7

Surface Water

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Overview

Lawrence Livermore National Laboratory monitors surface water at the Livermore site, in surrounding regions of the Livermore Valley, and at Site 300 and vicinity in the nearby Altamont Hills. At the Livermore site and vicinity, LLNL monitors reservoirs and ponds, the Livermore site swimming pool, the Drainage Retention Basin (DRB), rainfall, tap water, and storm water runoff. At Site 300 and vicinity, surface water monitoring encompasses rainfall, cooling tower discharges, and storm water runoff.

The water samples are analyzed for radionuclides, high explosives, total organic carbon, total organic halides, total suspended solids, conductivity, pH, chemical oxygen demand, total dissolved solids, oil and grease, metals, minerals, anions, and a wide range of organic compounds. In addition, bioassays are performed annually on water entering and leaving the Livermore site via the Arroyo Las Positas pathway, discharges from the DRB, and water contained in the DRB.

Storm Water

This section discusses general storm water information (including permits, constituent criteria, inspections, and sampling), sampling methods, and results.

General Information

Permits

The goals of the storm water (runoff) monitoring program are to demonstrate compliance with permit requirements, aid in implementing the Storm Water Pollution Prevention Plans (SWPPPs) (Eccher et al. 1994a and b), and measure the effectiveness of the Best Management Practices (BMPs) in preventing contamination of storm water discharges.

7 Surface Water

LLNL monitors storm water at the Livermore site in accordance with a Waste Discharge Requirements and National Pollutant Discharge Elimination System permit (WDR 95-174, NPDES Permit No. CA0030023) issued in 1995 (San Francisco Bay Regional Water Quality Control Board [SFBRWQCB] 1995). In 1994, the Central Valley Regional Water Quality Control Board (CVRWQCB) issued a Waste Discharge Requirements and National Pollutant Discharge Elimination System Permit (WDR 94-131, NPDES Permit No. CA0081396) for Site 300 (CVRWQCB 1994). These permits include specific monitoring and reporting requirements. In addition to the storm water constituents required by the permits, LLNL monitors other constituents to provide a more complete water quality profile. The current list of analyses provided for storm water samples is given in **Table 7-1**.

Table 7-1. Analyses conducted on storm water samples, 1999.

Livermore site	Site 300
Specific conductance	Specific conductance
Total suspended solids	Total dissolved solids
pH	Total suspended solids
Chemical oxygen demand	pH
Biochemical oxygen demand	Potassium
Fish bioassay (fathead minnow)	Beryllium
Anions	Mercury
General minerals	Volatile organic compounds
Metals	Semivolatile organic compounds
Volatile organic compounds	Pesticides
Pesticides	PCBs
Oil and grease	Total organic halides
PCBs	Total organic carbon
Total organic carbon	Dioxins
Semivolatile organic compounds	Explosives
Gross alpha and beta	Gross alpha and beta
Tritium	Tritium
Plutonium	Uranium

The NPDES permits for storm water require that LLNL sample effluent two times per year. In addition, LLNL is required to visually inspect the storm drainage system monthly during the wet season, whenever significant storms occur, and twice during the dry season to identify any dry weather flows. Influent sampling is also required at the

Livermore site. LLNL monitors up to two more storm events each year at the Livermore site (a total of four sampling events) in support of U.S. Department of Energy (DOE) Orders 5400.1 and 5400.5. In addition, annual facility inspections are required to ensure that the BMPs are adequate and implemented.

LLNL also meets the storm water compliance monitoring requirements of the Statewide General NPDES Permit for Storm Water Discharges Associated with Construction Activity (Order 92-08-DWQ, NPDES Permit No. CAS000002) for construction projects that disturb 2 hectares of land or more (State Water Resources Control Board [SWRCB] 1992). In August 1999, the SWRCB reissued Order 92-08-DWQ as Order 99-08-DWQ. The new requirements of the reissued permit were implemented by LLNL beginning in November 1999 as required by the permit's conditions (SWRCB 1999). These conditions apply to the 1999/2000 rainy season that will be discussed in the Environmental Report for 2000.

Storm water monitoring also follows the requirements in the *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (U.S. Department of Energy 1991) and meets the applicable requirement of DOE Order 5400.1, *General Environmental Protection Program*; DOE Order 5400.5, *Radiation Protection of the Public and the Environment*; and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) *Record of Decision for the Lawrence Livermore National Laboratory Livermore Site* (U.S. Department of Energy 1993).

Constituent Criteria

Currently, there are no numeric criteria that limit concentrations of specific constituents in LLNL's storm water effluent. The Environmental Protection Agency (EPA) established benchmark values for 41 parameters but stressed that these concentrations were not intended to be interpreted as effluent limits (U.S. Environmental Protection Agency 1995). Rather, the values are levels that the EPA has used to determine if storm water discharged from any given facility merits further monitoring. Although these criteria are not directly applicable, the use of a broad range of criteria can help evaluate LLNL's storm water management program and ensure high quality storm water effluent.

Storm water sample results for the Livermore site were also compared with criteria listed in the *Water Quality Control Plan, San Francisco Bay Basin* (San Francisco Bay Regional Water Quality Control Board 1995), and results for Site 300 were compared with criteria listed in *The Water Quality Control Plan* (*Basin Plan) for the California Regional Water Quality Control Board, Central Valley Region, Sacramento and San Joaquin River Basins* (Longley et al. 1994). Criteria in the basin plans include surface water quality objectives for the protection of aquatic life and water quality objectives for waters designated for use as domestic or municipal supply or agricultural supply. These criteria include, by reference, California Maximum Contaminant Levels (MCLs) for drinking water. In addition, LLNL compared results with EPA MCLs and ambient water quality criteria (AWQC) as well as California AWQC. Criteria not specifically listed in the basin plans were obtained from *A Compilation of Water Quality Goals* (Marshack 1998). Criteria are summarized in Table 7-1 in the Data Supplement, which lists Primary MCL/Secondary MCL (PMCL/SMCL), Ambient Water Quality Criteria/Criteria for Agricultural Use (AWQC/Ag), and the EPA benchmarks.

In addition to chemical-specific monitoring, LLNL is required by NPDES permit (WDR 95-174) to conduct acute and chronic fish toxicity testing in Arroyo Las Positas (Livermore Site) once per wet season (defined as October of one year through April of the following year). Currently, LLNL is not required to test for fish toxicity at Site 300.

Inspections

Each directorate at LLNL conducts an annual inspection of its facilities to verify implementation of the SWPPPs and to ensure that measures to reduce pollutant loadings to storm water runoff are implemented. The Laboratory's associate directors certify that their facilities comply with the provisions of WDR 94-131, WDR 95-174, and the SWPPPs. The deputy director for operations certifies the facilities directly reporting to the Director's Office, except those facilities in the Laboratory Site Operations organization, which are certified by the Laboratory site manager. LLNL submits annual storm water monitoring reports to the SFBRWQCB and to the CVRWQCB with the results of sampling, observations, and inspections.

Monitoring for construction projects permitted by Order 92-08-DWQ included visual observations of construction sites by the construction staff before and after storms to assess the effectiveness of implemented BMPs. Annual compliance certifications summarize these inspections.

As in past years, the SFBRWQCB requested submission of compliance status reports for the Livermore site projects. (The CVRWQCB has never requested compliance status reports for projects located at Site 300.) The 1999 compliance certifications (and compliance status reports) covered the period of June 1998 through May 1999. During this period, three Livermore site projects were inspected: the Decontamination and Waste Treatment Facility (DWTF), the National Ignition Facility (NIF), and the areas associated with the Soil Reuse Project. One Site 300 project, the Contained Firing Facility, was also inspected under this program.

Sampling

To evaluate the overall impact of Livermore site and Site 300 operations on storm water quality, storm water flows are sampled where they exit the sites and at upstream locations. Because of flow patterns at the Livermore site, storm water at sampling locations includes water runoff from other sources, such as neighboring agricultural land, parking lots, and landscaped areas. In contrast, storm water at Site 300 is sampled at locations that target specific industrial activities, with negligible run-on from other sources. These samples provide information used to evaluate the effectiveness of LLNL's storm water pollution control program.

Livermore Site

The natural drainage at the LLNL Livermore site was altered by construction activities several times up to 1966 (Thorpe et al. 1990) so that the current northwest flow of Arroyo Seco and the westward flow of Arroyo Las Positas do not represent historical flow paths. About 1.6 km to the west of the Livermore site, Arroyo Seco merges with Arroyo Las Positas, which continues to the west to eventually merge with Arroyo Mocho (see **Figure 7-1**).

The DRB was excavated and lined in 1992 to prevent infiltration of storm water that was dispersing ground water contaminants. It also serves storm water diversion and flood control purposes. The DRB collects about one-fourth of the surface water runoff from the site and a portion of the Arroyo Las Positas drainage (**Figure 7-2**).

The DRB discharges north to a culvert that leads to Arroyo Las Positas. The remainder of the site drains either directly or indirectly into the two arroyos by way of storm sewers and ditches. Arroyo Seco cuts across the southwestern corner of the site. Arroyo Las Positas follows the northeastern and northern boundaries of the site and exits the site near the northwest corner.

The routine Livermore site storm water runoff sampling network consists of nine locations (**Figure 7-2**). Six locations characterize storm water either entering (influent: ALPE, ALPO, ASS2, and GRNE) or exiting (effluent: ASW and WPDC) the Livermore site. Locations CDB and CDB2 characterize runoff from the southeastern quadrant of the Livermore site entering the DRB, and location CDBX characterizes water leaving the DRB. Additional locations were sampled during 1999 as part of a tritium source investigation and are described in this chapter in the Livermore Site Radioactive Constituents section.

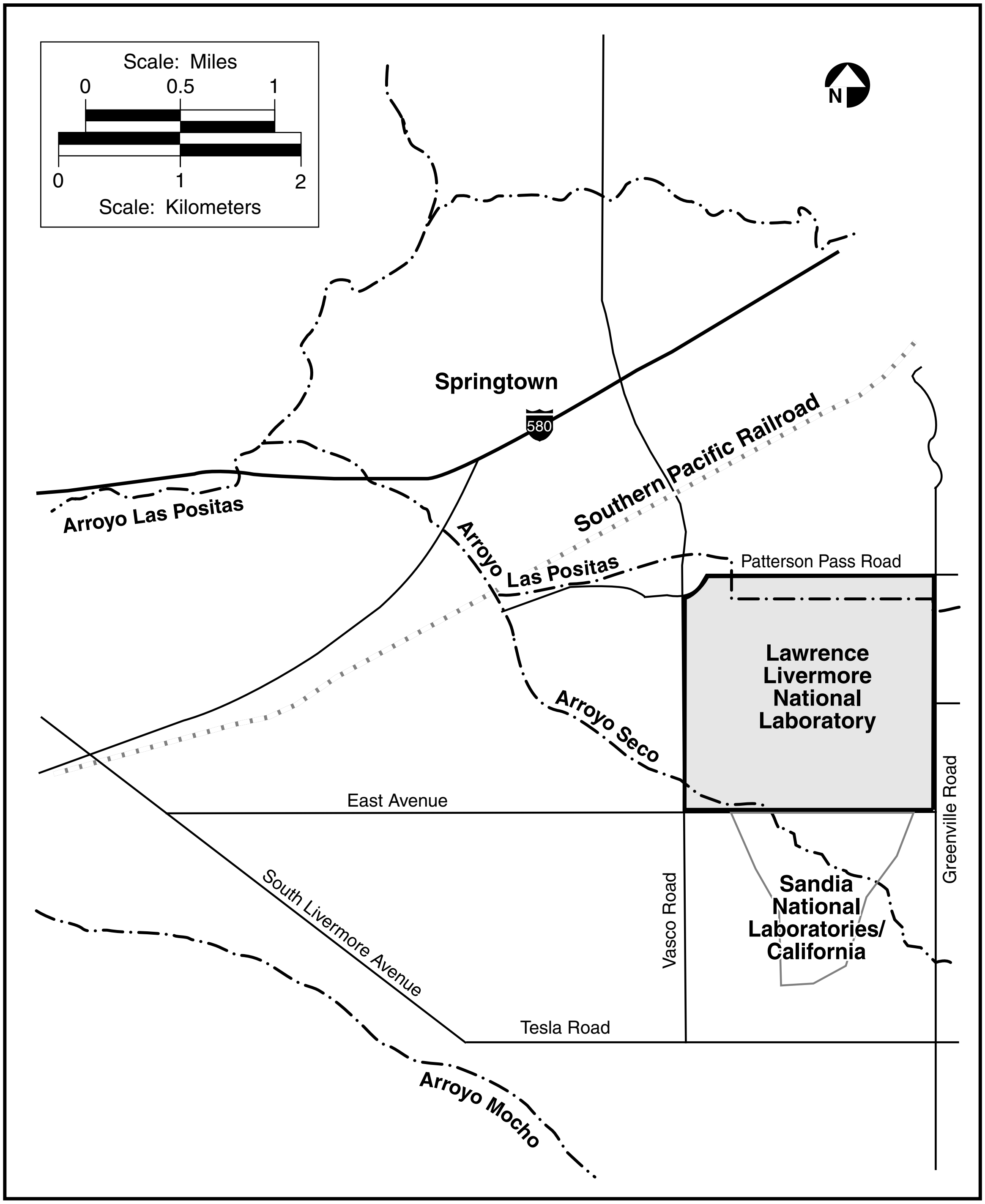

Figure 7-1. Surface water courses in the vicinity of the Livermore site.

