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Surface Water Monitoring

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Introduction

In accordance with federal, state, and internal requirements, Lawrence Livermore National Laboratory monitors and protects surface water quality at and around the facility. This includes the Livermore site, surrounding regions of the Livermore Valley and Altamont Hills, and Site 300. Specifically in the Livermore vicinity, LLNL monitors reservoirs and ponds, the Livermore site swimming pool, the Drainage Retention Basin (DRB), rainfall, tap water, storm water runoff, and receiving waters. At Site 300 and its vicinity, surface water monitoring encompasses rainfall, drinking water system discharges, storm water runoff, and receiving waters.

Given the diverse activities and environmental conditions at and around the LLNL sites, water samples are analyzed for several water quality parameters including radionuclides, high explosives, residual chlorine, total organic carbon, total organic halides, total suspended solids, conductivity, pH, chemical oxygen demand, total dissolved solids, oil and grease, metals, minerals, anions, temperature, nutrients, 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, discharges from the DRB, and water contained in the DRB.

The following sections describe in detail the surface water monitoring programs performed at and around LLNL.

Storm Water

This section provides a general introduction to the storm water program at LLNL, including information on permits, constituent comparison criteria, and building inspections, as well as sampling

methods and results. 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,b), assess the risk of storm water contamination from various potential sources, and evaluate the effectiveness of best management practices (BMPs) for preventing storm water contamination.

General Information

Permits

To assess compliance with permit requirements, LLNL monitors storm water at the Livermore site in accordance with Waste Discharge Requirements 95-174 (WDR 95-174), National Pollutant Discharge Elimination System (NPDES) Permit No. CA0030023, issued in 1995 by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB 1995). LLNL monitors storm water discharges at Site 300 in accordance with the California NPDES General Permit for Storm Water Discharges Associated with Industrial Activity (WDR 97-03-DWQ), NPDES Permit No. CAS000001, State Water Resources Control Board (SWRCB 1997).

In addition, Site 300 storm water monitoring meets the requirements of the *Post-Closure Plan for the Pit 6 Landfill Operable Unit* (Ferry et al. 1998). These permits include specific monitoring and reporting requirements. In addition to the storm water quality constituents required by the permits, LLNL monitors other constituents to provide a more complete water quality profile. The current list of analyses conducted on storm water samples is given in **Table 7-1**.

Storm water monitoring 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 5400.1, *General Environmental Protection Program*, and DOE Order 5400.5, *Radiation Protection of the Public and the Environment.*

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 (defined as October of one year through April or May of the following year, depending on the permit) 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 DOE Orders 5400.1 and 5400.5. In addition, annual facility inspections are required to ensure that the best management practices are adequate and implemented.

In 2002, LLNL also met the storm water compliance monitoring requirements of the Statewide NPDES General Permit for Storm Water Discharges Associated with Construction Activity (WDR 99-08-DWQ, NPDES Permit No. CAS000002) as modified by Resolution 2001-046 for construction projects that disturb two hectares (5 acres) of land or more (SWRCB 1999, 2001).

Constituent Criteria

Currently, there are no numeric criteria that limit concentrations of specific constituents in LLNL's storm water effluent. The U.S. Environmental Protection Agency (EPA) established parameter benchmark values but stressed that these concentrations were not intended to be interpreted as effluent limits (U.S. EPA 2000). 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, they are used as comparison criteria to

Table 7-1. Analyses conducted on storm water samples, 2002

Livermore site	Site 300
Chemical oxygen demand	Chemical oxygen demand
Dissolved oxygen	Cyanide
Oil and grease	Oil and grease
pH	pH
Specific conductance	Specific conductance
Total dissolved solids	Total dissolved solids
Total suspended solids	Total suspended solids
Anions	Ammonia
General minerals	Potassium
Metals	Metals
Polychlorinated biphenyls (PCBs)	Polychlorinated biphenyls (PCBs) and dioxins
Total organic carbon	Total organic carbon
Fish bioassay (fathead minnow)	Organic compounds
Diuron	Pesticides
Glyphosphate	High explosives (HE)
Herbicides	Total organic halides
Gross alpha and gross beta activity	Gross alpha and gross beta activity
Tritium	Tritium
Plutonium	Depleted uranium

help evaluate LLNL's storm water management program. To further evaluate the storm water management program, LLNL established or calculated site-specific threshold comparison criteria for a select group of parameters. A value exceeds the threshold if it is greater than the 95% confidence limit computed for the historical mean value for a specific parameter (**Table 7-2**). The threshold comparison criteria are used to identify out-of-the-ordinary data that merit further investigation to determine if concentrations of that parameter are increasing in the storm water runoff.

For a better understanding of how LLNL storm water data relate to other target values, water samples are also compared with criteria listed in the *Water Quality Control Plan, San Francisco Bay Basin* (SFBRWQCB 1995), *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), state and federal maximum contaminant levels (MCLs), and ambient water quality criteria (AWQC). The greatest importance is placed on the site-specific comparison criteria calculated from historical concentrations in storm runoff.

In addition to chemical monitoring, LLNL is required by NPDES permit WDR 95-174 to conduct acute and chronic fish toxicity testing on samples from the Arroyo Las Positas (Livermore site) once per wet season. Currently, LLNL is not required to test for fish toxicity at Site 300.

Table 7-2. Threshold comparison criteria for selected water quality parameters. The sources of values above these are examined to determine if any action is necessary.

Parameter	Livermore site	Site 300
Total suspended solids (TSS)	750 mg/L[(a)]	1700 mg/L[(a)]
Chemical oxygen demand (COD)	200 mg/L[(a)]	200 mg/L[(a)]
pH	<6.0, >8.5[(a)]	<6.0, >9.0[(b)]
Nitrate (as NO_3)	10 mg/L[(a)]	not monitored
Orthophosphate	2.5 mg/L[(a)]	not monitored
Mercury	above RL[(c)]	above RL[(c)]
Beryllium	0.0016 mg/L[(a)]	0.0016 mg/L[(a)]
Chromium(VI)	0.015 mg/L[(a)]	not monitored
Copper	0.013 mg/L[(d)]	not monitored
Lead	0.015 mg/L[(e)]	0.015 mg/L[(e)]
Zinc	0.35 mg/L[(a)]	not monitored
Diuron	0.014 mg/L[(a)]	not monitored
Oil and grease	9 mg/L[(a)]	9 mg/L[(a)]
Tritium	36 Bq/L[(a)]	3.17 Bq/L[(a)]
Gross alpha	0.34 Bq/L[(a)]	0.90 Bq/L[(a)]
Gross beta	0.48 Bq/L[(a)]	1.73 Bq/L[(a)]

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

b EPA benchmark

c RL = reporting limit = 0.0002 mg/L for mercury

d Ambient water quality criteria (AWQC)

e EPA primary maximum contaminant level

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 adequate. LLNL's associate directors certified in 2002 that their facilities complied with the provisions of WDR 95-174, WDR 97-03-DWQ, and the SWPPPs. LLNL submits annual storm water monitoring reports to the SFBRWQCB and to the Central Valley Regional Water Quality Control Board (CVRWQCB) with the results of sampling, observations, and inspections (Campbell 2002a,b).

For each construction project permitted by WDR 99-08-DWQ, the construction staff conducts visual observations of construction sites before, during, and after storms to assess the effectiveness of implemented BMPs. Annual compliance certifications summarize these inspections. Annual compliance certifications for 2002 covered the period of June 2001 through May 2002. When requested by the regional water quality control boards (RWQCBs), LLNL completes annual compliance status reports that cover the same reporting period.

During the 2001–2002 reporting period, LLNL inspected four projects located at the Livermore site: the National Ignition Facility (NIF), the areas associated with the Soil Reuse Project, the Terascale Simulation Facility, and the Sensitive Compartmented Information Facility. The SFBRWQCB requested completion of compliance status reports for three of the four Livermore site construction projects.

Sampling

For the purpose of evaluating the overall impact of the Livermore site and Site 300 operations on storm water quality, storm water flows are sampled at upstream and downstream locations. Because of flow patterns at the Livermore site, storm water at sampling locations includes 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 no run-on from off-site sources. These samples provide information used to evaluate the effectiveness of LLNL's storm water pollution control program.

Resolution 2001-046 requires that construction site runoff be sampled to assess the impact of the runoff on the receiving water in certain circumstances. Two specific assessments are required by the permit: 1) when the runoff from the project directly enters a water body identified on the state of California's Clean Water Act 303(d) list as being impaired for sediment-related pollutants (siltation, sedimentation, or turbidity), samples must be collected for these pollutants; and 2) when construction site materials that cannot be visually detected are exposed to storm water, runoff must be sampled for the potential nonvisible pollutants. LLNL projects do not have to sample for sediment-related pollutants because neither the receiving waters at the Livermore site nor Site 300 are currently identified as being impaired for sediment-related pollutants. To comply with the second required assessment, the specific nonvisible parameters to be sampled at each construction site are identified in the individual project SWPPP. In many cases, more stringent material storage practices can eliminate the need to sample construction site runoff. In 2002, construction site runoff sampling was not required at the Livermore site.

Livermore Site: As is commonly the case in urbanized areas, the surface water bodies and runoff pathways at LLNL do not represent the natural conditions. The drainage at the 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 groundwater 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**). When full, 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 drains and swales. 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 monitoring network consists of ten sampling locations (**Figure 7-2**). Seven locations characterize storm water either entering (influent: ALPE, ALPO, ASS2, ASSE, 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.

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 naturally 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. 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. Seven artificial surface water bodies are

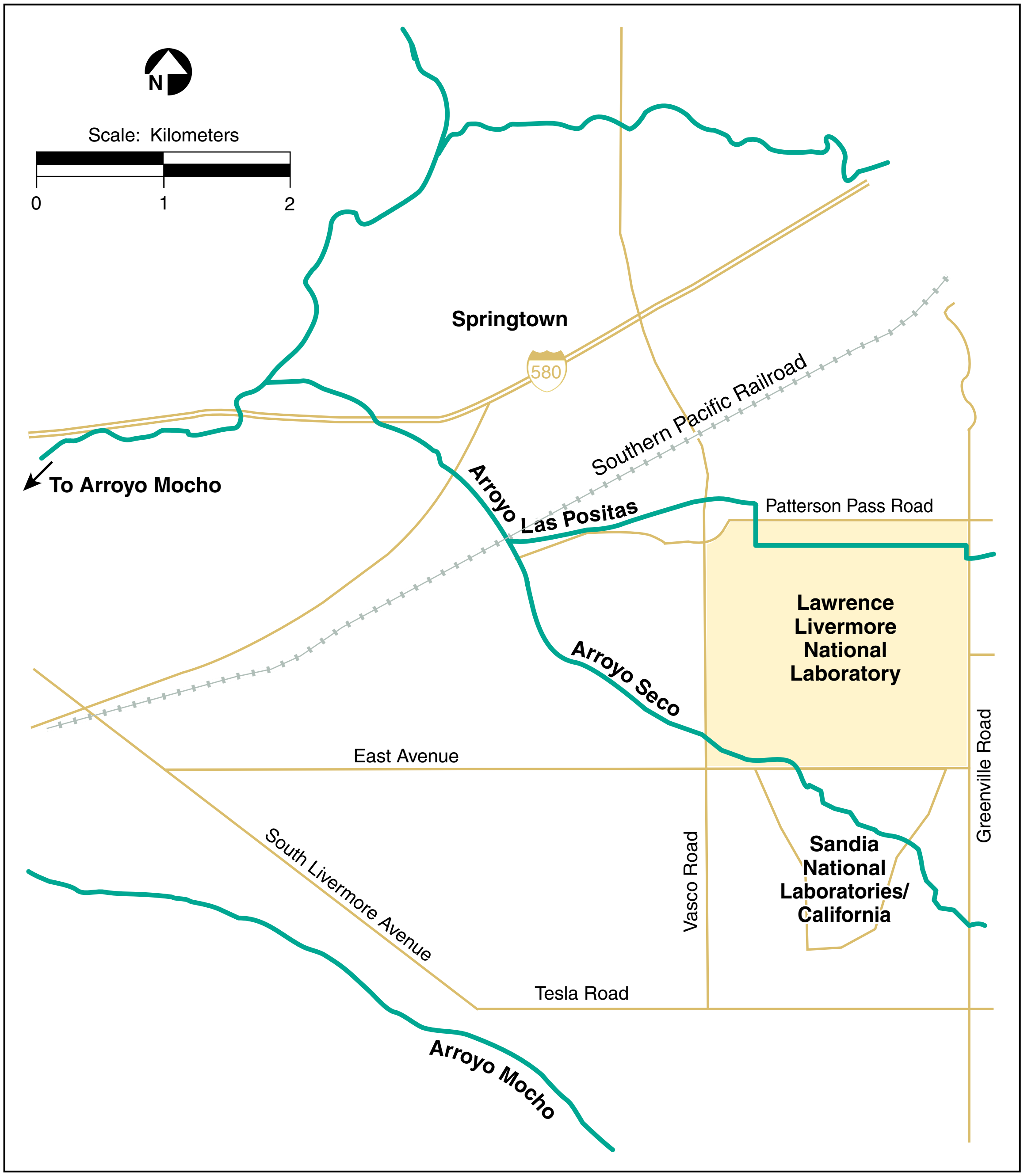

Figure 7-1. Surface waterways in the vicinity of the Livermore site

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) surface water impoundments are located to the west in the Explosives Process Area. Monitoring results associated with these facilities are discussed in Chapter 9. Three wetlands created by

