5. Water Monitoring Programs

Michael A. Revelli, Chris G. Campbell, Allen Grayson,
Henry E. Jones, Maureen Ridley, Duane Rueppel

Lawrence Livermore National Laboratory monitors a multifaceted system of waters that includes wastewaters, storm water, and groundwater, as well as rainfall and local surface waters. Water systems at the two LLNL sites (the Livermore site and Site 300) operate differently. For example, the Livermore site is serviced by publicly owned treatment works but Site 300 is not, resulting in different methods of treating and disposing of sanitary wastewater at the two sites. Many drivers determine the appropriate methods and locations of the various water monitoring programs, as described below.

In general, water samples are collected according to written, standardized procedures appropriate for the medium (Woods 2005). Sampling plans are prepared by the LLNL network analysts who are responsible for developing and implementing monitoring programs or networks. Network analysts decide which analytes are sampled (see **Appendix B**) and at what frequency, incorporating any permit-specified analyses. Except for analyses of certain sanitary sewer and retention tank analytes, analyses are usually performed by off-site, California-certified contract analytical laboratories.

5.1 Sanitary Sewer Effluent Monitoring

In 2007, the Livermore site discharged an average of 1.11 million L/d (292,308 gal/d) of wastewater to the City of Livermore sewer system, or 4% of the total flow into the City's system. This volume includes wastewater generated by Sandia/California and a very small quantity from Site 300. In 2007, Sandia/California generated approximately 10% of the total effluent discharged from the Livermore outfall. Wastewater from Sandia/California and Site 300 is discharged to the LLNL collection system and combined with LLNL sewage before it is released at a single point to the municipal collection system.

LLNL's wastewater contains both sanitary sewage and process wastewater and is discharged in accordance with permit requirements and the City of Livermore Municipal Code, as discussed below. Most of the process wastewater generated at the Livermore site is collected in various retention tanks and discharged to LLNL's collection system under prior approval from LLNL's Water Guidance and Monitoring Division (WGMD) Waste Discharge Authorization Requirement (WDAR) approval process.

5.1.1 Livermore Site Sanitary Sewer Monitoring Complex

LLNL's sanitary sewer discharge permit (Permit 1250, 2006/2007 and 2007/2008) requires continuous monitoring of the effluent flow rate and pH. Samplers at the Sewer Monitoring

Station (SMS) collect flow-proportional composite samples and instantaneous grab samples that are analyzed for metals, radioactivity, total toxic organics, and other water-quality parameters.

5.1.1.1 Radiological Monitoring Results

DOE orders and federal regulations establish the standards of operation at LLNL (see **Chapter 2**), including the standards for sanitary sewer discharges. Primarily the standards for radioactive material releases are contained in complementary (rather than overlapping) sections of the DOE Order 5400.5 and 10 CFR Part 20.

For sanitary sewer discharges, DOE Order 5400.5 provides the criteria DOE has established for the application of best available technology to protect public health and minimize degradation of the environment. These criteria (the DCGs) limit the concentration of each radionuclide discharged to publicly owned treatment works. If the measured monthly average concentration of a radioisotope exceeds its concentration limit, LLNL is required to improve discharge control measures until concentrations are again below the DOE limits.

The 10 CFR Part 20 sanitary sewer discharge numerical limits include the following annual discharge limits for radioactivity: tritium, 185 GBq (5 Ci); carbon-14, 37 GBq (1 Ci); and all other radionuclides combined, 37 GBq (1 Ci). The 10 CFR Part 20 limit on total tritium activity dischargeable during a single year (185 GBq [5 Ci]) takes precedence over the DOE Order 5400.5 concentration-based limit for tritium for facilities that generate wastewater in large volumes, such as LLNL. In addition to complying with the 10 CFR Part 20 annual mass-based discharge limit for tritium and the DOE monthly concentration-based discharge limit for tritium, LLNL also complies with the daily effluent concentration-based discharge limit for tritium established by WRD for LLNL. The WRD limit is smaller by a factor of 30 than the DOE monthly limit so the limits are therefore essentially equivalent; however, the WRD limit is more stringent in the sense that it is daily rather than monthly. The radioisotopes with the potential to be found in sanitary sewer effluent at LLNL and their discharge limits are discussed below. All analytical results are provided in **Appendix A**, **Section A.3**.

LLNL determines the total radioactivity contributed by tritium, gross alpha emitters, and gross beta emitters from the measured radioactivity in the monthly effluent samples. As shown in **Table 5-1**, the 2007 combined release of alpha and beta sources was 0.22 GBq (0.006 Ci), which is 0.6% of the corresponding 10 CFR Part 20 limit (37 GBq [1.0 Ci]). The tritium total was 2.83 GBq (0.08 Ci), which is 1.5% of the 10 CFR Part 20 limit (185 GBq [5 Ci]).

Table 5-1. Estimated total radioactivity in LLNL sanitary sewer effluent, 2007.

Radioactivity	Estimate based on effluent activity (GBq)	Limit of sensitivity (GBq)
Tritium	2.83	0.95
Gross alpha	0.01	0.05
Gross beta	0.21	0.11

Discharge limits and a summary of the measurements of tritium in the sanitary sewer effluent from LLNL and WRD are reported in LLNL monthly reports. The maximum daily concentration for tritium of 0.58 Bq/mL (16 pCi/mL) was far below the permit discharge limit of 12 Bq/mL (333 pCi/mL).

Measured concentrations of cesium-137 and plutonium-239 in the sanitary sewer effluent from LLNL, WRD, and in WRD sludge are reported in the LLNL March 2008 Report (Revelli 2008a). Cesium and plutonium results are from monthly composite samples of LLNL and WRD effluent and from quarterly composites of WRD sludge. For 2007, the annual total discharges of cesium-137 and plutonium-239 were far below the DOE DCGs. Plutonium discharged in LLNL effluent is ultimately concentrated in WRD sludge. The highest plutonium concentration observed in 2007 sludge is 0.19 mBq/g (0.005 pCi/g), which is many times lower than the U.S. EPA preliminary remediation goal for residential soil (93 mBq/dry g [2.5 pCi/dry g]) and is 0.05% of the remediation goal for industrial or commercial soil (370 mBq/dry g [10 pCi/dry g]).

The historical levels for plutonium-239 observed since 1997 averaged approximately 1 µBq/mL (3×10^{-5} pCi/mL). The historical levels are generally 0.0003% of the DOE DCG for plutonium-239. The highest plutonium and cesium concentrations are well below DOE DCGs.

LLNL also compares annual discharges with historical values to evaluate the effectiveness of ongoing discharge control programs. **Table 5-2** summarizes the radioactivity in sanitary sewer effluent over the past 10 years. During 2007, a total of 2.83 GBq (0.08 Ci) of tritium was discharged to the sanitary sewer, an amount that is well within environmental protection standards and is comparable to the amounts discharged during the past 20 years.

Table 5-2. Historical radioactive liquid effluent releases from the Livermore site, 1997–2007.[(a)]

Year	Tritium (GBq)	Plutonium-239 (GBq)
1997	9.1	2.1×10^{-4}
1998	10	0.77×10^{-4}
1999	7.1	0.68×10^{-4}
2000	5.0	0.96×10^{-4}
2001	4.9	1.1×10^{-4}
2002	0.74	0.42×1^{-4}
2003	1.11	0.51×10^{-4}
2004	1.34	1.16×10^{-5}
2005	3.12	9.64×10^{-6}
2006	19.9	7.56×10^{-6}
2007	2.83	6.24×10^{-6}

(a) Starting in 2002, following DOE guidance, actual analytical values instead of LOS values were used to calculate total.

5.1.1.2 Nonradiological Monitoring Results

LLNL monitors sanitary sewer effluent for chemical and physical parameters at different frequencies depending on the intended use of the result. For example, LLNL's wastewater discharge permit requires LLNL to collect monthly grab samples and 24-hour composites, weekly composites, and daily composites. Once a month, a 24-hour, flow-proportional composite is collected and analyzed; this is referred to as the monthly 24-hour composite in the discussion below. The weekly composite refers to the flow-proportional samples collected over a 7-day period continuously throughout the year. The daily composite refers to the flow-proportional sample collected over a 24-hour period, also collected continuously throughout the year. LLNL's wastewater discharge permit specifies that the effluent pollutant limit (EPL) is equal to the maximum pollutant concentration allowed per 24-hour composite sample. Only when a weekly composite sample concentration is at or above 50% of its EPL are the daily samples that were collected during the corresponding period analyzed to determine whether any of the concentrations are above the EPL.

A summary of the analytical results from the permit-specified monthly and weekly composite sampling programs is presented in **Table 5-3**. The permit also requires that grab samples of effluent be collected on a monthly and semiannual basis, and analyzed for total toxic organic compounds (TTO) and cyanide, respectively. (Complete results from LLNL's 2007 sanitary sewer effluent monitoring program are provided in **Appendix A**, **Section A.3**.)

During 2007, concentrations of the regulated metals show generally good agreement between the monthly composite samples and the corresponding weekly composite samples, and these results closely resemble the 2006 results. In **Table 5-3**, the 2007 maximum concentration for each metal is shown and compared with the EPL. These maximum values did not exceed 10% of their respective EPLs for eight of the nine regulated metals. Only arsenic, with maximum values of 14% and 17% of its EPL (monthly and weekly composite concentrations, respectively), was reported to have a maximum concentration above 10% of its EPL; comparable to 2006 results. All of the monthly 24-hour composite and weekly composite samples were in compliance with LLNL's wastewater discharge permit limits.

Figure 5-1 presents historical trends for the monthly 24-hour composite sample results from 2000 through 2007 for eight of the nine regulated metals; cadmium is not presented because this metal was not detected above the practical quantitation limit (PQL) in any of the 2000 through 2007 monthly sampling events. (Typical PQLs for the regulated metals in LLNL sanitary effluent are shown in **Table 5-3**.) The 2007 results routinely show concentrations of arsenic, copper, lead, and zinc at levels above their respective PQLs; nickel was detected in 5 of 12 samples, while silver, chromium, and mercury showed only one detection above their respective PQLs. These observations are generally consistent with the 2000 through 2004 data; however, with the exception of arsenic, the concentrations of those metals detected in 2005 through 2007 have shown an overall downward trend. The range of monthly 24-hour composite concentrations reported for arsenic in 2007, although never exceeding 14% of its EPL, has not shown a similar downward trend.