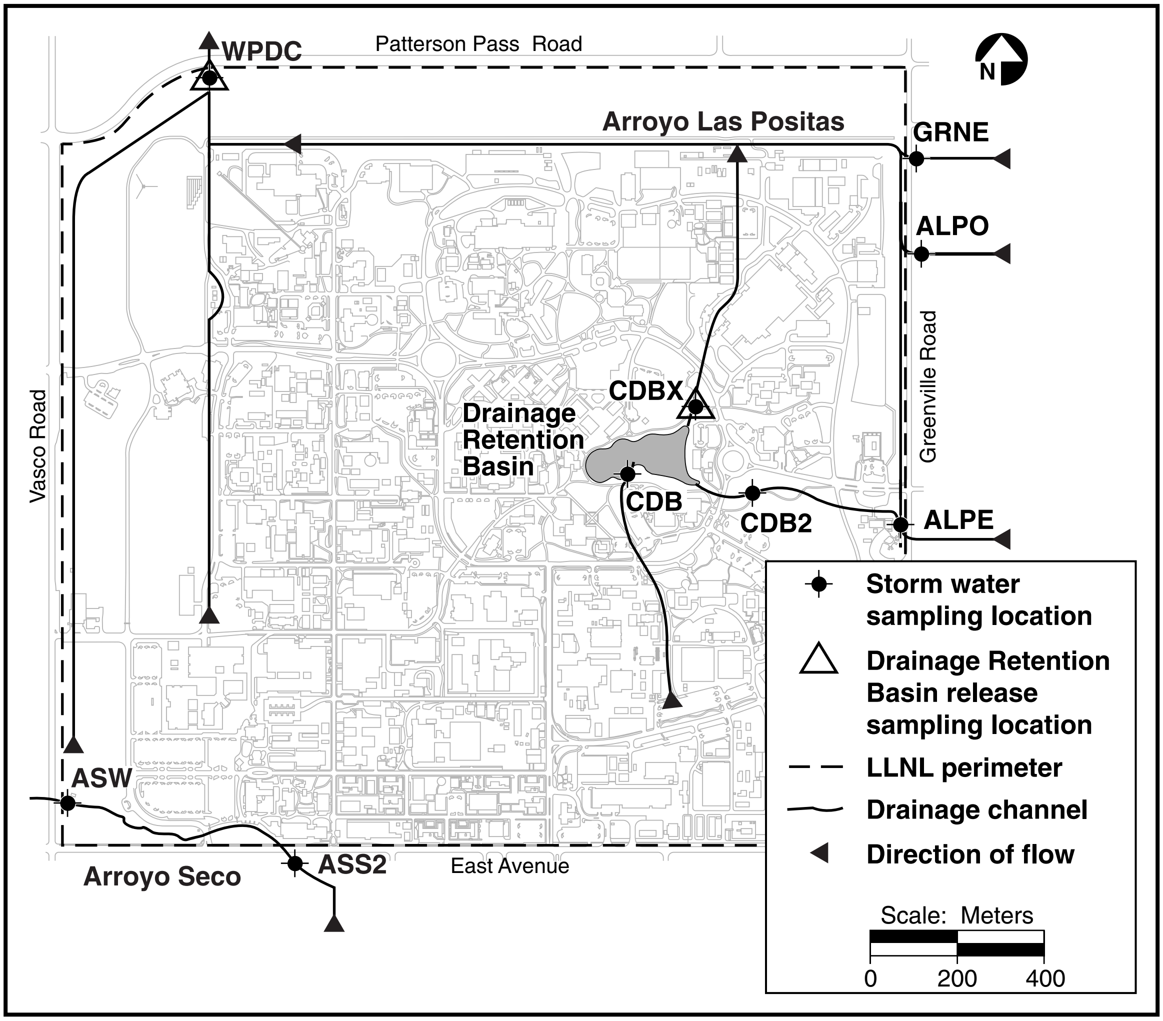

Figure 7-2. Storm water runoff and Drainage Retention Basin discharge sampling locations, Livermore site, 1999.

Site 300

Surface water at Site 300 consists of seasonal runoff, springs, and natural and man-made ponds. The primary waterway in the Site 300 area is Corral Hollow Creek, an ephemeral stream that borders the site to the south and southeast. No continuously flowing streams are present in the Site 300 area. Elk Ravine is the major drainage channel for most of Site 300; it extends from the northwest portion of the site to the east-central area (see **Figure 9-3**). Elk Ravine drains the center of the site into Corral Hollow Creek, which drains eastward to the San Joaquin River Basin. Some smaller canyons in the northeast portion of the site drain to the north and east toward Tracy.

There are at least 23 springs at Site 300. Nineteen are perennial, and four are intermittent. Most of the springs have very low flow rates and are recognized only by small marshy areas, pools of water, or vegetation. A number of artificial surface water bodies are present at Site 300. A sewage evaporation pond and a sewage percolation pond are located in the southeast corner of the site in the General Services Area (GSA), and two lined, high-explosives (HE) process water impoundments are located to the west in the Explosives Process Area. Monitoring results associated with these facilities are reported in Chapter 9.

Other surface water flow at Site 300 results from blowdown water from cooling towers in the Building 801 complex in the East/West Firing Area and Building 836A near the eastern site boundary. Additionally, three wetlands created by now-discontinued flows from cooling towers located at Buildings 827, 851, and 865 are currently maintained by discharges of potable water. Cooling tower discharges and their potential impact are discussed in the *Final Site-Wide Remedial Investigation Report* (Webster-Scholten 1994).

The Site 300 storm water sampling network began in 1994 with six locations and now consists of seven locations (**Figure 7-3**). Location CARW is used to characterize runoff in Corral Hollow Creek upgradient and therefore is unaffected by Site 300 activities. Location GEOCRK is used to characterize runoff in Corral Hollow Creek, downstream of Site 300. The remaining locations were selected to characterize storm water runoff at locations that could be affected by specific Site 300 activities.

Methods

Samples are collected by grab sampling from the runoff flow at specified locations. Sample bottle requirements, special sampling techniques, and preservation requirements for each analyte are specified in the *Environmental Monitoring Plan* (Tate et al. 1999) and summarized below.

If the water to be sampled is accessible to the technician, grab samples are collected by partially submerging sample bottles directly into the water and allowing them to fill with the sample water. If the water to be sampled is not directly accessible, a stainless steel bucket is used for sampling. The bucket is triple-rinsed with the water to be sampled, then dipped or submerged into the water, and withdrawn in a smooth motion. Sampling is conducted away from the edge of the water to minimize the collection of sediment with the sample matrix. Sample vials for volatile organics are filled first before sample vials for all other constituents and parameters.

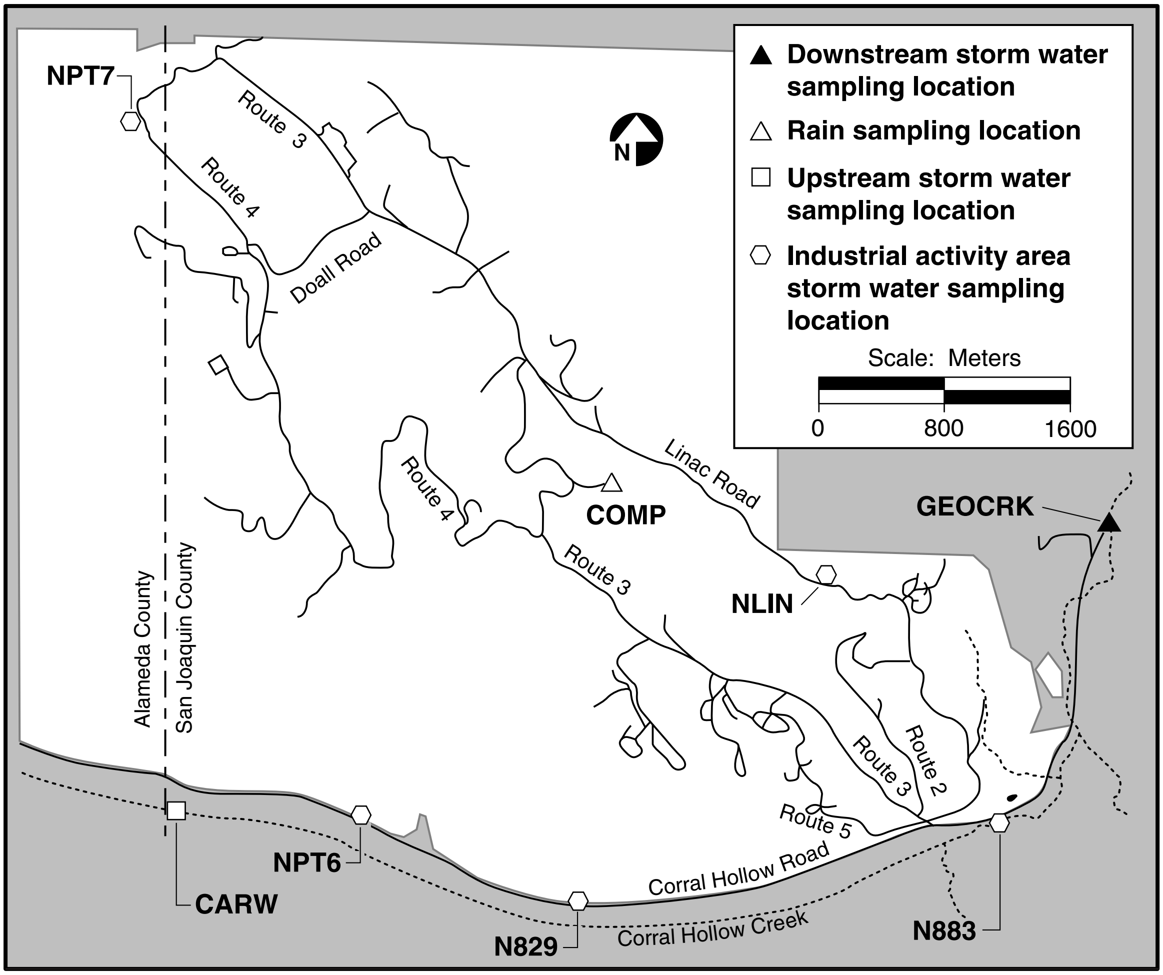

Figure 7-3. Surface water flow in the vicinity of Site 300.

Results

Inspections

All 12 directorate-level organizations at the Livermore site conducted the permit-required annual inspections during 1999. These inspections of more than 500 facilities indicated that all BMPs were in place, implemented, and adequate to protect storm water in all but five instances at the Livermore site. Three of the exceptions noted were the absence of BMPs for the outdoor storage of materials (paint cans, batteries, and drums). The paint cans and batteries were removed, and the drums are being evaluated to determine if secondary storage is necessary. In addition, there was one instance where dumpster covers were missing. The dumpster covers are being replaced. Finally, rainwater was observed in secondary containment pallets in one area. The rainwater was removed and disposed of properly. All Site 300 inspections of more than 100 facilities indicated that the applicable BMPs were in place, implemented, and adequate to protect storm water.

LLNL conducted the permit-required inspections before and after rain events at four permitted construction sites: three at the Livermore site and one at Site 300. The findings of these inspections indicated compliance with the permit and the construction site SWPPPs with these exceptions documented in the 1998/1999 annual compliance certifications:

- There were two instances on the Contained Firing Facility construction project where the SWPPP was not updated as required: (1) a new area of the project was not included, and (2) the SWPPP was not updated at the start of a new construction package.
- The Soil Reuse Project SWPPP was not updated as required to show the more protective BMPs being employed on the project.
- The NIF project did not perform inspections as required at some of the project’s laydown areas, and on the main construction site some BMPs were not repaired within the 48-hour time period specified in the SWPPP.

Livermore Sampling

LLNL collected storm water samples at all nine Livermore site locations on February 8 and April 8, 1999. Samples were collected from six locations on January 20, 1999. Three locations did not produce flow on this date but were sampled during a later storm that occurred on January 26, 1999. Samples were collected from eight locations on November 8, 1999; no sample was collected at location ASS2 because there was no flow at this location. Fish toxicity analyses were conducted on the January 20, 1999, sample.

Toxicity Monitoring

As required by WDR 95-174, grab samples were collected and analyzed for acute and chronic toxicity using the fathead minnow (*Pimephales promelas*) as the test species. In the acute test, the 96-hour survival test was observed in undiluted storm water collected from location WPDC. The permit states that an acceptable survival rate is 20% lower than the control sample. The testing laboratory provides water for the quality control sample. As specified by the permit, upgradient water from influent locations ALPE, ALPO, and GRNE is used as an additional control. Thus, a difference of more than 20% between location WPDC and the control sample with the lowest survival rate is considered a failed test. If the test is failed, the permit requires LLNL to conduct additional toxicity testing during the next significant storm event. If two consecutive tests fail, LLNL must perform a toxicity reduction evaluation to identify the source of the toxicity. Survival in the acute test at WPDC and all corresponding influent locations (ALPE, ALPO, and GRNE) was 100% in 1999 (sampled January 20).