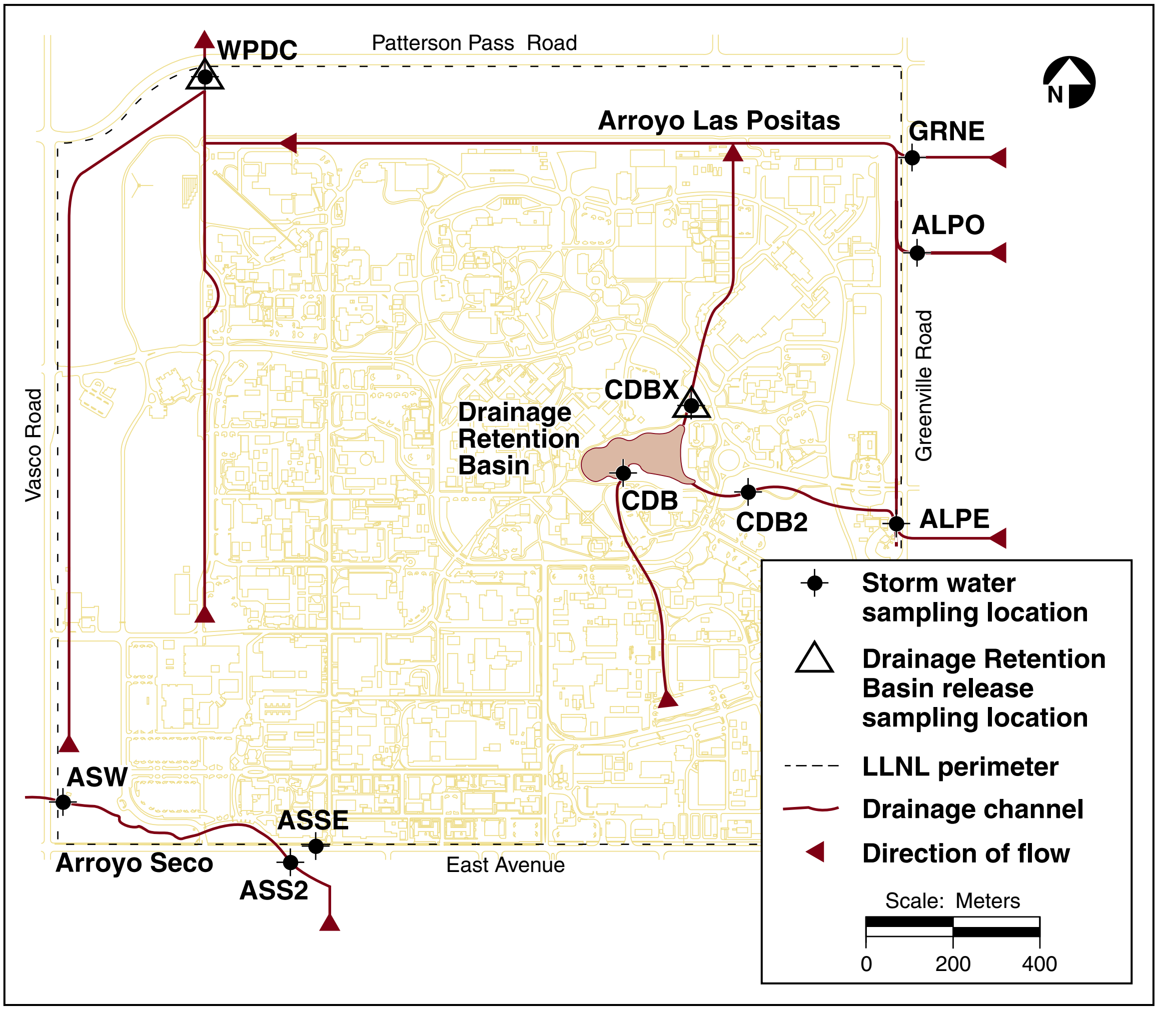

Figure 7-2. Storm water runoff and Drainage Retention Basin sampling locations, Livermore site, 2002

now-discontinued flows from cooling towers located at Buildings 827, 851, and 865 were maintained in 2002 by discharges of potable water.

The on-site Site 300 storm water sampling network began in 1994 with six locations and now consists of seven locations (**Figure 7-3**). Sampling locations were selected to characterize storm water runoff at locations that could be affected by specific Site 300 activities.

Off-site location CARW is used to characterize Corral Hollow Creek upstream and therefore is unaffected by Site 300 industrial storm water discharges. Location GEOCRK is used to characterize Corral Hollow Creek, downstream of Site 300.

Methods

At all monitoring locations at both the Livermore site and Site 300, grab samples are collected from the storm runoff flowing in the stream channels.

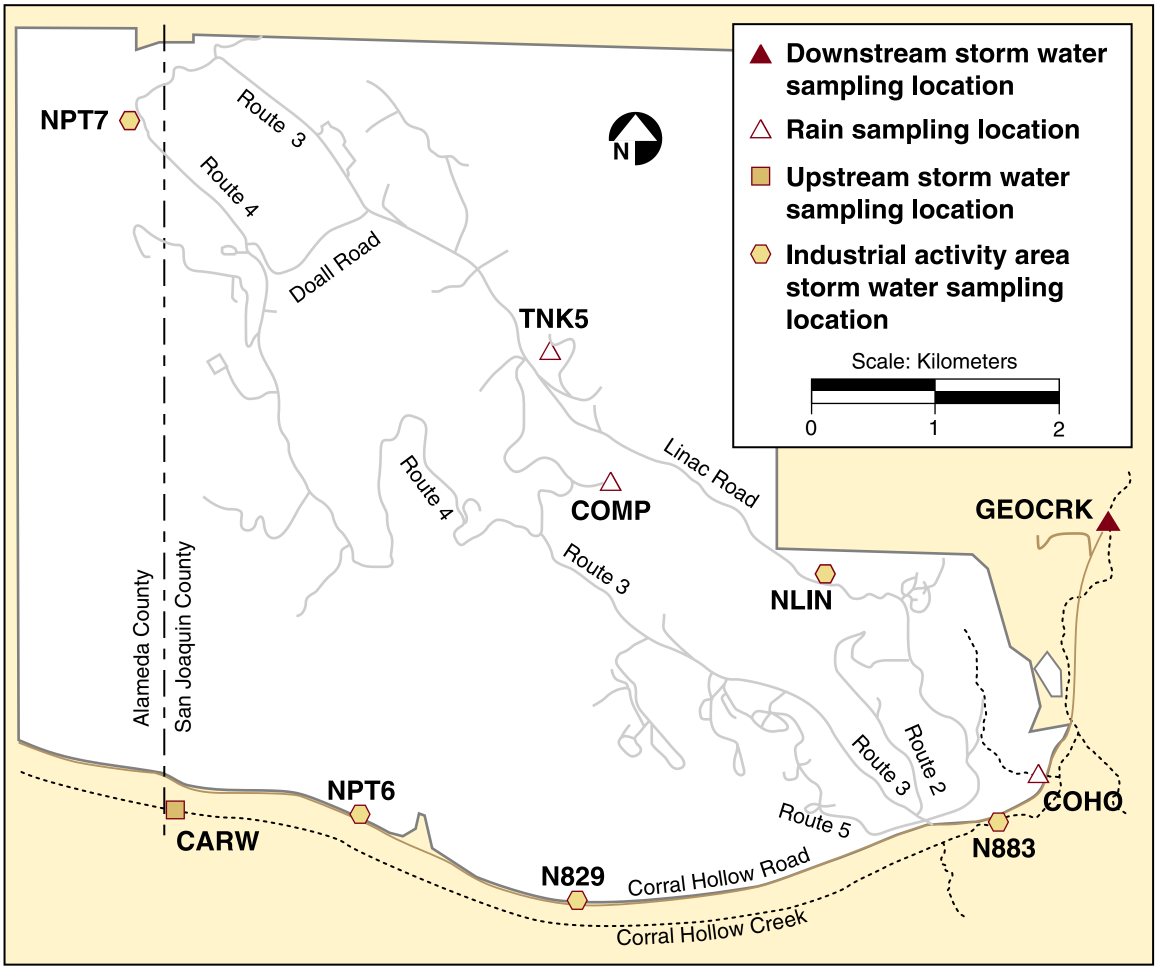

Figure 7-3. Storm water and rainwater sampling locations at Site 300, 2002

Standard 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.

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 or an automatic water sampler 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 arroyo to prevent the collection of sediment to the water samples. Sample vials for volatile organics are filled before sample bottles for all other constituents and parameters.

Results

Inspections

The Associate Director for each of the directorates certified that their facilities conducted the 2002 annual inspection of its facilities to verify implementation of the SWPPP and ensure that measures to reduce pollutant loading to storm water runoff are adequately and properly implemented. Each directorate documents and keeps on file the annual inspection results (as required by WDRs 95-174 and 97-03-DWQ). These records include the dates, places, and times of the site inspections and the names of individuals performing the inspections. Because of the large number of facilities inspected (more than 500 buildings and trailers), the detailed inspection results are not included in this report, but the individual inspection records are available for review.

All inspections were completed; findings and deficiencies are summarized in the Livermore site and Site 300 *Annual Storm Water Reports* (Campbell 2002a; Campbell and Laycak 2002). There were 10 findings listed as the result of the inspections that were not consistent with the BMPs identified in the SWPPP. All of these findings have either been corrected or are in the process of being corrected. All other inspections at both Site 300 and the Livermore site indicated that the applicable BMPs were implemented correctly and adequately.

Additionally, LLNL conducted the permit-required inspections before, during, and after rain events at each of the permitted construction sites at the Livermore site. The findings of these inspections indicated compliance with the permit and the construction site SWPPPs, with two exceptions documented in the 2001/2002 annual compliance certifications filed in July 2002 for the period of June 2001 through May 2002. At one project, project personnel failed to perform one of the required rain event inspections. At a second project, project personnel began construction activity prior to approval and certification of the SWPPP.

Livermore Site Sampling

LLNL collected samples at all ten Livermore site locations on May 20, November 8, and December 16, 2002, where the May sampling was a reduced analysis surveillance storm to satisfy DOE Order 450.1. The fish and algae toxicity analyses were conducted on November 8 in order to catch the first flush of runoff that occurs at the beginning of the wet season.

Livermore Site Toxicity Monitoring: As required by WDR 95-174, grab samples were collected and analyzed for acute and chronic toxicity using fathead minnows (*Pimephales promelas*) as the test species. In the acute test, 96-hour survival is observed in undiluted storm water collected from location WPDC.

The permit states that an acceptable survival rate is 20 percent lower than a control sample. The testing laboratory provides water for the quality control sample. As specified by the permit, upstream water samples from influent locations ALPO, ALPE, and GRNE are used as additional controls. Thus, a difference of more than 20 percent between location WPDC and the upstream control sample with the lowest survival rate is considered a failed test. If the test is failed, the permit requires LLNL to conduct toxicity testing during the next significant storm event. After failing two consecutive tests, LLNL must perform a toxicity reduction evaluation to identify the source of the toxicity.

During 2002, survival in the acute test at WPDC (November 8) was 70%, while all influent locations (ALPE, ALPO, and GRNE) ranged from 75 to 88% (**Table 7-3**). All of these values were calculated to be significantly different from the control waters tested at the α=0.05 level. The growth measurements did not produce significantly different results from controls, however, fish growth in water samples from the arroyo were consistently lower. The sub-contract laboratory (Pacific EcoRisk) explained that the results appeared to be related to a fungus growing on the fish in the arroyo samples. It was their conclusion that the observed results were due to pathogen related death and not caused by poor chemical water quality.

Table 7-3. Fish acute toxicity test results, Livermore site, November 8, 2002

Sample location	Percent survival		Growth (biomass mg)[a]	
	Control	Sample	Control	Sample
WPDC	100	70[a]	0.56	0.40
ALPE	100	75[a]	0.56	0.45
ALPO	100	83[a]	0.56	0.53
GRNE	100	88[a]	0.56	0.52

a Indicates a statistically significant difference from the control value.

In response to the November fish toxicity results, the test was performed again using water samples collected on December 16, 2002. These results found toxicity in fathead minnow caused by either pathogens or water quality issues (**Table 7-4**). In all cases the results were similar at influent and effluent storm water sampling locations, demonstrating that the observed toxicity was unrelated to operations at LLNL.

Table 7-4. Retest fish acute toxicity test results, Livermore site, December 16, 2002

Sample location	Percent survival	
	Control	Sample
WPDC	100	100
ALPE	100	100
ALPO	100	100
GRNE	100	95

In addition to the fish toxicity testing, LLNL performed acute toxicity testing with freshwater algae (*Selenastrum capricornutum*) using water collected from Arroyo Las Positas on November 8, 2002. The algae test indicated toxicity in storm water. This appears to be the result of continued upstream sources of herbicides. A historical investigation into the potential causes of the algae toxicity identified a likely source: a pre-emergent herbicide, diuron (Campbell 2001; Campbell et al. submitted).

