LMS/46122

2023 Annual Site Inspection and Monitoring Report for Uranium Mill Tailings Radiation Control Act Title II Disposal Sites

December 2023

U.S. DEPARTMENT OF ENERGY | Legacy Management

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Contents

Abbreviations

AAS	alternate abatement standard
ACL	alternate concentration limit
AS&T	Applied Studies and Technology
BIA	U.S. Bureau of Indian Affairs
BLM	U.S. Bureau of Land Management
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
EMP	erosion monitoring program
EPA	U.S. Environmental Protection Agency
ft	feet
IC	institutional control
lidar	light detection and ranging
LM	Office of Legacy Management
LMS	Legacy Management Support
LOESS	locally estimated scatterplot smoothing
LTS&M	long-term surveillance and maintenance
LTSP	Long-Term Surveillance Plan
mg/L	milligrams per liter
N	nitrogen
NA	not applicable
NAVD 88	North American Vertical Datum of 1988
NMED	New Mexico Environment Department
NRC	U.S. Nuclear Regulatory Commission
PCB	polychlorinated biphenyl
pCi/L	picocuries per liter
PL	photograph location
PMF	probable maximum flood
POC	point of compliance
POE	point of exposure
^{226}Ra	radium-226
^{228}Ra	radium-228
SAG	San Andres–Glorieta aquifer
SOARS	System Operation and Analysis at Remote Sites

TDS	total dissolved solids
^{230}Th	thorium-230
^{232}Th	thorium-232
UMTRCA	Uranium Mill Tailings Radiation Control Act
USACE	U.S. Army Corps of Engineers
WDEQ	Wyoming Department of Environmental Quality

Executive Summary

This report, in fulfillment of a license requirement, presents the results of long-term surveillance and maintenance (LTS&M) activities conducted by the U.S. Department of Energy (DOE) Office of Legacy Management (LM) in 2023 at six uranium mill tailings disposal sites reclaimed under Title II of the Uranium Mill Tailings Radiation Control Act (UMTRCA). These activities verified that the UMTRCA Title II disposal sites remain in compliance with license requirements. Site-specific Long-Term Surveillance Plans (LTSPs) and site compliance reports are available on the internet at https://www.energy.gov/lm/sites/lm-sites.

LM manages six UMTRCA Title II disposal sites under a general license established by the U.S. Nuclear Regulatory Commission (NRC) found in Title 10 *Code of Federal Regulations* Section 40.28 (10 CFR 40.28). Reclamation and site transition activities continue at other sites. Of the 30 future Title II sites, LM anticipates adding two sites to the LM management portfolio in 2024, the Split Rock, Wyoming, Disposal Site and the Durita, Colorado, Disposal Site.

LTS&M activities and services for LM-managed disposal sites include inspecting and maintaining the sites; monitoring environmental media and institutional controls; conducting any necessary corrective actions; and performing administrative actions, records management, stakeholder relations, and other regulatory stewardship functions.

Annual site inspections and monitoring are conducted in accordance with site-specific LTSPs and procedures established by LM to comply with license requirements. Each site inspection is performed to verify the integrity of visible features at the site, identify changes or new conditions that might affect the long-term performance of the site, and determine whether maintenance and follow-up inspections or corrective actions are needed in accordance with the LTSP.

All the sites require some degree of routine monitoring and maintenance, which can include groundwater and surface water monitoring, minor erosion control, vegetation management, fence and gate repairs, sign replacement, and minor trash removal. The following nonroutine activities[1] occurred in 2023:

- **Bluewater, New Mexico, Disposal Site:** In October 2023, the U.S. Army Corps of Engineers (USACE) completed a geotechnical investigation on the top slope of the disposal cell to collect data on the condition of the cell cover and underlying material.
- **L-Bar, New Mexico, Disposal Site:** During the March annual site inspection, inspectors identified two additional surface degradation features on the top slope of the disposal cell for a total number of 33 features. In September and October 2022, personnel from the Applied Studies and Technology team conducted a site investigation of the disposal cell and the western side of the riprap side slope. The purpose of the investigation was to characterize the morphology of the disposal cell cover soil in areas of observed erosion as part of a portfolio-wide assessment of erosion risk of UMTRCA sites. In June 2023, a geophysical investigation was completed to assess the subsurface conditions of the tailings, radon attenuation barrier, and top soil cover across the top slope of the disposal cell. Lastly, in August 2023, USACE completed a geotechnical investigation on the north and

[1] Nonroutine activities are activities implemented in response to changes in site conditions, the regulatory setting, or the management structure following an extraordinary event or regulatory compliance review.

south portions of the site, off the disposal cell, to collect data for the planned erosion control structure repairs.