Table 5-3. Summary of analytical results for permit-specified composite sampling of the LLNL sanitary sewer effluent, 2007.

Sample	Parameter	Detection frequency[a]	PQL[b]	EPL[c]	Minimum	Maximum	Median	Maximum % of EPL
Monthly 24-hour Composite	**Oxygen demand (mg/L)**							
	Biochemical oxygen demand	12 of 12	2	None Specified	69	170	96.5	N/A
	Solids (mg/L)							
	Total dissolved solids	12 of 12	1	None Specified	160	770	240	N/A
	Total suspended solids	12 of 12	1	None Specified	44	110	63	N/A
	Total metals (mg/L)							
	Silver	1 of 12	0.010	0.20	<0.01	0.017	<0.01	8.5
	Arsenic	9 of 12	0.0020	0.06	<0.002	0.0083	0.0063	14
	Cadmium	0 of 12	0.0050	0.14	<0.005	<0.005	<0.005	<3.6
	Chromium	1 of 12	0.010	0.62	<0.01	0.015	<0.01	2.4
	Copper	12 of 12	0.010	1.0	0.038	0.10	0.053	10
	Mercury	1 of 12	0.00020	0.01	<0.0002	0.00029	<0.0002	2.9
	Nickel	5 of 12	0.0050	0.61	<0.005	0.0080	<0.005	1.3
	Lead	10 of 12	0.0020	0.20	<0.002	0.0067	0.0028	3.4
	Zinc	12 of 12	0.050	3.00	0.078	0.17	0.12	5.7
Weekly Composite	**Total metals (mg/L)**							
	Silver	1 of 52	0.010	0.20	<0.01	0.011	<0.01	5.5
	Arsenic	41 of 52	0.0020	0.06	<0.002	0.01	0.0031	17
	Cadmium	0 of 52	0.0050	0.14	<0.005	<0.005	<0.005	<3.6
	Chromium	0 of 52	0.010	0.62	<0.01	<0.01	<0.01	<1.6
	Copper	52 of 52	0.010	1.0	0.019	0.079	0.035	7.9
	Mercury	1 of 52	0.00020	0.01	<0.0002	0.00024	<0.0002	2.4
	Nickel	2 of 52	0.0050	0.61	<0.005	0.0056	<0.005	0.92
	Lead	17 of 52	0.0020	0.20	<0.002	0.015	<0.002	7.5
	Zinc	47 of 52	0.050	3.00	<0.05	0.16	0.065	5.3

(a) The number of times an analyte was positively identified, followed by the number of samples that were analyzed (generally 12, one sample for each month of the year; or 52, one sample for each week of the year).

(b) PQL = Practical quantitation limit (these limits are typical values for sanitary sewer effluent samples).

(c) EPL = Effluent pollutant limit (LLNL Wastewater Discharge Permit 1250, 2006/2007 and 2007/2008).

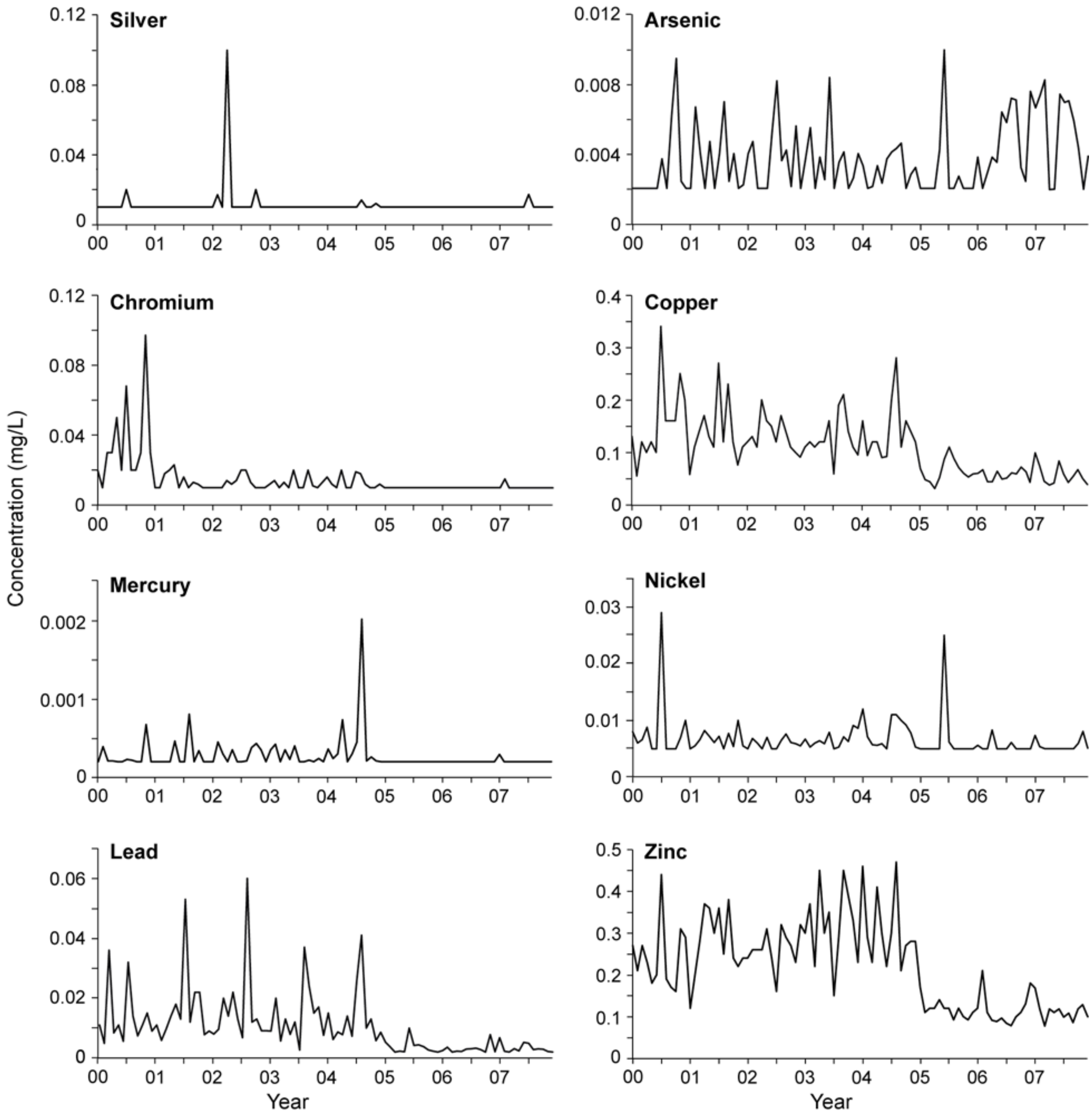

Figure 5-1. Monthly 24-hour composite sample concentrations for eight of the nine regulated metals in LLNL sanitary sewer effluent showing historical trends.

As previously noted, grab samples of LLNL's sanitary sewer effluent are collected monthly for TTO analysis (permit limit = 1.0 mg/L) and semiannually for cyanide analysis (permit limit = 0.04 mg/L). In 2007, LLNL did not exceed either of these discharge limits. Results from the monthly TTO analyses for 2007 show that no priority pollutants, listed by the EPA as toxic organics, were identified in LLNL effluent above the 10 µg/L permit-specified reporting limit. As shown in **Appendix A**, **<u>Section A.3</u>**, three non-regulated organic compounds (acetone, acetonitrile, and ethanol) were identified in monthly grab samples at concentrations above the

10 µg/L permit-specified reporting limit. Cyanide was below the analytical detection limit (0.02 mg/L) in both the April and November samples.

5.1.2 Categorical Processes

The EPA has established pretreatment standards for categories of industrial processes that EPA has determined are major contributors to point-source water pollution. These federal standards include prescribed sampling, self-monitoring, reporting, and numerical limits for the discharge of category-specific pollutants. At LLNL, the categorical pretreatment standards are incorporated into the wastewater discharge permit (Permit 1250, 2006/2007 and 2007/2008), which is administered by the WRD.

The processes at LLNL that are defined as categorical change as programmatic requirements dictate. During 2007, the WRD identified 14 wastewater-generating processes at LLNL that are defined under either 40 CFR Part 469 or 40 CFR Part 433.

Only processes that discharge to the sanitary sewer require semiannual sampling, inspection, and reporting. Two of the 14 processes discharge wastewater to the sanitary sewer: semiconductor processes located in the Building 153 microfabrication facility, and the abrasive jet machining located in Building 321C. In 2007, LLNL analyzed compliance samples for all regulated parameters from both processes and demonstrated compliance with all federal categorical discharge limits. As a further environmental safeguard, LLNL sampled the wastewater in each tank prior to each discharge to the sanitary sewer. These monitoring data were reported to the WRD in July 2007 and January 2008 semiannual wastewater reports (Grayson et al. 2007, 2008).

The remaining 12 processes, which do not discharge wastewater to the sanitary sewer, are regulated under 40 CFR Part 433. Wastewater from these processes is either recycled or contained for eventual removal and appropriate disposal by RHWM. Because the processes do not discharge directly or indirectly to the sanitary sewer, they are not subject to the monitoring and reporting requirements contained in the applicable standard. (See Grayson et al. 2007, 2008).

As required in LLNL’s wastewater discharge permit, LLNL demonstrated compliance with permit requirements by semiannual sampling and reporting in 2007. In addition, WRD source control staff performed their required annual inspection and sampling of the two discharging categorical processes in October 2007. The compliance samples were analyzed for all regulated parameters, and the results demonstrated compliance with all federal and local pretreatment limits.

5.1.3 Discharges of Treated Groundwater

LLNL’s groundwater discharge permit (1510G, 2006–2008) allows treated groundwater from the Livermore site GWP to be discharged in the City of Livermore sanitary sewer system (see **Chapter 8** for more information on the GWP). During 2007, a total of 69.4 million L (18.3 million gal) of treated groundwater were discharged to the sanitary sewer. This entire volume was associated with GWP treatment operations at well W-404. LLNL did not discharge groundwater from any other location to the sanitary sewer during 2007. All discharges were in compliance with self-monitoring permit provisions and discharge limits of the permit. Complete monitoring data are presented in Revelli (2008a).