Livermore Site Radioactive Constituents:
Storm water sampling and analysis were performed for gross alpha, gross beta, plutonium, and tritium. Storm water gross alpha, gross beta, and tritium results are summarized in **Table 7-5**. Complete results are in Data Supplement Tables 7-1, and 7-2. Tritium activities at effluent locations were less than 1% of the MCL. Radioactivity in the storm water samples collected during 2002 was generally low, with medians around background levels.

LLNL began analyzing for plutonium in storm water in 1998. Samples from the Arroyo Seco and the Arroyo Las Positas effluent locations (ASW and WPDC) are analyzed. In 2002, there were no plutonium results above the detection limit of 0.0037 Bq/L (0.100 pCi/L).

Table 7-5. Radioactivity in storm water from the Livermore site, 2002[a]

Parameters	Tritium (Bq/L)	Gross alpha (Bq/L)	Gross beta (Bq/L)
MCL	**740**	**0.555**	**1.85**
Influent			
Median	1.7	0.087	0.20
Minimum	–0.083	0.01	0.10
Maximum	20.0	0.23	0.85
Effluent			
Median	3.5	0.02	0.13
Minimum	–0.34	0.004	0.03
Maximum	18.0	0.10	0.77

a See Chapter 14 for a complete explanation of calculated values.

Livermore Site Nonradioactive Constituents:
In addition to data on radioactivity, storm water was analyzed for other water quality parameters.

Sample results were compared with the comparison criteria in **Table 7-2**. Of greatest concern are the constituents that exceed 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; therefore, further investigation is not warranted. Constituents that exceeded comparison criteria for effluent and influent locations are listed in **Table 7-6**.

Many of the values above threshold comparison criteria listed in **Table 7-6** for the Livermore site were recorded at influent tributaries to Arroyo Las Positas and Arroyo Seco. In all cases where the LLNL threshold limit was exceeded at WPDC or ASW, which are effluent locations, an influent value was similar or greater demonstrating that LLNL was not the source.

Site 300 Sampling

LLNL procedures specify sampling a minimum of two storms per rainy season from Site 300. Typically, a single storm does 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 2002, samples were collected at locations with flow on November 8 and December 16. There was no tritium above the minimum detectable activity in Site 300 storm water during 2002. The maximum values of all gross alpha and gross beta results were 0.25 and 1.1 Bq/L, respectively, approximately 45% and 59% of the drinking water MCLs (0.56 and 1.85 Bq/L). These gross alpha and gross beta values recorded on November 8 were the highest recorded from a Site 300 effluent location for the year. Although these values are higher than those at the Livermore site, they are not unusual. This area has had relatively high back-ground gross alpha and beta levels in stream flow that are closely associated with suspended sediment (Harrach et al. 1996).

Sampling at Pit 6 includes analyses required as part of the postclosure sampling; however, no storm runoff was sampled as the drains did not produce any runoff to collect in 2002.

Specific conductance and TSS at Site 300 locations were at times above internal comparison criteria and EPA benchmarks. However, in most cases effluent levels were lower than levels at the upstream location CARW, indicating that the levels observed in effluent are typical for the area. Total suspended solids results are shown in **Table 7-7**.

Most the values over the thresholds in **Table 7-6** at Site 300 are associated with high suspended sediment. The elevated lead and mercury have been demonstrated in the past to be related to total concentrations where the laboratory analysis includes the suspended sediment (Brandstetter 1998).

TSS values were measured above the LLNL comparison criteria in the November sample at upstream location CARW and discharge location NLIN. The sample concentration at NLIN of 4800 mg/L was above the comparison criteria but is consistent with the range of historic data at this location, 243 mg/L to 6600 mg/L, with an average of 2700 mg/L. It is possible that the sample concentration could have been affected by the September 5, 2002, release from a drinking water tank, which resulted in sediment from the hillside being washed into Elk Ravine, approximately 2 km upstream of this sampling location. However, the upstream receiving water location CARW TSS concentration (10,000 mg/L) was still higher than the NLIN concentration. This would also indicate that the NLIN concentration is typical for the area.

Table 7-6. Water quality parameters above the threshold comparison criteria shown in Table 7-2 from the Livermore site and Site 300 in 2002

Parameter	Date	Location	Influent or Effluent	Result (mg/L)	LLNL threshold criteria (mg/L)
Livermore Site					
Beryllium	11/8	ALPO	Influent	0.0018	0.0016
	11/8	GRNE	Influent	0.0022	0.0016
	12/16	ASS2	Influent	0.0020	0.0016
	12/16	ASW	Effluent	0.0019	0.0016
Chemical Oxygen Demand	11/8	ALPE	Influent	259	200
	11/8	ALPO	Influent	466	200
	12/16	ASS2	Influent	240	200
Copper[a]	11/8	ALPE	Influent	0.070	0.013
	11/8	ALPO	Influent	0.055	0.013
	11/8	GRNE	Influent	0.030	0.013
	11/8	WPDC	Effluent	0.018	0.013
	11/8	ASS2	Influent	0.034	0.013
	11/8	ASW	Effluent	0.028	0.013
	12/16	ALPE	Influent	0.015	0.013
	12/16	ALPO	Influent	0.021	0.013
	12/16	ASS2	Influent	0.060	0.013
	12/16	ASW	Effluent	0.051	0.013
	12/16	CDB	Internal	0.047	0.013
Diuron	12/16	ALPO	Influent	0.29	0.014
	12/16	WPDC	Effluent	0.044	0.014
Chromium(VI)	12/16	CDB	Internal	0.016	0.015
Lead[a]	11/8	ALPE	Influent	0.030	0.015
	11/8	ALPO	Influent	0.019	0.015
	11/8	GRNE	Influent	0.017	0.015
	11/8	ASS2	Influent	0.024	0.015
	11/8	ASW	Effluent	0.017	0.015
	12/16	ASS2	Influent	0.033	0.015
	12/16	ASW	Effluent	0.028	0.015
	12/16	CDB	Internal	0.020	0.015
Nitrate (as NO_3)	11/8	GRNE	Influent	11	10
	12/16	ASS2	Influent	14	10
	12/16	ASW	Effluent	13	10
	12/16	GRNE	Influent	19	10

Table 7-6. Water quality parameters above the threshold comparison criteria shown in Table 7-2 from the Livermore site and Site 300 in 2002 (continued)

Parameter	Date	Location	Influent or Effluent	Result (mg/L)	LLNL threshold criteria (mg/L)
Ortho-Phosphate	11/8	ALPE	Influent	4.24	2.5
	12/16	ALPE	Influent	5.56	2.5
	12/16	ASS2	Influent	5.61	2.5
	12/16	ASW	Effluent	5.12	2.5
pH	11/8	CDB	Internal	8.56	8.5
	12/16	CDBX	Internal	8.95	8.5
Total Suspended Solids	11/8	ALPE	Influent	1,300	750
	11/8	ALPO	Influent	800	750
	11/8	ASS2	Influent	800	750
	12/16	ASS2	Influent	1,100	750
	12/16	ASW	Effluent	980	750
	12/16	CDB	Internal	820	750
Zinc[(a)]	11/8	ASS2	Influent	0.46	0.35
	11/8	ASW	Effluent	0.41	0.35
	11/8	CDB	Internal	0.43	0.35
	11/8	GRNE	Influent	0.38	0.35
Site 300					
Total Suspended Solids	11/8	CARW	A	10,000	1,700
	11/8	NLIN	Effluent	4,800	1,700
	12/16	CARW	A	1,800	1,700
	12/16	GEOCRK	B	14,200	1,700
Chemical Oxygen Demand	11/8	CARW	A	393	200
	11/8	NLIN	Effluent	289	200
	12/16	GEOCRK	B	615	200
Lead[(a)]	11/8	CARW	A	0.174	0.015
	11/8	NLIN	Effluent	0.065	0.015
	12/16	GEOCRK	B	0.237	0.015
Mercury[(a)]	11/8	CARW	A	0.0003	0.0002
Total Organic Halides	11/8	N883	Effluent	160	none

A = Upstream receiving water

B = Downstream receiving water

a Includes both dissolved and total metals (including particulates)

Table 7-7. Total suspended solids in storm water samples from Site 300 in 2002

Sampled date	Location	Total suspended solids (mg/L)
11/8	CARW[(a)]	10,000
11/8	GEOCRK[(b)]	62
11/8	NLIN	4,800
11/8	N883	5.3
11/8	NPT7	400
12/16	CARW[(a)]	1,800
12/16	GEOCRK[(b)]	14,200
12/16	N883	58
12/16	NPT7	880

a Upstream receiving water location

b Downstream receiving water location

A high TSS value was also measured in the December samples at downstream location GEOCRK and at upstream location CARW (14,200 mg/L and 1,800 mg/L respectively); both of these locations are off-site. Based on historic data from these two locations, the TSS concentrations at CARW tend to be higher than GEOCRK, as was the case in the November samples. However, the December TSS concentration at GEOCRK was higher than the CARW concentration which is an anomaly. During this storm event, only one LLNL effluent location was discharging (N883), which had a TSS concentration of 58 mg/L. The low TSS concentration at N883 in addition to the lack of flow at NPT6 and NLIN indicate that LLNL activities were not the direct cause of the elevated concentration at GEOCRK. However, LLNL will continue to trend the TSS data at these locations to identify whether this data point at GEOCRK is an outlier or whether a change in LLNL activities has influenced an increase at the downstream receiving water location. Both the GEOCRK and CARW locations are influenced by the larger Corral Hollow watershed, which is dominated by a State off-road motorcycle park and ranching activities.

The elevated total organic halides (TOX) value observed in the November 8 sample from location N883 was examined in greater detail. There were no releases of solvents or chlorinated drinking water on or around this time period that could explain this result. Follow up sampling on December 16th found no TOX above the detection limit. Therefore LLNL has concluded that this was an isolated data outlier and not likely to be a result caused by operations at S300.

Complete storm water results for nonradioactive constituents are presented in Data Supplement Table 7-3.

Because of a CERCLA remedial investigation finding of past releases of dioxins related to activities in the vicinity of Building 850, analysis for dioxins was conducted at location NLIN, the storm water sampling discharge location downgradient of Building 850. The intent of the sampling was to determine whether these constituents are being released from the site in storm water runoff. Dioxins and furans detected at location NLIN (the laboratory analysis request for dioxins includes furans) ranged from 2.2 to 11,690 pg/L (**Table 7-8**). All dioxin congeners are below the equivalent federal MCL.

The federal MCL for dioxin is for the dioxin congener 2,3,7,8-TCDD. The NLIN 2,3,7,8-TCDD sample result is less than the MCL of 30 pg/L. The other dioxin congeners reported have varying degrees of toxicity. EPA has assigned toxic equivalency factors (TEFs) to specific dioxin congeners. 2,3,7,8-TCDD is considered the most toxic dioxin congener and is assigned a TEF of 1. The other congeners are assigned TEFs that estimate their toxicity relative to 2,3,7,8-TCDD. The

Table 7-8. Total toxicity equivalents of dioxin congeners in storm water runoff (pg/L) at Site 300, location NLIN, November 8, 2002[a]

	Value	TEQ[b]
Dioxin		
1,2,3,4,6,7,8-HpCDD	1,410	14.1
1,2,3,4,6,7,8,9-OCDD	11,690	11.69
1,2,3,4,7,8-HxCDD	2.5	0.025
1,2,3,6,7,8-HxCDD	59.9	5.99
1,2,3,7,8,9-HxCDD	61.6	6.16
1,2,3,7,8-PeCDD	15.6	15.6
2,3,7,8-TCDD	4	4
Furans (dioxin-like compounds)		
1,2,3,4,6,7,8-HpCDF	443	4.43
1,2,3,4,6,7,8,9-OCDF	1,290	0.129
1,2,3,4,7,8,9-HpCDF	34.8	0.348
1,2,3,4,7,8-HxCDF	47.4	4.74
1,2,3,6,7,8-HxCDF	17.5	1.75
1,2,3,7,8,9-HxCDF	11.3	1.13
1,2,3,7,8-PeCDF	2.2	0.11
2,3,4,6,7,8-HxCDF	23.9	2.39
2,3,4,7,8-PeCDF	5.5	2.75
2,3,7,8-TCDF	6.9	0.69

a No sample was collected during the December 2002 sampling event because there was no access.

b Toxicity Equivalents

toxic equivalency (TEQ) is determined by multiplying the concentration of a dioxin congener by its TEF. None of the dioxin congeners have a calculated TEQ greater than the MCL for 2,3,7,8-TCDD.

All data analysis included standard quality assurance and quality control practices; analysis information is available upon request. Records specific to storm water sampling of specific events are also maintained and available upon request.

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. Rain water is collected and analyzed for tritium activity in support of DOE Orders 5400.1 and 5400.5.