- **Edgemont, South Dakota, Disposal Site:** In August 2023, a remote telemetry meteorological station, also known as a System Operation and Analysis at Remote Sites (SOARS) station, was installed near the containment dam to monitor local weather conditions at the site and view conditions using a web camera.
- **Shirley Basin South, Wyoming, Disposal Site:** In August 2023, a remote telemetry SOARS station was installed on the cover of the disposal cell to monitor local weather conditions at the site.

NRC comments on the 2022 Annual Site Inspection and Monitoring report have been addressed in the environmental monitoring sections of the Bluewater and Shirley Basin South chapters of the 2023 report. Annual groundwater sampling data through July 2023 are included in this report.

Results of the annual site inspections, maintenance, and monitoring activities are reported in the site-specific chapters that follow. Significant actions and issues at each site are summarized in Table ES-1.

Table ES-1. 2023 Summary of UMTRCA Title II Site Issues and Actions

Site	Chapter	Page(s)	Issues and Actions
Bluewater, New Mexico	1	1-1	— Alluvial and bedrock aquifer groundwater monitoring results do not exceed established ACLs; however, groundwater leaving the site in both the alluvial and bedrock aquifers has uranium concentrations exceeding EPA drinking water standards.
		1-2	— Erosion continues to be an issue along the north and northwest areas of the road. LM is planning to repair the interior road in 2024 through an interagency agreement with USACE.
		1-2	— Minor areas of erosion on the site road along the western side of the site were top-dressed with gravel to prevent further erosion during routine maintenance work in 2023.
		1-6, 1-7	— Several minor depressions on the main tailings disposal cell continue to be observed.
		1-15	— Although below the ACL concentrations, downgradient wells 22(M) and 21(M) indicate that alluvial groundwater with uranium concentrations exceeding the EPA drinking water standard (0.03 milligrams per liter) is moving from the site toward the southeast.
		1-21	— Uranium concentrations in downgradient San Andres–Glorieta aquifer bedrock wells along the site boundary do not exceed the site-specific NRC-approved health-based standard. However, the wells have consistently exceeded the EPA drinking water standard for uranium.
Edgemont, South Dakota	2	2-4	— An additional depression was identified in 2023. No impact to the containment dam was observed.
		2-4	— No changes were observed from the two small depressions identified in 2021.
		2-4	— Measurements were taken on all three depressions to support continued monitoring.
L-Bar, New Mexico	3	3-1	— Two additional surface degradation features were observed on the top slope of the disposal cell. Slight variations in the containment dam side slope were observed and will continue to be monitored.
		3-2	— LM is planning to repair access roads and construct low-water crossings in areas impacted by erosion in 2023 through the interagency agreement with USACE.
		3-4	— The fence near perimeter sign P18 was extended vertically due to sedimentation; perimeter sign P31 was observed to be missing and was replaced.
		3-5	— More than 30 surface degradation features identified indicate a change in the as-built condition of the disposal cell and may require maintenance.
		3-6	— Evaluation of the surface degradation features are ongoing, and plans are being developed to further understand the extent and cause of these features and to determine if further maintenance is required.
		3-7	— Runoff Control Structure A, D, and G sustained severe erosion during previous runoff events and continue to erode.
		3-8	— An aerial survey was conducted in November 2022.
		3-9	— Groundwater monitoring is required at the site once every 3 years. Results of the most recent sampling event conducted on November 2, 2022, are included in this report.
		3-28	— Disposal cell cover erosion monitoring data indicate the surface elevation of the disposal cell is rising compared to the 2003 baseline.
		3-29	— Performed annual vegetation monitoring and comparison of perennial plant cover on the disposal cell cover.

