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Lawrence Livermore National Laboratory

Lawrence Livermore National Security, LLC Livermore, California 94551

UCRL-AR-126020-11

LLNL Ground Water Project

2011 Annual Report

Technical Editors

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P. McKereghan
M. Dresen*

Contributing Authors

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Environmental Restoration Department

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Acknowledgements

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Summary

In 2011, environmental restoration activities for the Lawrence Livermore National Laboratory (LLNL) Livermore Site Ground Water Project (GWP) included:

- Removing approximately 55 kilograms (kg) of volatile organic compounds (VOCs) from ground water and 39 kg of VOCs from soil vapor (Table Summ-1).
- Operating and maintaining 29 ground water treatment facilities and nine soil vapor treatment facilities.
- Operating and maintaining a network of 92 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 one extraction well, sealing and destroying one damaged extraction well, and conducting an extensive direct-push cone penetration testing (CPT) survey to better delineate the TFC Hotspot source area (Figures 1 and 2).
- Upgrading treatment facility TFB through ERD's Remediation Evaluation (REVAL) process (Figure 2), including a well field expansion with two new pipelines.
- Improving Livermore Site treatment facility hours of operation by 6% over 2010, excluding treatment facilities in enhanced source area remediation (ESAR) treatability test areas.
- Continuing ESAR treatability tests at TFD Helipad (bioremediation) and TFE Hotspot (pneumatic fracturing), initiating a third treatability test at TFE Eastern Landing Mat (enhanced thermal remediation), and planning a fourth treatability test at TFC Hotspot (*in situ* VOC destruction using zero valent (ZVI) iron emplaced using pneumatic fracturing) (Figure 2).
- Assisting with a second phase of soil sampling in support of the Resource Conservation and Recovery Act (RCRA) closure of Building 419 (Figure 2).
- Confirming tritium activities in ground water from all wells remained below the 20,000 picocuries per liter (pCi/L) U.S. Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL).
- Submitting the following documents to the regulatory agencies: 2010 Annual Report, 2011 quarterly reports, Addendum to Remedial Design Report No. 1 (Bourne et al., 2011), and Summary Report for the Delineation of Mercury in Soil at the Former Building 212 Facility (LLNL, 2011).

[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.

- Conducting preconstruction soil sampling and potholing associated with the planned Treatment Facility A (TFA) Arroyo Seco pipeline extension scheduled for 2012.

Restoration activities in 2011 at the Livermore Site were primarily focused on enhancing and optimizing ongoing operations at treatment facilities while continuing to evaluate technologies that could be used to accelerate clean up of the Livermore Site source areas and to address the mixed-waste management issue discussed in the *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). An ESAR bioremediation treatability test continued at the TFD Helipad and hydraulic and pneumatic aquifer testing was conducted following the ESAR pneumatic fracturing treatability test at TFE Hotspot. Both treatability tests are scheduled for completion in 2012. In 2011, the ESAR conductive heating treatability test at TFE Eastern Landing Mat was initiated, and planning and detailed source area delineation was conducted for an ESAR treatability test using pneumatic fracturing and ZVI to initiate *in situ* VOC destruction at TFC Hotspot.

Ground water concentration and hydraulic data indicate subtle but consistent declines in the VOC concentrations and areal extent of the contaminant plumes in 2011. Once again in 2011, there was little to no evidence of measureable contaminant plume migration resulting from the shut down of treatment facilities in late 2008 and early 2009.

Hydraulic containment along the western and southern boundaries of the site was fully maintained in 2011, and progress was made toward interior plume and source area clean up.

Since remediation began in 1989, nearly 4.4 billion gallons of ground water and about 486 million cubic feet of soil vapor have been treated, removing an estimated 2,970 kg (3 tons) of VOCs from the subsurface (Table Summ-2).

Table Summ-1. Summary of 2011 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 (Mcf)[b]	Estimated VOC mass removed from soil vapor (kg)[c]	Estimated total VOC mass removed (kg)[c, d]
TFA	115	4.9	na	na	4.9
TFB	26	2.4	na	na	2.4
TFC	44	5.1	na	na	5.1
TFD	71	29.4	16	3.1	32.5
TFE	22	9.4	13	3.3	12.7
TFG	8	0.7	na	na	0.7
TFH	11	3.5	25	32.6	36.1
Totals[d]	297	55.4	54	39.0	94.4

Notes:

Mgal = Millions of gallons.

kg = Kilograms.

Mcf = 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 4.

[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 (Mcf)[a]	Estimated VOC mass removed from soil vapor (kg)[b]	Estimated VOC mass removed (kg)[b, c]
TFA	1,857	207	na	na	207
TFB	439	79	na	na	79
TFC	479	103	na	na	103
TFD	1001	840	95	93	933
TFE	365	217	159	148	365
TFG	80	11	na	na	11
TFH	161	38	232	1,234	1,272
Totals[c]	4,382	1,495	486	1,475	2,970

Notes:

Mgal = Millions of gallons.

kg = Kilograms.

Mcf = 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 2011. 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, and decision support analysis. The treatment areas, treatment facilities, wells, and locations of significant projects conducted in 2011 at the Livermore Site, are shown on Figures 1, 2, and 3a through 3d. Table 1 presents 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, and Table 4 summarizes extraction well performance during 2011. Acronyms and abbreviations used in this report are defined in Section 6.

In June 2011, 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, 2011). Table 5 of the Remedial Action Implementation Plan (RAIP) (Dresen et al., 1993) was amended to include 21 new Federal Facility Agreement (FFA) milestones. All 2011 FFA milestones were completed early or on schedule.

Details of 2011 treatment facility operations are described further in Section 4.1 of this report.

2. Regulatory Compliance

In 2011, the U.S. Department of Energy (DOE)/LLNL submitted all regulatory documents on schedule. These documents included:

- *GWP 2010 Annual Report* (Buscheck et al., 2011);
- *GWP Quarterly Self-Monitoring Reports* (Yow and Wong, 2011, 2011a, 2011b, and 2011c);
- *Addendum to Remedial Design Report No. 1 for Treatment Facility A: Arroyo Seco Pipeline Extension, Lawrence Livermore National Laboratory, Livermore Site* (Bourne et al., 2011)**;** and
- *Summary Report for the Delineation of Mercury in Soil at the Former Building 212 Facility, Lawrence Livermore National Laboratory* (LLNL, 2011).

In 2011, Livermore Site environmental community relations' activities 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 the Environmental Information Repositories and the Administrative Record;

- Disseminating environment-related news releases and internal/external newsletter articles and responding to journalists' inquiries regarding the Livermore Site 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, 2011, as part of the activities funded by a U.S. Environmental Protection Agency (EPA) Technical Assistance Grant (TAG).

In June 2011, the 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 (RAIP) (Dresen et al., 1993), was amended to include 21 new Federal Facility Agreement (FFA) milestones. All 2011 FFA milestones were completed early or on schedule.

Eight treatment facilities remained off-line in 2011, 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). Four of the treatment facilities were discussed in a Focused Feasibility Study (FFS). 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). With EPA concurrence, restart of the these facilities has been put on hold pending the results of ESAR treatability tests being conducted at the Livermore Site, and a regional tritium sampling event and hydraulic test conducted in 2011 (described in Section 4.4). Two treatment facilities (TFD Helipad and VTFD Helipad) remained off-line in support of the *in situ* bioremediation ESAR treatability test at the TFD Helipad Source area. The remaining treatment facility (VTFD Hotspot) is shut down due to dual extraction well control problems, however progress was made in converting the wells to cyclically-operated ground water extraction wells.

3. Field Activities

This section summarizes 2011 ground water monitoring, ESAR treatability tests and drilling activities, as well as investigations in the offsite TFA, TFC Hotspot, Building 212, and Building 419.

3.1. Ground Water Monitoring

During 2011 ground water monitoring activities complied fully with applicable LLNL Standard Operating Procedures (Goodrich and Lorega, 2009). During 2011, ground water levels were measured quarterly as described below.

3.1.1. Ground Water Level Measurements

In 2011, ground water levels were measured on a quarterly basis. Continuous ground water levels were measured in extraction wells using real-time data acquisition, and additional ground water levels were measured prior to sampling of each well complement these data. In 2011, a total of 2,769 ground water levels were manually measured in 592 wells. These data were primarily used to generate quarterly ground water elevation contour maps showing estimated hydraulic capture areas for active extraction wells in Hydrostratigraphic Units (HSUs) 1B through 5 (Figures 9, 11, 13, 15, 17, and 19).

In addition to the routine quarterly measurements, ground water levels were to support ERD's REVAL activities, ESAR activities, a large-scale hydraulic test conducted in HSU-4 (Section 4.4), and offsite TFA extraction well-field optimization monitoring (Section 4.1.1). These measurements included manual depth-to-water readings as well as temporary installation of pressure transducers with data-loggers in selected wells.

3.1.2. Ground Water Sampling

As in previous years, LLNL ERD and 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 2011, the GWP conducted 708 well sampling events. The samplers were unable to complete 70 (9.9%) sampling events due to various circumstances (dry wells, inoperable pumps, etc.). The methods and numbers of samples collected were:

- Specific-Depth Grab Sampling (SDGS) using the Voss EasyPump®: 383 events (54.1%).
- Three-volume purge using a dedicated electric submersible pump: 75 events (10.6%).
- Low-volume purge: 42 events (5.9%).
- Other methods (bailer, portable electronic submersible pump, etc.): 138 events (19.5%).

Ongoing and significant cost reduction was achieved again in 2011 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 2011, ERD prioritized a significant portion of its resources to focus on ESAR-related work. ESAR treatability tests were continued at the TFD Helipad (*in situ* bioremediation) and TFE Hotspot (mechanical fracturing) source areas. Construction of the TFE Eastern Landing Mat Source Area treatability test system (thermally enhanced remediation) was completed and the system was started. Preliminary investigation of the TFC Hotspot Source Area to assess the efficacy of combining mechanical fracturing with *in situ* chemical reduction using ZVI was also initiated.

The results of the treatability tests will be used to help identify alternate remedial approaches that maybe taken at other Livermore Site source areas, specifically the FFS methods currently under evaluation to minimize mixed hazardous and low level radioactive waste. The current ESAR treatability tests are summarized below.

3.2.1. TFD Helipad Source Area

The ESAR treatability test at the TFD Helipad Source area (Figures 2 and 4) 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.

In 2011, the TFD Helipad *in situ* bioremediation facility (ISB01) was operational throughout the year except for periodic maintenance. The VTFD Helipad soil vapor treatment facility was secured and re-located for long-term storage, and the TFD Helipad ground water treatment facility remained secured so as not to interfere with the treatability test. The ISB01 system began operating in November 2010 and includes four extraction wells, W-1650, W-1653, W-1655, and W-1657, and one central injection well, W-1552. The initial circulation flow rate was approximately 1.5 gallons per minute. There are four main performance-monitoring wells, W-1651, W-1652, W-1654, and W-1656. There are downgradient and cross-gradient monitoring wells, W-1553, W-2304, and W-1551, that also monitor the HSU-3A/3B *in situ* bioremediation zone. In addition, there are several HSU-4 wells in the area to monitor for vertical migration.

The extraction and injection well pattern is designed to create a circulation cell that is vertically contained within HSU-3A/3B and horizontally contained within the TFD Helipad Source Area. Currently, extracted ground water is recirculated to establish hydraulic control in the subsurface. In February 2011, a Fluorescein dye-tracer injection test was conducted to define the extent of the subsurface volume under remediation, and to determine travel times between wells. Eight pounds of dye-tracer was instantaneously introduced to injection well W-1552 and all extraction and monitoring wells were sampled through July 2011. The sampling results were then used to estimate the total volume of active ground water in the circulation system and the travel times between wells. This information was used to calculate the electron donor dose necessary to establish favorable conditions for bioaugmentation, which will include the introduction of a dechlorinating microorganism. In addition, the results of this test were used to calibrate the transport parameters that will be used in a numerical model to simulate *in situ* bioremediation at the TFD Helipad.

In May 2011, a solution of 10% sodium lactate was introduced to the injection well to stimulate subsurface bioactivity. After a total of 28 gallons of sodium lactate were injected, a significant reduction in injection flow rates was observed and sodium lactate injection was discontinued. Based on an evaluation of the injection well and some of the extraction well filter assemblies, it was determined that significant biofouling had occurred in the injection well. The system was shut down until August 2011. During this period the injection well was re-developed using a chelating agent and the system was reconfigured to operate at lower flow rates of 0.3 to 0.7 gpm.

After the initial injection of sodium lactate in May, the oxidation-reduction potential (ORP) and the concentrations of nitrate and sulfate were monitored on a regular basis. A significant decline of the ORP was observed in most of the extraction and monitor wells. Nitrate concentrations also began to decrease; however no changes in sulfate concentrations were observed, indicating additional sodium lactate injection was needed prior to initiating bioaugmentation. In September 2011, the system was restarted in the circulation mode. On December 7, 2011, sodium lactate injection resumed using a dilute concentration (reduced to 2% from 10%) to avoid biofouling. Currently, sodium lactate is being injected on a daily basis and monitoring of field parameters continues. Since the ORP readings remain low, it is anticipated that subsurface conditions will become suitable for bioaugmentation (low nitrate and sulfate concentrations) in 2012.

Results thus far from the treatability test indicate creation of anaerobic subsurface conditions favorable to the introduction of the dechlorinating microorganism (KB-1). Once the dechlorinating microorganism is introduced, the system will be continually operated to determine whether VOC levels can be reduced below regulatory limits.

3.2.2. TFE Eastern Landing Mat Source Area

In early 2011, 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 modified for ESAR treatability testing (Figures 2 and 5). The TFE Eastern Landing Mat treatability test is designed to evaluate thermally enhanced remediation in the saturated and unsaturated zones by injecting heated air and by heating ground water in certain wells, while extracting both soil vapor and ground water in others. The treatability test system consists of the VTFE Eastern Landing Mat soil vapor and TFE East ground water treatment facilities, and an additional ambient air injection blower. Well W-1903 is the primary dual extraction well, and wells W-1909 and W-2305 are the two air injection and heating wells. In addition, well W-2305 can be used for dual extraction while well W-1909 can be used as a soil vapor extraction well. This enables utilization of another ESAR methodology, dynamic well-field operations, at this source area (Berg, 2008a, and Berg, 2008b). Wells W-1909 and W-2305 contain heating elements that are installed both above and below the static water level to facilitate heating of injected air and *in situ* ground water. All three wells are equipped with thermocouples to monitor subsurface temperatures, and well SIP-543-101, situated at the center of the three system wells, acts as the primary performance monitoring well for the test.

Treatability testing began in October 2011 and is currently in progress. The facility was shut down for short periods of time in November and December for maintenance and freeze protection. Observation well SIP-543-101 has shown significant responses to water level changes and pressure changes due to vapor extraction/injection. While it is too soon to expect temperature increases in wells SIP-543-101 and W-1903 due to heating in wells W-1909 and W-2305, such changes may become evident in 2012.

3.2.3. TFE Hotspot Source Area

In October 2010, an ESAR treatability test was conducted at the TFE Hotspot source area (Figures 2 and 6) 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 into the subsurface to initiate fracturing in targeted areas. Introducing fractures may accelerate transfer of contaminant mass from the source area by improving the yield of TFE Hotspot soil vapor and ground water extraction wellfield. The treatability test included pneumatically fracturing the vadose and saturated zones 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.

Prior to the pneumatic fracturing, pneumatic tests were conducted at 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 6). Hydraulic tests were also conducted at dual extraction well W-2105, extraction well W-2012, and piezometer SIP-ETS-601, before fracturing. These tests were repeated in 2011. 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. Well W-2012 was damaged beyond repair during pneumatic fracturing; consequently, this well was properly destroyed in 2011 and replaced by well W-2801 (Figure 6).

The post-mechanical fracturing performance tests included hydraulic tests of well SIP-ETS-601 in January and November of 2011, pneumatic tests of existing wells in January 2011, and pneumatic and hydraulic testing of new wells W-2618, W-2619, W-2620A, W-2621, W-2622, and W-2623 in August 2011. In addition, a ninety-day operational test of the entire extraction wellfield was conducted from June to September 2011. A final pneumatic test will be conducted in early 2012.

At the conclusion of post-mechanical fracturing tests, the data will be analyzed to evaluate the hydraulic and pneumatic effects of mechanical fracturing within the TFE Hotspot source area. In addition, 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 after all data from the treatability test have been collected and analyzed.

3.2.4. Trailer 5475 Source Area

No ESAR activities occurred in the Trailer 5475 (Figure 2) source area during 2011. The field activities in this source area will resume pending the results of the FFS for TF5475-1, TF5475-3, and VTF5475.

3.2.5. TFC Hotspot Source Area

A direct-push, CPT survey was conducted at the TFC Hotspot source area in January 2011 (Figure 2). The objective of the survey was to delineate the distribution of VOC concentrations within the TFC Hotspot source area in preparation for an ESAR treatability test. The treatability test will use pneumatic fracturing to emplace zero valent iron (ZVI) within the source area to promote rapid *in situ* destruction of the VOCs.

A total of 28 direct-push boreholes, including ten CPT boreholes, were advanced in the area. All 28 boreholes were subsequently grouted to the surface. The detailed CPT stratigraphic profiles were used to select depth intervals for HydroPunch® sampling of ground water and soil vapor. A total of 28 soil vapor and 13 ground water samples were collected during the survey. Soil vapor concentrations up to 24 parts per million by volume (ppmv) and ground water concentrations up to 69 parts per billion (ppb) trichloroethylene (TCE) were observed in the area. The results of the survey will be used to define the fracture borehole positions and the precise interval that will be targeted for fracturing and ZVI emplacement.

3.3. Drilling Activities

During 2011, one new well, W-2801, was installed at the Livermore Site (Figure 1 and Appendix A). Well W-2801 was designed and sited to replace HSU-3A extraction well W-2012 (Figures 3d and 6), which was damaged beyond repair during the TFE Hotspot treatability test pneumatic fracturing and sand emplacement. Well W-2012 was sealed in 2011. An analysis of the incident suggests that the breaching of the well casing was most likely due to a structural weakness owing to a gap in the annular seal at the depth where the well failed. Extraction well W-2801 was drilled using the sonic drilling method to minimize adverse impacts from drilling fluid to the sand-filled fractures propagated during the treatability test. Well W-2801 will be used to hydraulically contain and treat a HSU 3A VOC plume emanating from a source area to the east.

As discussed in Section 3.2.5, a CPT survey was conducted during 2011 in the TFC Hotspot area (Figure 2). The survey was designed to use CPT data to identify zones where samples of water or vapor could be collected, and then sample these zones using direct-push technology. As discussed above, the objective of the survey was to delineate the VOC plumes in both the saturated and unsaturated zones to allow for proper positioning of the fracture boreholes, and to strategically target the high concentration zones for fracturing and emplacement of ZVI.

3.4. Building 212 Mercury Investigation

During decontamination and demolition of the Building 212 superstructure in April 2008 (Figure 2), free-phase mercury and low-level radiological contamination were discovered. Initial cleanup activities consisted of removing soil along the northeast side of the building slab (LLNL, 2009) and additional work to define the vertical and lateral extent of mercury contamination (Buscheck et al., 2010). All mercury concentrations from soil samples collected at 45 locations during the 2010 campaign were found to be below the EPA Industrial Screening Level of 34 mg/kg. Accordingly, no further removal action is planned at this time. A report summarizing the findings of this investigation was submitted to the regulators in March 2011 (LLNL, 2011).

3.5. Building 419 Soil and Ground Water Sampling

During 2011, ERD conducted a second phase of soil sampling as part of the Resource Conservation and Recovery Act (RCRA) closure plan for Building 419 (B419) (EPD, 2009) (Figure 2). The sampling occurred following the decontamination and demolition of the Building 419 superstructure during November and December 2010. The building was originally constructed during World War II and was subsequently used by LLNL for a variety of industrial purposes, including the treatment of waste containing hazardous and radioactive materials.

The objective of the 2011 Building 419 sampling 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. Between July 13 and September 21, 2011, 42 vertical boreholes within the footprint of the building and two boreholes outside the footprint were drilled and sampled during the second phase of the investigation. In addition, ground water was sampled from two deep boreholes (down to 105 ft bgs). Concrete samples from the building slab were also analyzed to characterize the slab for demolition and proper disposal. As in Phase 1, the compounds of concern included tritium, gross alpha and beta, cyanide, arsenic, metals including hexavalent chromium and mercury, herbicides and pesticides, fuel hydrocarbons, VOCs, and semi-volatile organic compounds. Results of this investigation are pending and will be documented as part of Building 419 RCRA closure report, scheduled for 2012.

3.6. Offsite TFA Pipeline Extension Pre-Construction Sampling

As part of the proposed TFA Arroyo Seco Pipeline extension (Figure 2) to extraction well W-404 (Bourne et al., 2011), potholing and pre-construction soil sampling was conducted in October 2011. The objective of the effort was threefold: 1) confirm the location, vertical elevation, size, and type of pipe or conduit for certain underground utilities that currently exist along the planned pipeline extension; 2) to screen the soil for hazardous materials that could pose a hazard to pipeline workers or the community during the construction phase of the project; and (3) to assist in determining waste disposal requirements for pipeline trenching soil.