General Information

Livermore Site and Livermore Valley

Historically, the tritium activity measured in rainfall in the Livermore Valley has been attributed primarily to atmospheric emissions of tritiated water (HTO) from stacks at LLNL's Tritium Facility (Building 331), and from the former Tritium Research Laboratory at the Sandia National Laboratories/ California (Sandia/California). The total measured atmospheric emission of HTO from the Tritium Facility at LLNL in 2002 was 1.2 TBq (32.9 Ci) (see Chapter 4).

The rain sampling locations are shown in **Figure 7-4**. The fixed stations are positioned to record all ranges of tritium activity, from the background level up to the maximum activity expected. The maximum tritium activity is measured near the Tritium Facility, at the Building 343 rain sampling location (B343 in **Figure 7-4**).

Site 300

Three on-site locations (COHO, COMP, and TNK5) are used to collect rainfall for tritium activity measurements at Site 300 (**Figure 7-3**).

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 simply collected in stainless-steel buckets at specified locations. The buckets are placed in open areas and are elevated about 1 m above the ground to prevent collection of splashback water. Rainwater samples are decanted into 250-mL amber glass bottles with Teflon-lined lids. The tritium activity of each sample is measured at a contracted laboratory by a scintillation counting method equivalent to EPA Method 906, that has a lower limit of measurement of about 2.5 Bq/L.

Results

Livermore Site and Livermore Valley

During 2002, LLNL collected sets of rain samples following 4 rainfall events in the Livermore Valley (35 total routine samples obtained) and at the Livermore site (27 total routine samples obtained).

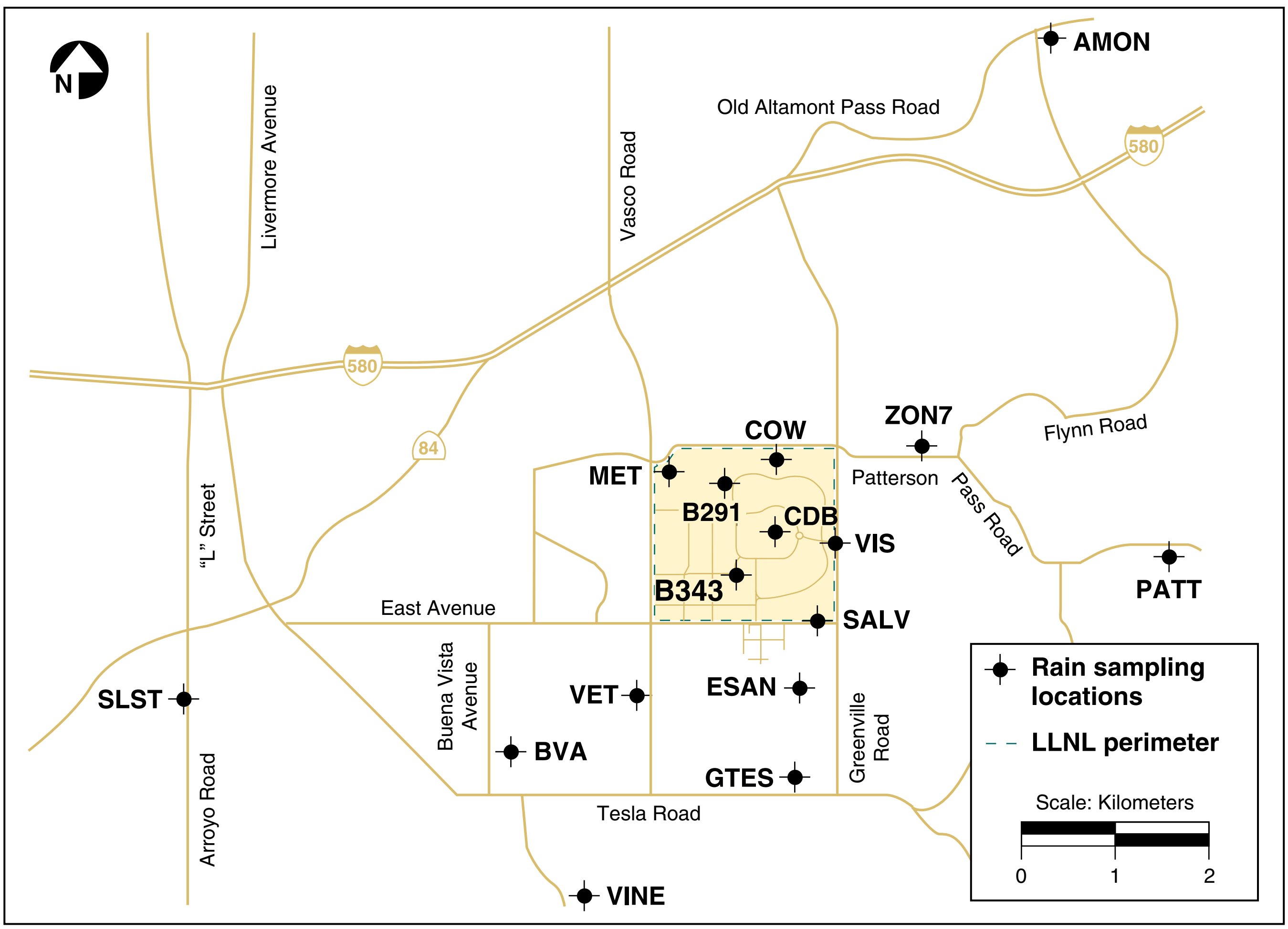

Figure 7-4. Rain sampling locations, Livermore site and Livermore Valley, 2002

Because of sparse rainfall at the semi-arid location of Site 300 during 2002, only 8 routine rain samples were obtained. The tritium activities of rainwater samples obtained during 2002 are listed in Table 7-5 of the Data Supplement.

The Livermore site rainfall has exhibited elevated tritium activities in the past (Gallegos et al. 1994). During 2002, however, no measurements of tritium activity in rainfall were above the 740 Bq/L MCL established by the EPA for drinking water. As in the past, the on-site rainfall sampling location 343B (the sampling location nearest the Tritium Facility) showed the highest tritium activity for the year: 47 Bq/L (see **Table 7-9**) for the rainfall event that immediately preceded the May 20 collection date. The tritium activities of all the off-site rainfall samples obtained during 2002 were below LLNL's lower limit of measurement of 2.5 Bq/L, which is equal to 0.3% of the tritium MCL for drinking water.

Table 7-9. Tritium activities in rainfall for the Livermore site, Livermore Valley, and Site 300, 2002

Parameter	Livermore site (Bq/L)	Livermore Valley (Bq/L)	Site 300 (Bq/L)
Median	3.1	–0.23	–0.54
Minimum	0.22	–1.7	–1.5
Maximum	47	1.8	1.1
Number of samples	27	35	8

Note: Tritium activities are presented relative to a low activity standard or "dead water." As a result, it is possible to have negative values or measurements that are lower than the reference "dead water" standard.

The median tritium activity measured in rainfall at LLNL increased slightly from 2.0 Bq/L in 2001 to 3.1 Bq/L in 2002 (**Figure 7-5**) and most likely reflects the slight increase of on-site HTO emissions from 0.68 TBq in 2001 to 1.2 TBq in 2002 (see Chapter 4). In 2001, the median tritium activity for rainfall at LLNL reached its lowest level since 1990 when it was 66 Bq/L.

The distribution of on-site locations where tritium activity was detected during 2002 indicates a northeastward direction of wind dispersed HTO from the stacks at the tritium facility during the sampled rain events. The historical higher values of tritium activity in rainfall samples are the result of HTO emissions from the Tritium Facilities at both LLNL and Sandia/ California. Operations at the Sandia/California Tritium Facility ceased in October 1994. The reduced measurements of tritium activity in rain since 1991 reflect the reduction of emissions from the two facilities.

Site 300

As in the past, none of the 8 routine rain samples obtained from monitoring locations at Site 300 during 2002 showed tritium activities above background activity, which is approximately 2 Bq/L (see Table 7-5 in the Data Supplement).

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, 1996, 1997). Beginning in 1997, LLNL discharges to the DRB included routine treated groundwater from Treatment Facilities D and E, and from related portable treatment units. These discharges contribute a year-round source of water entering and exiting the DRB. Storm water runoff still dominates wet weather

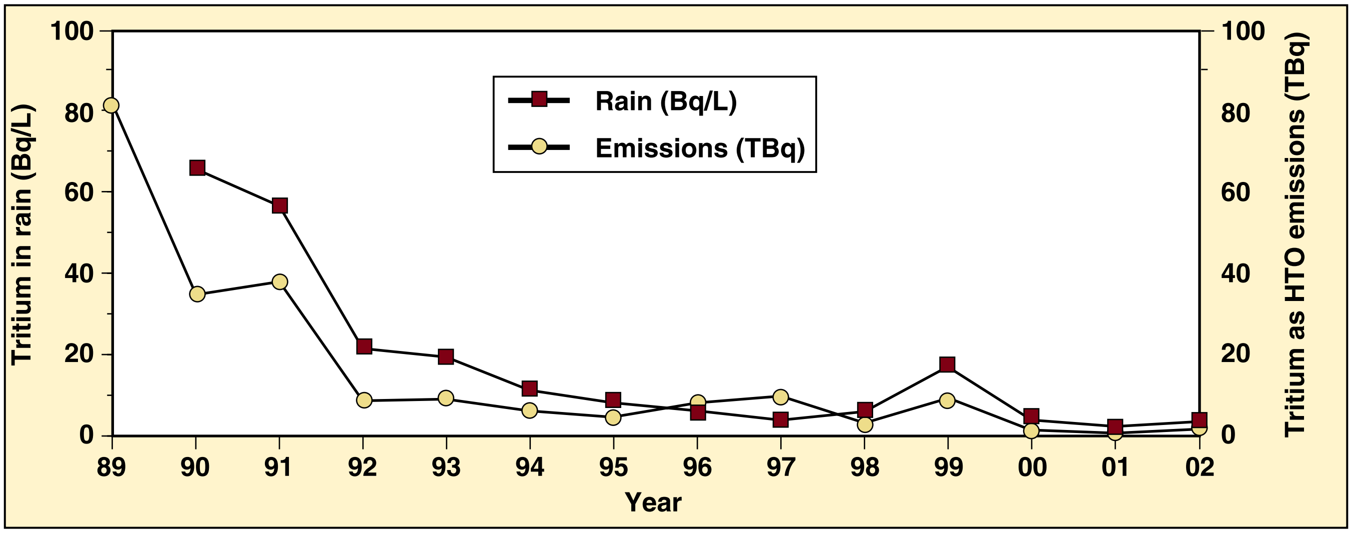

Figure 7-5. Trend of median tritium activity in rain and trend of total stack emissions of HTO. From 1989 to 1995 the emissions are from the Livermore site and Sandia/California. Emissions from 1996 to 2002 are from LLNL only.

flows through the DRB, but discharges from the treatment facilities now constitute a substantial portion of the total water passing through the DRB.

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

The DRB sampling program implements requirements established by the SFBRWQCB. The program consists of monitoring wet and dry weather releases for compliance with discharge limits, monitoring DRB water quality to support management actions established in the *Drainage Retention Basin Management Plan* (DRB Management Plan) (Limnion Corporation 1991), characterizing water quality before its release, and performing routine reporting. 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 1997). 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 et al. 1997) (wet season December 1 through March 31, dry season April 1 through November 30).

To characterize wet-season discharges, 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, at a minimum, from each discrete discharge event. Discharge sampling locations CDBX and WPDC are shown in **Figure 7-2**. LLNL collects samples at CDBX to determine compliance with discharge limits. Sampling at WPDC is done to identify any change in water quality as the 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 7-6 of the Data Supplement.

The routine management constituents, management action levels, and monitoring frequencies that apply to water contained in the DRB are identified in Data Supplement Table 7-7 and were established based on recommendations made in the DRB Management Plan. LLNL collects samples at the eight locations identified in **Figure 7-6** to determine whether water quality management objectives are met. Dissolved oxygen content and temperature are measured at the eight locations, while samples for the remaining chemical and physical constituents are collected from sample location CDBE because of the limited variability for these constituents within the DRB. CDBE is located at the middle depth of the DRB.

The DRB Management Plan identifies biological and microbiological surveys that are used as the primary means to assess the long-range environmental impact of DRB operations. LLNL monitors plant and animal species at the DRB, the drainage channels discharging into the DRB, and downstream portions of Arroyo Las Positas. LLNL's biologist conducts semiannual surveys to identify the presence or absence of amphibians, birds, and fishes, and annual surveys for mammals and plants. Bird, fish, and mammal surveys were not conducted during 2002. Although no formal plant surveys were completed, no changes to plant populations were expected (nor observed in anecdotal surveys) during 2002. Spring and summer amphibian surveys were completed and results shown in **Table 7-10**.

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 Hach brand test kit; and transparency is measured using a Secchi disk. State-certified laboratories analyze the collected samples for additional chemical and physical parameters.

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 et al. 1987), *Inventory and Monitoring of Wildlife Habitat* (Cooperrider et al. 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). Because of a lack of resources, LLNL was again unable to conduct the microbiological survey in 2002.