Table ES-1. 2023 Summary of UMTRCA Title II Site Issues and Actions (continued)

Site	Chapter	Page(s)	Issues and Actions
Maybell West, Colorado	4	4-4	— The missing entrance sign was replaced, and additional warning signs were added to the entrance gate.
		4-5	— Four small depressions on the disposal cell top are not impacting disposal cell performance and will continue to be monitored.
		4-6	— Continued to observe small depressions on the crest of the top slope of the ancillary cell with no observed changes. Additional small depressions were observed on the toe of the side slope of the ancillary cell.
		4-6	— Continued to observe gullies near the rock berm west of the ancillary cell with no observed changes.
Sherwood, Washington	5	5-4	— The fallen bollard at monitoring well MW-4 will be removed in 2024.
		5-5	— Continued to observe gullies near perimeter sign P1 and the southeast portion of the dike road.
		5-5	— Conducted an annual dam safety inspection.
		5-5	— Conducted water level measurements in piezometers atop the containment dam.
		5-10	— Conducted groundwater monitoring. Groundwater constituent concentrations continue to be less than the action levels for confirmatory sampling in all wells.
Shirley Basin South, Wyoming	6	6-2	— An arroyo undermined a section of fence on the west boundary, but the fence was realigned.
		6-4	— Cattle have worn a path around the north and south end of the eastern riprap-armored slope and it is showing signs of erosion; monitoring of the path will continue.
		6-6	— The rock-armored drainage in Pit 4 was first noted to have erosion in 2016 and has continued to erode; repair of displaced rock is not necessary at this time as erosion is not expected to impact slope stability.
		6-23	— Conducted groundwater monitoring at 14 wells. In 2023, ACLs were exceeded at POC well 5-DC. Groundwater protection standards were met at livestock well K.G.S. #3 and in wells near the site boundary but continued to be exceeded in other site wells near the disposal cell.

Abbreviations:
ACL = alternate concentration limit
EPA = U.S. Environmental Protection Agency
POC = point of compliance

1.0 Bluewater, New Mexico, Disposal Site

1.1 Compliance Summary

The Bluewater, New Mexico, Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II Disposal Site was inspected on March 7 and March 8, 2023. Minor depressions on the side slopes of the main tailings disposal cell continue to be observed. Depressions continue to be observed on the north portion of the top slope of the main tailings disposal cell. A new potential depression was identified on the southeastern top slope of the main tailings disposal cell. Inspectors identified several routine maintenance needs but found no cause for a follow-up or contingency inspection.

Groundwater was sampled in November 2022 and May 2023. Analytical results from the two sampling events indicate that alternate concentration limits (ACLs) were not exceeded. However, groundwater in both the alluvial and bedrock aquifer onsite monitoring wells has uranium concentrations exceeding the U.S. Environmental Protection Agency (EPA) drinking water standard. Results from the fall 2023 sampling event, conducted the week of November 13, 2023, will be documented in the 2024 Annual Inspection and Monitoring Report.

1.2 Compliance Requirements

Requirements for the long-term surveillance and maintenance of the site are specified in the site-specific Long-Term Surveillance Plan (DOE 1997) (LTSP) in accordance with procedures established to comply with the requirements of the U.S. Nuclear Regulatory Commission (NRC) general license at Title 10 *Code of Federal Regulations* Section 40.28 (10 CFR 40.28). Table 1-1 lists these requirements.

Table 1-1. License Requirements for the Bluewater, New Mexico, Disposal Site

Requirement	LTSP	This Report	10 CFR 40.28
Annual Inspection and Report	Sections 3.3 and 3.4	Section 1.4	(b)(3)
Follow-Up Inspections	Section 3.5	Section 1.5	(b)(4)
Routine Maintenance and Emergency Measures	Section 3.6	Section 1.6	(b)(5)
Environmental Monitoring	Section 3.7	Section 1.7	(b)(3)

1.3 Institutional Controls

The 3300-acre site, identified by the property boundary shown in Figure 1-1 and Figure 1-2, is owned by the United States and was accepted under the NRC general license in 1997. The U.S. Department of Energy (DOE) is the licensee and, in accordance with the requirements for UMTRCA Title II sites, the Office of Legacy Management (LM) is responsible for the custody and long-term care of the site. Institutional controls (ICs) at the site include federal ownership of the property, administrative controls, and the following physical ICs that are inspected annually: disposal cells, disposal areas, dumps, entrance gate and sign, perimeter fence and signs, a site marker, boundary monuments, and monitoring wellhead protectors. In addition to LM ICs, the New Mexico Office of the State Engineer implemented a well prohibition in the alluvial aquifer downgradient of the site in May 2018 (Romero 2018).