A total of four locations along the proposed pipeline route were pot-holed to a maximum depth of 8 ft bgs, and soil samples were obtained from seven locations at depths between two and five feet below ground surface. The samples were submitted for VOC, metals, pesticide, and gross alpha and gross beta analysis. The radiologic screening was conducted because trace amounts of plutonium related to a soil amendment derived from material from the Livermore Site were previously found in the eastern extension of Big Trees Park (ATSDR, 2000 and 2003). As discussed in the cited reports, the analytical results for plutonium were all well below the EPA action level. Dust mitigation and air monitoring to be conducted during pipeline construction is discussed in Bourne et al., 2011. Results of the pre-construction soil sampling are pending, and will be reported at an upcoming RPM meeting once they become available.

4. Summary of Remedial Action Program

This section summarizes the 2011 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) remedial action program activities at the Livermore Site. In 2011, DOE/LLNL operated and/or maintained 29 ground water treatment facilities in the TFA, TFB, TFC, TFD, TFE, TFG, and TFH areas (Figure 1 and Table 1). Ground water extraction and dual extraction wells produced approximately 298 million gallons of ground water, and the treatment facilities removed an estimated 55 kg of VOCs (Table Summ-1, Figure 7, and Table 4). In 2010, the ground water treatment facilities removed approximately 54 kg of VOCs. The higher mass removed in 2011 is attributable to the increased number of hours the treatment facilities operated and larger volume of water pumped during the year (298 million gallons in 2011 versus 278 million gallons in 2010). Since remediation began in 1989, nearly 4.4 billion gallons of ground water have been treated, resulting in the removal of an estimated 1,495 kg of VOCs (Table Summ-2 and Figure 7).

In 2011, DOE/LLNL also operated and/or maintained nine soil vapor treatment facilities in the TFD, TFE, and TFH areas (Figure 1 and Table 1). The soil vapor extraction and dual extraction wells produced approximately 54 million cubic feet of soil vapor, and the vapor treatment facilities removed approximately 39 kg of VOCs (Table Summ-1, Figure 8, and Table 4). In 2010, the soil vapor treatment facilities removed approximately 45 kg of VOCs. The lower mass removed in 2011 is attributable to two factors: 1) the decreasing amount of mass remaining in the vadose zone at these source areas available for treatment by soil vapor extraction and 2) the smaller volume of soil vapor treated in 2011 (54 million cubic feet) than in 2010 (60 million cubic feet). Since startup, more than 486 million cubic feet of soil vapor has been extracted and treated, removing an estimated 1,475 kg of VOCs (Table Summ-2 and Figure 3). In total, an estimated 2,970 kg (about 3 tons) of VOCs have been removed from the subsurface beneath the Livermore Site and surrounding area since 1989 (Table Summ-2 and Figure 8).

Treatment facility performance is evaluated using multiple data sets. Figures 9, 11, 13, 15, 17, and 19 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 2011. Figures 10, 12, 14, 16, 18, and 20 are isoconcentration maps showing total VOCs above MCLs in the same six HSUs during the third quarter 2011. The estimated hydraulic capture areas for third quarter 2011 have been superimposed on the isoconcentration contour maps to highlight where hydraulic containment of contaminant plumes was achieved during this 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 2011, 30 Livermore Site treatment facilities (24 ground water and six vapor) operated in compliance with applicable permits and were shut down only occasionally for routine maintenance. In addition, ERD's REVAL process was conducted for TFB and was initiated at TFD East (Figure 1). Five treatment facilities, TFA West, TF5475-1, TF5475-3, VTF5475, and TF518 North remain shut down due to regulatory concerns or mixed waste issues (McKereghan and Wong, 2009; Bourne et al., 2010; and LLNL, 2009a). TFD Helipad and VTFD Helipad are also currently shut down while an ESAR treatability test is conducted in the area (Section 3.2.1). VTFD Hotspot is shut down due to dual extraction well control problems. These eight facilities and their planned restarts are described subsequently in this section.

4.1.1. Treatment Facility A Area

TFA and TFA East (Figure 1), operated in compliance with all permit requirements during 2011.

A third facility, TFA West, remained shut down during 2011 due to regulatory concerns pertaining to the use of the Livermore Water Reclamation Plan (LWRP) for treatment of low concentration VOCs (11 ppb PCE, December 2011). A treatability test was conducted from January 2007 to January 2008 to evaluate the effectiveness of ground water extraction for cleanup of the leading edge of the HSU 2 plume near offsite well W-404 (Figure 12). The results of the treatability test are discussed in the *Treatability Summary and Proposed Cleanup Alternatives for the TFA West Area Report* (Noyes et al., 2009). Alternative 1 described in the report (pipeline extension to connect well W-404 to the Arroyo Seco Pipeline to treat ground water onsite at TFA) is consistent with the selected remedy at TFA (U.S. DOE, 1992) and was approved by the regulatory agencies. Details regarding the pipeline extension to well W-404 are presented in the *Addendum to Remedial Design Report No. 1 for Treatment Facility A: Arroyo Seco Pipeline Extension*, submitted to the regulators in September 2011 (Bourne et al., 2011).

TFA operated during most of 2011 and was shut down only occasionally for routine maintenance. As part of continual well field optimization and to determine whether full hydraulic capture could be achieved using the existing wellfield, flow rates in extraction wells

W-109, W-408, W-457, W-903, and W-904 along the Arroyo Seco pipeline were adjusted in December 2011 to increase the hydraulic influence of these wells on offsite HSU-2 well W-404. An analysis of water level data taken subsequent to the adjustment suggests that full hydraulic capture will require completion of the pipeline extension and reactivation of W-404 as an extraction well.

TFA East operated during most of 2011 and was shut down only occasionally for routine maintenance.

4.1.2. Treatment Facility B Area

TFB (Figure 1) operated in compliance with all permit requirements during 2011. This facility operated during most of 2011 was shut down occasionally for routine maintenance, installation of ion-exchange columns necessary for chromium treatment to meet discharge limits, and to support REVAL and well field expansion activities. During the TFB REVAL, new well enclosures for extraction wells W-610, W-620, W-621, and W-655 were installed, new GAC vessels were installed, and the facility piping and instrumentation was upgraded to accommodate the addition of two new extraction wells (W-2501 and W-2502). As part of the TFB well field expansion, construction of the pipelines and installation of extraction well equipment for wells W-2501 and W-2502 began in 2011 and a new road to well W-2501 was completed. Connection of wells W-2501 and W-2502 to TFB will be completed in 2012.

4.1.3. Treatment Facility C Area

All three treatment facilities, TFC, TFC East, and TFC Southeast (Figure 1), operated in compliance with all permit requirements during 2011.

TFC operated during most of 2011 and was shut down only occasionally for routine maintenance and installation of ion-exchange columns necessary for chromium treatment to meet discharge limits. 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 2010 and concluded in February 2011.

TFC East operated during most of 2011 and was shut down occasionally for routine maintenance and installation of monthly ion-exchange columns necessary for year round chromium treatment.

TFC Southeast operated during most of 2011 and was shut down only occasionally for routine maintenance and installation of ion exchange columns necessary for chromium treatment to meet discharge limits. The facility was also temporarily shut down as a precautionary measure during a CPT survey in the TFC Hotspot source area in January 2011 (Section 3.2.5).

4.1.4. Treatment Facility D Area

Seven of the ten TFD Area treatment facilities, TFD, TFD East, TFD South, TFD Southeast, TFD Southshore, TFD West, and VTFD East Traffic Circle (ETC) South (Figure 1), operated in compliance with all permit requirements during 2011. TFD Helipad and VTFD Helipad remained shut down in 2011 during the TFD Helipad ESAR *in situ* bioremediation treatability test. These two facilities may be restarted upon completion of the treatability test, depending on the residual VOC concentrations in the subsurface. VTFD Hotspot, which also remained shut down in 2011 due to dual extraction well control problems, will be restarted once the technical issues have been resolved.

TFD East operated during most of 2011 and was shut down occasionally for routine maintenance or minor repairs. As part of the REVAL process at TFD East in 2011, a detailed engineering assessment of the facility was conducted, equipment and parts necessary for treatment facility upgrades were procured, and preparation for REVAL activities in the field began. The TFD East REVAL will be completed in 2012.

TFD Southeast operated during most of 2011 and was shut down occasionally for routine maintenance or minor repairs. As part of continual well field optimization, HSU-2 extraction well W-1308 was shut down from late March to mid-April to evaluate the interconnectivity of HSU-2 wells in the area.

TFD operated during most of 2011 and was shut down only occasionally for routine maintenance. TFD extraction well W-907 was redeveloped to mitigate iron bacteria growth in the well. Following redevelopment of the well, a specially designed "well-in-well" packer system was installed. This system allows for pumping from the lower screened interval (HSU-5) and data acquisition from both the upper and lower screened intervals (HSU-4 and HSU-5, respectively). Ground water extraction from the lower screened interval (W-907-2) resumed following a hydraulic step test in July 2011.

TFD South operated during most of 2011 and was shut down occasionally for routine maintenance. As part of continual well field optimization, the flow rate for HSU-4 extraction well W-1503 was adjusted in May to evaluate the influence of ground water extraction rates at this well on contaminant concentration and hydraulic capture.

TFD Southshore, TFD West, and VTFD ETC South operated during most of 2011 and were shut down occasionally for routine maintenance.

VTFD Hotspot was shut down during 2011 due to down-hole ground water pump control problems 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 2011. The remaining TFD Hotspot wells, W-653, W-2011, and W-2102 will also be returned to operation in 2012.

4.1.5. Treatment Facility E Area

All eight TFE Area treatment facilities, TFE East, TFE Hotspot, TFE Northwest, TFE Southeast, TFE Southwest, TFE West, VTFE Eastern Landing Mat, and VTFE Hotspot (Figure 1), operated in compliance with all permit requirements during 2011.

TFE East operated during most of 2011 and was shut down occasionally for routine maintenance and to support the TFE Eastern Landing Mat ESAR field treatability test.

In the beginning of 2011, TFE Hotspot remained shut down because all down-hole equipment in the extraction wells had been removed in October 2010 for the TFE Hotspot ESAR pneumatic fracturing treatability test (Section 3.2.3). Notable 2011 activities at TFE Hotspot included:

- In March, the treatment facility resumed operation with ground water extraction from well W-2105.
- From late June to late September, a hydraulic test was conducted to collect post-treatability test performance data.

- In October, the facility was temporarily shut down as a precautionary measure during drilling of TFE Hotspot extraction replacement well W-2801.

TFE Northwest operated during most of 2011 and was shut down occasionally for routine maintenance or for minor repairs.

TFE Southwest operated during most of 2011 and was shut down occasionally for routine maintenance. Extraction wells W-1520 and W-1522 did not operate during 2011 due to the presence of increased tritium activities in ground water from the two wells (up to 7,180 pCi/L, January 2011). Wells W-1520 and W-1522 will be restarted once a solution to mixed waste management issues has been finalized and implemented (Bourne et al., 2010). These wells were only pumped for a brief period during the HSU-4 hydraulic test (Section 4.4).

TFE Southeast and TFE West operated during most of 2011 and were shut down occasionally for routine maintenance.

VTFE Eastern Landing Mat operated during most of 2011 and was shut down occasionally for routine maintenance and to support the TFE Eastern Landing Mat ESAR field treatability test (Section 3.2.2). From mid-July to early October, the facility was shut down to conduct a hazard analysis associated with the treatability test.

At the start of 2011, VTFE Hotspot remained shut down due to the TFE Hotspot ESAR pneumatic fracturing treatability test (Section 3.2.3). Notable activities at TFE Hotspot in 2011 included:

- In February, vapor extraction at VTFE Hotspot resumed.
- Throughout 2011, the treatment facility was used during multiple tests to collect post-treatability test performance data.
- In October, the facility was temporarily shut down as a precautionary measure during drilling of TFE Hotspot extraction well W-2801.

4.1.6. Treatment Facility G Area

Two treatment facilities, TFG-1 and TFG North (Figure 1), operated in compliance with all permit requirements during 2011. Both facilities operated during most of 2011 and were shut down only 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 1). 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 1), operated in compliance with all permit requirements during 2011.

TF406 operated during most of 2011 and was shut down occasionally for routine maintenance. As part of the HSU-4 hydraulic test described in Section 4.4, ground water extraction from HSU-4 well W-1309 resumed in October.

TF406 Northwest operated during most of 2011 and was shut down occasionally for routine maintenance, and to support the HSU-4 hydraulic test (Section 4.4). Extraction well W-1801 was redeveloped in late March to mitigate iron bacteria growth in the well.

VTF406 Hotspot operated during most of 2011 and was shut down occasionally for routine maintenance.

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 1), operated in compliance with all permit requirements during all 2011. The fourth facility, TF518 North, remained offline during 2011 pending resolution of mixed waste management issues (Bourne et al., 2010).

TF518 North was designed to treat VOC-contaminated ground water from HSU-4 using GAC. Tritium was not observed in this area when the facility was designed and began operating 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-PZ, VTF518-PZ, and VTF511 operated during most of 2011 and were shut down occasionally for routine maintenance.

As part of the HSU 4 hydraulic test, TF518 North HSU 4 extraction well W-1410 was briefly pumped in 2011 (Section 4.4).

4.1.7.3. Treatment Facilities Near Trailer 5475

Treatment facilities TF5475-1, TF5475-3, and VTF5475 remained shut down during 2011 pending resolution of mixed waste management issues (Bourne et al., 2010). These facilities have been impacted by tritiated ground water.

TF5475-2 operated during most of 2011 and was shut down occasionally for routine maintenance.

4.2. Ground Water Discharges

In 2011, LLNL discharged approximately 297 million gallons (Mgal) of treated ground water to the ground surface. Approximately 152 Mgal were discharged to Arroyo Las Positas, 82 Mgal to the West Perimeter Drainage Channel, and 63 Mgal to Arroyo Seco. In addition, approximately 0.002 Mgal (2,000 gallons) of filtered ground water from extraction well W-404 were discharged to the Livermore Water Reclamation Plant during sampling events and about 0.3 Mgal of ground water was recirculated through ISB01 at the TFD Helipad as part of the *in situ* bioremediation treatability test.

4.3. Remediation Performance Evaluation

In 2011, 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 (Section 4.1). The changes described below are consistent with the longer-term trends described in the Draft 2012 Fourth Five-Year Review for the LLNL Livermore Site (McKereghan et al., 2012) that show steady onsite and offsite mass removal and cleanup.

Ground water elevation contour maps for each HSU showing estimated capture areas for the third quarter 2011 are presented on Figures 9, 11, 13, 15, 17, and 19. Notable VOC concentration trends and results from the third quarter 2010 through the third quarter 2011 are discussed below and presented on isoconcentration contour maps showing VOCs above MCLs by HSU (Figures 10, 12, 14, 16, 18, and 20). Treatment facility locations are shown on Figure 1. Where available and relevant, VOC concentration data more recent than third quarter 2011 are discussed in the text below.

4.3.1. Hydrostratigraphic Unit 1B

In response to ongoing ground water extraction along the Arroyo Seco pipeline, concentrations in the HSU 1B offsite TFA plume have now fallen below MCLs in all offsite wells (Figure 10). Concentrations in W-1425, the last offsite monitor well with PCE above the 5 ppb MCL, have remained below that level in five sampling events since January 2011. Well W-1425 will continue to be sampled on a quarterly basis to determine whether PCE concentrations rise above 5 ppb. If so, adjustments to the HSU 1B extraction well W-408 pumping rate will be made to reduce PCE concentrations to below MCLs.

As in 2010, PCE concentrations remained below MCLs at all site boundary wells, immediately east of Vasco Road (Figures 1 and 10). The highest HSU 1B concentrations in the TFA area remain within its source area, where PCE concentrations at well W-1217 were essentially unchanged from last year (140 ppb in November 2010, 130 ppb in October 2011). Elsewhere at TFA, to the north at TFB and to the east at TFG, VOC concentrations remained relatively unchanged during 2011.

Farther north, in the TFC area, VOC concentrations declined at monitor well W-702, where TCE concentrations fell from 28 ppb (August 2010) to 9 ppb (November 2011). Continued ground water extraction from monitor well W-1104 is the primary reason for the concentration decline in well W-702.

At TFC East and TFC Southeast, TCE concentrations were essentially unchanged, and no evidence of westward migration of contaminant plumes was observed. At the TFC Hotspot source area, TCE remained elevated at 350 ppb in monitor well W-1212 (August 2011). A REVAL treatability test involving pneumatic fracturing and the emplacement of ZVI to destroy the VOCs *in situ* is scheduled to begin there in 2012.

Elsewhere, VOC concentrations in HSU 1B declined slightly or remained unchanged along the western margin of the Livermore Site during 2011.

As shown on Figures 9 and 10, 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 2011. 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 2011 (Figure 12*)*. In the offsite TFA area, the areal extent of the HSU-2 plume continued to shrink in response to ongoing pumping. PCE at monitor well W-654 decreased from 15 ppb (November 2010) to 2 ppb (November 2011), suggesting that the optimized flow regime for the Arroyo Seco Pipeline wells is accelerating clean up in the area. At the leading edge of the plume, however, PCE concentrations in well W-404 remained stable at around 11 ppb (December 2011). A pipeline extension to well W-404 is planned for 2012 (Bourne et al., 2011). Onsite, PCE at TFA monitor well W-118 increased slightly from 5 ppb (April 2010) to 13 ppb (May 2011). This area is fully contained within the hydraulic capture area of extraction wells W-714 and W-605. Elsewhere at TFA, concentrations remained relatively unchanged during the year, but are expected to continue their long-term decline in response to continued ground water extraction and treatment operations.

In the TFB area, no significant concentration trends were observed in 2011. TCE in monitor wells W-422 and W-1420 along Vasco Road continued to be closely monitored during 2011. TCE remained stable at well W-422 (13 ppb, October 2011) but rose slightly from 5 ppb (July 2010) to 8 ppb (October 2011) in monitor well W-1420. To ensure comprehensive hydraulic containment of the contaminant plume and to accelerate cleanup along the western LLNL Site margin at TFB, two new HSU-2 extraction wells, wells W-2501 and W-2502, have been connected to TFB and will be activated in early 2012. Well 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 (see Section 4.1.2). Elsewhere at TFB, TCE concentrations at monitor well W-365 rose slightly from 11 ppb (July 2010) to 19 ppb (September 2011). The well is within the capture area of extraction well W-621 and concentrations are expected to decline there during 2012 (Figure 12).

In the eastern portion of the site, few changes in HSU-2 concentrations were observed during 2011, with the following exceptions. At TFG, concentrations at monitor well W-301 rose slightly (TCE, PCE, and Freon 113 all rose several ppb). VOC concentrations in the vicinity of well W-301 are captured downgradient at either TFG North, or at TFB, depending on the direction of ground water flow. At TFD, an increase in TCE was noted at monitor well W-568, where concentrations rose from 2 ppb (February 2010) to 16 ppb (November 2011). VOCs from this area are captured by downgradient extraction well W-413 (TFC East).

As shown on Figure 12, the contaminant plumes in the TFA and TFB areas were entirely within the estimated capture areas except at well W-404. 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). Once activated, the proposed TFA Arroyo Seco Pipeline extension will enable full hydraulic capture, with treatment at TFA, in the well W-404 area.

4.3.3. Hydrostratigraphic Unit 3A

During 2011, remarkably little change was observed in the size and location of the contaminant plumes in HSU 3A (Figure 14). However, some changes in VOC concentrations within these plumes were noted. At TFA, concentrations within the carbon tetrachloride plume fell and the areal extent shrank slightly:

- Monitor well W-616, from 2.6 ppb (July 2009) to 0.6 ppb (June 2011);
- Monitor well W-267, from 1.1 ppb (July 2010) to 0.5 ppb (September 2011); and
- Extraction well W-712 remained unchanged at 3 ppb (October 2010 and October 2011).

In the TFB area at monitor well W-310, located at the leading edge of a low-concentration PCE plume, concentrations remained unchanged (5.7 ppb in October 2010 to 4.9 ppb in November 2011). The source of this contaminant plume has not yet been identified, but is likely located somewhere to the east. At downgradient HSU 3A monitor well W-325, concentrations of PCE remain below the 0.5 ppb detection level (November 2011).

Figures 13 and 14 show the estimated hydraulic capture areas in HSU 3A during the third quarter 2011. An area containing TCE above its MCL in the western TFE and eastern TFG areas remains outside of the hydraulic capture area. Constructed in 2010 and installed downgradient of the plume, monitor well W-2603 is used to monitor westward movement of the plume, and to determine whether additional treatment will be needed in this area (TCE remains below its MCL in this area). At TFE Hotspot, where extraction well W-2012 was damaged beyond repair during the pneumatic fracturing treatability test, replacement well W-2801 was installed in late 2011. Once connected to the TFC Hotspot ground water treatment facility and activated, hydraulic containment will be restored in this area.

4.3.4. Hydrostratigraphic Unit 3B

As with HSU 3A, the size and geometry of the HSU 3B VOC plumes (Figure 16) remained essentially unchanged during 2011. TCE concentrations declined somewhat at TFE Hotspot area well W-356 (from 61 ppb in February 2010 to 54 ppb in February 2011). To the west, TCE concentrations at TFE Southwest extraction well W-1522 increased slightly from 69 ppb (October 2010) to 89 ppb (November 2011). Well W-1522 is not currently operating pending resolution of mixed waste management issues (Bourne et al., 2010). TCE at downgradient well W-618 remained unchanged at 1 ppb during the year (August 2011) but continues to be monitored closely for any increases in concentration.

