14. Compliance Self-Monitoring

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Introduction

Unlike other chapters in this annual report, which describe mostly voluntary monitoring efforts that focus on potential impacts to the local community and environment, this chapter focuses on the monitoring of specific waste streams as required by regulatory permits as well as site influent and effluent waste streams. The monitoring methods range from sampling a specific process waste stream at the point of discharge to visual inspection of operational conditions of the waste stream. The type of monitoring depends on the waste stream and the applicable regulatory requirements. Since LLNL implements process controls to prevent the release of significant quantities of pollutants and to minimize waste, the volume of the waste streams and potential impacts are usually modest compared to commercial or industrial standards.

Discharges of Treated Ground Water

LLNL operates five treatment facilities (TFA, TFB, TFC, TFD, and TFF) for Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) cleanup of ground water at the Livermore site (see **Figure 14-1**). Self-monitoring is required at the point of discharge from each treatment facility to verify performance and effectiveness. Ground water contamination at the Livermore site and Site 300 resulted from past hazardous materials handling and disposal practices and leaks and spills both prior to and during LLNL operations. LLNL addresses CERCLA compliance issues. LLNL also assesses the impact of releases on the environment and determines the restoration activities needed to reduce contamination and thereby protect human health and the environment. Restoration activities include soil removal, ground water treatment, and closure of inactive facilities in a manner designed to prevent further environmental contamination.

Additional detail on specific treatment processes is contained in both the *LLNL Ground Water Project 1995 Annual Report* (Hoffman et al. 1995) and the *LLNL Site 300 Ground Water Monitoring Program Quarterly Reports* (Christofferson 1995a, 1995b, 1995c, 1996a). The self-monitoring activities and compliance sampling results that LLNL performs specifically for compliance with environmental discharge parameters are described below.

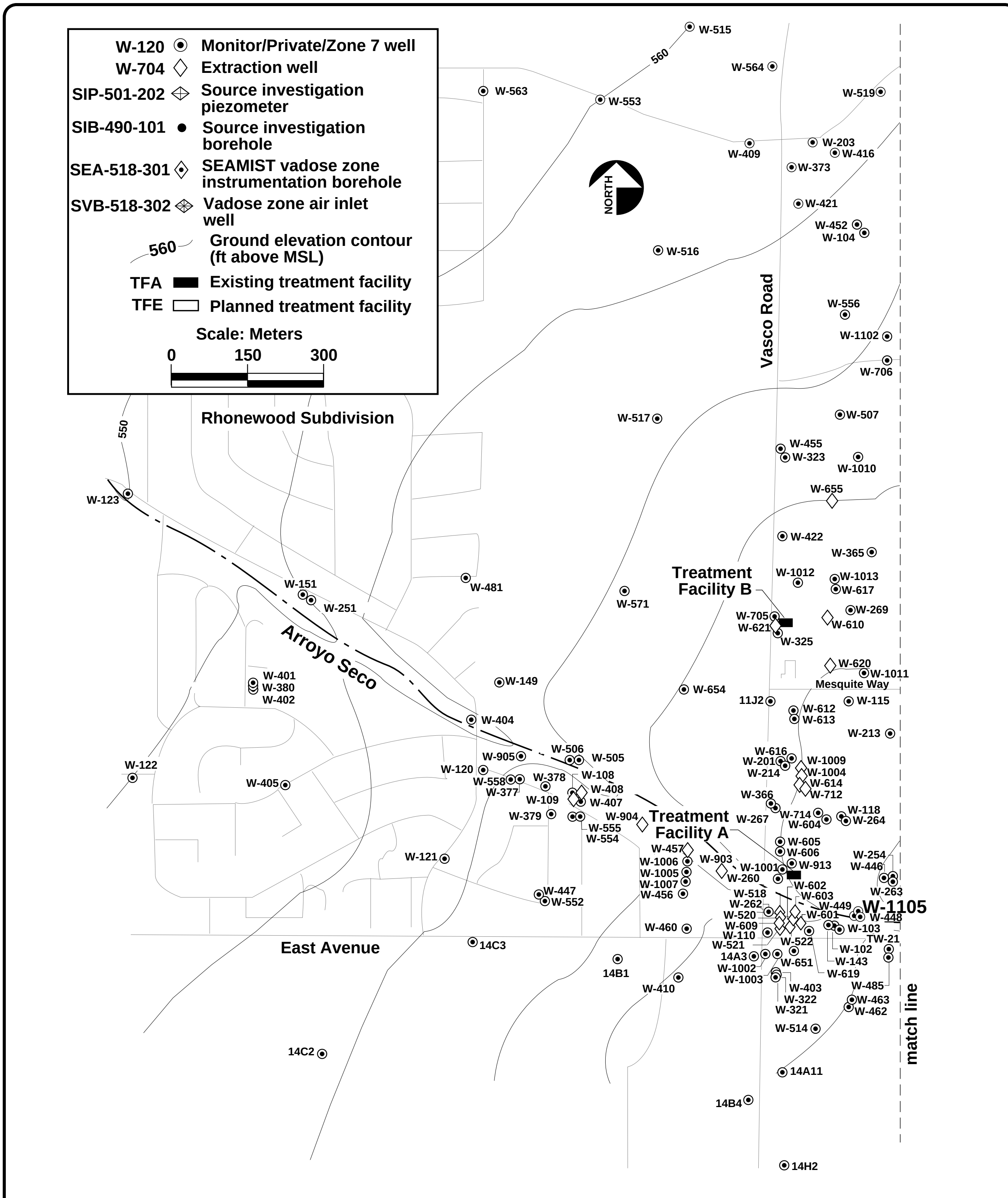

Figure 14-1. Livermore site location map for monitor wells, piezometers, extraction wells, and treatment facilities, December 1995.

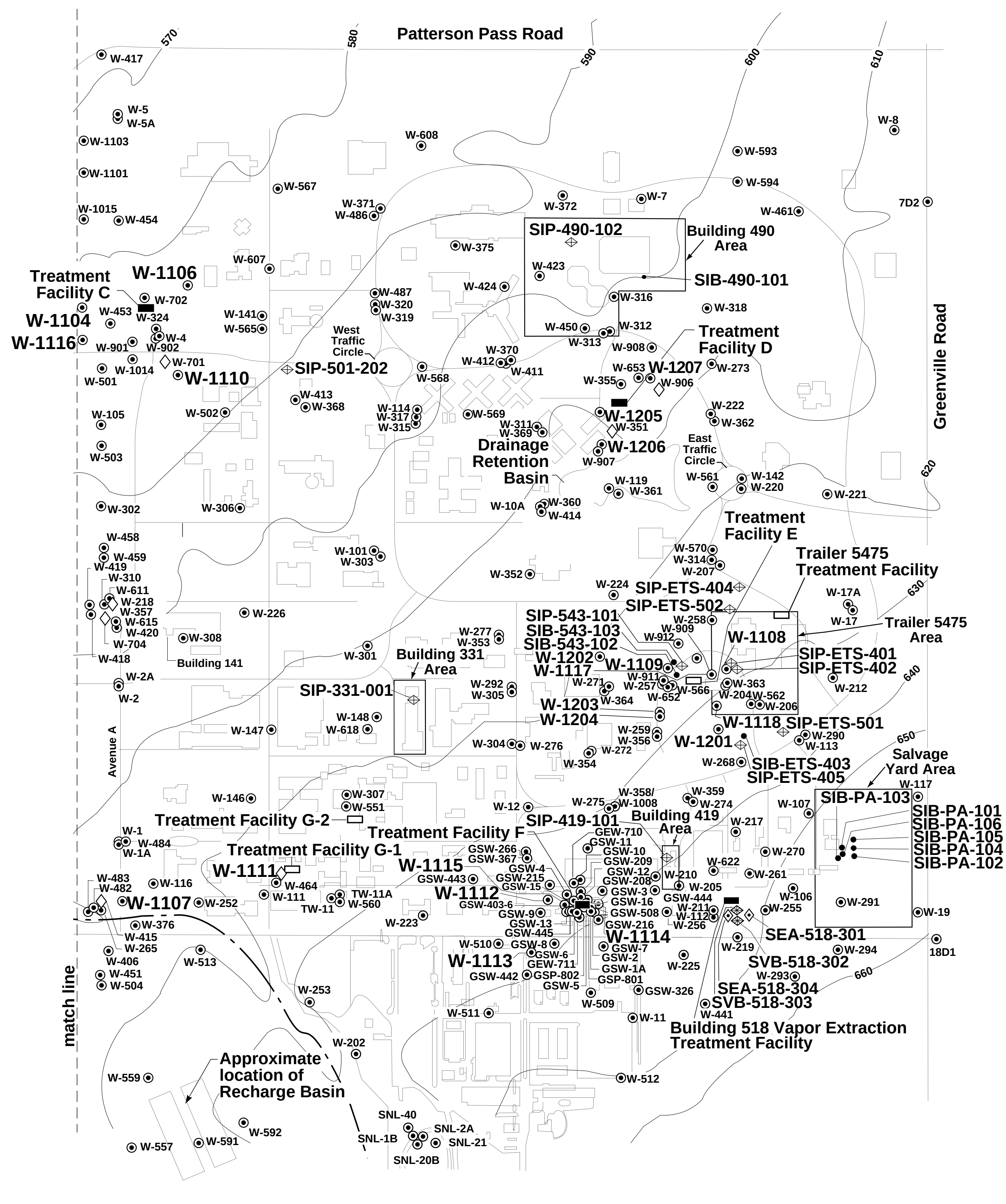

Figure 14-1. (continued).

Treatment Facility A

Treatment Facility A (TFA) is located in the southwestern part of LLNL near Vasco Road. At TFA, volatile organic compounds (VOCs) are removed from ground water using a vapor extractor with granulated activated-carbon canisters.

Western off-site plumes at TFA were hydraulically captured in 1995 (**Figures 14-2** and **14-3**). Ground water was pumped from W-415 from January through July at an average rate of 189 liters per minute (L/min). Eight wells south of TFA provided an additional average flow rate of 378 L/min via the TFA South Pipeline.