5.1.4 Environmental Impact of Sanitary Sewer Effluent

During 2007, no discharges exceeded any discharge limits for either radioactive or nonradioactive materials to the sanitary sewer. The data are comparable to the lowest historical LLNL values. All the values reported for radiological releases are a fraction of their corresponding limits. For nonradiological releases, LLNL achieved excellent compliance with all the provisions of its wastewater discharge permit.

The data demonstrate that LLNL continues to have excellent control of both radiological and nonradiological discharges to the sanitary sewer. Monitoring results for 2007 reflect an effective year for LLNL's award winning wastewater discharge control program[(1)] and indicate no adverse impact to the WRD or the environment from LLNL sanitary sewer discharges.

5.2 Site 300 Sewage Ponds

Wastewater samples collected from the influent to the sewage evaporation pond, within the sewage evaporation pond, and flow to the sewage percolation pond were obtained in accordance with the written, standardized procedures summarized in Woods (2005).

5.2.1 Sewage Evaporation and Percolation Ponds

Sewage (nonhazardous wastewater) generated at buildings in the General Services Area at Site 300 is disposed of through a lined evaporation pond. However, during winter rains, treated wastewater may discharge into an unlined percolation pond where it enters the ground and the shallow groundwater.

The environmental monitoring requirements for the sewage evaporation and percolation ponds (hereafter collectively referred to as sewage ponds) are specified in the Monitoring and Reporting Program (MRP) for WDR 96-248. The monitoring requirements include both wastewater monitoring and groundwater monitoring to detect potential impacts of the sewage on groundwater quality.

All wastewater parameters for the sewage evaporation and percolation ponds complied with permit provisions and specifications throughout 2007. All of the monitoring results are reported in the required quarterly monitoring reports (Brown 2007b; Ridley 2007a, 2007b, 2008).

5.2.2 Environmental Impact of Sewage Ponds

All discharges from the Site 300 sewage evaporation pond to the percolation pond were in compliance with discharge limits. Groundwater monitoring related to this area indicated there were no measurable impacts to the groundwater from the sewage pond operations (Ridley 2008).

(1) The wastewater discharge control program received the California Water Environment Association (CWEA) Facility of the Year award in 2007.

5.3 Storm Water Compliance and Surveillance Monitoring

LLNL monitors storm water at the Livermore site in accordance with Permit WDR 95-174 (SFBRWQCB 1995) and at Site 300 in accordance with the California NPDES General Permit for Storm Water Discharges Associated with Industrial Activities (WDR 97-03-DWQ) (SWRCB 1997). Site 300 storm water monitoring also meets the requirements of the *Post-Closure Plan for the Pit 6 Landfill Operable Unit* (Ferry et al. 1998). For construction projects that disturb 1 acre of land or more, LLNL also meets storm water compliance monitoring requirements of the California NPDES General Permit for Storm Water Discharges Associated with Construction Activity (WDR 99-08-DWQ) (SWRCB 1999). Storm water monitoring at both sites also follows the requirements in the *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (U.S. DOE 1991) and meets the applicable requirements of DOE Order 5400.5. **Appendix B** includes the current list of analyses conducted on storm water, including analytical methods and typical reporting limits.

At all monitoring locations grab samples are collected by submerging sample bottles directly into the storm water discharge. If a sample location is not directly accessible, an automatic water sampler is used to pump water into the appropriate containers. LLNL permits require sample collection and analysis at the sample locations specified in the permit two times per rainy season. Influent (upstream) sampling is also required at the Livermore site. In addition, LLNL is required to visually inspect the storm drainage system during one storm event per month in the wet season (defined as October through April for the Livermore site and October through May for Site 300) to observe runoff quality and twice during the dry season to identify any dry weather flows. Annual facility inspections are also required to ensure that the best management practices for controlling storm water pollution are implemented and adequate.

5.3.1 LLNL Site-Specific Storm Water

Various chemical analyses are performed on the storm water samples collected. There are no numeric concentration limits for storm water effluent; moreover, the EPA's benchmark concentration values for storm water are not intended to be interpreted as limits (U.S. EPA 2000). To evaluate the program, LLNL has established site-specific thresholds for selected parameters (Campbell and Mathews 2006). A value exceeds a parameter's threshold when it is greater than the 95% confidence limit for the historical mean value for that parameter (see **Table 5-4**). The thresholds are used to identify out-of-the-ordinary data that merit further investigation to determine whether concentrations of that parameter are increasing in the storm water runoff.

Table 5-4. Site-specific thresholds for selected water quality parameters for storm water runoff.[a]

Parameter	Livermore site	Site 300
Total suspended solids (TSS)	750 mg/L[b]	1,700 mg/L[b]
Chemical oxygen demand (COD)	200 mg/L[b]	200 mg/L[b]
pH	<6.0, >8.5[b]	<6.0, >9.0[c]
Nitrate (as NO_3)	10 mg/L[b]	Not monitored
Orthophosphate	2.5 mg/L[b]	Not monitored
Beryllium	1.6 µg/L[b]	1.6 µg/L[b]
Chromium(VI)	15 µg/L[b]	Not monitored
Copper	36 µg/L[b]	Not monitored
Lead	15 µg/L[d]	30 µg/L[b]
Zinc	350 µg/L[b]	Not monitored
Mercury	above RL[e]	1 µg/L[b]
Diuron	14 µg/L[b]	Not monitored
Oil and grease	9 mg/L[b]	9 mg/L[b]
Tritium	36 Bq/L[b]	3.17 Bq/L[b]
Gross alpha radioactivity	0.34 Bq/L[b]	0.90 Bq/L[b]
Gross beta radioactivity	0.48 Bq/L[b]	1.73 Bq/L[b]

(a) If data exceed the threshold comparison criteria, an investigation is initiated to assess if those data are indicative of a water quality problem.

(b) Site-specific value calculated from historical data and studies. These values are lower than the MCLs and EPA benchmarks except for copper, COD, TSS, and zinc

(c) EPA benchmark

(d) California and EPA drinking water action level

(e) RL (reporting limit) = 0.0002 mg/L for mercury

5.3.2 Storm Water Inspections

Each directorate at LLNL conducts an annual inspection of its facilities to verify implementation of the Storm Water Pollution Prevention Plans (SWPPPs) and to ensure that measures to reduce pollutant discharges to storm water runoff are adequate. LLNL's associate directors certified in 2007 that their facilities complied with the provisions of LLNL's SWPPPs. LLNL submits annual storm water monitoring reports to the SFBRWQCB (Campbell and Brunckhorst 2007) and to the CVRWQCB (Brown 2007a) with the results of sampling, observations, and inspections.

For each construction project permitted by WDR 99-08-DWQ, LLNL conducts visual monitoring of construction sites before, during, and after storms to assess the effectiveness of the best management practices. Annual compliance certifications summarize the inspections.

5.3.3 Livermore Site

The Livermore site storm water runoff monitoring network consists of nine sampling locations (see **Figure 5-2**). LLNL collected samples at all nine locations on February 22 and December 18, 2007. Fish toxicity tests were performed on December 18, 2007, and no toxicity issues were identified.

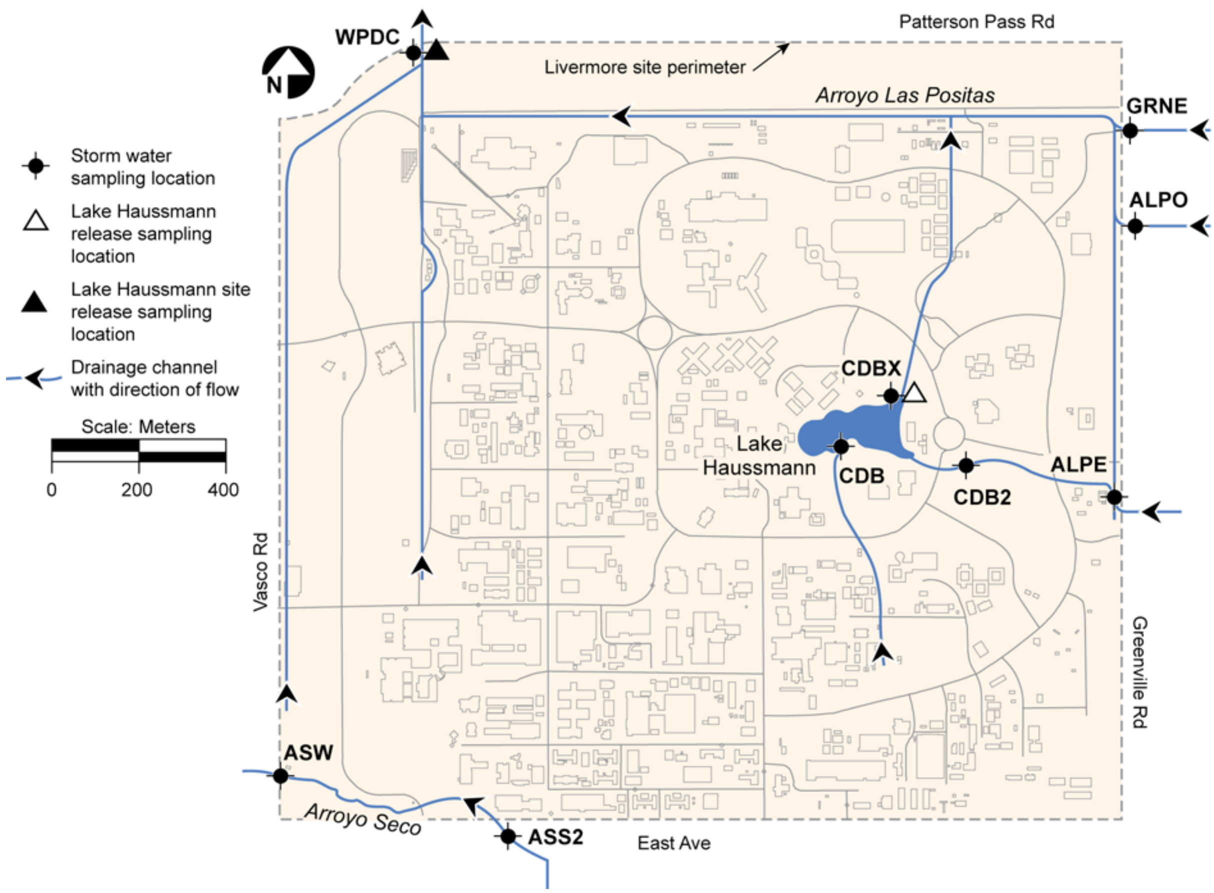

Figure 5-2. Storm water runoff and Lake Haussmann sampling locations, Livermore site, 2007.