As shown on Figures 15 and 16, large portions of the HSU 3B plumes in the TFD, TFE and TFH areas were under hydraulic control in the third quarter 2011. The pumping-induced ground water depression associated with active remediation at TFE-W, TFD-S and TFD-SS (Figures 1, 15 and 16) provided additional hydraulic containment over large portions of the TFE, TFH, and TFD areas.

As shown on Figures 15 and 16, an area of the contaminant plume to the west of TFD-SS may remain outside of the interpreted hydraulic capture areas. The ground water 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 18) were essentially unchanged from 2010, several notable concentration trends were observed during 2011. In the TFD Southeast area, TCE concentrations at extraction well W-314 declined from 190 ppb (October 2010) to 35 ppb (October 2011) in response to pumping at well W-314. TCE at monitor well W-1406 also declined, falling from 21 ppb (November 2010) to 5 ppb (November 2011).

Downgradient of TFD, TCE concentrations at monitor well W-1803-1 rose from 20 ppb (August 2010) to 94 ppb (September 2011). Due to the large pumping-induced ground water depression associated with active remediation at TFD, TFD East, TFD Southshore, and TFD South (Figures 17 and 18), VOC concentrations in the area are not expected to migrate towards the western margin of the Livermore Site. At extraction well W-351, TCE concentrations also increased, rising from 200 ppb (October 2010) to 590 ppb (October 2011). The lack of ground water extraction at the TFD Helipad (W-1254 is currently idle due to the ongoing bioremediation treatability test in the area) may be allowing the TCE plume to migrate towards the extraction wells at TFD Main.

To the south at TFD Southshore, TCE concentrations at extraction well W-1523 fell from 220 ppb (October 2010) to 140 ppb (July 2011) in response to pumping. Farther south in the TFE area, TCE declined at well W-354 from 53 ppb (August 2010) to 10 ppb (November 2011). TCE concentrations to the west at W-304 were essentially unchanged (9 ppb in August 2010 to 8 ppb in September 2011) again due to hydraulic containment within the HSU 4 pumping-induced ground water depression that covers a large area of the eastern portion of the site.

Figures 17 and 18 show the estimated hydraulic capture areas in HSU 4 during the third quarter 2011. The pumping-induced ground water depression associated with extraction at TFE-Northwest, TFD-South and TFD-Southshore is evident on Figures 17 and 18. As discussed previously, the ground water depression provided additional hydraulic containment in large portions of the TFD, TFE, and TFH areas during 2011.

4.3.6 Hydrostratigraphic Unit 5

The general configuration and location of HSU-5 VOC plumes in 2011 (Figure 20) remained essentially unchanged from 2010. However, several significant changes in concentrations were observed. At TFD, TCE concentrations fell at extraction well W-907-2 from 92 ppb (April 2009) to 44 ppb (October 2011) with the resumption of pumping there. At downgradient monitor well W-1803-2, TCE declined from 35 ppb (February 2010) to 26 ppb (September 2011) also in response to this pumping.

In the TFE East area, TCE concentrations remained unchanged at monitor wells W-912 and W-1203 (130 ppb, November 2011 and 150 ppb, September 2011, respectively), but fell slightly at downgradient monitor well W-1210 (47 ppb in November 2010 to 34 ppb in February 2011). Well W-1210 is within the capture zone of TFE East extraction well W-566.

To the south at TF406, TCE concentrations at the leading edge of the plume emanating from a source to the east increased slightly at monitor well W-1519 (from 5 ppb in May 2010 to 12 ppb in February 2011). Although concentrations have fluctuated to a limited extent, the long term decline in TCE (from 24 ppb in 2005) is expected to continue given its location within the capture area of TF406 extraction well W-1310.

Figures 19 and 20 show the estimated hydraulic capture areas in HSU-5 during the third quarter 2011. With the resumption of ground water extraction at well W-907-2, areas of elevated TCE concentrations in the TFD, TFE, and TFH areas are once again under hydraulic containment.

4.4. Tritium

During 2011, tritium activities in ground water from all wells at the Livermore Site, including those in the Trailer 5475, Building 292, and Building 419 areas (Figures 1 and 2), remained below the 20,000 pCi/L MCL and continued to decline by radioactive decay. Notable 2011 tritium activities include:

- 15,800 pCi/L in piezometer UP-292-007 (screened in HSU 1B, Figure 10)
- 9,850 pCi/L in well W-2205 (screened in HSU 3A, Figure 14)

- 7,940 pCi/L in SIP-419-202 (screened in HSU 3A, Figure 14)
- 7,920 pCi/L in well W-2606 (screened in HSU 2/5, Figure 20)
- 6,910 pCi/L in well W-2607 (screened in HSU 2/5, Figure 20)

Wells W-2606 and W-2607 are two inclined wells installed beneath Building 511 and are both screened in HSU 2/5; however, HSU-2 in this area is unsaturated and HSUs 3A, 3B, and 4 are currently interpreted to be absent beneath Building 511.

As part of the FFS, a sampling event encompassing most of the eastern half of the Livermore Site was initiated to establish tritium activity levels in 106 wells over a relatively short period of time (December 2010 through March 2011). The tritium activities resulting from this sampling event and from the 2010 direct-push sampling campaign encompassing Buildings 511, 518, 411, and former Buildings 419, 514, and 412 areas/yards, were presented and discussed in detail at the May 25, 2011 RPM meeting and are documented in the RPM meeting notes (McKereghan and Wong, 2011). Areas where ground water remediation may result in the generation of mixed waste GAC were identified in the T5475, TFE, and TFH areas (VTF5475, TF5475-1, TF5475-3, TFE-Southwest, and TF518North).

The updated, unpublished VOC and tritium concentration maps and plots indicate no significant transport out of the Trailer 5475 area since treatment facilities were shutdown in this area in 2007. Hence, leaving the Trailer 5475 facilities idle while solutions to the mixed waste management issue are tested, selected, and implemented should not appreciably increase the risk of VOC or tritium transport out of the very low-permeability source area sediments in the area.

HSU-3A tritium activities do not appear be migrating out of the Building 419 area, despite the slight activity increase observed at GSW-215. Analytical results and hydraulic data confirm that the large pumping-induced HSU-4 ground water depression is effectively preventing westward migration of contaminant plumes (Figure 18). Northward transport of VOCs and tritium in HSU-4 from the Building 518 North/Building 419 area appears to have occurred between 2006 and present, but new data do not show farther northward movement of the tritium beyond the TFE Southwest treatment facility area.

To help further delineate the tritium distribution in the southeast corner of the site and to help clarify the hydrostratigraphy in the Building 518 North and Building 419 areas, a regional HSU-4 hydraulic test was conducted in October and November 2011. The final stages of the test extended into 2012 (Figures 1 and 2). The test was designed to help clarify the hydraulic interconnections that may exist between HSUs 3A, 3B, and 4, and to establish a better understanding of the tritium sources and migration pathways in the area. In addition to measuring the hydraulic response of observation wells during the pumping of active and idle extraction wells, including HSU-4 extraction well W-1309 (TF406), HSU-4 extraction well W-1410 (TF518 North), and TFE Southwest extraction wells W-1520 and W-1522, time series tritium sampling of idle extraction wells was also conducted. The objective of this sampling was to help determine the proximity of tritium ground water plumes relative to these idle extraction wells. The results of the test will be presented in an upcoming 2012 RPM meeting after data analysis and interpretation have been completed.

4.5. Decision Support Analysis

A variety of decision support tools are used and multiple 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:

- Taurus Environmental Information Management System (TEIMS);
- Automated Data Review and Mapping Tools;
- Predictive Analysis Tools;
- Project Management Tools; and
- Treatment Facility Real-Time Data (TFRT).

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 that are included in the quarterly self-monitoring reports (Yow and Wong, 2011a, 2011b, 2011c, and 2012). 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. Plume and ground water elevation maps and animations that span the entire Livermore Site GWP history are updated each quarter within a matter of hours using the OPERA tool. The map library was updated quarterly in 2011 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 startup order of wells in extraction well fields. 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

CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CES	Cost effective sampling
DOE	U.S. Department of Energy
ELM	Eastern Landing Mat
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
ETC	East Traffic Circle
ETCS	East Traffic Circle South
ETS	East Taxi Strip
FFA	Federal Facility Agreement
FFS	Focused Feasibility Study
GAC	Granular activated carbon
GTU	GAC treatment unit
GWP	Ground Water Project
HSU	Hydrostratigraphic unit
kg	Kilogram
LLNL	Lawrence Livermore National Laboratory
LWRP	Livermore Water Reclamation Plant
MCL	Maximum contaminant level
Mcf	Millions of cubic feet
Mgal	Millions of gallons
OPERA	Optimized environmental restoration analysis
PCB	Polychlorinated biphenyl
PCE	Perchloroethylene
pCi/L	Picocuries per liter
ppb	Parts per billion
RCRA	Resource Conservation and Recovery Act
REVAL	Remediation evaluation (ERD)
RPM	Remedial Project Manager
RWQCB	California Regional Water Quality Control Board
SDGS	Specific depth grab sampling
SVE	Soil vapor extraction

TAG	Technical Assistance Grant
TCE	Trichloroethylene
TF	Treatment facility
VES	Vapor extraction system
VOC	Volatile organic compound
VTF	(Soil) vapor treatment facility
ZVI	Zero valent iron

Figures

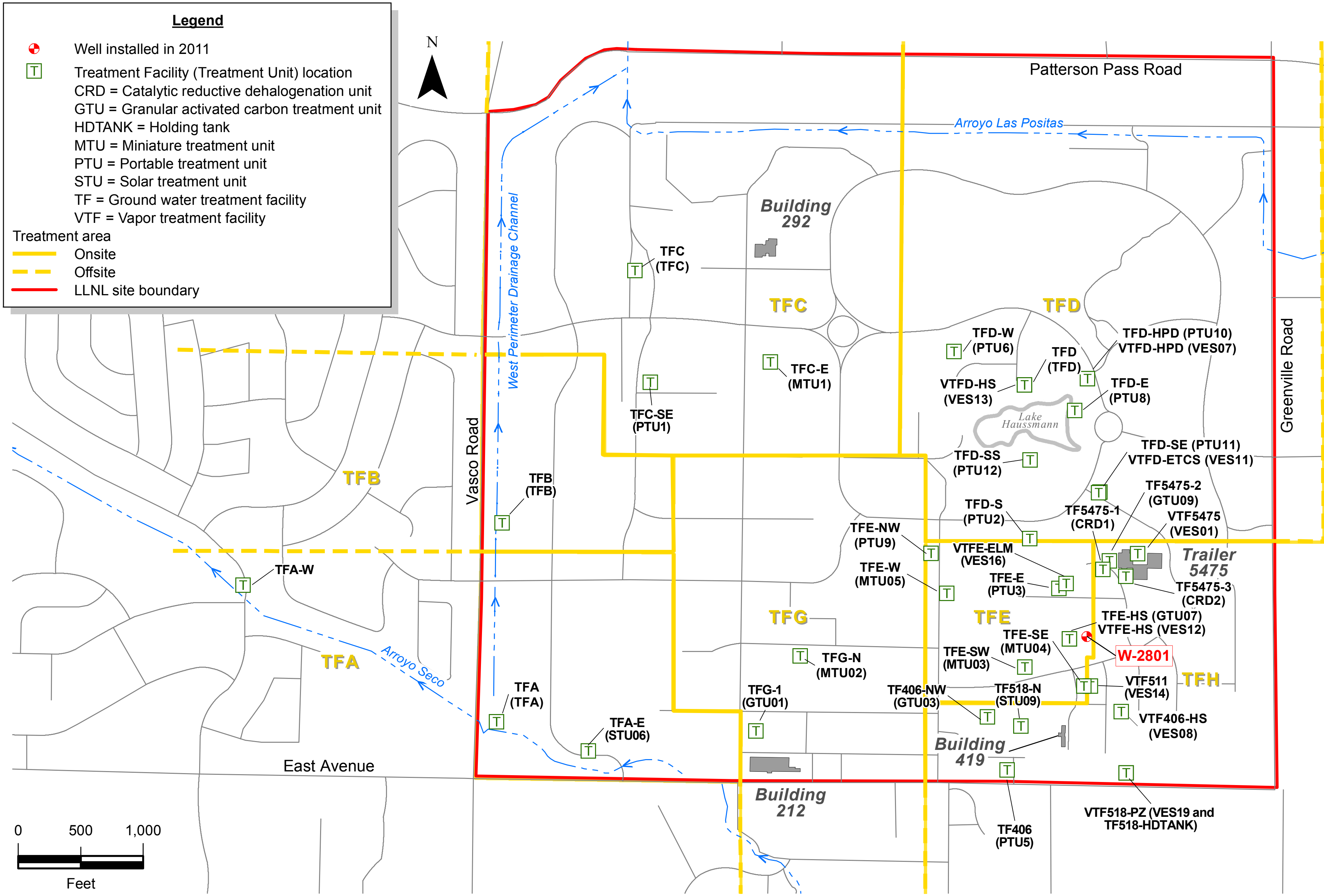

Figure 1. Livermore Site treatment areas, treatment facilities and wells constructed in 2011.

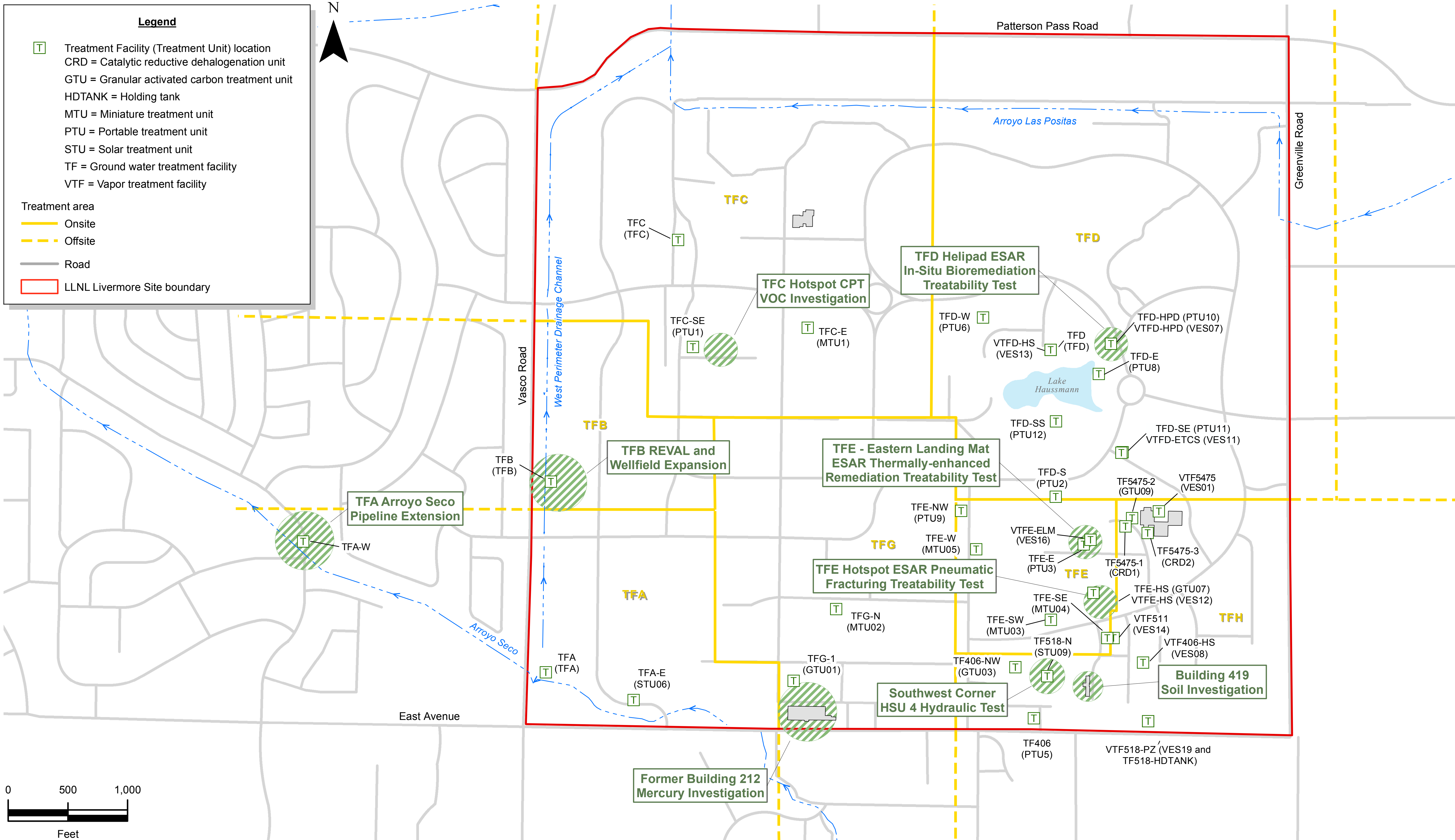

Figure 2. Livermore Site location map of significant projects conducted in 2011.

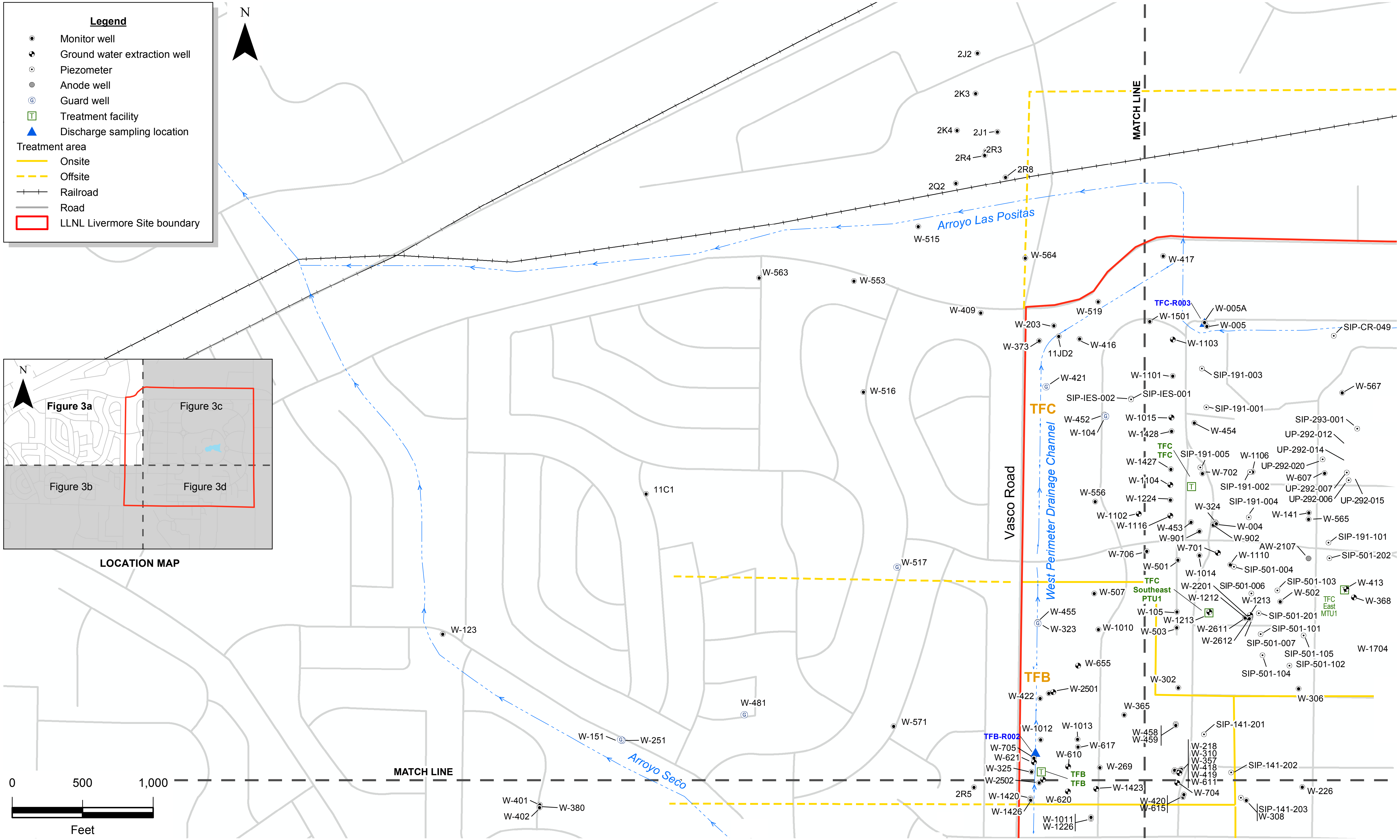

Figure 3a. Locations of Livermore Site wells and treatment facilities, December 2011.