1.4 Inspection Results

The site, approximately 9 miles northwest of Grants, New Mexico, was inspected March 7 and 8, 2023. The inspection was conducted by J. Cario, J. Graham, C. Murphy, and T. Santonastaso of the Legacy Management Support (LMS) contractor. B. Frazier, N. Olin, M. Young (LM) and A. Rheubottom (New Mexico Environment Department [NMED]) attended the inspection on both days. The purpose of the inspection was to confirm the integrity of visible features at the site, identify changes in conditions that might affect conformance with the LTSP, and evaluate whether maintenance or follow-up inspection and monitoring are needed.

1.4.1 Site Surveillance Features

Figure 1-1 and Figure 1-2 show the locations of site features, including site surveillance features and inspection areas, in black and gray font. Some site features that are present but not required to be inspected are shown in italic font. Observations from previous inspections that are currently monitored are shown in blue, and new observations identified during the 2023 annual inspection are shown in red. Inspection results and recommended maintenance activities associated with site surveillance features are described in the following subsections. Photographs to support specific observations are noted in the text and in Figure 1-1 and Figure 1-2 by photograph location (PL) numbers. The photographs and photograph log are presented in Section 1.9.

1.4.1.1 Site Access, Entrance Gate, and Interior Roads

Access to the site is directly from gravel-surfaced Cibola County Road 63 (also known as Anaconda Road); no private property is crossed to gain site access. The entrance gate is a tubular steel, double-swing gate secured by a chain and locks belonging to LM and the various utility companies that have rights-of-way across the site. The site access road is surfaced with crushed basalt and extends northward along a narrow strip of LM property for approximately 1700 feet (ft) from the entrance gate to the main site access road gate. Two culverts allow drainage of surface runoff under the road.

Interior roads used to access LM assets consist of a dirt track covered at places with crushed basalt. The roads are susceptible to erosion and are repaired when they become impassable. Erosion on the road northwest of the main tailings disposal cell continues to be an issue (PL-1). In 2017, riprap was added to repair a gully intersecting this section of the road. Additional erosion was noted along the road parallel to the northern perimeter of the site. Thirteen road repair areas were identified around the site perimeter road. LM is planning to repair the roads in spring 2024 through the interagency agreement with the U.S. Army Corps of Engineers (USACE). Minor areas of erosion on the site road along the west side of the site were identified during the 2023 inspection. These minor areas were top dressed with gravel to prevent further erosion during routine maintenance work in 2023. No other maintenance needs were identified.