Results

Some samples collected during 2002 within the DRB at CDBE for dissolved oxygen saturation, temperature, transparency, nitrate (as nitrogen [N]), total dissolved solids (TDS), total phosphorus (as phosphate [P]), chemical oxygen demand (COD), pH, and specific conductance (**Table 7-11**) did not meet the management action levels and triggered administrative review. Water

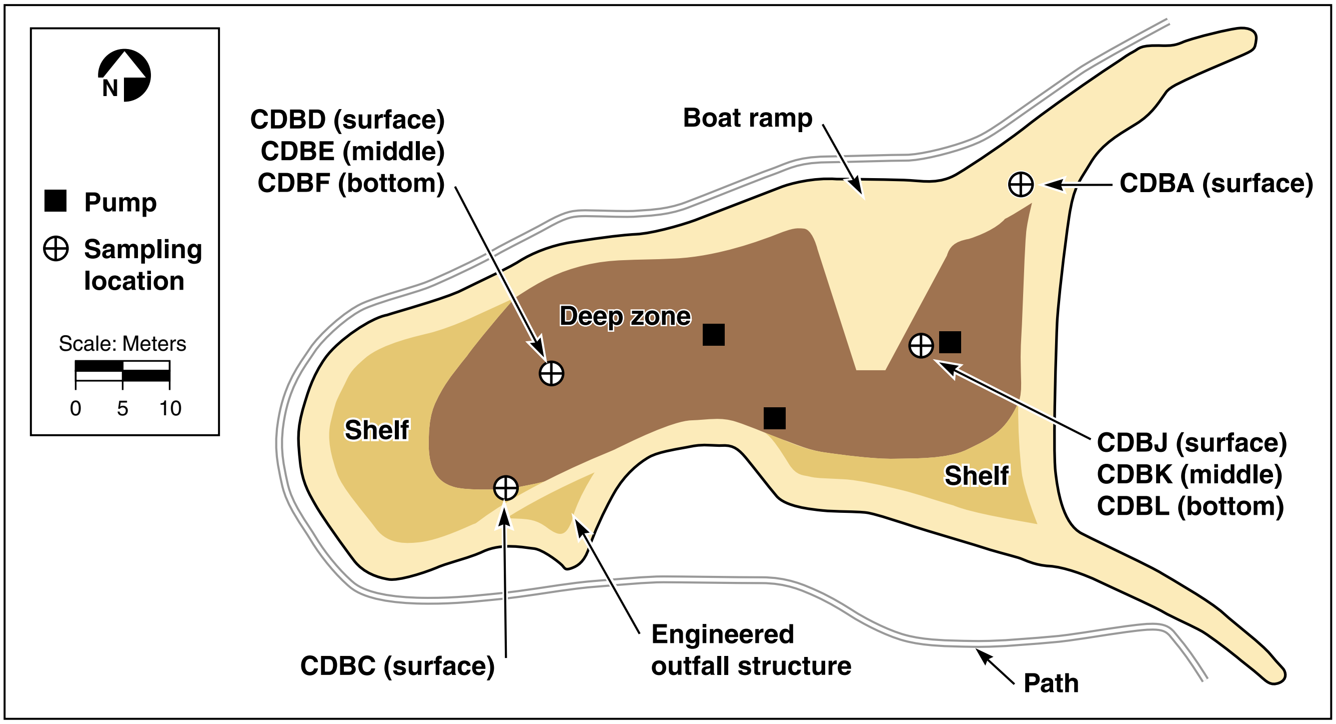

Figure 7-6. Sampling locations within the Drainage Retention Basin, 2002

Table 7-10. Inventory of amphibians in the Drainage Retention Basin, 2002

Common name	Scientific name	Date					
		30 May	25 Jul	6 Aug	15 Aug	20 Aug	17 Sept
Bullfrog	*Rana catesbeiana*	27	49	55	73	60	75
Pacific tree frog	*Hyla regilla*	3	1	4	0	3	2
California red-legged frog	*Rana aurora draytonii*	0	1	0	7	6	2
Western toad	*Bufo borieus*	0	0	1	2	2	1

releases occurred continuously to maintain relatively low nutrient levels. Samples collected at CDBX and WPDC exceeded only the pH and COD discharge limits **Table 7-11**).

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 7-8 through 7-13 in the Data Supplement.

Table 7-11. Summary of Drainage Retention Basin monitoring not meeting management action levels

Parameter	Management action level	Jan	Feb	Mar	Apr	May	June
Sampling location CDBE							
Dissolved oxygen saturation (%)[a]	<80	—[b]	—[b]	—[b]	—[b]	—[b]	—[b]
Temperature (degrees C)[a]	<15 or >26	11.2	12.4	14.4	—[b]	—[b]	29
Transparency (m)[a]	<0.91	0.84	—[b]	—[b]	—[b]	—[b]	—[b]
Nitrate (as N) (mg/L)	>0.2	2.2	2.3	2	1.1	0.57	0.9
pH (pH units)	<6.0 or >9.0	—[b]	—[b]	—[b]	—[b]	—[b]	9.21
Specific conductance (μS/cm)	>900	939	1070	1120	1110	1100	1070
Total dissolved solids (TDS) (mg/L)	>360	557	646	647	660	647	630
Total phosphorus (as P) (mg/L)	>0.02	0.22	0.15	0.06	<0.05	<0.05	<0.05
Chemical oxygen demand (mg/L)	>20	58	—[c]	—[c]	<25	—[c]	—[c]
		July	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Sampling location CDBE (continued)							
Dissolved oxygen saturation (%)[a]	<80	—[b]	76	31	—[b]	76	55
Temperature (degrees C)[a]	<15 and >26	—[b]	—[b]	—[b]	—[b]	14.2	11.1
Transparency (m)[a]	<0.91	—[b]	—[b]	—[b]	—[b]	—[b]	—[b]
Nitrate (as N) (mg/L)	>0.2	—[b]	—[b]	—[b]	1.1	1.4	1.4
pH (pH units)	<6.0 or >9.0	9.04	—[b]	9.06	—[b]	—[b]	—[b]
Specific conductance (μS/cm)	>900	1030	1160	1110	1270	1190	1020
Total dissolved solids (TDS) (mg/L)	>360	643	688	653	775	820	690
Total phosphorus (as P) (mg/L)	>0.02	0.07	<0.05	<0.05	<0.05	0.06	<0.05
Chemical oxygen demand (mg/L)	>20	36	—[c]	—[c]	29	—[c]	—[c]
		4 Jun	**1 Jul**	**6 Aug**	**3 Sep**	**24 Sep**	**8 Nov**
Sampling location CDBX							
Chemical oxygen demand (mg/L)	>20	—[c]	—[c]	—[c]	—[c]	—[c]	36
pH (pH units)	<6.5 or >9.0	9.24	9.61	9.72	9.65	9.55	8.56
Sampling location WPDC							
Chemical oxygen demand (mg/L)	>20	—[c]	—[c]	—[c]	—[c]	—[c]	81
pH (pH units)	<6.5 or >8.5	8.62	8.58	8.69	—[b]	—[b]	—[b]

Table 7-11. Summary of Drainage Retention Basin monitoring not meeting management action levels (continued)

Parameter	Management action level	16 Dec					
Sampling location CDBX							
Chemical oxygen demand (mg/L)	>20	36					
pH (pH units)	<6.5 or >9.0	—[b]					
Sampling location WPDC							
Chemical oxygen demand (mg/L)	>20	30					
pH (pH units)	<6.5 or >9.0	—[a]					

a Monthly average, measurements taken weekly

b Concentrations met management action level or discharge limit.

c Chemical oxygen demand was analyzed one per quarter at location CDBE, and only in conjunction with storm water runoff sampling events at locations CDBX and WPDC.

Chemical and Physical Monitoring

Monthly averages for surface-level dissolved oxygen saturation were at or above the management action level of at least 80% oxygen saturation for 4 of 12 months. Oxygen saturation represents the oxygen available to aquatic organisms and is determined by the water temperature and the dissolved oxygen concentration. COD was above management action levels during the fourth quarter of 2002. Chlorophyll-a, though below the management action level of 10,000 µg/L, had one summer and one fall peak indicating algae blooms (**Figure 7-7**).

The chlorophyll-a levels can be used as an indicator of algae populations and of the duration and intensity of algae blooms. The elevated pH level within the DRB corresponds to the peak of the summer bloom and may be associated with the occurrence of increased photosynthesis. The higher pH readings seen in the DRB discharge samples during the summer and fall also correspond to the peak of the summer and fall blooms.

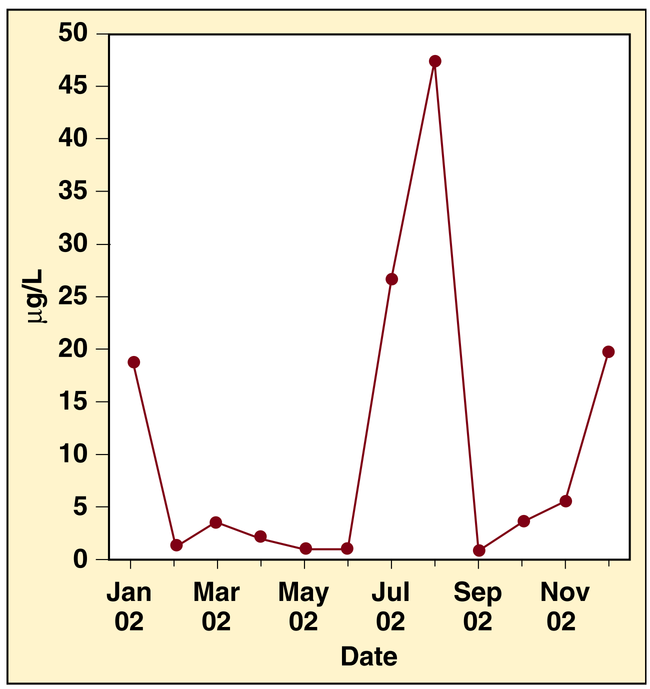

Figure 7-7. Monthly chlorophyll-a in the Drainage Retention Basin, 2002

Beginning during the summer of 1994, transparency was below the management action level of 0.91 meters. Since February 2002, the transparency in the DRB began to increase to levels consistently above the 0.91 meters clarity (**Figure 7-8**). January 2002 yielded the only measurements exceeding the action level, indicating clearer water. The loss of transparency seen during the warmer summer and fall months is most likely the result of algae growth (Harrach et al. 1996).

Beginning in the 1999/2000 wet season and throughout 2002, LLNL has operated the DRB to minimize the water level fluctuations and maintain the water level as much as possible between 1 and 2 feet above the shelf. This management strategy allowed both submergent and emergent vegetation to be established throughout the DRB for the first time, which may explain the trend toward increased clarity.

Nutrient levels continued to be high during 2002 (**Figure 7-9**). Concentrations were well above management action levels throughout the year, but decreased concentrations occurred in the periods when chlorophyll-a was high (**Figure 7-7**), possibly indicating an uptake of nutrients during algae growth. Total phosphorus remained fairly constant throughout 2002 at concentrations at the analytical laboratory detection limit and near the management action levels. Sources of nitrate and phosphorous include external sources, storm water runoff, treated groundwater discharges, and an internal source of nutrient cycling related to algae and plant growth.