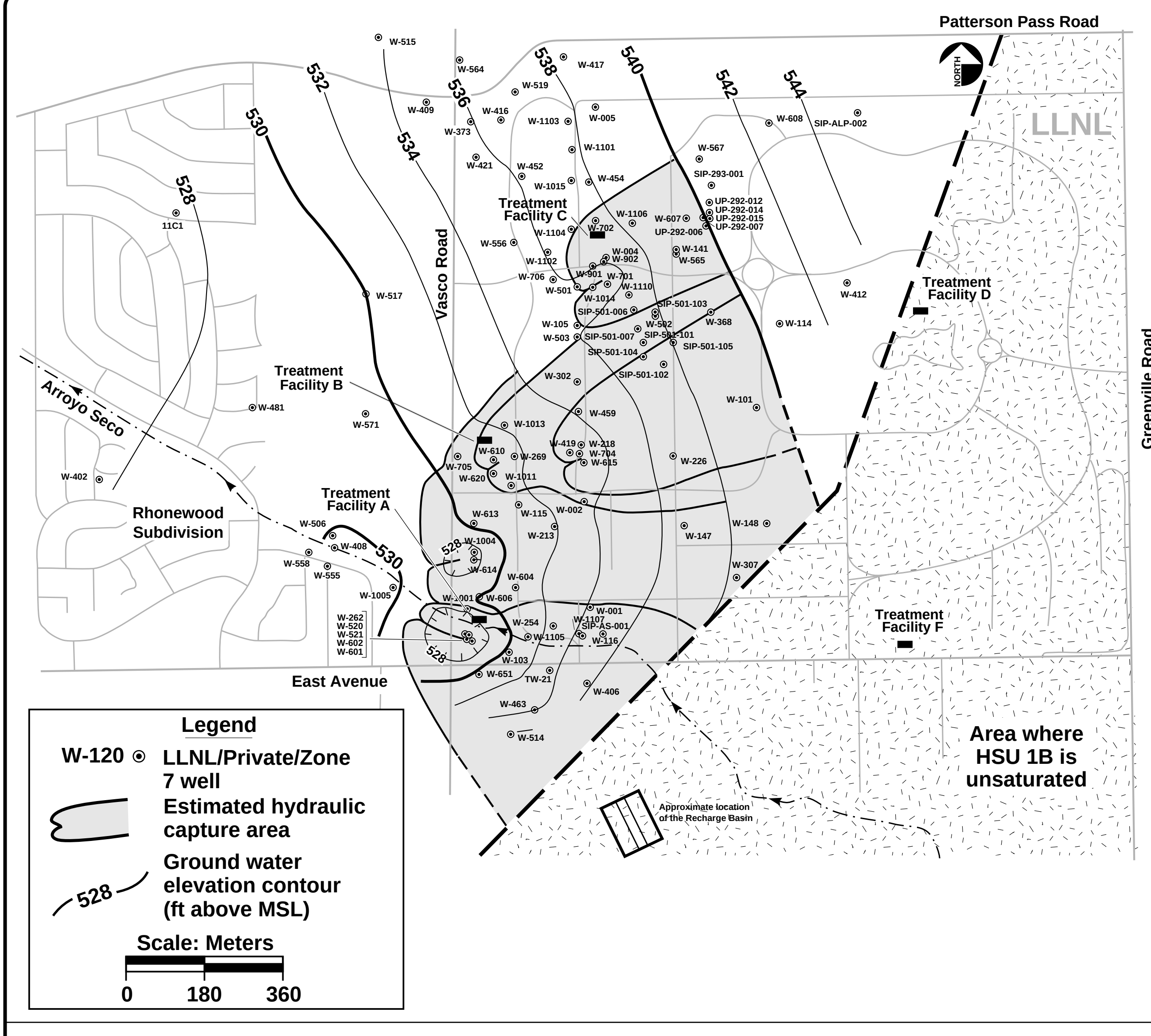

Figure 14-2. Ground water elevation contour map based on 107 wells completed within HSU 1B and estimated HSU 1B hydraulic capture areas, LLNL and vicinity, November 1995.

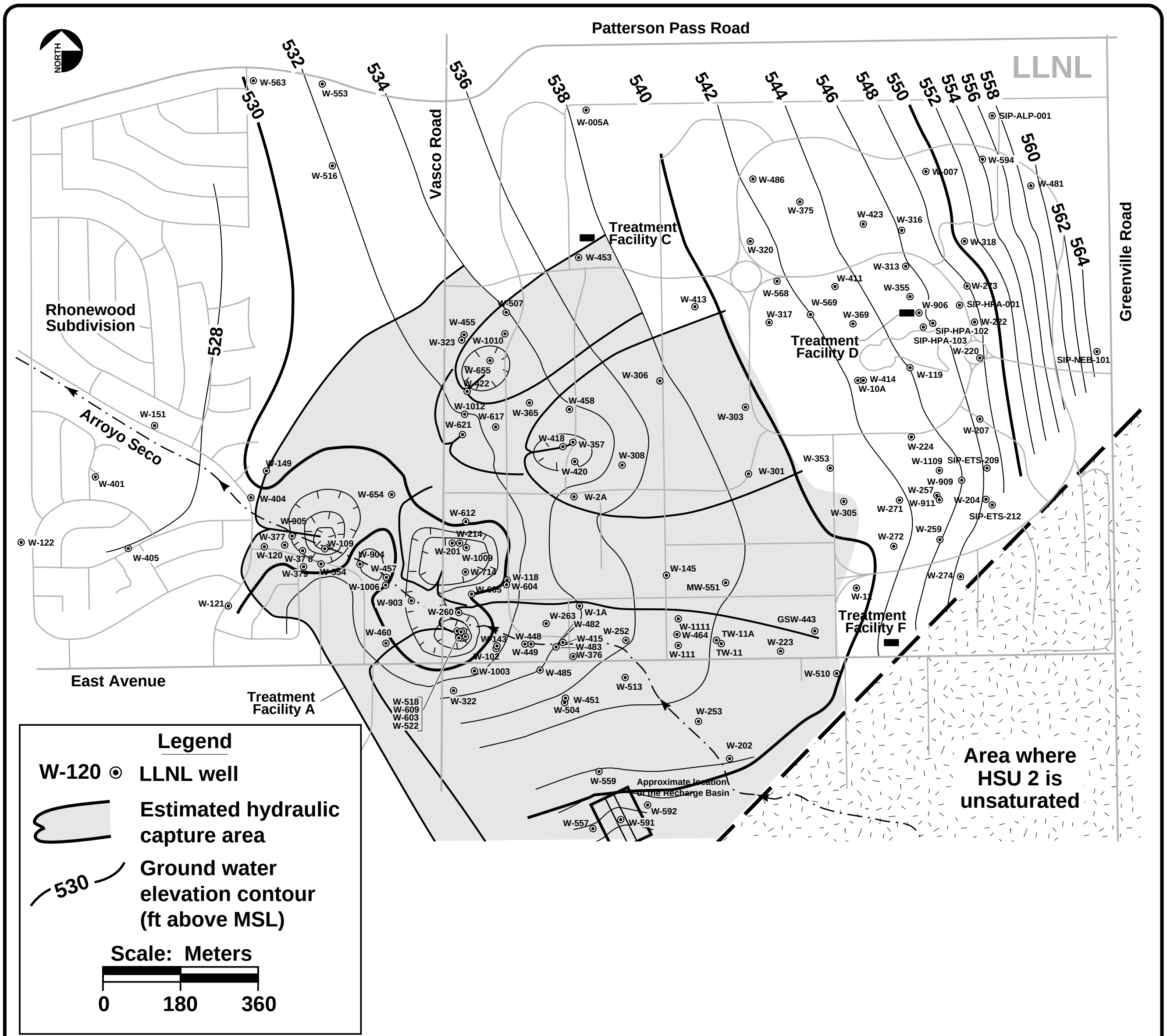

Figure 14-3. Ground water elevation contour map based on 127 wells completed within HSU 2 and estimated HSU 2 hydraulic capture areas, LLNL and vicinity, November 1995.

The TFA North Pipeline was completed in July, and pumping began from extraction wells W-614, W-712, W-1004, and W-1009 (**Figure 14-1**) at an average combined flow rate of 189 L/min. Arroyo Pipeline extraction wells W-109 and W-408 were pumped at an average flow of about 170 L/min in 1995. Three new Arroyo Pipeline extraction wells (W-457, W-903, and W-904), located west of Vasco Road, were activated in October 1995 and were fully operational in April 1996. With completion of the four TFA pipelines, the TFA well field has the ability to extract about 1136 L/min, which would exceed the TFA design capacity of 757 L/min.

In December 1995, TFA was shut down for facility modifications designed to increase the maximum flow rate**.** Under a new air permit issued by the Bay Area Air Quality Management District (BAAQMD), TFA can treat up to 3785 L/min. The regional water quality control boards and remedial project managers agreed to the treatment of up to 1325 L/min.

During 1995, more than 273 million liters (ML) of ground water containing VOCs was processed at TFA. All treated ground water was discharged to the Recharge Basin, located about 610 m southeast of TFA. Based on monthly influent concentrations and flow data, about 12 kg of VOCs was removed during 1995. Between system startup in 1989 and 1995, TFA has processed nearly 643 ML of ground water and removed about 58 kg of VOCs from the subsurface.

Waste Discharge Requirement (WDR) No. 88-075 requires a sampling program for this facility (**Table 14-1**). Self-monitoring analytical results of TFA effluent samples indicate that the VOC discharge limit of 5 parts per billion (ppb) was exceeded on August 2, 1995, August 16, 1995, and November 29, 1995, with results of 5.1, 5.3, and 5.5 ppb, respectively.

Treatment Facility B

Treatment Facility B (TFB) is located along Vasco Road just north of Mesquite Way (**Figure 14-1**). Similar to TFA, TFB processes ground water contaminated with chromium and VOCs using a combination of UV/H_2O_2 treatment and air-stripping technologies. During 1995, construction of the TFB North Pipeline was completed, and the pipeline was activated on September 5, 1995. This pipeline connects wells W-610, W-620, W-621, and W-655 to TFB. These wells add an additional 95 L/min, increasing the total flow to TFB to about 189 L/min. The facility discharges the treated water into a north-flowing drainage ditch along Vasco Road. Maintenance of the drainage ditch was completed in August before the flow was increased in September.

During 1995, about 40 ML of ground water was extracted from wells W-357, W-704, W-610, W-620, W-621, and W-655 and treated at TFB. The total mass of VOCs removed was about 3.4 kg. Between system startup in 1991 and 1995, TFB processed 127 ML of ground water and removed about 12.4 kg of VOCs from the subsurface.

National Pollutant Discharge Elimination System (NPDES) Permit No. CA0029289 and WDR No. 91-091 governs the operation of TFB and imposes sampling requirements (**Table 14-2**). Self-monitoring analytical results of TFB effluent samples indicate that the VOC discharge limit of 5 ppb was not exceeded. Metals concentrations were all in compliance with discharge limits, except for hexavalent chromium (Cr [VI]), which reached a high of 78 ppb.

Table 14-1. Treated ground water discharge limits identified in WDR Order No. 88-075 for TFA.

Constituent	Discharge limit[(a)]
Metals (μg/L)	
Antimony	1460
Arsenic	500
Beryllium	0.68
Boron	7000
Cadmium	100
Chromium (III)	1700×10^3
Chromium (VI)	500
Copper	2000
Iron	3000
Lead	500
Manganese	500
Mercury	20
Nickel	134
Selenium	100
Silver	500
Thallium	130
Zinc	20,000
Volatile organic compounds (μg/L)	
Total volatile organic compounds	5
Acid extractable organic compounds (μg/L)	
2,4-Dimethylphenol	400
Phenol	5
2,4,6-Trichlorophenol	5
Base/neutral extractable organic compounds (μg/L)	
1,4-Dichlorobenzene	5
Naphthalene	620
Phenanthrene	5
Pyrene	5

a These limits are instantaneous maximum values.

Table 14-2. Treated ground water and Drainage Retention Basin discharge limits identified in WDR Order No. 91-091 for outfalls at locations CDBX, TFB, TFC, and TFD.

Constituent	Discharge limit
Metals (μg/L)	
Antimony	1460
Arsenic	20
Beryllium	0.7
Boron	7000
Cadmium	5
Chromium (total)	50
Chromium (VI)	11
Copper	20
Iron	3000
Lead	5.6
Manganese	500
Mercury	1
Nickel	7.1
Selenium	100
Silver	2.3
Thallium	130
Zinc	58
Organics (μg/L)	
Volatile organic compounds (total)	5
Benzene	0.7
Tetrachloroethene	4
Vinyl chloride	2
1,2-Dibromoethane	0.02
Total petroleum hydrocarbons	50
Polynuclear aromatic hydrocarbons	15
Base/neutral and acid extractable compounds and pesticides	5
Physical	
pH	6.5–8.5
Toxicity	
Aquatic survival bioassay (96 hours)	90% survival median, 90 percentile value of not less than 70% survival

Tests have shown that hexavalent chromium can be reduced to trivalent chromium by adding 20 to 25 ppm of hydrogen peroxide, lowering the pH of ground water to about 7, and then increasing the residence time prior to air stripping. The pH of ground water is lowered by adding carbon dioxide after it comes out of the UV reactor. Necessary changes have been made in the facility to enable the continuous addition of carbon dioxide and provide a reaction tank in the flow path of the ground water between the UV reactor and the air stripper. The low concentration of hydrogen peroxide in the effluent meets fish toxicity requirements.

Treatment Facility C

Treatment Facility C (TFC) is located in the northwest quadrant of LLNL and employs air-stripping and ion-exchange technologies to process ground water contaminated with VOCs and chromium. The ion-exchange resin was regenerated seven times and replaced once in 1995. A polyphosphate additive is now being used to control calcium carbonate scale in the TFC piping. No major repairs or upgrades were performed on the system during 1995.

In 1995, the design of the TFC North Pipeline was completed. This pipeline will convey water from monitoring/extraction Wells W-1015, W-1102, W-1103, W-1104, and W-1116 to TFC (**Figure 14-1**). Construction of the pipeline is expected to be completed by mid-1996.

