W-359	20-Mar-87	Drawdown	18.6	1,100	110	Good
W-359	5-Jun-09	Drawdown	10	1,200	95	Fair
W-360	22-May-87	Drawdown	30.0	4,800	210	Excel
W-361	16-Mar-87	Drawdown	4.3	67	11	Good
W-361	12-Jan-85	Longterm	5.3	178	30	Good
W-362	23-Mar-87	Drawdown	16.4	470	49	Good

Table B-1. Results of hydraulic tests[a].

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-362	21-Sep-87	Longterm	13.6	370	39	Good
W-363	24-Jul-87	Slug	NA	20	3.0	Excel
W-364	8-Apr-87	Drawdown	8.6	51	10	Fair
W-364	1-Jun-87	Longterm	4.8	110	22	Good
W-365	14-May-87	Drawdown	10.0	36	15	Fair
W-366	11-May-87	Drawdown	19.0	780	92	Fair
W-368	11-May-87	Drawdown	2.9	81	8.5	Fair
W-368	31-Jul-01	Step	6.0	2,600	350	Fair
W-368	15-Apr-09	Step	3.8	410	51	Fair
W-369	25-Jun-87	Drawdown	7.0	580	96	Good
W-369	10-Nov-87	Longterm	5.5	89	18	Good
W-370	23-Jun-87	Drawdown	4.4	84	10	Fair
W-371	24-Jun-87	Drawdown	3.3	15	3.0	Good
W-372	23-Nov-87	Slug	NA	310	62	Excel
W-373	28-Jul-87	Drawdown	4.0	660	77	Fair
W-373	28-Jul-87	Drawdown	6.5	50	6.0	Poor
W-376	26-Jan-88	Drawdown	2.9	65	8.5	Fair
W-380	23-Oct-87	Drawdown	4.0	33	4.7	Excel
W-401	23-Oct-87	Drawdown	42.0	950	24	Excel
W-402	22-Oct-87	Drawdown	41.0	13,500	1,400	Good
W-403	3-Dec-87	Drawdown	9.7	370	26	Good
W-404	4-Feb-85	Drawdown	45.0	3,200	530	Good
W-405	16-Feb-85	Drawdown	47.2	546	14	Good
W-406	28-Jan-85	Drawdown	7.4	7,500	940	Fair
W-407	23-Feb-85	Drawdown	14.4	75	7.5	Fair
W-408	5-Apr-85	Drawdown	45.0	43,000	3,100	Good
W-409	22-Mar-85	Drawdown	20.0	230	38	Good
W-410	28-Apr-85	Drawdown	35.0	6,800	570	Fair
W-411	5-May-85	Drawdown	14.0	50	83	Good
W-412	6-May-88	Drawdown	4.1	700	64	Fair
W-413	30-Aug-01	Drawdown	20.0	9,400	790	Good
W-413	15-Apr-09	Step	10	5,500	370	Good
W-414	27-Jul-85	Slug	NA	150	38	Good
W-415	31-Aug-85	Drawdown	10.0	3,100	78	Fair
W-416	11-Jul-85	Drawdown	50.0	2,600	330	Good
W-417	27Jun-88	Drawdown	5.3	340	57	Fair
W-420	16-Aug-85	Drawdown	3.5	710	100	Excel
W-421	12-Sep-85	Drawdown	4.8	320	27	Excel

Table B-1. Results of hydraulic tests[a].

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-422	19-Sep-85	Drawdown	8.6	230	42	Good
W-423	12-Oct-85	Drawdown	22.0	1,500	130	Good
W-424	17-Oct-85	Drawdown	4.5	130	19	Good
W-441	30-Oct-87	Drawdown	6.0	500	56	Good
W-441	13-Apr-88	Drawdown	13.0	2,200	240	Poor
W-441	19-Apr-88	Longterm	14.0	470	52	Good
W-447	26-Feb-88	Drawdown	7.1	124	850	Poor
W-448	24-Mar-85	Drawdown	24.5	4,200	600	Good
W-449	21-Mar-85	Drawdown	6.2	170	11	Good
W-450	14-Apr-88	Drawdown	3.3	38	650	Fair
W-451	27-Apr-88	Drawdown	2.1	80	16	Good
W-452	2-May-88	Drawdown	5.2	310	21	Excel
W-453	3-May-88	Drawdown	5.8	67	7.4	Fair
W-455	22-Jun-88	Drawdown	5.8	160	13	Good
W-456	14-Jul-85	Drawdown	4.5	260	33	Fair
W-457	29-Jul-85	Drawdown	20.5	450	24	Excel
W-458	2-Aug-85	Drawdown	0.8	24	150	Fair
W-460	1-Sep-85	Drawdown	17.0	1,900	380	Fair
W-461	7-Sep-85	Slug	NA	690	140	Good
W-462	27-Sep-85	Drawdown	19.0	360	60	Good
W-463	11-Oct-85	Drawdown	24.0	1,600	200	Good
W-464	8-Nov-88	Drawdown	9.0	370	53	Good
W-481	2-Dec-87	Drawdown	1.1	8	1.7	Good
W-486	23-Mar-85	Drawdown	6.0	230	30	Good
W-487	14-Apr-88	Drawdown	2.2	45	15	Good
W-501	21-Oct-85	Drawdown	9.7	170	21	Good
W-502	14-Nov-85	Slug	NA	12	30	Good
W-503	11-Nov-88	Drawdown	1.3	15	3.0	Fair
W-504	8-Dec-85	Drawdown	10.0	590	84	Good
W-505	21-Mar-89	Drawdown	34.2	653	76	Good
W-506	10-Feb-89	Drawdown	31.0	7,423	460	Good
W-507	6-Feb-89	Drawdown	39.0	2,900	290	Good
W-508	29-Mar-89	Drawdown	30.0	47,000	2,600	Good
W-509	11-May-89	Drawdown	0.9	10	2.0	Fair
W-510	11-May-89	Slug	NA	220	110	Good
W-511	11-May-89	Drawdown	1.7	63	11	Fair
W-512	27-Apr-89	Drawdown	2.9	85	9.4	Good
W-513	9-May-89	Drawdown	0.6	33	3.0	Fair

Table B-1. Results of hydraulic tests[a].