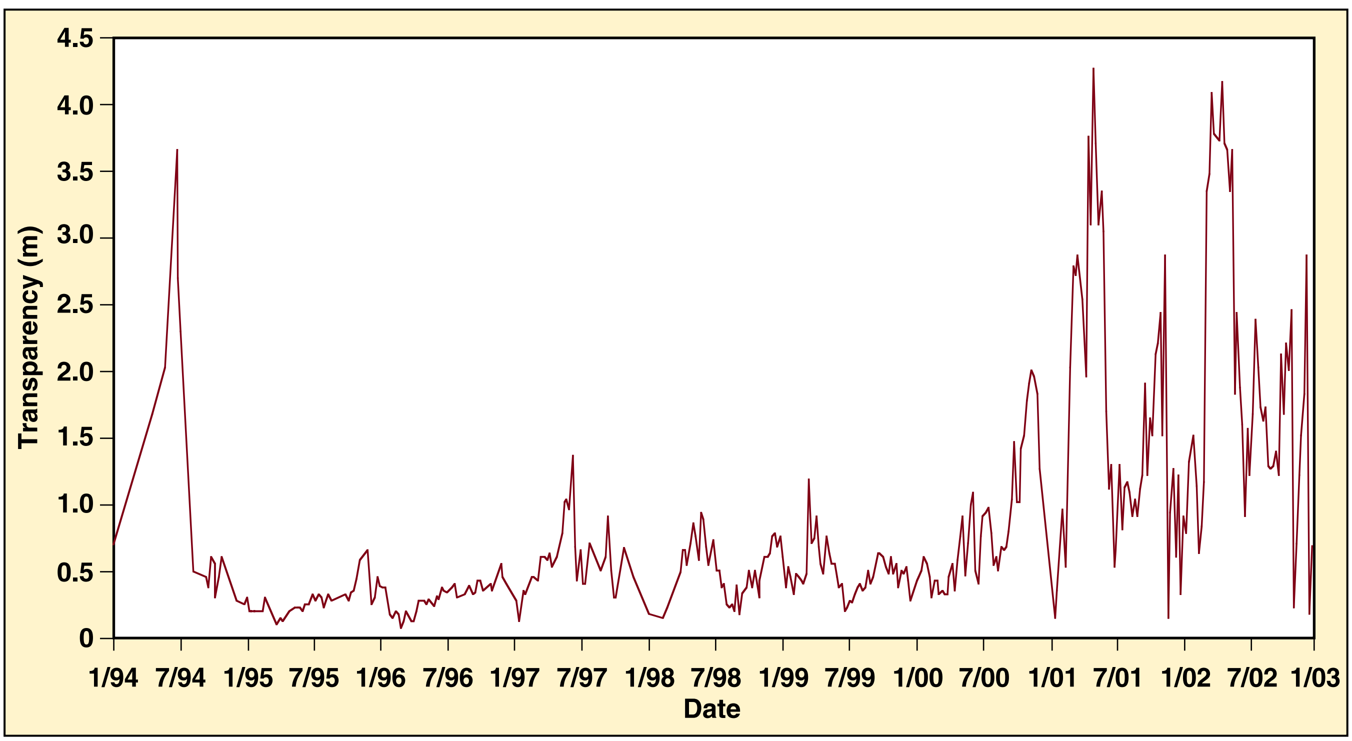

Figure 7-8. Transparency in Drainage Retention Basin, 1994–2002

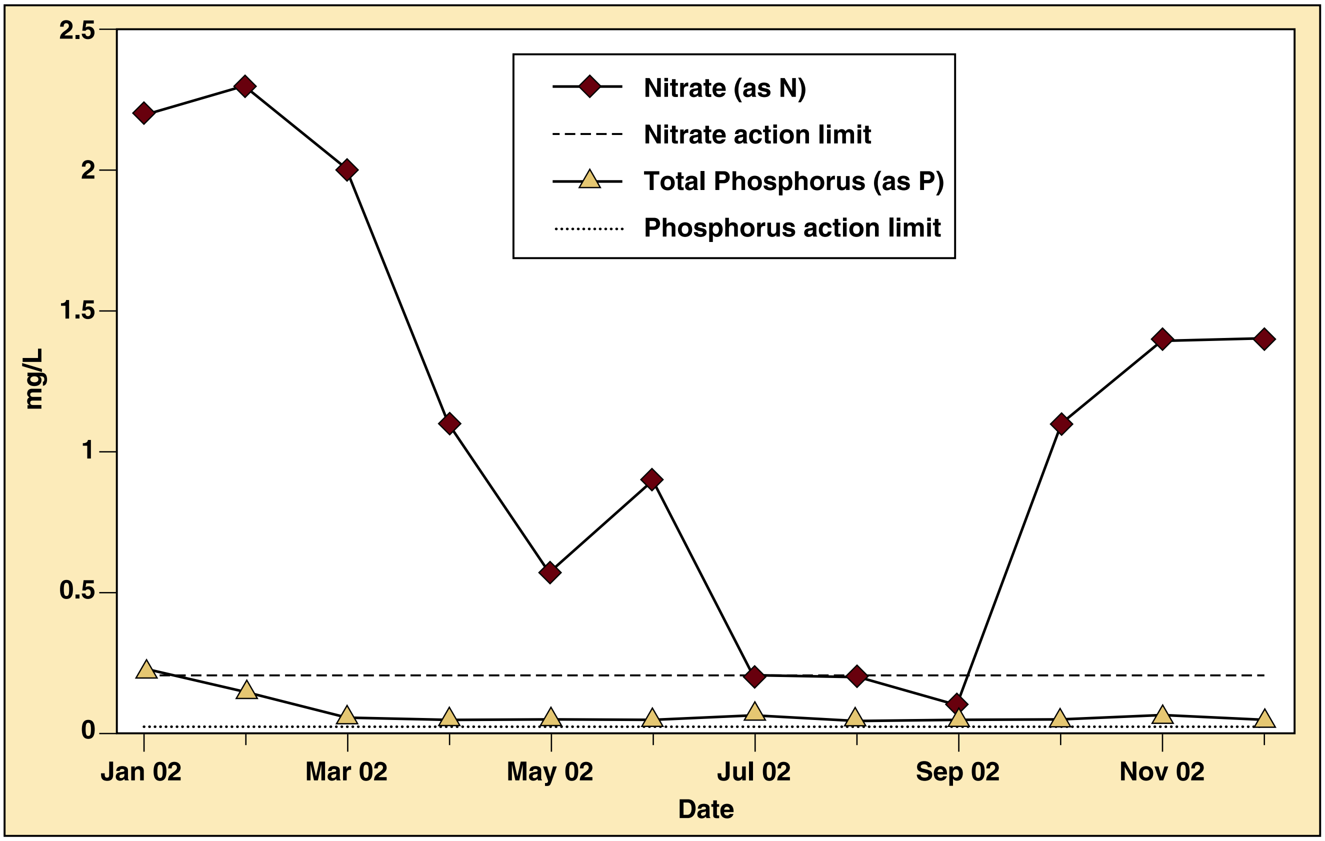

Figure 7-9. Nutrient levels in the Drainage Retention Basin, 2002

During 2002, total dissolved solids continued to exceed the management action levels (360 mg/L) in all 12 months when samples were collected. Specific conductance exceeded the management action level of 900 µS/cm for all 12 months, showing a relation between the increase in TDS and the increase seen in specific conductance.

LLNL collects and analyzes samples for acute fish toxicity and for the chronic toxicity of three species (fathead minnow, water flea, and algae) a minimum of once per year from sample location CDBE and upon the first wet-season release at CDBX. In addition, LLNL collects acute fish toxicity samples from each discrete dry-season release. Samples collected in October from sample location CDBE showed minor algae toxicity (2 toxic units). All other toxicity samples collected showed no toxic effects.

Biological Monitoring

Biological monitoring has not been conducted long enough to identify any trends resulting from operation of the DRB. However, biological monitoring has revealed an expansion in the wetland areas in Arroyo Las Positas; this increase appears to be a result of the continuous discharges of water from the DRB and other sources of treated groundwater throughout the dry season. The California red-legged frog is found in Arroyo Las Positas and the DRB. A number of other species routinely use the DRB, its tributaries, and receiving water. Amphibians found in the DRB and the Arroyo las Positas are listed in **Table 7-10**.

Site 300 Cooling Towers

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

General Information

The CVRWQCB rescinded WDR 94-131, NPDES Permit No. CA0081396, on August 4, 2000, which previously governed discharges from the two primary cooling towers at Site 300. The CVRWQCB determined that these cooling towers discharge to the ground rather than to surface water drainage courses. Therefore, the CVRWQCB is issuing a new permit (see discussion in **Chapter 2**) to incorporate these cooling tower discharges, and other low-threat discharges, going to ground. Pending the issuance of the new permit, LLNL continues to monitor the cooling tower wastewater discharges following the WDR 94-131 monitoring requirements at the direction of CVRWQCB staff.

Two primary cooling towers, located at Buildings 801 and 836A, regularly discharge to the ground. Blowdown flow from the cooling towers located at these two buildings is monitored biweekly. TDS and pH are monitored quarterly at both of these locations. The 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 7-10**.

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, LLNL 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 7-10**).

The GEOCRK sampling location is also fed by discharges of treated groundwater from Site 300. Therefore, even when the upstream location is dry, there may be 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.

If the blowdown flow from any 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

Monitoring results indicate only one discharge from the Buildings 801 and 836A cooling towers that was above the maximum values, previously imposed for discharges to surface water drainage courses, under WDR 94-131. The fourth quarter sample from the Building 801 tower showed a TDS value (2980 mg/L) above the previous limit of 2400 mg/L for discharges to surface waters. LLNL continues to monitor these discharges at the

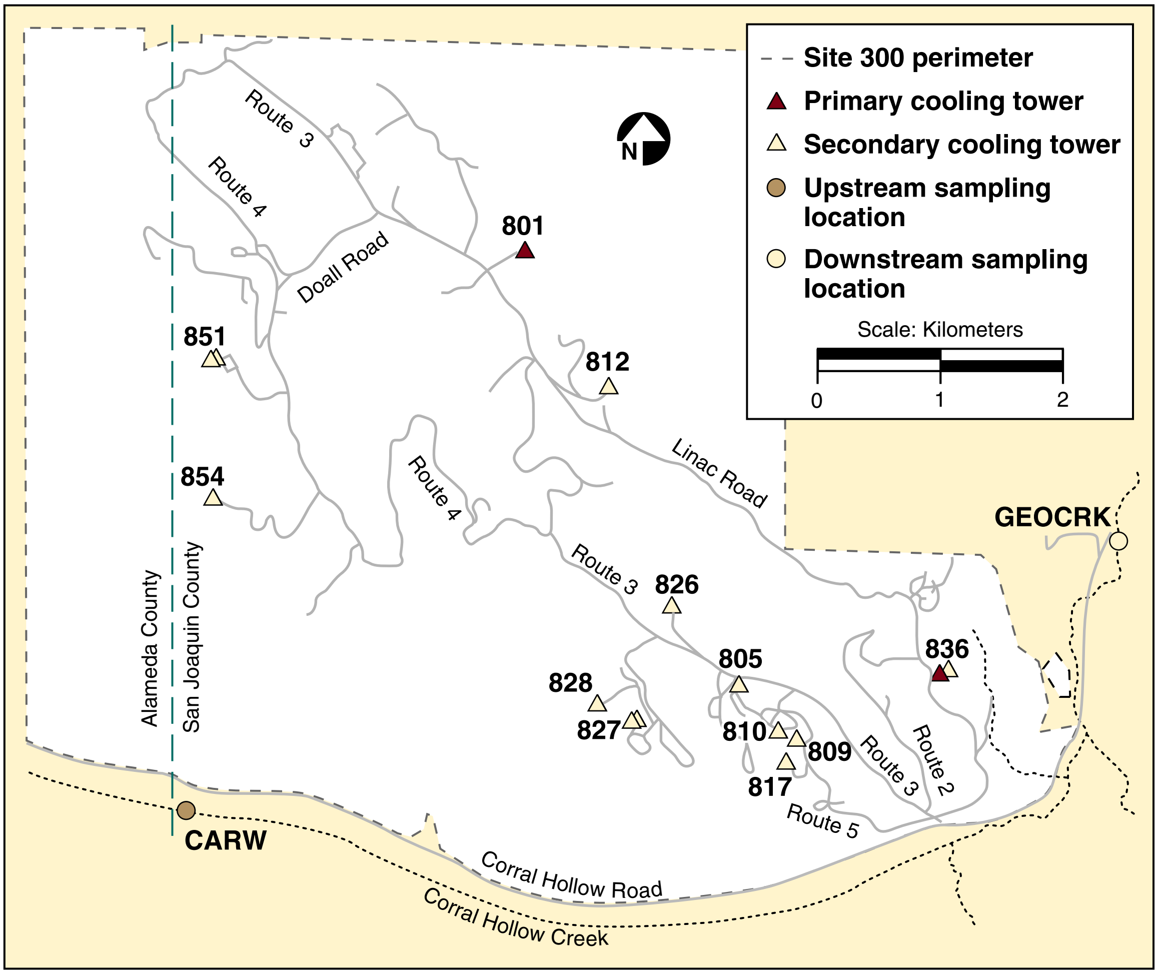

Figure 7-10. Cooling tower locations and receiving water monitoring locations, Site 300, 2002

direction of CVRWQCB staff. Resampling at this location, completed one month after the routine fourth quarter sampling, showed a TDS value of 1420 mg/L, which is a value consistent with the results from previous quarters. Table 7-12 summarizes the data from the quarterly TDS and pH monitoring, as well as the biweekly measurements of blowdown flow.

The biweekly observations at CARW and GEOCRK reported conditions ranging from medium flow to dry for both sampling locations throughout 2002. Only on January 4 and December 18 was there adequate flow to measure pH. The resulting field pH measurements for the CARW and GEOCRK locations were 8.04 and 7.92 in January, and 8.50 and 8.51 in December, respectively. These results indicate essentially no change between the upstream and downstream locations. Visual observations of Corral Hollow Creek were performed each quarter, and no visible oil, grease, scum, foam, or floating suspended materials were noted in the creek during 2002.

Table 7-12. Summary data from monitoring of primary cooling towers, Site 300, 2002

Test	Tower no.	Minimum	Maximum	Median	Interquartile range	Number of samples
Total dissolved solids (TDS) (mg/L)	801	1400	2980	1500	80	5
	836A	1230	1500	1350	—[a]	4
Blowdown flow (L/day)	801	0	12371	4970	4614	25
	836A	0	3596	1389	1915	25
pH (pH units)	801	9.0	9.2	9.1	—[a]	4
	836A	8.9	9.0	9.0	—[a]	4

a Not enough data points to determine

Site 300 Drinking Water System Discharges

This section discusses general information about the monitoring requirements for discharges from the Site 300 drinking water system, including permit information, sampling methods, and sampling results.

