UCRL-AR-143121-04

Environmental Protection Department

Operations and Regulatory Affairs Division

Lawrence Livermore National Laboratory
Site 300

Compliance Monitoring Program for the Closed Building 829 Facility

REGISTERED GEOLOGIST
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No. 5051
STATE OF CALIFORNIA

Annual Report 2004

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This work was performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.

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1.1 Description of Site 300

The Lawrence Livermore National Laboratory (LLNL) Site 300 (Site 300) is owned by the U.S. Department of Energy (DOE) and is operated by the University of California as an experimental test site. This site is located in the southern Altamont Hills of the Diablo Range, which is part of the Coast Range Physiographic Province. It is situated about 20 km (12 mi) east of the LLNL Livermore site (**Figure 1**). Site 300 covers an area of approximately 30.3 km^2 (11.8 mi^2) north of Corral Hollow Road (**Figure 2**). Its elevation ranges from about 500 ft in the southeast corner to about 1750 ft in the northwest area. The western one-sixth of the site lies in Alameda County; the remaining portion is in San Joaquin County. The surrounding area is primarily agricultural, used as grazing land for cattle and sheep. Site 300 is an active Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) site.

1.2 Description of the B-829 Facility

As shown in **Figure 2**, the B-829 Facility is located in the High-Explosives (HE) Process Area Operable Unit in the south-central portion of Site 300. The B-829 Facility, part of the B-829 Complex, was used to thermally treat explosives process waste generated by operations at Site 300 and similar waste from explosives research operations at the LLNL Livermore site. The B-829 Facility was operated under the Resource Conservation and Recovery Act (RCRA) as an interim status treatment facility. Built in 1955, the B-829 Facility consisted of three separate burn pits, which were constructed in unconsolidated sediments, and an open-air burn unit. The B-829 Facility was closed in 1998, and an impervious cap was constructed over the burn pits as described in the *Final Closure Plan for the High-Explosives Open Burn Treatment Facility at Lawrence Livermore National Laboratory Experimental Test Site 300* (B-829 Final Closure Plan) (Mathews and Taffet 1997).

2.0 Post-Closure Monitoring and Inspection Activities

Monitoring and inspection of the closed burn pits during the post-closure period reflects the prime consideration: to protect human health and the environment by preventing any infiltration of rainwater that may cause the low concentrations of explosive compounds and volatile organic compounds (VOCs) in near-surface soils to migrate to groundwater. The design of the post-closure plan is presented in Chapter 2 of the *B-829 Final Closure Plan* (Mathews and Taffet 1997).

In January 2002, LLNL submitted a revised *Post-Closure Permit Application for the B829 Facility* (LLNL 2001) to the Department of Toxic Substances Control (DTSC). The DTSC issued the *Hazardous Waste Facility Post-Closure Permit for the B829 Facility* (DTSC 2003) in February 2003. This permit, effective April 3, 2003 through April 2, 2013, necessitated changes to three key areas of the monitoring and inspection activities described in the *B-829 Final Closure Plan* (Mathews and Taffet 1997).

- First, the permit directed LLNL to install one additional groundwater monitoring well within 10 ft of the boundary of the capped area. This new well (W-829-1938) and two existing wells (W-829-15 and W-829-22) constitute the groundwater monitoring locations (**Figure 3**) required by the permit.
- Second, the permit required slight modifications to the sampling plan and subsequent reporting requirements for the three wells. Perchlorate was added as a constituent of concern (COC). Both the cis- and trans- isomers of 1,2-dichloroethene (DCE) were included in the COC list, as well as total DCE. Groundwater elevations, measured at the time of sampling, are reported.
- Third, the permit specified that visual inspection of the covered area (previously performed quarterly) be conducted, at a minimum, on a monthly basis.

These required changes were implemented during calendar year (CY) 2003, and have been incorporated into the current monitoring program.

2.1 Groundwater Monitoring

Based on groundwater samples recovered from wells, previous CERCLA remedial investigations determined that the perched groundwater near the B-829 Facility was contaminated with VOCs, primarily trichloroethene (TCE), perchlorate, and nitrate, but that the deeper regional aquifer was free of any contamination stemming from operation of the facility (Ferry, et al., 1999). Subsequent assays of soil samples obtained from shallow boreholes prior to closure revealed that low concentrations of HE compounds, VOCs, and metals are present beneath the burn pits (Mathews and Taffet 1997). Conservative transport modeling indicates that the shallow contamination will not adversely impact the regional aquifer, primarily because its downward movement is restricted by more than 100 m (330 ft) of unsaturated Neroly Formation sediments that include interbeds of claystone and siltstone. At this location in the regional aquifer, the flow rate is low; an estimated 0.05 to 0.1 gallons/minute. The groundwater flow velocity is about 20 feet/year, and the direction of flow is approximately ESE.

Beginning in 1999, the dual-purpose, groundwater-monitoring program described in the *B-829 Final Closure Plan* (Mathews and Taffet 1997) was initiated for this area to track the fate of contaminants in the soil and perched water-bearing zone, and to monitor the deep regional aquifer for the unlikely appearance of any potential contaminants from the closed burn facility. This monitoring program remained in effect through the first quarter of 2003, at which time LLNL began implementation of the provisions specified in the *Hazardous Waste Facility Post-Closure Permit for the B829 Facility* (DTSC 2003). Following the guidance outlined in the DTSC *Technical Completeness* (DTSC 2002) assessment, LLNL installed one additional groundwater monitoring well at the point of compliance (POC) within 10 ft of the edge of the capped High Explosive Open Burn Treatment Facility. This well was screened in the regional aquifer, beneath the B-829 Facility. The *B829 Well Installation As-Built Diagram* (LLNL 2003) for well W-829-1938 was submitted to DTSC in November 2003. Since the first quarter of 2004, well W-829-1938 has been sampled as part of the permit-specified groundwater monitoring network (**Figure 3**). Also shown in **Figure 3** are two previously existing wells (W-829-15 and W-829-22), which were used throughout CY 2004 for quarterly collection of groundwater samples from the regional aquifer. The most recently obtained data are discussed in **Section 3.1.**

LLNL uses statistical methods consistent with the state regulations [California Code of Regulations (CCR) Title 22, Section 66264.97(e)(8)(D)] to accomplish the monitoring and reporting provisions of the post-closure plan (Mathews and Taffet 1997). The methodology relies on our ability to establish a background concentration, which is defined as the concentration limit (CL), for each constituent of concern (COC). Additionally, statistically determined limits of concentration (SLs) for the COCs have been calculated from the monitoring data. During CY 2000, LLNL developed a preliminary set of CLs and SLs for the specified COCs (See **Table 7.2** in LLNL 2000 and **Table 1** in DTSC 2003). These limits have been reviewed annually and revised to reflect the accumulating data. The CL and SL values for monitoring wells W-829-15 and W-829-22 (**Table 1**) are now based on six years of data, collected 1999 through 2004. They remain unchanged from the values developed two years ago, reported by LLNL (Revelli 2003), and reviewed by DTSC (DTSC 2004). The SLs for most COCs are given as the analytical reporting limits (RLs), because the measurements are below the detection limits for those constituents.

CY 2004 produced the first four quarters of monitoring data from well W-829-1938. Analytical results from these samples identified six COCs (arsenic, chromium, manganese, molybdenum, nickel, and gross beta) that were detected above their respective RLs (See **Table 4** and discussion in **Section 3.1**). Of these analytes, only arsenic, manganese, and gross beta were detected in all four quarterly samples. Based solely on the four data points reported for each of these three COCs, LLNL used statistical methods to calculate the following preliminary results:

Arsenic: CL = 27 μg/L, SL = 65 μg/L;
Manganese: CL = 54 μg/L, SL = 220 μg/L; and
Gross Beta: CL = 0.42 Bq/L, SL = 0.71 Bq/L.

(With so few data points, the uncertainty with which the “true” average is estimated is large; the SL has to be higher to take that uncertainty into account.)
Similar calculations (even preliminary) for chromium, molybdenum, and nickel are not statistically meaningful without additional data. Once the CY 2005 quarterly analytical results become available from well W-829-1938, LLNL will review these preliminary calculations and propose an initial set of CLs and SLs for this well. The CL and SL values for well W-829-1938, currently identified in **Table 1** as “to be determined” (TBD), will be documented in the annual report for 2005.

Updated SLs provide the basis for comparison with next year’s quarterly COC measurements to identify potential releases to the deep regional aquifer. If a future measurement exceeds an SL, we will implement a method of data verification that involves two discrete retests, in accordance with CCR Section 66264.97(e)(8)(E). If an exceedance is confirmed by either or both of the retests, these results will be interpreted and reported as "statistically significant evidence of a release of the COC to groundwater."

2.2 Inspection and Maintenance

In accordance with the permit (DTSC 2003), LLNL performed monthly visual inspections of the closed B-829 Facility (final cover cap, drainage and diversion ditches, groundwater monitoring system, signage, etc.). Additional inspections are required after major rainstorms, significant earthquakes, or other events that may cause substantial damage to the capped facility. Any deficiencies noted, such as erosion of the cover, fissures or low spots, burrowing by animals, and bare areas needing reseeding, are remediated. In addition to these inspections performed by LLNL staff, an independent, California-registered Professional Engineer (PE) must perform an annual engineering inspection. The PE prepares a written inspection report, which includes comments and recommendations, and submits that documentation to LLNL.

3.0 Results of Post-Closure Monitoring and Inspection for CY 2004

3.1 Discussion of Monitoring Results

CY 2004 analytical results for the well locations W-829-15, W-829-22, and W-829-1938 are listed in **Tables 2, 3, and 4**, respectively. These wells were sampled in all four quarters of 2004. Note that all non-detections of constituents are shown in the data tables as being less than (<) the analytical reporting limit.

Appendix A presents graphical depictions of groundwater elevations and concentration trends for all confirmed COC detections above their respective RLs, for the permit-specified wells (W-829-15, W-829-22, and W-829-1938). Graphs for the two established wells (W-829-15 and W-829-22) present data accumulated over the last six years, going back to 1999, the first year of monitoring under the *B-829 Final Closure Plan* (Mathews and Taffet 1997). The graphs for well W-829-1938, which was installed during CY 2003, present only four quarters of data; beginning with the first-quarter results from CY 2004.

During CY 2004, no organic or explosive COCs were detected above their respective RLs in groundwater samples from any of the three monitoring wells (**Tables 2, 3, and 4**). The inorganic constituents that were detected in CY 2004 samples from the two established wells (W-829-15 and W-829-22) show concentrations that do not differ significantly from background concentrations (the CLs shown in **Table 1**) for the deep aquifer beneath the HE Process Area (Webster-Scholten 1994). Although zinc and mercury were detected in routine quarterly samples from well W-829-22, these results were subsequently invalidated. Analytical details are summarized below.

A zinc concentration of 33 μg/L (RL = 20 μg/L) was initially reported for the first-quarter sample from well W-829-22, and a mercury concentration of 0.37 μg/L (RL = 0.2 μg/L) was similarly reported for the fourth-quarter sample from this same well. To confirm these initial results, we used a method of data validation that utilizes discrete retests and is consistent with state regulations [CCR Title 22, Section 66264.97(e)(8)(E)]. Two additional groundwater samples were subsequently obtained from well W-829-22 for each COC detection in question: retest samples were collected for zinc on March 2 and 9, and for mercury on December 14 and 21, 2004. These samples were analyzed using the same analytical tests (EPA Methods) as those used in the analyses of the routine quarterly samples. Neither COC was detected above the RL in either of their retest samples. According to the state-approved methodology, these two non-detections in the retest samples invalidate the earlier detections in the routine quarterly samples for each COC in question. DTSC was notified of both the initial zinc and mercury detections, as well as the retest results that did not confirm the presence of these COCs (LLNL 2005).

With one exception, the concentrations of inorganic COCs detected in the new well (W-829-1938, **Table 4**) were consistent with background concentrations reported for the other wells, which have been sampled for this network (Revelli 2003). Only nickel, detected in two of the quarterly samples from well W-829-1938 (at 14 μg/L and 5.1 μg/L; which are above the 5 μg/L analytical reporting limit), had not previously been detected in groundwater samples from this monitoring network. Nickel, however, is typically found in Site 300 groundwater at background concentrations of 21μg/L (Webster-Scholten 1994). Continued quarterly sampling at well W-829-1938 through CY 2005 will provide additional data to better establish background concentrations and statistically determined limits of concentrations in accordance with state regulations [CCR Title 22, Section 66264.97(e)(8)(D)].

Total organic halides (TOX) were reported by the contract analytical laboratory to be above the analytical reporting limit (20 μg/L) in a quarterly groundwater sample from two of the three monitoring wells. The third-quarter sample from well W-829-15 (**Table 2**) and the first-quarter sample from well W-829-1938 (**Table 4**) showed TOX concentrations of 100 mg/L and 34 mg/L, respectively. Although not a specified COC, TOX are included in the list of state-specified water quality parameters (Mathews and Taffet 1997). We suspect that these TOX detections in wells W-829-15 and W-829-1938 are analytical artifacts, for two reasons. First, these TOX detections were not observed in subsequent quarter(s). Second, unlike results for another Site 300 monitored area where TOX detections are accompanied by equivalent detections of specific organic halides (typically Freon 113), none of the VOC analyses for the regional aquifer beneath the closed B-829 Facility have detected any specific organic halide COC above analytical reporting limits since post-closure monitoring began in 1999.

During 2004, as in past years, total organic carbon (TOC) was detected above its RL. (TOC is another analyte included in the list of state-specified water quality parameters, but it is not a specified COC.) TOC was reported by the contract analytical laboratory to be slightly above the reporting limit of 1 mg/L in one or more samples of the groundwater monitored at all three monitoring wells (W-829-15, W-829-22, and W-829-1938) during 2004. The maximum concentration measured was 2.6 mg/L, in both a first-quarter groundwater sample from well W-829-22 (**Table 3**) and a second-quarter sample from well W-829-1938 (**Table 4**). We believe that these reported TOC concentrations, near the RL and consistent with results from the past five years, are related to natural sources primarily because we have no statistical evidence of any carbon-based COCs above their RLs, measures which are typically three orders of magnitude more sensitive than the TOC RL.

Finally, coliform bacteria (again an analyte included in the state list of water quality parameters that is not a specified COC) were detected in two groundwater samples from well W-829-1938 (**Table 4**). Because this is a newly constructed well and the coliform detections occurred in only the first- and second-quarter samples, the bacteria may have been introduced during construction. Well W-829-22, completed in 1998, exhibited a similar detection trend for this analyte in the quarterly groundwater samples collected during 1999 (LLNL 2000).

3.2 Inspection of the B-829 Facility

During CY 2004, LLNL staff completed twelve monthly post-closure inspections of the covered area at the B-829 Facility. The inspection checklist form, used during these LLNL inspections, is provided in **Figure 4.** In addition, the checklist form shown in **Figure 5** was used to document the monitoring well inspections, completed during quarterly sampling. All completed forms are retained for three years by the LLNL Environmental and Special Projects Manager at Site 300. Finally, the required annual cap inspection by a California-registered Professional Engineer was completed on August 3, 2004. (A copy of the *Annual Engineering Inspection of Site 300, 829 Cap*, prepared by Chow Engineering, Inc., and dated September 15, 2004, is included in this report as **Appendix B**.) The inspection included a review of existing documentation on the cap as well as an on-site inspection. With one exception (drainage facilities), all items required to be inspected under Title 22 of the CCR, Part 66264.228(k), were noted to be in good condition. The drainage facilities were reported to be in fair to good condition because of stress cracks, and joint separations of up to 1 in, in the concrete channel sections. The annual engineering inspection report contains a total of five recommendations, including drainage channel repairs, which were addressed by the Site 300 Manager's Office during the fourth quarter of CY 2004.

4.0 References

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Table 1. Constituents of concern, typical analytical reporting limit (RL), background concentration limit (CL)[a], and statistical limit (SL)[b] for B-829 Facility monitoring wells W-829-15, W-829-22, and W-829-1938.

Constituent of concern	Typical analytical RL	Unit of measure	Well W-829-15		Well W-829-22		Well W-829-1938	
			CL	SL	CL	SL	CL	SL
Antimony	5	μg/L	<RL	RL	<RL	RL	TBD	TBD[c]
Arsenic	2	μg/L	17	22	<2.9	2.9	TBD	TBD
Barium	25	μg/L	26	75	<RL	RL	TBD	TBD
Beryllium	0.5	μg/L	<RL	RL	<RL	RL	TBD	TBD
Cadmium	0.5	μg/L	<RL	RL	<RL	RL	TBD	TBD
Chromium	1	μg/L	2.2	7.8	0.9	1.5	TBD	TBD
Cobalt	25	μg/l	<RL	RL	<RL	RL	TBD	TBD
Copper	10	μg/L	<RL	RL	<RL	RL	TBD	TBD
Lead	2	μg/L	<RL	RL	<RL	RL	TBD	TBD
Manganese	10	μg/L	<RL	RL	<RL	RL	TBD	TBD
Mercury	0.2	μg/L	<RL	RL	<RL	RL	TBD	TBD
Molybdenum	25	μg/L	24	27	<RL	RL	TBD	TBD
Nickel	5	μg/L	<RL	RL	<RL	RL	TBD	TBD
Selenium	2	μg/L	<RL	RL	<RL	RL	TBD	TBD
Silver	1	μg/L	<RL	RL	<RL	RL	TBD	TBD
Vanadium	25	μg/L	<RL	RL	<RL	RL	TBD	TBD
Zinc	20	μg/L	<RL	RL	<RL	RL	TBD	TBD
Perchlorate	4	μg/L	<RL	RL	<RL	RL	TBD	TBD

(continued)

Table 1. Constituents of concern, typical analytical reporting limit (RL), background concentration limit (CL)[a], and statistical limit (SL)[b] for B-829 Facility monitoring wells W-829-15, W-829-22, and W-829-1938 (concluded).

Constituent of concern	Typical analytical RL	Unit of measure	Well W-829-15		Well W-829-22		Well W-829-1938	
			CL	SL	CL	SL	CL	SL
1,1,1-Trichloroethane	0.5	µg/L	<RL	RL	<RL	RL	TBD	TBD
1,1-Dichloroethene	0.5	µg/L	<RL	RL	<RL	RL	TBD	TBD
1,2-Dichloroethane	0.5	µg/L	<RL	RL	<RL	RL	TBD	TBD
cis-1,2-Dichloroethene	0.5	µg/L	<RL	RL	<RL	RL	TBD	TBD
trans-1,2-Dichloroethene	0.5	µg/L	<RL	RL	<RL	RL	TBD	TBD
1,2-Dichloroethene (total)	1	µg/L	<RL	RL	<RL	RL	TBD	TBD
Benzene	0.5	µg/L	<RL	RL	<RL	RL	TBD	TBD
Carbon disulfide	5	µg/L	<RL	RL	<RL	RL	TBD	TBD
Chloroform	0.5	µg/L	<RL	RL	<RL	RL	TBD	TBD
Dichlorodifluoromethane	0.5	µg/L	<RL	RL	<RL	RL	TBD	TBD
Ethylbenzene	0.5	µg/L	<RL	RL	<RL	RL	TBD	TBD
Freon 113	0.5	µg/L	<RL	RL	<RL	RL	TBD	TBD
Tetrachloroethene	0.5	µg/L	<RL	RL	<RL	RL	TBD	TBD
Toluene	0.5	µg/L	<RL	RL	<RL	RL	TBD	TBD
Total xylene isomers	1	µg/L	<RL	RL	<RL	RL	TBD	TBD
Trichloroethene	0.5	µg/L	<RL	RL	<RL	RL	TBD	TBD
Trichlorofluoromethane	0.5	µg/L	<RL	RL	<RL	RL	TBD	TBD
Bis (2-ethylhexyl) phthalate	5	µg/L	<RL	RL	<RL	RL	TBD	TBD
Phenols	2	µg/L	<RL	RL	<RL	RL	TBD	TBD
HMX	5.0	µg/L	<RL	RL	<RL	RL	TBD	TBD
RDX	5.0	µg/L	<RL	RL	<RL	RL	TBD	TBD
TNT	5.0	µg/L	<RL	RL	<RL	RL	TBD	TBD
Gross alpha	0.074	Bq/L	0	0.123	0	RL	TBD	TBD
Gross beta	0.11	Bq/L	1.81	3.77	0.27	0.43	TBD	TBD

[a] CL is defined as the average background concentration of a COC.