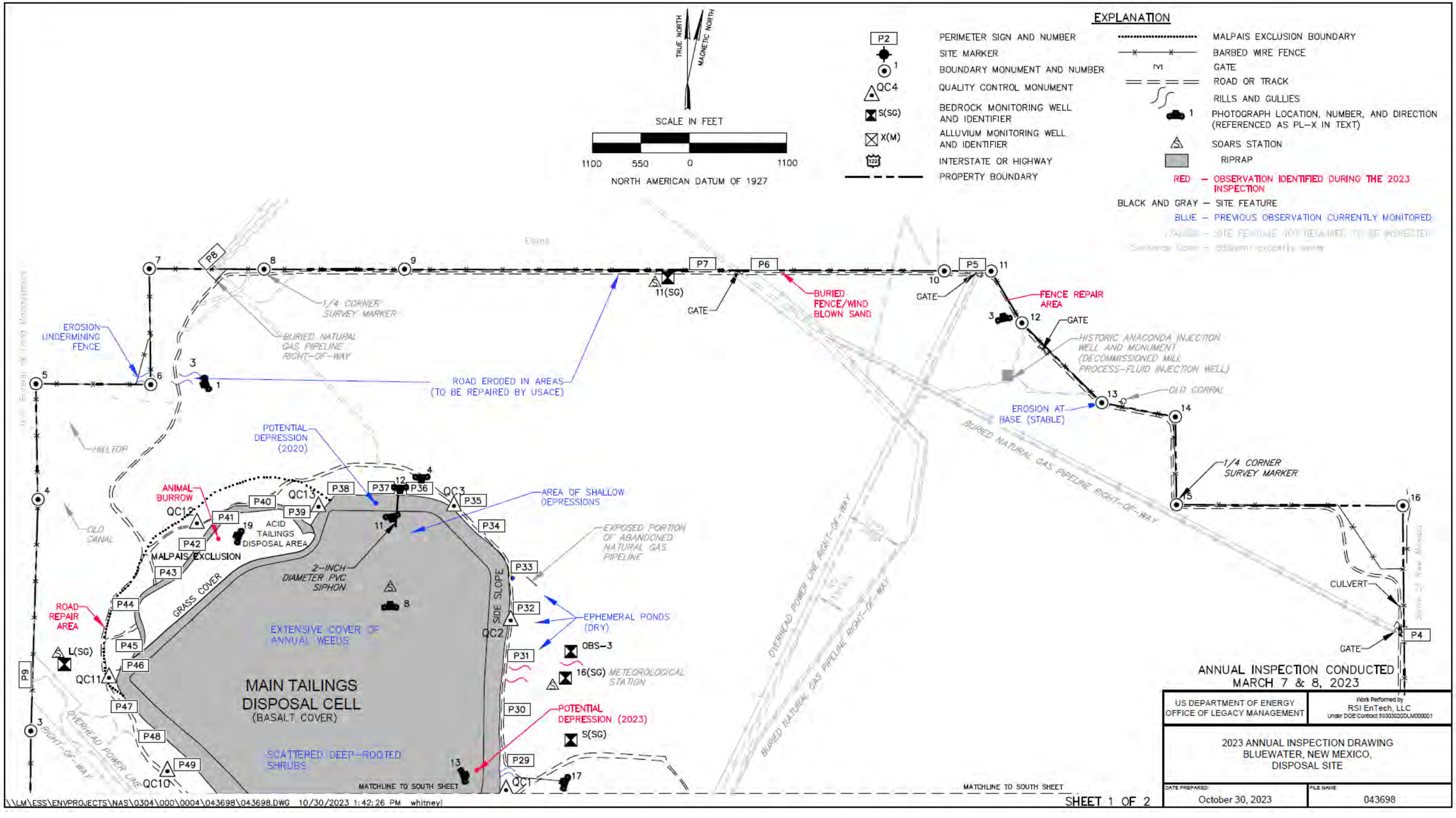


Figure 1-1. 2023 Annual Inspection Drawing for the Bluewater, New Mexico, Disposal Site (Northern Area)