During 1995, TFC processed about 22 ML of ground water extracted from Well W-701 at an average flow rate of about 57 L/min. The total VOC mass removed during 1995 was about 2.7 kg. Between system startup in October 1993 and 1995, TFC processed about 32 ML of ground water and removed about 3.8 kg of VOCs.

LLNL conducted samplings at TFC in compliance with WDR No. 91-091 requirements. The self-monitoring analytical results of TFC effluent samples indicate that the VOC discharge limit of 5 ppb was not exceeded during 1995. All regulated metals parameters were below discharge limits designated in the WDR No. 91-091 requirements.

Treatment Facility D

Treatment Facility D (TFD) is located in the northeast quadrant of LLNL and uses air-stripping and ion-exchange technologies to process contaminated ground water (**Figure 14-1**).

TFD processed water from extraction wells W-351 and W-906 (**Figure 14-1**) during most of 1995. Because nickel concentrations exceeded the 7.1 ppb NPDES discharge limit, we were constrained from using extraction well W-907.

In January 1995, TFD discharged about 665,000 L of treated ground water into the Drainage Retention Basin. On January 30, treated water was temporarily diverted past the Drainage Retention Basin into an underground pipe that discharges into the Arroyo Las Positas. In February 1995, injection of poly-phosphate at 10 ppm or less to control calcium carbonate scale began. To avoid loading additional phosphates into the Drainage Retention Basin, TFD water was permanently diverted to the underground pipe on May 18, 1995. However, the capability to discharge to the basin still exists.

During 1995, TFD processed about 8 ML of ground water containing VOCs. The combined flow rate from wells W-351 and W-906 averaged about 32 L/min. The total VOC mass removed during 1995 was about 5.8 kg. Between system startup in September 1994 and 1995, about 8 ML of ground water has been treated, removing about 6.1 kg of VOCs.

LLNL conducted samplings at TFD in accordance with WDR No. 91-091 requirements. The self-monitoring analytical results of TFD effluent samples indicated that metals and VOC, were within compliance discharge limits during 1995.

Treatment Facility F

Treatment Facility F (TFF) is located in the southeastern portion of LLNL (**Figure 14-1**). Prior to remediation, significant fuel hydrocarbon contamination existed in the vadose zone and in the ground water and saturated sediments in hydrostratigraphic units 3A and 3B. Only low levels of VOCs were found within the hydrocarbon plume. An extensive VOC plume exists in the TFF area in HSUs-4 and -5 extending from B-518 southwest onto SNL/California property.

A series of remedial actions were implemented at TFF beginning in 1988 for the remediation of the hydrocarbon contamination in the vadose zone and HSU-3 ground water. In 1993, TFF was used as a research site in support of the DOE-sponsored Dynamic Stripping Research Project, which removed approximately 28,388 L of gasoline from the TFF soil and HSU-3 ground water.

In 1995, chemical analyses of vadose sediment samples from pilot boreholes of two new TFF wells clearly indicated the absence of residual fuel hydrocarbons (FHCs) in the vadose zone. Based on these results and the exponential decline of recovered hydrocarbons in extracted vapors, treatment of the vadose zone at TFF was discontinued with the consent of the regulatory agencies in August 1995.

During 1995, ground water was extracted and treated at TFF for 5 months, during business hours only. Ground water extraction ceased at TFF on April 18, 1995, for a 6-month biodegradation study, and restarted on October 17. The treatment facility was again shut down on December 8 because of storm damage. With regulatory concurrence, extraction and treatment of the residual dissolved FHCs in the HSU-3 ground water has been discontinued in favor of a passive bioremediation approach. We submitted a draft Containment Zone (CZ) report for the hydrocarbon-contaminated ground water zone in the TFF area to the regulatory agencies in early 1996.

TFF treated and discharged to sanitary sewer approximately 5.3 ML of ground water in 1995 from extraction wells GEW-808 and GEW-816, which contained a volume-weighted average FHC concentration of about 1323 ppb. This is equivalent to about 11 L of liquid gasoline. In addition, TFF extracted about 40,000 cubic meters (m^3)of vapor from extraction wells GEW-808, GEW-816, and GSW-16, containing a volume-weighted FHC concentration of about 20 parts per million by volume (ppmv), about 2.8 L of liquid gasoline. The total liquid-equivalent of gasoline removed from the TFF subsurface during 1995 was about 14 L.

The sampling requirements for TFF discharges are: quarterly sampling for benzene, ethyl benzene, toluene, and xylene (BETX; EPA Method 624) and annual sampling for total toxic organic compounds (EPA Methods 624 and 625), metals, and inorganic compounds. **Table 14-3** shows the BETX sampling results; no result was above the detection limit. Annual sample results for total toxic organics, sampled on November 15, 1995, showed no detections for all reportable organic compounds (detection limit is 0.01 mg/L). Annual metals sample results for National Pollutant Discharge Elimination System (NPDES) metals (EPA Method 200) are shown in **Table 14-3**. No results were found above discharge limits. Annual total cyanide sample results (EPA Method 335.2) for the year, sampled on November 15, 1995, showed no detections at the reporting limit of 0.020 mg/L. The LWRP permit limit for cyanide is 0.040 mg/L.

Sitewide Treatability Testing

LLNL's ground water discharge permit allows ground water from hydraulic tests and VOC treatability studies to be discharged to the City of Livermore sanitary sewer. Permit No. 1510G (1995–1996) allows discharges of ground water to the sanitary sewer in compliance with **Table 14-3** effluent limitations taken from the Livermore municipal code. During 1995, discharges were associated with treatability testing performed at TFD. Ground water was sampled and released to the sanitary sewer, all in compliance with metals, total toxic organic, and self-monitoring permit provisions.

Total ground water discharged to the sanitary sewer during this annual period was 129,000 L.

Table 14-3. Treatment Facility F self-monitoring sampling results.

Constituent	Sample date (1995)	Concentration (μg/L)	Effluent limitations[a] (μg/L)
BETX (total)	February 9	<10	250 (LWRP permit)
	No discharge	---	
	No discharge	---	
	October 25	<10	
Metals[a]	November 15		
Arsenic		<2	60
Cadmium		<0.5	140
Copper		<10	1000
Chromium (total)		<10	620
Lead		<2.0	200
Mercury		1.5	10
Nickel		<5.0	610
Silver		<0.5	200
Zinc		<200	3000
Cyanide	November 15	<20	40
Toxic organics (total)	November 15	<10	1000

[a] From Section 13.32.100 of the Livermore Municipal Code.

Site 300 Central and Eastern General Services Area Treatment Facilities

Since 1993, a ground water treatment system has been in operation at Site 300 as a CERCLA Removal Action. This system is located at the Experimental Test Facility in the central General Services Area (GSA) in the vicinity of Building 875. Following dewatering of bedrock through ground water extraction, soil vapor extraction and treatment was initiated in July 1994 . During 1995, 830,620 L of ground water was extracted and treated, and a total of 19.3 kg of VOCs was removed from ground water and soil vapor by the central GSA system. Monthly self-monitoring sample requirements are listed in **Table 14-4**.

Since June 1991, a ground water extraction and treatment system has been operating in the eastern GSA as a CERCLA Removal Action. During 1995, 73.4 ML of ground water containing 724 g of VOCs was extracted and treated by the eastern GSA system. Monthly self-monitoring requirements for GSA water treatment system effluent samples are listed in **Table 14-4**.

Table 14-4. General Services Area ground water treatment system effluent limitations.

Parameter	Treatment facility	
	Central General Services Area	Eastern General Services Area
VOCs	Halogenated and aromatic VOCs	Halogenated VOCs
Maximum daily	5.0 µg/L	5.0 µg/L
Monthly median	0.5 µg/L	0.5 µg/L
Dissolved oxygen	≥5.0 mg/L	≥5.0 mg/L
pH	Between 6.5 and 8.5, no receiving water alteration greater than ±0.5 units	Between 6.5 and 8.5, no receiving water alteration greater than ±0.5 units
Temperature	No alteration of ambient conditions more than 3°C	No alteration of ambient conditions more than 3°C
Place of discharge	Surface water drainage course in eastern GSA canyon	Corral Hollow Creek
Flow rate (30-day average daily dry weather maximum discharge limit)	328,320 L	273,600 L
Mineralization	Mineralization must be controlled to no more than a reasonable increment	Mineralization must be controlled to no more than a reasonable increment
Methods and detection limits for VOCs	EPA Method 601—method detection limit of 0.5 µg/L EPA Method 602—method detection limit of 0.3 µg/L	EPA Method 601—method detection limit of 0.5 µg/L

The central GSA is operating under Substantive Requirements for wastewater discharge issued by the Central Valley Regional Water Quality Control Board (RWQCB). The central GSA treatment facility discharges to bedrock in the eastern GSA canyon, where the water percolates to the surface. The eastern GSA operates under NPDES permit No. CA0082651, WDR 91-052 issued by the Central Valley RWQCB for discharges into Corral Hollow Creek. Both the central and eastern GSA treatment systems operated in compliance with regulatory requirements during 1995.

Site 300 Building 834 Treatment Facility

The ground water and soil vapor extraction treatment facility at Building 834 was significantly modified during 1995. Modifications were performed in accordance with Site 300 CERCLA Removal Action requirements. This facility was designed to treat VOCs extracted from soil and ground water by air sparging and soil venting, with carbon absorption to remove VOCs from offgas streams. Additional modifications to the facility were identified as a result of a spring 1994 Proof-of-System test (POS1), and a second test in the winter of 1995 (POS2). Influent ground water concentrations ranged from 60 to 100 parts per million (ppm) total VOCs during both tests. Despite a substantial increase in the aggressiveness of sparging and recirculation, trichloroethene (TCE) permeated into polymeric components during the initial phase of water treatment in POS1.

During the sparging process, TCE slowly diffused from the polymeric material back into the water as the concentration gradient shifted, greatly slowing the removal of VOCs at concentration, near the discharge limits.

All polymeric components were eliminated from the influent side of the treatment facility. Numerous components were salvaged from LLNL Salvage and dismantled equipment from Building 834. The facility also incorporates additional liquid-phase carbon filtration following the two sparging stages to ensure complete removal of the tetrabutyl orthosilicate (TBOS) present in substantial amounts (<100 ppm) in the influent ground water. Once ground water is treated to the permit standards, it is discharged by air-misting towers located east of the treatment facility.

The modified facility was tested in February 1995 and successfully demonstrated removal of VOCs and TBOS. Additional equipment was installed in fiscal year 1995 to support automated operation, continuous gas-phase monitoring, and remote inspection of facility status. The treatment facility was constructed with modularity in mind so that experimental treatment apparatus could be readily incorporated for direct comparison with the baseline sparging and carbon filtration approach.

During 1995, while modifications were being made, no ground water was treated or discharged from this facility. Continuous, full-scale ground water treatment was begun on October, 30 1995. Final operating substantive requirements granted by the Central Valley RWQCB are expected to be issued in 1996. **Table 14-5** lists the CERCLA substantive requirements for this removal action.

Table 14-5. Site 300 Building 834 ground water treatment effluent limitations.

Parameter	Building 834 Treatment Facility
VOCs[(a)]	
Maximum daily (per compound)	5.0 µg/L
Monthly median	0.5 µg/L
pH	Between 6.5 and 8.5
Location discharge	Treated effluent will be discharged by air misting east of Building 834.
Total petroleum hydrocarbons	
Daily maximum contaminant level	100 µg/L
Monthly median	50 µg/L
Flow rate (30-day average daily dry weather maximum discharge limit)	7580 L
Mineralization	Mineralization must be controlled to no more than a reasonable increment
Methods and detection limits	
VOCs	Method EPA 601/602[(b)]
TBOS	Modified EPA Method 8015, discharge limit = 100 µg/L[(c)]

a The sum of VOC concentrations in a single sample shall not exceed 5.0 µg/L.

b Confirmatory VOC identifications were sometimes required during treatment facility characterization, and EPA 624 analyses were requested in addition to the EPA 601/602 analyses.

c Detection limits for TBOS are currently ~100 µg/L by a modified EPA 8015 procedure.