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-514	26-May-89	Drawdown	1.4	84	530	Fair
W-515	6-Jun-89	Drawdown	2.8	37	4.2	Fair
W-516	19-Jun-89	Drawdown	19.5	1,428	286	Good
W-517	27-Jun-89	Drawdown	7.3	370	53	Good
W-518	10-Aug-89	Drawdown	6.2	1,421	178	Good
W-519	31-Aug-89	Drawdown	31.5	5,700	475	Excel
W-520	24-Jan-90	Drawdown	22.8	3,300	560	Excel
W-521	1-Feb-90	Drawdown	0.6	44	4.9	Fair
W-522	5-Feb-90	Drawdown	20.0	3,700	620	Fair
W-551	8-Nov-85	Drawdown	37.0	350	88	Good
W-552	12-Dec-88	Drawdown	38.0	4,700	390	Good
W-553	17-Nov-85	Drawdown	2.2	55	7.9	Fair
W-554	10-Jan-89	Drawdown	21.5	1,800	150	Good
W-555	28-Dec-88	Drawdown	14.0	460	23	Fair
W-556	25-Jan-89	Drawdown	17.0	850	170	Fair
W-557	23-Jan-89	Drawdown	1.2	570	36	Poor
W-558	23-Mar-89	Drawdown	24.7	5,200	650	Good
W-560	8-Mar-89	Drawdown	1.7	30	7.6	Fair
W-561	13-Mar-89	Drawdown	1.1	12	2.1	Fair
W-562	28-Mar-89	Drawdown	1.0	16	2.3	Fair
W-563	31-Mar-89	Drawdown	1.1	14	2.3	Fair
W-564	26-Apr-89	Drawdown	1.6	44	5.0	Poor
W-565	18-Apr-89	Drawdown	15.6	1,600	260	Good
W-566	2-May-89	Drawdown	17.0	780	86	Good
W-566	31-Aug-93	Longterm	22.5	2,580	520	Fair
W-566	11-Aug-09	Step	8.2	860	86	Good
W-567	4-May-89	Drawdown	10.4	2,600	320	Excel
W-568	20-Jun-89	Drawdown	18.3	620	160	Fair
W-569	24-May-89	Drawdown	2.8	100	15	Fair
W-570	8-Jun-89	Drawdown	1.1	7	1.1	Fair
W-571	17-Jul-89	Drawdown	17.7	1,000	200	Excel
W-592	23-Jan-89	Drawdown	2.2	2,200	280	Poor
W-593	22-Feb-89	Drawdown	2.2	57	11.4	Good
W-594	16-Mar-89	Slug	NA	380	54	Excel
W-601	8-Feb-90	Drawdown	22.5	6,900	770	Excel
W-602	29-Jan-90	Drawdown	24.0	5,300	620	Good
W-603	7-Feb-90	Drawdown	6.1	100	20	Fair
W-604	20-Feb-90	Slug	NA	380	63	Good

Table B-1. Results of hydraulic tests[a].

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-605	28-Feb-90	Drawdown	4.8	50	12	Good
W-606	21-Feb-90	Slug	NA	120	20	Fair
W-607	22-Feb-90	Drawdown	1.4	800	100	Good
W-608	28-Feb-90	Drawdown	1.2	230	30	Fair
W-609	9-Mar-90	Drawdown	6.7	470	70	Good
W-610	28-Mar-90	Drawdown	5.8	5,500	380	Good
W-611	16-Apr-90	Drawdown	3.5	1,000	110	Fair
W-612	24-May-90	Drawdown	13.5	550	55	Good
W-612	5-Apr-94	Longterm	14	230	40	Good
W-613	23-May-90	Drawdown	4.8	2,550	360	Good
W-614	7-Jun-90	Drawdown	6.7	1,650	130	Good
W-615	21-Jun-90	Drawdown	1.3	130	19	Fair
W-616	27-Jun-90	Drawdown	2.0	390	40	Fair
W-617	12-Jul-90	Drawdown	2.8	53	6.8	Good
W-618	1-Aug-90	Drawdown	1.9	24	4.8	Fair
W-619	30-Aug-90	Drawdown	11.8	190	11	Good
W-620	1-Oct-90	Drawdown	5.8	6,500	650	Good
W-621	4-Oct-90	Drawdown	3.8	310	39	Good
W-622	12-Oct-90	Slug	NA	130	16	Fair
W-651	16-Mar-90	Slug	NA	530	180	Fair
W-652	22-Mar-90	Drawdown	1.0	11	3.8	Good
W-653	11-Apr-90	Drawdown	0.3	2	2.0	Fair
W-653	16-Mar-05	Drawdown	0.45	1.0	1.0	Good
W-654	25-Apr-90	Drawdown	21.7	390	25	Fair
W-655	12-May-90	Drawdown	12.2	1,000	220	Good
W-701	23-Oct-90	Drawdown	14.5	6,800	650	Good
W-701	3-Oct-92	Step	16.5	5,200	430	Good
W-701	1-Apr-93	Drawdown	24.0	3,700	370	Good
W-702	29-Nov-90	Drawdown	2.5	150	30	Good
W-702	25-Feb-93	Step	4.6	36	7	Poor
W-703	19-Dec-90	Drawdown	7.0	230	9.1	Good
W-704	4-Mar-91	Drawdown	19.0	1,800	140	Fair
W-705	20-Feb-91	Drawdown	0.8	40	6.1	Fair
W-706	29-Jan-91	Drawdown	0.2	8	1	Fair
W-712	25-Feb-92	Drawdown	7.8	750	48	Good
W-712	18-Mar-93	Longterm	15.1	1,440	93	Good
W-714	6-Dec-91	Drawdown	2.9	140	6.7	Good
W-902	25-Mar-93	Drawdown	0.6	6	2	Fair

Table B-1. Results of hydraulic tests[a].

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-906	20-Jun-09	Step	8.6	290	4.0	Good
W-909	18-Oct-95	Drawdown	2.7	150	5.1	Good
W-911	2-Feb-96	Drawdown	1.4	53	2.1	Good
W-912	10-Nov-95	Drawdown	4.1	65	11	Poor
W-913	16-Aug-95	Drawdown	23.5	730	36	Good
W-1001	13-Aug-95	Drawdown	1.3	170	25	Fair
W-1002	19-Jun-97	Drawdown	16.8	680	49	Good
W-1003	26-Jun-97	Drawdown	1.2	5.1	0.7	Poor
W-1005	16-Jun-97	Drawdown	17	110,000	91,000	Poor
W-1006	17-Jun-97	Drawdown	17.4	180	23	Fair
W-1007	23-Sep-95	Drawdown	1.6	13	1.3	Fair
W-1007	4-May-99	Drawdown	6.6	4,300	540	Fair
W-1008	17-Jan-97	Drawdown	7.3	110	13	Good
W-1010	10-Jul-95	Drawdown	20.3	1,650	140	Fair
W-1011	11-Jul-95	Drawdown	3.8	240	17	Good
W-1012	13-Jul-95	Drawdown	3.3	35	2.2	Fair
W-1013	13-Jul-95	Drawdown	2.7	2,000	250	Poor
W-1014	28-Aug-96	Drawdown	31.1	7,700	320	Good
W-1101	22-Nov-95	Drawdown	0.8	9.9	3.3	Good
W-1102	29-Jan-96	Drawdown	14.7	81	4.5	Fair
W-1103	29-Nov-95	Drawdown	3	19	1.6	Fair
W-1105	17-Jul-95	Drawdown	2.4	320	26	Fair
W-1106	24-Jul-96	Drawdown	7.1	5,200	580	Good
W-1107	9-Apr-97	Drawdown	6.7	3,500	250	Poor
W-1107	4-May-99	Drawdown	6.6	4,300	310	Fair
W-1108	3-Nov-95	Drawdown	12.3	950	68	Good
W-1108	25-Jun-96	Longterm	11.6	1,000	70	Poor
W-1108	1-Nov-05	Drawdown	7.1	800	57	Fair
W-1108	26-Jun-09	Step	2.9	1,300	89	Fair
W-1109	26-Jun-95	Drawdown	8.7	460	33	Fair
W-1109	4-Jun-96	Longterm	6.8	760	40	Poor
W-1109	11-Aug-09	Step	1.5	650	72	Good
W-1110	22-Jan-96	Drawdown	6.3	690	29	Fair
W-1111	20-Oct-95	Drawdown	15.8	2,100	95	Good
W-1111	9-Dec-96	Longterm	11.2	160	7.9	Poor
W-1112	24-May-96	Drawdown	6.4	94	10	Fair
W-1113	26-Aug-96	Drawdown	1	5.5	0.6	Good
W-1114	27-Oct-95	Longterm	15.1	270	12	Fair

Table B-1. Results of hydraulic tests[a].