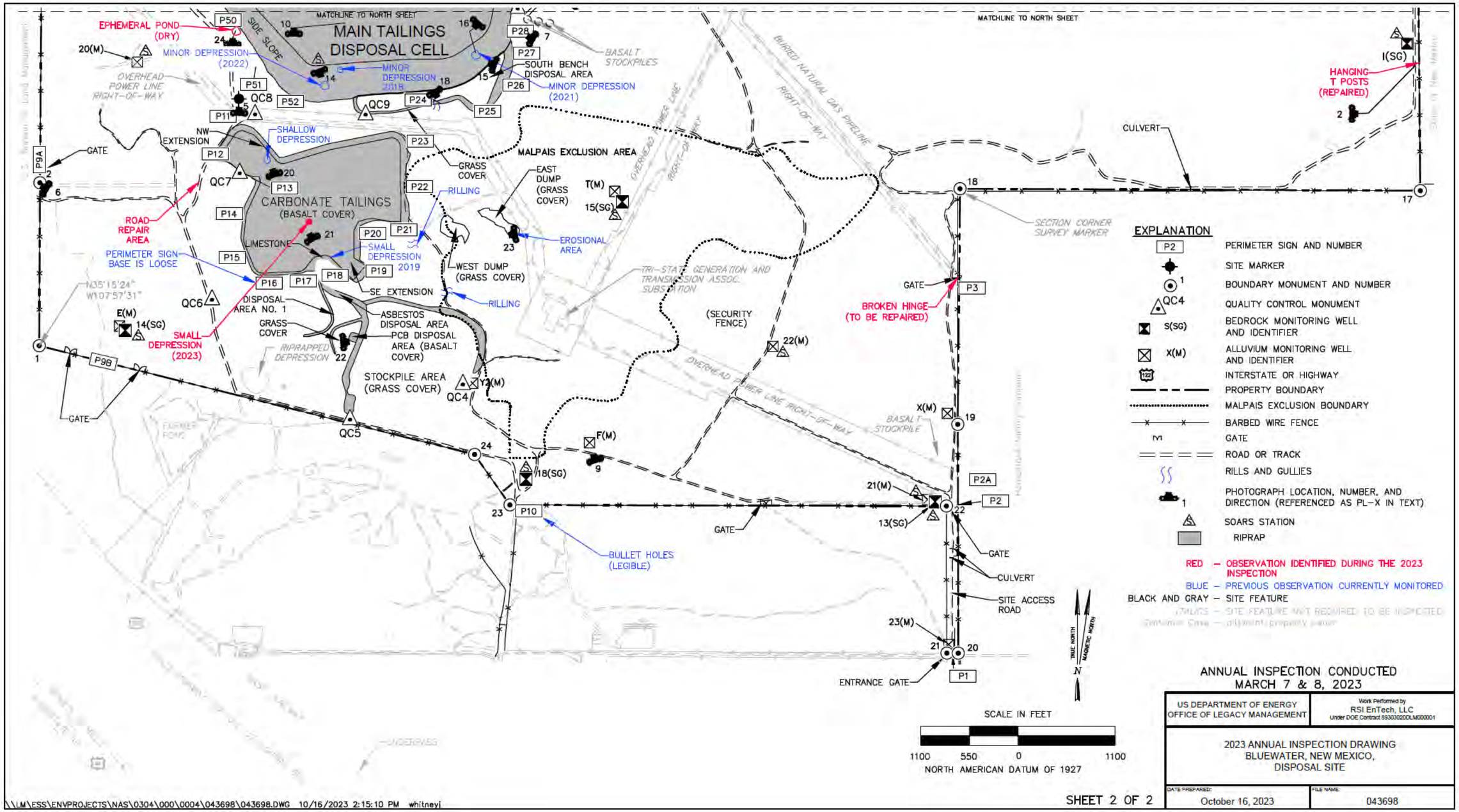


Figure 1-2. 2023 Annual Inspection Drawing for the Bluewater, New Mexico, Disposal Site (Southern Area)

1.4.1.2 Perimeter Fence and Signs

A four-strand barbed-wire fence encloses the site to facilitate land management by LM, which retains a local subcontractor to periodically check the site perimeter fence and remove trespassing cattle. Numerous sections of the fence are in remote areas of the site and cannot be observed from site access roads. Inspectors identified hanging or loose T-posts along the eastern fence near monitoring well I(SG) and boundary monument BM-12 (PL-2, PL-3), and windblown sediment was observed burying the lower strands of wire near perimeter sign P6. All were repaired post inspection during the week of April 10, 2023. A broken hinge was observed on a right-of-way gate near perimeter sign P3. Maintenance staff contacted employees from the Tri-State utility company while onsite. Tri-State said they intended to repair the gate. Inspectors observed the gullies, identified in the 2019 inspection, parallel to the perimeter fence northwest of the main tailings disposal cell. No significant changes were observed. LM will continue to monitor this area for damage to the perimeter fence.

Fifty-five perimeter signs (warning and no-trespassing signs) are mounted on steel posts along the site boundary and around the main and carbonate tailings disposal cells (PL-4). Perimeter sign P10 has bullet hole damage but is legible. Perimeter sign P16 has a loose base but remains functional. No other maintenance needs were identified.

1.4.1.3 Site Marker

The site has one granite site marker between the southwest corner of the main tailings disposal cell and the northwest corner of the carbonate tailings disposal cell (PL-5). No maintenance needs were identified.

1.4.1.4 Boundary Monuments

Twenty-four boundary monuments define the site boundary (PL-6). These monuments are typically inside the perimeter fence and several feet inside the true corner or boundary line. Some monuments become covered by drifting sand, and metal T-posts have been driven at those locations to help locate them. Other boundary monuments are in remote sections of the site and cannot be observed from site access roads. All boundary monuments were inspected during the 2023 inspection except for boundary monument BM-7. Boundary monument BM-7 will be observed during the next inspection. Some erosion was observed at the base of boundary monument BM-13, but it is stable. No maintenance needs were identified.

1.4.1.5 Aerial Survey Quality Control Monuments

Thirteen aerial survey quality control monuments were installed in 2019, and an aerial survey was conducted by USACE in 2021. The aerial survey quality control monuments were inspected during the 2023 annual inspection (PL-7). No maintenance needs were identified.

1.4.1.6 Monitoring Wells

The site groundwater monitoring network consisted of nine monitoring wells when the site was transferred to LM in 1997. Two additional wells were installed in summer 2011, and eight more wells were installed in summer 2012 in response to elevated uranium concentrations in the two aquifers (alluvial and bedrock) at the site. The onsite groundwater monitoring network

now consists of 19 monitoring wells; 10 are completed in the bedrock aquifer and 9 in the alluvial aquifer. Eleven wells (3 alluvial and 8 bedrock) have telemetry towers, known as System Operation and Analysis at Remote Sites (SOARS) stations to transmit groundwater level and weather data to the LM Field Support Center at Grand Junction, Colorado. The monitoring wells and SOARS stations are identified in Figure 1-2. The wellhead protectors and SOARS stations were observed to be undamaged and locked (PL-8). Animal burrows identified during the 2021 inspection near monitoring well F(M) showed signs of abandonment and filling in with sediment during the 2023 inspection (PL-9). They are not threatening the well integrity and will no longer be monitored. No maintenance needs were identified.