5.3.3.1 Radiological Monitoring Results

Storm water gross alpha, gross beta, and tritium results are summarized in **Table 5-5**. (Complete analytical results are provided in **Appendix A**, **Section A.4**.) Tritium activities at the site effluent sampling locations were less than 1% of the maximum contaminant level (MCL). Gross alpha and gross beta radioactivity in the storm water samples collected during 2007 were also generally low, less than 72% and 49% of their MCLs, respectively.

Gross alpha and beta activities exceeded LLNL-specific thresholds on February 22, 2007, in water samples collected at influent location ALPO (see **Table 5-6**). However, gross alpha and beta activities in samples collected from the effluent location WPDC on the same date were well below the thresholds. Therefore, this result was unlikely to be related to LLNL activities. LLNL began analyzing for plutonium in storm water in 1998. Current storm water sampling locations for plutonium are the Arroyo Seco and the Arroyo Las Positas effluent locations (ASW and WPDC). In 2007, there were no plutonium results above the detection limit of 0.0037 Bq/L (0.10 pCi/L).

Table 5-5. Radioactivity in storm water from the Livermore site, 2007.[a]

Parameter	Tritium (Bq/L)	Gross Alpha (Bq/L)	Gross Beta (Bq/L)
MCL	740	0.555	1.85
Influent			
Minimum	–0.80	–0.009	0.083
Maximum	7.00	0.400	0.900
Median	0.40	0.037	0.120
Effluent			
Minimum	–0.80	0.004	0.078
Maximum	4.30	0.029	0.130
Median	2.50	0.012	0.089

(a) See **Chapter 9** for an explanation of calculating summary statistics.

5.3.3.2 Nonradiological Monitoring Results

Nonradiological results were compared to the site-specific thresholds listed in **Table 5-4**. Of interest were the constituents that exceeded the thresholds at effluent points and whose concentrations were lower in influent than in effluent water samples. If influent concentrations are higher than effluent concentrations, the source is generally assumed to be unrelated to LLNL operations and LLNL conducts no further investigation. (Complete analytical results are provided in **Appendix A**, **Section A.4**.)

Constituents that exceeded site-specific thresholds for effluent and/or influent locations are listed in **Table 5-6**. All of the values above the site-specific thresholds for the Livermore site during 2007 were found at influent tributaries at similar or higher concentrations than at effluent locations. A majority of the data in **Table 5-6** appear to be sediment associated contaminants flowing on-site at location ALPO on February 22. The presence of diuron (an herbicide used for roadside vegetation management) in runoff flowing onto the LLNL site has been documented by Campbell et al. (2004). These results suggest that current operations at the Livermore site during 2007 did not impact the quality of storm water runoff.

Table 5-6. Water quality parameters in storm water runoff above LLNL site-specific thresholds, Livermore site in 2007.

Nonradioactive/ Radioactive	Parameter	Date	Location	Influent / Effluent	Result	LLNL threshold
Nonradioactive	Lead (µg/L)	2/22	ALPO	Influent	32	15
	Diuron (µg/L)	2/22	ALPE	Influent	400	14
		2/22	ALPO	Influent	70	14
		2/22	CDB2	On-site	25	14
		2/22	GRNE	Influent	97	14
		12/18	ALPE	Influent	51	14
		12/18	ALPO	Influent	130	14
		12/18	GRNE	Influent	19	14
		12/18	WPDC	Effluent	23	14
	Nitrate (NO_3) (mg/L)	2/22	GRNE	Influent	22.0	10.0
		12/18	GRNE	Influent	35.0	10.0
		12/18	ALPO	Influent	14.0	10.0
	Total suspended solids (mg/L)	2/22	ALPO	Influent	1300	750
Radioactive	Gross alpha (Bq/L)	2/22	ALPO	Influent	0.4	0.34
	Gross beta (Bq/L)	2/22	ALPO	Influent	0.9	0.48

5.3.4 Site 300

On February 22, 2007, storm water samples were collected and analyzed from all locations that normally have storm water flow. These were three sampling locations (NLIN2, NPT7, and N883) that characterize runoff from on-site industrial activities, an upstream off-site location (CARW2) and a downstream off-site location (GEOCRK) on the Corral Hollow Creek (**Figure 5-3**). No significant runoff was detected at two similar sampling locations (NPT6 and N829).

5.3.4.1 Radiological Monitoring Results

During 2007, none of the radiological analytical results from the storm water samples exceeded the site-specific thresholds listed in **Table 5-4**. (Complete analytical results are provided in **Appendix A**, **Section A.4**.)

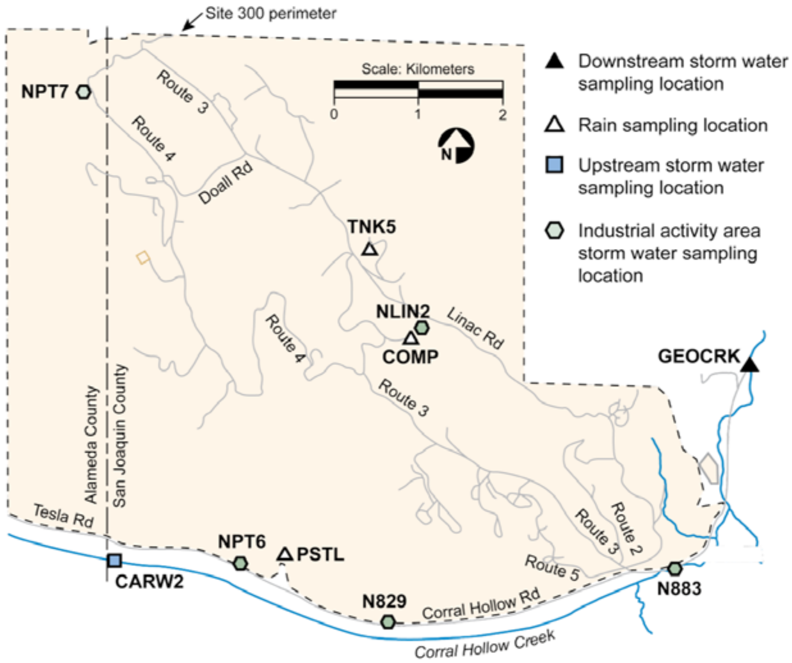

Figure 5-3. Storm water and rainwater sampling locations at Site 300, 2007.

5.3.4.2 Nonradiological Monitoring Results

No nonradiological constituents exceeded the site-specific thresholds listed in **Table 5-4** during 2007. As in the past, low concentrations of dioxins were detected in water samples from storm runoff at Site 300. The federal MCL for dioxin and furans (dioxin-like compounds) is for the most toxic congener 2,3,7,8-tetrachloro-dibenzo-*p*-dioxin (2,3,7,8-tetraCDD). The other dioxin and furan congeners have varying degrees of toxicity. EPA has assigned toxicity equivalency factors (TEFs) to specific dioxin and furan congeners. The congeners 2,3,7,8-tetraCDD and 1,2,3,7,8-pentaCDD have an assigned TEF of 1; the other dioxin and furan congeners have TEFs of <1. The toxicity equivalency (TEQ) is determined by multiplying the concentration of a dioxin and furan congener by its TEF. See **Appendix A**, **Section A.4**, for the concentrations of dioxin and furan compounds that have non-zero TEFs along with their calculated TEQs. Using the approach of multiplying the dioxin and furan congeners by the TEF and adding them together and conservatively including those reported at the detection limits as half the reported detection limit, the TEQ for effluent location NLIN2 was less than 6.5 pg/L on February 22, 2007. On that same date the TEQs were slightly higher at the upstream location CARW2 (>10.0 pg/L) and lower at GEOCRK (5.0 pg/L). All dioxins detected were below the equivalent federal MCL of 30 pg/L. LLNL will continue to monitor storm water concentrations to determine whether trends are emerging.

5.3.5 Environmental Impact of Storm Water

Storm water runoff from the Livermore site did not have any apparent environmental impact in 2007. Tritium activities in storm water runoff effluent were <1% of the drinking water MCL.

Gross alpha and gross beta activities in effluent samples at the Livermore site were both less than their respective MCLs. Site 300 storm water monitoring continues to show low concentrations of dioxins.

5.4 Groundwater

LLNL conducts surveillance monitoring of groundwater in the Livermore Valley and at Site 300 through networks of wells and springs that include off-site private wells and on-site DOE CERCLA wells. To maintain a comprehensive, cost-effective monitoring program, LLNL determines the number and locations of surveillance wells, the analytes to be monitored, the frequency of sampling, and the analytical methods to be used. A wide range of analytes is monitored to assess the impact, if any, of current LLNL operations on local groundwater resources. Because surveillance monitoring is geared to detecting substances at very low concentrations in groundwater, contamination can be detected before it significantly impacts groundwater resources. Groundwater monitoring wells at the Livermore site, in the Livermore Valley, and at Site 300 are included in LLNL's *Environmental Monitoring Plan* (Woods 2005)**.**

Beginning in January 2003, LLNL implemented a new CERCLA comprehensive compliance monitoring plan at Site 300 (Ferry et al. 2002) that adequately covers the DOE requirements for on-site groundwater surveillance. In addition, LLNL continues two additional surveillance networks to supplement the CERCLA compliance monitoring plan and provide additional data to characterize potential impacts of LLNL operations. LLNL monitoring related to CERCLA activities is described in **Chapter 8**. Additional monitoring programs at Site 300 comply with numerous federal and state controls such as state-issued permits associated with closed landfills containing solid wastes and with continuing discharges of liquid waste to sewage ponds and percolation pits; the latter are discussed in **Section 5.2.1**. Compliance monitoring is specified in WDRs issued by the CVRWQCB and in landfill closure and post-closure monitoring plans. (See **Chapter 2**, **Table 2-2** for a summary of LLNL permits.)