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-1116	23-Feb-96	Drawdown	6.6	290	11	Fair
W-1117	23-Aug-96	Drawdown	0.7	3.4	0.34	Fair
W-1118	18-Jan-96	Drawdown	5.6	350	35	Good
W-1201	1-Nov-96	Drawdown	1	8.3	0.92	Poor
W-1203	2-May-96	Drawdown	18.8	900	90	Good
W-1204	22-Feb-96	Drawdown	1.3	17	2.2	Poor
W-1205	27-Nov-96	Slug	NA	330	33	Fair
W-1206	20-Jun-09	Step	18	1,900	160	Fair
W-1207	27-Nov-96	Slug	NA	900	45	Poor
W-1208	20-Jun-09	Step	23	784	28	Fair
W-1209	17-May-96	Drawdown	0.98	11	0.69	Good
W-1210	30-May-96	Drawdown	3.8	7.3	0.73	Fair
W-1211	26-Jul-96	Drawdown	28.6	5,000	330	Good
W-1212	14-May-96	Drawdown	1.9	35	2.5	Good
W-1212	10-Sep-96	Longterm	1.3	85	3.6	Poor
W-1213	22-Jul-96	Drawdown	11.6	500	42	Fair
W-1213	30-Jul-96	Longterm	9.6	440	37	Poor
W-1213	9-Feb-09	Step	3.3	4,400	360	Fair
W-1214	28-Apr-97	Drawdown	2.2	110	5.4	Fair
W-1215	15-Aug-96	Drawdown	11.6	610	61	Fair
W-1215	8-Oct-96	Longterm	9.8	3,000	300	Poor
W-1216	14-Aug-96	Drawdown	11.4	210	6.9	Good
W-1216	15-Oct-96	Longterm	11.1	160	5.4	Poor
W-1218	11-Nov-96	Drawdown	5.8	83	4.6	Fair
W-1218	8-Jul-97	Longterm	4.8	210	12	Fair
W-1219	27-May-97	Drawdown	0.4	2.5	0.63	Poor
W-1220	13-Nov-96	Drawdown	20.3	2,600	120	Good
W-1220	15-Jul-97	Longterm	20.0	4,700	210	Fair
W-1221	27-Dec-96	Drawdown	3.1	29	2.9	Fair
W-1222	31-Oct-96	Drawdown	6.1	430	43	Good
W-1224	22-May-97	Drawdown	5.0	55	11	Good
W-1225	31-Mar-97	Drawdown	4.1	83	10	Good
W-1226	27-Feb-97	Drawdown	2.2	14	1.4	Excel
W-1227	11-Apr-97	Drawdown	15.1	380	48	Fair
W-1254	19-Nov-96	Longterm	18.9	1,130	110	Fair
W-1301	10-Mar-97	Longterm	4.7	120	15	Fair
W-1303	18-Mar-97	Longterm	7.8	490	21	Fair
W-1304	2-Jul-97	Drawdown	0.7	2.6	0.52	Poor

Table B-1. Results of hydraulic tests[a].

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-1306	30-Apr-97	Drawdown	2.8	24	1.2	Good
W-1306	18-Jun-97	Longterm	1.6	54	2.7	Poor
W-1307	31-Jul-97	Drawdown	11.6	1,100	110	Good
W-1308	14-Aug-97	Drawdown	6.5	150	5.1	Good
W-1308	7-Oct-97	Longterm	4.0	530	18	Fair
W-1309	15-Oct-97	Drawdown	9.1	90	8.9	Fair
W-1310	10-Mar-97	Drawdown	27.9	1,060	53	Good
W-1310	17-Nov-08	Drawdown	5.1	1,200	62	Poor
W-1311	29-Oct-97	Drawdown	12.2	290	15	Good
W-1401	11-Nov-97	Drawdown	7.0	100	6.8	Excel
W-1402	12-Dec-97	Drawdown	2.6	100	10.2	Fair
W-1403	21-Jul-98	Drawdown	5.4	95	13	Good
W-1404	21-Apr-98	Drawdown	6.5	210	84	Good
W-1405	23-Apr-98	Drawdown	6.4	1,300	360	Fair
W-1406	17-Apr-98	Drawdown	11.1	3,600	360	Good
W-1407	3-Apr-98	Drawdown	1.1	8.7	1.0	Excellent
W-1408	15-Apr-98	Drawdown	2.7	85	28	Fair
W-1410	29-Jun-98	Drawdown	11.5	3,000	500	Poor
W-1410	8-Sep-99	Step	6.5	3,800	650	Poor
W-1411	15-May-98	Drawdown	12.3	14,700	1,300	Poor
W-1412	29-May-98	Slug	NA	2	0.67	Fair
W-1413	8-Jun-98	Drawdown	0.63	8.7	3.5	Fair
W-1415	11-Jun-98	Drawdown	0.87	18	1.2	Fair
W-1416	28-Jul-98	Drawdown	12.3	1,300	180	Good
W-1417	1-Jul-98	Drawdown	15.1	130	11	Good
W-1417	16-Jul-98	Step	5.9	150	13	Fair
W-1418	25-Sep-98	Drawdown	10.7	78	6.5	Excellent
W-1418	16-Dec-98	Step	10.5	490	41	Fair
W-1419	15-Jul-98	Step	6.1	47	3	Poor
W-1420	12-Aug-98	Drawdown	13.1	3,000	220	Poor
W-1421	14-Jul-98	Step	1.82	14	1.8	Poor
W-1421	17-Jul-98	Step	3.8	22	2.8	Poor
W-1422	18-Sep-98	Drawdown	12.0	170	33	Excellent
W-1422	18-Dec-98	Step	11.7	160	32	Good
W-1423	12-Nov-98	Drawdown	24.6	540	39	Fair
W-1424	1-Oct-98	Drawdown	6	48	6.9	Excellent
W-1425	1-Oct-98	Drawdown	1.4	15	2.4	Fair
W-1426	13-Nov-98	Drawdown	6.5	840	56	Good

Table B-1. Results of hydraulic tests[a].