[b] SL is defined as the concentration of a COC, above which an exceedance occurs.

[c] TBD indicates the value is “To Be Determined.” (See **Section 2.1**)

Table 2. B-829 area well W-829-15, monitoring results for CY 2004.
(Constituent detections, in bold, are discussed in the text.)

Constituents	A[a]	B[b]	Sampling dates 2004 5-Feb	5-May	26-Jul	9-Nov
General (units)						
Groundwater elevation (feet)			696	697	697	697
pH (pH Units)		X	8.69	8.67	8.36	8.36
Specific conductance (μmho/cm)		X	1069	1066	1075	1078
Inorganic (μg/L)						
Antimony	X		< 5	< 5	< 5	< 5
Arsenic	X	X	17	8.6	17	14
Barium	X	X	41	43	46	49
Beryllium	X		< 0.5	< 0.5	< 0.5	< 0.5
Cadmium	X	X	< 0.5	< 0.5	< 0.5	< 0.5
Chromium	X	X	< 1	< 1	< 1	< 1
Cobalt	X		< 25	< 25	< 25	< 25
Copper	X		< 10	< 10	< 10	< 10
Iron		X	< 50	< 50	< 50	< 50
Lead	X	X	< 2	< 2	< 2	< 2
Manganese	X	X	< 10	< 10	< 10	< 10
Mercury	X	X	< 0.2	< 0.2	< 0.2	< 0.2
Molybdenum	X		< 25	< 25	< 25	< 25
Nickel	X		< 5	< 5	< 5	< 5
Selenium	X	X	< 2	< 2	< 2	< 2
Silver	X		< 0.5	< 0.5	< 0.5	< 0.5
Vanadium	X		< 25	< 25	< 25	< 25
Zinc	X		< 20	< 20	< 20	< 20
Perchlorate	X		< 4	< 4	< 4	< 4
Chloride (mg/L)		X	96	93	94	95
Fluoride (mg/L)		X	0.25	0.27	0.25	0.32
Nitrate (as NO_3) (mg/L)		X	< 0.5	< 0.5	< 0.5	< 0.5
Sodium (mg/L)		X	190	180	190	180
Sulfate (mg/L)		X	188	188	188	188
Turbidity (NT Units)		X	0.12	0.17	0.24	0.19
Organic (μg/L)						
1,1,1-Trichloroethane	X		< 0.5	< 0.5	< 0.5	< 0.5
1,1-Dichloroethene	X		< 0.5	< 0.5	< 0.5	< 0.5
1,2-Dichloroethane	X		< 0.5	< 0.5	< 0.5	< 0.5
cis-1,2-Dichloroethene	X		< 0.5	< 0.5	< 0.5	< 0.5
trans-1,2-Dichloroethene	X		< 0.5	< 0.5	< 0.5	< 0.5
1,2-Dichloroethene (total)	X		< 1	< 1	< 1	< 1
Benzene	X		< 0.5	< 0.5	< 0.5	< 0.5
Carbon disulfide	X		< 1	< 1	< 1	< 1
Chloroform	X		< 0.5	< 0.5	< 0.5	< 0.5
Dichlorodifluoromethane	X		< 0.5	< 0.5	< 0.5	< 0.5

(continued)

Table 2. B-829 area well W-829-15, monitoring results for year 2004 (concluded).
(Constituent detections, in bold, are discussed in the text.)

Constituents	A[a]	B[b]	Sampling dates 2004 5-Feb	5-May	26-Jul	9-Nov
Ethylbenzene	X		< 0.5	< 0.5	< 0.5	< 0.5
Freon 113	X		< 0.5	< 0.5	< 0.5	< 0.5
Tetrachloroethene	X		< 0.5	< 0.5	< 0.5	< 0.5
Toluene	X		< 0.5	< 0.5	< 0.5	< 0.5
Total xylene isomers	X		< 1	< 1	< 1	< 1
Trichloroethene	X		< 0.5	< 0.5	< 0.5	< 0.5
Trichlorofluoromethane	X		< 0.5	< 0.5	< 0.5	< 0.5
BHC, gamma isomer (Lindane)		X	< 0.005	< 0.005	< 0.005	< 0.005
Bis(2-ethylhexyl)phthalate	X		< 5	< 5	< 5	< 5
Endrin		X	< 0.005	< 0.005	< 0.005	< 0.005
Phenol	X	X	< 2	< 2	< 2	< 2
Total organic halides (TOX)		X	< 20	< 20	**100**	< 20
Total organic carbon (TOC)(mg/L)		X	**1.3**	**1.4**	< 1	< 1
Total coliform (MPN/100 mL)		X	< 2	< 2	< 2	< 2
Methoxychlor		X	< 0.01	< 0.01	< 0.01	< 0.01
Toxaphene		X	< 2	< 2	< 2	< 2
2,4-D		X	< 0.4	< 0.4	< 0.4	< 0.4
2,4,5 TP (Silvex)		X	< 0.07	< 0.07	< 0.07	< 0.07
Explosive (μg/L)						
HMX	X		< 5	< 5	< 5	< 5
RDX	X		< 5	< 5	< 5	< 5
TNT	X		< 5	< 5	< 5	< 5
Radioactive (Bq/L)[c]						
Gross alpha	X	X	-0.021 ± 0.037	-0.045 ± 0.044	-0.035 ± 0.037	-0.061 ± 0.041
Gross beta	X	X	0.99 ± 0.17	1.10 ± 0.20	1.12 ± 0.18	1.03 ± 0.16
Radium 226		X	0.006 ± 0.004	0.001 ± 0.002	0.006 ± 0.003	0.004 ± 0.003

[a] Column A denotes permit-specified constituents of concern (COCs) for the deep regional aquifer (DTSC 2003).

[b] Column B denotes California state-specified background water quality parameters [22 CCR 66265.97(e) (16)].

[c] Radioactivity results in Becquerels/liter (Bq/L) are shown as the reported sample radioactivity and associated 2-sigma counting errors. (Divide these values by 0.037 to convert them to picocuries/liter.)
The reported value is negative when the measured sample radioactivity is less than the measured background activity.
The result is zero when the measured sample radioactivity is equal to the measured background activity.

Table 3. B-829 area well W-829-22, monitoring results for CY 2004.
(Constituent detections, in bold, are discussed in the text.)

Constituents	A[a]	B[b]	Sampling dates 2004 12-Feb	4-May	3-Aug	17-Nov
General (units)						
Groundwater elevation (feet)			653	653	654	653
pH (pH units)		X	8.55	8.39	8.38	8.50
Specific conductance (μmho/cm)		X	1059	1102	1064	1137
Inorganic (μg/L)						
Antimony	X		< 5	< 5	< 5	< 5
Arsenic	X	X	< 2	< 2	< 2	< 2
Barium	X	X	< 25	< 25	< 25	< 25
Beryllium	X		< 0.5	< 0.5	< 0.5	< 0.5
Cadmium	X	X	< 0.5	< 0.5	< 0.5	< 0.5
Chromium	X	X	< 1	< 1	< 1	< 1
Cobalt	X		< 25	< 25	< 25	< 25
Copper	X		< 10	< 10	< 10	< 10
Iron		X	< 50	< 50	< 50	< 50
Lead	X	X	< 2	< 2	< 2	< 2
Manganese	X	X	< 10	< 10	< 10	< 10
Mercury	X	X	< 0.2	< 0.2	< 0.2	**0.37**[d]
Molybdenum	X		< 25	< 25	< 25	< 25
Nickel	X		< 5	< 5	< 5	< 5
Selenium	X	X	< 2	< 2	< 2	< 2
Silver	X		< 0.5	< 0.5	< 0.5	< 0.5
Vanadium	X		< 25	< 25	< 25	< 25
Zinc	X		**33**[d]	< 20	< 20	< 20
Perchlorate	X		< 4	< 4	< 4	< 4
Chloride (mg/L)		X	105	110	106	115
Fluoride (mg/L)		X	0.40	0.39	0.35	0.36
Nitrate (as NO_3) (mg/L)		X	< 0.5	< 0.5	< 0.5	< 0.5
Sodium (mg/L)		X	220	220	210	230
Sulfate (mg/L)		X	158	179	165	197
Turbidity (NT Units)		X	0.10	< 0.1	< 0.1	< 0.1
Organic (μg/L)						
1,1,1-Trichloroethane	X		< 0.5	< 0.5	< 0.5	< 0.5
1,1-Dichloroethene	X		< 0.5	< 0.5	< 0.5	< 0.5
1,2-Dichloroethane	X		< 0.5	< 0.5	< 0.5	< 0.5
cis-1,2-Dichloroethene	X		< 0.5	< 0.5	< 0.5	< 0.5
trans-1,2-Dichloroethene	X		< 0.5	< 0.5	< 0.5	< 0.5
1,2-Dichloroethene (total)	X		< 1	< 1	< 1	< 1
Benzene	X		< 0.5	< 0.5	< 0.5	< 0.5
Carbon disulfide	X		< 1	< 1	< 1	< 1
Chloroform	X		< 0.5	< 0.5	< 0.5	< 0.5
Dichlorodifluoromethane	X		< 0.5	< 0.5	< 0.5	< 0.5

(continued)

Table 3. B-829 area well W-829-22, monitoring results for year 2004 (concluded).
(Constituent detections, in bold, are discussed in the text.)

Constituents	A[a]	B[b]	Sampling dates 2004			
			12-Feb	4-May	3-Aug	17-Nov
Ethylbenzene	X		< 0.5	< 0.5	< 0.5	< 0.5
Freon 113	X		< 0.5	< 0.5	< 0.5	< 0.5
Tetrachloroethene	X		< 0.5	< 0.5	< 0.5	< 0.5
Toluene	X		< 0.5	< 0.5	< 0.5	< 0.5
Total xylene isomers	X		< 1	< 1	< 1	< 1
Trichloroethene	X		< 0.5	< 0.5	< 0.5	< 0.5
Trichlorofluoromethane	X		< 0.5	< 0.5	< 0.5	< 0.5
BHC, gamma isomer (Lindane)		X	< 0.005	< 0.005	< 0.005	< 0.005
Bis(2-ethylhexyl)phthalate	X		< 5	< 5	< 5	< 5
Endrin		X	< 0.005	< 0.005	< 0.005	< 0.005
Phenol	X	X	< 2	< 2	< 2	< 2
Total organic halides (TOX)		X	< 20	< 20	< 20	< 20
Total organic carbon (TOC)(mg/L)		X	**2.6**	**1.0**	< 1	< 1
Total coliform (MPN/100 mL)		X	< 2	< 2	< 2	< 2
Methoxychlor		X	< 0.01	< 0.01	< 0.01	< 0.01
Toxaphene		X	< 2	< 2	< 2	< 2
2,4-D		X	< 0.4	< 0.4	< 0.4	< 0.4
2,4,5 TP (Silvex)		X	< 0.07	< 0.07	< 0.07	< 0.07
Explosive (μg/L)						
HMX	X		< 5	< 5	< 5	< 5
RDX	X		< 5	< 5	< 5	< 5
TNT	X		< 5	< 5	< 5	< 5
Radioactive (Bq/L)[c]						
Gross alpha	X	X	-0.009 ± 0.035	-0.005 ± 0.044	0.007 ± 0.041	-0.003 ± 0.044
Gross beta	X	X	0.24 ± 0.07	0.26 ± 0.07	0.39 ± 0.07	0.29 ± 0.08
Radium 226		X	0.002 ± 0.002	0.002 ± 0.003	0.010 ± 0.004	0.007 ± 0.003

[a] Column A denotes permit-specified constituents of concern (COCs) for the deep regional aquifer (DTSC 2003).
[b] Column B denotes California state-specified background water quality parameters [22 CCR 66265.97(e) (16)].
[c] Radioactivity results in Becquerels/liter (Bq/L) are shown as the reported sample radioactivity and associated 2-sigma counting errors. (Divide these values by 0.037 to convert them to picocuries/liter.)
The reported value is negative when the measured sample radioactivity is less than the measured background activity.
The result is zero when the measured sample radioactivity is equal to the measured background activity.
[d] Analytical results from two discrete retests each showed the concentration of this COC to be less than the RL.
The initial detection was not confirmed. (See **Section 3.1**)

Table 4. B-829 area well W-829-1938, monitoring results for CY 2004.
(Constituent detections, in bold, are discussed in the text.)

Constituents	A[a]	B[b]	Sampling dates 2004 19-Feb	27-Apr	5-Aug	15-Nov
General (units)						
Groundwater elevation (feet)			704	704	705	705
pH (pH units)		X	8.09	7.89	7.77	7.73
Specific conductance (μmho/cm)		X	1078	1074	1074	1073
Inorganic (μg/L)						
Antimony	X		< 5	< 5	< 5	< 5
Arsenic	X	X	26	38	23	22
Barium	X	X	< 25	< 25	< 25	< 25
Beryllium	X		< 0.5	< 0.5	< 0.5	< 0.5
Cadmium	X	X	< 0.5	< 0.5	< 0.5	< 0.5
Chromium	X	X	3.1	< 1	< 1	< 1
Cobalt	X		< 25	< 25	< 25	< 25
Copper	X		< 10	< 10	< 10	< 10
Iron		X	< 50	< 50	< 50	< 50
Lead	X	X	< 2	< 2	< 2	< 2
Manganese	X	X	27	87	78	25
Mercury	X	X	< 0.2	< 0.2	< 0.2	< 0.2
Molybdenum	X		28	< 25	26	< 25
Nickel	X		< 5	**14**	**5.1**	< 5
Selenium	X	X	< 2	< 2	< 2	< 2
Silver	X		< 0.5	< 0.5	< 0.5	< 0.5
Vanadium	X		< 25	< 25	< 25	< 25
Zinc	X		< 20	< 20	< 20	< 20
Perchlorate	X		< 4	< 4	< 4	< 4
Chloride (mg/L)		X	102	97	95	99
Fluoride (mg/L)		X	0.38	0.28	0.32	0.41
Nitrate (as NO_3) (mg/L)		X	1.8	< 0.5	< 0.5	3.3
Sodium (mg/L)		X	170	160	160	160
Sulfate (mg/L)		X	194	187	193	199
Turbidity (NT Units)		X	1.3	0.60	1.8	0.15
Organic (μg/L)						
1,1,1-Trichloroethane	X		< 0.5	< 0.5	< 0.5	< 0.5
1,1-Dichloroethene	X		< 0.5	< 0.5	< 0.5	< 0.5
1,2-Dichloroethane	X		< 0.5	< 0.5	< 0.5	< 0.5
cis-1,2-Dichloroethene	X		< 0.5	< 0.5	< 0.5	< 0.5
trans-1,2-Dichloroethene	X		< 0.5	< 0.5	< 0.5	< 0.5
1,2-Dichloroethene (total)	X		< 1	< 1	< 1	< 1
Benzene	X		< 0.5	< 0.5	< 0.5	< 0.5
Carbon disulfide	X		< 1	< 1	< 1	< 1
Chloroform	X		< 0.5	< 0.5	< 0.5	< 0.5
Dichlorodifluoromethane	X		< 0.5	< 0.5	< 0.5	< 0.5

(continued)

Table 4. B-829 area well W-829-1938, monitoring results for year 2004 (concluded).
(Constituent detections, in bold, are discussed in the text.)

Constituents	A[a]	B[b]	Sampling dates 2004 19-Feb	27-Apr	5-Aug	15-Nov
Ethylbenzene	X		< 0.5	< 0.5	< 0.5	< 0.5
Freon 113	X		< 0.5	< 0.5	< 0.5	< 0.5
Tetrachloroethene	X		< 0.5	< 0.5	< 0.5	< 0.5
Toluene	X		< 0.5	< 0.5	< 0.5	< 0.5
Total xylene isomers	X		< 1	< 1	< 1	< 1
Trichloroethene	X		< 0.5	< 0.5	< 0.5	< 0.5
Trichlorofluoromethane	X		< 0.5	< 0.5	< 0.5	< 0.5
BHC, gamma isomer (Lindane)		X	< 0.005	< 0.005	< 0.005	< 0.005
Bis(2-ethylhexyl)phthalate	X		< 5	< 5	< 5	< 5
Endrin		X	< 0.005	< 0.005	< 0.005	< 0.005
Phenol	X	X	< 2	< 2	< 2	< 2
Total organic halides (TOX)		X	**34**	< 20	< 20	< 20
Total organic carbon (TOC)(mg/L)		X	**2.3**	**2.6**	**1.0**	< 1
Total coliform (MPN/100 mL)		X	**7**	**2**	< 2	< 2
Methoxychlor		X	< 0.010	< 0.010	< 0.01	< 0.01
Toxaphene		X	< 2	< 2	< 2	< 2
2,4-D		X	< 0.4	< 0.4	< 0.4	< 0.4
2,4,5 TP (Silvex)		X	< 0.07	< 0.07	< 0.07	< 0.07
Explosive (μg/L)						
HMX	X		< 5	< 5	< 5	< 5
RDX	X		< 5	< 5	< 5	< 5
TNT	X		< 5	< 5	< 5	< 5
Radioactive (Bq/L)[c]						
Gross alpha	X	X	0.067 ± 0.063	0.038 ± 0.044	0.007 ± 0.041	-0.028 ± 0.041
Gross beta	X	X	0.43 ± 0.11	0.47 ± 0.09	0.46 ± 0.11	0.34 ± 0.08
Radium 226		X	0.005 ± 0.003	0.004 ± 0.003	0.004 ± 0.003	0.012 ± 0.004

[a] Column A denotes permit-specified constituents of concern (COCs) for the deep regional aquifer (DTSC 2003).
[b] Column B denotes California state-specified background water quality parameters [22 CCR 66265.97(e) (16)].
[c] Radioactivity results in Becquerels/liter (Bq/L) are shown as the reported sample radioactivity and associated 2-sigma counting errors. (Divide these values by 0.037 to convert them to picocuries/liter.)
The reported value is negative when the measured sample radioactivity is less than the measured background activity.
The result is zero when the measured sample radioactivity is equal to the measured background activity.