In the chronic test, storm water dilutions of 0 (lab control), 6.25, 12.5, 25, 50, and 100% (undiluted storm water) were used to determine a dose-response relationship, if any, for both survival and growth of the fathead minnow (see **Table 7-2**). No criteria are set for this test; it is performed for information purposes only. Also, because this test is only required at effluent location WPDC and not conducted with water from corresponding influent locations, there is no way to determine if any effect should be attributed to LLNL or to upgradient water quality. From the data collected for this test, no observed effect concentrations (NOECs) and lowest observed effect concentrations (LOECs) were calculated using *EPA/600/4-91-002*. The NOECs and LOECs for survival and growth were 100%. Thus, both the acute and chronic fish toxicity tests indicated that storm water had no effect on survival or growth of the fathead minnow.

Table 7-2. Fish chronic toxicity test results, Livermore site, 1999.

Sample concentration (%)	7-day survival		7-day weight[(a)]	
	Average (%)	Standard deviation	Average (mg)	Standard deviation
Lab control	100	0	0.64	0.060
6.25	95	5.8	0.53	0.058
12.5	98	5.0	0.44	0.221
25	95	5.8	0.52	0.084
50	95	10.0	0.58	0.056
100	98	5.0	0.56	0.100

[a] Weight of the fathead minnows at the end of the 7-day toxicity test.

Livermore Site Radioactive Constituents

Storm water tritium, gross alpha, and gross beta results are summarized in **Table 7-3**. Complete results are in the Data Supplement Tables 7-2, 7-3 and 7-4. Median activities at effluent locations were less than 10% of the respective MCLs. **Figures 7-4** and **7-5**, which show the historic trend in storm water gross alpha and gross beta, respectively, do not reveal a discernible trend. In these and other storm water historical trend figures, LLNL has aggregated all available data for the influent and effluent locations of the two runoff pathways through the Livermore site. Also, data have been aggregated on a wet season basis—that is, October of one year through May of the next—rather than on a calendar-year basis. The 1999 points represent a partial wet season, pending collection of year 2000 data, and are based on only one sampling event (November 8, 1999).

Table 7-3. Radioactivity in storm water runoff (Bq/L), Livermore site, 1999.

	Tritium	Gross alpha	Gross beta
All locations			
Median	17.4	0.0642	0.179
Minimum	–0.903	0	0.0351
Maximum	7215	0.477	0.655
Interquartile range	36.9	0.0773	0.120
Effluent locations			
Median	19.4	0.0381	0.184
Minimum	–0.703	0	0.109
Maximum	129	0.0681	0.237
Interquartile range	42.4	0.0445	0.0935
MCL[a]	740	0.555	1.85

[a] MCL = Maximum contaminant level

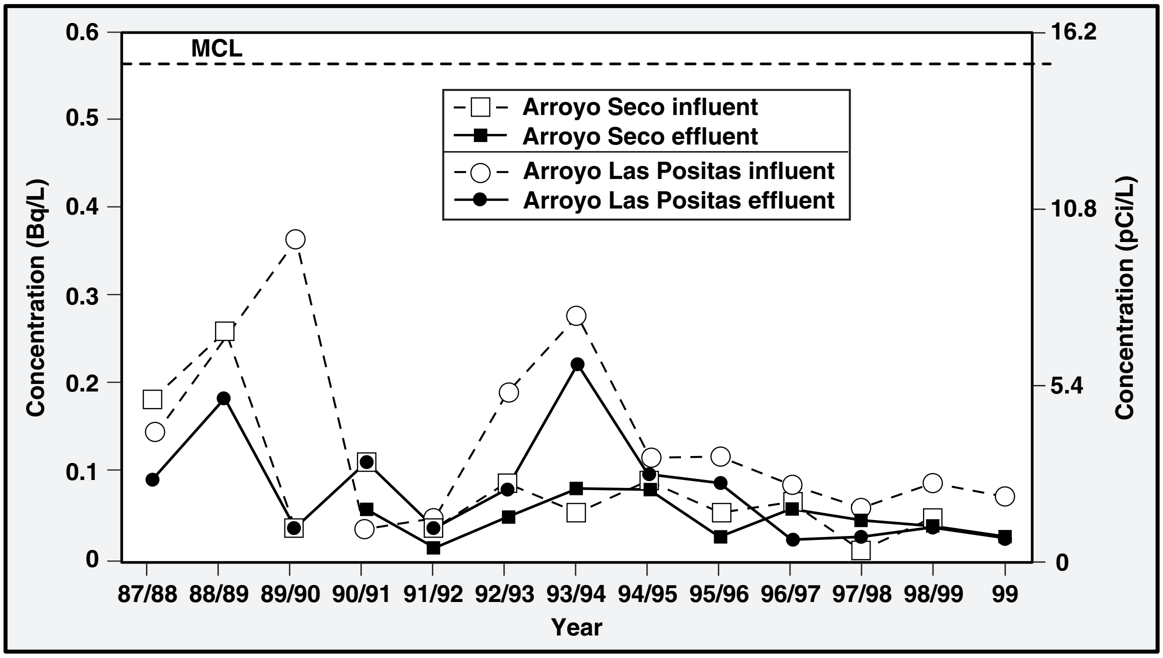

Figure 7-4. Annual median gross alpha concentrations in Livermore site storm water compared with the maximum contaminant level (MCL).

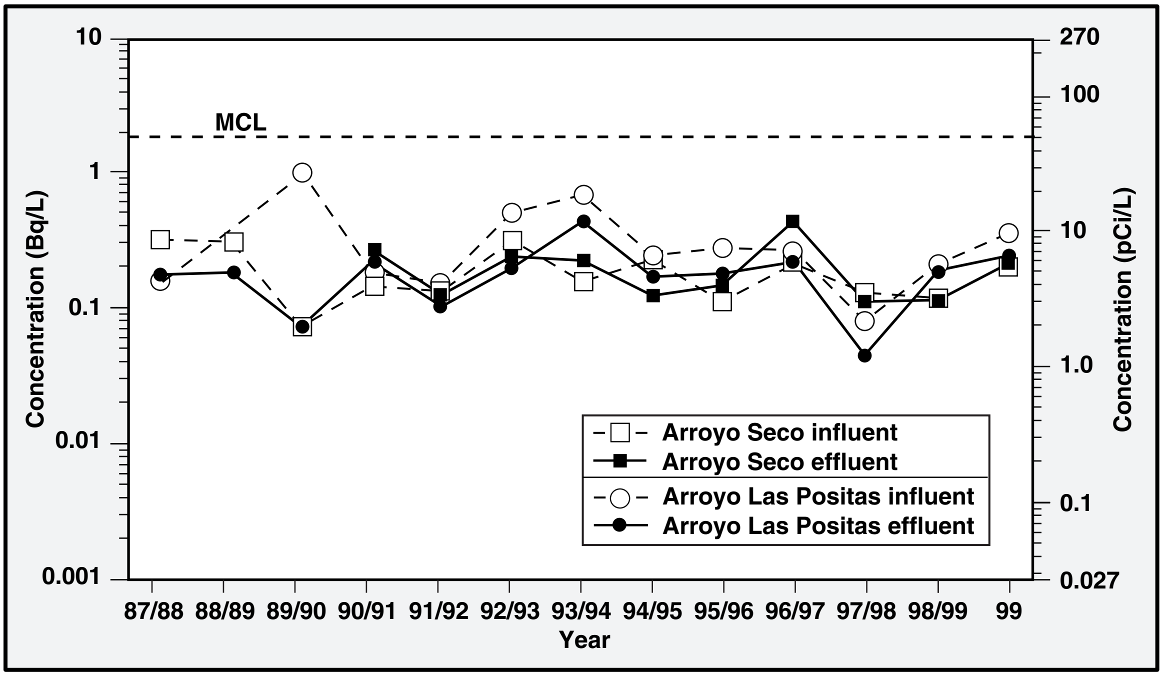

Figure 7-5. Annual median gross beta concentrations in Livermore site storm water compared with the maximum contaminant level (MCL).

The historical trend in tritium levels is presented in **Figure 7-6**. Prior to the 1998/1999 wet season, the analytical laboratory reported the minimum detectable level for nondetections, and these values were used in calculating medians for the plots. Beginning in the 1998/1999 wet season, changes in laboratory reporting procedures included reporting a "calculated value" for nondetections. The calculated value is an estimate of an unmeasurably low level. It is less than the minimum detectable level, and can even be negative (due to subtraction of background radiation). (See Chapter 14 for a complete explanation of calculated values.) Under the former reporting method, medians involving nondetections were biased high. This change in reporting procedures results in a better estimate, on average, of the true level. At some locations the decrease in tritium levels in the 1998/1999 wet season represented on **Figure 7-6** may be a result of the new reporting procedures. The historical trend in tritium levels generally correlates with decreased emissions (see Chapter 5), and indicates decreasing tritium levels in storm water from a peak in the 1988/1989 season.

Beginning with the 1996/1997 season, the tritium concentration in Arroyo Las Positas has been higher in storm water leaving the site than in storm water entering the site. On May 23, 1997, at location WPDC, where effluent is measured, a single higher-than-typical result for tritium in storm water (359 Bq/L) was measured.

In response to the elevated effluent tritium concentrations, additional tritium investigations were initiated in the fall of 1998 to reconfirm the current evidence that effluent tritium concentration is greater than influent tritium concentration and to identify sources for the higher tritium concentrations. These investigations included:

- Review of air tritium sampling results (the air tritium data during and prior to 1998 did not indicate a source for the tritium).
- Increased frequency of rain sampling.
- Increased frequency and number of locations of storm water sampling.

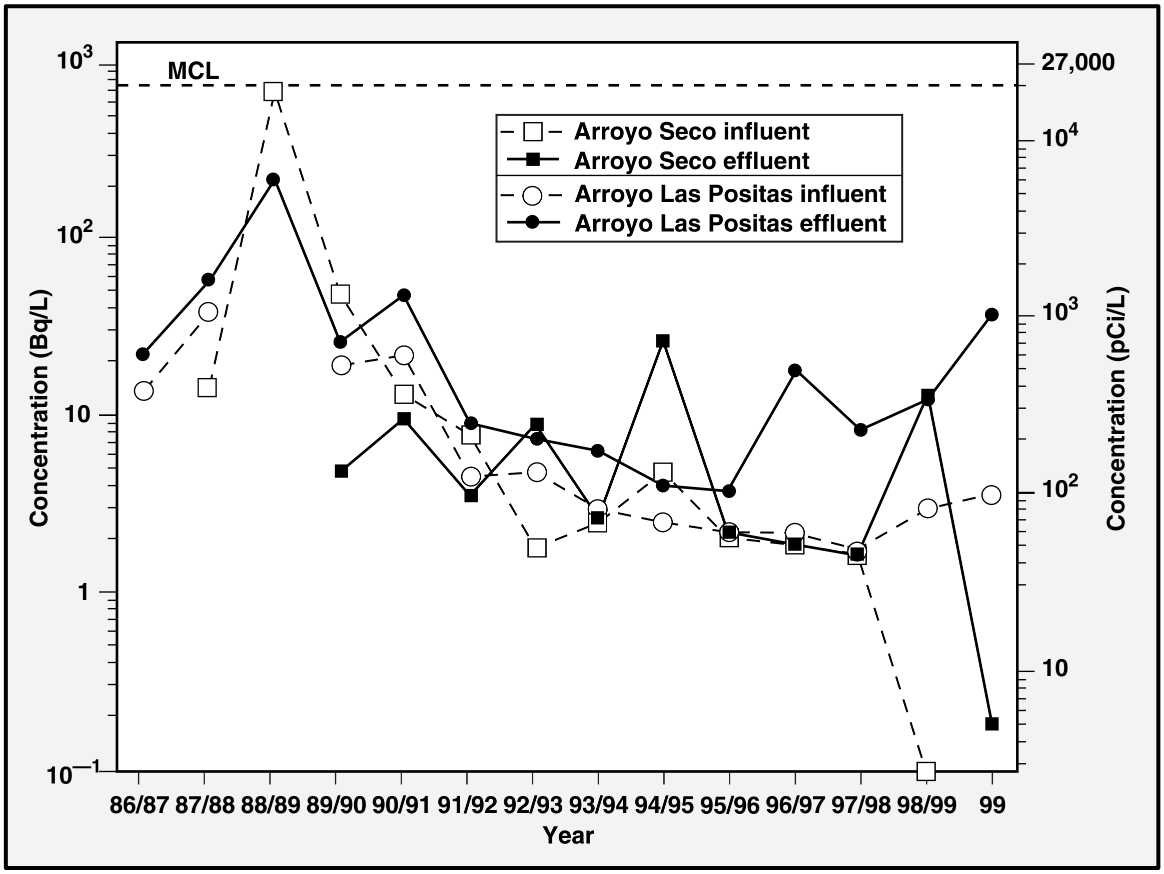

Figure 7-6. Annual median tritium concentrations in Livermore site storm water compared with the maximum contaminant level (MCL). Negative results were assigned a value of 10^{-1} for plotting purposes

The initial approach taken to evaluate tritium flow patterns across the Livermore site was to evaluate two locations (WPDW and 196S in **Figure 7-7**) where the storm drainage channels join the main Arroyo Las Positas channel slightly upstream of where Arroyo Las Positas leaves the Livermore site effluent location (WPDC). Samples were collected at these junctures on November 30, 1998, and reported in the *Environmental Report 1998* (Larson et al. 1999). Tritium was not detected in the incoming channels (calculated values of 2.0 and 0.9 Bq/L at WPDW and 196S, respectively), but was detected at 31 Bq/L in the main Arroyo Las Positas channel at both WPDS and 196E. Additional locations were added in each subsequent sampling event during the spring of 1999 to further evaluate the tritium flow patterns (**Figure 7-7**). There was a general increase in runoff tritium detected at internal sampling locations during the course of the wet season (Data Supplement Tables 7-2 and 7-3). **Figure 7-7** demonstrates that the source was from the north-south channel, sampled at locations 3726 and 2582.