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-1427	11-Jan-99	Drawdown	7.9	2,100	300	Good
W-1428	13-Jan-99	Drawdown	8.1	8,200	550	Good
W-1501	20-Nov-98	Drawdown	7.2	68	11	Good
W-1502	17-May-99	Drawdown	1.5	360	60	Good
W-1503	12-Feb-99	Drawdown	17.6	1,700	180	Good
W-1503	21-Apr-09	Step	14	1,000	100	Fair
W-1504	18-Feb-99	Drawdown	15.4	600	60	Fair
W-1504	21-Apr-09	Step	3.2	370	18	Good
W-1505	29-Apr-99	Drawdown	11.2	280	35	Fair
W-1506	19-Apr-99	Drawdown	3.1	50	5.4	Good
W-1507	27-Apr-99	Drawdown	0.65	15	1.9	Fair
W-1508	28-Jun-01	Slug	NA	160	16	Good
W-1509	9-Apr-99	Drawdown	7.2	7,000	700	Good
W-1510	14-Apr-99	Drawdown	6.6	280	20	Fair
W-1510	21-Apr-09	Step	4.5	3,200	160	Fair
W-1512	21-Jun-01	Slug	NA	230	23	Good
W-1514	23-Jun-99	Longterm	5.8	440	90	Good
W-1515	18-Jan-00	Drawdown	1.5	26	1.5	Poor
W-1515	2-Feb-00	Longterm	1.1	75	4.1	Fair
W-1518	22-Mar-00	Step	6.0	440	19	Good
W-1520	21-Mar-00	Longterm	4.0	165	20	Poor
W-1522	20-Mar-00	Step	10.5	3,500	235	Good
W-1550	28-Dec-99	Drawdown	10.0	330	35	Fair
W-1601	25-Feb-00	Drawdown	3.0	35	3.6	Good
W-1602	3-Mar-00	Drawdown	8.3	3,100	310	Fair
W-1604	2-Apr-01	Drawdown	4.0	1,600	220	Fair
W-1609	14-Dec-05	Injection	0.30	1.90	0.10	Fair
W-1610	14-Jul-00	Injection	2.0	17	0.8	Good
W-1610	17-Jul-00	Injection	3.0	17	0.8	Excel
W-1610	7-Dec-05	Injection	1.5	17	0.80	Fair
W-1614	25-Aug-00	Drawdown	1.9	75	8.3	Good
W-1654	20-Apr-00	Drawdown	0.5	12	2.0	Good
W-1655	21-Apr-00	Drawdown	1.5	27	4.9	Good
W-1701	23-Jul-01	Drawdown	9.0	160	40	Good
W-1701	26-Sep-01	Longterm	15.0	60	15	Fair
W-1703	25-Oct-01	Drawdown	12.0	16,000	2,300	Fair
W-1801	3-May-02	Drawdown	10.0	6,600	660	Fair
W-1801	18-Jun-09	Step	7	1,100	110	Good

Table B-1. Results of hydraulic tests[a].

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-1802	30-Sep-02	Drawdown	1.3	11	1.1	Fair
W-1805	22-Jan-03	Drawdown	11.1	13,000	800	Fair
W-1806	15-Apr-03	Drawdown	3.1	450	77	Good
W-1807	24-Aug-09	Step	3	3,200	320	Good
W-1902	19-Mar-03	Step	11.0	1,100	29	Good
W-2012	8-Jul-10	Drawdown	NA	83.0	27.7	Fair
W-2201	9-Feb-09	Step	3.0	12,000	680	Fair
W-2202	2-Mar-06	Drawdown	0.95	65	6.5	Poor
W-2203	23-Feb-06	Drawdown	1.04	15	1.4	Fair
W-2501	5-May-10	Drawdown	35.00	240	12	Good
W-2502	23-Apr-10	Drawdown	24	51	2.1	Good
W-2601	15-May-10	Drawdown	34	760	51	Fair
W-2602	2-Jun-10	Drawdown	5	38	7.6	Poor
W-2603	5-May-10	Drawdown	4.8	68.8	14.0	Good
SIP-ETC-201	1-Apr-04	Drawdown	1.0	200	10	Fair
SIP-ETS-201	13-Mar-96	Drawdown	0.0	430	89	Fair
SIP-ETS-204	13-Mar-96	Drawdown	0.0	150	15	Poor
SIP-ETS-207	26-Oct-93	Drawdown	0.58	710	68	Fair
SIP-ETS-207	10-Nov-93	Drawdown	2.7	440	51	Fair
SIP-ETS-207	13-Mar-96	Slug	0.0	1,800	200	Poor
SIP-ETS-601	15-Jun-10	Slug	NA	5.3	0.82	Fair
SIP-ETS-601	16-Jun-10	Slug	NA	2.4	0.36	Fair
SIP-ETS-601	17-Jun-10	Slug	NA	3.0	0.46	Fair
TW-11	24-Jan-85	Drawdown	0.3	200	20	Good
TW-11A	24-Jan-85	Drawdown	10.0	3,100	110	Fair
GSW-01	11-Dec-85	Slug	NA	72	0.2	Fair
GSW-01A	14-Jul-86	Drawdown	13.4	12,000	790	Good
GSW-02	17-Dec-85	Slug	NA	240	10	Good
GSW-03	23-Dec-85	Slug	NA	510	41	Good
GSW-04	19-Dec-85	Slug	NA	17	0.9	Good
GSW-05	12-Feb-86	Slug	NA	99	9	Excel
GSW-06	23-Iun-86	Drawdown	25.0	4,800	310	Good
GSW-06	16-Jun-87	Longterm	20.0	5,500	350	Good
GSW-07	3-Apr-86	Drawdown	4.3	230	23	Excel
GSW-08	19-Nov-86	Drawdown	2.0	230	38	Good
GSW-09	28-May-86	Drawdown	1.9	500	63	Poor
GSW-10	22-May-86	Drawdown	14.3	21,000	2,000	Good

Table B-1. Results of hydraulic tests[a].