Storm Water Runoff

Storm water contacts a large number of potential pollution sources and has the potential to disperse contaminants across broad areas. For this reason, comprehensive sampling and analysis of storm water discharges is not a practical means of isolating and controlling pollutant releases. To evaluate the overall impact of Livermore site and Site 300 operations on storm water quality, samples are taken of the integrated storm water flows where they leave the site. These samples, described in Chapter 7, provide information used to evaluate the effectiveness of LLNL's pollution control program. The monitoring requirements in NPDES permits, under which storm water is discharged, require that LLNL conduct effluent sampling, wet and dry season observations, and annual facility inspections to assure that the necessary management measures are implemented and are adequate. The goals of the industrial activity storm water monitoring program are to:

- Demonstrate compliance with permit requirements.

- Aid in implementing the Storm Water Pollution Prevention Plan (SWPPP) (Eccher 1994).
- Measure the effectiveness of the Best Management Practices (BMPs) in removing pollutants in storm water discharges.
- Ensure that storm water discharges are in compliance with the discharge prohibitions, effluent limitations, and receiving water limitations as specified in the permits.
- Ensure that practices at the facility to control pollutants are evaluated and revised to meet changing conditions.

The storm water compliance monitoring program includes:

(1) Annual facility inspections conducted by each Directorate.

(2) Sampling and analysis of storm water from two qualifying storm events for pH, total suspended solids (TSS), total organic carbon (TOC), specific conductance, toxic substances, and other pollutants that are likely to be in storm water discharges in significant quantities.

(3) Visual observations at storm water discharge points and areas with high potential for storm water pollution during the dry and wet seasons.

(4) Annual reporting to the appropriate regional water quality control boards.

(5) Analysis of samples collected at several influent locations to provide background information. These influent samples are only collected at the Livermore site.

Under the WDR Order No. 95-174 for the Livermore site and WDR Order No. 94-131 for Site 300, visual inspections of the storm drainage system are required monthly during the wet season, when significant storm events occur, and twice during the dry season to identify any dry weather flows. During the wet weather observations, LLNL noted floatables, evidence of debris (mostly leaves and twigs with some litter) washing from the site, and cloudy water from the heavy sediment load carried in the storm water at both the Livermore site and Site 300. Dry weather observations at the Livermore site noted that water flowed in Arroyo Las Positas all year. In previous years, Arroyo Las Positas only flowed during rain events. This water was traced to two sources: natural flow of water from off site that entered LLNL property at the ALPO influent location and permitted discharges from ground water treatment facilities. Dry weather inspections at Site 300 showed no indication of nonstorm water flows discharging from the site.

Each LLNL directorate inspected its facilities to verify that the BMPs identified in the LLNL's Storm Water Pollution Prevention Plans were in place, properly implemented, and adequate. LLNL implements BMPs at construction sites and at facilities that use significant materials (as defined by the storm water regulations) to prevent storm water from being contaminated. The results of the inspections indicated LLNL facilities were in compliance with the requirements of the SWPPPs and the provisions of the NPDES permits. LLNL submits an annual storm water monitoring report to the San Francisco Bay RWQCB and the Central Valley RWQCB reporting the results of sampling, observations, and inspections.

LLNL also meets the storm water compliance monitoring requirements that are authorized under the California General Construction Activity Storm Water Permit for construction projects disturbing 2 hectares of land or more. Monitoring for these construction projects included visual observation of sites before and after storms to assess the effectiveness of implemented BMPs. Using the monitoring results, LLNL determined whether or not it was necessary to modify these practices to accomplish better storm water runoff protection. Two Livermore construction sites were inspected during 1995, Building 132 and the MWMF/DWTF project area. LLNL made only minor changes to the BMPs implemented at MWMF/DWTF project area. Minor changes were also made to smaller projects located in environmentally sensitive areas. These changes included modifying the placement of straw bales and adding silt fences where needed to minimize sediment in runoff. As required by the California General Construction Activity Storm Water Permit, the construction manager annually certifies compliance with the Storm Water Pollution Prevention Plan and the requirements of this general permit.

Livermore Site Drainage Retention Basin

The Drainage Retention Basin (DRB) (**Figure 14-4**) can hold approximately 53 ML (43 acre-feet) of water. The DRB was lined in March 1992 after remedial action studies indicated that infiltration of storm water from the basin was a cause of increased dispersal of ground water contaminants. When the basin lining was completed, LLNL adopted the *Drainage Retention Basin Management Plan* (The Limnion Corporation 1991).

The focus of the management plan was to implement a long-term biological monitoring and maintenance program and to address water quality problems by bioremediation and by reducing the nutrient load. The management plan identified two water sources to fill and maintain the level of the DRB. The primary source was water generated from ground water treatment units and discharged to the basin through the existing storm water collection system or piped directly to the DRB. The secondary water source was storm water runoff. During 1995, storm water runoff was the only DRB water source.

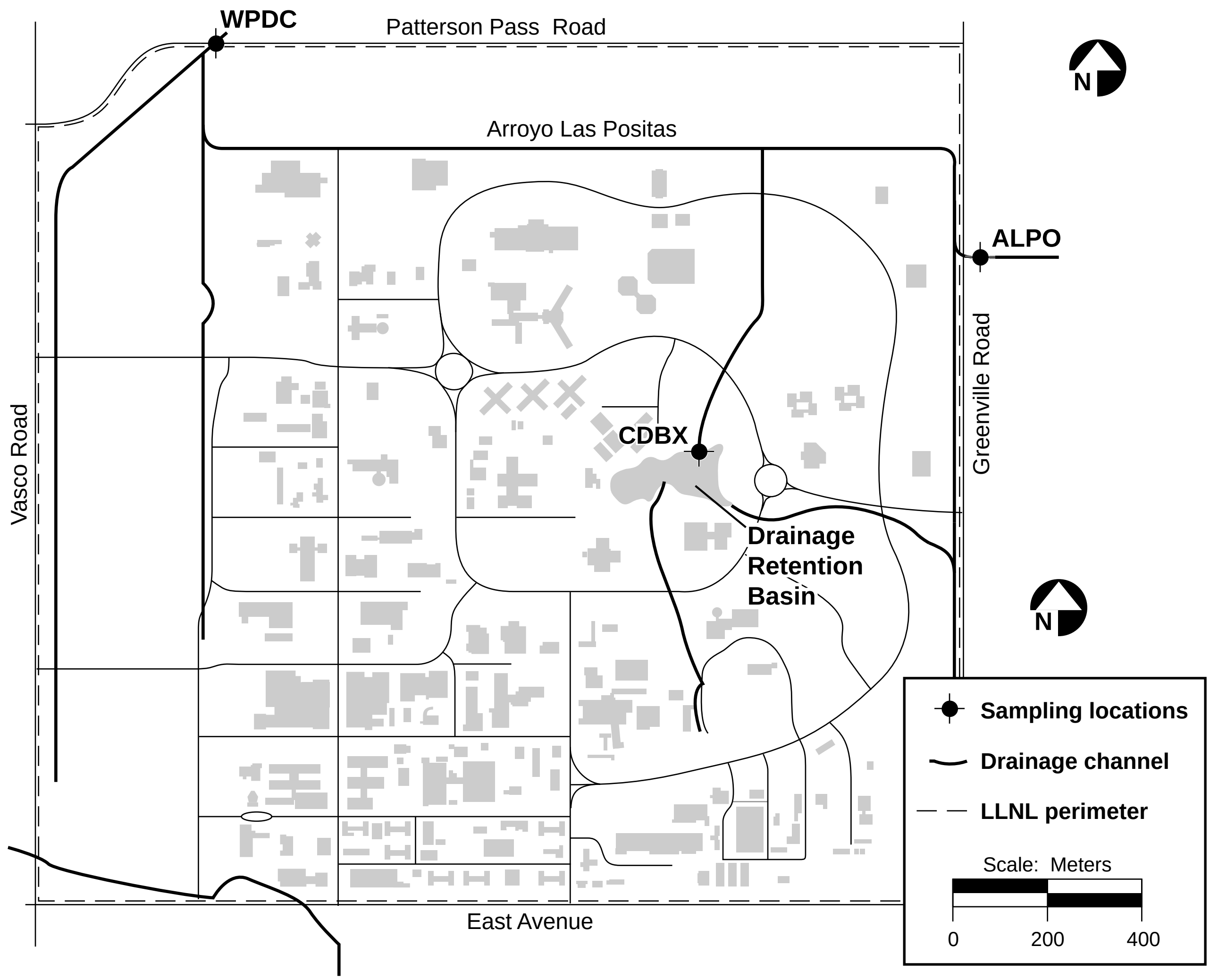

Figure 14-4. Sampling locations to monitor compliance with waste discharge permit.

The San Francisco Bay RWQCB regulates discharges from the basin under WDR Order No. 91-091, NPDES Permit No. CA0029289, and the Livermore site CERCLA Record of Decision. WDR Order No. 91-091 and the CERCLA Record of Decision establish discharge limits for all remedial activities at the Livermore site. In 1992, LLNL developed a sampling program for the DRB, which was approved by the San Francisco Bay RWQCB. The sampling program consists of sampling discharges from the DRB (location CDBX) and the site storm water outfall (location WPDC; **Figure 14-4**) during the first release from the DRB and a minimum of one additional storm (chosen in conjunction with storm water runoff monitoring). Samples are taken at the DRB outfall (CDBX) to determine compliance with WDR Order No. 91-091. Additional sampling at the site storm water outfall monitoring location at Arroyo Las Positas (WPDC) is done to identify the change in water quality as the DRB discharges travel through the LLNL storm water drainage system and leave the site. Effluent limits established in WDR 91-091 for discharges from the DRB are found in **Table 14-2**.

By agreement with the San Francisco Bay RWQCB, LLNL reports quarterly on the routine weekly, monthly, quarterly, semiannual, and annual monitoring of the basin as specified in the *Drainage Retention Basin Management Plan* (The Limnion Corporation 1991) to meet water quality management objectives. Sampling to determine whether water quality maintenance objectives are met is conducted at several points within the DRB. Water at eight locations (**Figure 14-5**) is sampled for dissolved oxygen and temperature. Sampling during the 1992–1993 wet season was also conducted at all these monitoring locations for all other monitoring parameters. However, because there was evidence of limited variability between sampling locations for all parameters except dissolved oxygen and temperature, all sampling locations except CDBE located at the middle depth of the DRB were eliminated starting March 31, 1993. The routine maintenance parameters are identified in **Table 14-6**.

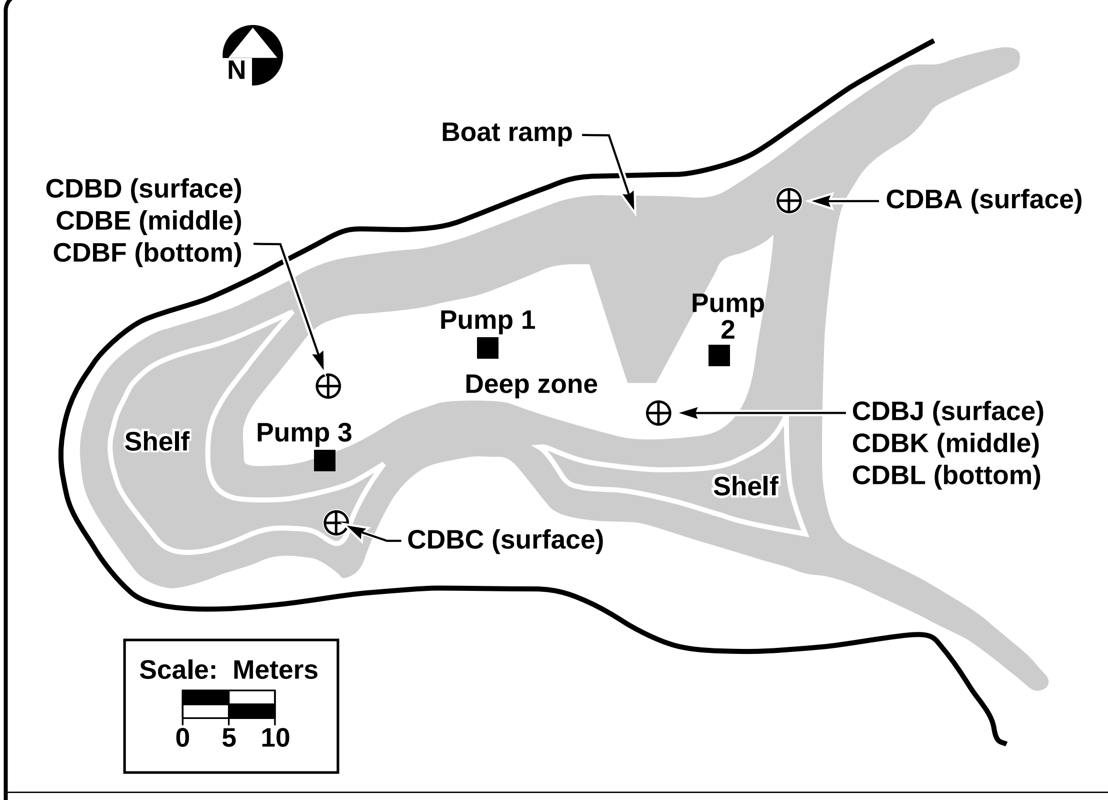

Figure 14-5. Sampling locations within Drainage Retention Basin to determine maintenance of water quality management objectives.