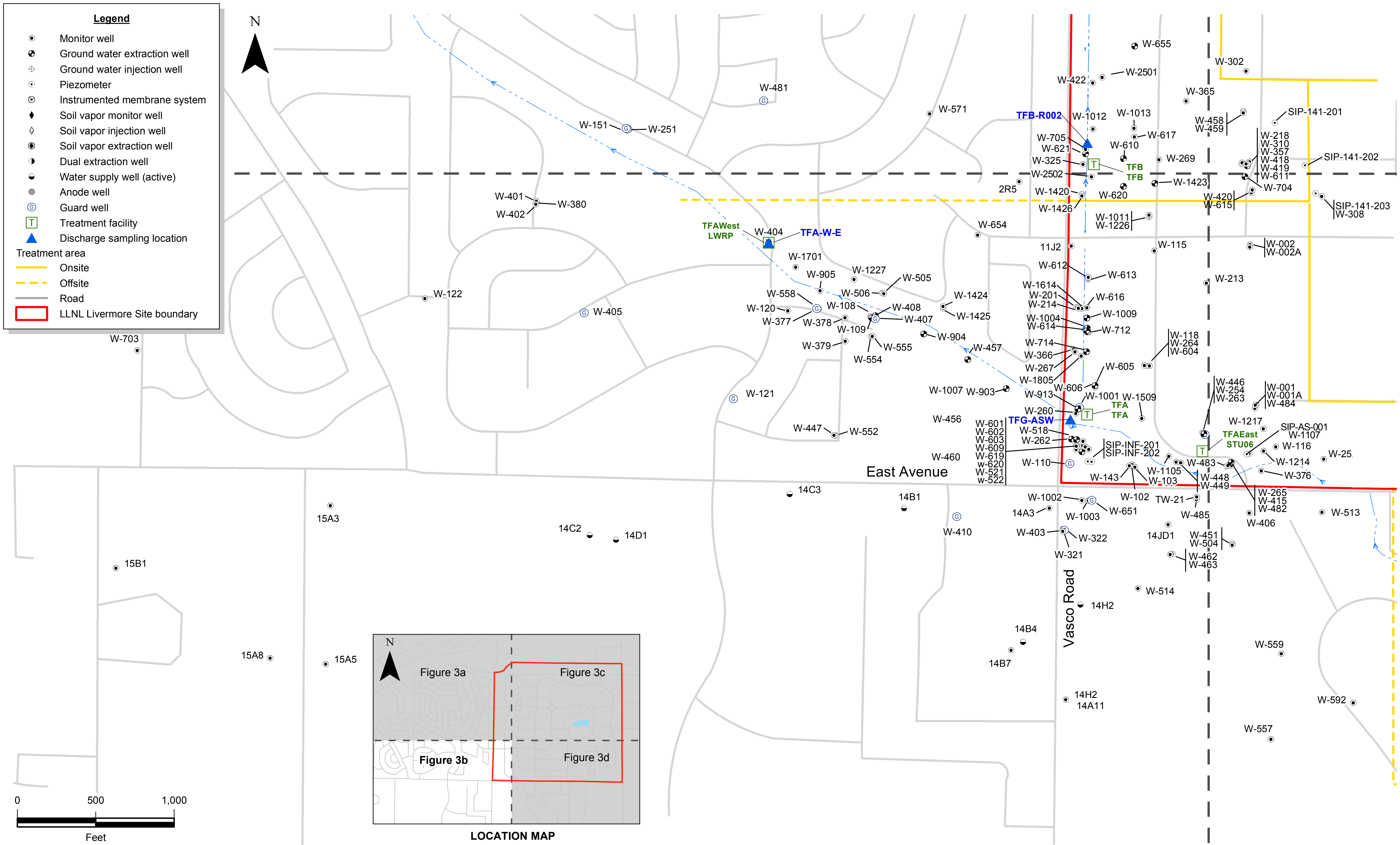

Figure 3b. Locations of Livermore Site wells and treatment facilities, December 2011.

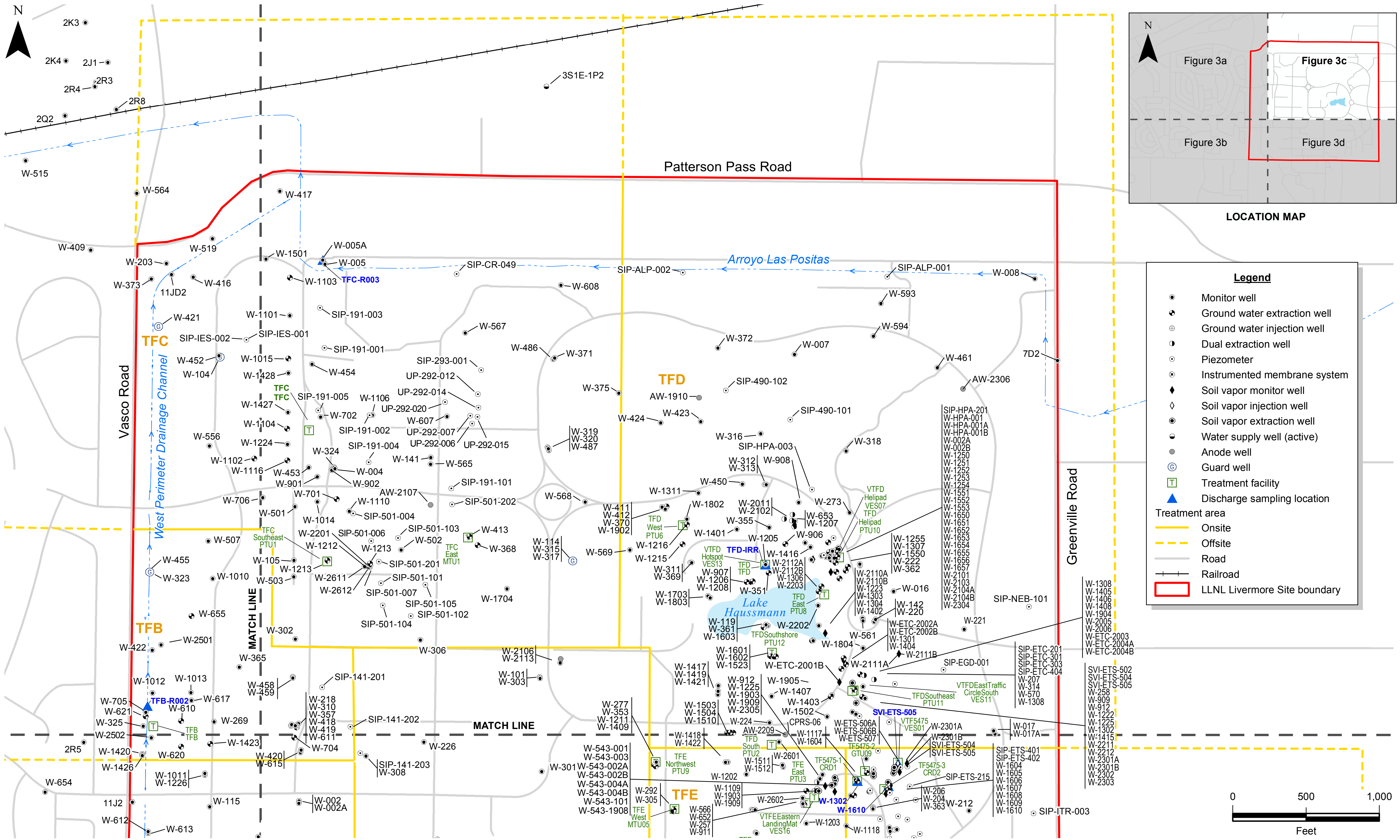

Figure 3c. Locations of Livermore Site wells and treatment facilities, December 2011.

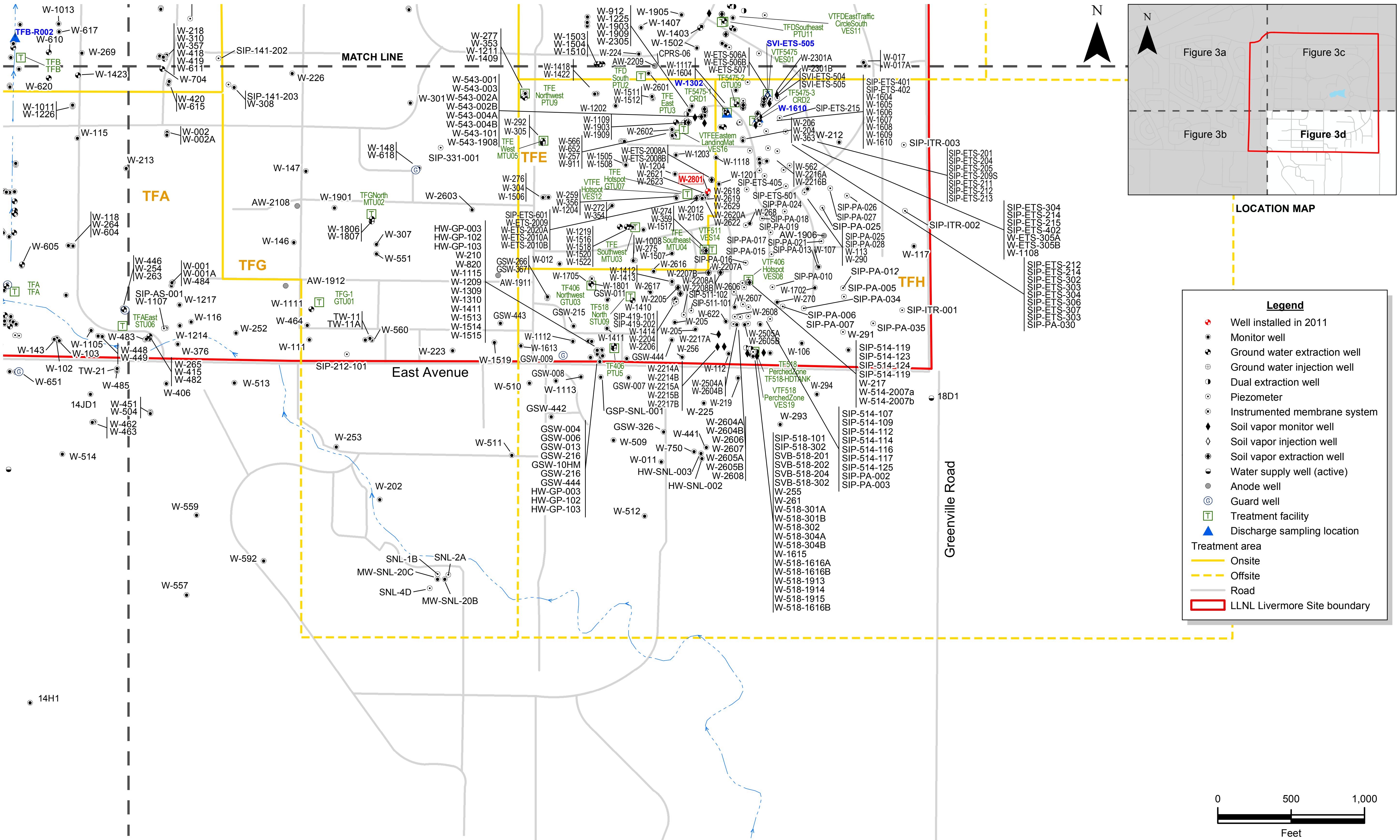

Figure 3d. Locations of Livermore Site wells and treatment facilities, December 2011.

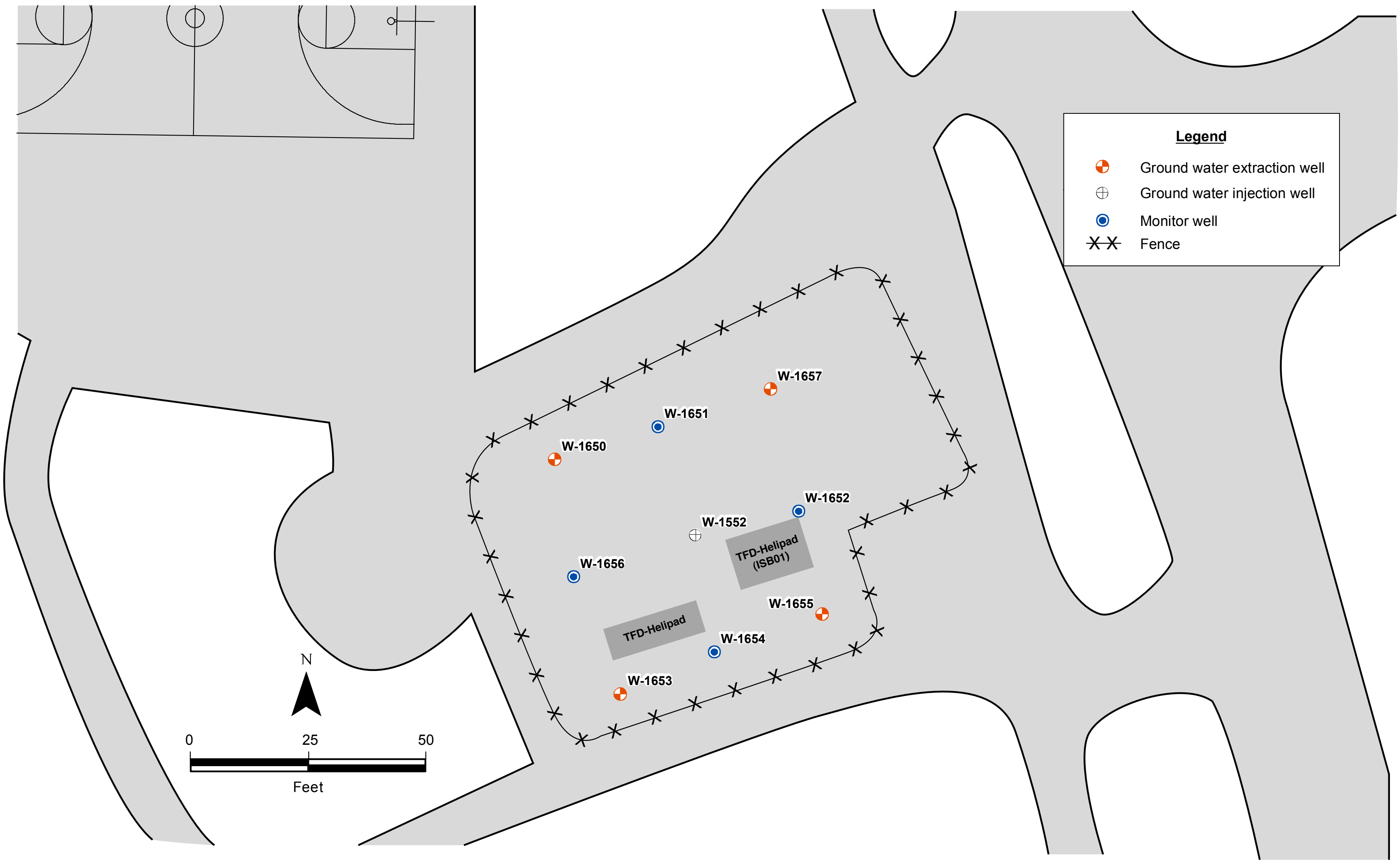

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Figure 4. Locations of wells and treatment facilities in the TFD Helipad *in situ* bioremediation treatability test area.

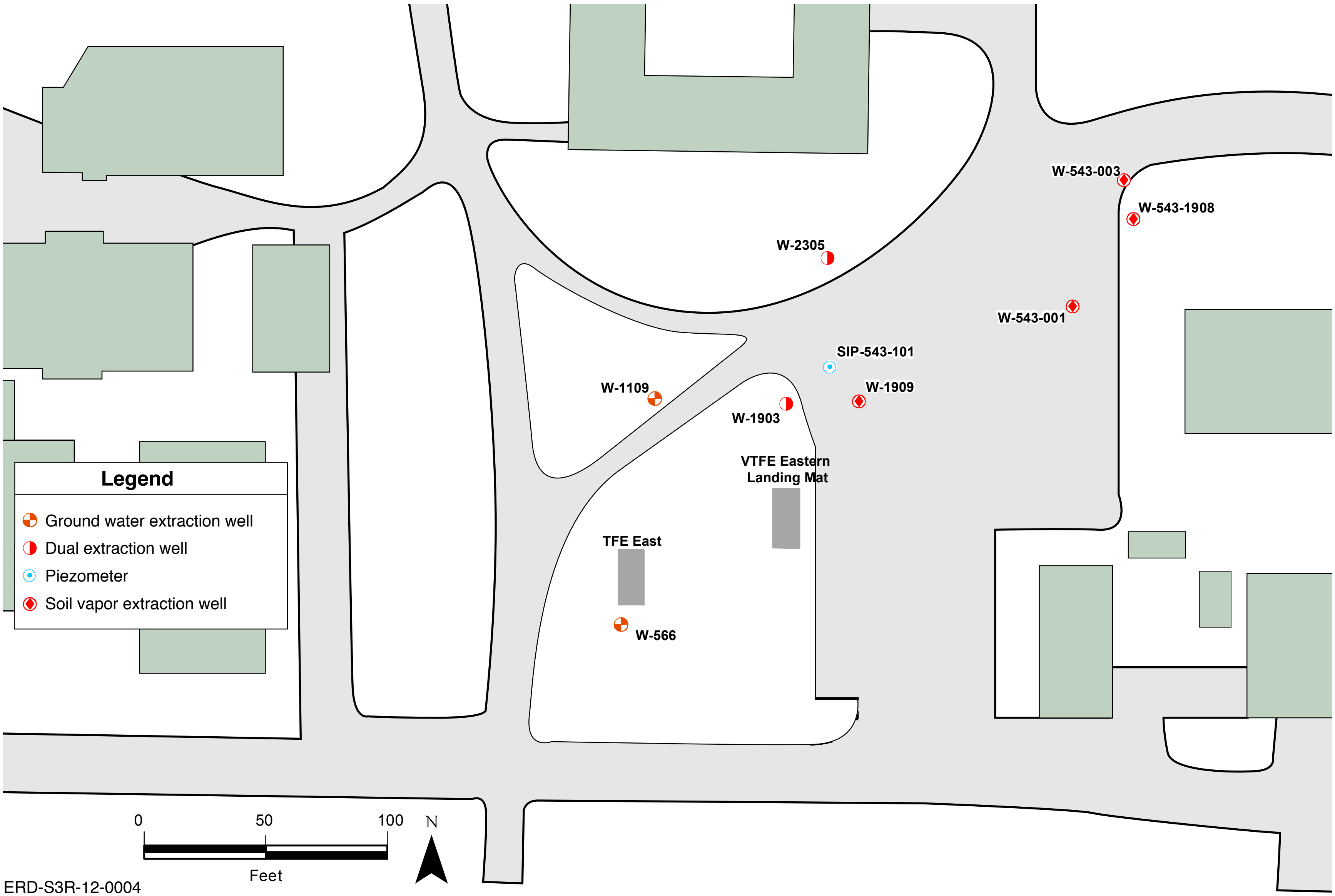

Figure 5. Locations of wells and treatment facilities in the TFE Eastern Landing Mat thermally-enhanced remediation treatability test area.

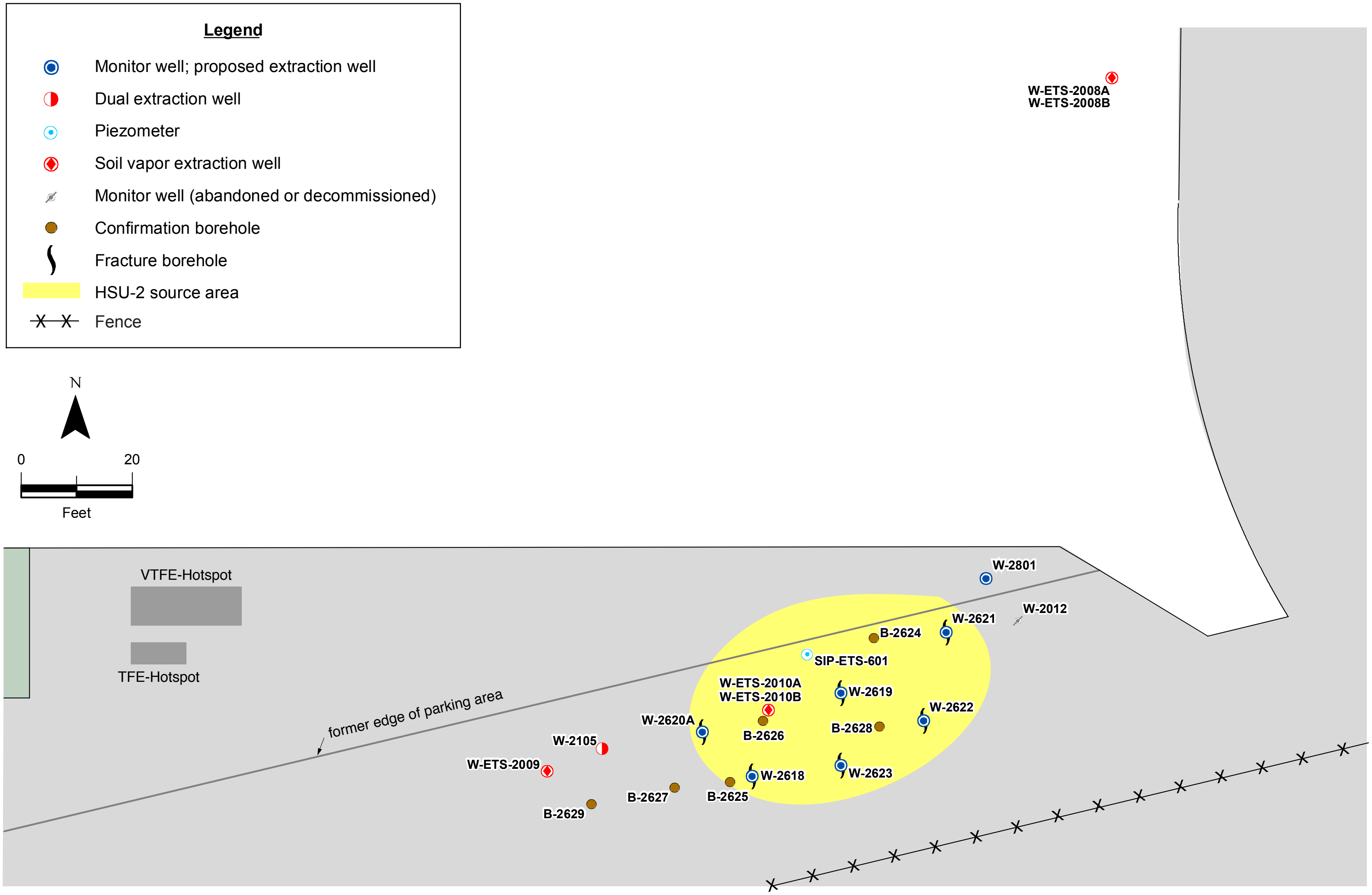

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Figure 6. Locations of wells and treatment facilities in the TFE Hotspot pneumatic fracturing treatability test area.