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
GSW-11	2-Jun-86	Drawdown	4.7	390	45	Excel
GSW-12	7-Jun-86	Drawdown	0.8	51	11	Fair
GSW-13	4-Aug-86	Slug	NA	110	13	Excel
GSW-13	8-Aug-86	Slug	NA	62	7	Good
GSW-15	23-Feb-88	Drawdown	25.8	1,500	190	Good
GSW-208	8-May-86	Drawdown	1.9	440	80	Good
GSW-209	8-May-86	Drawdown	6.1	1,200	120	Good
GSW-215	4-Jun-86	Drawdown	1.9	220	40	Poor
GSW-216	16-Jan-92	Drawdown	10.5	3,500	440	Fair
GSW-266	20-Jun-86	Drawdown	2.1	470	72	Good
GSW-266	18-Nov-86	Drawdown	3.0	450	64	Good
GSW-266	18-Nov-86	Drawdown	4.7	410	59	Good
GSW-367	11-May-87	Drawdown	6.9	200	29	Fair
GSW-403-6	8-Dec-85	Slug	NA	4	0.2	Good
GSW-442	23-Nov-87	Drawdown	1.2	32	4.6	Good
GSW-443	30-Nov-87	Drawdown	10.3	260	8.7	Good
GSW-444	28-Jan-88	Slug	NA	9	0.86	Good
GSW-445	26-Jan-85	Drawdown	4.7	43	4.30	Fair
GEW-710	23-Sept-91	Step	36.0	4,800	220	Excel
GEW-816	15-Aug-92	Drawdown	39.0	12,000	1,100	Good
11H4	15-Jan-85	Drawdown	24.6	2,000	77	Good
11H4	19-Jan-85	Longterm	29.5	1,780	18	Good
11J4	10-Jun-88	Drawdown	17.0	1,000	15	Excel
11J4	14-Jun-85	Longterm	16.0	1,100	16	Good
13D1	9-Feb-85	Longterm	50.0	4,800	48	Excel

Notes and footnotes appear on the following page.

Table B-1. Results of hydraulic tests[a].

Notes:

gpd = Gallons per day.
gpm = Gallons per minute.
NA = Not applicable.
sq ft = Square feet.

[a] **The pumping test results were obtained by using the analytic techniques of Theis (1935), Cooper and Jacob (1946), Papadopulos and Cooper (1967), Hantush and Jacob (1955), Hantush (1960), or Boulton (1963). The particular method used depends on the character of the data obtained. The slug test results were obtained using the method of Cooper et al. (1967) (See references below).**

[b] **"Drawdown" denotes 1-hr pumping tests; "Longterm" denotes 24- to 48-hr pumping tests; "Slug" denotes monitoring and recovery after an instantaneous change in ground water elevations; "Step" denotes a step-drawdown test, flow rate given is the maximum or final step. "Injection" denotes the introduction of treated ground water under gravity into a well.**

[c] **K is calculated by dividing T by the thickness of permeable sediments intercepted by the sand pack of the well. This thickness is the sum of all sediments with moderate to high estimated conductivities determined from the geologic and geophysical logs of the well.**

[d] **Hydraulic test quality criteria:**

Excel: High confidence that type curve match is unique. Data are smooth and flow rate well controlled.

Good: Some confidence that curve match is unique. Data are not too "noisy." Well bore storage effects, if present, do not significantly interfere with the curve match. Boundary effects can be separated from properties of the pumped zone.

Fair: Low confidence that curve match is unique. Data are "noisy." Multiple leakiness and other boundary effects tend to obscure the curve match.

Poor: Unique curve match cannot be obtained due to multiple boundaries, well bore storage, uneven flow rate, or equipment problems. Usually, the test is repeated.

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Appendix C

Soil Vapor Extraction Test Results

Table C-1. Soil vapor extraction test results.

Well	Date	HSU	Duration test (hours)	Flow rate (scfm)	Vacuum, inches (Hg)	Max. conc.[a] (ppm_v)	Air permeability (cm^2)
W-543-001	22-Apr-03	2	6	19.3	3.7	296	3E-08
W-543-002A	30-Apr-03	2	6	10	5.1	138	8E-09
W-543-002B	1-May-03	2	6	14	5.1	145	2E-08
W-543-003	29-Apr-03	2	6	31	5.1	236	7E-08
W-543-004A	23-Apr-03	2	6	37	3.7	198	2E-08
W-543-004B	28-Apr-03	2	6	36.5	5.1	188	2E-08
W-HPA-001B	13-May-03	2	1.5	9.3	6.6	31	1E-08
W-HPA-002A	20-May-03	1B	2	0.8	6.6	4.3	1E-08
W-1552	6-Oct-03	3A/B	1.8	1	15	NM	9E-11
W-1650	9-Oct-03	3A/B	2.8	0.8	12	22.7[b]	1E-10
W-1651	9-Oct-03	3A/B	3	0.9	12	31[b]	1E-10
W-1652	7-Oct-03	3A/B	6	1.1	12	29[b]	2E-10
W-1653	10-Oct-03	3A/B	2	0.8	12	17.7[b]	3E-10
W-1654	10-Oct-03	3A/B	2.5	0.8	12	10[b]	3E-11
W-1655	8-Oct-03	3A/B	1	1.5	12	NM	4E-10
W-1656	13-Oct-03	3A/B	0.5	NM	12	10[b]	2E-10
W-1657	8-Oct-03	3A/B	2.8	1	12	20[b]	3E-10
SIP-518-201	26-Jan-04	2	6	4.5	13	102	7E-10
SVB-518-204	22-Jan-04	2	6	0.9	25	1,944	2E-11
W-518-1913	21-Jan-04	2	6	0.5	26	106	2E-11
W-518-1914	23-Jan-04	1B	6	5.5	16	44	1E-09
W-518-1915	28-Jan-04	2	6	0.03	25	193	2E-12
W-1615	29-Jan-04	2	6	1.4	24	478	4E-11
W-ETC-2001A	16-Mar-04	1B	6	8.3	5	52.5	2E-08
W-ETC-2001B	19-Mar-04	2	6	0.7	5	145.3	1E-09
W-ETC-2002A	11-Mar-04	1B/2	6	6	5	22.6	3E-09
W-ETC-2002B	15-Mar-04	2	6	4	5.5	26	NC
W-ETC-2003	22-Mar-04	1B	6	17	4.5	77.4	8E-09
W-ETC-2004A	5-Mar-04	1B/2	6	12	8	82.8	3E-09
W-ETC-2004B	9-Mar-04	2	6	18	3.8	188	3E-09
SIP-ETC-201	4-Mar-04	2	6	8	7	185.5	7E-09
W-1904	2-Mar-04	2	6	23	4	63.3	2E-08
W-514-2007A	19-Apr-04	1B	96	14	7.5	17.6	NC
W-514-2007B	26-Apr-04	5	96	21	3.3	39.6	NC
W-217	3-May-04	5	96	20	3	63.2	NC
W-ETS-2008A	28-Sep-04	1B	6	50	7	23.7	NC
W-ETS-2008B	29-Sep-04	2	6	33	9.5	67.8	NC
W-ETS-2009	30-Nov-04	2	6	76	4.8	16.4	NC
W-ETS-2010A	7-Oct-04	1B	6	70	3	20.5	NC

Table C-1. Soil vapor extraction test results.