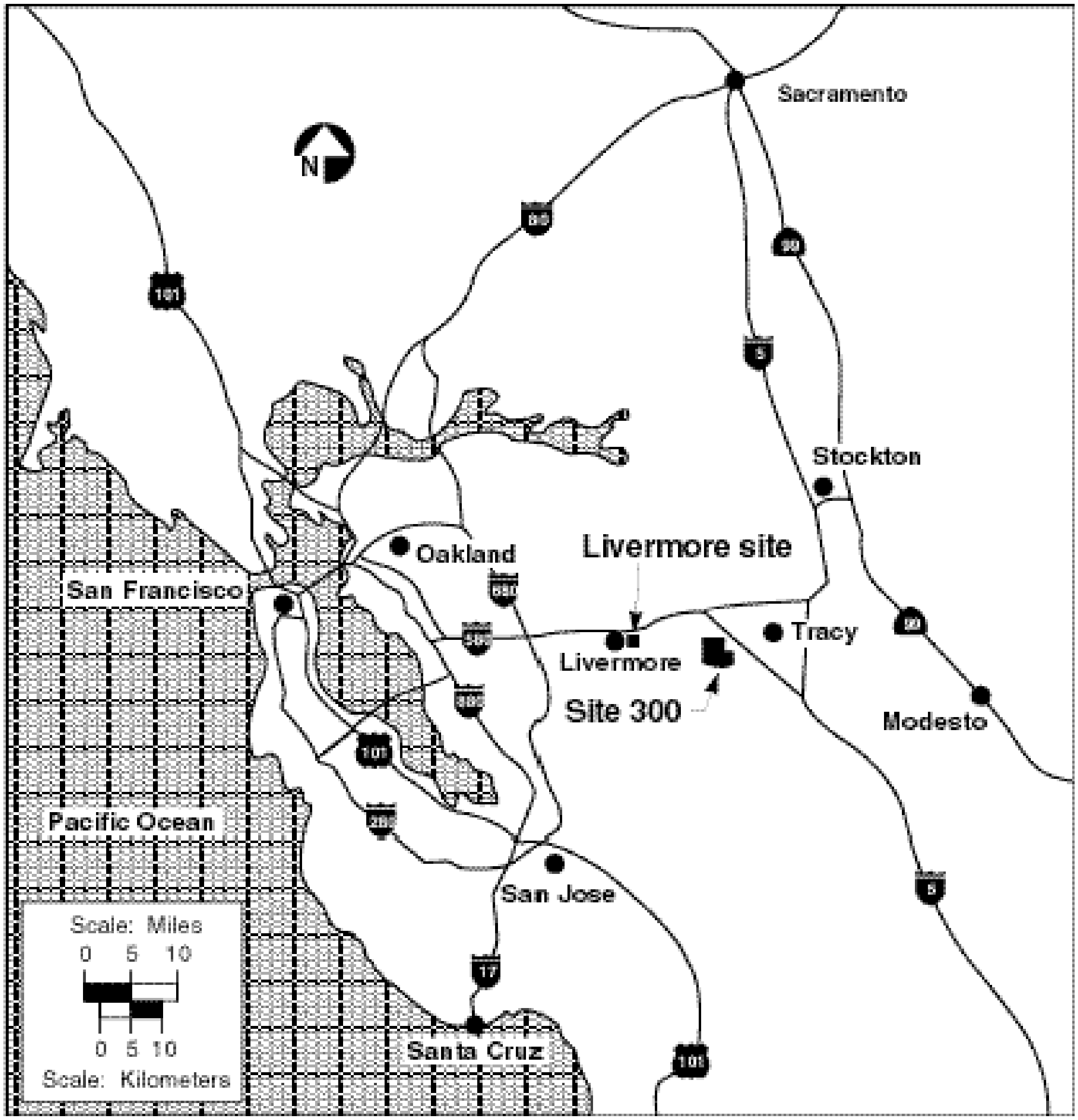


Figure 1. Locations of LLNL Livermore Site and Site 300

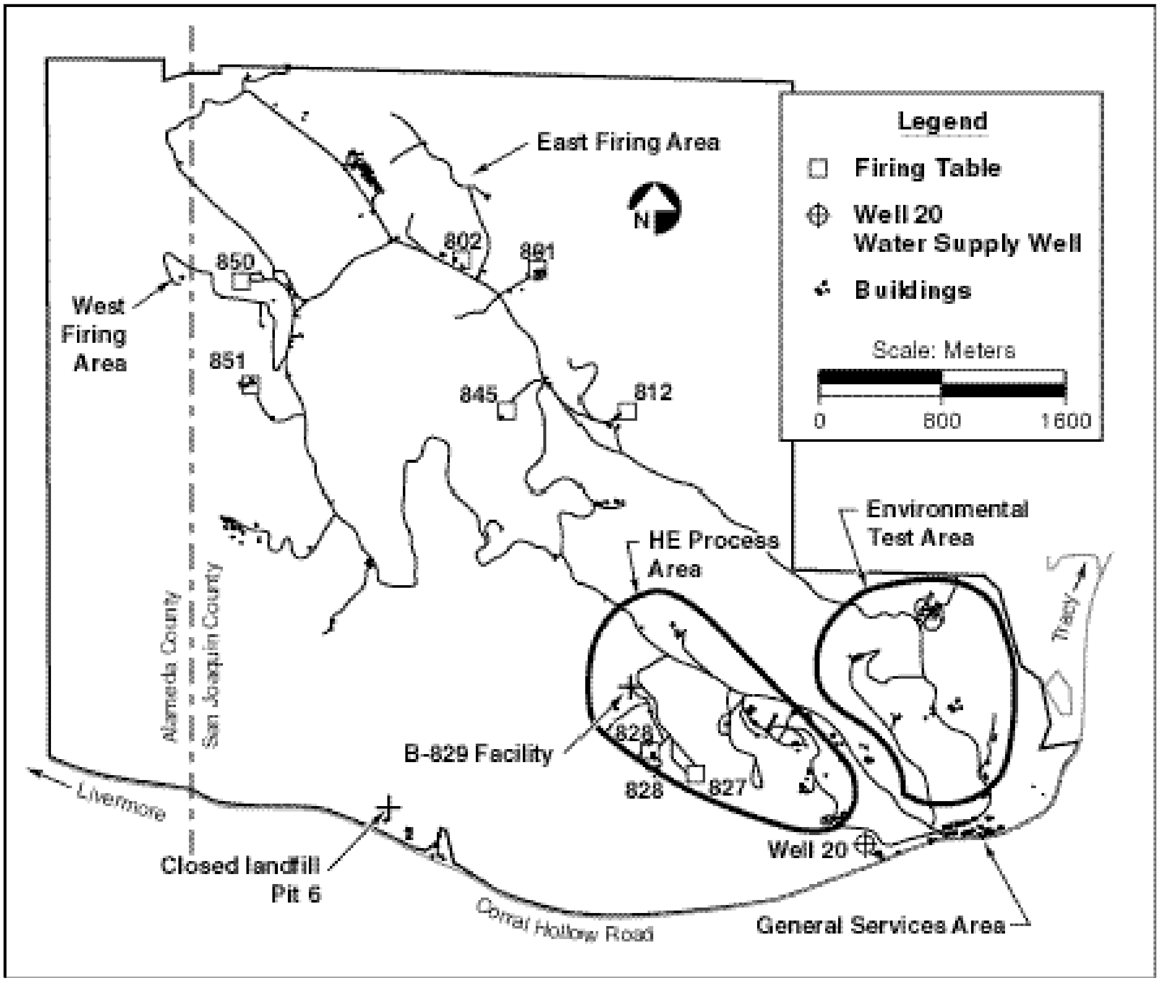


Figure 2. Location of the closed B-829 Facility at LLNL Site 300

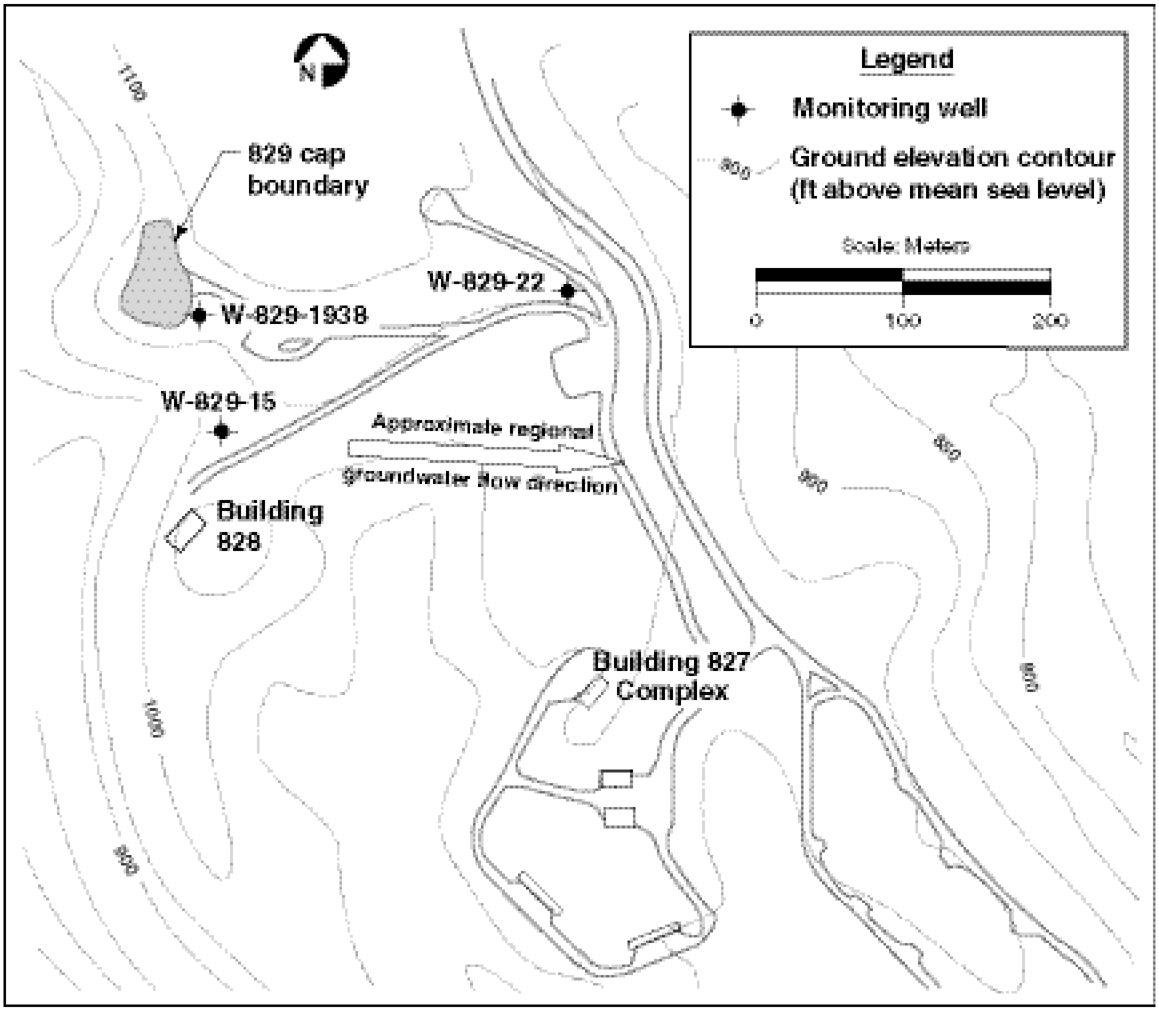


Figure 3. Location of the closed B-829 Facility and monitoring wells at LLNL Site 300

Location: ______________________ Inspector's name: ______________________________

Date: __________________________Inspector's signature: ___________________________

Time: _________________________

Condition of the facility	Condition as described?	If correction needed, describe condition and needed repairs.	Corrections completed?	Date completed
DESCRIPTION	**Y/N**	**INSPECTOR'S COMMENTS**	**Y/N**	**DATE**
1. Cap is in good condition.				
a. Settlement or gullying observed?				
b. Surface erosion visible?				
c. Fissures visible?				
d. Cracks visible?				
e. Low spots visible?				
f. Animal burrows visible?				
g. Bare spots observed?				
h. Subsidence observed?				
i. Vegetation beyond topsoil layer observed?				
2. Runoff is diverted away from HE Open Burn Treatment Facility.				
3. Erosion controls are present and in good condition (i.e, grading, vegetation, and clear diversion channels).				
4. Permanent, surveyed benchmarks are present and maintained.				
5. Groundwater monitoring network is in good working order.				
a. Well label is intact and legible.				
b. Surface seal is intact.				
c. No evidence of damage (i.e, settlement, pipe tilting, poor protective pipe condition, standing water around the pipe, etc.) is observed.				
6. Warning sign is in place.				
7. Emergency Coordinator's name and phone number posted.				
8. Communications are in good working order.				
9. Access available to emergency vehicles.				
10. Copy of Post-Closure Plan is on file at Site 300.				
11. Other observations attached.				

Figure 4. B-829 Facility post-closure inspection checklist

Well No.	Is Well No. clearly marked?	Is surface seal intact?	Is well capped & locked ?	Is there evidence of damage?	Is there settlement?	Is there standing water?	Is reference point marked?	Comments
829-15								
829-22								
New well								

Form date: 4/17/03, rev.0

Inspection date:____________________________

Inspector name: ____________________________**Signature:**____________________________

Figure 5. B-829 Facility monitoring well inspection checklist

Appendix A

Groundwater Elevation and COC Concentration Plots

Appendix A

Groundwater Elevation and COC Concentration Plots

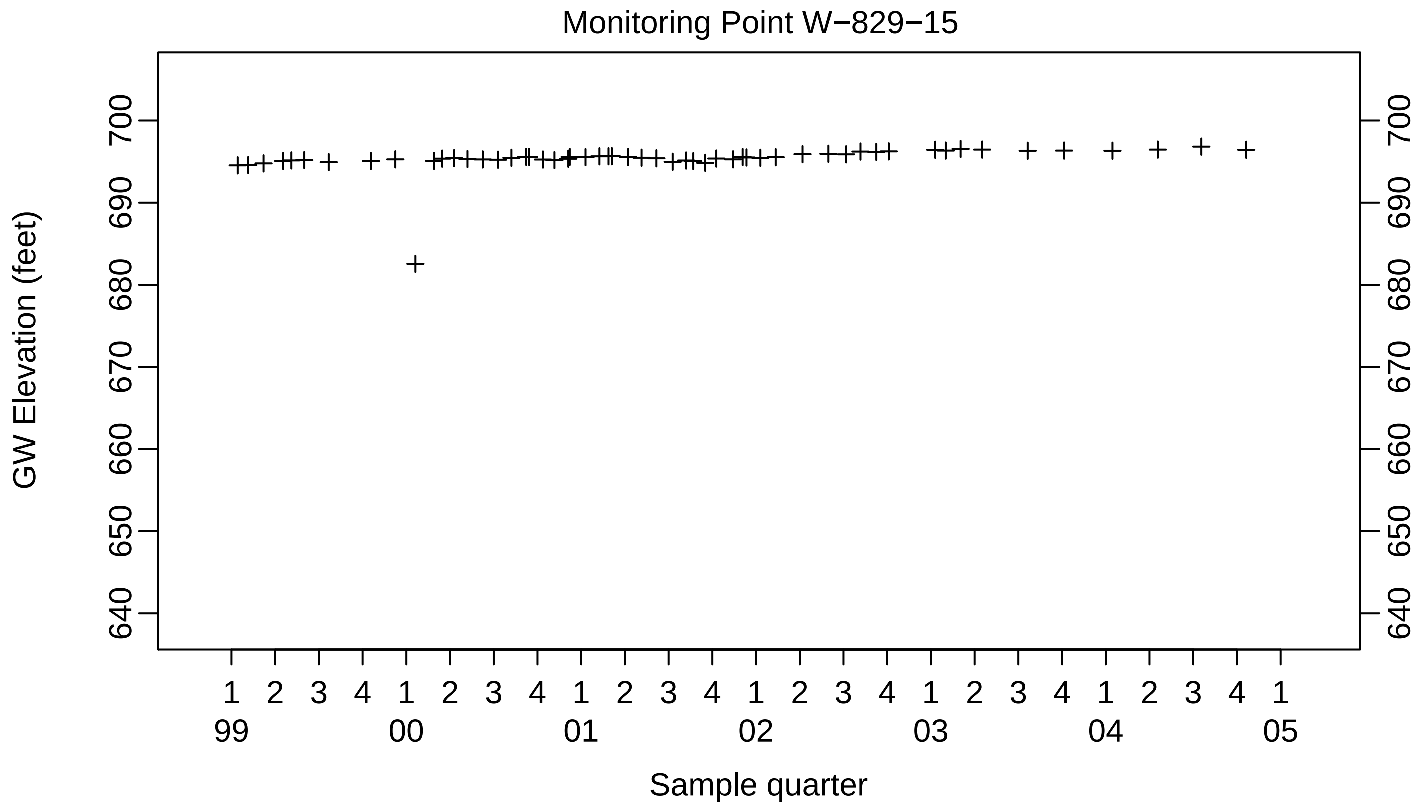
As required by the monitoring and reporting provisions of 22 CCR 66264.97(e), this appendix presents graphical depictions of groundwater elevations and concentration trends. Concentration-versus-time plots have been prepared for all confirmed constituent of concern (COC) detections above their respective analytical reporting limits (RLs), for the permit-specified wells. The graphs for the two established wells (W-829-15 and W-829-22) present data accumulated over the last six years, going back to 1999, showing post-closure trends since the first year of monitoring under the *B-829 Final Closure Plan* (Mathews and Taffet 1997). The graphs for well W-829-1938, first monitored in CY 2004, present the limited data (four quarters) available.