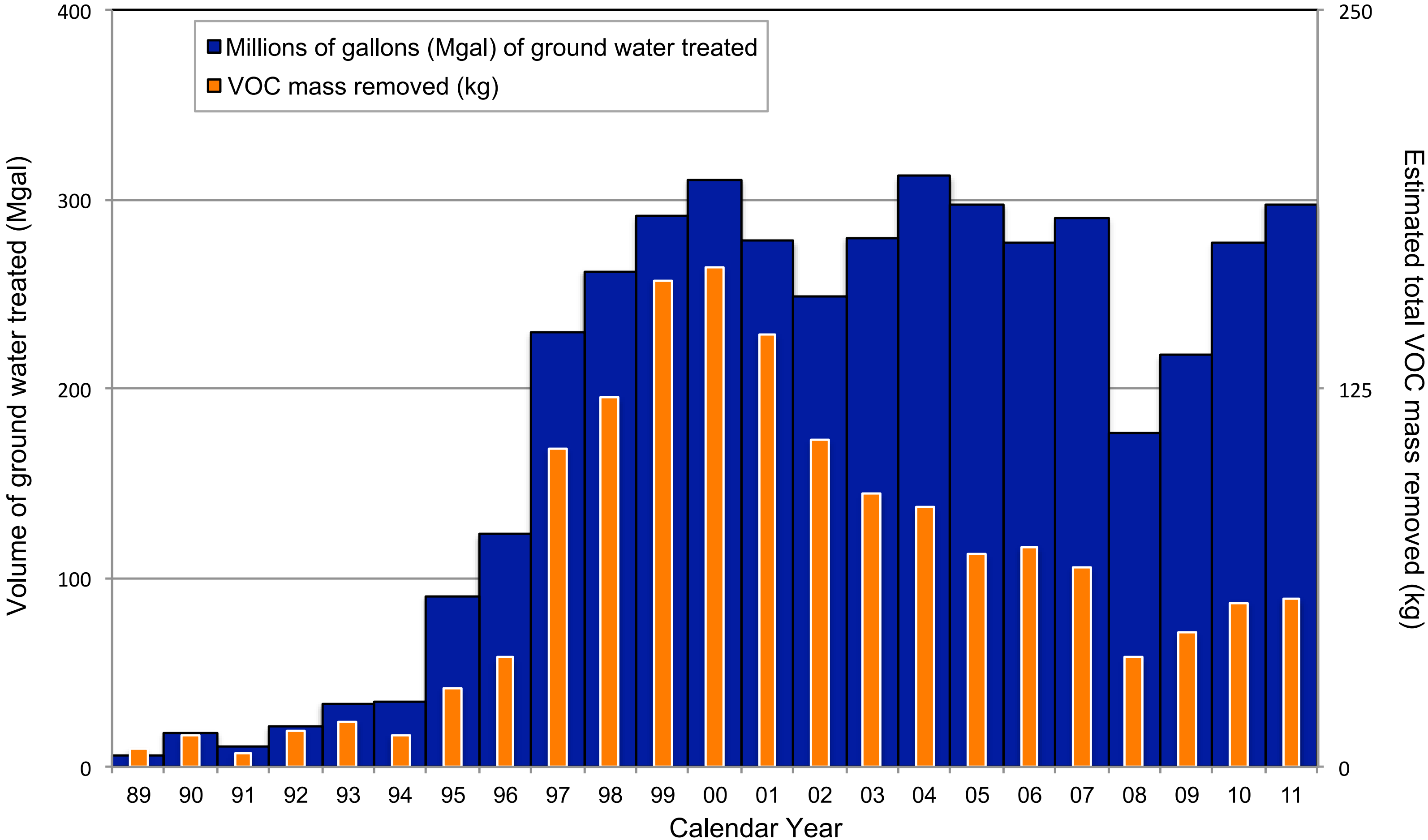

Figure 7. Estimated total VOC mass removed from Livermore Site ground water since 1989.

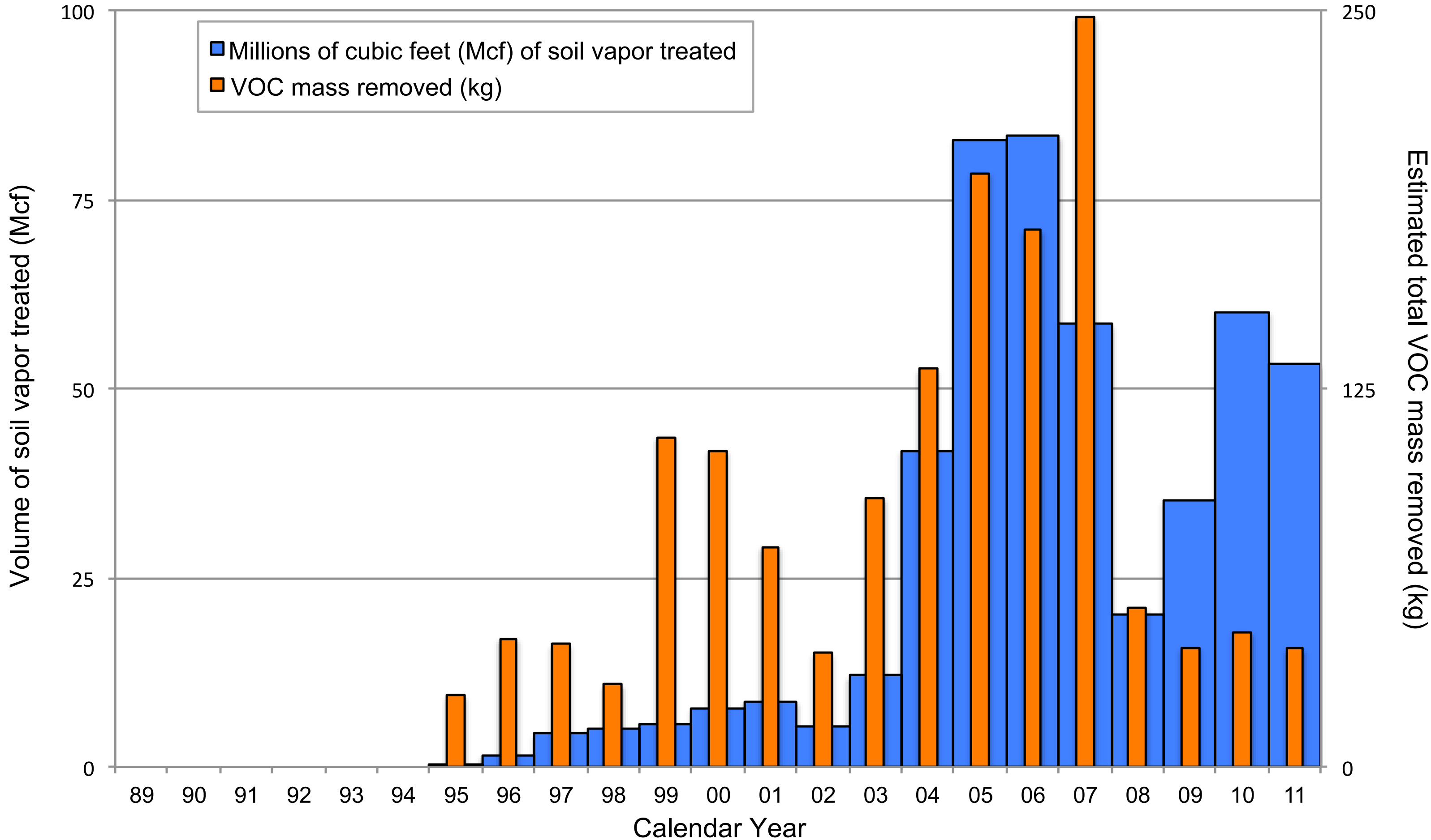

Figure 8. Estimated total VOC mass removed from Livermore Site soil vapor since 1989.

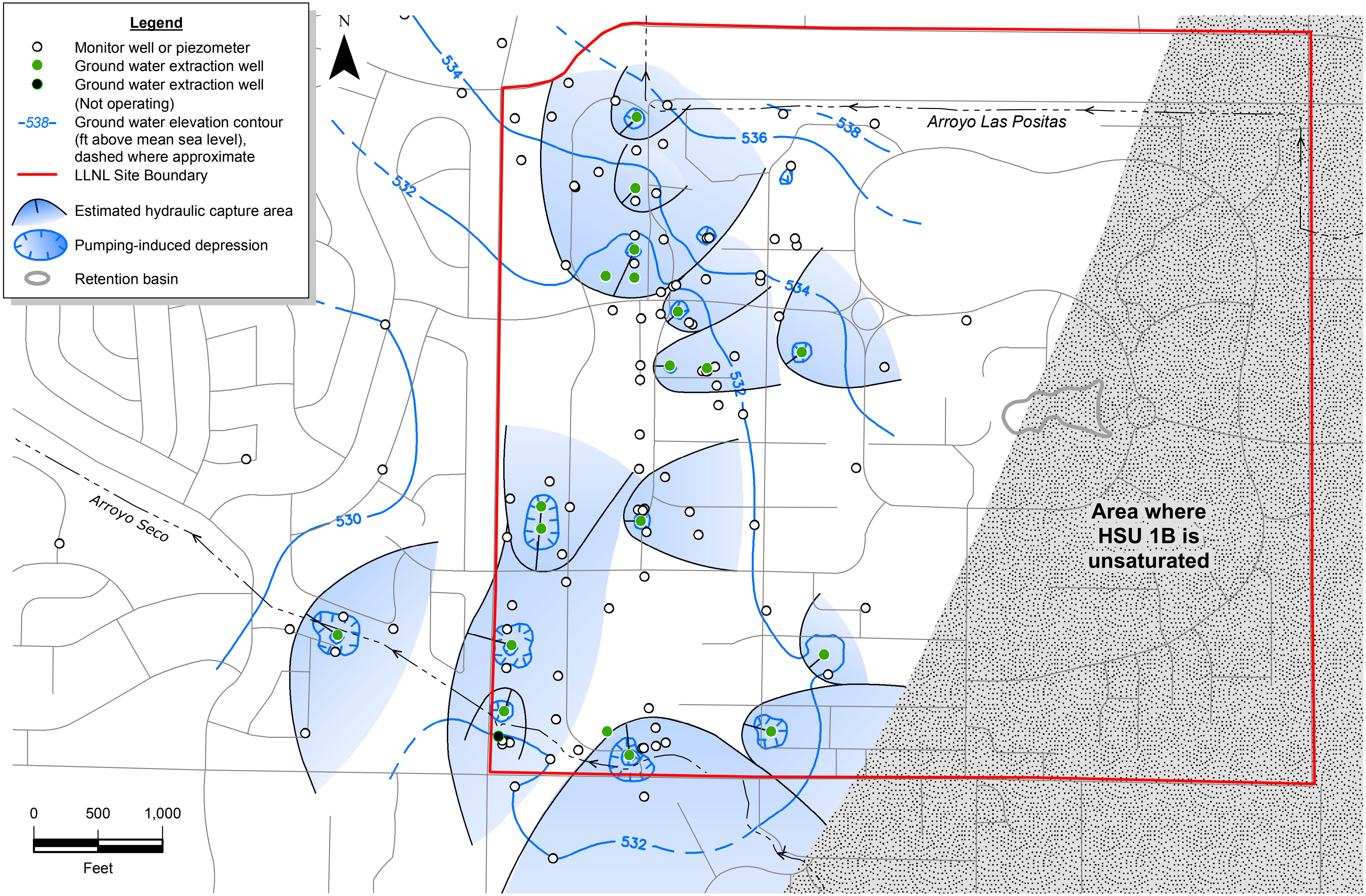

Figure 9. Ground water elevation contour map based on 124 wells completed within HSU 1B showing estimated hydraulic capture areas, LLNL and vicinity, July 2011.

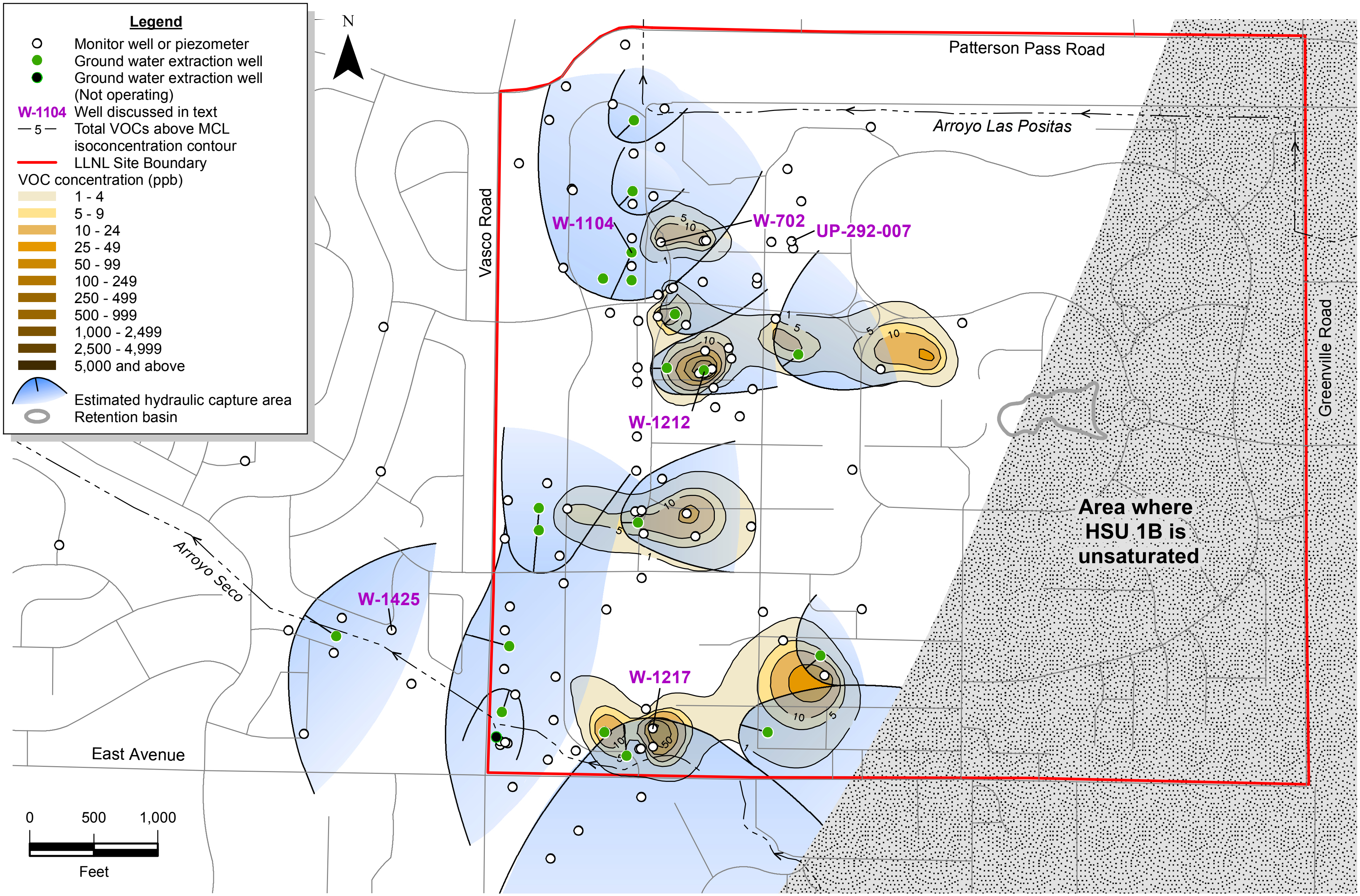

Figure 10. Isoconcentration contour map of total VOCs above MCLs from 129 wells completed within HSU 1B, third quarter 2011 (or the next most recent data), and supplemented with soil chemistry data from 41 borehole locations.

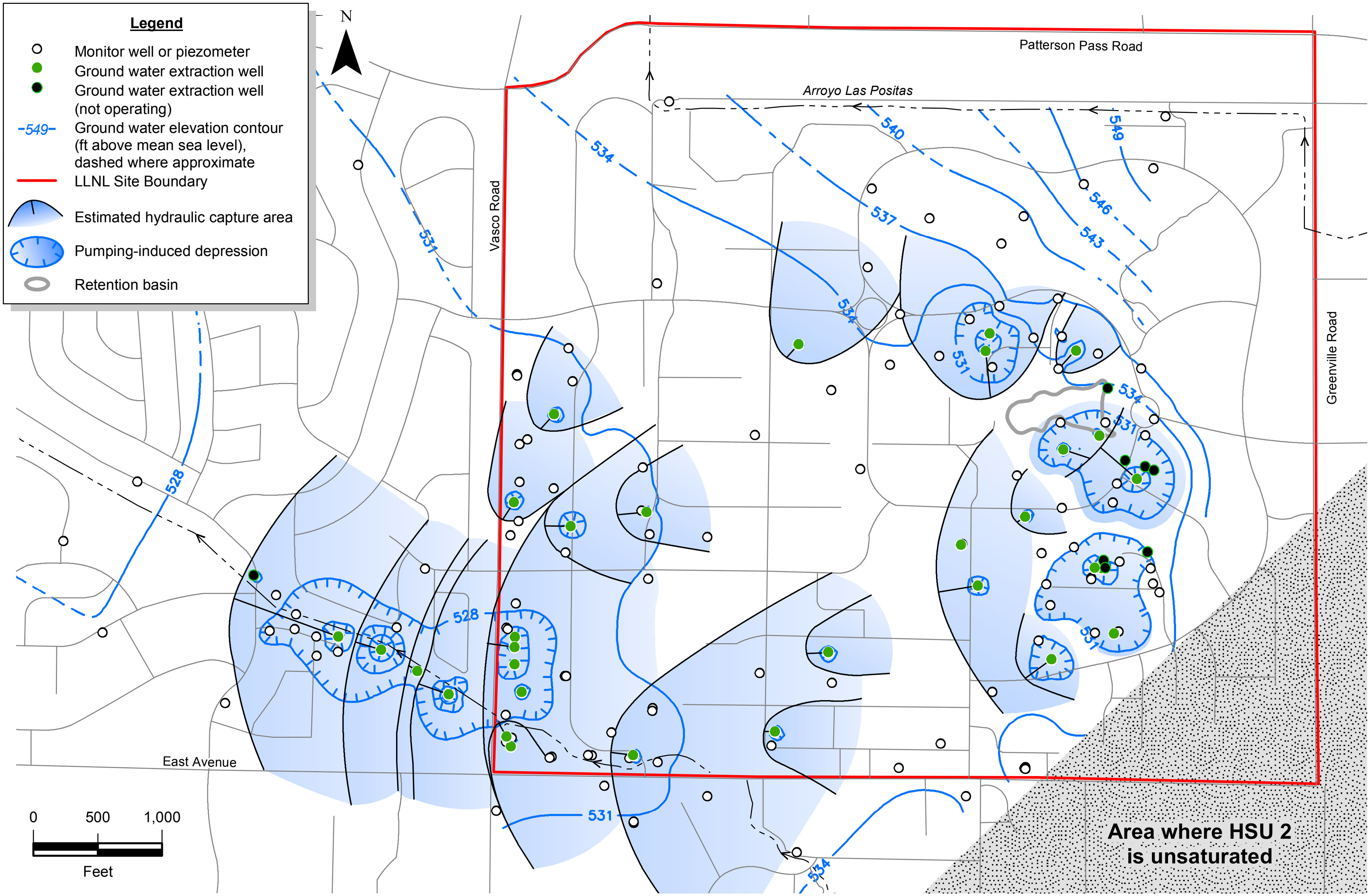

Figure 11. Ground water elevation contour map based on 159 wells completed within HSU 2 showing estimated hydraulic capture areas, LLNL and vicinity, July 2011.