Well	Date	HSU	Duration test (hours)	Flow rate (scfm)	Vacuum, inches (Hg)	Max. conc.[a] (ppm_v)	Air permeability (cm^2)
W-ETS-2010B	11-Oct-04	2	6	63	4.5	39.8	NC
SIP-ETS-601	13-Oct-04	2	2.5	0.5	10	153.7	NC
W-653	16-Mar-05	3A	2	0	NA	9.6	NC
W-2011	18-Mar-05	3A	2	0	NA	1.5	NC
W-2101	6-Apr-05	3A	1.75	0	NA	8.1	NC
W-2102	25-Apr-05	3A	5	0.46	28	4.7	NC
W-2103	14-Apr-05	3A	1.25	0.35	28.2	NM	NC
W-2104A	9-Mar-05	1B	24	43	10	0.13	NC
W-2104B	14-Mar-05	2	24	43	10	0.16	NC
W-2110A	8-Nov-05	1B/2	3	37	6.4	5.2	NC
W-2110B	9-Nov-05	2	3	32	6.5	8.4	NC
W-2111A	3-Nov-05	1B	3	39	5.4	4.0	NC
W-2111B	4-Nov-05	2	3	28	3.0	4.1	NC
W-2112A	15-Nov-05	1B/2	3	44	2.9	0.75	NC
W-2112B	17-Nov-05	2	3	51	2.8	15	NC
W-2204	22-Feb-06	2	26.25	16.7	6.1	62.5	4.16E-09
W-2205	9-May-06	2/3A	71.75	18	6.5	25.2	NC
W-2206	28-Feb-06	2/3A	24	13.3	8.9	37.9	2.70E-09
W-2207A	20-Apr-06	2	23.75	20	6.1	87.8	1.07E-08
W-2208A	13-Apr-06	1B	24	23	2.44	394.8	2.52E-08

Notes:

cm^2 = Square centimeters.

Hg = Mercury.

HSU = Hydrostratigraphic unit.

Max. conc. = Maximum concentration.

NM = Not measured.

ppm_v = Parts per million by volume.

scfm = Standard cubic feet per minute.

NC = Not computed due to insufficient data for analysis.

NA = Not applicable.

[a] **Sample collected in Tedlar bag for TO-14 analysis.**

[b] **Sample measured with organic vapor analyzer.**

References

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Appendix D

2010 Ground Water Sampling Schedule

Table D-1. 2010 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
W-001	E	2-12	
W-001A	A	1-11	
W-002	E	3-12	
W-002A	O	3-11	
W-004	A	2-11	
W-005	O	3-11	
W-005A	E	4-12	
W-007	O	1-11	EFA
W-008	E	2-12	EFA
W-011	O	3-11	
W-012	Q	1-11	
W-017	E	1-12	EFA
W-017A	O	1-11	
W-101	O	3-11	EFA
W-102	O	1-11	
W-103	O	1-11	
W-104	Q	1-11	
W-105	S	1-11	
W-106	O	1-11	
W-107	A	1-11	
W-108	O	3-11	
W-110	Q	1-11	
W-111	A	1-11	
W-112	A	2-11	
W-113	A	3-11	
W-114	O	1-11	
W-115	E	2-12	
W-116	Q	1-11	
W-117	O	1-11	
W-118	E	2-12	
W-119	Q	1-11	EFA
W-120	Q	1-11	
W-121	Q	1-11	EFA
W-122	E	1-12	
W-123	E	1-12	
W-141	A	2-11	
W-142	O	1-11	
W-143	Q	1-11	
W-146	A	1-11	
W-147	E	2-12	EFA
W-148	O	4-11	EFA
W-151	Q	1-11	EFA
W-201	E	4-12	
W-202	O	1-11	
W-203	E	2-12	
W-204	A	1-11	EFA

Table D-1. 2010 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
W-205	Q	1-11	
W-206	Q	1-11	
W-207	O	2-11	
W-210	A	1-11	
W-212	O	1-11	
W-213	E	3-12	
W-214	A	1-11	
W-218	S	1-11	
W-219	O	3-11	
W-220	A	2-12	
W-221	E	1-12	EFA
W-222	A	3-11	
W-223	O	3-11	
W-224	E	4-12	
W-225	E	1-12	
W-226	E	1-12	EFA
W-251	Q	1-11	
W-252	O	1-11	
W-253	O	3-11	
W-255	A	1-11	
W-256	A	3-11	
W-257	S	1-11	
W-258	Q	1-11	
W-259	Q	1-11	
W-260	E	4-12	
W-261	O	2-11	
W-263	Q	1-11	
W-264	A	4-11	
W-265	O	3-11	
W-267	E	3-12	
W-268	A	3-11	
W-269	E	1-12	
W-270	O	1-11	EFA
W-271	E	4-12	
W-272	A	1-11	
W-273	O	4-11	
W-274	Q	1-11	
W-275	E	2-12	
W-276	S	2-11	
W-277	A	1-11	
W-290	O	1-11	
W-291	O	1-11	
W-293	O	1-11	
W-294	O	1-11	
W-301	A	3-11	
W-302	A	3-11	

Table D-1. 2010 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
W-303	S	1-11	
W-304	S	1-11	
W-305	S	2-11	EFA
W-306	E	2-12	EFA
W-307	S	1-11	EFA
W-308	A	2-12	
W-310	Q	1-11	
W-311	A	1-11	
W-312	O	1-11	
W-313	A	3-11	
W-315	Q	1-11	
W-316	A	1-11	
W-317	A	3-11	
W-319	A	3-11	
W-320	E	4-12	
W-321	E	1-12	
W-322	Q	1-11	
W-323	Q	1-11	
W-324	E	4-12	
W-325	E	4-12	
W-353	A	1-11	
W-354	Q	1-11	
W-355	A	3-11	
W-356	A	1-11	
W-359	S	2-11	EFA
W-361	A	2-11	
W-362	A	2-11	
W-363	Q	1-11	EFA
W-364	Q	1-11	
W-365	E	3-12	
W-366	O	4-11	
W-369	A	1-11	
W-370	O	2-11	
W-371	O	4-11	
W-372	O	1-11	
W-373	E	3-12	EFA
W-375	A	1-11	
W-376	O	2-11	
W-377	O	4-11	
W-378	E	4-12	
W-379	A	2-11	
W-380	O	2-11	
W-401	E	4-12	
W-402	O	2-11	
W-403	O	2-11	
W-405	Q	1-11	

Table D-1. 2010 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
W-406	O	4-11	
W-407	Q	1-11	
W-409	A	4-11	
W-410	Q	1-11	
W-411	S	2-11	
W-412	A	1-11	
W-416	O	3-11	
W-417	O	4-11	
W-418	E	4-12	
W-419	A	4-11	
W-420	E	4-12	
W-421	Q	1-11	
W-422	Q	1-11	
W-423	A	4-11	
W-424	S	2-11	
W-446	O	4-12	
W-447	E	4-12	
W-448	A	4-11	
W-449	E	1-12	
W-450	E	4-12	
W-451	O	1-11	
W-452	E	2-12	
W-453	E	4-12	
W-454	E	1-11	
W-455	O	2-11	
W-458	E	2-12	
W-459	O	4-11	
W-462	O	4-11	
W-463	O	1-11	
W-464	A	4-11	
W-481	Q	1-11	
W-482	S	2-11	
W-483	E	4-12	
W-484	O	3-11	
W-485	O	1-11	
W-486	E	2-12	
W-487	E	2-12	
W-501	A	1-11	
W-502	E	2-12	
W-503	S	1-11	
W-504	O	4-11	
W-505	E	3-12	
W-506	Q	1-11	
W-507	O	4-11	
W-509	S	1-11	
W-510	O	1-11	