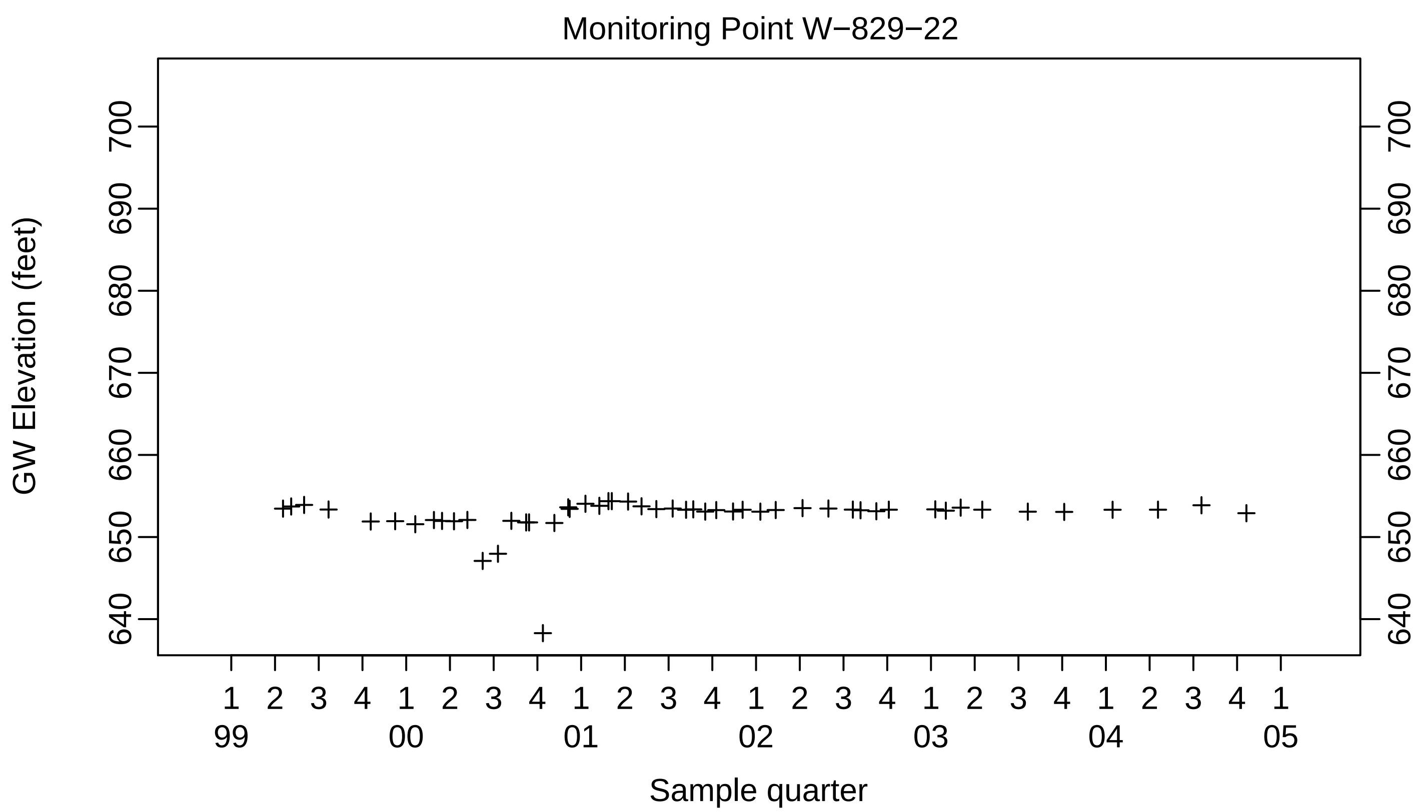
The sequence of graphs is by parameter (groundwater elevation, concentration, or activity) and by well. Graphs show the reported parameter on the y axis, with time on the x axis (time in years is divided into quarterly sample periods). The header and the vertical axis labels on each plot give the units of measurement. Statistical limits of concentration (SLs) are shown on the COC graphs as horizontal dotted lines. The numerical value of an SL is also given in the plot legend. Three different symbols are used to plot the COC data: a black diamond, an inverted white triangle, and a plus sign. Their different uses are explained below.

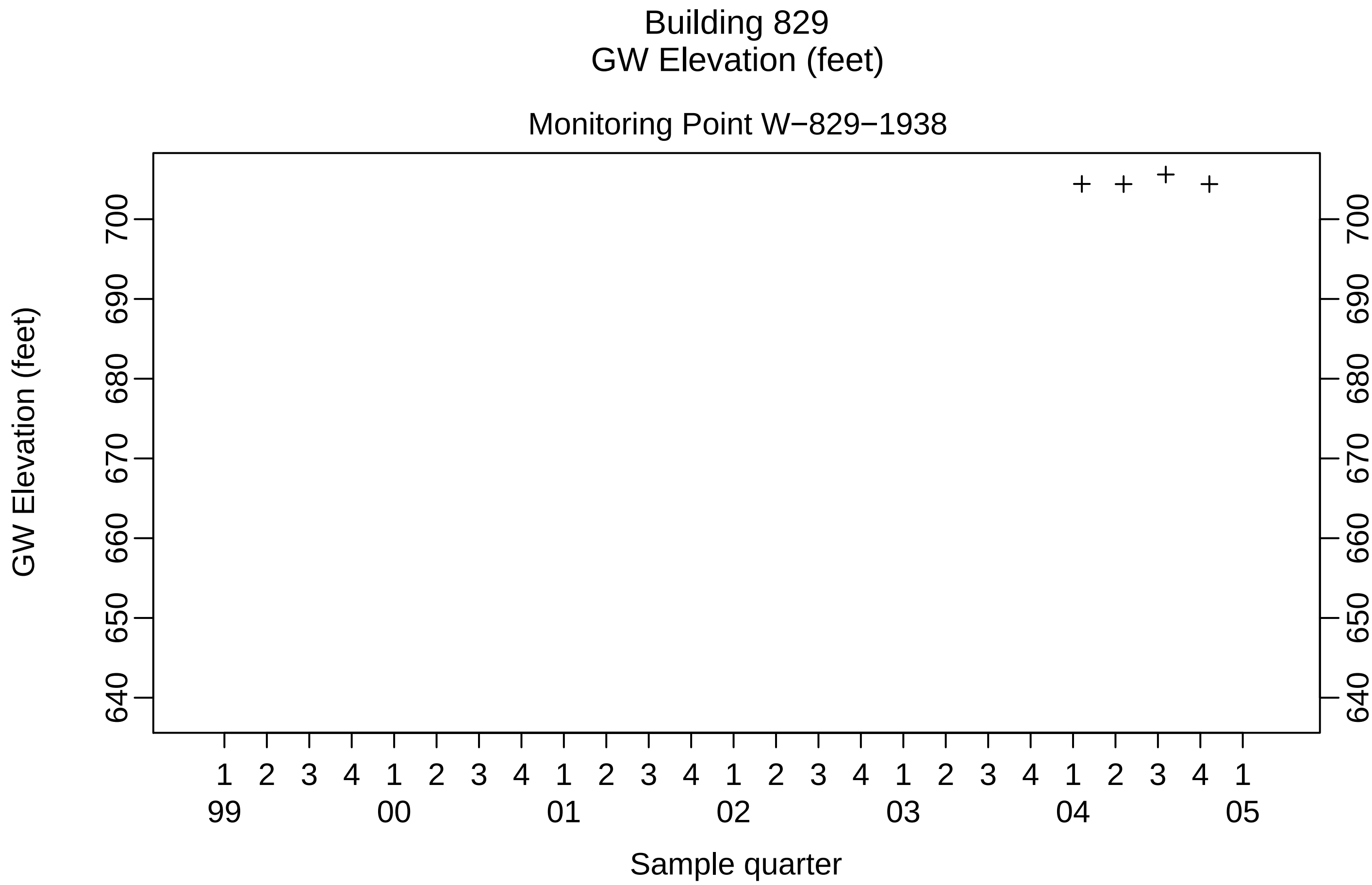
COC detections are plotted as black diamonds. Analytical laboratories report COC measurements above RLs as detections. (The RL for a COC is a contractual concentration value near zero.) COC concentrations below RLs are non-detections and are reported as "less than the RL." For non-radioactive COCs, non-detections are assigned RL values and appear as inverted white triangles in the data graphs.

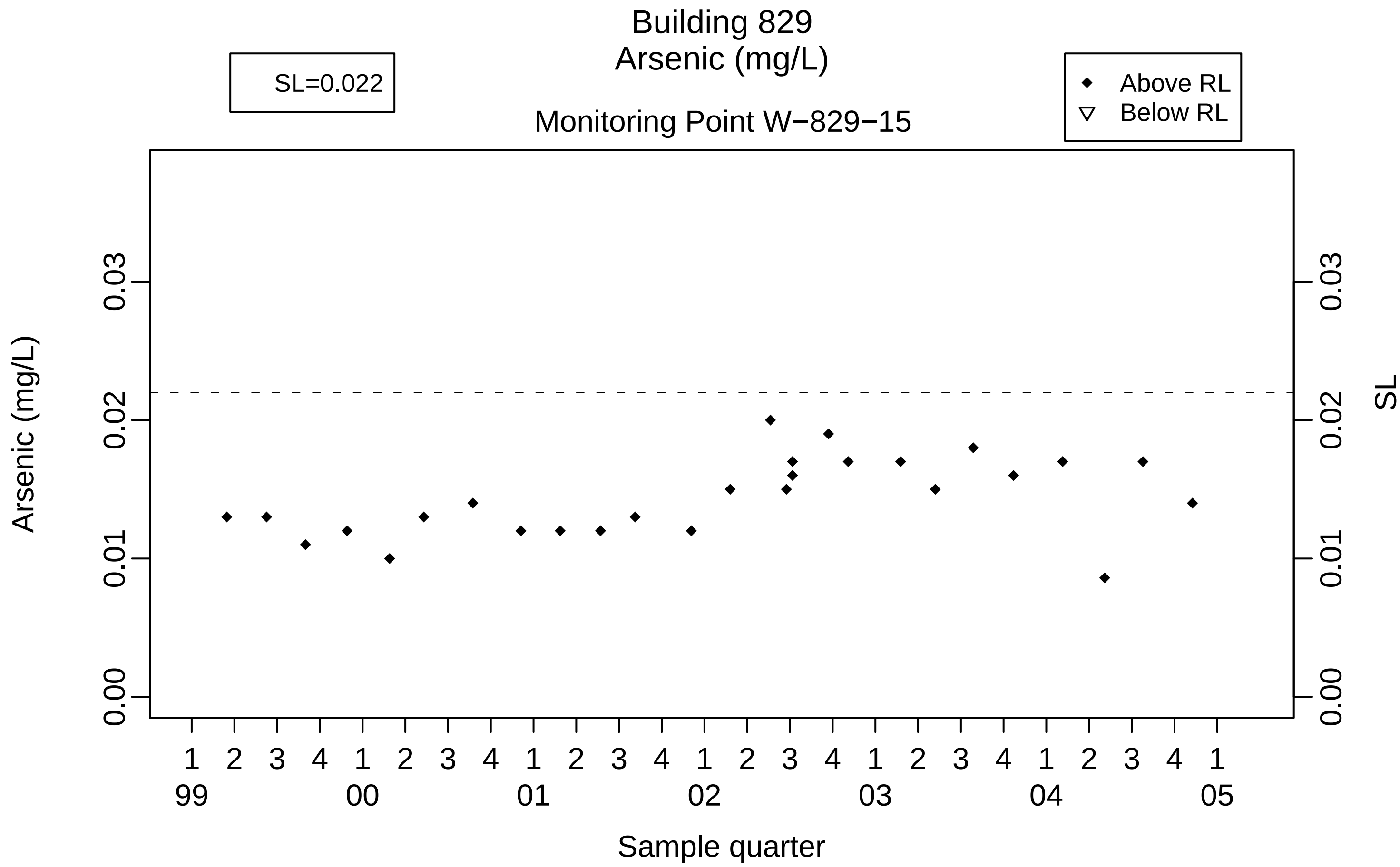
Non-detections of radioactive COCs, however, are treated differently. The reported value for radioactive COCs is the measured sample radioactivity minus the measured background radioactivity. When the result of this calculation is less than the RL, the value is plotted as a plus sign, indicating an estimated non-detection. (Note that the calculated value may be negative, or zero, if the measured sample radioactivity is less than, or equal to, the measured background activity.) When the reported activity is greater than the RL, the value is plotted as a black diamond, indicating a radioactive COC detection.

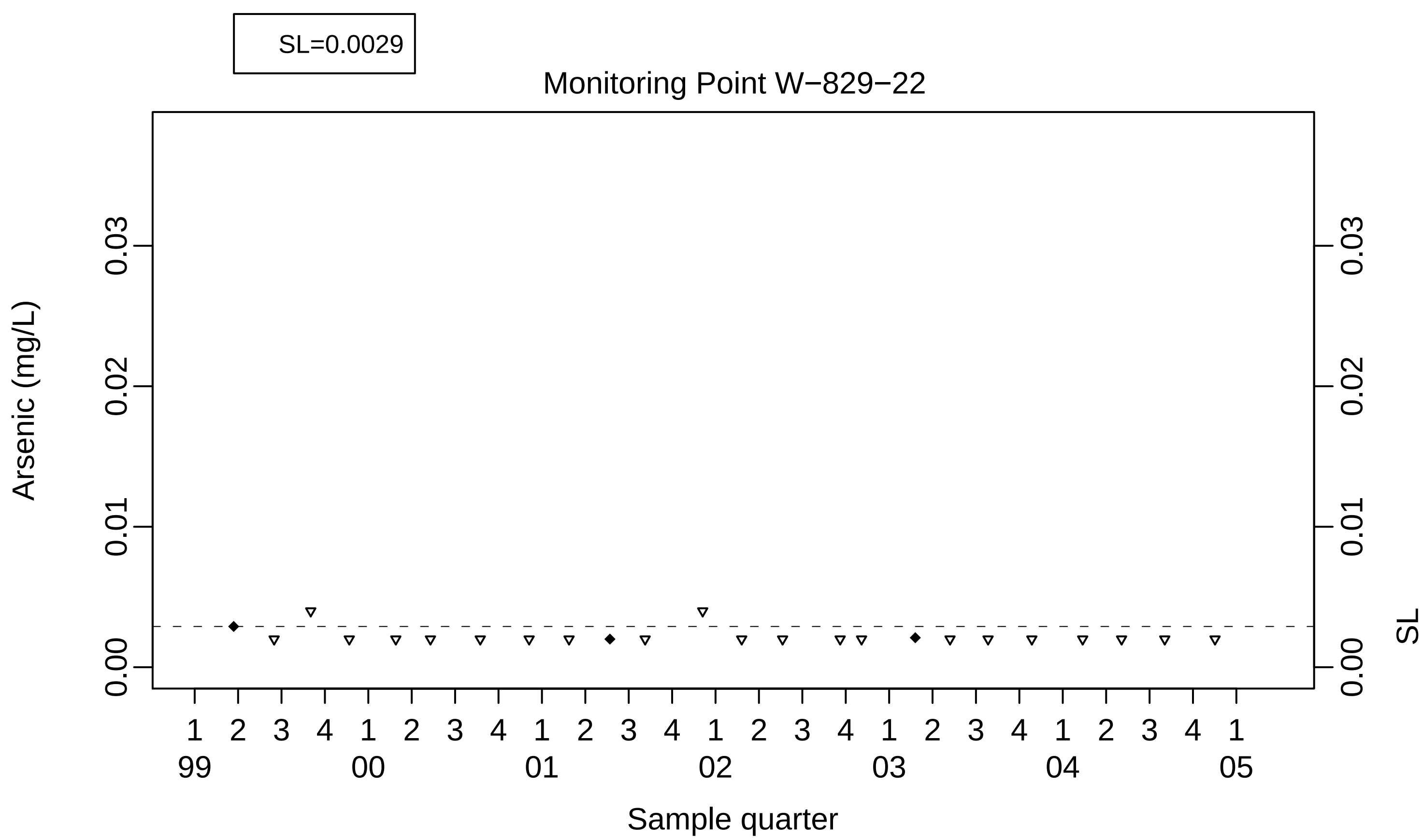
Building 829
GW Elevation (feet)