General Information

LLNL samples large-volume discharges from the Site 300 drinking water system that reach surface water drainage courses in accordance with the requirements of WDR 5-00-175, NPDES General Permit No. CAG995001. LLNL obtained coverage under this general permit for drinking water system discharges to surface waters when WDR 94-131 was rescinded in August 2000. The monitoring and reporting program that LLNL developed for these discharges was approved by the CVRWQCB.

Discharges that are subject to sampling under WDR 5-00-175 include:

Drinking water storage tanks: monitor all discharges that have the potential to reach surface waters.

System flushes: monitor one flush per pressure zone per year for flushes that have the potential to reach surface waters.

Dead-end flushes: semiannually monitor all flushes that have the potential to reach surface waters, and for any discharge that continues for more than four months.

Discharges must comply with the effluent limits for residual chlorine established by the permit, which require that it must not be greater than 0.02 mg/L, and that the pH must be between 6.5 and 8.5. Discharges are also observed to ensure that no erosion results and no other pollutants are washed into surface waters. To meet the chlorine limit, drinking water system discharges with the potential to reach surface waters are dechlorinated.

Methods

Sample collection procedures are discussed in *Lawrence Livermore National Laboratory Site 300 Water Suppliers' Pollution Prevention and Monitoring and Reporting Program* (Mathews 2000). Grab samples are collected in accordance with Operations and Regulatory Affairs Division (ORAD) procedures EMP-W-S and EMP-WSS-

WSD. Residual chlorine and pH are immediately analyzed in the field, using a spectrophotometer and calibrated pH meter, respectively.

Samples are collected at the point of discharge and at the point where the discharge flows into a surface water. If the discharge reaches Corral Hollow Creek, samples are collected at the upstream sampling location, CARW, and the downstream sampling location, GEOCRK.

Results

Monitoring results are detailed in the quarterly self monitoring reports to the CVRWQCB. Releases occurred in the first and second quarters of 2002. In both events difficulty was encountered obtaining valid chlorine readings with the field equipment due to interferences. Correction to the analysis protocols have since been instituted. The pH of all releases met the effluent limitations (see **Table 7-13**). These releases quickly percolated into the streambed and did not reach Corral Hollow Creek, the receiving water (see **Table 7-14**). In the third quarter, a line break at Tank 5 resulted in the release of 330,000 gallons of drinking water into Elk Ravine. Because of the nature of the release, water could not be dechlorinated and was not monitored. There were no releases in the fourth quarter.

Other Waters

This section discusses general information about monitoring network requirements, sampling methods, and sampling results.

Table 7-13. Measured pH and residual chlorine values in Site 300 drinking water system releases

Release location	Date	Estimated volume (gallons)	pH (units)		Residual chlorine (mg/L)	
			Effluent	Surface water	Effluent	Surface water
Permit limit		—	—	≥6.5, ≤8.5	—	0.02
Well 18[(a)]	March 15 (a.m.)	7200	8.4	—[(a)]	ND[(b)]	—[(a)]
Well 18	March 15 (p.m.)	—[(a)]	8.33	8.42	ND	NV[(c)]
Hydrant D13	April 3	70	7.66	NS[(d)]	NV	NS
Hydrant D6	April 3	70	7.48	NS	NV	NS
Hydrant D5	April 3	70	7.71	NS	NV	NS
Hydrant D3	April 3	70	7.79	NS	NV	NS

a Well 18 was one continuous release of 7200 gallons. Some parameters were sampled upon initiation (in the morning) and some were sampled later in the day.

b ND = Not detected at a concentration sensitivity of 0.01 mg/L.

c NV = Not valid, sample collected but result not valid due to interference.

d NS = Not sampled, volume of water entering surface water immediately soaked into the ground and a sample could not be collected.

Table 7-14. Field observations Site 300 drinking water system releases

Release location	Date	Observations
		Effluent location
Well 18	March 15	Flow rate estimated at 40 gallons per minute. Water flowed clear from defuser. No discoloration, sediment, or oil was noted in the water.
Hydrant D3, D5, D6, D13	April 3	No discoloration, sediment, or oil was noted in the water.
		Surface water location
Well 18	March 15	Flow entered Corral Hollow Creek, which was dry. Water was discolored due to sediment in the creek bed. Water flowed approximately 100 feet downstream and soaked into the dry creek bed.
Hydrant D3, D5, D6, D13	April 3	Approximately 20 gallons of flow from each hydrant entered Elk Ravine and immediately soaked into the ground.

General Information

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 Livermore site and in the Livermore Valley are sampled at the locations shown in **Figure 7-11**. 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. Radioactivity data from drinking water sources and drinking water outlets are used to calculate drinking water statistics (see **Table 7-15**) 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, in January and July 2002, for gross alpha, gross beta, and tritium. The on-site swimming pool location (POOL) was sampled semiannually for gross alpha and gross beta, and quarterly for tritium.

Results

The median activity for tritium in surface and drinking waters was estimated from calculated values to be below the laboratory's minimum detectable activities, or minimum quantifiable activities. The maximum tritium activity detected was less than 1% of the MCL in drinking water from an off-site residence location PALM (**Figure 7-11**). Median activities for gross alpha and gross beta radiation in surface and drinking water samples were both less than 5% of their respective MCLs. However, maximum activities detected for gross alpha and gross beta, respectively, were 0.046 Bq/L and 0.253 Bq/L; both less than 15% of their respective MCLs (see **Table 7-15**). Detailed data are in Table 7-14 of the Data Supplement. Historically, gross alpha and gross beta radiation have fluctuated around the laboratory minimum detectable activities. At these very low levels, the counting error associated with the measurements are nearly equal to, or in many cases greater than, the calculated values so that no trends are apparent in the data.

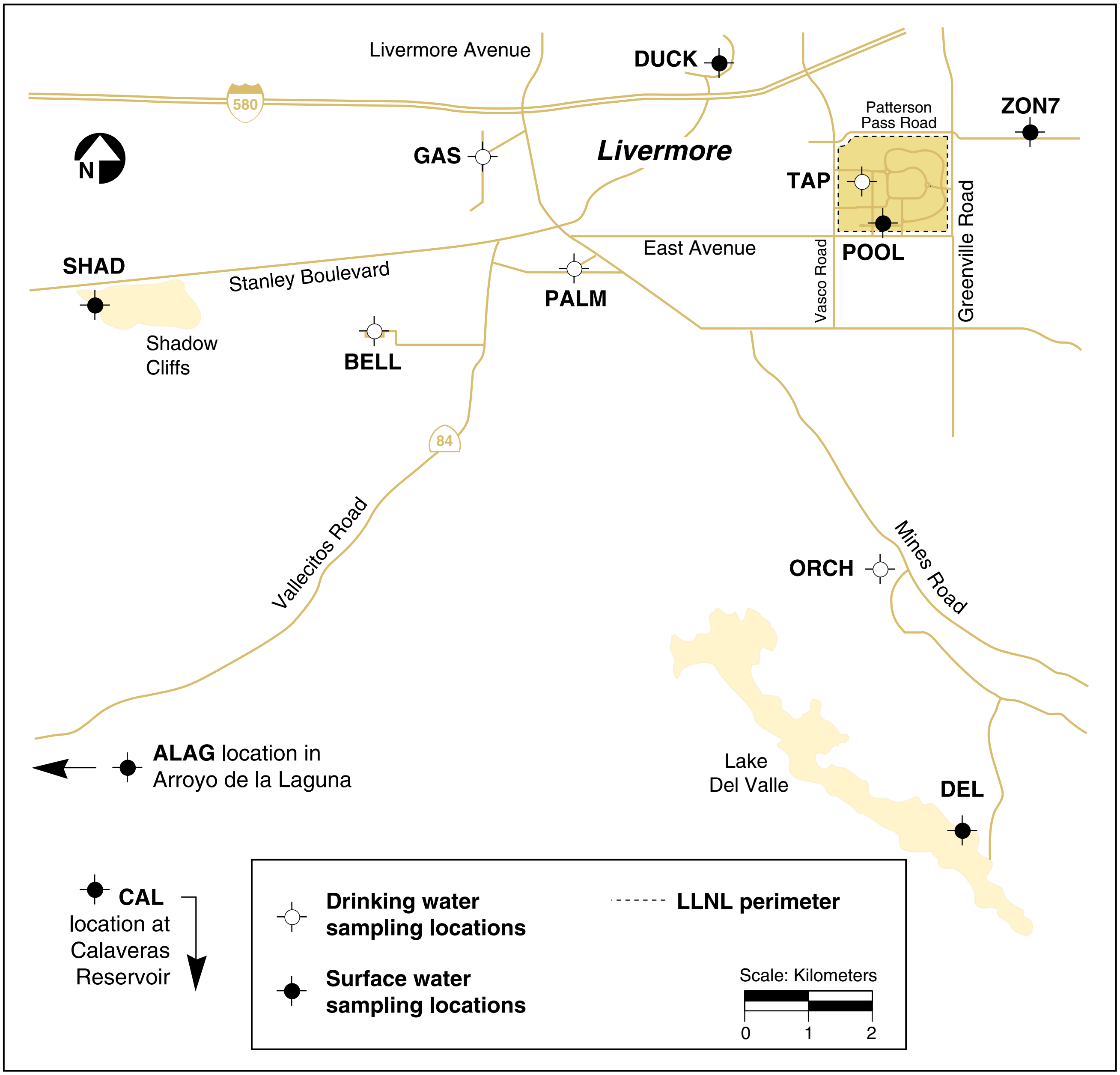

Figure 7-11. Surface and drinking water sampling locations, Livermore Valley, 2002

Historical median tritium values in surface and drinking waters in the Livermore Valley since 1988 are shown in Figure 7-12. Since 1988, when measurements began, water in the LLNL swimming pool has had the highest tritium activities until 2002 because it is closest to tritium sources within LLNL. No individual tritium activity measured in the pool in 2002 was greater than the minimum detectable activity, near 3.7 Bq/L, for these samples.

Table 7-15. Radioactivity in surface and drinking water in the Livermore Valley, 2002

Locations	Tritium (Bq/L)	Gross alpha (Bq/L)	Gross beta (Bq/L)
All locations			
Median	0.200	–0.001	0.074
Minimum	–2.36	–0.110	0.008
Maximum	4.81	0.046	0.253
Interquartile range	1.84	0.018	0.087
Drinking water locations			
Median	–0.323	0.000	0.054
Minimum	–2.36	–0.034	0.008
Maximum	4.81	0.030	0.253
Interquartile range	1.12	0.011	0.042
Drinking water MCL	740	0.555	1.85

Note: A negative number means the sample radioactivity was less than the background radioactivity.

Arroyo Las Positas Maintenance Project

This section discusses general information about the monitoring requirements for discharges occurring during maintenance activities within Arroyo Las Positas, including permit information, sampling methods, and sampling results.

General Information

LLNL performs annual maintenance activities within the flood-control channel that diverts the flow of Arroyo Las Positas around the perimeter of the Livermore site. Maintenance activities include phased desilting of the 7000-linear-foot stretch of Arroyo Las Positas on LLNL property over five years, trimming cattail heights, and conducting bank stabilization/erosion control activities. These activities are regulated by:

- WDR 99-086 issued by the SFBRWQCB in 1999
- A Biological Opinion issued by U.S. Fish and Wildlife Service in 1999
- A streambed alteration agreement issued by California Department of Fish and Game in 1998
- A nationwide permit for the construction of six check dams issued by the Army Corps of Engineers in 2000
- A nationwide permit for the construction of coffer dams issued by the Army Corps of Engineers in 2002

Work is done in pre-identified zones (**Figure 7-13**). Each year, no more than 20% of the arroyo length is desilted following the pre-identified patchwork pattern. During August and early September 2002, LLNL conducted maintenance work in Zones 2B, 1B (northernmost 100 feet), 1F, 5B, 2F, 4D, and 2E.