Table D-1. 2010 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
W-511	O	3-11	
W-512	A	1-11	
W-513	O	1-11	
W-514	O	4-11	
W-515	A	4-11	
W-516	O	4-11	
W-517	Q	1-11	
W-519	O	1-11	
W-520	E	4-12	
W-521	O	1-11	
W-551	S	1-11	
W-552	A	1-11	
W-553	O	4-11	
W-554	O	4-11	
W-555	O	4-11	
W-556	O	2-11	EFA
W-557	O	1-11	
W-558	Q	1-11	
W-559	O	1-11	
W-560	O	1-11	
W-561	E	4-12	
W-562	O	1-11	
W-563	E	4-12	
W-564	S	2-11	
W-565	A	4-11	
W-567	O	3-11	
W-568	A	1-11	
W-569	S	2-11	
W-570	O	1-11	
W-571	E	1-12	EFA
W-592	O	4-11	
W-593	O	1-11	EFA
W-594	E	1-12	EFA
W-601	E	2-12	
W-602	E	2-12	
W-603	A	4-11	
W-604	A	1-11	
W-606	A	1-11	
W-607	E	3-12	
W-608	O	1-11	
W-609	E	2-12	
W-611	A	4-11	
W-612	A	3-11	
W-613	A	1-11	
W-615	E	4-12	
W-616	O	2-11	

Table D-1. 2010 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
W-617	E	4-12	
W-618	Q	1-11	
W-619	O	3-11	
W-622	Q	1-11	
W-651	Q	1-11	
W-652	O	2-11	
W-653	A	2-11	EFA
W-654	Q	1-11	
W-702	O	1-11	
W-705	E	4-12	
W-706	E	1-12	
W-750	A	1-11	
W-901	O	1-11	
W-902	A	4-11	
W-905	E	4-12	
W-906	Q	1-11	EFA
W-907-1	S	2-12	
W-908	O	1-11	
W-909	Q	1-11	
W-911	E	3-12	
W-912	S	1-11	
W-913	Q	1-11	
W-1002	O	1-11	
W-1003	O	4-11	
W-1008	O	1-11	
W-1010	E	1-12	
W-1011	E	2-12	
W-1012	E	4-12	EFA
W-1013	A	1-11	
W-1014	E	2-12	
W-1101	A	1-11	
W-1105	O	4-11	
W-1106	E	3-12	
W-1107	S	1-11	
W-1110	A	1-11	
W-1112	E	2-12	
W-1113	E	3-12	
W-1115	O	1-11	
W-1117	S	1-11	
W-1118	Q	1-11	
W-1201	S	1-11	
W-1202	A	1-11	
W-1203	Q	1-11	
W-1204	A	3-11	
W-1205	A	4-11	
W-1207	O	3-11	EFA

Table D-1. 2010 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
W-1209	E	3-12	
W-1210	Q	1-11	
W-1212	S	1-11	
W-1214	S	1-11	
W-1217	S	2-11	
W-1219	S	1-11	
W-1222	S	1-11	
W-1223	Q	1-11	
W-1224	E	4-12	
W-1225	A	2-11	
W-1226	E	3-12	
W-1227	A	1-11	
W-1250	S	2-11	
W-1251	Q	1-11	
W-1252	A	2-11	
W-1303	Q	1-11	EFA
W-1304	Q	1-11	
W-1306	Q	1-11	EFA
W-1308	Q	1-11	EFA
W-1311	A	3-11	
W-1401	A	2-11	
W-1402	S	1-11	
W-1405	Q	1-11	
W-1406	Q	1-11	
W-1407	A	4-11	
W-1408	Q	1-11	
W-1411	O	4-11	
W-1412	S	1-11	
W-1413	Q	1-11	
W-1414	Q	1-11	
W-1416	E	2-12	
W-1417	Q	1-11	
W-1418	Q	1-11	
W-1419	E	2-12	
W-1420	Q	1-11	
W-1421	S	1-11	
W-1422	Q	1-11	
W-1424	A	2-11	
W-1425	Q	1-11	
W-1426	E	4-12	
W-1427	Q	1-11	
W-1428	E	1-12	
W-1501	A	1-11	
W-1502	S	2-12	
W-1505	A	3-11	
W-1506	A	1-11	

Table D-1. 2010 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
W-1507	Q	1-11	
W-1508	E	3-12	
W-1509	E	4-12	
W-1511	Q	1-11	
W-1512	E	3-12	
W-1513	E	1-12	
W-1514	O	1-11	
W-1515	O	1-11	
W-1516	A	3-11	
W-1517	Q	1-11	
W-1519	S	1-11	
W-1553	Q	1-11	
W-1606	E	3-12	
W-1607	E	2-12	
W-1613	O	1-11	
W-1614	E	4-12	
W-1701	A	1-11	
W-1703	O	1-11	
W-1704	A	1-11	
W-1802	A	1-11	
W-1803-1[a]	Q	1-11	
W-1803-2[a]	A	1-11	
W-1804-1[a]	S	2-11	
W-1804-2[a]	Q	1-11	
W-1805	E	4-12	
W-1901-1[a]	E	2-12	
W-1901-2[a]	A	3-11	
W-1905-1[a]	Q	1-11	
W-1905-2[a]	Q	1-11	
W-1909	Q	1-11	
W-2103	Q	1-11	
W-2113	A	3-11	
W-2202	Q	1-11	
W-2215A	Q	1-11	
W-2216B	Q	1-11	
W-2304	Q	1-11	
W-2501	Q	1-11	
W-2502	Q	1-11	
TW-11	O	3-11	
TW-11A	E	3-12	
TW-21	O	4-11	
11C1	O	1-11	
14A11	O	2-11	
14A3	O	2-11	
14B1	O	3-11	EFA

Table D-1. 2010 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
14B4	O	3-11	
14C2	O	2-11	
18D1	O	4-11	
GSW-006	E	1-12	
GSW-007	O	1-11	
GSW-008	E	1-12	
GSW-009	Q	1-11	
GSW-011	S	1-11	EFA
GSW-013	O	1-11	
GSW-215	O	4-11	
GSW-216	O	2-11	
GSW-266	E	2-12	
GSW-326	O	3-11	
GSW-367	A	3-11	
GSW-442	O	1-11	
GSW-443	O	4-11	
GSW-444	O	1-11	
W-2501	Q	1-11	
W-2502	Q	1-11	
W-2601	Q	1-11	
W-2602	Q	1-11	
W-2603	Q	1-11	
W-2604A	Q	1-11	
W-2604B	Q	1-11	
W-2605A	Q	1-11	
W-2605B	Q	1-11	
W-2606	Q	1-11	
W-2607	Q	1-11	
W-2611	Q	1-11	
W-2612	Q	1-11	
W-2616	Q	1-11	
W-2617	Q	1-11	

Notes:

All analyses are by EPA Method 601 for purgeable halocarbons.