The WDRs and post-closure plans specify wells and effluents to be monitored, constituents of concern (COCs) and parameters, frequency of measurement, inspections, and the frequency and form of required reports. These monitoring programs include quarterly and semiannual monitoring of groundwater, monitoring of various influent waste streams, and visual inspections. LLNL performs the maintenance necessary to ensure the physical integrity of closed facilities, such as those that have undergone CERCLA or RCRA closure, and their monitoring networks.

During 2007, representative samples of groundwater were obtained from monitoring wells in accordance with the *LLNL Livermore Site and Site 300 Environmental Restoration Project Standard Operating Procedures* (Goodrich and Wimborough 2006). The procedures cover sampling techniques and information concerning the chemicals that are routinely analyzed for in groundwater. Different sampling techniques were applied to different wells depending on whether they were fitted with submersible pumps or had to be bailed. All of the chemical and radioactivity analyses of groundwater samples were performed by California-certified analytical laboratories.

For comparison purposes only, some of the results were compared with drinking water limits (MCLs). This MCL comparison is used as one way to evaluate groundwater quality, not as a way to determine compliance with Safe Drinking Water Act requirements.

5.4.1 Livermore Site and Environs

5.4.1.1 Livermore Valley

LLNL has monitored tritium in water hydrologically downgradient of the Livermore site since 1988. HTO is potentially the most mobile groundwater contaminant from LLNL operations. Groundwater samples were obtained during 2007 from 24 of 25 water wells in the Livermore Valley (see **Figure 5-4**) and measured for tritium activity. One well could not be sampled during 2007.

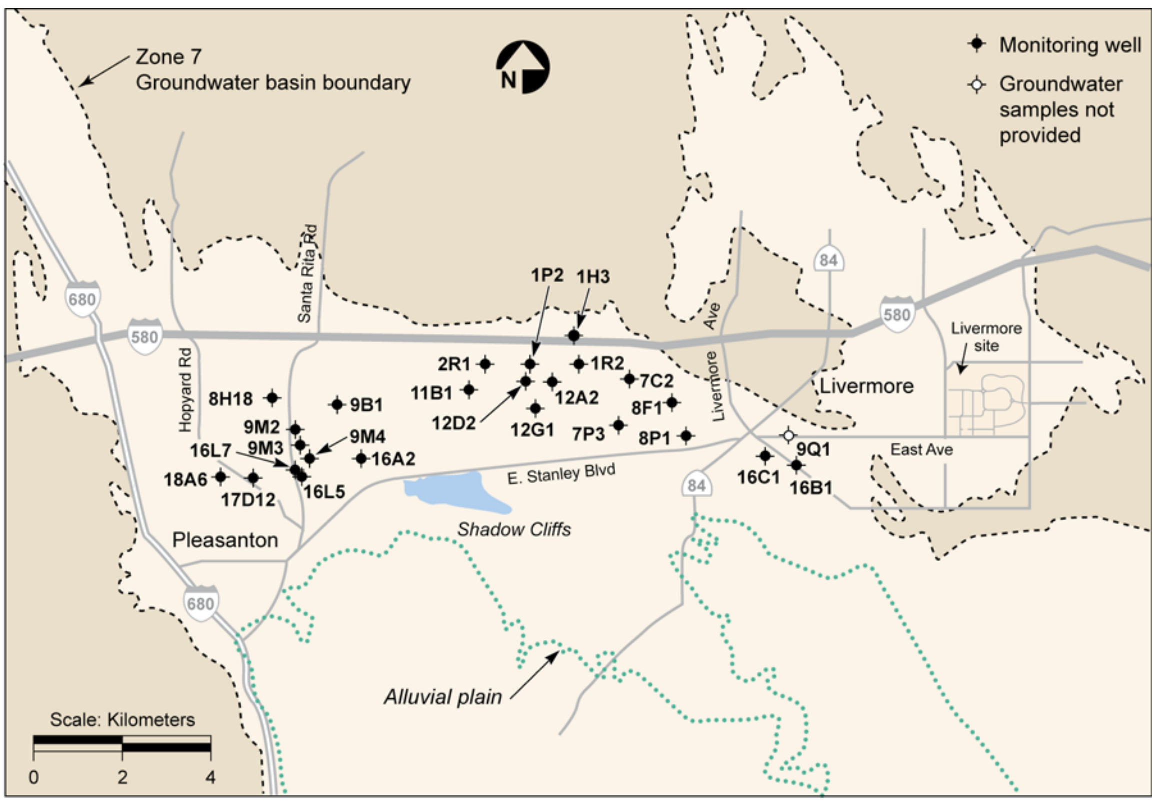

Figure 5-4. Off-site tritium monitoring wells in the Livermore Valley, 2007.

Tritium measurements of Livermore Valley groundwaters are provided in **Appendix A**, **Section A.5**. The measurements continue to show very low and decreasing activities compared with the 740 Bq/L (20,000 pCi/L) MCL established for drinking water in California. The maximum tritium activity measured off site was in the groundwater at well 12D2, located about 6.2 mi west of LLNL (see **Figure 5-4**). The measured activity there was 3.0 Bq/L (81.1 pCi/L) in 2007, less than 0.5% of the MCL.

5.4.1.2 Livermore Site Perimeter

LLNL's groundwater surveillance monitoring program was designed to complement the Livermore Site GWP (see **Chapter 8**). The intent of the program is to monitor for potential groundwater contamination from LLNL operations. The perimeter portion of the surveillance groundwater monitoring network uses three upgradient (background) monitoring wells (wells W-008, W-221, and W-017) near the eastern boundary of the site and seven downgradient monitoring wells located near the western boundary (wells 14B1, W-121, W-151, W-1012, W-571, W-556, and W-373) (see **Figure 5-5**). As discussed in **Chapter 8**, the alluvial sediments have been divided into nine hydrostratigraphic units (HSUs) dipping gently westward. Screened intervals (depth range from which groundwater is drawn) for these monitoring wells range from the shallow HSU-1B to the deeper HSU-5. Two of the background wells, W-008 and W-221, are screened partially in HSU-3A; well W-017 is considered a background well for the deeper HSU-5. To detect contaminants as quickly as possible, the seven western downgradient wells (except well 14B1, screened over a depth range that includes HSU-2, HSU-3A, and HSU-3B) were screened in shallower HSU-1B and HSU-2, the uppermost water-bearing HSUs at the western perimeter. These perimeter wells were sampled and analyzed at least once during 2007 for pesticide and herbicide compounds that are used on- and off-site, for nitrate, for chromium(VI), and for certain radioactive constituents. Analytical results for the Livermore site perimeter wells are provided in **Appendix A**, **Section A.5**.

No pesticide or herbicide organic compounds were detected above analytical reporting limits in groundwater samples from any of the perimeter (upgradient or downgradient) wells during 2007. The inorganic compounds detected include dissolved trace metals and minerals, which occur naturally in the groundwater. Although there have been variations in these concentrations since regular surveillance monitoring began in 1996, the concentrations detected in the 2007 groundwater samples from the upgradient wells represent current background values.

Historically, chromium(VI) has been detected above the MCL (50 µg/L) in groundwater samples from western perimeter well W-373. However, the 2007 sample from this location showed a chromium(VI) concentration of 37 µg/L, continuing the overall downward trend that first dropped below the MCL in 2002.

From 1996 through 2004, concentrations of nitrate detected in groundwater samples from downgradient well W-1012 were greater than the MCL of 45 mg/L. The nitrate concentrations detected in samples from this well during 2007 (33 and 27 mg/L) were again, as in 2006 and 2005, below the MCL. During 2007, concentrations of nitrate in on-site shallow background wells W-008 and W-221 ranged from 26 mg/L to 33 mg/L. Detected concentrations of nitrate in western perimeter wells ranged from 11 mg/L (in well W-373) to 40 mg/L (in well W-151).

No concentrations of plutonium radioisotopes were detected above the radiological laboratory's minimum detectable activities in any of the samples from LLNL's site perimeter wells in 2007. Gross alpha, gross beta, radium-226, and tritium were detected occasionally and at levels consistent with the results from recent years; however, the concentrations again remain well below drinking water MCLs.