During this same time period (beginning in mid-January 1999), analytical results from molecular sieves that monitor stack effluent at Building 331 (the Tritium Facility) began to show evidence of above-normal releases of tritium (detected as both tritiated hydrogen and tritiated water, or HT and HTO). On March 28, facility staff located a glove box with a faulty pump that was causing the glove box contents to vent directly to the building stack. The pump/glove box was repaired on March 29, and storm water effluent tritium levels returned to levels seen in recent years. The highest site storm water effluent tritium level (58.5 Bq/L, or 1580 pCi/L) was collected February 8, compared to 11.1 Bq/L (301 pCi/L) collected on April 8.

Based on the sample results described above, the north-south channel containing locations 3726 and 2582 will be the focus of the tritium source investigation for year 2000. Additional storm water sampling locations will be added to this flow path to further investigate this source. LLNL will also evaluate sampling sediment for tritium in this area.

LLNL began analyzing for plutonium in storm water in 1998. Samples were analyzed from the Arroyo Seco and Arroyo Las Positas effluent locations (ASW and WPDC). When the samples were low in suspended sediments (January 26 and February 8), the unfiltered water was analyzed. At intermediate suspended sediment levels (April 8), the runoff was filtered, and the filtered water and filtrate were analyzed. When the laboratory determined that sufficient suspended sediment was present in the runoff (as in the November 8 sample), a portion of the runoff was analyzed unfiltered, and the remaining runoff was filtered. The filtrate and filtered water were analyzed (three analyses total from each location). Plutonium was never detected in the liquid portion

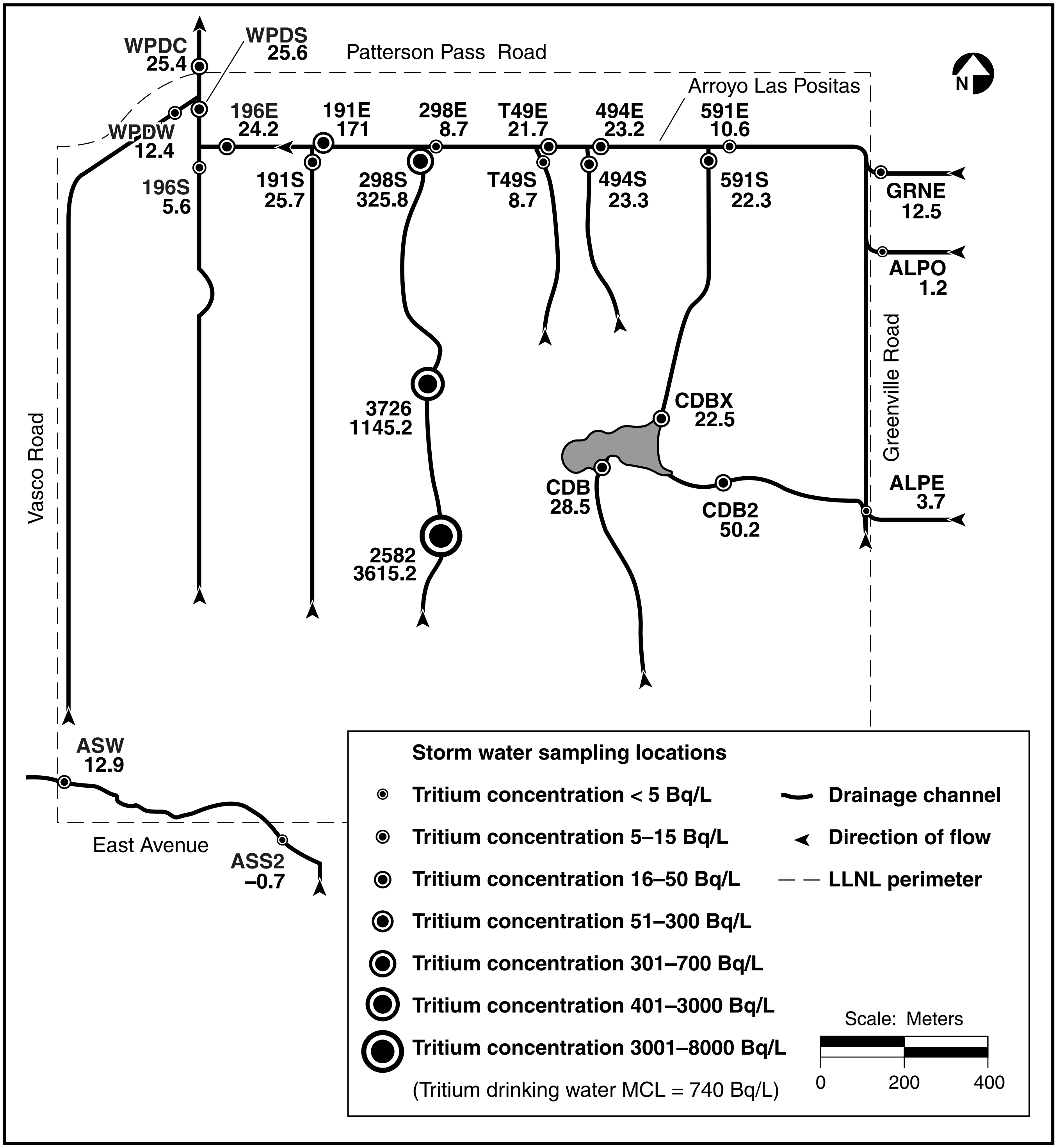

Figure 7-7. Median tritium concentrations in storm water runoff at the Livermore site, 1999.

of 1999 runoff. The only plutonium detected in 1999 was in the filtrate from the November 8 sample from location WPDC (4.22×10^{-4} Bq/g of plutonium-239+240). This value is comparable to plutonium-239+240 levels routinely seen in sediments at the location and is below the background level (4.44×10^{-4} Bq/g) for sediments. This background concentration reflects worldwide fallout and naturally occurring concentrations (see Chapter 10). Thus, there is no evidence in the data to indicate that LLNL has contributed plutonium to runoff. Complete plutonium results are found in Data Supplement Table 7-4.

Livermore Site Nonradioactive Constituents

Sample results were compared to the criteria in Table 7-1 of the Data Supplement. Of greatest concern are the constituents that exceeded comparison criteria at effluent points and whose concentrations are lower in influent than in effluent. If influent concentrations are higher than effluent concentrations, the source is generally assumed to be unrelated to LLNL operations; and, therefore, further investigation is not warranted. Constituents that exceeded comparison criteria, and for which effluent concentrations were higher than influent concentrations, are listed in **Table 7-4**. All the constituents identified by this screening process were metals, which were attributed to naturally occurring concentrations transported in sediments during a previous 2-year study (Brandstetter 1999). Furthermore, nearly half of the high effluent values occurred in Arroyo Seco on January 26; on this date, effluent total suspended solids (TSS) concentration was nearly three times higher than influent TSS concentration, indicating that the source is runoff-borne sediments. Under the requirements of WDR 99-086, LLNL will perform an analysis of Arroyo Seco and develop a management plan that includes a proposal to stabilize the channel and banks. Zinc was the only constituent identified by the screening process for other storm water sampling events. Complete storm water results for nonradioactive constituents are presented in Data Supplement Tables 7-5, 7-6, and 7-7.

Site 300 Sampling

LLNL procedures specify sampling of a minimum of two storms per rainy season from Site 300. Typically, a single storm will not produce runoff at all Site 300 locations because Site 300 receives relatively little rainfall and is largely undeveloped. Therefore, at many locations, a series of large storms is required to saturate the ground before runoff occurs. In 1999, samples were collected at locations with flow on February 9 and April 8. There was no detectable tritium in Site 300 storm water during 1999. The maximum of all effluent and downstream gross alpha and gross beta results were 0.37 and 0.48 Bq/L, respectively, approximately 65% and 25% of their MCLs (0.56 and 1.85 Bq/L). Upstream (location CARW) gross alpha and gross beta activities ranged as high as 3.7 and 5.1 Bq/L, respectively. A previous study (Harrach et al. 1996) demonstrated a relationship in Site 300 runoff between naturally occurring isotopes in suspended solids, and gross alpha and gross beta. TSS concentrations in the 1999 CARW samples are consistent with the results of that study, indicating that the high gross alpha and gross beta are from natural sources. Complete data results are in Data Supplement Table 7-8.

Table 7-4. Nonradioactive constituents above comparison criteria in storm water runoff, Livermore site, 1999.

Metal (mg/L)	Requested analysis	Storm date	Arroyo Seco			
			Influent ASS2		Effluent ASW	
			Dissolved	Total	Dissolved	Total
Aluminum	GENMIN	1/26		0.92	0.21	3.6
	NPDESMETAL			0.88	0.27	3.3
Iron	GENMIN	1/26		0.97		3.8
	NPDESMETAL			0.95		3.7
Manganese	GENMIN	1/26				0.074
	NPDESMETAL					0.073
Zinc	GENMIN	1/26		0.081		0.098
	NPDESMETAL			0.078		0.097
	GENMIN	2/8		0.077	0.042	0.085
	NPDESMETAL			0.074	0.04	0.08
	NPDESMETAL	4/8	0.058		0.062	

Metal (mg/L)	Requested analysis	Storm date	Arroyo Los Positas							
			Influent						Effluent	
			ALPE		ALPO		GRNE		WPDC	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Zinc	GENMIN	1/20							0.055	
	NPDESMETAL								0.058	
	GENMIN	2/8				0.047		0.083		0.086
	GENMIN	4/8		0.033		0.096		0.07		0.013
	NPDESMETAL					0.088	0.034	0.079	0.046	0.097

Tables 7-9, 7-10, and 7-11 in the Data Supplement list results for nonradioactive constituents in Site 300 storm water runoff. Because of a CERCLA remedial investigation finding of past releases of polychlorinated biphenyls (PCBs) and dioxins related to activities in the vicinity of Building 850, analysis for PCBs and dioxins was conducted at location NLIN, the storm water sampling location downstream of Building 850. The intent of the sampling was to determine whether these constituents are being released from the site in storm water runoff. PCBs, dioxins, and furans were detected at low levels (maximum of 2800 pg/L, or 2.8×10^{-6} mg/L); all concentrations were below MCLs and other comparison criteria.

Sampling at Pit 6 includes analyses required as part of the post-closure sampling (Table 7-11 in the Data Supplement). All post-closure sample results were below comparison criteria.

Specific conductance and TSS at Site 300 locations were at times above comparison criteria (see Table 7-1 in the Data Supplement); however, effluent levels were lower than levels at the upstream location (CARW), indicating that the levels observed in effluent are typical for the area. Results for pH were below the MCL and AWQC minimum (6.5) at location IV883 in both storm events sampled (6.04 and 6.1). All other Site 300 results were below comparison criteria.

Rainfall

This section discusses general information about rainfall in the Livermore site, Livermore Valley, and Site 300, as well as methods for sampling rainfall and the sampling results.

General Information

Livermore Site and Livermore Valley

Historically, the tritium activity measured in rainfall in the Livermore Valley resulted primarily from atmospheric emissions of HTO from stacks at LLNL's Tritium Facility (Building 331), and Sandia National Laboratories/California's (Sandia/California) former Tritium Research Laboratory. The Building 343 rain sampling location is near the Tritium Facility (Building 331). The total measured atmospheric emission of HTO from LLNL facilities in 1999 was 7.9 TBq, equal to 214 Ci (see Chapter 4).

The rain sampling station locations are shown on **Figure 7-8.** The fixed stations are positioned to record the maximum activity expected down to background levels.