During 1995, summaries of results of routine water quality monitoring for management parameters and discharge monitoring were reported to regulatory agencies in the quarterly progress reports and annual ground water project report(Hoffman et al. 1996).

During 1995, only one release from the DRB was sampled. This was the first release sampled in the 1995–1996 rainy season. The second sample required by the DRB monitoring plan was collected in 1996 concurrent with a storm water sampling event. During 1995, releases from the DRB exceeded NPDES discharge limits for iron, lead, and zinc (**Table 14-7**) established in WDR 91-091. These same three metals plus copper were found above the discharge limits in samples of storm water runoff collected at WPDC at the time of the DRB release. Samples collected at the WPDC represent a combination of storm water running onto the Livermore site, storm water running off the site, NPDES permitted treated ground water and process discharges, and the DRB release.

Metals concentrations in the sample collected at location WPDC were higher than samples collected from the DRB discharge showing the presence of these metals at the measured concentrations is consistent with typical storm water runoff from the site. Lead showed up for the first time in the November 15, 1994, release from the DRB. Lead was not detected in the subsequent December 1994 discharge sample but was again seen in the December 1995 sample (the first release of the 1995–1996 rainy season). Zinc and iron appeared for the first time in the December 1995 sample. Previously, in samples of discharges from the DRB collected at CDBX from 1992 through 1994, neither zinc nor iron were present above discharge limits. However, these and other metals have been detected with increasing frequency above the discharge limits within the DRB as demonstrated by the results of maintenance monitoring sampling occurring at CDBE.

During 1995, temperature, turbidity, alkalinity, nitrate, nitrite, ammonia nitrogen, phosphorous, iron, lead, nickel, and zinc were measured at levels exceeding management action levels (MALs) at sampling location CDBE (**Table 14-8**).

Dissolved oxygen concentrations rarely were maintained at or above the management action level of at least 80% saturation of oxygen in the water (**Figure 14-6**). However, concentrations did not drop below the critical management action level of 5 mg/L. Dissolved oxygen levels were controlled manually with aeration pumps. The two solar powered aeration pumps operate during daylight hours and the traditional pump can be operated 24 hours a day. The aeration pumps are started whenever oxygen levels at any level of the DRB drop close to or below the critical management action level of 5 mg/L. Typically, these pumps are used continuously through the spring, summer, and fall months. During the winter, the pumps are started as needed.

Table 14-6. Routine water quality management levels for the Drainage Retention Basin.

Parameter	Location	Frequency	Management action levels
Physical			
Dissolved oxygen (mg/L)	CDBA, CDBC, CDBD, CDBE, CDBF, CDFJ, CDBK, CDBL	Weekly	<80% saturation
Temperature (°C)	CDBA, CDBC, CDBD, CDBE, CDBF, CDFJ, CDBK, CDBL	Weekly	<15 and >26
Total alkalinity (as $CaCO_3$) (mg/L)	CDBE	Monthly	<50
Chlorophyll a (mg/L)	CDBE	Monthly	>10
pH	CDBA, CDBC, CDBD, CDBE, CDBF, CDFJ, CDBK, CDBL	Weekly	<6.0 and >9.0
Total suspended solids (mg/L)	CDBE	Monthly	none
Total dissolved solids (mg/L)	CDBE	Monthly	>350
Turbidity (m)	CDBE	Monthly	<0.914
Chemical oxygen demand (mg/L)	CDBE	Quarterly	>20
Oil and grease (mg/L)	CDBE	Quarterly	>15
Conductivity (µmhos/cm)	CDBE	Monthly	>900
Nutrients			
Nitrate (mg/L)	CDBE	Monthly	>0.2
Nitrite (mg/L)	CDBE	Monthly	>0.2
Ammonia nitrogen (mg/L)	CDBE	Monthly	>0.1
Phosphate (as phosphorous) (mg/L)	CDBE	Monthly	>0.02
Microbiological			
Total coliform (MPN[(a)]/0.1L)	CDBE	Quarterly	>5000
Fecal coliform (MPN[(a)]/0.1L)	CDBE	Quarterly	>400
Metals (µg/L)			
Antimony	CDBE	Semiannually	>1460
Arsenic	CDBE	Semiannually	>20
Beryllium	CDBE	Semiannually	>0.7
Boron	CDBE	Semiannually	>7000
Cadmium	CDBE	Semiannually	>5
Chromium, total	CDBE	Semiannually	>50

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Table 14-6. Routine water quality management levels for the Drainage Retention Basin (concluded).

Parameter	Location	Frequency	Management action levels
Metals (µg/L) (continued)			
Chromium (VI)	CDBE	Semiannually	>11
Copper	CDBE	Semiannually	>20
Iron	CDBE	Semiannually	>3000
Lead	CDBE	Semiannually	>5.6
Manganese	CDBE	Semiannually	>500
Mercury	CDBE	Semiannually	>1
Nickel	CDBE	Semiannually	>7.1
Selenium	CDBE	Semiannually	>100
Silver	CDBE	Semiannually	>2.3
Thallium	CDBE	Semiannually	>130
Zinc	CDBE	Semiannually	>58
Organics (µg/L)			
Total volatile organic compounds	CDBE	Semiannually	>5
Benzene	CDBE	Semiannually	>0.7
Tetrachloroethene	CDBE	Semiannually	>4
Vinyl chloride	CDBE	Semiannually	>2
Ethylene dibromide	CDBE	Semiannually	>0.02
Total petroleum hydrocarbons	CDBE	Semiannually	>50
Polynuclear aromatic hydrocarbons	CDBE	Semiannually	>15
Base/neutral acid extractable compounds and pesticide	CDBE	Semiannually	>5
Radiological (pCi/L)			
Gross alpha	CDBE	Semiannually	>15
Gross beta	CDBE	Semiannually	>50
Tritium	CDBE	Semiannually	>20,000
Toxicity (% survival/96-hour)			
Aquatic bioassay	CDBE	Annually	90% survival median, 90 percentile value of not less than 70% survival

[a] Most probable number.

Table 14-7. Drainage Retention Basin monitoring event in which the concentration of metals exceeded discharge limits at CDBX shown with associated metal concentration at WPDC. A single sample was taken on December 12, 1995.

Parameter	Location, result (µg/L)		Discharge limit
	CDBX	WPDC	(µg/L)
Iron	4700	17,000	3000
Copper	11	24	20
Lead	8	11	2
Zinc	70	200	58

Table 14-8. Drainage Retention Basin monitoring events exceeding Management Action Levels, 1995.

Parameter	Action level	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	<15.6 >26.7	10.0	12.1	13.5	—(a)	—(a)	—(b)	—(b)	—(b)	—(b)	—(b)	—(b)	12.2
Turbidity (secchi disk)(c) (m)	<0.914	0.24	0.20	0.17	0.21	0.22	0.23	0.31	0.29	0.28	0.33	0.51	0.41
Alkalinity (as $CaCo_3$) (mg/L)	<50	37	42	28	36	41	46	—(b)	45	43	—(b)	—(b)	45
Nitrate (as NO_3) (mg/L)	≥0.2	<0.5	0.74	1.8	1.9	1.9	<0.5	1.5	<0.5	<0.5	<0.5	<0.5	3.4
Nitrite as N (mg/L)	≥0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ammonia nitrogen (mg/L)	>0.1	—(b)	—(b)	—(b)	—(b)	0.12	0.12	0.32	0.21	0.3	—(b)	—(b)	0.12
Phosphate (as P) (mg/L)	≥0.02	0.076	0.096	0.12	0.22	0.23	0.22	0.17	0.21	0.18	0.18	0.10	0.17
Iron (µg/L)	>3000	—(a)	—(a)	—(a)	6800	—(a)	—(a)	4600	4400	4100	—(b)	—(b)	3200
Lead (µg/L)	>2	—(a)	—(a)	—(a)	4.8	—(a)	—(a)	6	4.4	3.5	—(b)	—(b)	<5
Nickel (µg/L)	>7.1	—(a)	—(a)	—(a)	17	—(a)	—(a)	—(b)	13	11	12	—(b)	17
Silver (µg/L)	>2.3	—(a)	—(a)	—(a)	—(b)	—(a)	—(a)	—(b)	—(b)	—(b)	—(b)	—(b)	<5
Zinc (µg/L)	>58	—(a)	—(a)	—(a)	—(b)	—(a)	—(a)	410	—(b)	—(b)	—(b)	—(b)	

a Not measured.

b Data are below the management action level.

c Monthly average .

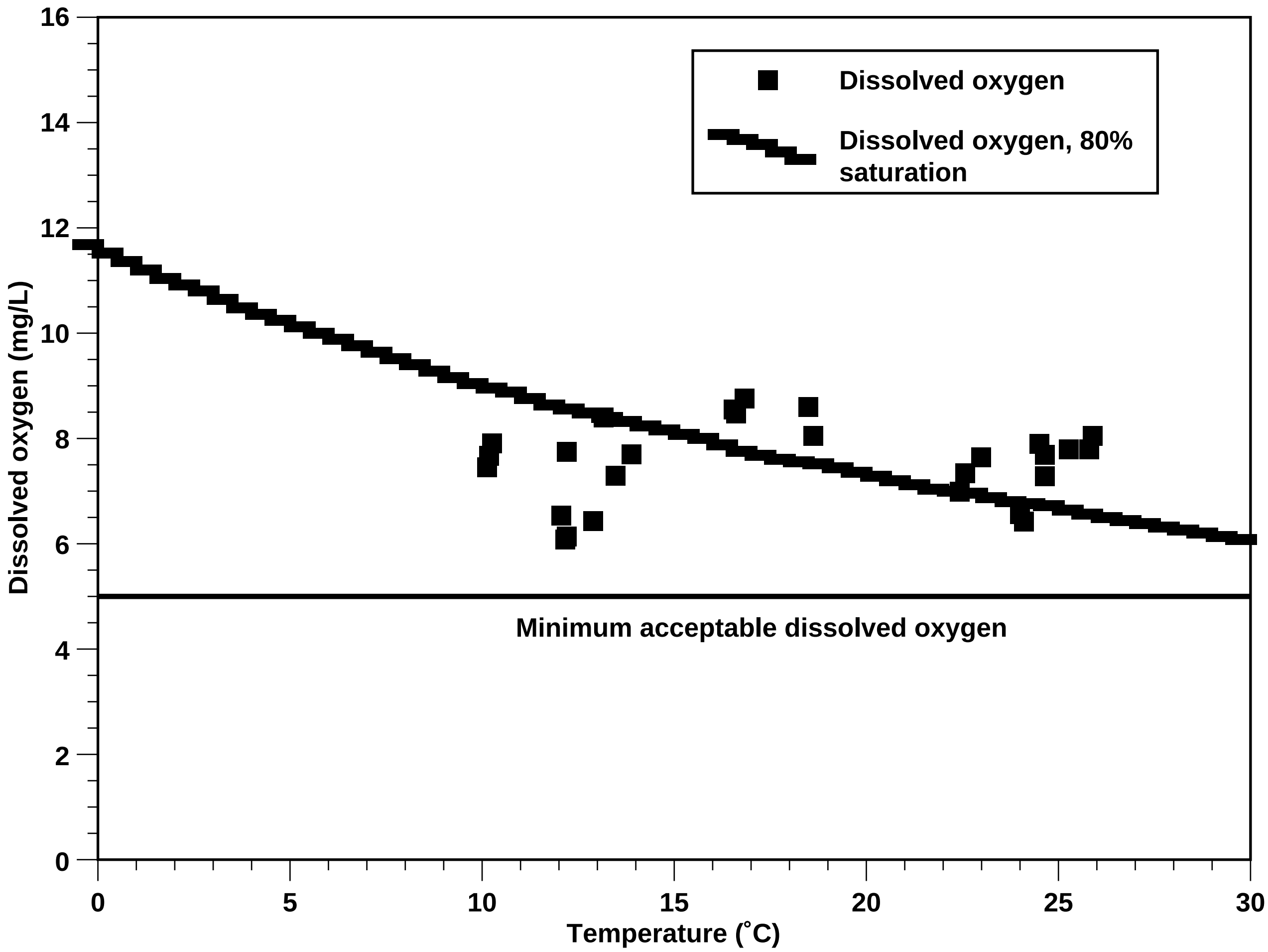

Figure 14-6. Dissolved oxygen vs temperature in the Drainage Retention Basin from January through December, 1995.