1.4.2 Inspection Areas

In accordance with the LTSP, the site is divided into four inspection areas (referred to as "transects" in the LTSP) to ensure a thorough and efficient inspection. The inspection areas are (1) the main tailings disposal cell, including the acid tailings and south bench disposal areas; (2) the carbonate tailings disposal cell, including the asbestos disposal area, the polychlorinated biphenyl (PCB) disposal area, and associated disposal areas and dumps; (3) the region between the disposal structures and the site perimeter; and (4) the site perimeter and outlying area. Inspectors examined the specific site surveillance features within each area and looked for evidence of erosion, settling, slumping, or other modifying processes that might affect conformance with LTSP requirements.

1.4.2.1 Main Tailings Disposal Cell, Acid Tailings, and South Bench Disposal Areas

The 354-acre contiguous main tailings disposal cell, acid tailings, and south bench disposal areas constitute one large disposal area. The top slope of the main tailings disposal cell is covered with basalt riprap and was designed to shed runoff water over the north edge of the top slope. The top slope grade is 3% to 4% at the south end and decreases to less than 0.5% at the north end. The top slopes of the acid tailings and south bench disposal areas are nearly flat and covered by grass. Basalt riprap protects the side slopes of the disposal areas.

Plant encroachment (by annual weeds, perennial grasses, forbs, and scattered perennial shrubs) continues on the main tailings disposal cell top and side slopes (PL-10). Siberian elm saplings on the top slope are periodically treated with herbicide to prevent the establishment of trees that could damage the main tailings disposal cell cover materials. No live elms were observed during the inspection.

Several depressions are evident on the north end of the top slope of the main tailings disposal cell and along the east and northwest edges of the top slope. This portion of the top slope overlies predominantly clay-rich tailings referred to as slimes. Although the former licensee attempted to dewater the slimes to consolidate them, that portion of the top slope continued to settle after the site transitioned to LM. Annual inspections indicated that the depressions have enlarged in area and depth over time. LM, therefore, conducted high-resolution topographic mapping using the light detection and ranging (lidar) method in 2012 and 2016 to determine if settlement continued and to gauge its magnitude (DOE 2017). The 2016 lidar results, when compared to the 2012 lidar results and the original topographic map developed in 1997, demonstrated that settlement measures up to 4 feet in places. The rate of settlement since 2012 (an average of 0.72 inch per year between 2012 and 2016) is much less than the rate before 2012 (an average of 1.8 inches per year between 1997 and 2012). Another lidar survey was conducted

by USACE in April 2021. The data from this survey were received in February 2023. The data from this survey will be compared to previous surveys to calculate the rate of settlement.

Ponds often develop in the depressions from stormwater and occasionally coalesce into one large pond after a series of storm events. The area of depressions is monitored continuously using a remotely operated webcam to detect the presence of ponded water. No ponding was observed on the main tailings disposal cell during the inspection. No algae were present during the inspection even though algae have been noted in previous reports.

A 2-inch-diameter siphon was installed in fall 2015 to dewater as much of the ponded water as possible (PL-11). The siphon is manually started when the webcam indicates that a large pond has developed. The intent is to avoid potential erosion of the main tailings disposal cell cover materials if the pond surface reaches an elevation high enough to spill over the north side slope. Water would start to spill over at the lowest point along the north edge of the top slope, which could initiate erosion in that area. LM entered into an interagency agreement with USACE in October 2019 to design a repair to the depressions and ensure continued positive drainage from the main tailings disposal cell. In October 2023, USACE completed a geotechnical investigation on the top slope of the disposal cell to collect data on the condition of the cell cover and underlying material; results pending. NRC will be involved in reviewing designs as they are developed and will concur upon the final design before construction.

The siphon is usually operated at least once a year, depending on precipitation, and it successfully removes nearly all the water; any remaining water tends to evaporate. When operated, the siphon discharges water at a rate of approximately 100 gallons per minute at the toe of the north side slope where runoff water was intended to discharge (PL-12). The discharged water ponds over a large area north of the main tailings disposal cell and eventually either evaporates or infiltrates into the soil. The discharged water does not flow off the site. Due to lack of significant precipitation during the 2023 monsoon season (1.93 inches measured by onsite rain gauge), the siphon did not require operation this year.