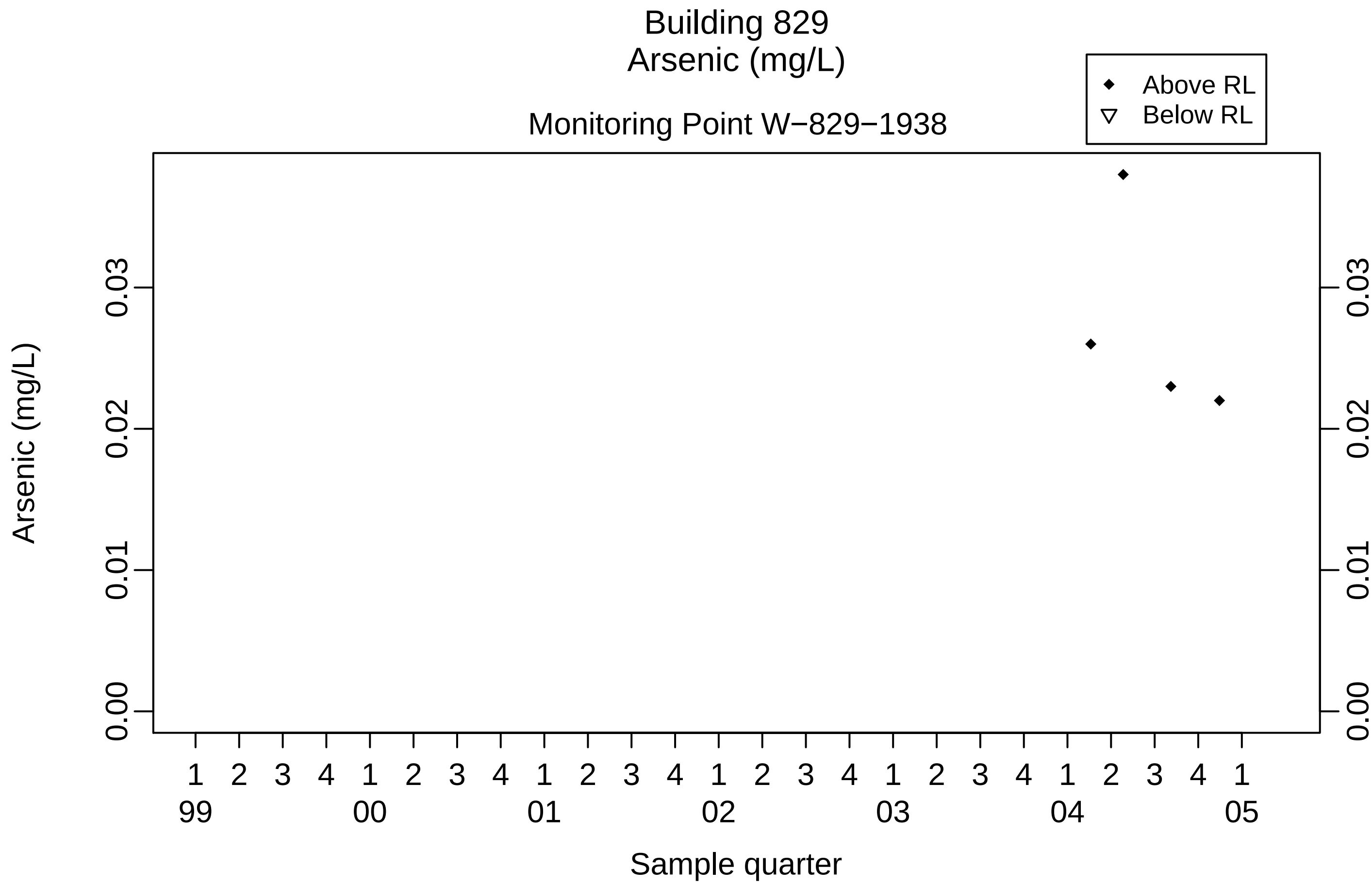


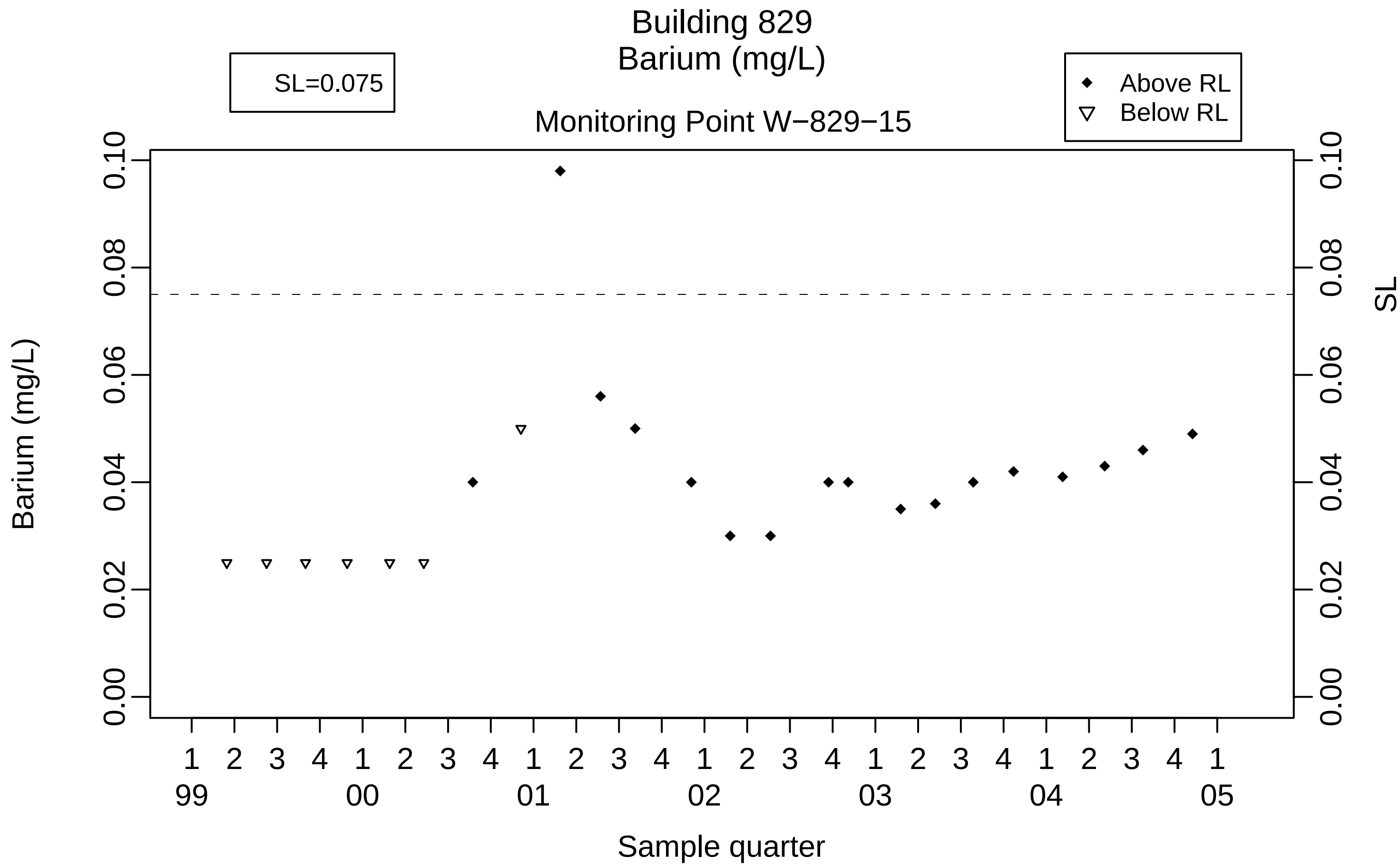


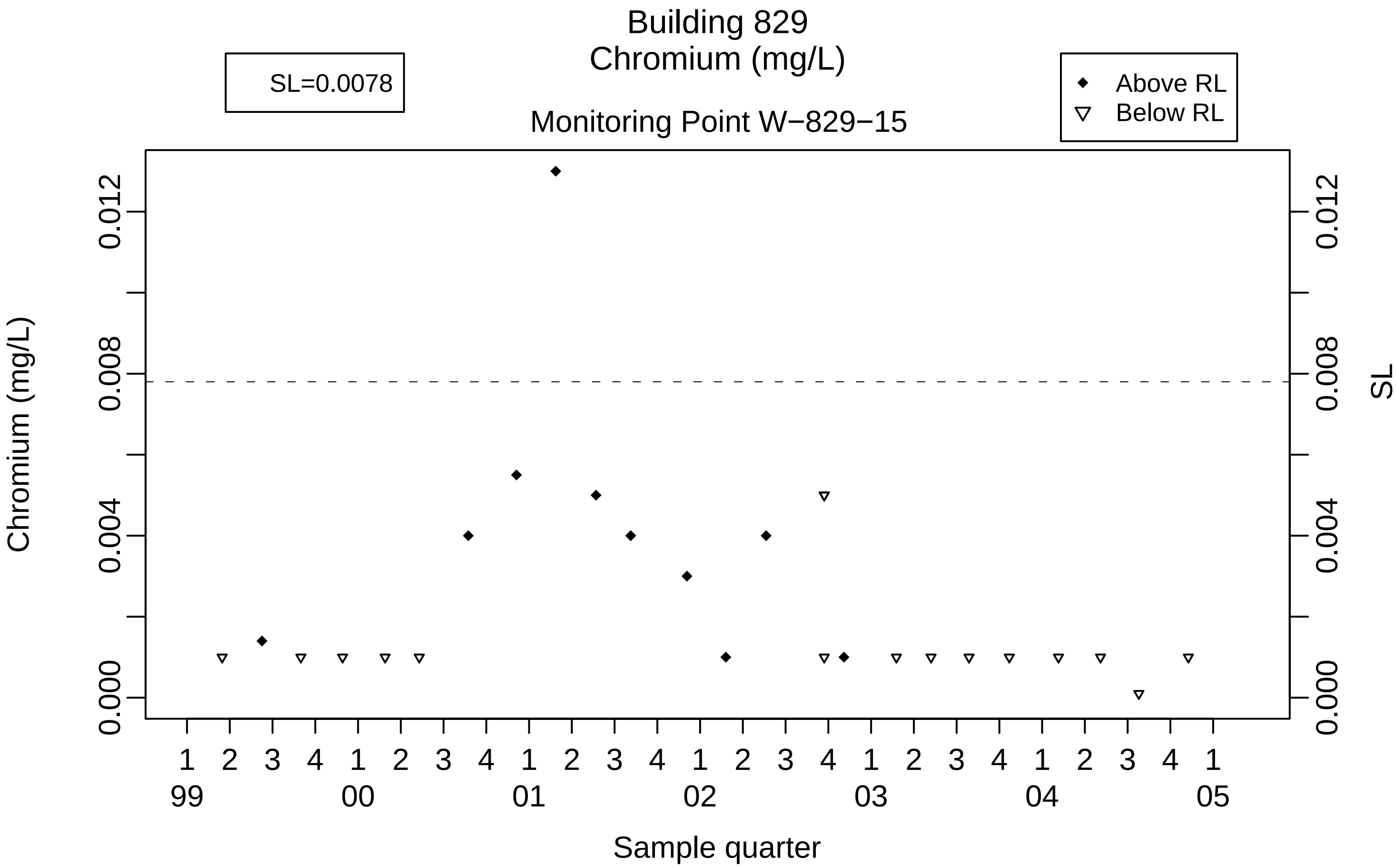

Building 829
GW Elevation (feet)
Monitoring Point W−829−1938
GW Elevation (feet)
640
650
660
670
680
690
700
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1
99 00 01 02 03 04 05
Sample quarter

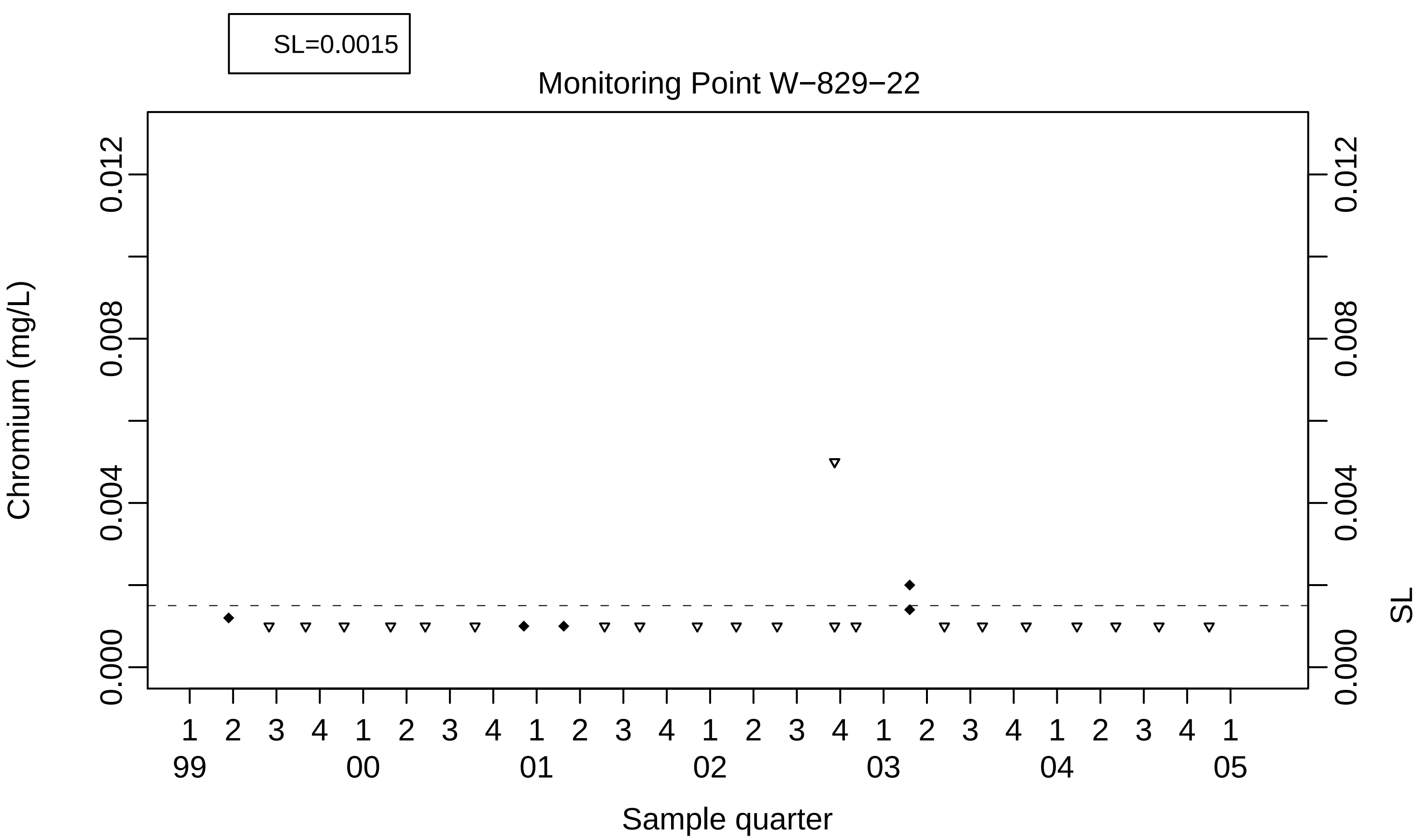

Building 829
Arsenic (mg/L)
SL=0.022
Above RL
Below RL
Monitoring Point W−829−15
Arsenic (mg/L)
0.00
0.01
0.02
0.03
SL
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1
99 00 01 02 03 04 05
Sample quarter

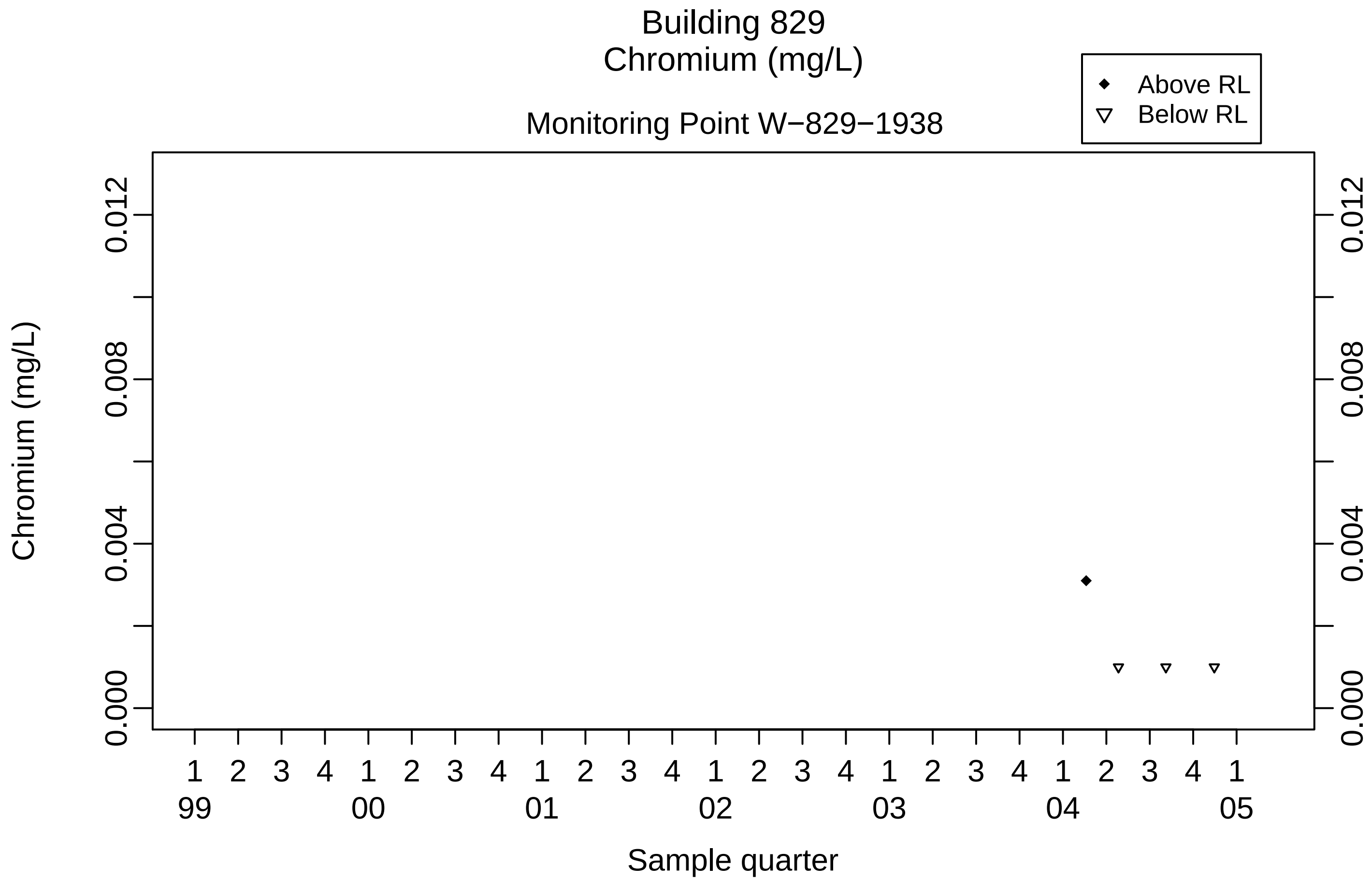

SL=0.0029
Monitoring Point W−829−22
Arsenic (mg/L)
0.00
0.01
0.02
0.03
SL
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1
99 00 01 02 03 04 05
Sample quarter

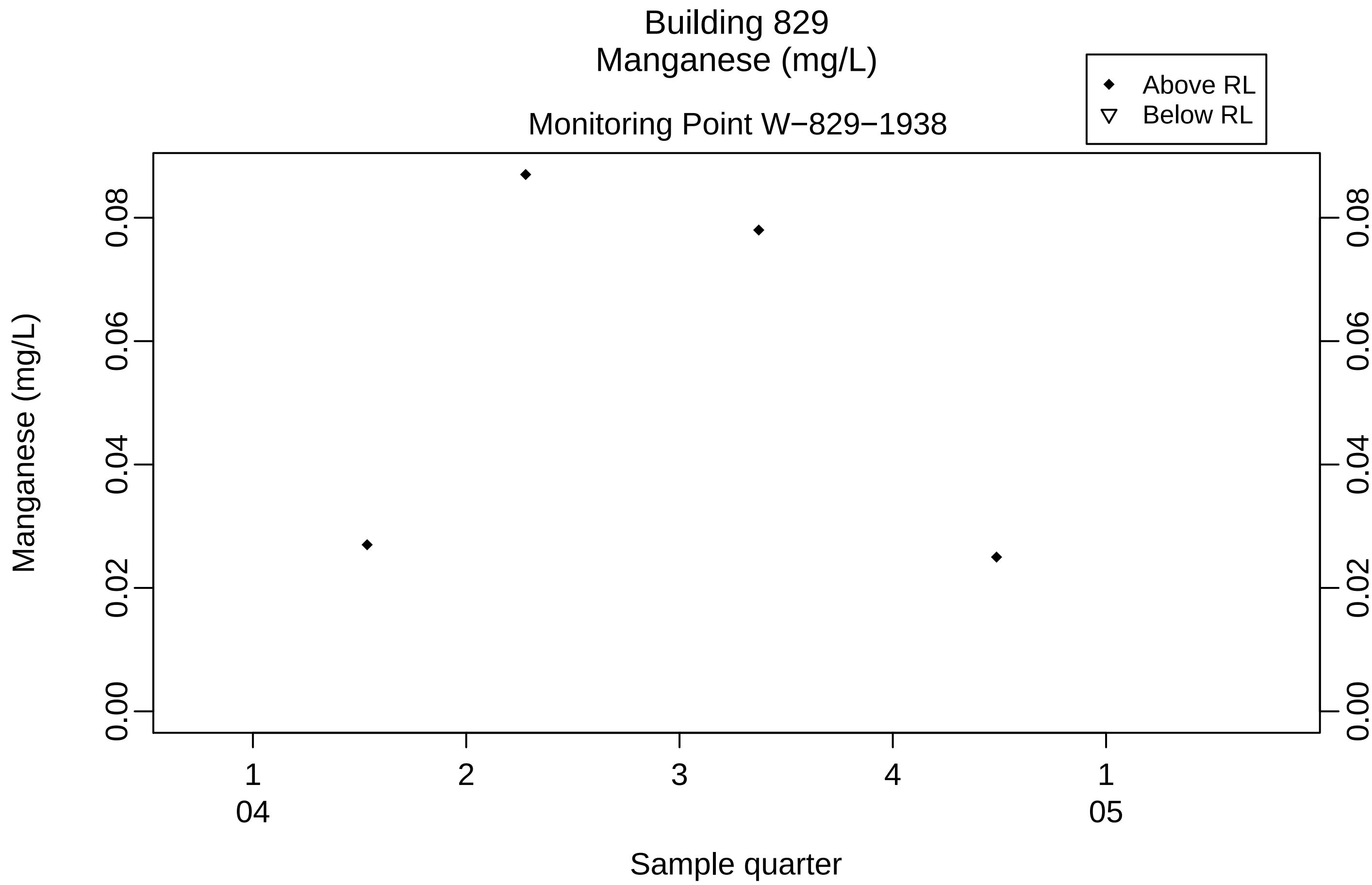

Building 829
Arsenic (mg/L)
Monitoring Point W−829−1938
Above RL
Below RL
Arsenic (mg/L)
0.00
0.01
0.02
0.03
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1
99 00 01 02 03 04 05
Sample quarter


Building 829
Barium (mg/L)
SL=0.075
Above RL
Below RL
Monitoring Point W−829−15
Barium (mg/L)
0.00
0.02
0.04
0.06
0.08
0.10
SL
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1
99 00 01 02 03 04 05
Sample quarter