Pump operation probably is responsible for the relatively uniform distribution of dissolved oxygen at the surface, middle, and bottom elevations seen throughout the 3 years of DRB operation. The oxygen distribution for 1995 is shown in **Figure 14-7**. Adequate dissolved-oxygen levels prevent nutrient release back into the DRB water column by decaying organic matter in the bottom sediments. Temperature, the other important parameter in determining how much oxygen is dissolved in water, showed characteristic seasonal trends (**Figure 14-8**). Dissolved oxygen and temperature monitoring were not conducted in April and May because of equipment failure and repairs. The uniform distribution of temperature in the top, middle, and bottom elevations also reflects the uniform mixing achieved by the operation of the pumps. Without mixing, the water temperature would be expected to show seasonal stratification in addition to the changes in temperature.

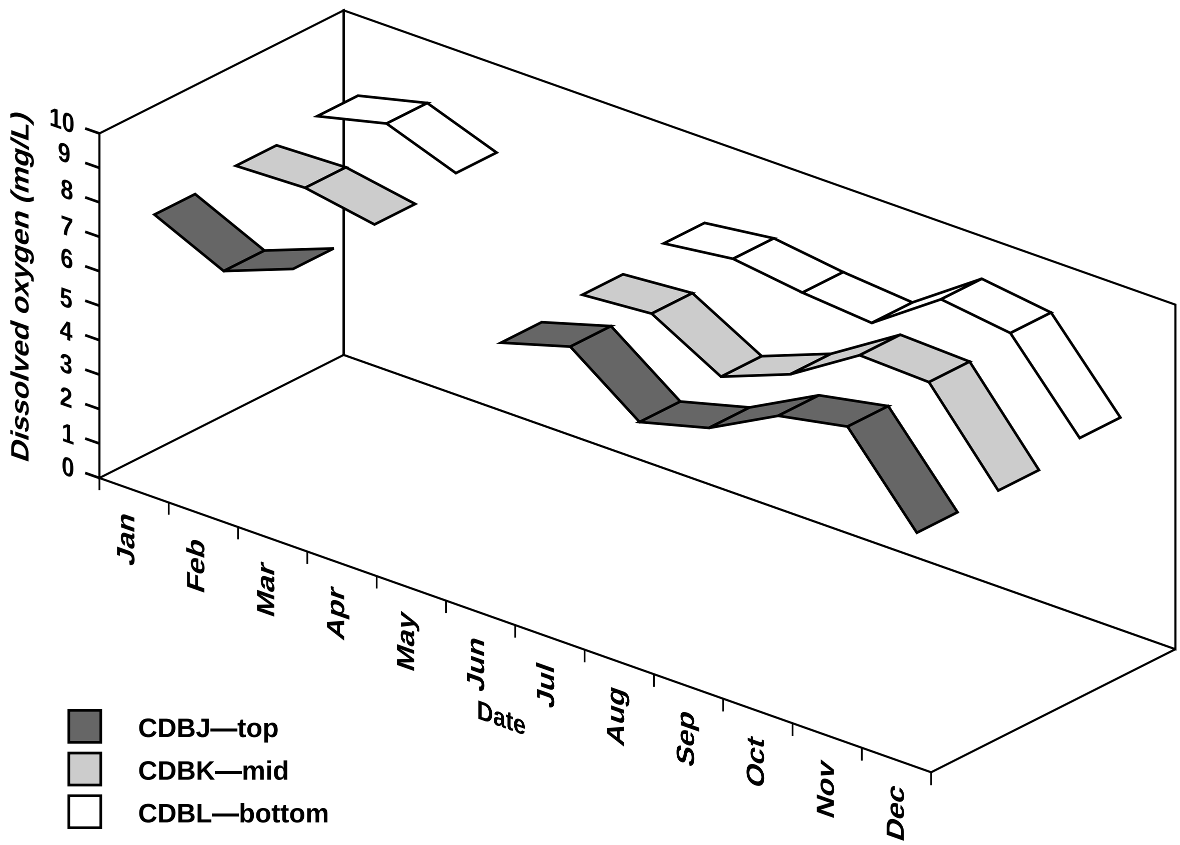

Figure 14-7. Dissolved oxygen vs time at three monitoring points within the Drainage Retention Basin, 1995.

Turbidity rose above acceptable management levels during the 1993–1994 wet season, and throughout 1994 and 1995. Wet season turbidity probably results from sediments that pass through the sediment traps discharging into the DRB. Turbidity seen during the warmer summer months of 1994 was most likely the result of algae growth. This was confirmed by high chlorophyll a values and visual observations during the 1994 summer months. However, during 1995, though turbidity continued to be high, chlorophyll-a values were just above detection indicating very little algae growth. Visual observations made during sampling events confirmed that there was little or no algae growth. In January 1995, total alkalinity dropped below the MAL for the first time since June 1993 and continued below the MAL in every month except October and November.

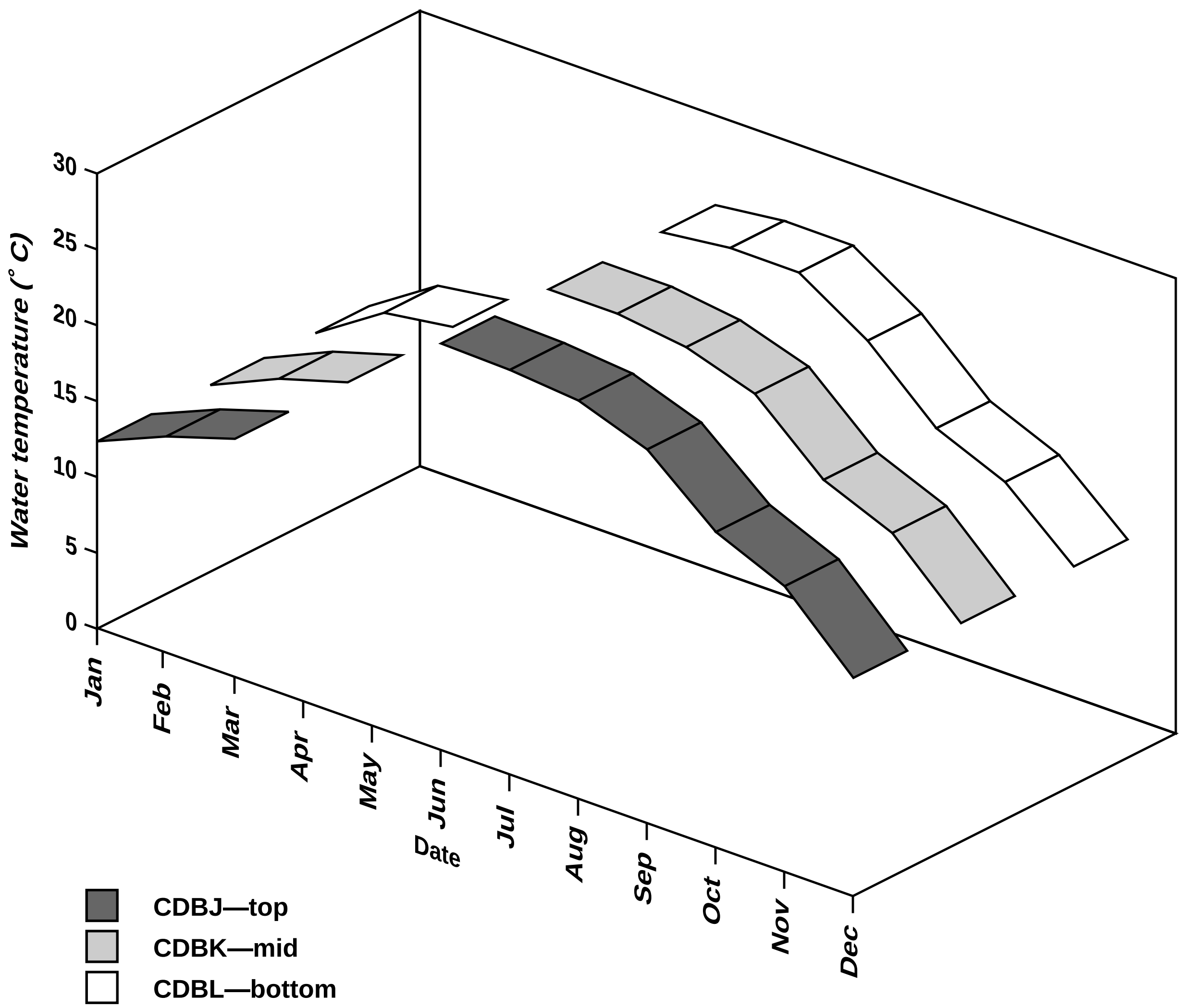

Figure 14-8. Temperature vs time at three monitoring points within the Drainage Retention Basin, 1995.

The Drainage Retention Basin Management Plan did not anticipate alkalinity drops below 50 mg/L but recommends that if this does occur that the alkalinity be adjusted to 75 mg/L using either hydrated lime or sodium sesquicarbonate. Low alkalinity could contribute to the high turbidity observed in the DRB by affecting the ability of solids to settle out of solution. In 1996, LLNL will attempt to treat the DRB to maintain alkalinity above the MAL.

During September 1995, LLNL conducted chronic toxicity tests on algae and fish to determine if the lack of algae growth was due to something other than the high turbidity, which would reduce light penetration in the water and limit the photic zone where plant growth could occur. The results of the test using algae, *Selanastrum capricornutum*, indicated that algae growth was inhibited at 12.5% concentration of DRB water. The test using fathead minnow, *Pimephales promelas* showed no chronic toxicity in 100% DRB water. This indicates that the observed absence of algae in the DRB is caused by an agent other than turbidity.

LLNL is continuing to study the cause of the low algae growth within the DRB as well as investigating a means to remove the turbidity and establish a viable plant community within the DRB.

Levels for nitrates, nitrites, total ammonia, and phosphorous exceeded the MALs for most of 1995. Concentrations of these nutrients continued to increase over 1992 through 1994 levels. The nutrients are introduced from storm water discharges, fecal matter from migrating water fowl, and mosquito fish and decaying organic matter. Attempts in 1993 and 1994 to reduce nutrient loading by introducing plants both within the Nutri-Pods (suspended nylon sacks that house the plants) and planted on the shallow shelves were not successful. This is most likely the result of the chronic turbidity problem and some operational difficulties encountered with the Nutri-Pods. Until a healthy plant community is established in the DRB, high nutrient loadings are expected to continue.