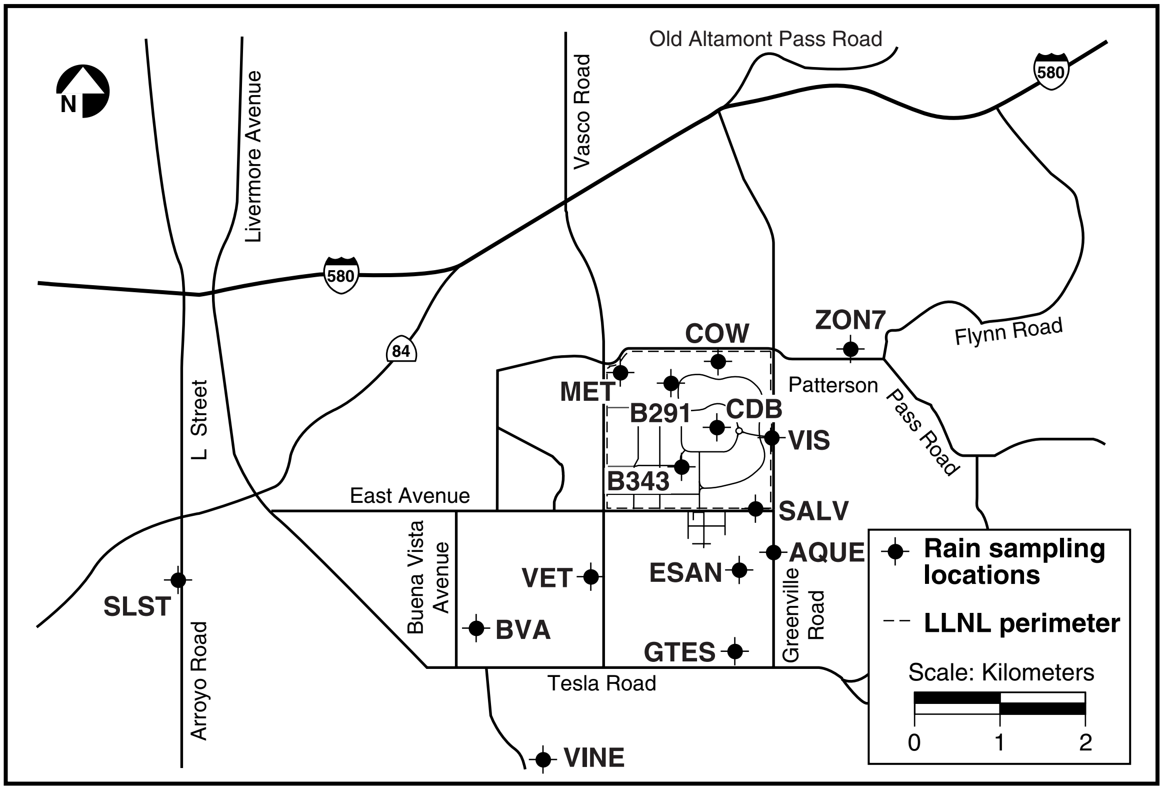

Figure 7-8. Rain sampling locations, Livermore site and Livermore Valley, 1999.

Site 300

One central location (COMP) is used to collect rainfall for tritium activity measurements at Site 300 (**Figure 7-3**). Rainfall is composited (i.e., added together) for each month and analyzed when there is sufficient volume.

Methods

Rainfall is sampled for tritium according to written procedures, described in Appendix B of the *Environmental Monitoring Plan* (Tate et al. 1999) and summarized here. Rainfall is collected in stainless steel buckets mounted about 1 m above the ground at specified locations. Samples are decanted into 500-mL argon-flushed amber glass bottles with Teflon-lined lids and analyzed for tritium.

Results

Livermore Site and Livermore Valley

LLNL collected rainfall samples four times in 1999. Complete data are shown in Table 7-12 of the Data Supplement. The Livermore site rainfall has exhibited elevated tritium activities in the past (Gallegos et al. 1994). During 1999, measurements of tritium activity in rainfall were all below the 740 Bq/L MCL established by the EPA for drinking water. The highest overall activity was 540 Bq/L (see **Table 7-5**), measured on March 23, 1999, near Building 343, just to the north of the on-site Tritium Facility. This value is approximately 73% of the MCL for tritium. The highest off-site activity was 30.7 Bq/L, recorded in a sample collected from station ZON7 on February 10, 1999.

Table 7-5. Tritium activities in rainfall for the Livermore site and Livermore Valley, 1999.

	Livermore site (Bq/L)	Livermore Valley (Bq/L)
Maximum	540 ± 11	30.7 ± 3.2
Minimum	–5.11 ± 2.16	–7.33 ± 2.00
Median	19.0	2.53
Interquartile range	71.1	9.39
Number of samples	28	30

Similar to tritium concentrations in storm water, the concentrations of tritium in rain generally increased during the course of the wet season. The highest tritium concentration was measured in March. On March 29, when the Building 331 (the Tritium Facility) pump/glove box was repaired, the concentrations of tritium in rain were reduced. The highest tritium concentration (540 Bq/L) observed during 1999 was in a rain sample collected on March 23, compared to 154 Bq/L in a rain sample collected on April 9.

The median tritium activity measured in rainfall on site at LLNL increased from 5.59 Bq/L (151 pCi/L) in 1998 to 19.0 Bq/L (514 pCi/L) in 1999. However, median tritium activity measured in rainfall on site at LLNL remains decreased since 1990, down from 65.9 Bq/L (1780 pCi/L) to 19.0 Bq/L (514 pCi/L). This decrease mirrors the downward trend in total HTO emissions from LLNL's Tritium Facility and the closure of Sandia/California's former Tritium Research Laboratory. The increase in tritium activity in rainfall from 1998 to 1999 follows an increase in tritium emissions from LLNL's Tritium Facility from 4 TBq in 1998 to 10 TBq in 1999. These trends are shown in **Figure 7-9**. Rainfall will be sampled at additional locations and at an increased frequency in 2000 in order to understand the pattern of tritium activity in rainfall samples.

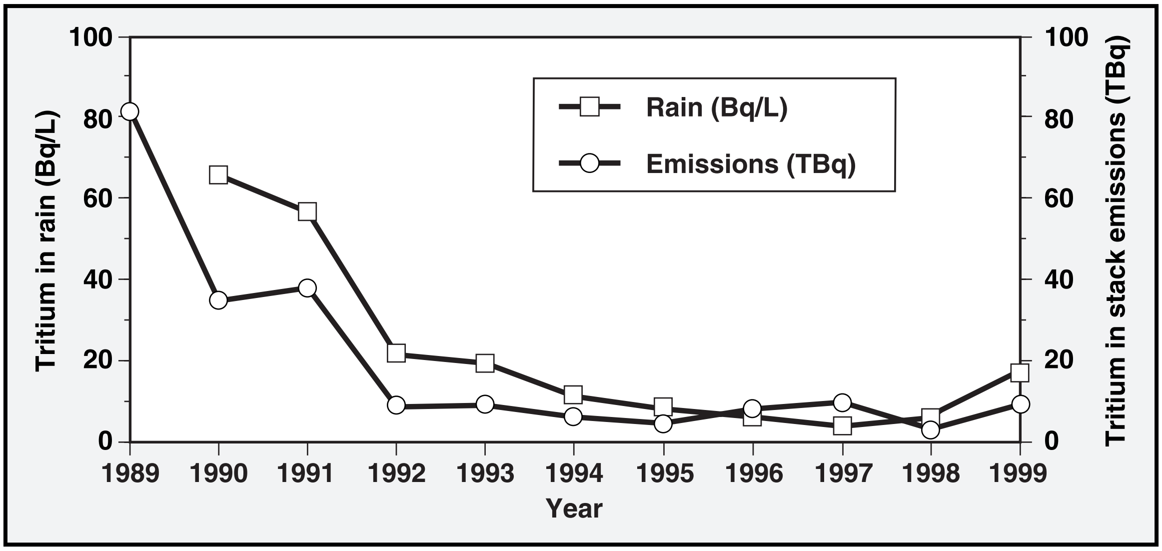

Figure 7-9. Trends of median tritium activity in rain and total stack emissions of HTO from the Livermore site and Sandia/California, 1989–1999. Emissions from 1996–1999 are from LLNL only.

Values for median tritium activity shown in **Figure 7-9** are derived from the six on-site rain sampling locations (Building 343, Building 291, CDB, SALV, VIS, and COW) that historically have given the highest activities. A decrease in total HTO emissions has occurred since 1990, down from 34.9 TBq (943 Ci) to 8.1 TBq (220 Ci).

Site 300

During 1999, Site 300 rain samples were analyzed for January, February, March, and April, with tritium activities of –5.74 ± 1.49, 0.241 ± 1.88, –1.45 ± 1.27, and 1.01 ± 2.70 Bq/L, (–155 ± 40.4, 6.52 ± 50.8, –39.1 ± 34.3, and 27.4 ± 73.1 pCi/L), respectively. These values are all below the minimum detectable activity.

Livermore Site Drainage Retention Basin

This section discusses general information about the DRB, sampling methods, and sampling results.

General Information

Previous environmental reports detail the history of the construction and management of the DRB (see Harrach et al. 1995–1997). In 1997, LLNL began to discharge treated ground water routinely to the DRB. In 1999, discharges from Treatment Facility D, Treatment Facility E, and related portable treatment units continued to be a year-round source of water entering the DRB. Wet weather flows into the DRB are still dominated by storm water runoff, but dry weather discharges from the treatment facilities now constitute a substantial portion of the total water entering and exiting the DRB.

The SFBRWQCB regulates discharges from the DRB within the context of the Livermore site CERCLA *Record of Decision* (U.S. Department of Energy 1993), as modified by the *Explanation of Significant Differences for Metals Discharge Limits at the Lawrence Livermore National Laboratory Livermore Site* (Berg 1997a). The CERCLA Record of Decision establishes discharge limits for all remedial activities at the Livermore site to meet applicable, relevant, and appropriate requirements derived from the Federal Clean Water Act, the Federal and State Safe Drinking Water Acts, and the California Porter-Cologne Water Quality Act.

The DRB sampling program implements requirements established by the SFBRWQCB and modified in 1997 (Galles 1997a). The program consists of monitoring wet and dry weather releases for compliance with discharge limits, and monitoring internal DRB water quality to support management actions, characterize water quality before its release, and perform routine reporting.

LLNL samples DRB discharges (at location CDBX) and the corresponding site outfall (at location WPDC) during the first release of the rainy season, and from a minimum of one additional storm (chosen in conjunction with storm water runoff sampling). During the dry season, samples are collected from each discrete discharge event. Discharge sampling locations CDBX and WPDC are shown in **Figure 7-2**. Samples are collected at CDBX to determine compliance with discharge limits. Sampling at WPDC is done to identify any change in water quality as DRB discharges travel through the LLNL storm water drainage system and leave the site. Sampling frequencies for CDBX and WPDC and effluent limits for discharges from the DRB, applied at CDBX, are found in Table 7-13 of the Data Supplement.

The routine management constituents, management action levels, and the monitoring frequency that apply to water contained in the DRB are identified in Data Supplement Table 7-14. Sampling to determine whether water quality management objectives are met is conducted at several points within the DRB. Dissolved oxygen content and temperature are measured at eight locations (**Figure 7-10**). Because of limited variability

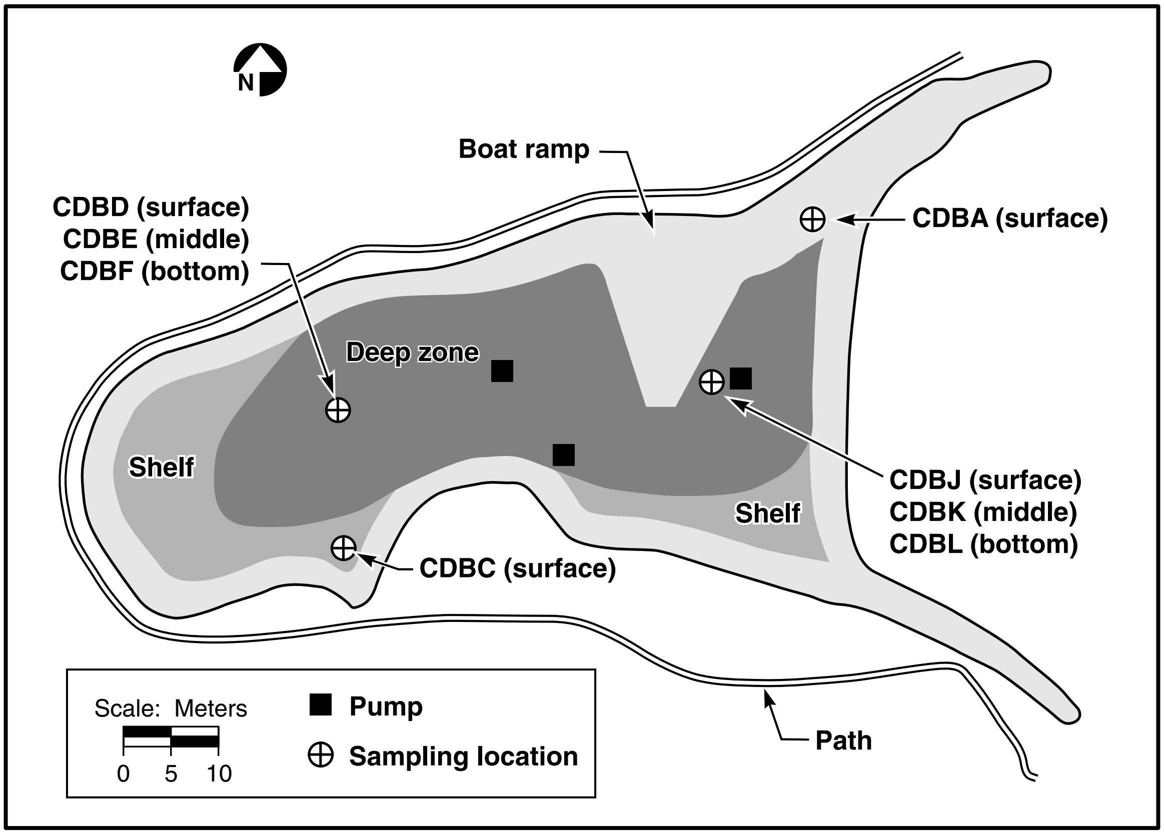

Figure 7-10. Sampling locations within the Drainage Retention Basin, 1999.

among sampling locations, all samples are routinely collected from sample location CDBE. CDBE is located at the middle depth of the DRB. For purposes of determining discharge monitoring requirements and frequency, the wet season is defined as October 1 through May 31, the period when rain-related discharges usually occur (Galles 1997a). Discharge limits are applied to the wet and dry seasons as defined in the *Explanation of Significant Differences for Metals Discharge Limits at the Lawrence Livermore National Laboratory Livermore Site* (Berg 1997a) (wet season December 1 through March 31, dry season April 1 through November 30).