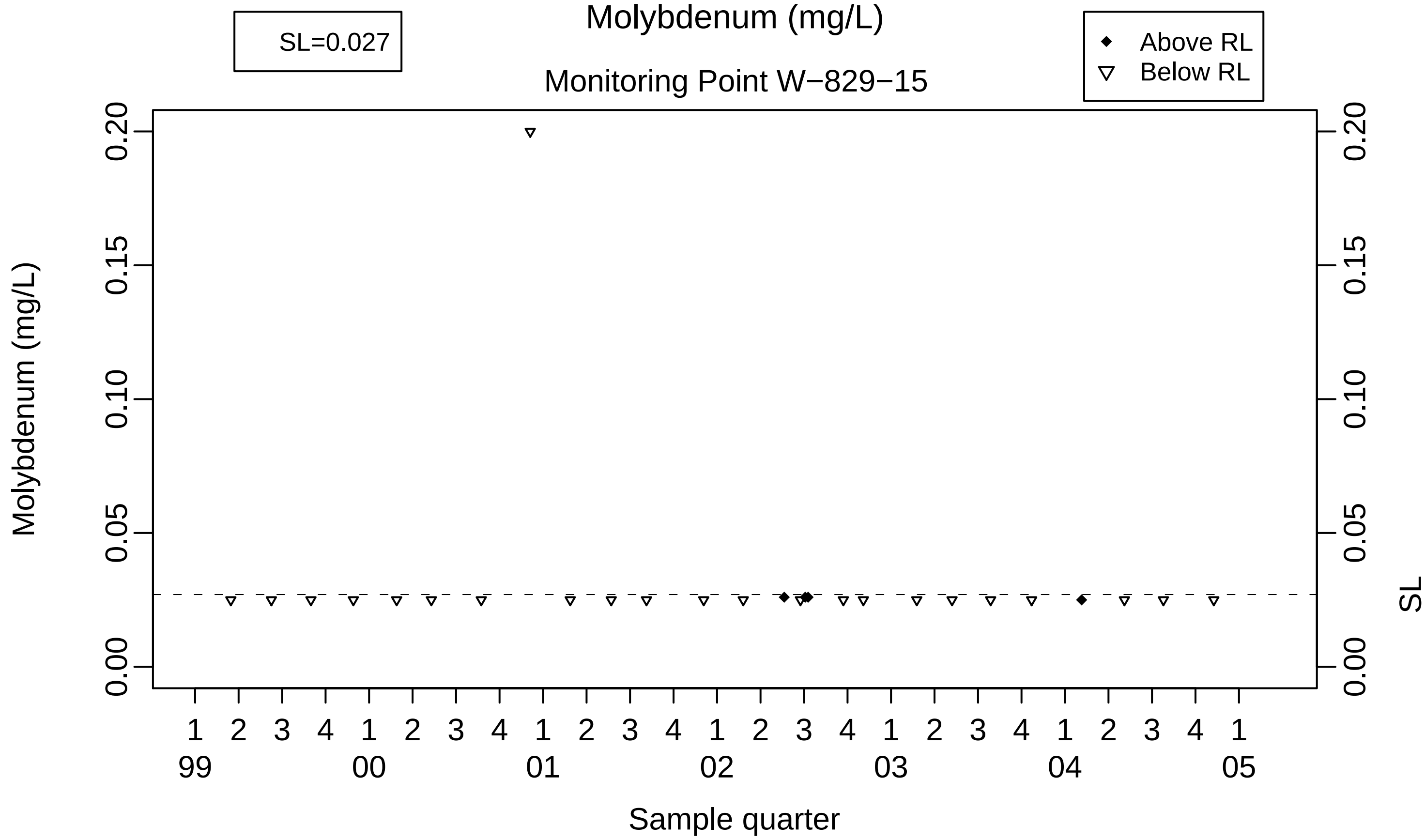

Building 829
Chromium (mg/L)
SL=0.0078
Above RL
Below RL
Monitoring Point W−829−15
Chromium (mg/L)
0.000
0.004
0.008
0.012
SL
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1
99 00 01 02 03 04 05
Sample quarter

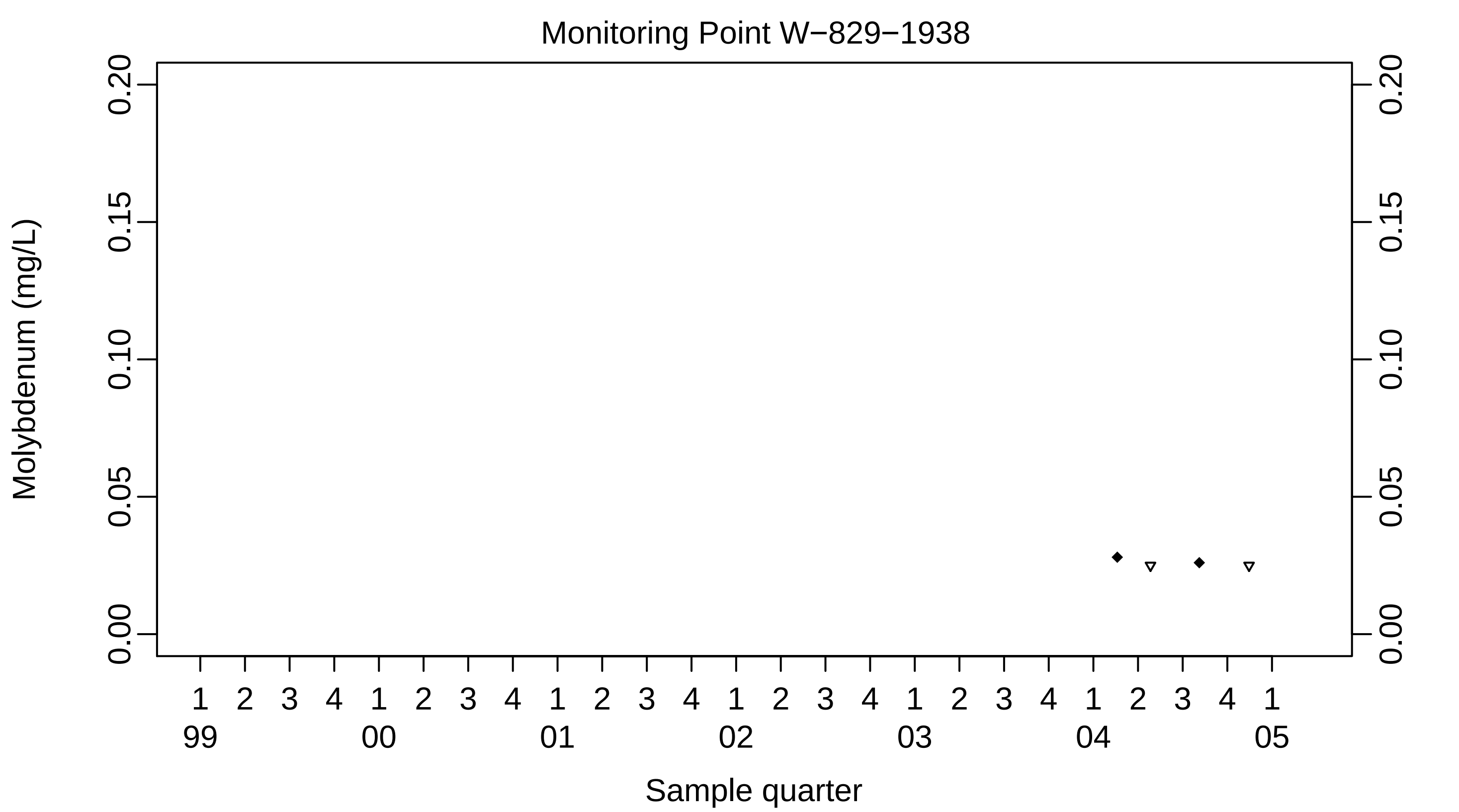

SL=0.0015
Monitoring Point W−829−22
Chromium (mg/L)
0.000
0.004
0.008
0.012
SL
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1
99 00 01 02 03 04 05
Sample quarter

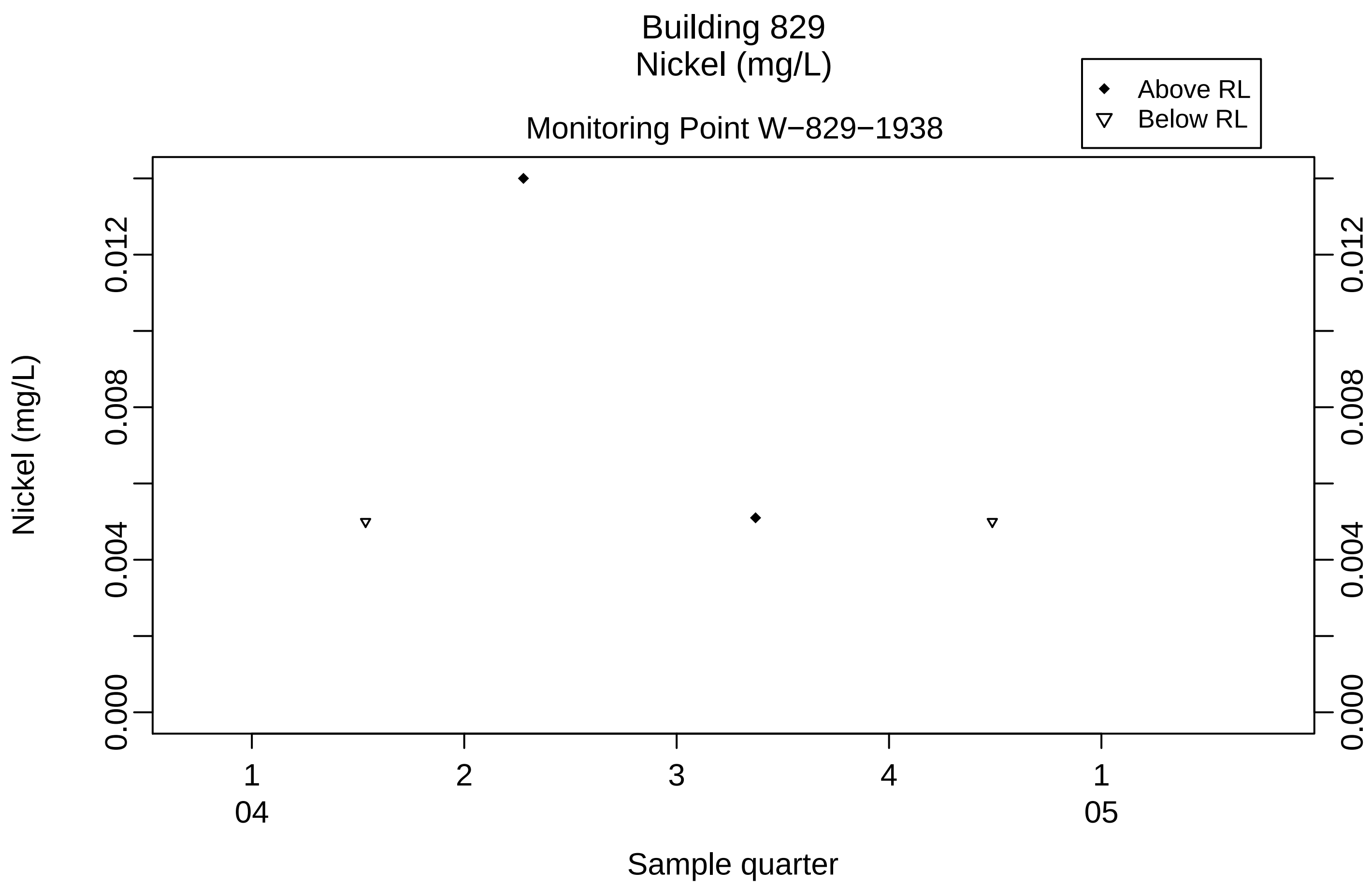

Building 829
Chromium (mg/L)
Monitoring Point W−829−1938
Above RL
Below RL
Chromium (mg/L)
0.000
0.004
0.008
0.012
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1
99 00 01 02 03 04 05
Sample quarter

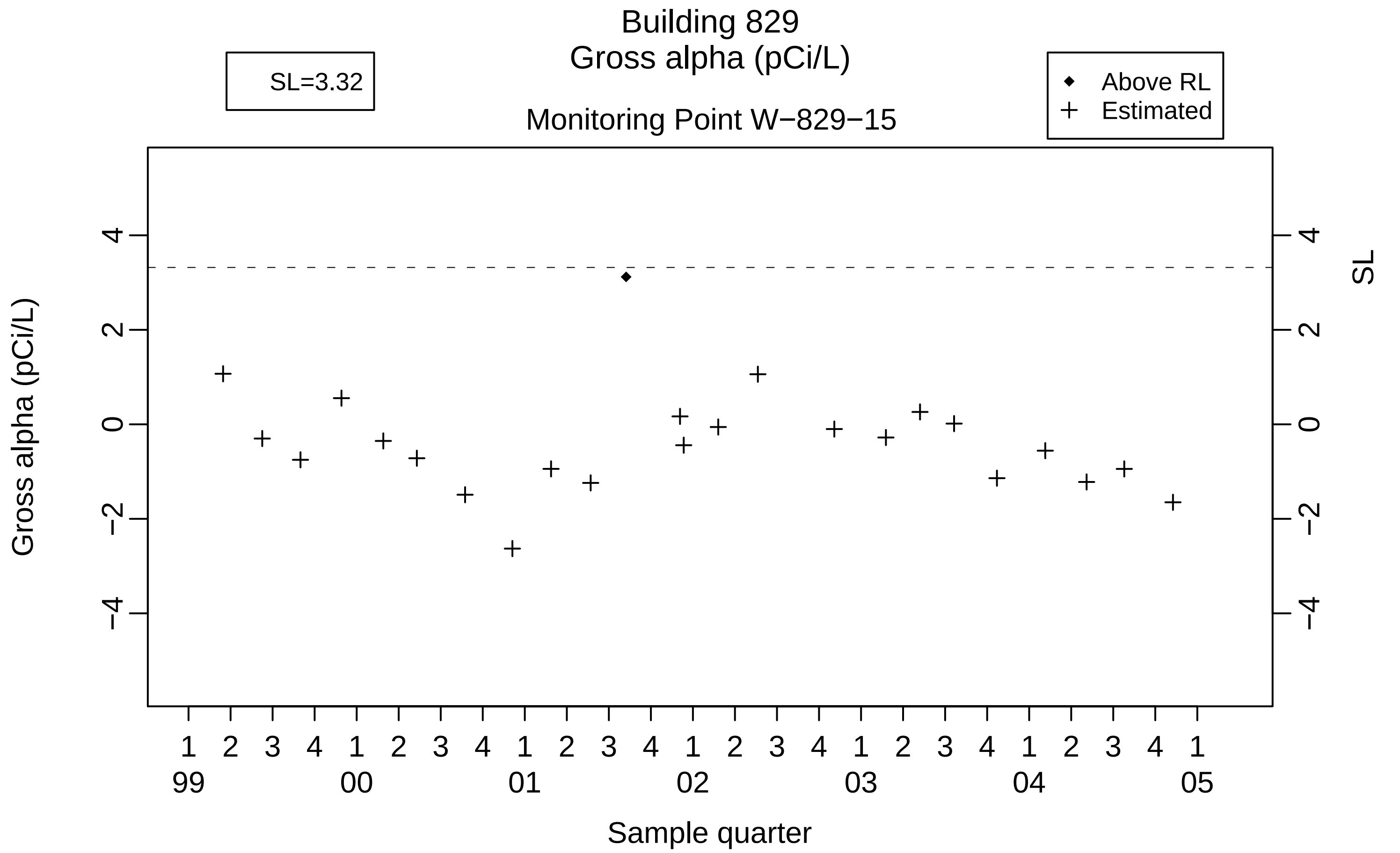

Building 829
Manganese (mg/L)
Monitoring Point W−829−1938
Above RL
Below RL
Manganese (mg/L)
0.00
0.02
0.04
0.06
0.08
1
04
2
3
4
1
05
Sample quarter

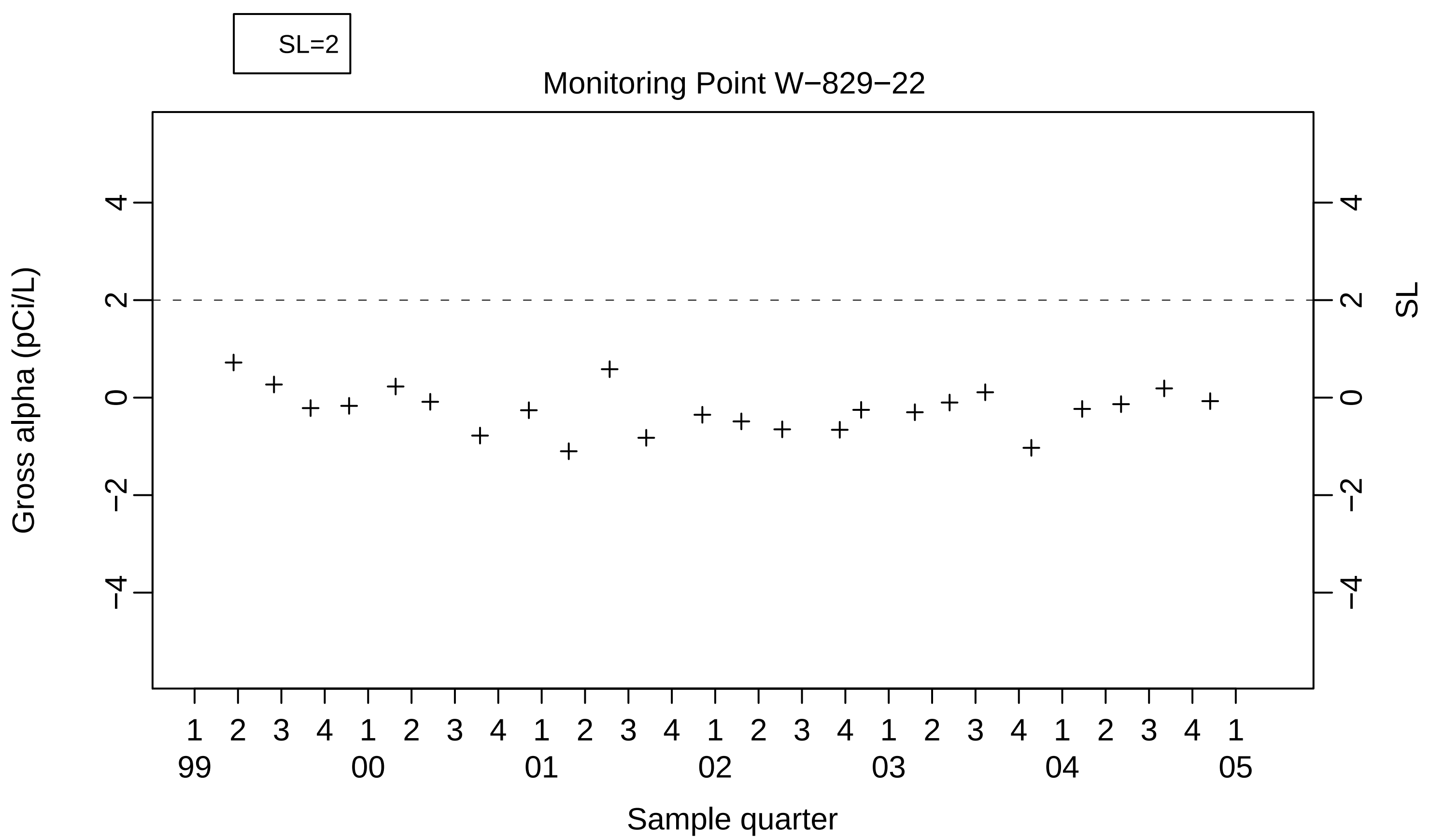
Building 829
Molybdenum (mg/L)