E = Even years.

O = Odd years.

A = Annual.

S = Semiannual.

Q = Quarterly.

Q1 = First Quarter.

EFA = Environmental Functional Area. Analyses are for the environmental surveillance monitoring programs carried out at DOE sites to complement restoration activities.

[a] **Wells completed with two discrete screened intervals which are hydraulically isolated from one another by a packer and are sampled individually.**

Appendix E

Lake Haussmann
Annual Monitoring Program

Appendix E

Lake Haussmann
Annual Monitoring Program Summary

This appendix summarizes the LLNL Environmental Functional Area discharge data for Lake Haussmann. Lake Haussmann is an artificial water body that has a 37 acre-ft capacity. It is located in the central portion of the Livermore Site (Fig. E-1) and receives storm water runoff and treated ground water. Discharge from Lake Haussmann flows north through a culvert into Arroyo Las Positas.

Samples are collected from water discharge from Lake Haussmann and analyzed as outlined in Jackson (2002). The discharge samples are used to determine compliance with discharge limits in the *Record of Decision* (DOE, 1992), and the subsequent *Explanation of Significant Differences for Metals Discharge Limits* (Berg et al., 1997).

Dry season (June, July, August, September) discharges are sampled during each manual release or monthly during periods of continual release. Wet season (October through May) discharge samples are collected during the first release of the wet season and one other discharge in conjunction with a storm water monitoring event. Analytical results of discharge samples collected at sampling location CDBX are compared with the LLNL Arroyo Las Positas outfall sample results collected at sampling location WPDC (Fig. E-1).

The analytical results for release samples were reported in the LLNL Livermore Site Quarterly Self-Monitoring Reports (Yow and Wong 2010, 2010a, 2010b, and 2011).

E-1. Lake Haussmann Discharge Monitoring

Releases from Lake Haussmann remained continuous throughout the year, with one exception. Invasive species mitigation in Arroyo Las Positas required the temporary cessation of upstream discharges. No discharge from Lake Haussmann occurred from October 25 through November 3, 2010, to support this mitigation effort. Release samples collected during the wet season occurred on October 11 and November 29, 2010. Dry season samples were collected on June 14, July 20, July 28, August 30, and September 28, 2010.

Samples from Lake Haussmann were within discharge limits for all parameters except pH. Samples collected at CDBX exceeded the pH 8.5 limit in all reported wet and dry season monitoring events, with a maximum of 9.68. Corresponding samples collected at location WPDC did not exceed the pH discharge limit in any of the monitoring events. Since 1998, the pH has averaged 9.2 at CDBX and 8.2 at WPDC in release samples and is typically higher during the summer due to increased photosynthesis. Several metals were detected above detection limits at both CDBX and WPDC; however, all of the analytical results were below discharge limits. All acute and chronic aquatic toxicity tests resulted in satisfactory survival, reproduction, and/or growth of the test species.

Lake Haussmann release samples were also analyzed for VOCs, herbicides, polychlorinated biphenyl compounds and radiological activity. All analytical results were below detection limits.

E-2. References

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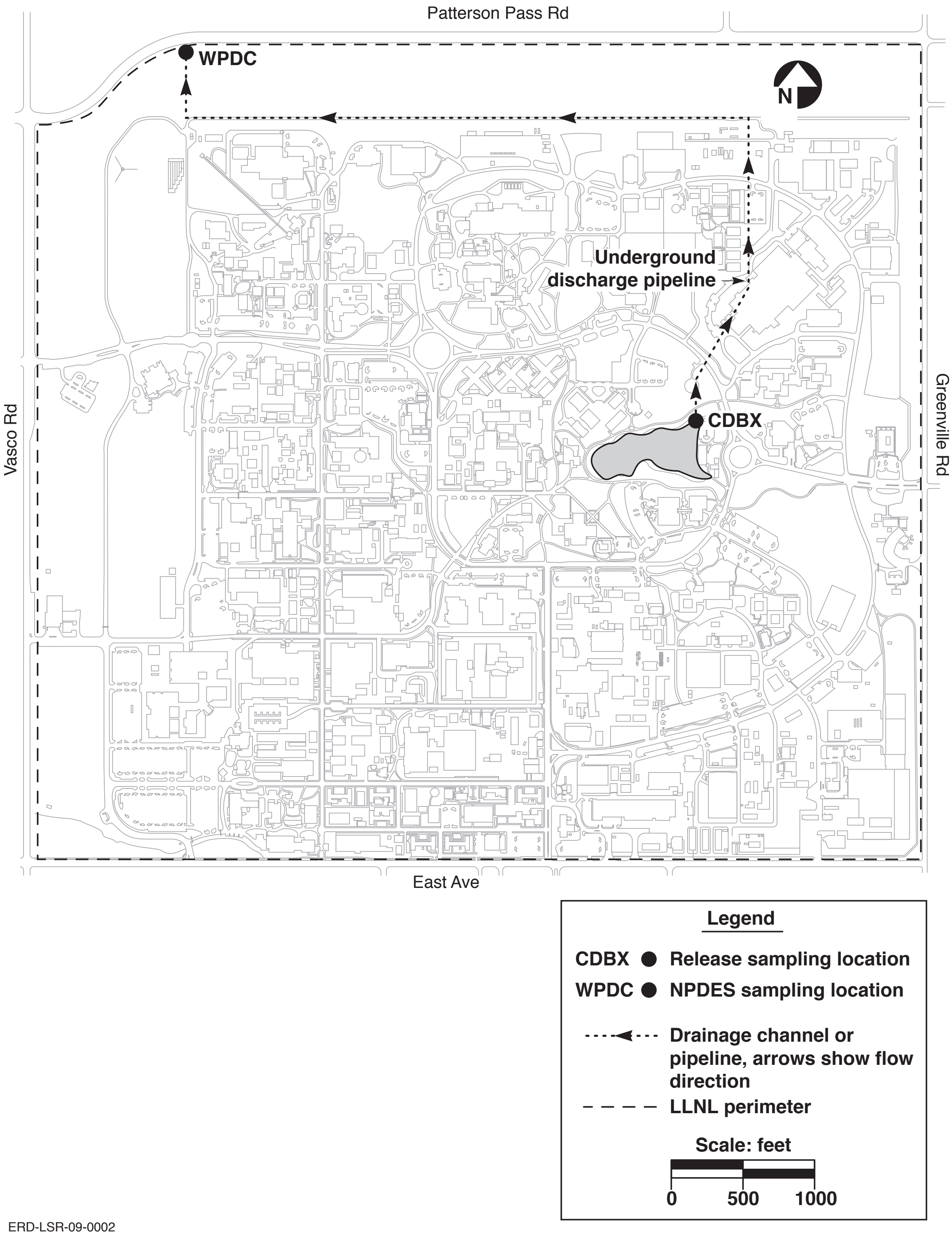

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Figure E-1. Location of Lake Haussmann showing discharge sampling locations.

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