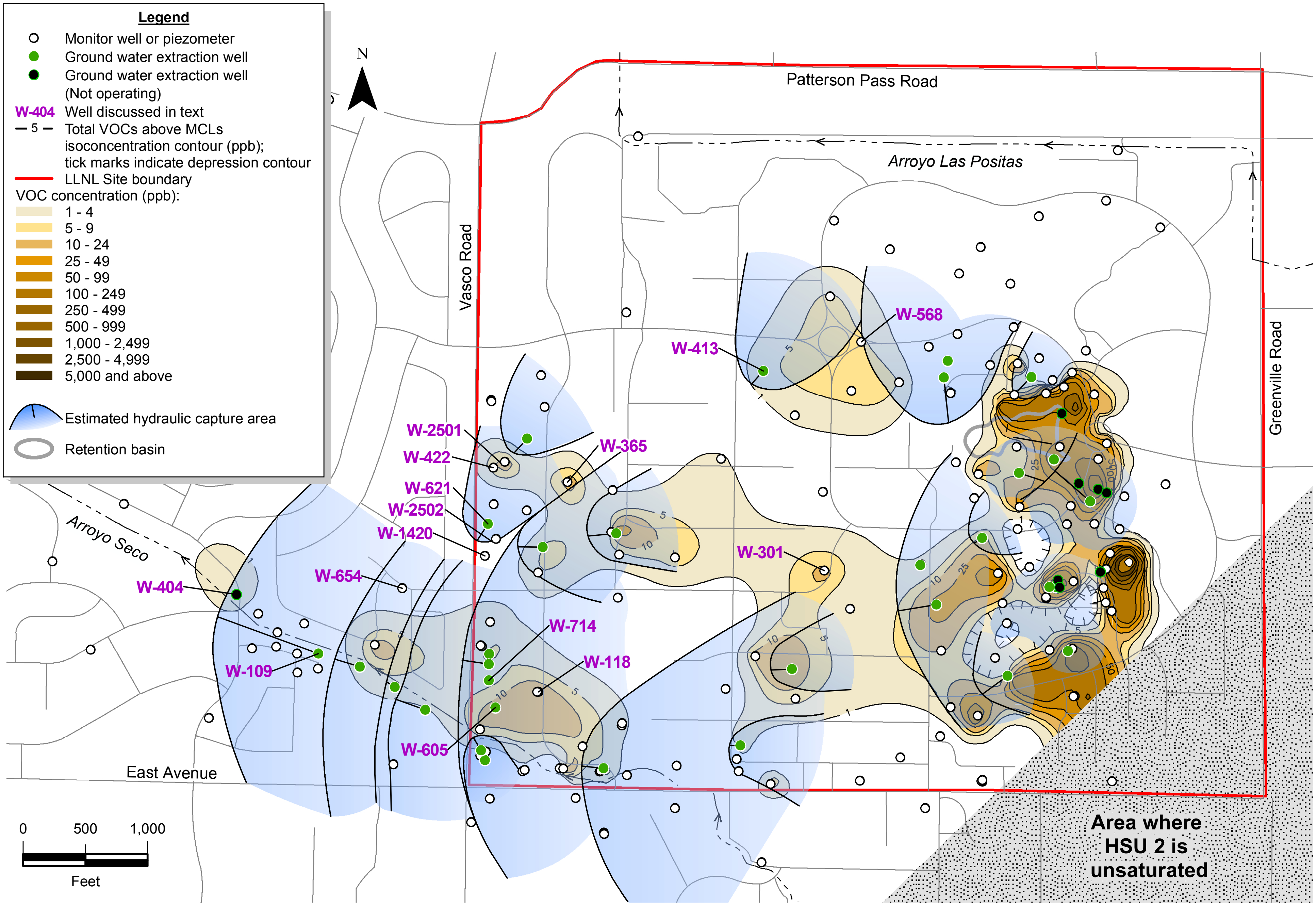

Figure 12. Isoconcentration contour map of total VOCs above MCLs from 196 wells completed within HSU 2, third quarter 2011 (or the next most recent data), and supplemented with soil chemistry data from 95 borehole locations.

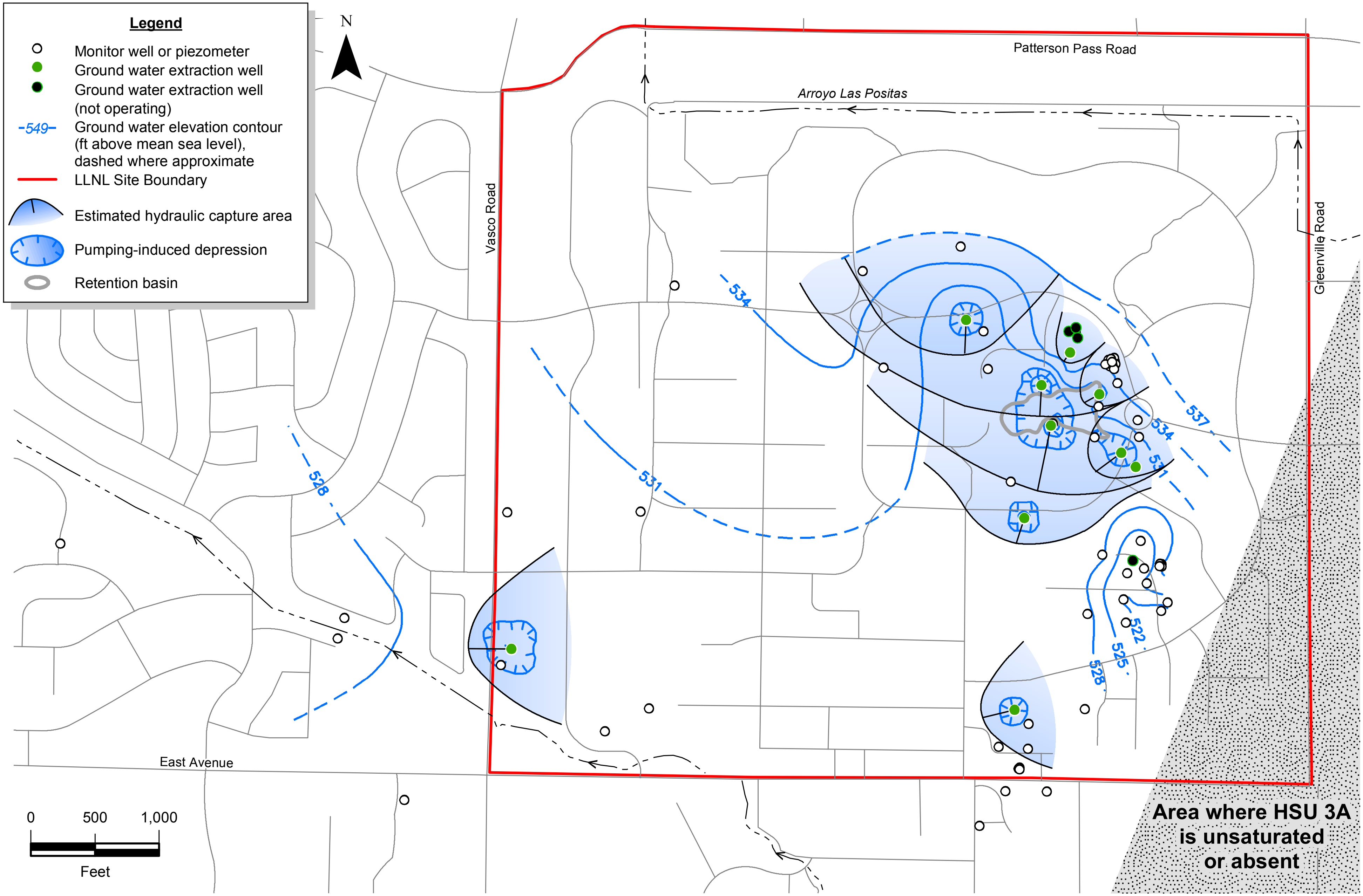

Figure 13. Ground water elevation contour map based on 72 wells completed within HSU 3A showing estimated hydraulic capture areas, LLNL and vicinity, July 2011.

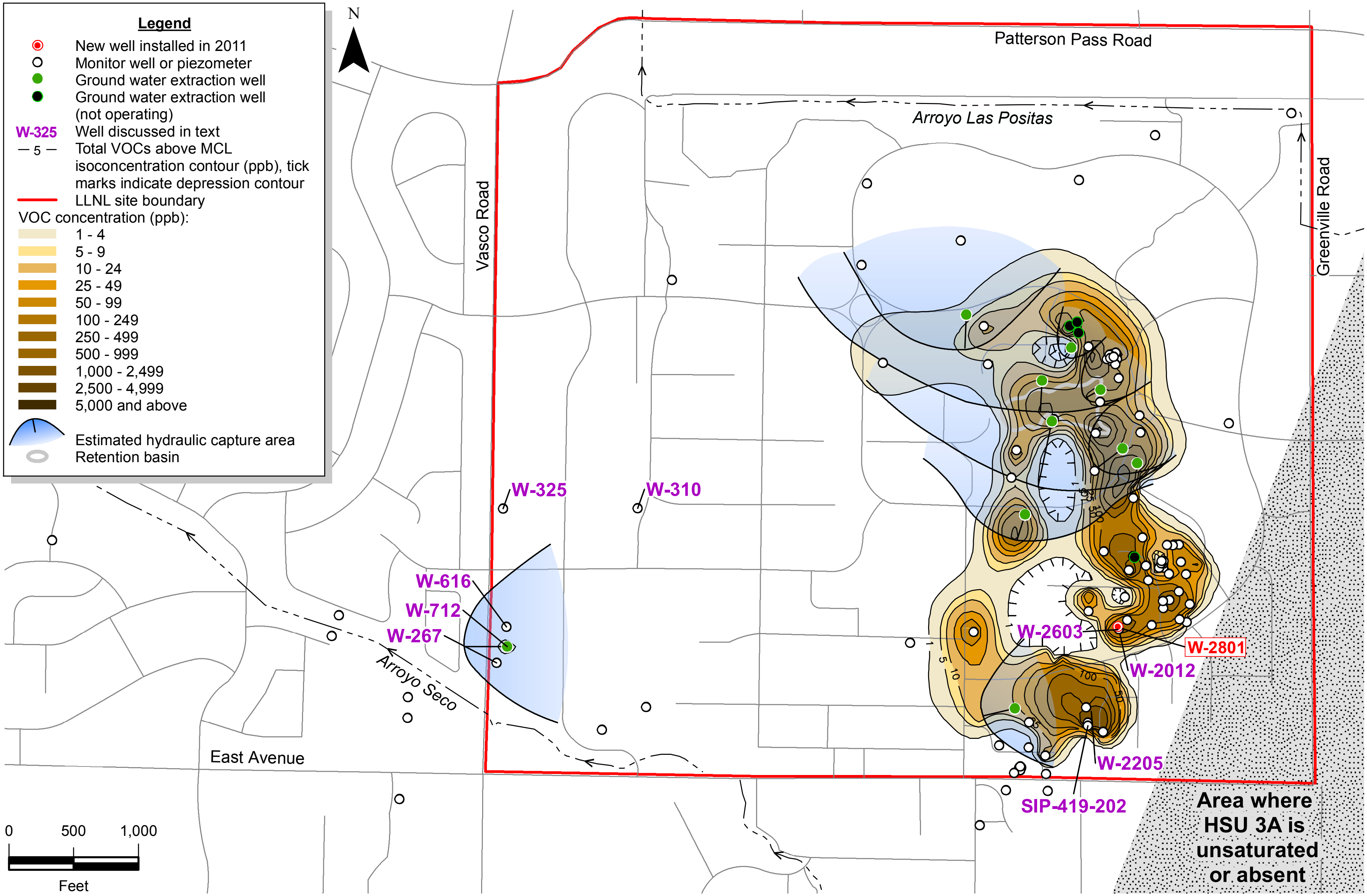

Figure 14. Isoconcentration contour map of total VOCs above MCLs from 113 wells completed within HSU 3A, third quarter 2011 (or the next most recent data), and supplemented with soil chemistry data from 144 borehole locations.

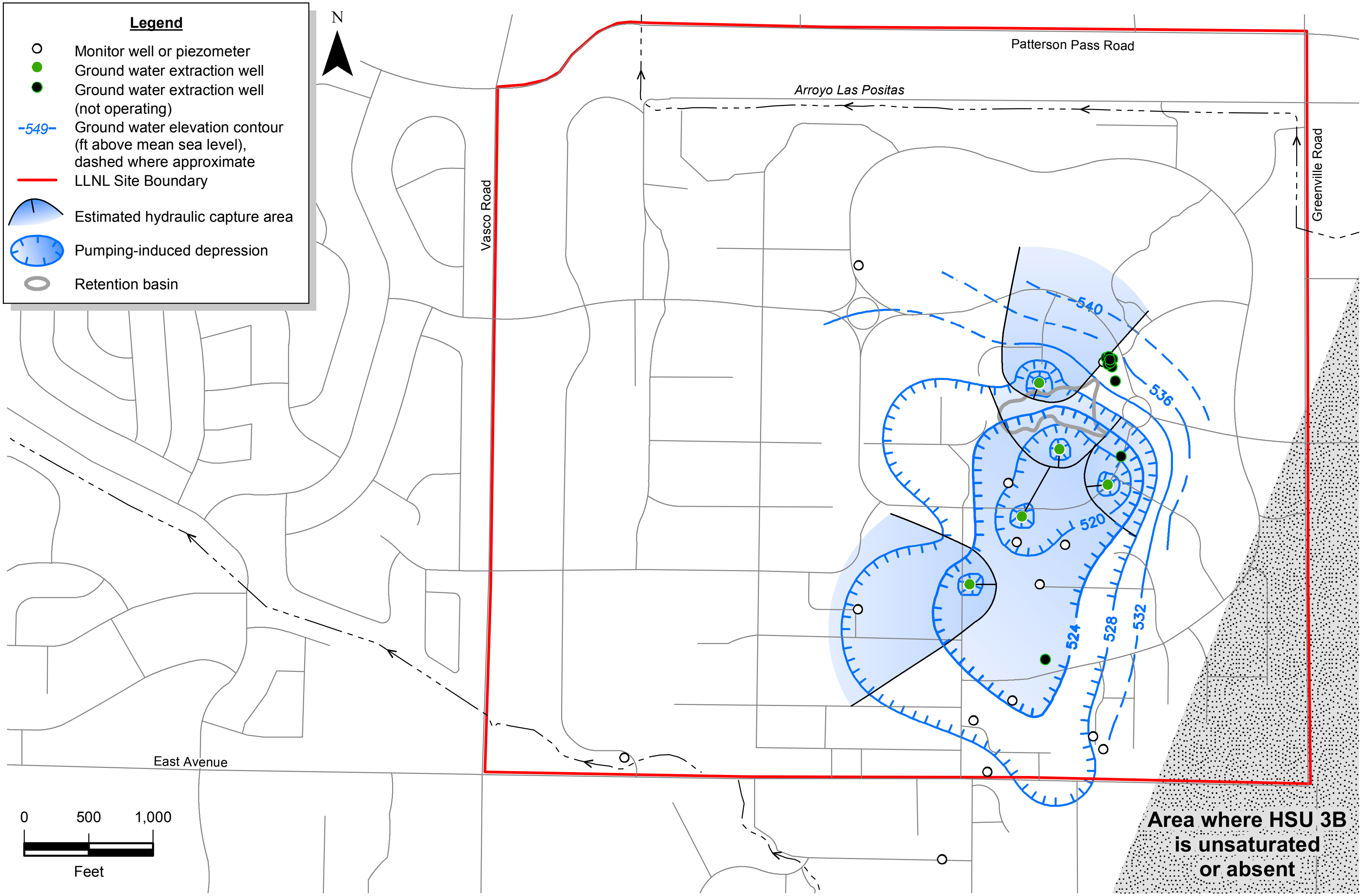

Figure 15. Ground water elevation contour map based on 29 wells completed within HSU 3B showing estimated hydraulic capture areas, LLNL and vicinity, July 2011.

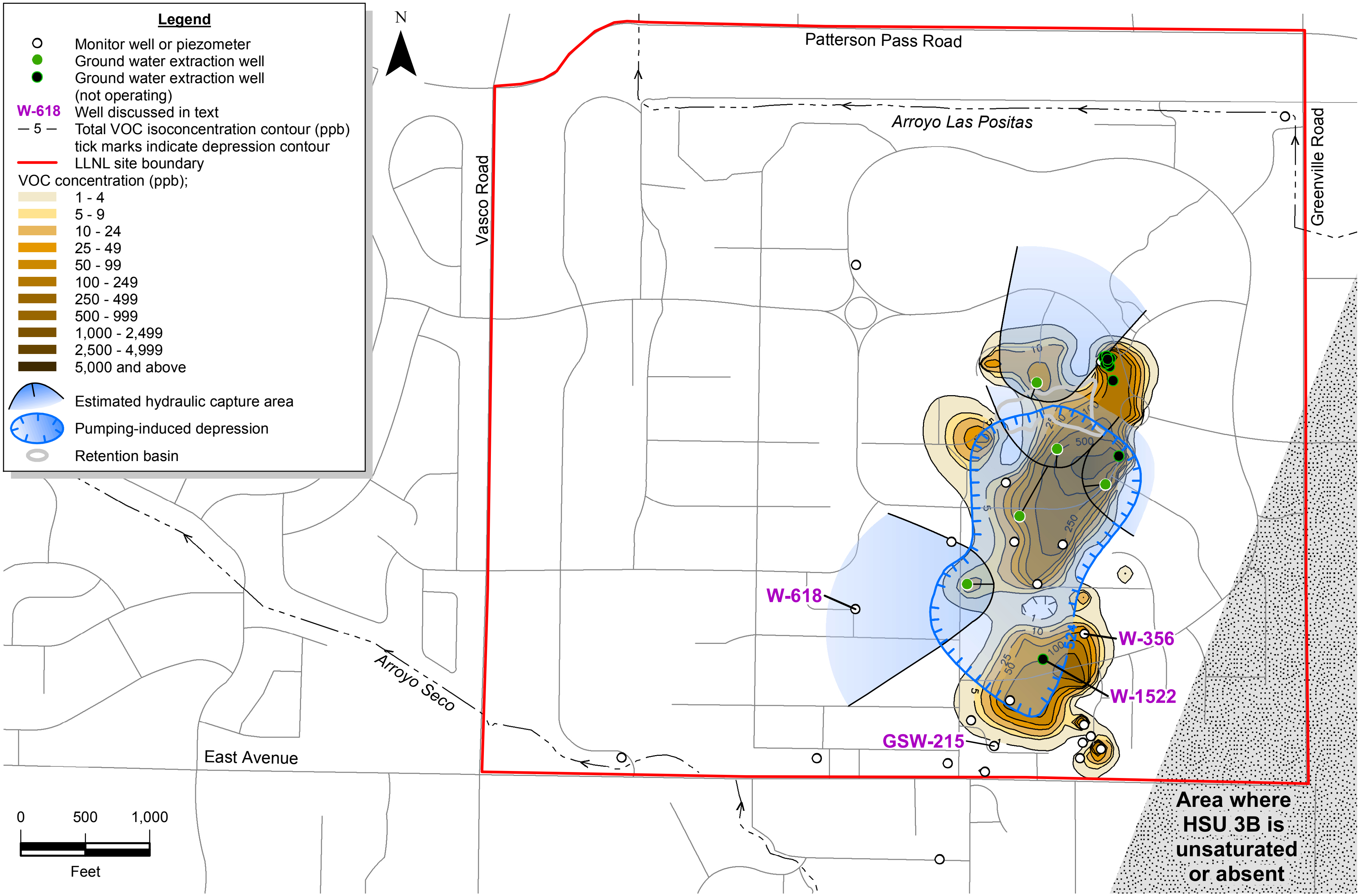

Figure 16. Isoconcentration contour map of total VOCs above MCLs from 40 wells completed within HSU 3B, third quarter 2011 (or the next most recent data), and supplemented with soil chemistry data from 109 borehole locations.