Building 829
Nickel (mg/L)
Monitoring Point W−829−1938
Above RL
Below RL
Nickel (mg/L)
0.000
0.004
0.008
0.012
1
2
3
4
1
04
05
Sample quarter


Building 829
Gross alpha (pCi/L)
SL=3.32
Above RL
Estimated
Monitoring Point W−829−15
Gross alpha (pCi/L)
SL
4
2
0
−2
−4
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1
99 00 01 02 03 04 05
Sample quarter


SL=2
Monitoring Point W−829−22
Gross alpha (pCi/L)
SL
4
2
0
−2
−4
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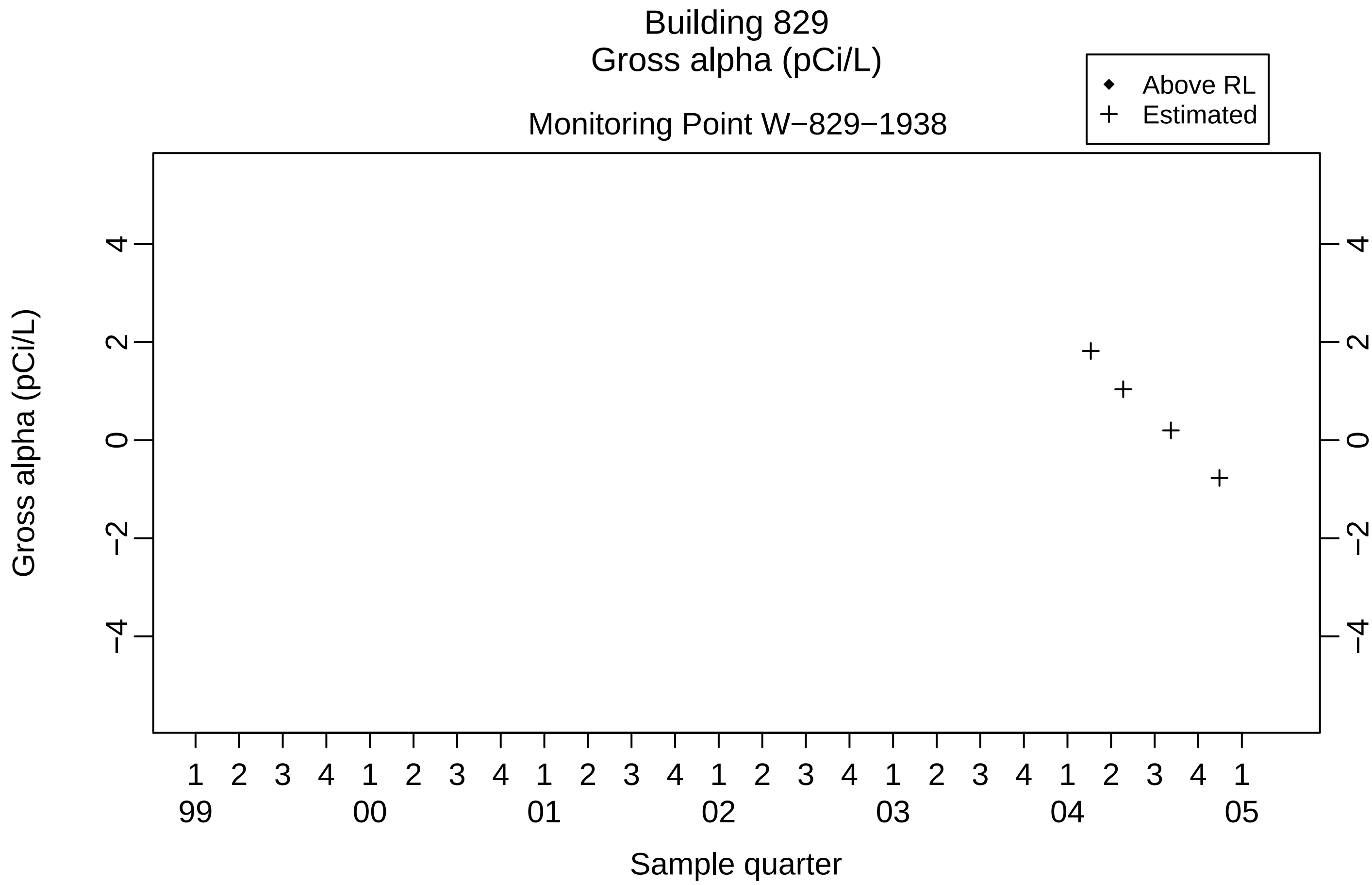
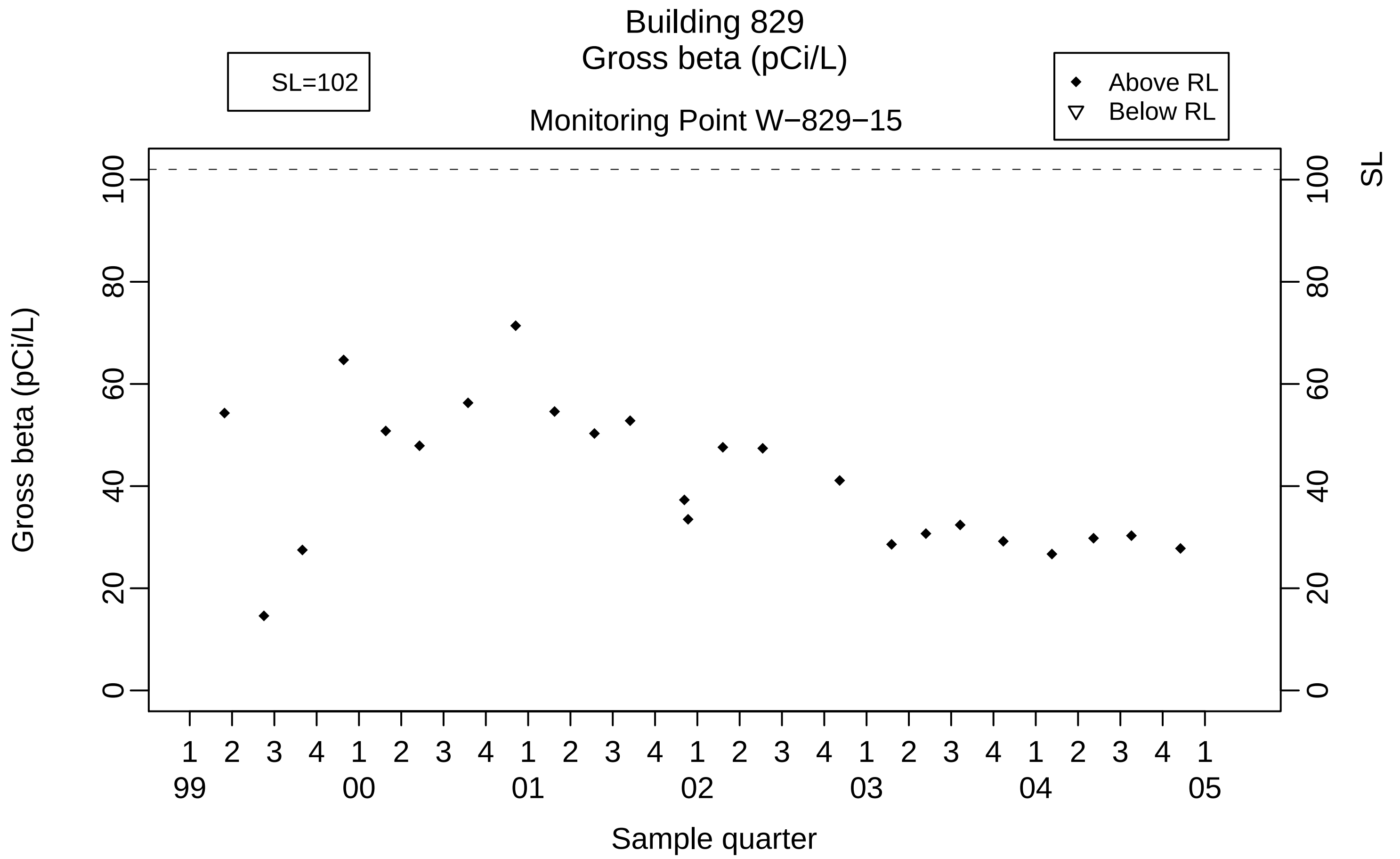
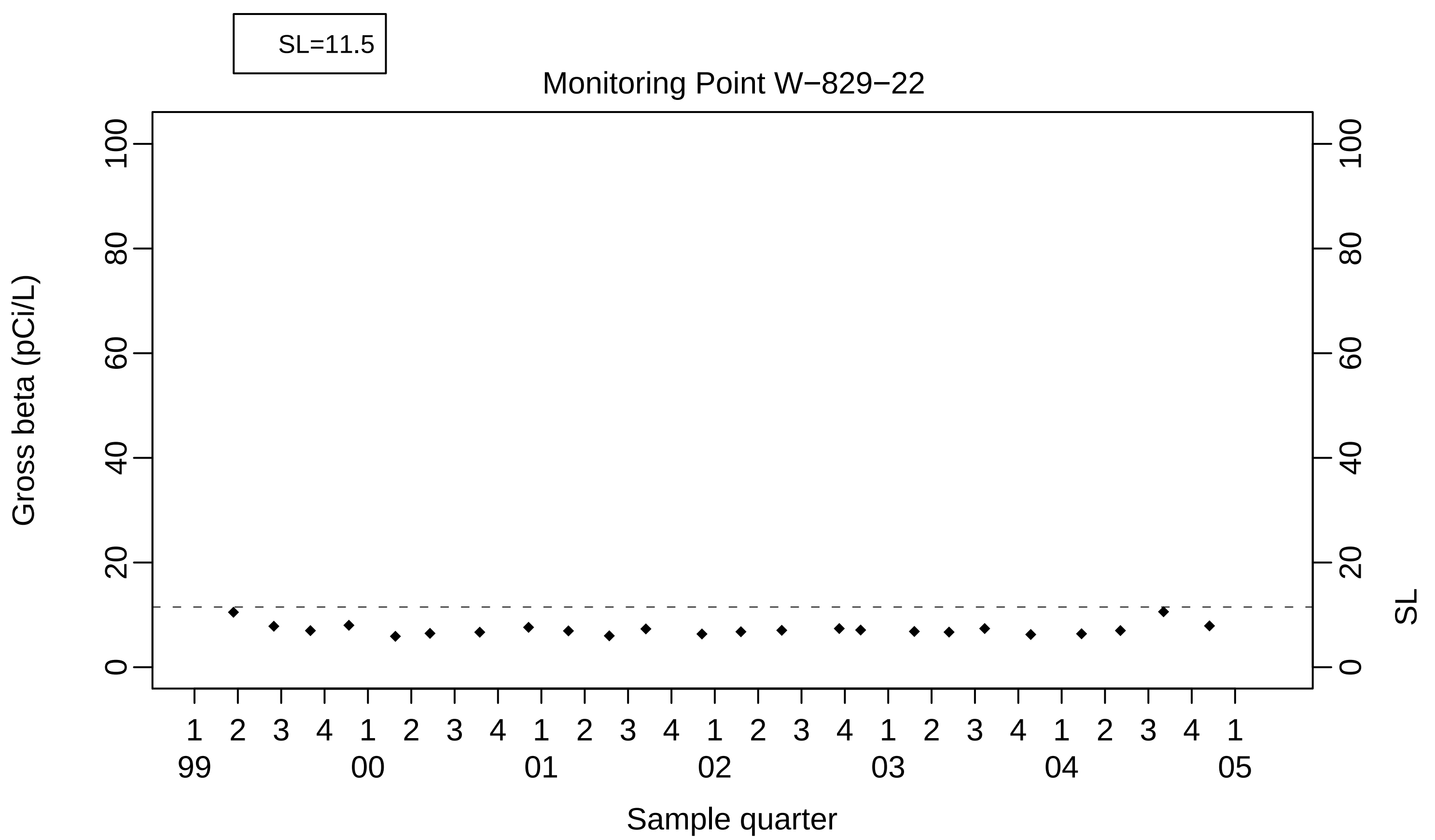
99 00 01 02 03 04 05
Sample quarter


Building 829
Gross alpha (pCi/L)
Monitoring Point W−829−1938
Above RL
Estimated
Gross alpha (pCi/L)
4
2
0
−2
−4
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1
99 00 01 02 03 04 05
Sample quarter


Building 829
Gross beta (pCi/L)
SL=102
Above RL
Below RL
Monitoring Point W−829−15
Gross beta (pCi/L)
0
20
40
60
80
100
SL
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1
99 00 01 02 03 04 05
Sample quarter


SL=11.5
Monitoring Point W−829−22
Gross beta (pCi/L)
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60
80
100
SL
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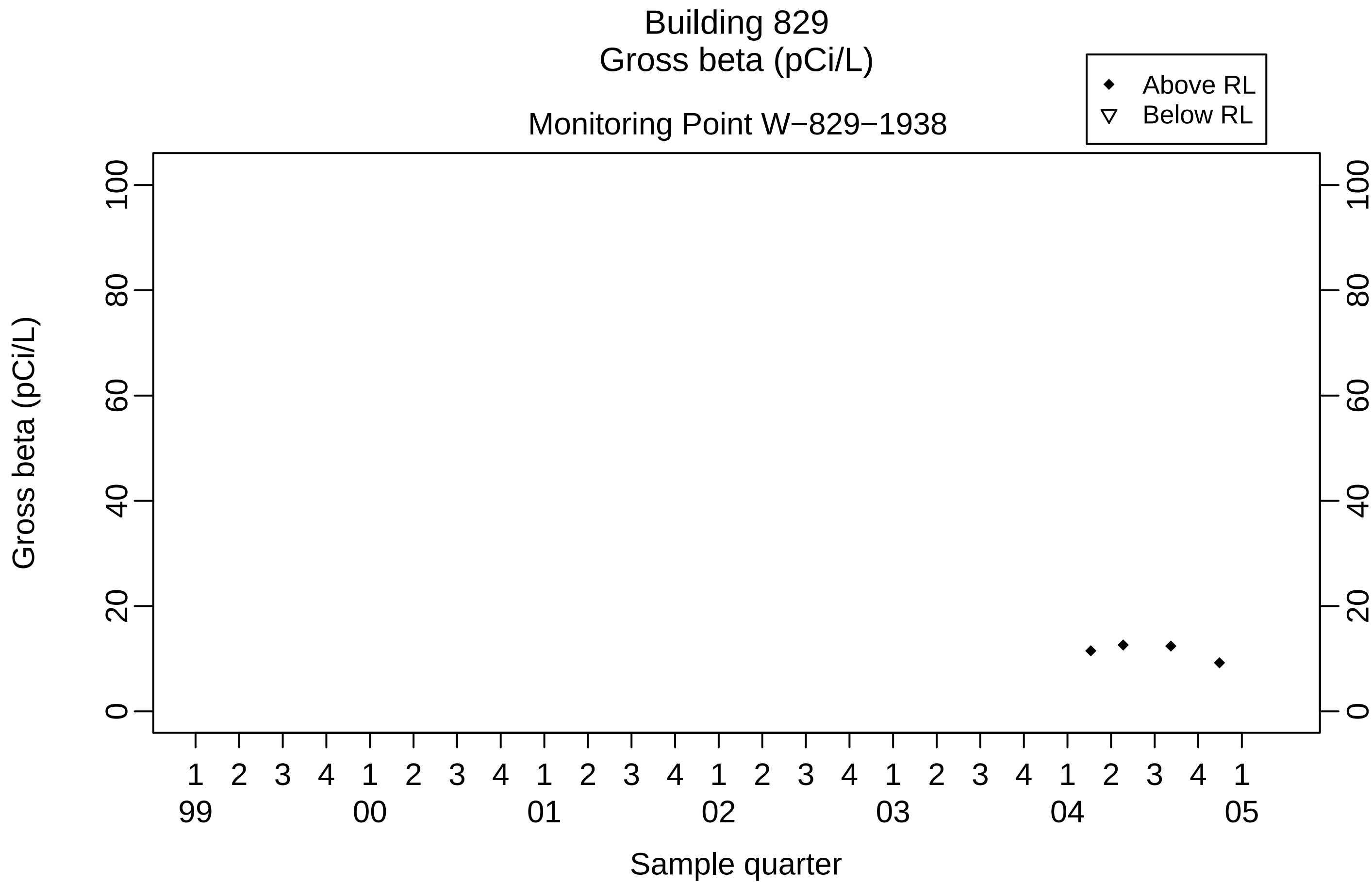
99 00 01 02 03 04 05
Sample quarter


Building 829
Gross beta (pCi/L)
Monitoring Point W−829−1938
Above RL
Below RL
Gross beta (pCi/L)
0
20
40
60
80
100
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1
99 00 01 02 03 04 05
Sample quarter

Appendix B

Annual Engineering Inspection of Site 300, 829 Cap

ANNUAL ENGINEERING INSPECTION

of

SITE 300 829 CAP

Prepared for:

LAWRENCE LIVERMORE NATIONAL LABORATORY
University of California
Livermore, CA 94551

REGISTERED PROFESSIONAL ENGINEER
REUBEN H. CHOW
No: M22778
EXPIRES 9-30-06
MECHANICAL
STATE OF CALIFORNIA

9/15/2004

Prepared By:

CHOW ENGINEERING, INC.
7770 Pardee Lane, Suite 100
Oakland, CA 94621

September 15, 2004

CHOW ENGINEERING, INC.
7770 Pardee Lane, Suite 100, Oakland, CA 94621
Tel: (510) 636-8500 FAX (510) 636-8544

September 15, 2004

Ms. Dawn Chase
Lawrence Livermore National Laboratory
7000 East Avenue
PO Box 808, L-871
Livermore, CA 94551

Subject: Year 2004 Annual Engineering Inspection of the Landfill for Cap 829, Site 300

Dear Ms. Chase:

Chow Engineering, Inc. is pleased to submit this report on the Engineering Inspection of the 829 Landfill Cap, at the Lawrence Livermore National Laboratory (LLNL) location at Site 300. This site inspection was performed on August 3, 2004. This report was prepared based on the inspection and is the final activity in the present scope of work.

Please call me at (510) 636-8500 with any questions, or to let me know how else I can be of service. Thank you.

Sincerely,

Reuben H. Chow, P.E.
Principal

Enclosure

TABLE CONTENTS

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Figures

Executive Summary

Chow Engineering, Inc. (CE) has completed an inspection of the Building 829 Complex High-Explosives (HE) Open Burn Treatment Facility closure cap (829 cap) at Lawrence Livermore National Laboratory (LLNL) Site 300. This work was performed for Lawrence Livermore National Laboratory in accordance with the regulations specified in Title 22, Section 66264.300 of the California Code of Regulations (CCR), as required in Sections 66264.228 and 66264.310, for landfill caps. The inspection was supervised by a Professional Engineer registered in the State of California. The inspection included a review of existing documentation on the cap, and an on-site inspection of the 829 cap. This report documents the inspection procedures and findings, and includes comments and recommendations on the status and maintenance of the cap and associated closure facilities.