Every quarter LLNL submits a report summarizing weekly, monthly, quarterly, semiannual, and annual monitoring of the basin to the SFBRWQCB. The *Drainage Retention Basin Management Plan* (DRB Management Plan) (Limnion Corporation 1991) identifies biological and microbiological surveys that are to be used as the primary means to assess the long-range environmental impact of the DRB. LLNL monitors plant and animal species at the DRB, the drainage channels discharging into the DRB, and downstream portions of Arroyo Las Positas. These surveys are conducted semiannually to identify the presence or absence of species. Surveys include amphibians, birds, fishes, and mammals. Plant surveys are also done in the spring and the fall. During 1999, LLNL lacked resources to conduct the microbiological surveys but continued the biological surveys.

Methods

Sample collection procedures are discussed in Appendix B of the *Environmental Monitoring Plan* (Tate et al. 1999). All samples from the DRB are collected as grab samples. Field measurements for dissolved oxygen and temperature are made using a dissolved oxygen/temperature meter. Turbidity is measured using a Secchi disk. Certified laboratories analyze the collected samples. Flow measurements were not made during 1999.

Biological and microbiological methods are discussed in detail in the *Environmental Monitoring Plan* (Tate et al. 1999). Biological surveys are conducted by LLNL's biologist. Animal surveys follow standard survey protocols such as *Raptor Management Techniques Manual* (Pendleton 1987), *Inventory and Monitoring of Wildlife Habitat* (Cooperrider 1986), and *Wildlife Management Techniques Manual* (Schemnitz 1980). Vegetation surveys use protocols identified in the *U.S. Army Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987).

Results

Samples collected during 1999 within the DRB at CDBE did not meet the management action levels for dissolved oxygen concentration and saturation, temperature, turbidity, nitrate (as N), total dissolved solids (TDS), total phosphorus (as P), ammonia nitrogen (as N), chemical oxygen demand, pH, specific conductance, and lead (**Table 7-6**). No action was taken to adjust nutrient levels. LLNL continued to operate the DRB circulation pumps to increase the dissolved oxygen levels. No action was taken in response to the temperature changes because the low temperatures were consistent with normal seasonal patterns.

Releases were outside the allowable pH discharge range of 6.5 to 8.5 four times (January 20, 8.77; April 8, 8.75; June 28, 8.82; and November 8, 8.52). The February 8 DRB discharge exceeded the lead discharge limit of 6.4 µg/L (7.9 µg/L) (Data Supplement Table 7-15).

Table 7-6. Summary of Drainage Retention Basin monitoring exceeding management action levels at sampling location CDBE.

Parameter	Management action level	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Field dissolved oxygen (mg/L)(a)	> 5	–	–	–	–	–	–	–	–	4.5	4.9	–	–
Oxygen saturation (%)(a)	< 80% saturation	–	78	–	–	70	72	–	64	52	51	66	65
Temperature (°C)(a)	<15.6 and >26.7	8.7	10.4	12.6	13	–	–	–	–	–	–	13.6	9.7
Turbidity (meters)(a)	<0.91	0.57	0.43	0.52	0.77	0.61	0.45	0.26	0.381	0.50	0.57	0.51	0.4826
Nitrate (as N)	> 0.2	1.7	1.2	0.57	–	0.33	0.77	1.2	0.59	0.49	1.2	2	1.9
pH	< 6.0 and > 9.0	9.09	–	9.24	9.08	9.13	9.06	–	–	–	–	–	–
Specific conductance (µmho/cm)	> 900	910	–	–	–	–	1000	1180	1160	1200	1210	1210	1100
Total dissolved solids (TDS) (mg/L)	> 360	510	457	372	414	435	600	745	680	695	700	735	653
Total phosphorus (as P) (mg/L)	> 0.02	0.08	0.12	0.17	0.1	0.21	0.21	0.21	0.12	0.14	0.14	0.13	0.1
Ammonia nitrogen (as N) (mg/L)	> 0.1	–	–	–	–	0.22	–	–	–	0.14	–	–	–
Chemical oxygen demand (mg/L)	> 20	–	–	–	46	–	–	–	27	–	–	–	–
Lead (mg/L)(b)	Wet season > 0.0064	–	0.0093	–	–	–	–	–	–	–	–	–	–

[a] Monthly average

[b] Wet-season management action level applies from April 1 through November 30.

Data for maintenance and release monitoring at sampling locations CDBA, CDBC, CDBD, CDBE, CDBF, CDBJ, CDBK, CDBL, CDBX, and WPDC and from the biological survey are presented in Tables 7-15 through 7-20 in the Data Supplement.

Chemical and Physical Monitoring

Surface water dissolved oxygen concentration monthly averages were at or above the management action level of at least 80% saturation of oxygen during all but 3 months. Middle depth samples monthly averages indicated that dissolved oxygen was below 80% saturation during 6 months, while the bottom depths samples were below 80% saturation in all but 2 months. (**Figure 7-11**). Dissolved oxygen concentrations can be manually increased using aeration pumps. These pumps are started whenever oxygen concentrations at any level of the DRB drop close to or below the critical management action level of 5 mg/L. In 1999, all three pumps operated continuously. During the colder

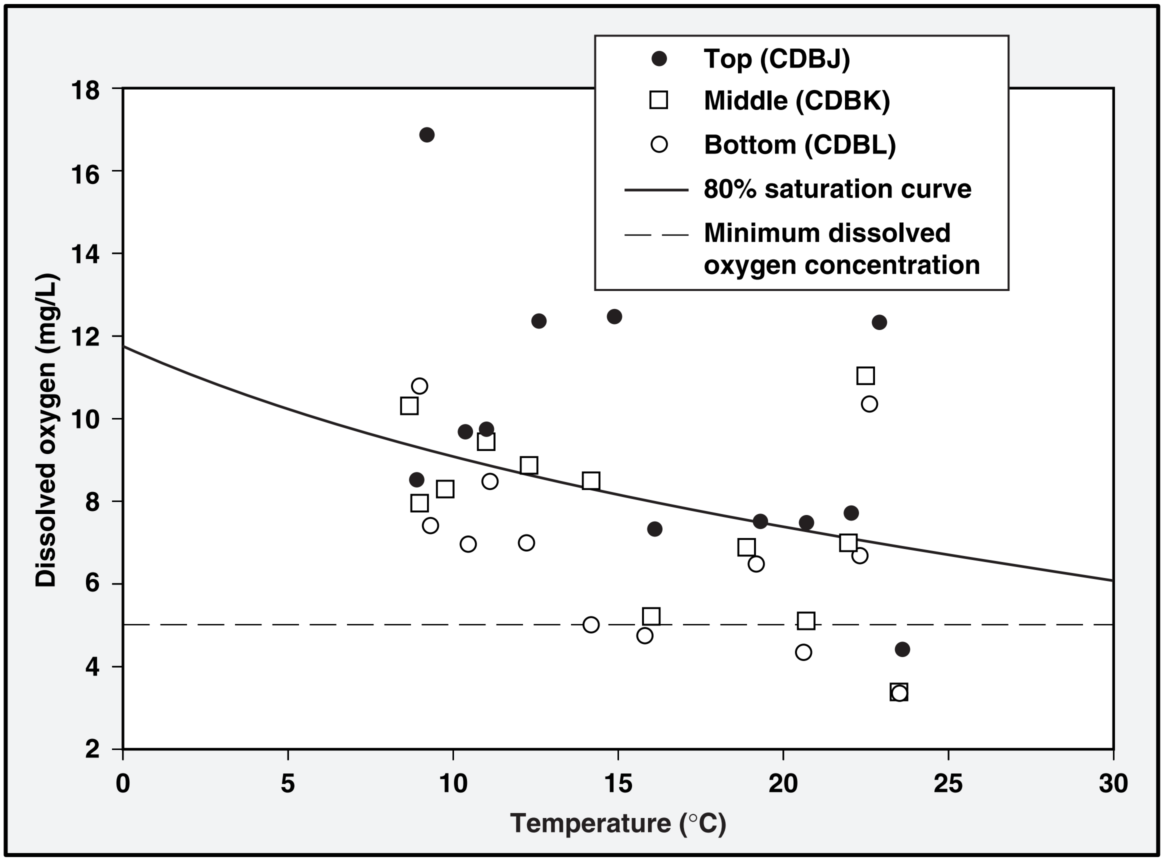

Figure 7-11. Monthly average dissolved oxygen vs temperature at each depth location in the Drainage Retention Basin, 1999.

winter months when the water has an increased capacity to contain oxygen, the dissolved oxygen levels were consistently above 5 mg/L. Dissolved oxygen concentrations at the surface, middle, and bottom elevations continued to differ during 1999 (**Figure 7-12**). Temperature, the other important parameter in determining how much oxygen is dissolved in water, showed characteristic seasonal trends (**Figure 7-13**). The uniform distribution of temperature in the top, middle, and bottom elevations reflects that the aerators were providing uniform physical mixing of the water.

Chemical oxygen demand was above management action levels during the second and third quarters of 1999. Chlorophyll-a had one winter and one summer peak. The elevated pH levels correspond to the period of the winter peak and may be associated with an occurrence of increased photosynthesis. The elevated pH within the DRB was reflected in the elevated pH during releases. The chlorophyll-a levels can be used as an indicator of alga population and of the duration and intensity of alga blooms.

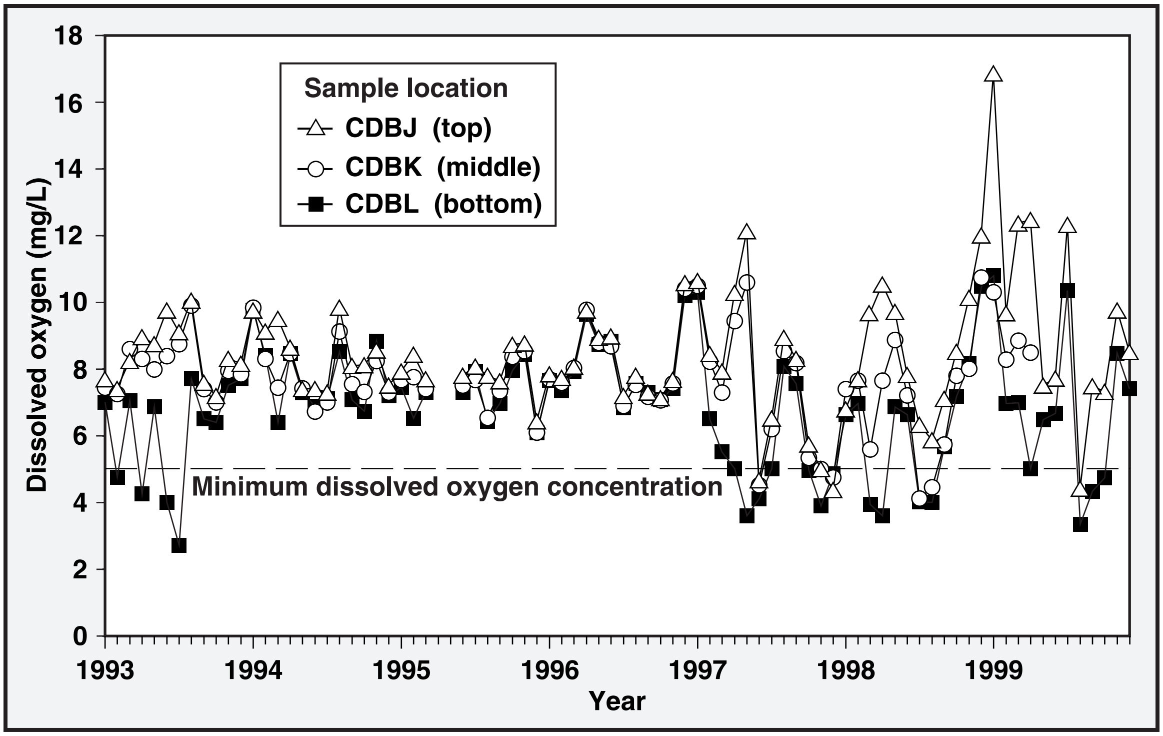

Figure 7-12. Monthly average dissolved oxygen concentration variations from the beginning of Drainage Retention Basin operations.