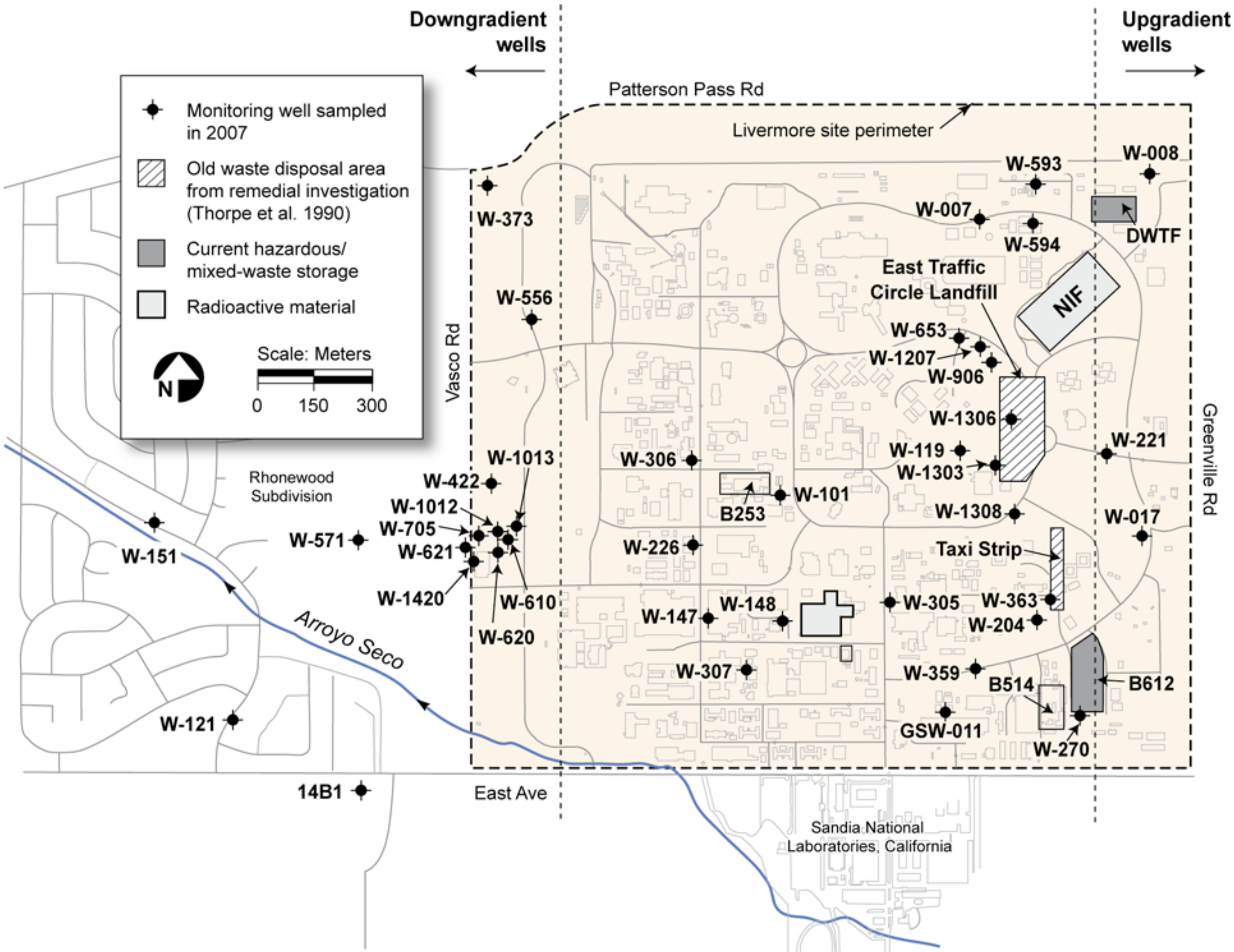

Figure 5-5. Routine surveillance groundwater monitoring wells at the Livermore site, 2007.

5.4.1.3 Livermore Site

Groundwater sampling locations within the Livermore site include areas where releases to the ground may have occurred in the recent past, where previously detected COCs have low concentrations that do not require CERCLA remedial action, and where baseline information needs to be gathered for the area near a new facility or operation. Wells selected for monitoring are screened in the uppermost aquifers and are downgradient from and as near as possible to the potential release locations. Well locations are shown in **Figure 5-5**. All analytical results are provided in **Appendix A**, **Section A.5**.

The Taxi Strip and East Traffic Circle Landfill areas (see **Figure 5-5**) are two potential sources of historical groundwater contamination. Samples from monitoring wells screened in HSU-2 (W-204) and HSU-3A (W-363) downgradient from the Taxi Strip area were analyzed in 2007 for copper, lead, zinc, americium-241, plutonium-238, plutonium-239, radium-226, radium-228, and tritium. Samples from monitoring wells screened at least partially in HSU-2 (W-119, W-906, W-1303, W-1306, and W-1308) within and downgradient from the East Traffic Circle Landfill were analyzed for the same elements as the Taxi Strip area. No concentrations of americium or plutonium radioisotopes were detected above the radiological laboratory's minimum detectable activities. Concentrations of radium and tritium remained well below the drinking water MCLs. Of the trace metals, only zinc was detected (18 µg/L, reported for well W-906) in any of these seven monitoring wells during 2007.

Although the NIF has not yet begun full operations, LLNL measures pH, conductivity, and tritium concentration of groundwater to establish a baseline. During 2007, tritium analyses were conducted on groundwater samples collected from wells W-653 and W-1207 (screened in HSU-3A and HSU-2, respectively) downgradient of NIF. Samples were also obtained downgradient from the DWTF from wells W-007, W-593, and W-594 (screened in HSU-2/3A, HSU-3A, and HSU-2, respectively) during 2007 and were analyzed for tritium. Monitoring results from the wells near NIF and DWTF showed no detectable concentrations of tritium, above the limit of sensitivity of the analytical method, in the groundwater samples collected during 2007. Monitoring will continue near these facilities to determine baseline conditions.

The former storage area around Building 514 and the hazardous waste/mixed waste storage facilities around Building 612 are also potential sources of contamination. The area and facilities are monitored by wells W-270 and W-359 (both screened in HSU-5), and well GSW-011 (screened in HSU-3A). Groundwater from these wells was sampled and analyzed for general minerals, gross alpha, gross beta, americium-241, plutonium-238, plutonium-239, radium-226, and tritium in 2007. No significant contamination was detected in the groundwater samples collected downgradient from these areas in 2007.

Groundwater samples were obtained from monitoring well W-307 (screened in HSU-1B), downgradient from Building 322. Soil samples previously obtained from this area showed concentrations elevated above the Livermore site's background levels for total chromium, copper, lead, nickel, zinc, and occasionally other metals. LLNL removed contaminated soils near Building 322 in 1999 and replaced them with clean fill. The area was then paved over, making it less likely that metals would migrate from the site. In 2007, the monitoring results for well W-307 showed only slight variations from the concentrations reported in recent years.

Groundwater samples were obtained downgradient from a location where sediments containing metals (including cadmium, chromium, copper, lead, mercury, and zinc) had accumulated in a storm water catch basin near Building 253. In 2007, the samples obtained from monitoring wells W-226 and W-306 (screened in HSU-1B and HSU-2, respectively) contained dissolved chromium at concentrations elevated above background, but concentrations were essentially unchanged from last year.

Additional surveillance groundwater sampling locations, established in 1999, are in areas surrounding the Plutonium Facility and Tritium Facility. Potential contaminants include plutonium and tritium from these facilities, respectively. Plutonium is much more likely to bind to the soils than migrate into the groundwater. Tritium, as HTO, can migrate into groundwater if spilled in sufficient quantities. Upgradient of these facilities, well W-305 is screened in HSU-2;

downgradient wells W-101, W-147, and W-148 are screened in HSU-1B. Groundwater samples collected from these wells during 2007 showed no detectable concentration, above the limit of sensitivity for the analytical method, of either plutonium-238 or plutonium-239+240.

In August 2000, elevated tritium activity was detected in the groundwater sampled at well W-148 (115 ± 5.0 Bq/L [3100 ± 135 pCi/L]). The activity was most likely related to local infiltration of storm water containing elevated tritium activity. Tritium activities in groundwater in this area had remained at or near the same level through 2005, but samples collected from well W-148 in 2006 and 2007 showed significantly lower values—approximately one half the August 2000 value. LLNL continues to collect groundwater samples from these wells periodically for surveillance purposes, primarily to demonstrate that tritium and plutonium contents remain below MCLs.

5.4.2 Site 300 and Environs

For surveillance and compliance groundwater monitoring at Site 300, LLNL uses DOE CERCLA wells and springs on site and private wells and springs off site. Representative groundwater samples are obtained at least once per year at every monitoring location; they are routinely measured for various elements (primarily metals), a wide range of organic compounds, general radioactivity (gross alpha and gross beta), uranium activity, and tritium activity. Groundwater from the shallowest water-bearing zone is the target of most of the monitoring because it would be the first to show contamination from LLNL operations at Site 300.

Brief descriptions of the Site 300 groundwater monitoring networks that are reported in this chapter are given below. (All analytical data from 2007 are included in **Appendix A**, **Section A.6**.)

5.4.2.1 Elk Ravine Drainage Area

The Elk Ravine drainage area, a branch of the Corral Hollow Creek drainage system, includes most of northern Site 300 (see **Figure 5-6**). Storm water runoff in the Elk Ravine drainage area collects in arroyos and quickly infiltrates into the ground. Groundwater from wells in the Elk Ravine drainage area is monitored for COCs to determine the impact of current LLNL operations on the system of underground flows that connects the entire Elk Ravine drainage area. The area contains eight closed landfills, known as Pits 1 through 5 and 7 through 9, and firing tables where explosives tests are conducted. None of the closed landfills has a liner, which is consistent with the disposal practices when the landfills were constructed. The following descriptions of monitoring networks within Elk Ravine begin with the headwaters area and proceed downstream. (See **Chapter 8** for a review of groundwater monitoring in this drainage area conducted under CERCLA.)

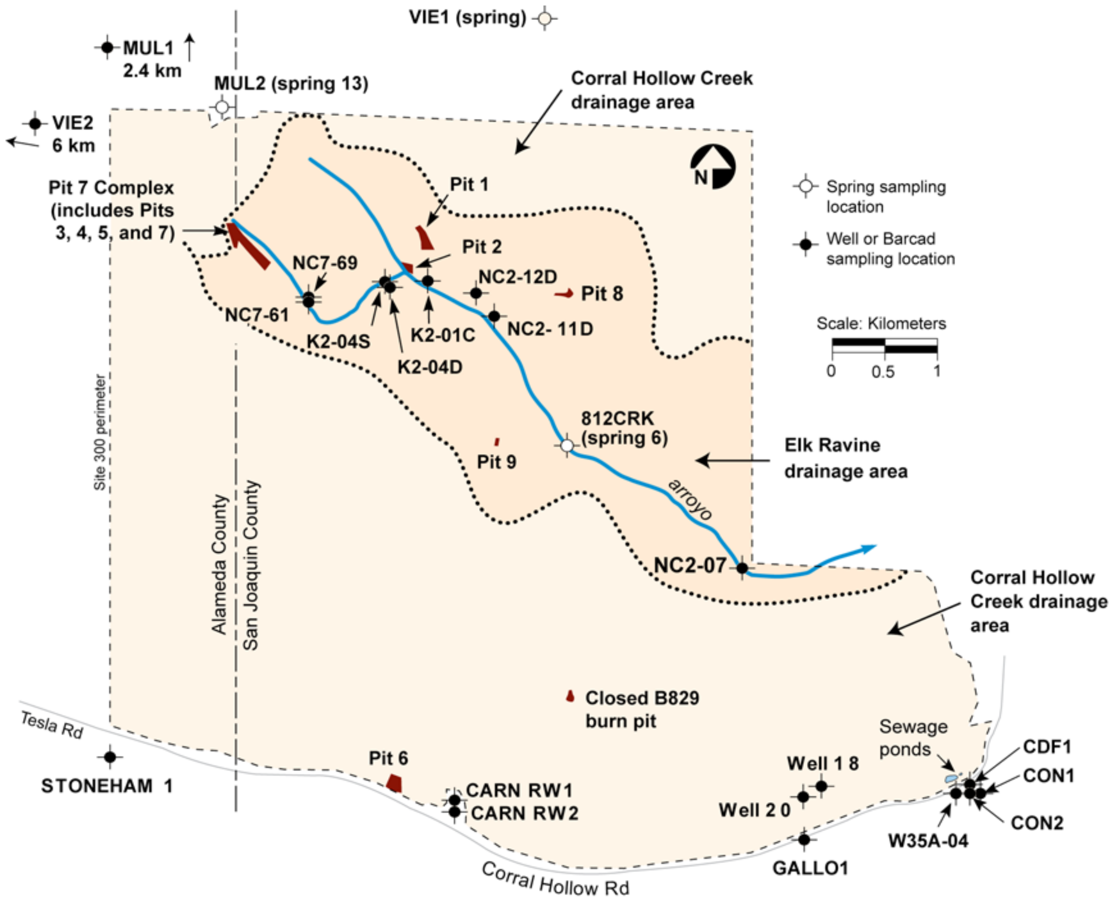

Figure 5-6. Surveillance groundwater wells and springs at Site 300, 2007.