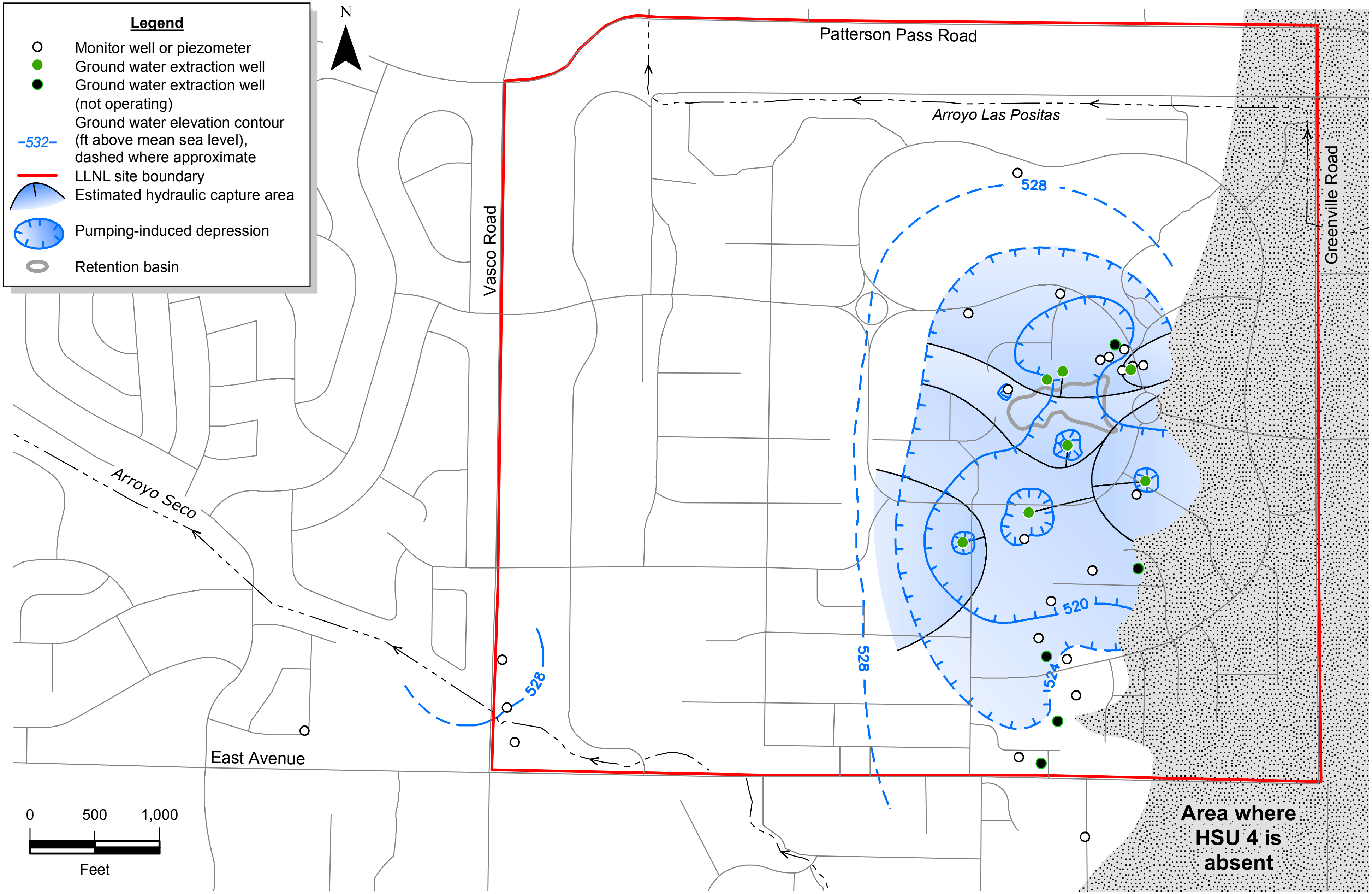

Figure 17. Ground water elevation contour map based on 36 wells completed within HSU 4 showing estimated hydraulic capture areas, LLNL and vicinity, July 2011.

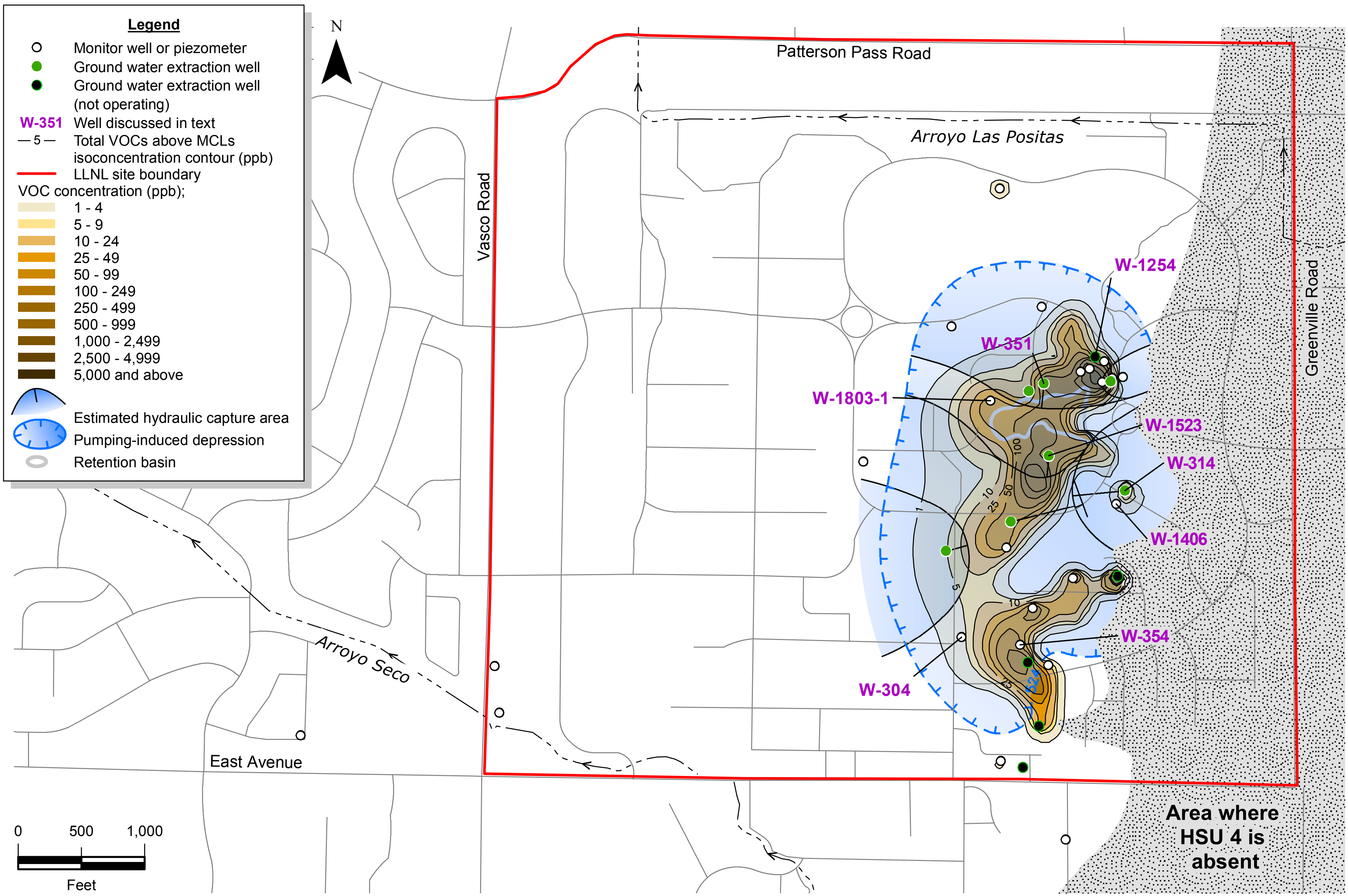

Figure 18. Isoconcentration contour map of total VOCs above MCLs from 42 wells completed within HSU 4, third quarter 2011 (or the next most recent data), and supplemented with soil chemistry data from 57 borehole locations.

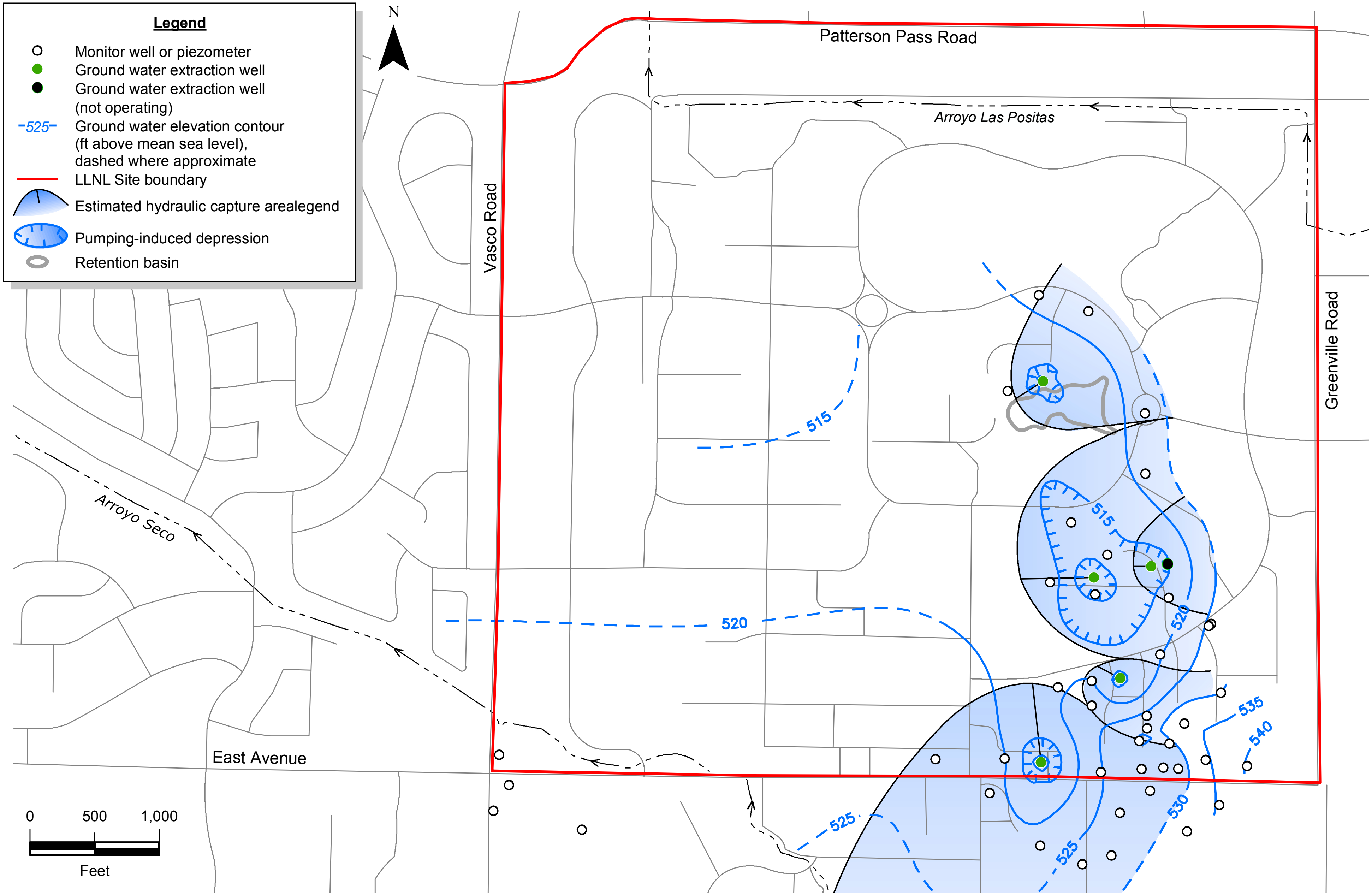

Figure 19. Ground water elevation contour map based on 50 wells completed within HSU 5 showing estimated hydraulic capture areas, LLNL and vicinity, July 2011.

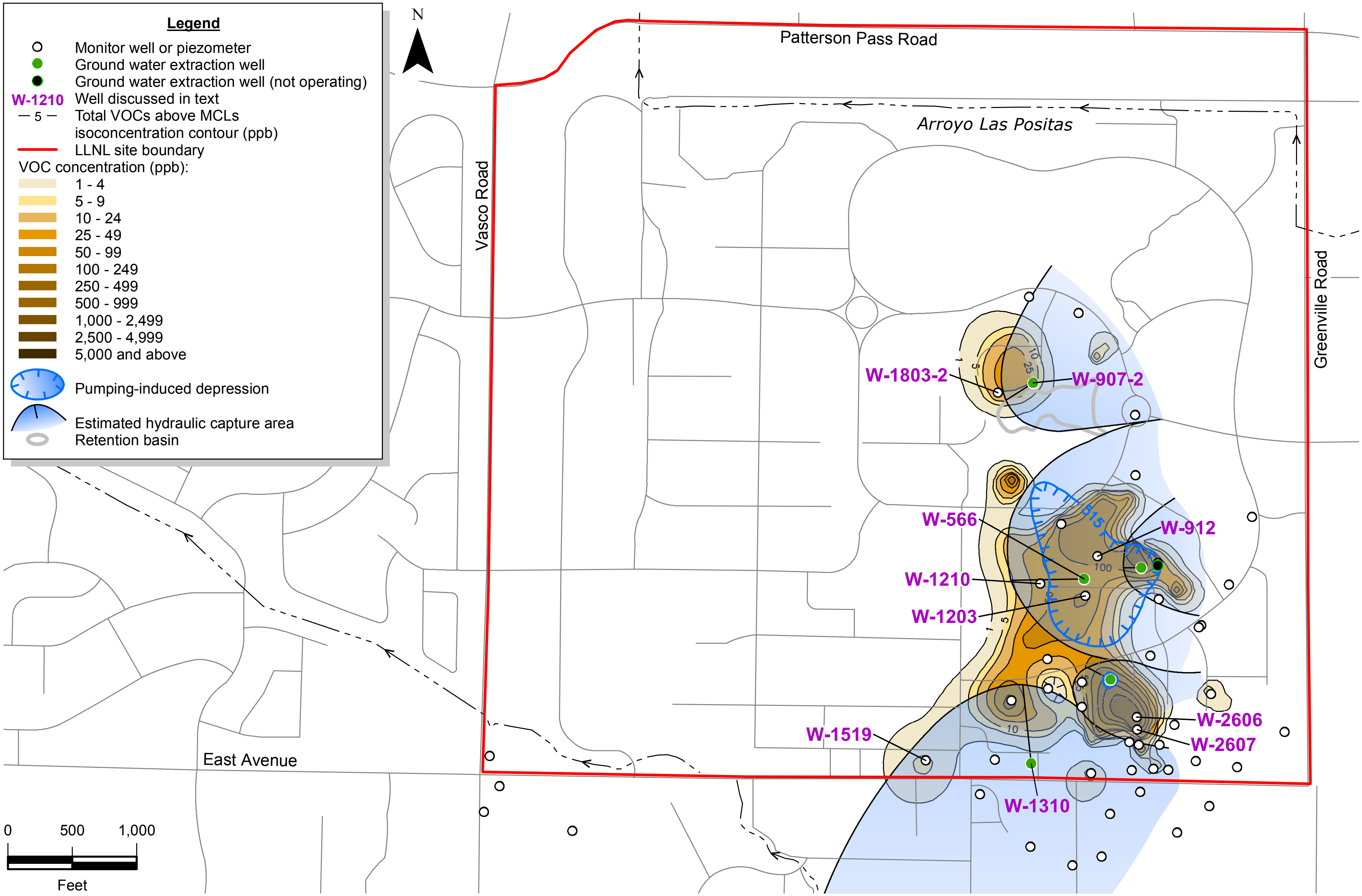

Figure 20. Isoconcentration contour map of total VOCs above MCLs from 60 wells completed within HSU 5, third quarter 2011 (or the next most recent data), and supplemented with soil chemistry data from 96 borehole locations.

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	92
Ground Water Injection	2
Ground Water Monitor[a]	412
Ground Water Guard	20
Solinst CMT[3] Multiwell 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 2011.

Table A-1 of Appendix A summarizes construction information for all wells.

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

[1] The wells protect metallic objects (e.g. pipelines) 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.

[3] CMT = Continuous Multichannel Tubing.

Table 3. Summary of treatment facility discharge sampling locations.

Treatment facility		Discharge sampling location[a]
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) and TFD irrigation supply (TFD-IRR)
	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 TFB
	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] **See Figures 3a through 3d for water discharge locations to ground surface.**

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

Table 4. 2011 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 (kcf)	Estimated VOC mass removed from soil vapor (kg)
		Treatment Facility A (TFA)			
1B	W-262	25	0	-	-
1B	W-408	11,945	0.03	-	-
1B	W-1001	1,488	0	-	-
1B	W-1004	5,476	0.06	-	-
1B/2	W-415	16,435	1.07	-	-
2	W-109	7,921	0.07	-	-
2	W-457	5,637	0.22	-	-
2	W-518	2,171	0.12	-	-
2	W-522	7,961	0.24	-	-
2	W-605	4,154	0.35	-	-
2	W-614	4,299	0.12	-	-
2	W-714	3,945	0.14	-	-
2	W-903	12,160	0.42	-	-
2	W-904	16,628	0.59	-	-
2	W-1009	11,485	1.20	-	-
3A	W-712	3,266	0.23	-	-
		Treatment Facility A East (TFA-E)			
1B	W-254	416	0.07	-	-
		Treatment Facility A West (TFA-W)			
2	W-404	2	<0.01	-	-
		Treatment Facility B (TFB)			
1B	W-610	2,931	0.09	-	-
1B	W-620	2,316	0.11	-	-
1B	W-704	8,484	1.26	-	-
2	W-357	2,840	0.53	-	-
2	W-621	3,319	0.09	-	-
2	W-655	3,353	0.09	-	-
2	W-1423	2,323	0.23	-	-

Table 4. 2011 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 (kcf)	Estimated VOC mass removed from soil vapor (kg)
		Treatment Facility C (TFC)			
1B	W-701	6,426	1.29	-	-
1B	W-1015	2,022	0.07	-	-
1B	W-1102	1,647	0.03	-	-
1B	W-1103	1,078	0.01	-	-
1B	W-1104	13,359	0.59	-	-
1B	W-1116	777	0.05	-	-
		Treatment Facility C East (TFC-E)			
1B	W-368	2,010	0.40	-	-
2	W-413	7,237	1.10	-	-
		Treatment Facility C Southeast (TFC-SE)			
1B	W-1213	3,391	0.46	-	-
1B	W-2201	5,860	1.12	-	-
		Treatment Facility D (TFD)		**Vapor Treatment Facility D Hotspot (VTFD-HS)[a]**	
2/3A	W-906	1,930	0.03	-	-
3A	W-653	0	0	0	0
3A	W-2011	0	0	0	0
3A	W-2101	126	0.17	0	0
3A	W-2102	0	0	0	0
3A/3B	W-1208	10,925	4.58	-	-
4	W-351	582	0.95	-	-
4	W-1206	1,954	0.16	-	-
5	W-907-2	2,032	0.33	-	-
		Treatment Facility D East (TFD-E)			
2	W-1303	1,247	1.13	-	-
2	W-1306	59	0.02	-	-
2	W-1404	0	0	-	-
3A	W-1301	316	0.31	-	-
3A	W-1550	0	0	-	-
3A	W-2203	249	0.10	-	-

Table 4. 2011 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 (kcf)	Estimated VOC mass removed from soil vapor (kg)
		Treatment Facility D East (TFD-E) (continued)			
3B	W-2006	0	0	-	-
4	W-1253	0	0	-	-
4	W-1255	0	0	-	-
4	W-1307	2,792	0.54	-	-
		Treatment Facility D Helipad (TFD-HPD)[b]		**Vapor Treatment Facility D Helipad (VTFD-HPD)[b]**	
1B	W-HPA-002A	-	-	-	-
2	W-HPA-002B	-	-	-	-
2/3A	W-1655	0	0	-	-
2/3A/3B	W-1651	-	-	-	-
3A	W-1551	0	0	-	-
3A	W-1552	-	-	-	-
3A	W-1650	0	0	-	-
3A	W-1653	0	0	-	-
3A	W-1654	-	-	-	-
3A	W-1656	-	-	-	-
3A/3B	W-1652	-	-	-	-
3A/3B	W-1657	0	0	-	-
4	W-1254	0	0	-	-
		Treatment Facility D South (TFD-S)			
2	W-1510	1,509	0.16	-	-
3A/3B	W-1504	3,997	1.75	-	-
4	W-1503	5,952	1.69	-	-
		Treatment Facility D Southeast (TFD-SE)		**Vapor Treatment Facility D East Traffic Circle South (VTFD-ETCS)**	
1B	W-ETC-2003	-	-	6,658	0.35
1B/2	W-ETC-2004A	-	-	2,727	0.30
2	W-ETC-2004B	-	-	6,687	2.48
2	W-1308	1,401	1.30	-	-
2	W-1904	0	0	<1	<0.01
2	SIP-ETC-201	0	0	<1	<0.01
3A	W-2005	51	0.01	-	-
3B	W-1403	668	1.44	-	-

Table 4. 2011 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 (kcf)	Estimated VOC mass removed from soil vapor (kg)
		Treatment Facility D Southeast (TFD-SE) (continued)			
4	W-314	4,795	1.89	-	-
		Treatment Facility D Southshore (TFD-SS)			
2	W-1602	2,394	0.24	-	-
3A	W-1603	5,519	4.73	-	-
3B	W-1601	522	0.80	-	-
4	W-1523	2,594	2.23	-	-
		Treatment Facility D West (TFD-W)			
2	W-1215	5,046	0.68	-	-
2	W-1216	5,328	1.05	-	-
3A	W-1902	9,321	3.10	-	-
		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	-	-	4,769	1.00
2	W-1109	739	0.84	-	-
2	W-1903	286	0.09	500	0.32
2	W-1909	0	0	<1	<0.01
2	W-2305	43	0.08	<1	<0.01
5	W-566	4,102	1.30	-	-
		Treatment Facility E Hotspot (TFE-HS)		**Vapor Treatment Facility E Hotspot (VTFE-HS)**	
1B	W-ETS-2008A	-	-	4	<0.01
1B/2	W-ETS-2010A	-	-	5	<0.01
2	W-ETS-2008B	-	-	2,222	0.86
2	W-ETS-2009	-	-	1	<0.01
2	W-ETS-2010B	-	-	4,696	0.74
2	W-2105	3	<0.01	330	0.33
3A	W-2012	0	0	-	-