Turbidity rose above acceptable management levels during the 1993/1994 wet season and, through 1999, remained above the turbidity management action level. Wet season turbidity probably results from sediments that pass through the sediment traps discharging into the DRB. Turbidity seen during the warmer summer months is most likely the result of alga growth (Harrach et al. 1996). Turbidity is also caused by the operation of the aerators resuspending sediments and preventing smaller particles from settling. Lead exceeded the management action level at sample locations CDBE and CDBX during February.

Nutrient levels continued to be high during 1999. Nitrate and total phosphorous concentrations were well above management action levels throughout the year. Nitrate exceeded management action levels for all but one month of the year, while phosphorous exceeded management action levels every month. Sources of nitrate and phosphorous include storm water runoff and treated ground water discharges. In addition, ammonia exceeded the management action level during 2 months of the year. Ammonia formation is normally an indication of anoxic conditions. During 1999, total dissolved solids continued to exceed the management action levels with the concentration exceeding

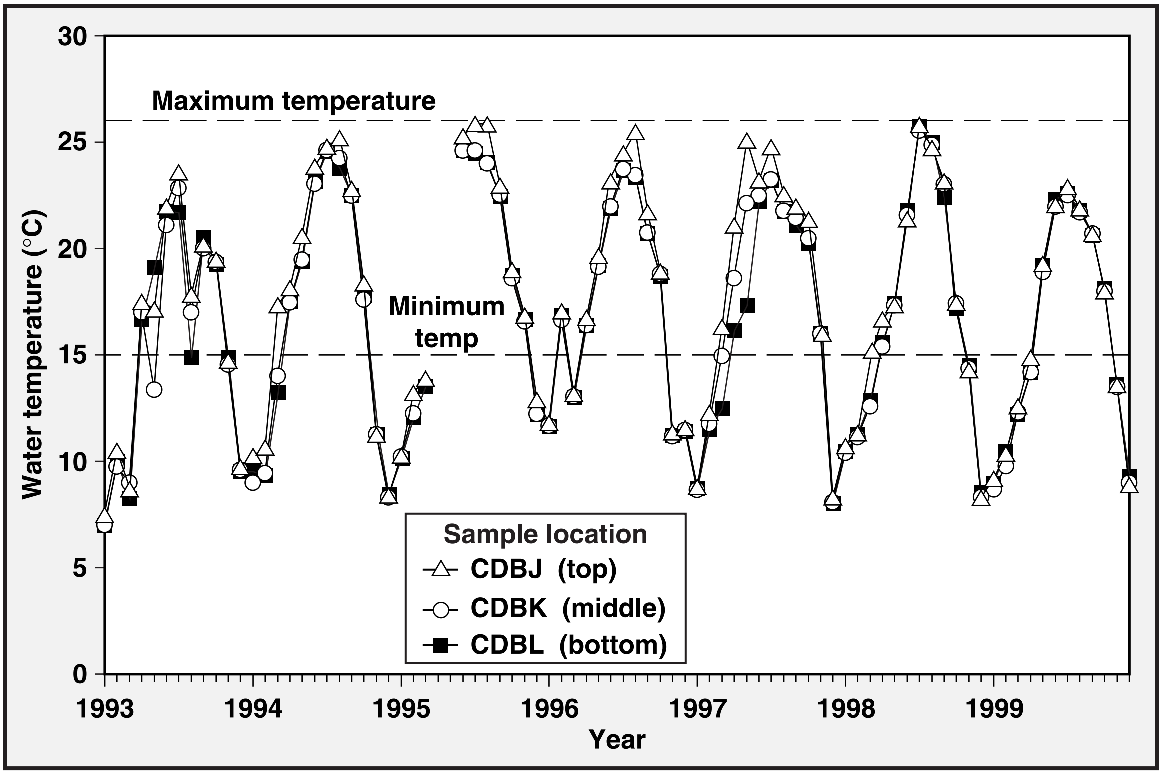

Figure 7-13. Monthly average seasonal temperature variation measured at sample top, middle, and bottom levels from the start of operations in 1993.

360 mg/L in all 12 months. Related to the increase in total dissolved solids is the increase seen in specific conductance. Specific conductance exceeded the management action level of 900 µmho/cm for 8 months.

Biological Monitoring

Biological monitoring has not been conducted long enough to identify any trends resulting from operation of the DRB. However, biological monitoring has shown an expansion in the wetland areas in Arroyo Las Positas as a result of the continuous discharges of water from the DRB and other sources of treated ground water throughout the dry season. The California red-legged frog (*Rana aurora draytonii*), a federally listed threatened species, was found in Arroyo Las Positas, the DRB, and in the southwestern DRB tributary (upstream from sample location CDB). A number of other species routinely use the DRB and are listed in Data Supplement Table 7-20.

Site 300 Cooling Towers

This section discusses general information about the Site 300 cooling towers, sampling methods, and sampling results.

General Information

LLNL samples cooling tower wastewater discharges as required by the Self-Monitoring Program of WDR 94-131, NPDES Permit No. CA0081396, and reports the results of the compliance sampling to the CVRWQCB quarterly.

Two primary cooling towers, located at Buildings 801 and 836A, regularly discharge to surface water drainage courses. The remaining 13 secondary cooling towers routinely discharge to percolation pits under a waiver of Waste Discharge Requirements from the CVRWQCB. Cooling tower locations are shown in **Figure 7-14**. (The Building 815 secondary cooling tower was removed from service in 1999.) The permit establishes separate effluent limits for the regular discharges from the primary cooling towers and secondary cooling towers that discharge only occasionally to surface water drainage courses. One secondary cooling tower discharged to a surface water drainage course in 1999.

Blowdown flow is monitored biweekly from the cooling towers located at Buildings 801 and 836A. TDS and pH are monitored quarterly at both locations.

Methods

Sample collection procedures are discussed in Appendix B of the *Environmental Monitoring Plan* (Tate et al. 1999) and summarized here. To determine the effects of the cooling tower blowdown on Corral Hollow Creek, the permit requires quarterly pH monitoring of the creek, both upstream (background) and downstream of the cooling tower discharges, whenever the creek is flowing. CARW is the upstream sampling location, and GEOCRK is the downstream sampling location (**Figure 7-14**). The GEOCRK sampling location is also fed by discharges of treated ground water from LLNL. Therefore, even when the upstream location is dry, there is often flow at GEOCRK. Field pH measurements, taken by LLNL technicians using calibrated meters, are used to monitor Corral Hollow Creek. These technicians also perform the required visual observations that are recorded on the field tracking forms along with the field pH measurements.

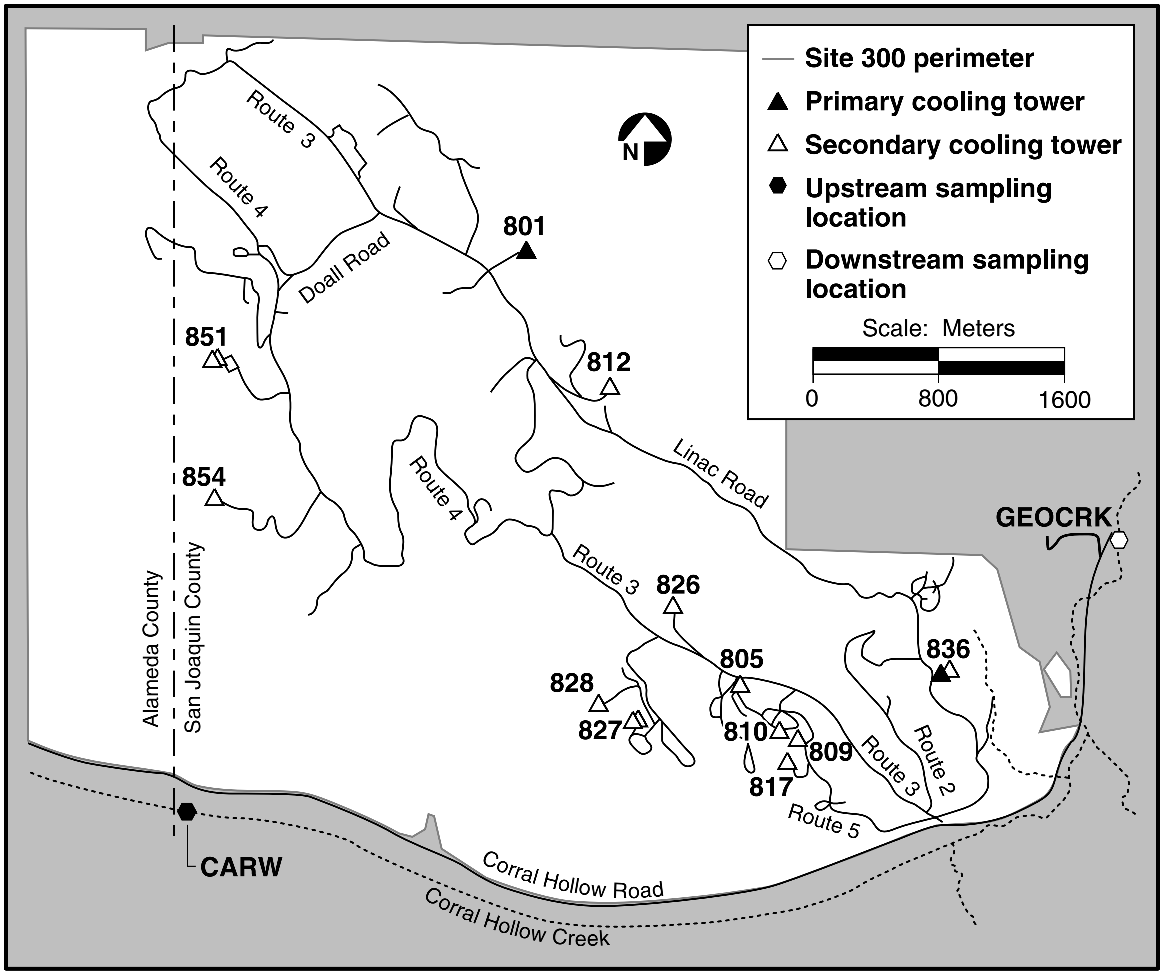

Figure 7-14. Cooling tower locations and receiving water monitoring locations, Site 300, 1999.

LLNL maintenance staff take operational TDS and pH measurements biweekly, using calibrated meters. LLNL reports these operational values at the request of CVRWQCB, but they are not used to determine compliance.

If the blowdown flow from one of the 13 secondary cooling towers is diverted to a surface water drainage course, the discharge is sampled for pH and TDS immediately. If the discharge continues, that location is monitored for the same constituents and on the same schedule as the primary cooling towers.

Results

Biweekly and quarterly monitoring results are detailed in the quarterly self-monitoring report to the CVRWQCB. Summary data from primary cooling tower compliance monitoring and operational monitoring are found in **Tables 7-7** and **7-8**, respectively.

Table 7-7. Summary data from compliance monitoring of primary cooling towers, Site 300, 1999.

Test	Tower no.	Permitted maximum	Minimum	Maximum	Median	Interquartile range	Number of samples
Total dissolved solids (TDS) (mg/L)(a)	801	2,400	1,200	1,700	1,300	—(b)	3
	836A	2,400	1,200	1,500	1,200	—(b)	3
Flow (L/day)	801	16,276	1,802	9,886	6,227	2,981	26
	836A	8,138	0	29,166	1,464	1,968	26
pH (pH units)	801	10	8.5	9.0	8.6	—(b)	3
	836A	10	8.3	8.9	8.5	—(b)	3

[a] Fourth quarter samples were inadvertently omitted. Samples collected 1/7/00 resulted in the following: 8.5 pH units, 1300 mg/L TDS at 801; 8.3 pH units, 1200 mg/L TDS at 836A.

[b] Not enough data points to determine.

Table 7-8. Summary data from operational monitoring of primary cooling towers, Site 300, 1999.

Test	Tower no.	Permitted maximum	Minimum	Maximum	Median	Interquartile range	Number of samples
Total dissolved solids (TDS) (mg/L)	801	2400	1050	1450	1200	188	26
	836A	2400	700	2000	1100	150	26
pH (pH units)	801	10	8.8	9.1	9.0	0.1	26
	836A	10	8.6	9.1	9.0	0.1	26

All pH samples collected from the cooling tower discharges were below the permitted maximum of 10. All TDS concentrations were below both the daily maximum (2400 mg/L) and monthly average (2000 mg/L) limits. Fourth quarter samples were inadvertently omitted. Samples collected January 7, 2000, and the November 8, 1999, operational values, indicate fourth quarter compliance. These monitoring results demonstrate that cooling tower discharges were consistently in compliance with permitted limits (**Tables 7-7** and **7-8**).

Blowdown flow was below the maximum permitted design flow for 1999 with one exception. On July 7, 1999, blowdown from the Building 836A cooling tower exceeded the maximum permitted design flow of 8138 liters per day by 21,029 liters per day. By the next scheduled measurement on July 21, blowdown flow was 1382 liters per day, well below permitted design flow. Operational flow measurements taken on July 5 (2593 liters per day) and July 19 (2120 liters per day) demonstrated normal blowdown flow. High blowdown flow was attributed to a stuck solenoid on the blowdown valve, which has since been replaced.