Semiannual and annual samplings were conducted during April and September 1995. Quarterly sampling was conducted in January, April, July, and November. In July, LLNL began monitoring for metals on a monthly basis to track three metals (iron, nickel, and lead), which were detected above the MALs in previous semiannual monitoring. Since starting monthly monitoring, iron and zinc have also been detected above MALs. Silver, though not detected above the analytical reporting limit, still had a reporting limit above the MAL in December as a result of a change in analytical laboratories. The source of these elevated metals is unknown. However, storm water runoff data discussed in Chapter 7 indicate that the concentrations of these metals found in water collected within in the DRB are consistent with concentrations found in storm water running on to and off of the Livermore site.

Data for maintenance monitoring at sampling location CDBE , CDBX, and CDBA through L are presented in Tables 14-1, 14-2, and 14-3 in Volume 2. Data from location WPDC are summarized in Chapter 7.

Site 300 Cooling Tower Discharges

LLNL samples cooling-tower wastewater discharges as required by the Self-Monitoring Program of WDR 94-131, NPDES permit CA0081396 and reports the results of the compliance sampling to the Central Valley Regional Water Quality Control Board (CVRWQCB) quarterly.

The cooling towers, used to cool buildings and equipment at Site 300, discharge noncontact cooling water to man-made and natural drainage courses (**Figure 14-9**). These drainage courses flow into Corral Hollow Creek, a tributary of the San Joaquin River. Because the San Joaquin River is a “water of the United States” all discharges to it and its tributaries require NPDES permits.

WDR 94-131 establishes effluent limits for three parameters: (1) daily flow must not exceed the maximum design flow; (2) total dissolved solids (TDS) must not exceed a monthly average of 2000 mg/L or a maximum daily limitation of 2400 mg/L; and (3) pH must not exceed a maximum of 10. Along with effluent monitoring, when Corral Hollow Creek is flowing, the permit requires LLNL to collect pH samples upstream and downstream of the cooling tower discharge points into the creek and to conduct visual observations of the creek. Cooling tower discharges must not raise the pH of Corral Hollow Creek above 8.5 or alter the ambient pH by more than 0.5.

Three cooling towers located at Building 801, 836A, and 865 regularly discharge to surface water drainage courses under the requirements of WDR 94-131. Fourteen other cooling towers routinely discharge to percolation pits under a waiver of waste discharge requirements from the CVRWQCB. WDR 94-131 establishes effluent limits for these 14 towers in the event that discharge to surface water drainage courses is necessary, such as during maintenance of the percolation pits; however, no surface water discharges occurred from these towers during 1995.

In July 1995, the cooling tower at Building 865 was taken off line as a result of a planned facility mothballing. To preserve the tower for future use, components of the wooden tower are kept wet with the use of a sprinkler system to prevent the loss of structural integrity. LLNL informed the CVRWQCB of the change in the tower status and continues to monitor the sprinkler water discharge according to the requirements of WDR 94-131.

Monitoring results demonstrate that all cooling tower discharges were in compliance with all permitted limits. Monitoring results are detailed in the quarterly reports to the CVRWQCB and are summarized in **Table 14-9**. All pH samples collected at the of cooling tower discharges were below the permitted maximum of 10. The cooling towers routinely discharge less than half the permitted maximum. TDS concentrations are consistently below both the daily maximum and monthly average limits. During the 1995 reporting period, flow only occurred in Corral Hollow Creek in the first quarter. The pH measurements of 8.3 upstream, and 8.3 and 8.44 downstream were below 8.5. The difference of 0.14 between the

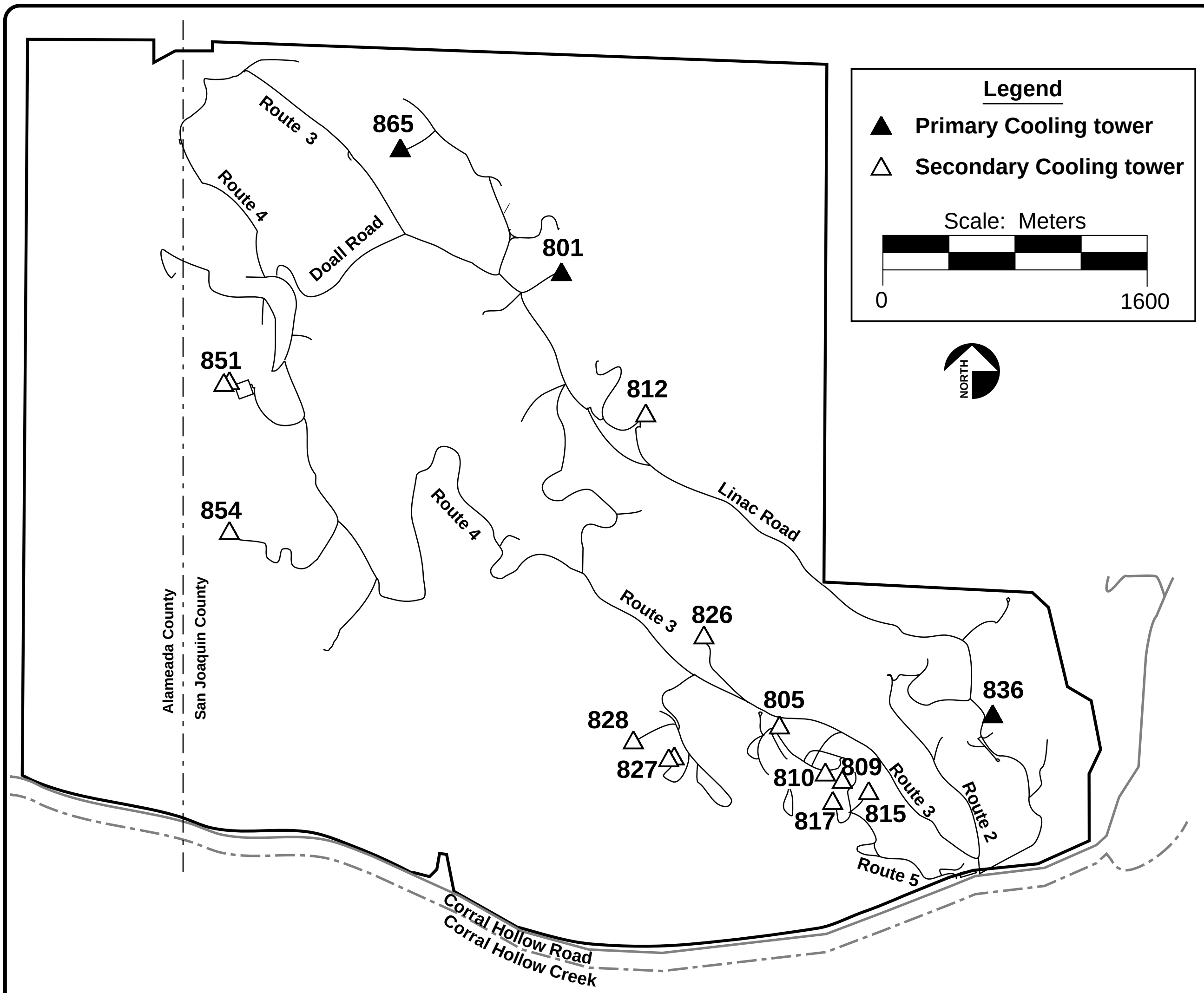

Figure 14-9. Site 300 cooling tower locations, 1995.

two locations indicates the cooling towers did not adversely affect the creek's ambient pH. No visible oil, grease, scum, foam, or floating or suspended materials were observed in the creek.

Industrial Pretreatment and Categorical Discharges

Self-monitoring pretreatment programs are required at both the Livermore site and Site 300 by the Livermore Water Reclamation Plant (LWRP) under the authority of San Francisco Bay Regional Water Quality Control Board. The sampling and monitoring of nondomestic, industrial sources covered by pretreatment standards defined in 40 CFR 403 is required in the 1995–1996

Table 14-9. Summary data from measurements of Site 300 primary cooling-towers, 1995.

Test	Tower No.	Minimum	Maximum	Median	Interquartile range	Number of samples
Total dissolved solids (mg/L)[(a)]	801	1200	1400	1300	50	23
	836A	800	1300	1200	50	23
	865	1000	1300	1150	75	15
Flow (L/day)	801[(b)]	0	13,936	6355	5300	28
	836A[(c)]	0	7684	1083	1628	28
	865[(d)]	0	48,467	17,048	27,805	23
pH[(e)]	801	8.43	8.96	8.71	0.21	23
	836A	8.46	9.03	8.76	0.21	23
	865	8.27	8.74	8.50	0.10	15

a Maximum permitted total dissolved solids = 2400 mg/L.

b Maximum permitted design flow, 16,276 L/day.

c Maximum permitted design flow, 8138 L/day.

d Maximum permitted design flow, 90,840 L/day.

e Maximum permitted pH = 10.

Wastewater Discharge Permit (No. 1250) issued for the discharge of wastewater from LLNL into the City of Livermore sewer system. The General Pretreatment Regulations establish both general and specific standards for the discharge of prohibited substances (40 CFR 403.5) that apply to all industrial users. Categorical standards are published by the EPA as separate regulations and contain numerical limits for the discharge of pollutants from specified processes (or industrial categories). The LWRP has identified specific LLNL wastewater generating processes that fall under the definition of two Categorical Standards: electrical and electronic components and metal finishing.

LLNL petitioned the EPA for an exemption from the Categorical Standards. To date, no decision has been rendered. This year, LLNL maintained compliance with the applicable categorical standard discharge limits that apply to the significant industrial processes that discharge to the sanitary sewer. This compliance was achieved through the review of retention-tank data prior to discharge and the application of the appropriate categorical discharge limits to the discharge. The analytical data and discharge records are available for review by any regulatory agency. However, pending a decision on our request, we suspended the formal monitoring and reporting requirements stated in the Standards. Quarterly and semiannual sampling of minor discharges were suspended, and semiannual wastewater reports were not submitted to the LWRP. Similarly LWRP suspended its inspection schedule of the regulated processes at LLNL. This is being done with the understanding and concurrence of both the LWRP and the Pretreatment Coordinator, EPA Region 9. LLNL wastewater representatives are working closely with LWRP and the EPA personnel to reach a decision in this matter. When a decision is reached on the future level of compliance LLNL must follow regarding the categorical standards, LLNL will continue to maintain strict adherence to the applicable requirements.

Tables 14-10 and **14-11** show LLNL's internal discharge limits for wastewaters discharged to the sanitary sewer. Those processes that discharge to the sanitary sewer are subject to the pretreatment self-monitoring program specified in the Wastewater Discharge Permit issued by the LWRP. In 1995, no exceptions to the pollutant limitations of the discharge permit were observed.

Site 300 Ground Water Compliance Monitoring

Ground water compliance monitoring programs are carried out at Site 300 in response to LLNL Site 300 Resource Conservation and Recovery Act (RCRA) Closure and Post-Closure Plans for Landfill Pits 1 and 7 and WDR Order Nos. 93-100 and 85-188. Compliance monitoring and reporting allow LLNL to

Table 14-10. LLNL's internal discharge limits for nonradioactive parameters in wastewaters from noncategorical and categorical processes, mg/L.

Parameter	Noncategorical[b]	Discharge limits[a]	
		Metal finishing	Electronic components
Metals			
Beryllium	0.74		
Cadmium	0.9	0.26	
Chromium	4.9	1.0	
Copper	10	2.07	
Cyanide[c]	5	0.65	
Lead	4.9	0.43	
Mercury	0.05		
Nickel	5	2.38	
Silver	1	0.24	
Zinc	15	1.48	
Organics			
Total toxic organics	4.57	2.13	1.37
Physical			
pH	5–10	5–10	5–10

a These standards are specified by the EPA. By regulation, the EPA or City of Livermore limit is used, whichever is lower. Noncategorical limits apply where no standard is specified.

b These standards have been established to meet the City of Livermore's requirements at the Building 196 outfall.

c Limits apply to CN discharges other than CN salts. CN salts are classified by the State of California as "extremely hazardous waste" and cannot be discharged to the sewer.

Table 14-11. LLNL's internal discharge limits for radioisotopes in wastewaters. There is no gross gamma limit; isotope-specific limits apply.