The 829 cap was inspected on August 3, 2004, by a California Registered Professional Engineer. The cap on the HE Open Burn Treatment Facility had been fully burned during an accidental fire at the site in the summer of 2000. Vegetation has grown to an average of 6 inches since the fire. The drainage system associated with the cap is in good condition and appears to be functioning properly. The groundwater monitoring wells associated with the cap generally appear to be in good condition. This year's land survey of the cap to monitor for settlement had not occurred prior to this inspection report. Excessive settlement just beyond the concrete swale resulting in damage to the drainage facilities was observed in the southeast pit drainage area.

1.0 Introduction

LLNL Site 300 is in the Altamont Hills, approximately 15 miles east of Livermore, California, and 8.5 miles southwest of Tracy (Figure 1). Site 300 is approximately 11 square miles and is bordered by Corral Hollow Road to the south. Approximately one sixth of the site is in Alameda County while the remainder is in San Joaquin County. The 829 complex is in Sections 16 and 17, Township 3 South, Range 4 East, Mount Diablo Base and Meridian in the southeastern corner of Site 300 (Figure 2). The 829 cap is in San Joaquin County. Site 300 is currently operated by the University of California as an active high explosives and materials testing site of the U.S. Department of Energy.

The HE Open Burn Treatment Facility has been closed, having been capped, graded, and revegetated under a California Department of Toxic Substance Control (DTSC) approved Resource Conservation and Recovery Act (RCRA) closure plan. The facility previously included three unlined pits and an open air burn unit that were used to thermally treat high-explosives waste (Figure 3). LLNL discontinued use of the HE Open Burn Treatment Facility in 1997. The facility was closed in place per the closure plan. The cap consists of four engineered layers which included a 2-foot soil and vegetative cover, a geocomposite drainage layer, a combined HDPE and geosynthetic clay liner, and a 2-ft-thick compacted foundation layer consisting of fine-grain silty sand with slightly varying silt, clay, and gravel content. Infiltration pipes were installed to intercept water and divert it to concrete drainage channels that direct surface flow around the cap and into drainage channels.

2.0 Inspection Comments and Recommendations

During the current inspection performed on August 3, 2004, all applicable items listed in 22 CCR 66264.228 (k) were addressed. In performing the inspection, the independent engineer walked the perimeter and the majority of the surface of the cap. The resulting comments and recommendations are discussed in the following text. The inspection checklists, documenting the items inspected in the field, are included in **Section 3.0** of this report.

2.1 829 Cap

In general, the 829 Cap appears to be in good condition. The cap is fully intact and the drainage system appears to be operating adequately. During the 2002 and 2003 inspections and also during the current inspection, stress cracks along the south end of the pit were observed. The following recommendations should be implemented to ensure effective function of the cap.

Drainage Facilities: Some dried vegetation (e.g., tumbleweeds) has accumulated on the east side in the concrete channel and should be removed. The drainage facilities appear to be in fair condition, except for an emerging problem area. Several cracks more than 10 feet long were observed in the soil beyond the concrete channel and at the edge of the bluff (see Photo 1). These cracks were on the order of magnitude of 2 inches wide and more than 10 inches deep. The settlement here is uneven and greater than in 2003. The concrete channel adjacent to the soil area with the cracks and increased settlement has developed some cracks several feet long in random directions. The concrete channel is also developing cracks at the joints, with the vertical shift of the adjacent sections approximately 1 inch (see Photo 2). The integrity of the cap has not been compromised at this time by this settlement. Compaction of the soils in this area and monitoring of the concrete drainage channel cracks are recommended.

Vegetative cover/condition of the vegetation: The aboveground portion of the vegetative cover was burned during an accidental fire at the site in the summer 2000. The vegetative cover has been restored and is in fairly good condition over the cap.

Settlement: During this current inspection, a depression was observed along the slope of the cap on the northeast side. In the 2003 inspection, this depression was noted under the heading for erosion. During this current inspection the affected area was approximately 5 feet in diameter and approximately one foot at the deepest point. This depression should be filled in and compacted.

Erosion: During the current inspection, erosion of the cap was not observed. Erosion grooves were observed in an area at the northwest foundation of the cap. The grooves were up to 8 to 10 feet wide and 24 inches deep and continued 60 feet down the steep slope of the hillside. Per LLNL observations during a rain event earlier in 2004, runoff was not preferentially running down these grooves. Uneven settlement may be a contributing factor in the grooves.

Cracking: Cracking was observed during the 1999 inspection over several portions of the western and northern sections of the cap. During the 2000 inspection, the placement of new top soil had reduced the surficial cracking observed. During the 2002 inspection, stress cracks up to 1" wide and 50 feet in length were observed along the south side of the pit and intermittent stress cracks were observed on the west side of the cap. During the 2003 inspection, surficial stress cracks were observed only on the south side of the pit. During this current inspection, cracking was observed on the west/southwest side of the cap.

Groundwater monitoring system: The groundwater monitoring wells appear to be intact and secured.

Surface improvements: Small rodent holes were observed during the inspection and should be monitored.

3.0 Inspection Checklists

The attached checklists include the items specified in 22 CCR Part 66264.228.

Annual Landfill Inspection
Lawrence Livermore National Laboratory
Site 300
Pit 829

Landfill: Pit 829 | Date: Aug. 3, 2004
Weather: Sunny / Clear | Time: 9:37 AM
Independent Engineer: Mr. Reuben Chow, P.E.
Signature:

The following items are required to be inspected under Title 22 of the California Code of Regulations, Part 66264.228(k). The comments are listed by number, following the checklist. Specific recommendations follow the comments:

ITEM	DESCRIPTION	CONDITION	COMMENTS
1.	Surface Improvements	Good	1
2.	Drainage Facilities	Fair to Good	1
3.	Erosion Control Facilities	Good	2
4.	Vegetative Cover	Good	3
5.	Gas Control Facilities	Not Applicable	
6.	Gas Monitoring Facilities	Not Applicable	
7.	Water Flowing From Disposal Area	No	
8.	Leachate Flowing From Disposal Area	No	
9.	Access Control (Fences & Gates)	Good	
10.	Condition of Vegetation	Good	3
11.	Erosion	Good	2
12.	Cracking	Good	4
13.	Disturbance by Cold Weather	Good	
14.	Seepage	Good	
15.	Slope Stability	Good	
16.	Subsidence	Good	
17.	Settlement	Good	5
18.	Monitoring of Leak Detection System	Not Applicable	
19.	Operation of the Leachate Collection & Removal System	Not Applicable	
20.	Monitoring The Groundwater Monitoring System	Good	
21.	Condition of Run-on & Run-off Control Systems	Good	
22.	Condition of Surveyed Benchmarks	Good	

Comments:

1. Dried vegetation (e.g. tumbleweeds) was observed in the east channel and should be removed. Stress cracks in the concrete channel sections and separation of 1 inch were observed in the south and southwest sides of the channel. Settlement in the soils areas adjacent to the pit were observed including cracks 2 inches wide and 10 inches deep and more than 10 feet long.

2. The primary erosion control is the vegetation. The vegetative cover is in good condition.

3. The average height of the vegetation is approximately 4 to 6 inches. The vegetation consists primarily of grasses.

4. Cracks were observed on the west/southwest side of the pit. These areas should be compacted and reseeded. At the northwest side of the cap foundation, erosion grooves were observed up to 8 to 10 feet wide and 24 inches deep and 60 feet long downslope. These grooves should be monitored closely.

5. A depression has formed on the northeast portion of the cap which has not affected the integrity of the cap. This area should be filled in and compacted.

Recommendations:

Vegetation in the drainage channel should be removed.

Soils areas adjacent to the concrete channel in the south and southeast area should be compacted to protect the pit and channel. Joints that have separated over ½ inch should be patched and sealed. Stress cracks in the channels should be monitored.

The west/southwest side of the pit should be compacted in areas of stress cracking of the soils. The area should be revegetated following compaction.

The 5 foot depression area of the cap on the northeast end should be filled in, compacted, and reseeded.

The erosion grooves at the northwestern area of the foundation of the cap should be monitored and best management practices employed to mitigate the conditions, as necessary.

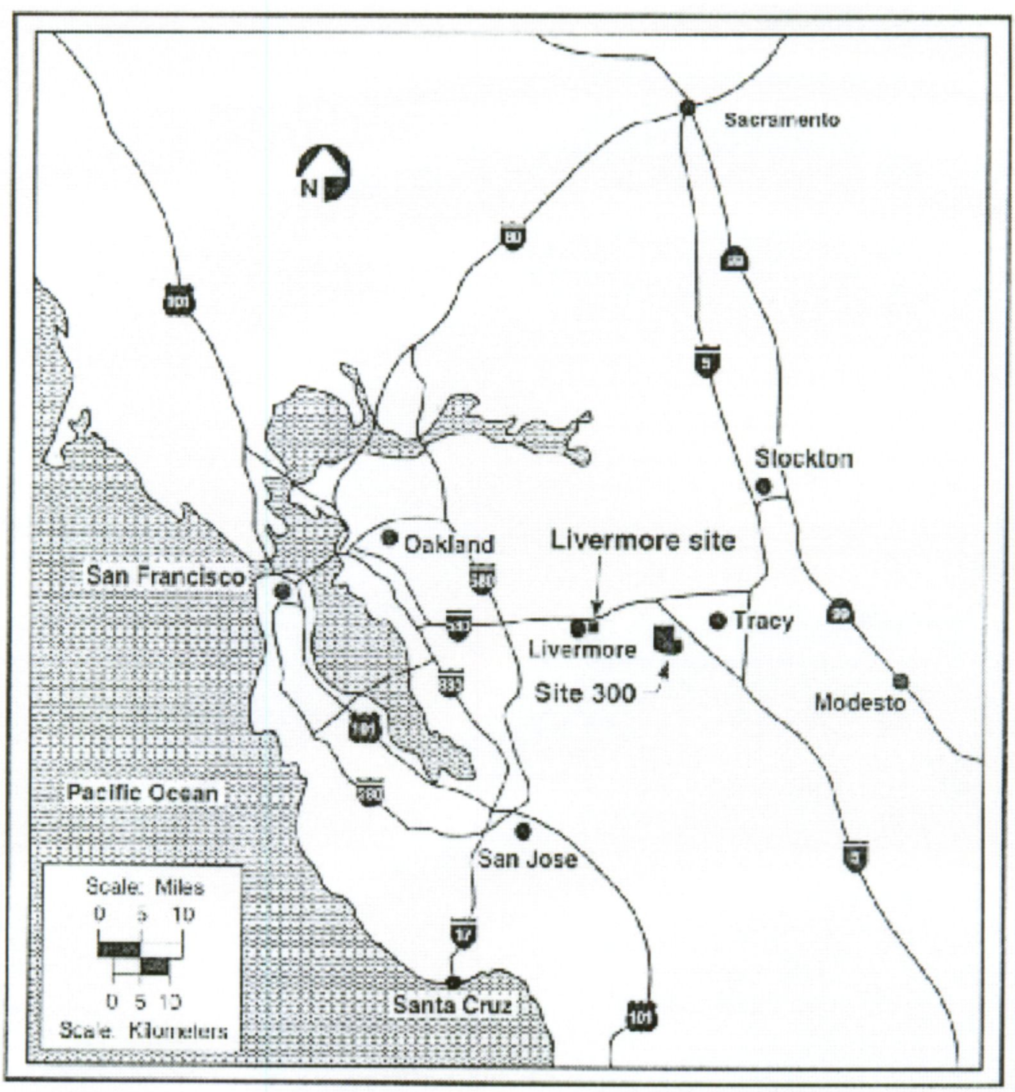

Figure 1. Vicinity Map showing locations of Livermore LLNL site and Site 300.
Source: LLNL Environmental Report for 1998.

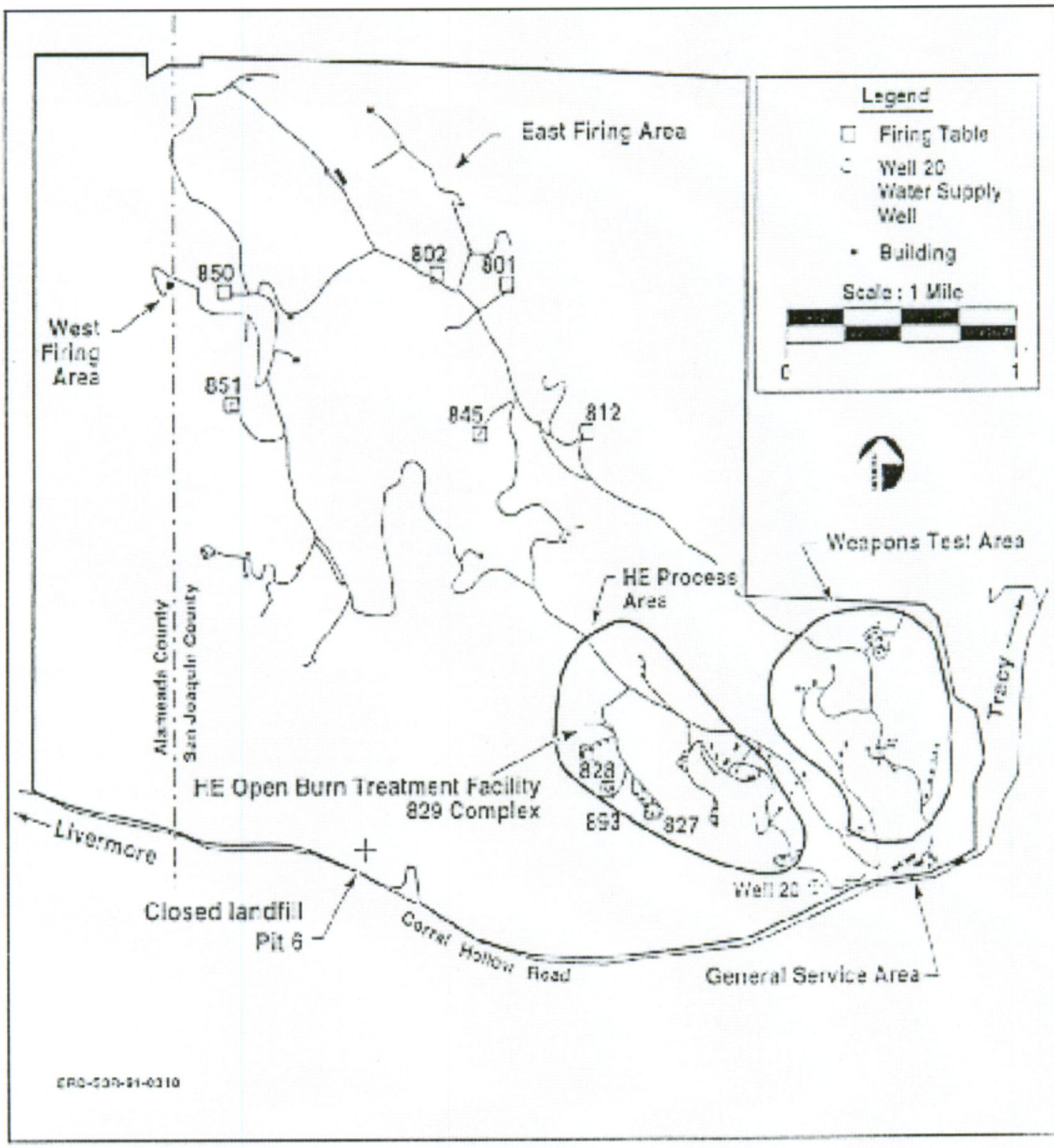

Figure 2. General Facilities Map
Source: Compliance Monitoring Program Second Quarter Report April-June, 1997 for Site 300.

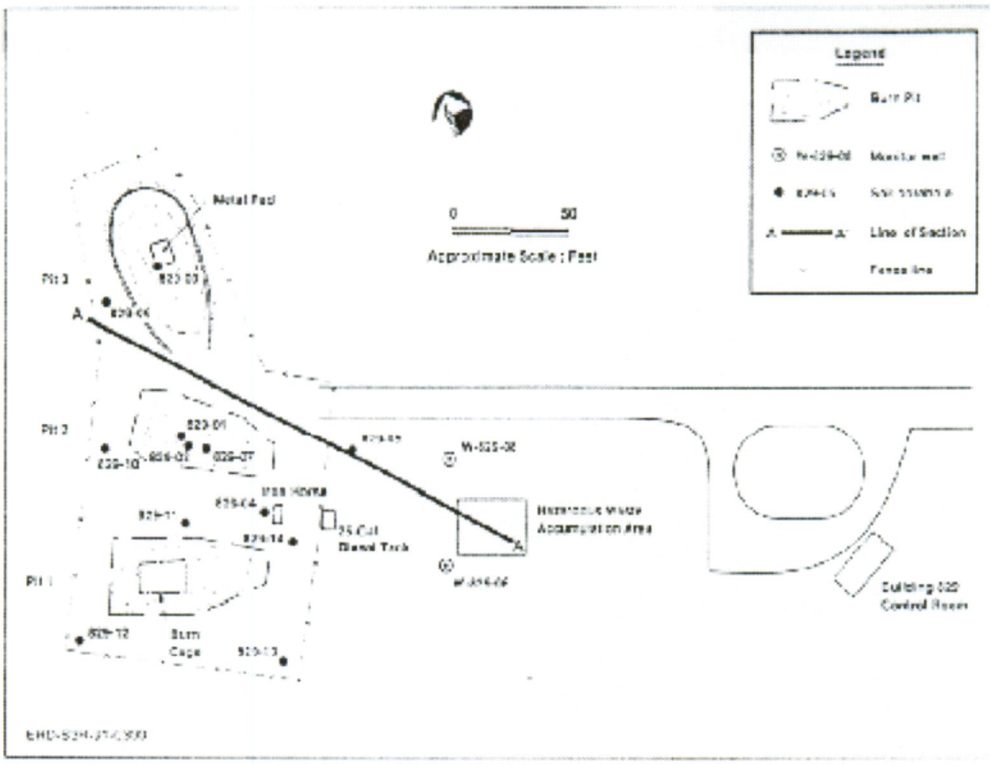

Figure 3. Building 829 Complex HE Open Burn Treatment Facility, Site 300

Photo 1: 829 Cap

Cracks observed beyond the concrete channel

Photo 2: 829 Cap

Cracks at the drainage channel joints

Appendix C

Acronyms and Abbreviations

Appendix C

Acronyms and Abbreviations

CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CL	concentration limit
COC	constituent of concern
CY	calendar year
DCE	1,2-dichloroethene
DOE	Department of Energy
DTSC	Department of Toxic Substances Control
EPA	Environmental Protection Agency
HE	high explosives
LLNL	Lawrence Livermore National Laboratory
MPN	most probable number
PE	Professional Engineer
POC	point of compliance
RCRA	Resource Conservation and Recovery Act
RL	reporting limit
SL	statistically determined limit of concentration
TBD	to be determined
TCE	trichloroethene
TOC	total organic carbon
TOX	total organic halides
VOC	volatile organic compound

Operations & Regulatory Affairs Division, Lawrence Livermore National Laboratory
University of California, P.O. Box 808, L-627, Livermore, California 94551