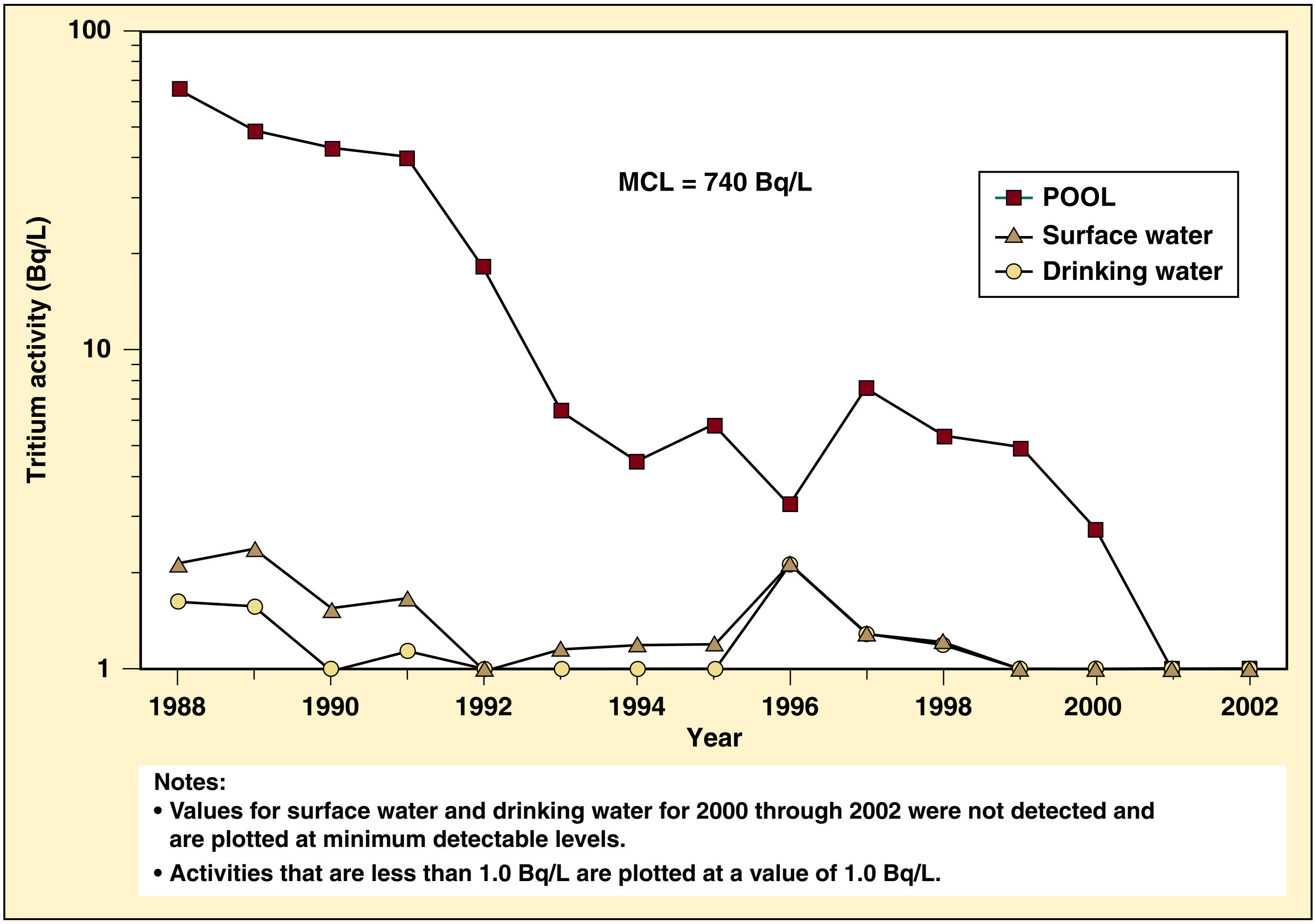

Figure 7-12. Annual median tritium activity in Livermore Valley surface and drinking water, 1988 to 2002

Discharges occur as a result of water diversions, but they cannot cause the receiving water limits, specified in WDR 99-086, to be exceeded. Monitoring is conducted following requirements established in Self-Monitoring Program 99-086 to document compliance with effluent requirements and prohibitions established in WDR 99-086. LLNL submits self-monitoring reports to the SFBRWQCB annually when any receiving water limit is exceeded while work occurred.

Methods

Samples are collected following procedure EMP-W-S and Water Sampling Supplement EMP-WSS-ALP SOP, set up by ORAD. Turbidity, pH, and dissolved oxygen are immediately analyzed in the field using calibrated meters. Weekly duplicate samples are collected and sent to a certified laboratory for analysis.

Receiving water (downstream) samples are collected at the work site twice a day at times evenly spaced during work hours. Receiving water samples are collected no more than 50 feet downstream of the work site while water is diverted around the work site. Upstream samples are collected to characterize background conditions. These samples are collected at least 500 feet above the work site. Prestart background samples are also

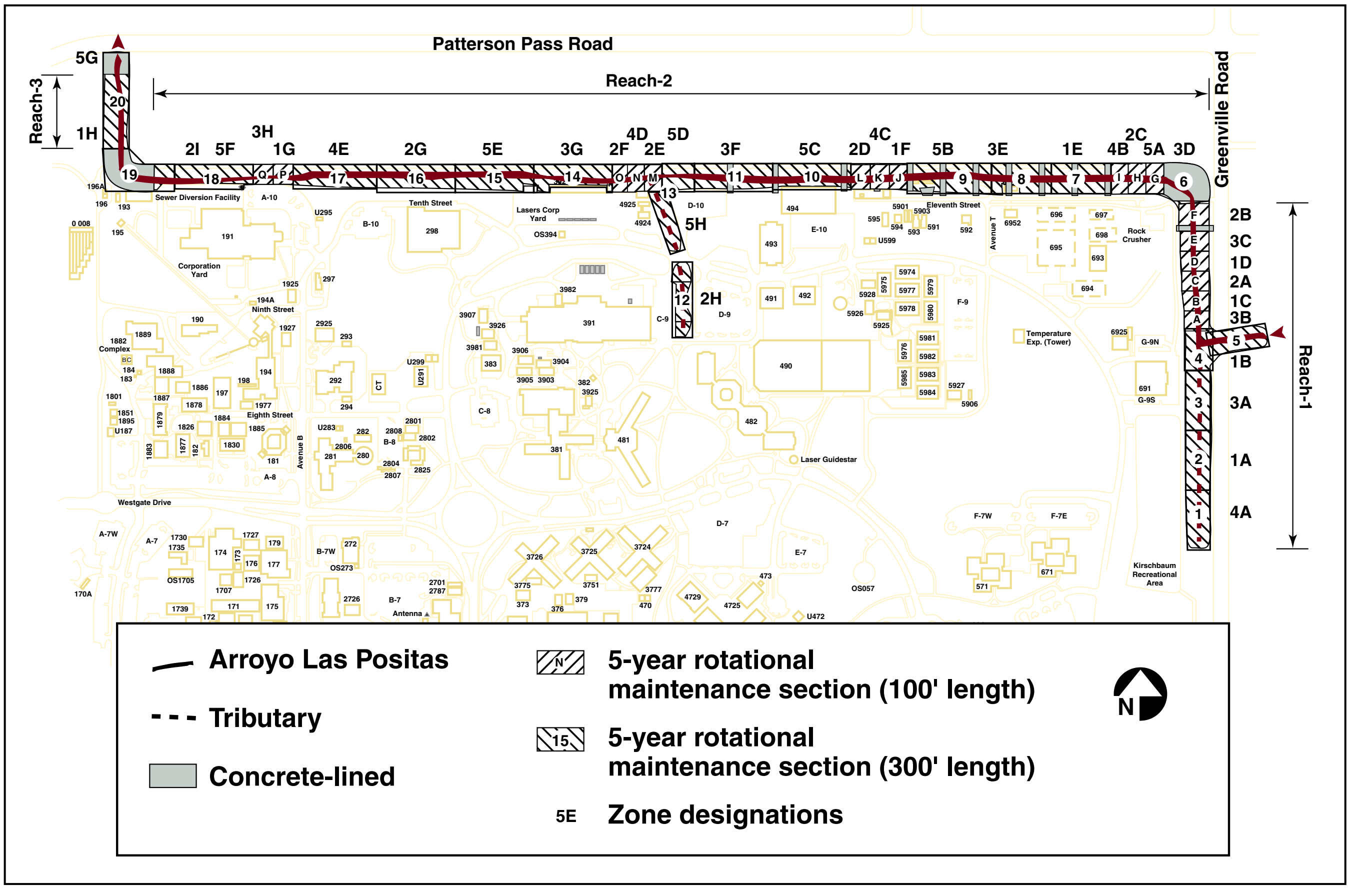

Figure 7-13. Arroyo Las Positas maintenance zones

collected to characterize the receiving water and help evaluate the impact of discharges on the receiving water.

Results

Monitoring results are presented in Table 7-16. Annual self-monitoring reports are required if any of the receiving water limits are exceeded. When the background turbidity is greater than 50 NTU, discharges from the Arroyo Las Positas maintenance project cannot exceed 10% of the background measurement. These discharges must also have a dissolved oxygen concentration of 5.0 mg/L, unless natural factors cause a lower concentration of dissolved oxygen. If background samples do have a dissolved oxygen concentration less than 5.0 mg/L, the Arroyo Las Positas maintenance activities cannot cause further reduction in the concentration of dissolved oxygen at the point of discharge. Furthermore, the pH at the point of discharge cannot vary from the background pH by more than 0.5 pH units. No receiving water limits were exceeded in 2002 so no annual self-monitoring report to the SFBRWQCB was required. Water diversion during desilting activities occurred only at Zones 1F, 5B, 2F, 4D, and 2E.

Table 7-16. Arroyo Las Positas maintenance project monitoring data, 2002

Location and Date	Time	Turbidity (NTU)	pH (pH units)	Dissolved oxygen (mg/L)
Location Zone 1F and 5B[a], prestart (background)				
July 31, 2002	1237	3.0	9.1	7.4
Location: Zone 1F and 5B[a]				
August 22, 2002	0926	2.6	9.2	6.0
August 22, 2002	1150	3.3	8.9	6.2
August 26, 2002	1000	2.8	9.1	5.9
August 26, 2002	1510	2.4	9.1	5.9
August 27, 2002	0840	3.4	9.2	6.3
Location: Zone 2F, 4D, and 2E[a], upstream (background)				
September 11, 2002	1030	3.3	9.0	5.8
September 12, 2002	1330	4.0	9.1	6.0
Location: Zone 2F, 4D, and 2E[a]				
September 11, 2002	0930	4.1	9.0	5.6
September 11, 2002	1400	3.7	8.9	5.5
September 11, 2002	1430	3.3	8.8	6.1
September 12, 2002	0930	4.4	8.8	6.1
September 12, 2002	1330	3.6	9.0	6.1

a Adjacent sections have 1 discharge sampling.

No flow diversions were required around Zones 2B and 1B because they were dry during the work period. Where flow diversions were needed, coffer dams were used in compliance with the Army Corp nationwide permit.

Environmental Impacts

This section discusses the environmental impacts of storm water, rainfall, the DRB, Site 300 cooling towers, Site 300 drinking water system discharges, other waters, and Arroyo Las Positas maintenance activities.

Storm Water

Storm water runoff from the Livermore site and Site 300 did not have any apparent environmental impacts in 2002. Tritium activities in storm water runoff effluent (location WPDC) were less than 1% of the drinking water MCL during 2002. Most values were below detection limits for tritium. Gross alpha and gross beta activities in Livermore site storm water effluent were both less than 32% of their respective MCLs.

Storm water quality runoff from Site 300 is similar to background levels. Although some 2002 storm water results were above comparison criteria at the

Livermore site, there is no evidence of any impact to off-site biota. The fish toxicity tests conducted during 2002 showed moderate toxicity in Livermore site storm water runoff likely caused by a pathogen in the arroyo unrelated to LLNL operations. Follow-up sampling in December 2002 found no fish toxicity. Algae toxicity was also identified in 2002; however, it has been demonstrated that this was caused by upstream pesticide applications not associated with LLNL activities.

Rainfall

Tritium in rainfall had a negligible impact on the environment at the Livermore site, in the Livermore Valley, and at Site 300. The median tritium activity measured in rainfall at LLNL rose slightly from 1.97 Bq/L in 2001 to 3.1 Bq/L in 2002 (all less than 1% of the drinking water MCL). The measured tritium activities of rainfall samples taken at Site 300 were all less than the minimum detect-able activity (or less than the 2σ counting uncer-tainty). The tritium activity measured in rainfall at Site 300 continues to be indistinguishable from atmospheric background levels (2 Bq/L).

Drainage Retention Basin

There is no evidence of adverse environmental impact resulting from releases from the DRB. Because of the frequent dry season discharges that occurred from the DRB, discharges from groundwater treatment facilities, and the wetter rainfall years that occurred from 1997 through 1999, wetland vegetation has increased both upstream and downstream of the DRB. The federally listed threatened California red-legged frog has colonized these wetland areas.

Site 300 Cooling Towers

During 2002, the monitoring results for flow, pH, and TDS from both primary cooling towers show only one value (the TDS value for the fourth quarter) above the previously established WDR 94-131 limits. 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.

Site 300 Drinking Water System Discharges

Although some difficulties were encountered in accurately monitoring the residual chlorine concentrations of the released water, releases did not reach the receiving water, Corral Hollow Creek, and most of the water percolated into dry streambeds where it could not negatively affect aquatic life.

Other Waters

The potential impact of tritium on drinking water supplies was estimated by determining the effective dose equivalent (EDE) (see Appendix C). Maximum tritium activity in drinking waters was 4.81 Bq/L. The EDE to an adult who ingested 2 L/day of water at this maximum concentration for a year would be 0.063 µSv, or 0.16% of the DOE standard allowable dose of 40 µSv for drinking water systems. Gross alpha and gross beta activities (as well as tritium activities) were below their MCLs. The sample data indicate that the impact of Livermore site operations on surface and drinking waters in the Livermore Valley is negligible.

Arroyo Las Positas Maintenance Project

Discharges of diverted water related to the Arroyo Las Positas maintenance project did not adversely impact receiving water quality. No receiving water quality criteria were exceeded throughout the duration of the project.