Pit 7 Complex. Monitoring requirements for the Pit 7 landfill, which was closed under RCRA in 1993, are specified in WDR 93-100 administered by the CVRWQCB (1993, 1998) and in *LLNL Site 300 RCRA Closure and Post-Closure Plans—Landfill Pits 1 and 7* (Rogers/Pacific Corporation 1990). The main objective of this monitoring is the early detection of any new release of COCs from Pit 7 to groundwater.

For compliance purposes, LLNL obtained groundwater samples quarterly during 2007 from the Pit 7 monitoring well network. Samples were analyzed for inorganic COCs (mostly metallic elements), general radioactivity (gross alpha and beta), activity of certain radioisotopes (tritium, radium, uranium, and thorium), explosive compounds (HMX and RDX), and VOCs. For a detailed account of Pit 7 compliance monitoring during 2007, including well locations and tables and graphs of groundwater COC analytical data, see Campbell and MacQueen (2008).

Elk Ravine. Groundwater samples were obtained on various dates in 2007 from the widespread Elk Ravine surveillance monitoring network shown in **Figure 5-6** (NC2-07, NC2-11D, NC2-12D, NC7-61, NC7-69, SPRING6 [812CRK], K2-04D, K2-04S, K2-01C). Samples were analyzed for inorganic constituents (mostly metallic elements), VOCs, general radioactivity (gross alpha and beta), tritium and uranium activity, and explosive compounds (HMX and RDX).

No new release of COCs from LLNL operations in Elk Ravine to groundwater is indicated by the chemical and radioactivity data obtained during 2007. The major source of contaminated groundwater beneath Elk Ravine is from historical operations in the Building 850 firing table area (Webster-Scholten 1994; Taffet et al. 1996). Constituents that are measured as part of the Elk Ravine drainage area surveillance monitoring network are listed in **Appendix B**.

The tritium activity in well NC7-61 decreased from 1200 Bq/L in 2006 to 1080 Bq/L in 2007. This tritium activity remains elevated with respect to the background concentrations. Tritium, as HTO, has been released in the past in the vicinity of Building 850. The majority of the Elk Ravine surveillance network tritium measurements made during 2007 support earlier CERCLA studies that show that the tritium in the plume is diminishing over time because of natural decay and dispersion (Ziagos and Reber-Cox 1998). CERCLA modeling studies indicate that the tritium will decay to background levels before it can reach a site boundary.

Groundwater surveillance measurements of gross alpha, gross beta, and uranium radioactivity in Elk Ravine are all low and are indistinguishable from background levels. (Note that gross beta measurements do not detect the low-energy beta emission from tritium decay.) Additional detections of nonradioactive elements including arsenic, barium, chromium, selenium, vanadium, and zinc are all within the natural ranges of concentrations typical of groundwater elsewhere in the Altamont Hills.

Pit 1. Monitoring requirements for the Pit 1 landfill, which was closed under RCRA in 1993, are also specified in WDR 93-100 administered by the CVRWQCB (1993, 1998) and in Rogers/Pacific Corporation (1990). The main objective of this monitoring is the early detection of any release of COCs from Pit 1 to groundwater. LLNL obtained groundwater samples quarterly during 2007 from the Pit 1 monitoring well network. Samples were analyzed for inorganic COCs (mostly metallic elements), general radioactivity (gross alpha and beta), activity of certain radioisotopes (tritium, radium, uranium, and thorium), explosive compounds (HMX and RDX), and VOCs (EPA Methods 601 and 8260). Additional annual analyses were conducted on groundwater samples for extractable organics (EPA Method 625), as well as pesticides and PCBs (EPA Method 608). Compliance monitoring showed no new releases at Pit 1 in 2007; a detailed account of Pit 1 compliance monitoring during 2007, including well locations and tables and graphs of groundwater COC analytical data, is in Campbell and MacQueen (2008).

5.4.2.2 Corral Hollow Creek Drainage Area

Pit 6. Compliance monitoring requirements for the closed Pit 6 landfill in the Corral Hollow Creek drainage area are specified in Ferry et al. (1998, 2002). Two Pit 6 groundwater monitoring programs, which operate under CERCLA, ensure compliance with all regulations. They are (1) the Detection Monitoring Plan (DMP), designed to detect any new release of COCs to groundwater from wastes buried in the Pit 6 landfill, and (2) the Corrective Action Monitoring Plan (CAMP), which monitors the movement and fate of historical releases. To comply with monitoring requirements, LLNL obtained groundwater samples monthly, quarterly, semiannually, and annually during 2007 from specified Pit 6 monitoring wells. No new releases were detected at Pit 6 in 2007; a detailed account of Pit 6 compliance monitoring during 2007, including well locations, tables of groundwater analytical data, and maps showing the distribution of COC plumes, is in Campbell and Taffet (2008).

Building 829 Closed High Explosives Burn Facility. Compliance monitoring requirements for the closed burn pits in the Corral Hollow Creek drainage area are specified in Mathews and Taffet (1997), and in LLNL (2001), as modified by DTSC (2003). As planned for compliance purposes, LLNL obtained groundwater samples during 2007 from the three wells in the Building 829 monitoring network. Groundwater samples from these wells, screened in the deep regional aquifer, were analyzed for inorganics (mostly metals), general minerals, turbidity, explosive compounds (HMX, RDX, and TNT), VOCs (EPA Method 624), extractable organics (EPA Method 625), pesticides (EPA Method 608), herbicides (EPA Method 615), general radioactivity (gross alpha and beta), radium activity, total organic carbon (TOC), total organic halides (TOX), and coliform bacteria.

During 2007, there were no confirmed COC detections above their respective statistical limits in groundwater samples from any of the Building 829 network monitoring wells. Among the inorganic constituents, perchlorate was not detected above its reporting limit in any sample. The metal COCs that were detected showed concentrations that are not significantly different from background concentrations for the deep aquifer beneath the HE Process Area. Similarly, all results for gross alpha and gross beta (the radioactive COCs) were below their statistical limit values. There were no organic or explosive COCs detected above reporting limits in any samples. For a detailed account of compliance monitoring of the closed burn pit during 2007, including well locations and tables and graphs of groundwater COC analytical data, see Revelli (2008b).

Water Supply Well. Water supply well 20, located in the southeastern part of Site 300 (**Figure 5-6**), is a deep, high-production well. The well is screened in the Neroly lower sandstone aquifer (Tnbs1) and can produce up to 1500 L/min (396 gal/min) of potable water. As planned for surveillance purposes, LLNL obtained groundwater samples quarterly during 2007 from well 20. Groundwater samples were analyzed for inorganic COCs (mostly metals), VOCs, general radioactivity (gross alpha and gross beta), and tritium activity. Quarterly measurements of groundwater from well 20 do not differ significantly from previous years. As in past years, the primary potable water supply well at Site 300 showed no evidence of contamination. Gross alpha, gross beta, and tritium activities were very low and are indistinguishable from background level activities.

5.4.2.3 Off-site Surveillance Wells and Springs

As planned for surveillance purposes, during 2007 LLNL obtained groundwater samples from two off-site springs (MUL2 and VIE2) and ten off-site wells (MUL1, VIE1, CARNRW1, CARNRW2, CDF1, CON1, CON2, GALLO1, STONEHAM1, and W35A-04) **(Figure 5-6)**. With the exception of one well, all off-site monitoring locations are near Site 300. The exception, well VIE2, is located at a private residence 6 km west of the site. It represents a typical potable water supply well in the Altamont Hills.

Samples from CARNRW2, CDF1, CON1, and GALLO1 were analyzed quarterly for inorganic COCs (mostly metals), general radioactivity (gross alpha and beta), tritium activity, explosive compounds (HMX and RDX), and VOCs (EPA method 502.2). Additional annual analyses were conducted on third-quarter samples for uranium activity and extractable organic compounds (EPA Method 625) for samples collected from CARNRW2 only. In addition, CARNRW1 and CON2 samples were analyzed for VOCs; samples from well CARNRW1 were also sampled for perchlorate and tritium.

Groundwater samples were obtained once (annually) during 2007 from the remaining off-site surveillance monitoring locations: MUL1, MUL2, and VIE1 (north of Site 300); VIE2 (west of Site 300); and STONEHAM1 and W-35A-04 (south of Site 300). Samples were analyzed for inorganic COCs (metals, nitrate, and perchlorate), general radioactivity (gross alpha and beta), tritium and uranium activity, explosive compounds (HMX and RDX), VOCs, and extractable organic compounds (EPA Method 625).

5.5 Other Monitoring Programs

5.5.1 Rainwater

Rainwater is sampled and analyzed for tritium activity in support of DOE Order 5400.5. Rainwater is collected in stainless-steel buckets at fixed locations. The tritium activity of each sample is measured and all analytical results are provided in **Appendix A**, **Section A.7**.