First quarter pH samples collected on February 3 measured a pH of 8.63 at CARW and 8.60 at the downstream GEOCRK location. Although these values are slightly over the 8.5 pH limit, biweekly flow monitoring data show that there was no discharge from the Building 836A cooling tower that day. Additionally, observations of the drainage courses leading from both the Building 801 and Building 836A cooling towers on February 3 were dry at approximately 500 yards downstream and 200 yards downstream, respectively. This indicates that the flow did not reach Corral Hollow Creek and, therefore, was not responsible for the elevated pH value in the creek.

Second quarter pH monitoring was done on April 28, 1999. The pH was 8.59 at CARW and 8.62 at GEOCRK. On May 25, flow was observed only at GEOCRK; the pH was 8.62. Although these values are slightly above the 8.5 pH limit, it is unlikely that the cooling tower blowdown caused the pH elevation in the receiving water because the flow can only reach Corral Hollow Creek if there is significant rain, and there was no significant rain during the second quarter. Previous studies have shown that the maximum blowdown rate from the cooling towers at Buildings 801 and 836A percolates into the ground before reaching Corral Hollow Creek (Fisher 1993 and Folks 1999).

During the third quarter, flow was observed only at GEOCRK. This downstream flow was sampled on August 4; the resulting pH was 8.56. As with the second quarter samples, this is slightly above the 8.5 pH limit; however, there was no rain during the third quarter.

During the fourth quarter, flow was observed only at GEOCRK, but samples were inadvertently omitted during this timeframe. As soon as the omission was noted, samples were collected even though the monitoring period had ended. The pH at GEOCRK was 8.8 on January 7, 2000. As with the second and third quarters, this is slightly above the 8.5 pH limit. However, there was no runoff at the time of the sampling event. (The most recent rain event preceding the sampling occurred on December 8, 1999.)

Visual observations of Corral Hollow Creek were performed each quarter as required in the permit. The ambient pH did not change by more than 0.5 units, and no visible oil, grease, scum, foam, or floating suspended material was noted in the creek during 1999.

One discharge occurred from a secondary cooling tower in 1999. The Building 827 cooling tower percolation pit overflowed on August 20, 1999, because a coating of clay had sealed the gravel layer. The flow was diverted to the surface water drainage course until the pit was repaired (August 20–September 9, 1999). As required by the permit, monitoring samples were collected immediately from both cooling towers that discharge to that pit. Permit limits for the secondary cooling towers are as follows: TDS must not exceed a monthly average of 2000 mg/L or 5000 mg/L daily, pH must not exceed 10, and flow must not exceed the permitted design maximum. Analytical results (1820 mg/L TDS and 8.83 pH for cooling tower 827-1; 1440 mg/L TDS and 8.7 pH for cooling tower 827-2) were below the permit limits. The September 1, 1999, flow measurements were inadvertently omitted for this location. The operational flow values for this interval demonstrate compliance. For the period ending August 30, 1999, the operational values were 4088 liters per day for cooling tower 827-1 and 1968 liters per day for cooling tower 827-2. These values are below the 11,355 liters per day maximum permitted design flow.

Other Waters

Additional surface water monitoring is required by DOE Order 5400.1, *General Environmental Protection Program*, and DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. Surface and drinking water near the LLNL Livermore site and in the Livermore Valley are sampled at locations shown in **Figure 7-15.** Sampling locations DEL, ZON7, DUCK, ALAG, SHAD, and CAL are surface water bodies; of these DEL, ZON7, and CAL are drinking water sources. BELL, GAS, PALM, ORCH, and TAP are drinking water outlets. Location POOL is the on-site swimming pool. Data from drinking water sources and drinking water outlets are used to calculate drinking water statistics (see **Table 7-9**) and doses.

Methods

Samples are analyzed for gross alpha, gross beta, and tritium, according to procedures set out in Appendix B of the *Environmental Monitoring Plan* (Tate et al. 1999). LLNL sampled these locations semiannually for gross alpha, gross beta, and tritium. The on-site swimming pool (POOL) was sampled semiannually for gross alpha and gross beta, and quarterly for tritium.

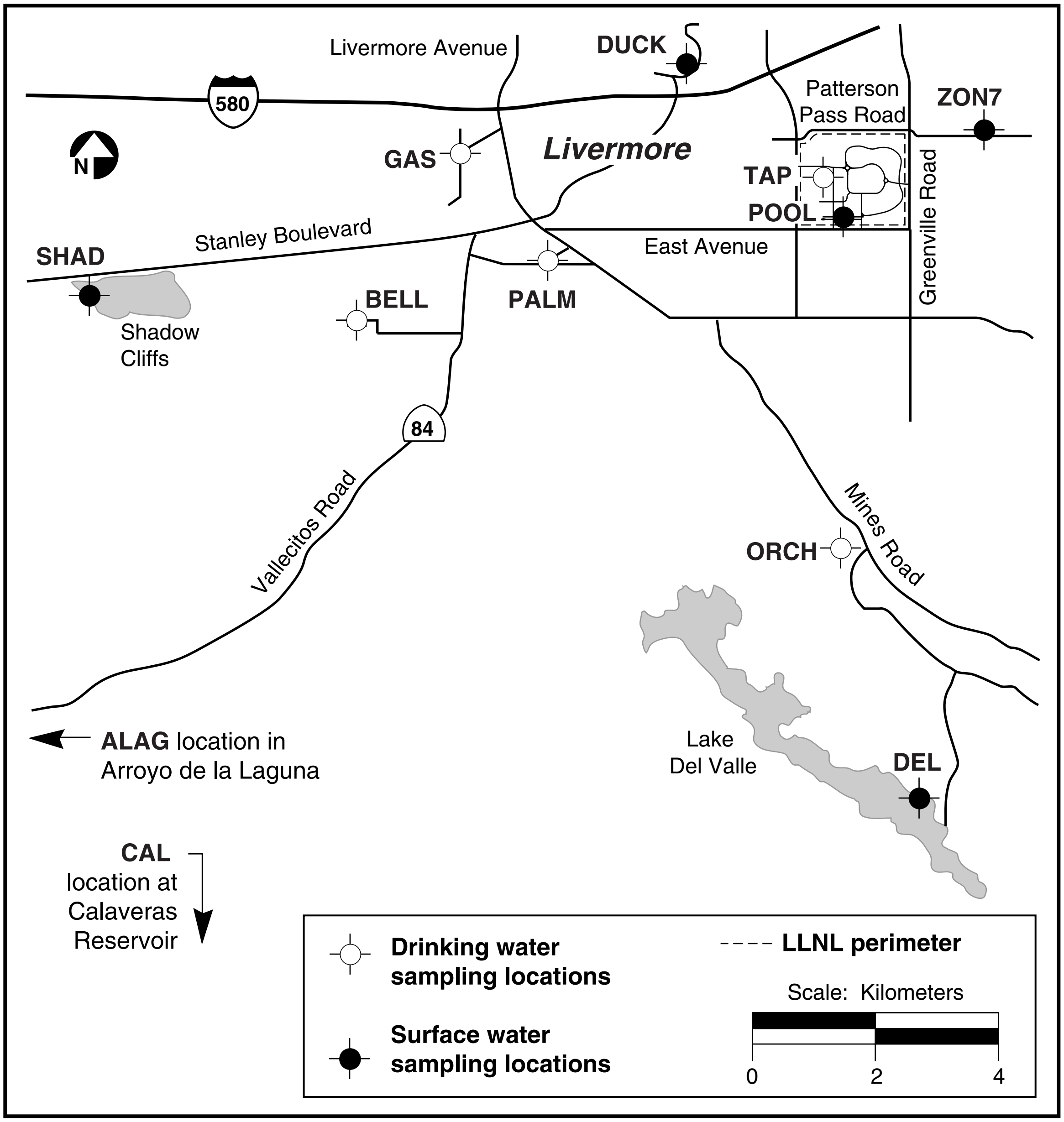

Figure 7-15. Surface and drinking water sampling locations, Livermore Valley, 1999.

Results

The median activity for tritium in surface waters was a result of nondetect; the maximum tritium activity was 1% of the MCL. Median activities for gross alpha and gross beta radiation in surface water samples were approximately 5% of the MCL.

However, maximum activities detected for gross alpha and gross beta, respectively, were 0.374 Bq/L (10.1 pCi/L) and 0.18 Bq/L (4.9 pCi/L); both less than 10% of their respective MCLs (see **Table 7-9**). Detailed data are in Table 7-21 of the Data Supplement. Historically, gross alpha and gross beta radiation have fluctuated about the laboratory reporting limits. At these very low levels, the error measurements are nearly equal to the measured values so that no trends are apparent in the data.

Table 7-9. Radioactivity in surface and drinking water in the Livermore Valley, 1999

	Tritium (Bq/L)	Gross alpha (Bq/L)	Gross beta (Bq/L)
All locations			
Median	–1.34	0.0459	0.181
Minimum	–5.96	–0.00181	0.0353
Maximum	10.1	0.374	0.18
Interquartile range	4.84	0.0734	0.271
Drinking water locations			
Median	–3.12	0.0330	0.132
Minimum	–5.96	–0.00181	0.0353
Maximum	0.356	0.374	1.03
Interquartile range	4.55	0.0466	0.314

Environmental Impacts

This section discusses environmental impacts of storm water, rainfall, the DRB, cooling towers, and other waters.

Storm Water

The potential off-site impact of tritium was estimated by determining the effective dose equivalent (EDE). (See Appendix A for the method LLNL used to calculate dose.) Median tritium activity in storm water (runoff) effluent (location WPDC) was 19.4 Bq/L, about 3% of the MCL. The EDE to an adult who ingested 2 liters of water per day at the maximum storm water tritium concentration for 1 year would be less than 0.0003 mSv (0.03 mrem), or 0.03% of the 1 mSv DOE standard allowable dose for ingestion. Median effluent gross alpha and gross beta activities in storm water were 0.038 and 0.18 Bq/L, both less than 10% of their respective MCLs.

Concentrations of some metals were above comparison criteria; this was caused by metals associated with suspended solids in the storm water. Although some 1999 storm water results were above criteria, there is no evidence that indicates any impact to off-site biota. The acute and chronic fish toxicity tests conducted during 1999 showed no toxicity in LLNL storm water runoff, further supporting the conclusion that LLNL storm water has no adverse effect on off-site biota.

Rainfall

Livermore Site and Livermore Valley

The environmental impact of tritium measured in rainfall samples from the Livermore site and the Livermore Valley was negligible. The median tritium activity measured in rainfall on site at LLNL increased from 5.59 Bq/L (151 pCi/L) in 1998 to 19.0 Bq/L (514 pCi/L) in 1999. However, median tritium activity measured in rainfall on site at LLNL has decreased since 1990: down from 65.9 Bq/L (1780 pCi/L) to 19.0 Bq/L (514 pCi/L). In 2000, rainfall samples will be collected at an increased frequency and at additional locations in an attempt to further understand the pattern of tritium activity observed in rainfall.

Site 300

The environmental impact of tritium measured in rainfall samples from Site 300 was negligible. The measured tritium activities of rainfall samples taken at Site 300 were all either less than the minimum detectable activity or less than the 2σ uncertainty. Over the past 27 years, 166 measurements of rainfall samples collected at this location give a maximum tritium activity of only 9.1 Bq/L. The tritium activity measured in rainfall at Site 300 has been indistinguishable from atmospheric background levels over the past 27 years.

Drainage Retention Basin

There is no evidence of adverse environmental impact resulting from releases from the DRB. Although mild toxicity was observed in the DRB and in water discharged from the DRB, there is no evidence that the discharge had an effect on the downstream receiving water. Because of the frequent dry season discharges that occurred from the DRB, discharges from ground water treatment facilities, and the wetter rainfall years that occurred from 1997 through 1999, wetland vegetation has increased both up- and downstream of the DRB. The federally listed threatened California red-legged frog has colonized these wetland areas.

Cooling Towers

Both primary cooling towers that discharge to surface were within their permitted limits for pH and TDS. With one exception, flow from these cooling towers was below the maximum permitted design flow. Corral Hollow Creek was not flowing during the July 1999 flow excursion from the Building 836A cooling tower, and even with the higher flow, the blowdown is unlikely to have reached the creek during the hot dry weather typical of July. Thus, data indicate no negative impact to surface waters from these cooling towers. The secondary cooling tower percolation pit overflow at Building 827 was also within permitted limits, which indicates no negative impact to surface waters from this one-time event.

Because blowdown flow from the cooling towers does not reach Corral Hollow Creek, it is unlikely to have a negative impact on the receiving water. Run-off from livestock areas or natural pH variations may have a more significant impact than cooling tower blowdown.

Other Waters

The potential impact of tritium on drinking water supplies was estimated by determining the EDE (see Appendix A). Maximum tritium activity in drinking waters was 0.36 Bq/L (9.6 pCi/L). The EDE to an adult who ingested 2 liters of water per day at this maximum concentration for 1 year would be 0.000005 mSv (0.0005 mrem), or 0.013% of the DOE standard allowable dose of 0.04 mSv for drinking water systems. Gross alpha and gross beta activities were below their MCLs. The sample data indicate that the impact of LLNL Livermore site operations on surface and drinking waters is negligible.