Parameter	Individual discharges		Total daily limit for site	
Gross alpha	11.1 Bq/L	(0.3 µCi/1000 L)	185 kBq	(5.0 µCi)
Gross beta	111 Bq/L	(3.0 µCi/1000 L)	1.85 MBq	(50.0 µCi)
Tritium	185 kBq/L	(5.0 mCi/1000 L)	3.7 GBq	(100.0 mCi)

evaluate operations of closed RCRA Landfill Pits 1 and 7 and the High Explosive(HE) Process Area Class II surface impoundments and assure that they are consistent with regulatory requirements. WDR Order No. 85-188 establishes the basis for compliance monitoring for HE Process Area Class II surface impoundments. WDR Order No. 93-100 and the post-closure monitoring plan developed within the RCRA Closure and Post-Closure Plans established the basis for the compliance monitoring network around Pits 1 and 7. Data presentation and evaluation for these compliance networks are presented in Chapter 7, Site 300 Ground Water Monitoring. These monitoring programs include quarterly monitoring of the ground water wells in each monitoring network and quarterly and annual self-monitoring reporting.

Monitoring Reporting Program (MRP) No. 93-100 for the Pits 1 and 7 network includes sampling and analysis of ground water monitoring wells for parameters listed in **Table 14-12** and establishes concentration limits at the point of compliance. In letters submitted to the Central Valley RWQCB on October 17 and December 21, 1995, LLNL requested modifications to MRP No. 93-100 proposing to change the concentration limits for most parameters as well as the statistical test method to determine statisticallyt significant evidence of a release.

The Central Valley RWQCB verbally accepted the proposal and LLNL implemented the new concentration limits and statistical test methods to evaluate fourth quarter 1995 data. The new concentration limits and statistical test levels are listed in **Tables 14-13** and **14-14**.

The post-closure monitoring plan requires sampling and analysis of ground water from wells for following the parameters:

- Pit 1—Arsenic, cadmium, chloride, chromium, iron, phenols, manganese, mercury, nickel, nitrate, selenium, silver, sodium, sulfate, conductivity, pH, TOC, TOX, barium, beryllium, lead, VOCs using EPA Method 601/624, semivolatile organic compounds using EPA Method 625, gross alpha, gross beta, tritium, HMX, RDX, and TNT.

Table 14-12 Monitoring parameters and concentration limits for landfill Pits 1 and 7 under MRP Order No. 93-100 used to evaluate first through third quarter monitoring data.

Constituents	Concentration limits Pit 1	Concentration limits Pit 7
Parameters		
Depth to ground water (m)	TBD	TBD
Total dissolved solids (mg/L)	TBD	TBD
Specific conductance (µmho/cm)	TBD	TBD
Temperature (°C)	TBD	TBD
pH	TBD	TBD
Metals (µg/L)		
Arsenic	20	TBD[a]
Barium	50	90
Beryllium	0.5	0.5
Cadmium	0.5	TBD
Cobalt	TBD	TBD
Copper	70	TBD
Lead	9	2
Nickel	100	TBD
Vanadium	90	50
Zinc	60	TBD
Radionuclides (Bq/L)		
Radium 226	0.037	TBD
Tritium	18.5	3.17
Uranium-233,234	0.074	0.078
Uranium-235	0.0074	0.0037
Uranium-238	0.037	0.059
Thorium 228	TBD	TBD
Thorium 232	TBD	TBD
Explosives (µg/L)		
HMX	26	TBD
RDX	30	TBD

[a] TBD = Concentration limits are to be determined.

Table 14-13. Monitoring parameters and concentration limits for landfill Pit 1 amendments to MRP Order No. 93-100 used to evaluate fourth quarter monitoring data.

Constituent of concern	Well	Concentration limit[(a)]	Statistical limit
Metals (μg/L)			
Arsenic	K1-02B	11	16
	K1-03	12	18
	K1-04	10	14
	K1-05	14	27
	K1-08	14	18
	K1-09	13	18
Barium	K1-02B	<25	25
	K1-03	<25	25
	K1-04	<25	25
	K1-05	28	34
	K1-08	34	45
	K1-09	32	38
Beryllium	All	<0.5	0.5
Cadmium	All	<0.5	0.5
Cobalt	All	<50	50
Copper	All	<70	70
Lead	All	<6	6
Nickel	All	<100	100
Vanadium	All	58	103
Zinc	All	17	91
Radionuclides (Bq/L)			
Radium 226	All	0.005	0.046
Tritium	K1-03	3.78	11.4
	K1-04	0.859	6.15
	K1-05	1.24	6.89
	K1-08	1.36	5.22
	K1-09	1.43	5.52
Uranium (Total)	All	0.084	0.13
Thorium 228	All	0.006	0.039
Thorium 232	All	0.001	0.02
Energetic Materials (μg/L)			
HMX	All	<20	20
RDX	All	<30	30

a Background concentration (mean of LLNL historical data).

Table 14-14. Monitoring parameters and concentration limits for landfill Pit 7 amendments to MRP Order No. 93-100 used to evaluate fourth quarter monitoring data.

Constituent of concern	Well	Concentration limit[a]	Statistical limit
Metals (µg/L)			
Arsenic	K7-01	9.7	14
	K7-03	3.3	6.4
	K7-09	<2	2
	K7-10	3.8	8.6
	NC7-25	6.1	8.9
	NC7-26	4.1	13
	NC7-47	14	21
	NC7-48	8.4	14
Barium	K7-01	180	210
	K7-03	66	79
	K7-09	<50	50
	K7-10	41	92
	NC7-25	58	70
	NC7-26	<50	50
	NC7-47	42	62
	NC7-48	150	290
Beryllium	All	<0.5	0.5
Cadmium	K7-01	<0.5	0.5
	K7-03	<0.5	0.5
	K7-09	<0.5	0.5
	K7-10	<1.6	1.6
	NC7-25	<0.6	0.6
	NC7-26	<0.5	0.5
	NC7-47	<1.5	1.5
	NC7-48	<1.5	1.5
Cobalt	All	<25	25
Copper	K7-01	12	47
	K7-03	71	140
	K7-09	<10	10
	K7-10	<10	10
	NC7-25	<10	10
	NC7-26	<10	10
	NC7-47	<10	10
	NC7-48	<10	10

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Table 14-14. Monitoring parameters and concentration limits for landfill Pit 7 amendments to MRP Order No. 93-100 used to evaluate fourth quarter monitoring data (continued).

Constituent of concern	Well	Concentration limit[a]	Statistical limit
Lead	K7-01	1.4	6
	K7-03	1.3	6.1
	K7-09	<5.9	5.9
	K7-10	<2	2
	NC7-25	<2	2
	NC7-26	1.1	5.1
	NC7-47	1.5	7.6
	NC7-48	<2	2
Nickel	K7-01	2.9	12
	K7-03	10	21
	K7-09	<5	5
	K7-10	7.4	37
	NC7-25	5.7	23
	NC7-26	<5	5
	NC7-47	2.5	14
	NC7-48	22	65
Vanadium	K7-01	<50	50
	K7-03	<50	50
	K7-09	<50	50
	K7-10	<50	50
	NC7-25	<50	50
	NC7-26	<50	50
	NC7-47	49	77
	NC7-48	46	140
Zinc	K7-01	<54	54
	K7-03	34	70
	K7-09	<20	20
	K7-10	<20	20
	NC7-25	<36	36
	NC7-26	<20	20
	NC7-47	<27	27
	NC7-48	20	71

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Table 14-14. Monitoring parameters and concentration limits for landfill Pit 7 amendments to MRP Order No. 93-100 used to evaluate fourth quarter monitoring data (concluded).

Constituent of concern	Well	Concentration limit[(a)]	Statistical limit
Radionuclides (Bq/L)			
^{226}Ra	K7-01	1.18	2.61
	K7-03	0.52	1.20
	K7-09	0.23	0.59
	K7-10	0.40	0.88
	NC7-25	0.70	1.31
	NC7-26	0.41	0.93
	NC7-47	0.14	0.79
	NC7-48	9.11	29.7
Tritium	K7-09	64.8	373
	K7-10	64.8	373
	NC7-47	64.8	373
	NC7-48	64.8	373
Uranium (Total)	K7-01	12.8	16.0
	K7-03	3.65	6.16
	K7-09	0.59	1.13
	K7-10	1.10	2.17
	NC7-25	21.6	33.0
	NC7-26	0.40	0.87
	NC7-47	2.28	3.30
	NC7-48	27.2	60.0
^{228}Th	All	0.0	0.86
^{232}Th	All	0.13	1.36
Energetic materials (µg/L)			
HMX	All	<20	20
RDX	All	<30	30

a Background concentration (mean of LLNL historical data).

- Pit 7—Antimony, VOCs using 601/624, gross alpha, gross beta, and tritium.

MRP No. 85-188 does not establish concentration limits at the point of compliance but requires quarterly sampling for the following parameters and constituents: total organic halogens (TOX), total organic carbon (TOC), pH, electrical conductivity, nitrate, nitrite, high explosive compounds (HMX and RDX), nickel, selenium, silver, thallium, vanadium, zinc, molybdenum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, and mercury. The monitoring program also requires weekly inspection of the surface impoundments leachate collection systems for fluid accumulation and quarterly checking of lysimeters or the leachate collection systems. If water is found in the lysimeters or the leachate collection systems, the water must be analyzed for pH, electrical conductivity, HMX, and RDX.

In June 1995, during a routine inspection, water was detected dripping from one of the three perforated pipes that comprise the leachate collection system for the upper of the two surface impoundments. The flow, which goes directly into the lower surface impoundment, averaged about 15 L/day. As required by MRP 85-188, samples were collected on June 16, 19, 22, and 30. The results of these samples were reported to the Central Valley RWQCB in the *LLNL Experimental Test Site 300 Compliance Monitoring Program for RCRA Closed Landfills Pits 1 and 7 and Process Water Surface Impoundments Second Quarter Report April – June 1995* (Christofferson 1995b). As indicated in this and other subsequent reports, LLNL took immediate actions upon discovery of the leak including diverting the majority of flows from the upper surface impoundment to the lower surface impoundment and reducing water volume contained in the upper surface impoundment.

In October, LLNL located three leak points using an electrical surveying method. The upper impoundment was drained and its inner high density polyethylene liner (HDPE) was repaired on December 19, 1995. The leachate collection system pipe continues to drip at the same average flow rate even through repairs to the inner liner were completed. As stated in the *LLNL Experimental Test Site 300 Compliance Monitoring Program for RCRA Closed Landfills Pits 1 and 7 and Process Water Surface Impoundments Fourth Quarter Report October – December 1995* (Christofferson 1995a), the leachate collection system could not immediately reflect the cessation of HDPE liner leakage, because previously leaked water is stored in the sand layer surrounding the pipes. Until exhausted, this previously leaked water will continue to flow from the leachate collection system.

Environmental Impact

Wastewater, treated water, storm water, and Site 300 water were monitored as part of our compliance self-monitoring activities. Monitoring results from the compliance networks indicate that LLNL operations had no adverse impacts on human health or the environment in 1995.

No exceptions to the discharge limits of the LWRP Wastewater Discharge Permit were observed.

Treated ground water from all treatment facilities was within compliance limits set up by the remedial project managers, a group comprising project managers from EPA, DTSC, and the San Francisco Bay Area RWQCB, for VOCs and metals during 1995. Although Cr(VI) exceeded limits in water discharged from TFB and the VOC limit of 5 ppb was slightly exceeded three times at TFA, the impact of these discharges was deemed to be not significant by the remedial project managers.

Storm water was monitored at two locations during 1995. Captured storm water from the Drainage Retention Basin (DRB) was found to contain iron, lead, and zinc, at levels above the water quality objectives stated in the management plan. Monitoring at the LLNL storm water outfall also found these three metals plus copper at levels above the objectives. While above the objectives of the management plan, storm water was within compliance.

No environmental impacts on Site 300 ground water were detected in 1995. Even though water was found dripping from one of the perforated pipes that make up the leachate collection system, immediate action ensured that no process water was released to the environment. All cooling towers at Site 300 were also found to be in compliance with permitted limits.