5.5.1.1 Livermore Site and Environs

Rain sampling locations are shown in **Figure 5-7**. During 2007, LLNL collected rainwater samples following one rain event in the Livermore Valley. All of the rainwater sampling dates correspond to storm water runoff sampling. During 2007, no on-site measurement of tritium activity was above the MCL of 740 Bq/L (20,000 pCi/L) established by the EPA for drinking water. As in past years, the on-site rainwater sampling location B343 showed the highest tritium activity for the year, 23 Bq/L (622 pCi/L), for the rain event that was sampled on February 26. The maximum tritium activity measured in off-site rainwater samples during 2007 were estimated values below the minimum reporting limit of 3.7 Bq/L (100 pCi/L).

5.5.1.2 Site 300 and Environs

During 2007, LLNL collected rainwater samples following one rain event at Site 300. Two on-site locations (COMP and TNK5) were positioned to collect rainfall for tritium activity measurements at Site 300 during 2007 (see **Figure 5-3**). As in past years, none of the rainwater samples from monitoring locations at Site 300 during 2007 showed tritium activities above the analytical laboratory reporting limit.

5.5.2 Livermore Valley Surface Waters

LLNL conducts additional surface water surveillance monitoring in support of DOE Order 5400.5. Surface and drinking water near the Livermore site and in the Livermore Valley were sampled at the locations shown in **Figure 5-7** in 2007. Off-site sampling locations CAL, DEL, DUCK, ALAG, SHAD, and ZON7 are surface water bodies; of these, CAL, DEL, and ZON7 are also drinking water sources. GAS and TAP are drinking water outlets. Radioactivity data from drinking water sources are used to calculate drinking water statistics (see **Table 5-7**).

Samples are analyzed according to written, standardized procedures summarized in Woods (2005). LLNL sampled these locations semiannually in 2007 for gross alpha, gross beta, and tritium. All analytical results are provided in **Appendix A**, **Section A.7**.

The median activity for tritium in surface and drinking waters was estimated from calculated values to be below the analytical laboratory's minimum detectable activities, or minimum quantifiable activities. The maximum tritium activity detected in any sample collected in 2007 was 2.35 Bq/L (63.5 pCi/L), less than 1% of the drinking water MCL. Median activities for gross alpha and gross beta radiation in surface and drinking water samples were both less than 5% of their respective MCLs. Maximum activities detected for gross alpha and gross beta radioactivity, respectively, were 0.194 Bq/L (5.24 pCi/L) and 0.374 Bq/L (10.11 pCi/L); both were less than 35% of their respective MCLs (see **Table 5-7**). Historically, concentrations of gross alpha and gross beta radiation have fluctuated around the laboratory's minimum detectable activities. At these very low levels, the counting error associated with the measurements is nearly equal to, or in many cases greater than, the calculated values so that no trends are apparent in the data.

5.5.3 Lake Haussmann Release

Lake Haussmann can hold approximately 45.6 million L (37 acre-feet) of water and is located near the center of the Livermore site. It collects treated groundwater from surrounding groundwater treatment facilities TFD and TFE and portable treatment units, and from storm water runoff. Previous LLNL environmental reports detail the history of the construction and management of Lake Haussmann, the regulatory drivers, sampling requirements, and discharge limits (see Harrach et al. 1995, 1996, 1997). LLNL collects discharge samples at location CDBX (**Figure 5-2)** and compares them with samples collected at location WPDC to identify any change in water quality. Written, standardized sample collection procedures are summarized in Woods (2005). State-certified laboratories analyze the collected samples for chemical and physical parameters. All analytical results are included in **Appendix A**, **Section A.7**.

The only limit exceeded for samples collected at CDBX and WPDC was the pH discharge limit of 8.5. Dry season and wet season pH has averaged 9.3 and 8.3, respectively, since 1992. The higher pH readings seen in Lake Haussmann discharge samples during the dry season correspond to the peak of the summer algal bloom within Lake Haussmann. During 2007, total dissolved solids and specific conductance continued to reflect the levels found in groundwater discharged to Lake Haussmann. While some metals were detected, no metals were above discharge limits. All organics and PCBs were below analytical detection limits. Pesticides, gross alpha, gross beta, and tritium levels were well below discharge limits. Aquatic bioassays for toxicity showed no effects in Lake Haussmann discharge water.

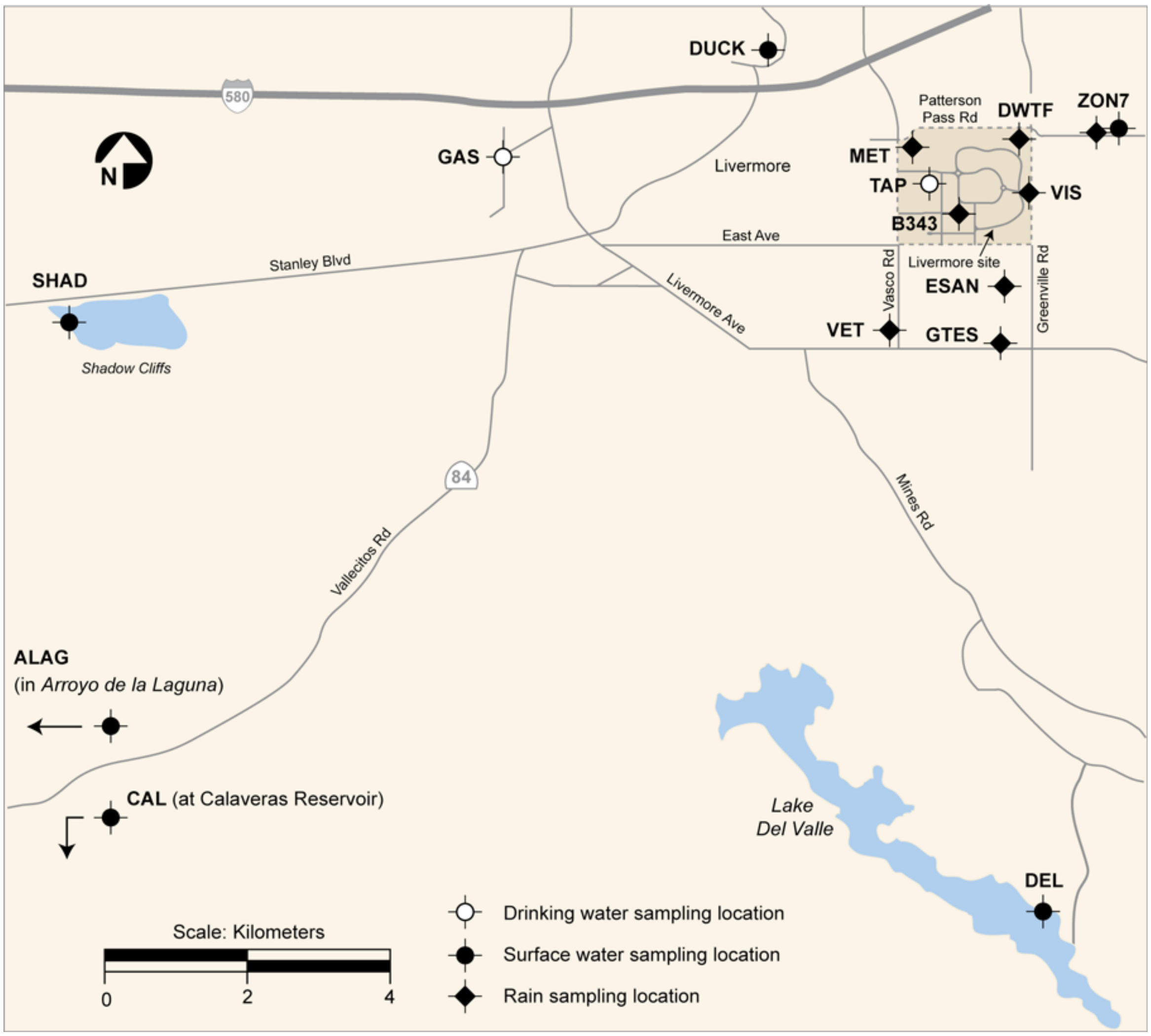

Figure 5-7. Livermore site and Livermore Valley sampling locations for rain, surface water, and drinking water, 2007.

Table 5-7. Radioactivity in surface and drinking waters in the Livermore Valley, 2007.

Location	Metric	Tritium (Bq/L)[(a)]	Gross alpha (Bq/L)[(a)]	Gross beta (Bq/L)[(a)]
All locations	Median	0.65	0.0069	0.081
	Minimum	–1.57	–0.045	–0.0033
	Maximum	2.35	0.194	0.374
	Interquartile range	2.49	0.044	0.052
Drinking water locations	Median	0.88	0.021	0.047
	Minimum	–0.96	–0.038	–0.0033
	Maximum	2.35	0.098	0.079
	Drinking water MCL	740	0.555	1.85

(a) A negative number means the sample radioactivity was less than the background radioactivity.

5.5.4 Site 300 Drinking Water System Discharges

LLNL samples large-volume discharges from the Site 300 drinking water distribution system that reach surface water drainage courses in accordance with the requirements of WDR 5-00-175, NPDES General Permit No. CAG995001. The monitoring and reporting program that LLNL developed for these discharges was approved by the CVRWQCB. Discharges that are subject to these sampling and monitoring requirements are:

- Drinking water storage tanks: Discharges that have the potential to reach surface waters are monitored.
- System flushes: One flush per pressure zone per year is monitored for flushes that have the potential to reach surface waters.
- Dead-end flushes: All flushes that have the potential to reach surface waters and any discharge that continues for more than four months are monitored.

Complete monitoring results from 2007 are detailed in the quarterly self-monitoring reports to the CVRWQCB. The annual testing, required by the CVRWQCB, was completed during the third quarter when LLNL conducted flushing of the drinking water system for water quality purposes. These system flush releases were monitored and met the effluent limits. All 2007 releases from the Site 300 drinking water system reaching surface waters quickly percolated into the drainage ditches or streambed and did not reach Corral Hollow Creek, the potential receiving water.

5.5.5 Percolation Pits

Percolation pits designed to accept discharges from mechanical equipment are located at Site 300 Buildings 806A, 827A, 827C, 827D, and 827E. These discharges are permitted by WDR 96-248, which specifies monthly observations and monitoring requirements for overflows of the percolation pits. In other Site 300 facilities, these types of waste streams are discharged to septic systems. If an overflow occurs, it is sampled and analyzed to determine concentrations of any metals present. During 2007, all of the percolation pits operated normally with no overflows.