Table 4. 2011 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 (kcf)	Estimated VOC mass removed from soil vapor (kg)
		Treatment Facility E Northwest (TFE-NW)			
2	W-1409	1,278	0.12	-	-
4	W-1211	3,115	0.15	-	-
		Treatment Facility E Southeast (TFE-SE)			
5	W-359	4,165	5.27	-	-
		Treatment Facility E Southwest (TFE-SW)			
2	W-1518	654	0.05	-	-
3B	W-1522	<1	<0.01	-	-
4	W-1520	<1	<0.01	-	-
		Treatment Facility E West (TFE-W)			
2	W-305	4,372	1.16	-	-
3B	W-292	2,861	0.31	-	-
		Treatment Facility G-1 (TFG-1)			
1B/2	W-1111	4,403	0.33	-	-
		Treatment Facility G North (TFG-N)			
1B	W-1806	1,400	0.10	-	-
2	W-1807	2,307	0.26	-	-
		Treatment Facility 406 (TF406)			
4	W-1309	427	<0.01	-	-
5	W-1310	7,236	0.18	-	-
		Treatment Facility 406 Northwest (TF406-NW)			
3A	W-1801	1,300	0.16	-	-

Table 4. 2011 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 (kcf)	Estimated VOC mass removed from soil vapor (kg)
				Vapor Treatment Facility 406 Hotspot (VTF406-HS)	
1B/2	W-514-2007A	-	-	619	0.06
2/5	W-514-2007B	-	-	5,987	2.29
5	W-217	-	-	8,344	6.15
				Vapor Treatment Facility 511 (VTF511)	
1B	W-2207A	-	-	<1	<0.01
2	W-274	-	-	<1	<0.01
2	W-1517	-	-	<1	<0.01
2	W-2204	-	-	0	0
2	W-2205	-	-	0	0
2	W-2206	-	-	0	0
2	W-2207B	-	-	3,631	1.46
2	W-2208A	-	-	<1	<0.01
2	W-2208B	-	-	3,773	18.26
		Treatment Facility 518 North (TF518-N)[c]			
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	1	<0.01	1,866	3.10
2	W-518-1913	0	0	0	0
2	W-518-1915	<1	<0.01	332	1.26
2	SVB-518-201	0	0	0	0
2	SVB-518-204	0	0	0	0
		Treatment Facility 5475-1 (TF5475-1)[c]			
3A	W-1302-2	0	0	-	-
		Treatment Facility 5475-2 (TF5475-2)			
2	W-1415	0	0	-	-

Table 4. 2011 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 (kcf)	Estimated VOC mass removed from soil vapor (kg)
		Treatment Facility 5475-2 (TF5475-2) (continued)			
5	W-1108	2,465	3.17	-	-
		Treatment Facility 5475-3 (TF5475-3)[c]			
3A	W-1605	0	0	-	-
3A	W-1608	0	0	-	-
4	W-1604	0	0	-	-
5	W-1609	0	0	-	-
				Vapor Treatment Facility 5475 (VTF5475)[c]	
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.**

kcf = **Thousands of cubic feet.**

VOC = **Volatile Organic Compound.**

[a] **VTFD-HS is currently secured to evaluate cyclic ground water pumping operations at the TFD Hotspot wells.**

[b] **TFD-HPD and VTFD-HPD were secured in year 2010 to perform an ongoing in situ bioremediation treatability test at the TFD Helipad area.**

[c] **TF518-N, TF5475-1, TF5475-3 and VTF5475 are secured pending the results of the Focused Feasibility Study (FFS) to address mixed waste disposition issues.**

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

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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-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

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-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
W-2801	GW Extraction	18-Oct-11	140	135	1	114-119	3A	NA
					2	124.5-129.5	3A	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

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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-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
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

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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-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
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

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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-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
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

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-001	IMS	NA	67	NA	1	NA	NA	NA
IMS-INF-002	IMS	NA	67	NA	1	NA	NA	NA
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

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)
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
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

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)
MW-NLF-21	GW Monitor	NA	NA	NA	1	NA	NA	NA
MW-NLF-22	GW Monitor	NA	NA	NA	1	NA	NA	NA
					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

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)
18D1	Water-supply (pumping)	20-Apr-84	NA	NA	1	NA	7	12
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
W-2012	GW Extraction	21-Oct-04	155	136.6	111-116	3A	20-Oct-11
					126-131	3A	
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

Notes and footnotes appear on the following page.

Table A-2. 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
W-2801	18-Nov-11	Drawdown	3.1	339	33.9	Good
W-2801	22-Nov-11	Step	1.0	256	25.6	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-Jun-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

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-10	22-May-86	Drawdown	14.3	21,000	2,000	Good
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

2011 Ground Water Sampling Schedule

Table D-1. 2011 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
W-001	O	3-13	
W-001A	E	1-12	
W-002	E	1-12	
W-002A	O	3-13	
W-004	A	2-12	
W-005	O	3-13	
W-005A	E	4-12	
W-007	O	1-13	
W-008	A	1-12	EFA
W-011	O	3-13	
W-012	A	1-12	
W-017	A	1-12	EFA
W-017A	O	1-13	
W-101	O	3-13	
W-102	O	1-13	
W-103	O	1-13	
W-104	Q	1-12	
W-105	E	1-12	
W-106	O	1-13	
W-107	A	1-12	
W-108	O	3-13	
W-110	Q	1-12	
W-111	E	1-12	
W-112	A	1-12	
W-113	A	1-12	
W-114	A	1-12	
W-115	E	2-12	
W-116	Q	1-12	
W-117	O	1-13	
W-118	A	2-12	
W-119	Q	1-12	EFA
W-120	E	1-12	
W-121	Q	1-12	EFA
W-122	E	1-12	
W-123	E	1-12	
W-141	A	2-12	
W-142	A	1-12	
W-143	A	1-12	
W-146	O	3-13	
W-147	O	3-13	
W-148	E	1-12	
W-151	Q	1-12	EFA
W-201	E	1-12	
W-202	O	1-13	
W-203	E	2-12	
W-204	S	1-12	EFA

Table D-1. 2011 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
W-205	A	3-12	
W-206	Q	1-12	
W-207	E	1-12	
W-210	A	3-12	
W-212	O	1-13	
W-213	E	3-12	
W-214	E	1-12	
W-218	A	1-12	
W-219	O	3-13	
W-220	A	2-12	
W-221	A	1-12	EFA
W-222	Q	1-12	
W-223	O	3-13	
W-224	E	2-12	
W-225	E	1-12	
W-226	O	1-13	
W-251	Q	1-12	
W-252	O	1-13	
W-253	O	3-13	
W-255	O	1-13	
W-256	O	2-13	
W-257	S	1-12	
W-258	A	1-12	
W-259	Q	1-12	
W-260	O	4-13	
W-261	O	2-13	
W-263	Q	1-12	
W-264	A	4-12	
W-265	O	3-13	
W-267	O	3-13	
W-268	S	1-12	
W-269	A	1-12	
W-270	O	1-13	
W-271	A	1-12	
W-272	O	1-13	
W-273	E	1-12	
W-274	Q	1-12	
W-275	E	2-12	
W-276	S	1-12	
W-277	A	1-12	
W-290	O	1-13	
W-291	O	1-13	
W-293	O	1-13	
W-294	O	1-13	
W-301	A	3-12	
W-302	O	3-13	

Table D-1. 2011 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
W-303	O	3-13	
W-304	O	3-13	
W-305	S	2-11	
W-306	E	2-12	
W-307	S	1-12	
W-308	O	2-13	
W-310	O	3-13	
W-311	A	1-12	
W-312	O	2-13	
W-313	A	3-12	
W-315	Q	1-12	
W-316	A	1-12	
W-317	A	3-12	
W-319	A	3-12	
W-320	A	4-12	
W-321	E	1-12	
W-322	Q	1-12	
W-323	Q	1-12	
W-324	E	4-12	
W-325	O	4-13	
W-353	A	3-12	
W-354	Q	1-12	
W-355	Q	1-12	
W-356	A	1-12	
W-359	S	2-11	
W-361	A	2-11	
W-362	A	2-13	
W-363	A	1-12	EFA
W-364	A	3-12	
W-365	A	1-12	
W-366	E	1-12	
W-369	A	1-12	
W-370	O	2-13	
W-371	E	1-12	
W-372	O	1-13	
W-373	A	1-12	EFA
W-375	A	1-12	
W-376	O	2-13	
W-377	O	4-13	
W-378	O	4-13	
W-379	A	2-12	
W-380	O	2-13	
W-401	E	4-12	
W-402	O	2-13	
W-403	O	2-13	
W-405	Q	1-12	

Table D-1. 2011 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
W-406	E	1-12	
W-407	Q	1-12	
W-409	A	4-12	
W-410	Q	1-12	
W-411	A	1-12	
W-412	A	3-12	
W-416	O	2-13	
W-417	O	4-13	
W-418	O	4-13	
W-419	A	4-12	
W-420	O	4-13	
W-421	Q	1-12	
W-422	Q	1-12	
W-423	A	1-12	
W-424	A	2-12	
W-446	O	1-13	
W-447	E	4-12	
W-448	O	1-13	
W-449	E	1-12	
W-450	E	4-12	
W-451	O	1-13	
W-452	E	2-12	
W-453	E	4-12	
W-454	O	3-13	
W-455	O	2-13	
W-458	E	2-12	
W-459	O	4-13	
W-462	E	1-12	
W-463	O	1-13	
W-464	A	1-12	
W-481	Q	1-12	
W-482	A	2-12	
W-483	O	4-13	
W-484	O	3-13	
W-485	O	1-13	
W-486	E	2-12	
W-487	A	2-12	
W-501	A	1-12	
W-502	O	2-13	
W-503	E	1-12	
W-504	E	1-12	
W-505	E	3-12	
W-506	O	3-13	
W-507	O	4-13	
W-509	A	1-12	
W-510	O	1-13	

Table D-1. 2011 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
W-511	O	3-13	
W-512	O	1-13	
W-513	O	1-13	
W-514	E	1-12	
W-515	A	4-12	
W-516	O	4-13	
W-517	Q	1-12	
W-519	O	1-13	
W-520	A	1-12	
W-521	O	1-13	
W-551	S	1-12	
W-552	A	1-12	
W-553	O	2-13	
W-554	E	4-12	
W-555	O	4-13	
W-556	A	1-12	EFA
W-557	O	1-13	
W-558	Q	1-12	
W-559	O	1-13	
W-560	O	1-13	
W-561	E	4-12	
W-562	O	1-13	
W-563	E	4-12	
W-564	A	2-12	
W-565	A	4-12	
W-567	O	3-13	
W-568	A	3-12	
W-569	S	1-12	
W-570	O	1-13	
W-571	A	1-12	EFA
W-592	E	1-12	
W-593	O	1-13	
W-594	E	1-12	
W-601	E	1-12	
W-602	E	1-12	
W-603	A	4-12	
W-604	O	1-13	
W-606	O	1-13	
W-607	A	3-12	
W-608	O	1-13	
W-609	O	1-12	
W-611	A	4-12	
W-612	A	3-12	
W-613	O	1-13	
W-615	O	4-13	
W-616	O	2-13	

Table D-1. 2011 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
W-617	O	4-13	
W-618	Q	1-12	
W-619	O	3-13	
W-622	A	3-12	
W-651	Q	1-12	
W-652	O	2-13	
W-654	S	1-12	
W-702	S	2-12	
W-705	E	1-12	
W-706	O	2-13	
W-750	O	1-13	
W-901	O	1-13	
W-902	A	4-12	
W-905	O	4-13	
W-906	Q	1-12	EFA
W-907-1	Q	1-12	
W-908	O	1-13	
W-909	Q	1-12	
W-911	S	1-12	
W-912	A	1-12	
W-913	Q	1-12	
W-1002	O	1-13	
W-1003	O	4-13	
W-1008	O	1-13	
W-1010	E	1-12	
W-1011	E	2-12	
W-1012	A	1-12	EFA
W-1013	E	1-12	
W-1014	Q	1-12	
W-1101	O	1-13	
W-1105	O	3-13	
W-1106	O	3-13	
W-1107	S	2-12	
W-1110	A	1-12	
W-1112	O	2-13	
W-1113	E	3-12	
W-1115	O	1-13	
W-1117	S	1-12	
W-1118	O	1-13	
W-1201	Q	1-12	
W-1202	A	1-12	
W-1203	Q	1-12	
W-1204	A	3-12	
W-1205	O	1-13	
W-1207	O	2-13	
W-1209	E	3-12	

Table D-1. 2011 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
W-1210	A	1-12	
W-1212	A	3-12	
W-1214	S	1-12	
W-1217	A	4-12	
W-1219	E	1-12	
W-1222	S	1-12	
W-1223	Q	1-12	
W-1224	E	1-12	
W-1225	Q	1-12	
W-1226	O	3-13	
W-1227	O	1-13	
W-1250	Q	1-12	
W-1251	Q	1-12	
W-1250	Q	1-12	
W-1251	Q	1-12	
W-1253	Q	1-12	
W-1255	Q	1-12	
W-1303	Q	1-12	EFA
W-1304	Q	1-12	
W-1306	Q	1-12	EFA
W-1308	Q	1-12	EFA
W-1311	S	1-12	
W-1401	A	2-12	
W-1402	S	1-12	
W-1405	Q	1-12	
W-1406	Q	1-12	
W-1407	Q	1-12	
W-1408	Q	1-12	
W-1411	E	1-12	
W-1412	A	2-12	
W-1413	Q	1-12	
W-1414	Q	1-12	
W-1416	O	2-13	
W-1417	S	1-12	
W-1418	Q	1-12	
W-1419	O	3-13	
W-1420	O	4-13	
W-1421	S	1-12	
W-1422	Q	1-12	
W-1424	A	1-12	
W-1425	S	2-12	
W-1426	O	4-13	
W-1427	A	3-12	
W-1428	O	3-13	
W-1501	O	1-13	
W-1502	A	2-12	

Table D-1. 2011 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
W-1505	A	1-12	
W-1506	A	1-12	
W-1507	Q	1-12	
W-1508	A	3-12	
W-1509	O	4-13	
W-1511	Q	1-12	
W-1512	E	3-12	
W-1513	E	1-12	
W-1514	O	1-13	
W-1515	O	1-13	
W-1516	A	3-12	
W-1517	Q	1-12	
W-1519	O	1-13	
W-1553	S	1-12	
W-1606	A	1-12	
W-1607	A	1-12	
W-1613	O	1-13	
W-1614	O	4-13	
W-1701	E	1-12	
W-1703	O	1-13	
W-1704	O	1-13	
W-1705-1	Q	1-12	
W-1705-2	Q	1-12	
W-1705-3	Q	1-12	
W-1802	A	1-12	
W-1803-1[a]	Q	1-12	
W-1803-2[a]	S	1-12	
W-1804-1[a]	Q	1-12	
W-1804-2[a]	Q	1-12	
W-1805	O	4-13	
W-1901-1[a]	O	2-13	
W-1901-2[a]	A	3-12	
W-1905-1[a]	Q	1-12	
W-1905-2[a]	S	2-12	
W-2103	Q	1-12	
W-2113	E	1-12	
W-2202	Q	1-12	
W-2215A	A	1-12	
W-2216B	S	1-12	
W-2304	Q	1-12	
W-2601	Q	1-12	
W-2602	Q	1-12	
W-2603	Q	1-12	
W-2604A	Q	1-12	
W-2604B	Q	1-12	

Table D-1. 2011 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-10)
W-2605A	Q	1-12	
W-2605B	Q	1-12	
W-2606	Q	1-12	
W-2607	Q	1-12	
W-2611	Q	1-12	
W-2612	Q	1-12	
W-2616	Q	1-12	
W-2617	Q	1-12	
W-2618	Q	1-12	
W-2619	Q	1-12	
W-2620A	Q	1-12	
W-2621	Q	1-12	
W-2622	Q	1-12	
W-2623	Q	1-12	
W-2801	Q	1-12	
TW-11	Q	1-12	
TW-11A	E	3-12	
TW-21	E	1-12	
11C1	O	1-13	
14A11	O	4-13	
14A3	O	4-13	
14B1	A	1-12	EFA
14B4	O	4-13	
14C2	O	4-13	
18D1	E	1-12	
GSW-006	E	1-12	
GSW-007	O	1-13	
GSW-008	O	3-13	
GSW-009	Q	1-12	
GSW-011	O	1-13	
GSW-013	O	1-13	
GSW-215	E	1-12	
GSW-216	O	2-13	
GSW-266	O	3-13	
GSW-326	O	3-13	
GSW-367	A	3-12	
GSW-442	A	1-12	
GSW-443	E	1-12	
GSW-444	A	1-12	

Notes and footnotes appear on the following page.

Table D-1. 2011 LLNL Livermore Site VOC ground water sampling schedule.

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 that 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, 2011, 2011a, 2011b, and 2012).

E-1. Lake Haussmann Discharge Monitoring

Releases from Lake Haussmann remained continuous throughout the year, with two exceptions. The top weir gate was closed from June 1 to June 7, 2011 to allow the basin under the dam to dry out to clean the grate. The bottom gate was opened on September 27, 2011 to lower the lake level in preparation for invasive species control. The top and bottom gates were closed from September 30 to October 11, 2011 to support mitigation of invasive species in Arroyo Las Positas and to have the grate removed while the flow was stopped. Release samples collected during the wet season occurred on February 16 and October 11, 2011. Dry season samples were collected on June 7, July 20, August 16, and September 20, 2011.

Samples from Lake Haussmann were within discharge limits for all parameters except pH. Samples collected at CDBX exceeded the pH 8.5 limit in one reported dry season monitoring event, with a value of 9.11. Corresponding samples collected at location WPDC did not exceed the pH discharge limit. 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 evaporation and increased photosynthesis. The process of evaporation transfers pure water into the atmosphere, leaving behind salts that would increase pH. In addition, elevated pH levels are thought to be a by-product of photosynthesis through uptake of dissolved CO_2 from the water column. Several metals were detected above detection limits at both CDBX and WPDC; however, all of the analytical results were below discharge limits. Acute and chronic bioassay tests showed no toxicity.

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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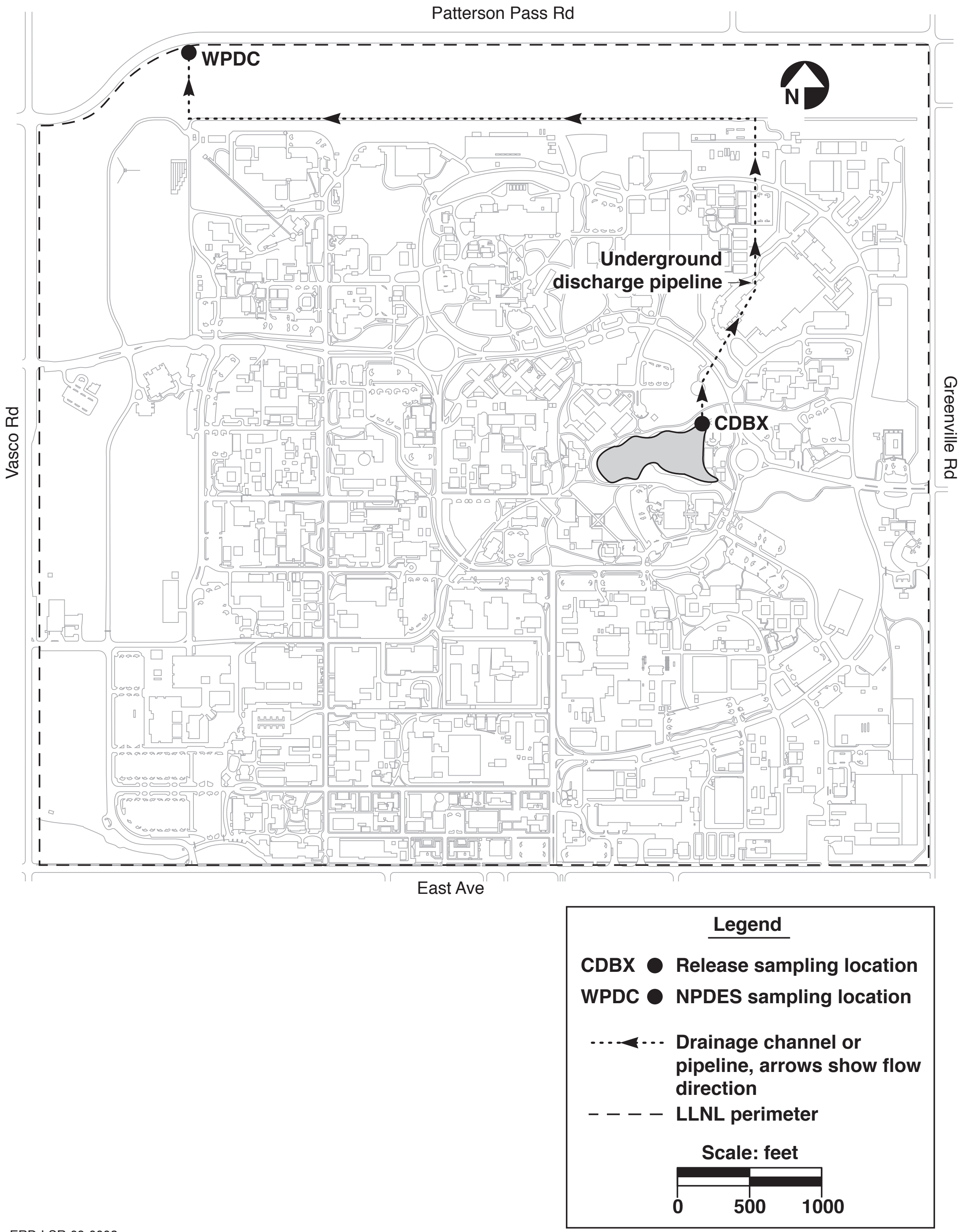

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Figure E-1. Location of Lake Haussmann showing discharge sampling locations.

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