The side slopes and toe of the main tailings disposal cell were inspected for signs of erosion or sediment deposition. An area of potential depression was identified during the 2023 inspection on the southeastern portion of the top slope that is approximately 8 ft long and 3 ft wide (PL-13). A potential depression feature on the western side of the south side slope was first observed during the 2022 inspection. This was observed again in 2023 and measured approximately 15 ft long and 30 ft wide (PL-14). An area of minor depression was observed on the south side slope during the 2018 annual inspection. It was not identified during the 2021 inspection, observed again during the 2022 inspection, and not observed during the 2023 inspection. This feature is very minor and will be removed from tracking if there are no observed changes in 2024. Another area of minor depression observed in 2021 on the eastern side of the south side slope was not observed during the 2022 inspection. During 2023, inspectors believe they located this minor depression once again. Inspectors concluded there may have been a field documentation error in the location of this feature in 2021. Waypoint polygon data were collected on this feature to confirm its location. This depression was observed to be approximately 20 ft long, 10 ft wide, and 10 to 12 inches deep (PL-15, PL-16). An area of potential depression was observed on the north side slope during the 2020 annual inspection. Inspectors observed the area during the 2023 inspection, but no apparent changes were noted. The side slopes will continue to be observed for depressions. All identified depressions will continue to be monitored and will be evaluated using lidar.

During the 2019 annual inspection, minor rills with a maximum depth of 6 inches were observed at the base of the east side slope and minor rills with a maximum depth of 8 inches were observed at the base of the south bench of the main tailings disposal. The rills did not appear to increase in depth or extent (PL-17, PL-18). During the 2020 annual inspection, a linear desiccation crack was observed along the base of the east side slope. During the 2023 inspection, inspectors observed that the linear crack had filled in with sediment; this item will be removed from the inspection drawing and not monitored in the next inspection. LM will continue to monitor the rills for potential impact to the main tailings disposal cell and south bench area. Animal burrows identified on the top of the south bench disposal area in 2022 appear to have been abandoned and filled with sediment. These burrows will not be monitored in the next inspection. New animal burrows were observed on the top slope of the acid tailings disposal area (PL-19). No sediment deposits were present along the toe. No maintenance needs for the side slopes, acid tailings, or south bench disposal areas were identified.

1.4.2.2 Carbonate Tailings Disposal Cell, Other Disposal Areas, and Dumps

The 54-acre carbonate tailings disposal cell is south of the main tailings disposal cell. Basalt riprap covers the top and side slopes of the carbonate tailings disposal cell. The top generally slopes gently eastward. The carbonate tailings disposal cell includes extensions to the northwest and southeast. A shallow depression exists on the northwest extension, and stormwater runoff occasionally ponds at this location; the depression was dry during the 2023 inspection (PL-20). This depression does not appear to be enlarging but will continue to be visually inspected and evaluated using periodic lidar survey results. A minor depression was observed on the south-central top slope of the carbonate cell (PL-21). Annual weeds, perennial grasses, and scattered woody shrubs were on the carbonate tailings disposal cell and its extensions. Siberian elm saplings are periodically treated with herbicide. No saplings were observed during the inspection. No additional maintenance needs were identified.

The 2-acre asbestos disposal area is a bowl-like feature just south of the carbonate tailings disposal cell. The north, west, and south side slopes of this feature are covered by limestone riprap; the bottom of the bowl (the asbestos cell cover) is covered with grass. The depressions repaired in May 2018 were observed, and no changes were apparent. As no changes have been identified in the past four inspections, the repaired depression area was removed from the inspection map. A depression on the north side slope, first identified during the 2019 annual inspection, had no observed changes in 2023. LM will continue to observe the depression and make repairs as necessary. No immediate maintenance needs were identified.

An 11-acre grass-covered disposal area is south of the asbestos disposal area. A small riprap-covered PCB cell (less than 1 acre) is within the disposal area (PL-22). Two grass-covered dumps, totaling approximately 2 acres, are east of the carbonate tailings disposal cell. Inspectors observed a minor erosional area along the basalt along the southern interface of the east dump; it was first identified during the 2019 annual inspection (PL-23). This feature appears to have become larger since the 2022 inspection. The erosional area was measured at approximately 11.3 ft long, 5.1 ft wide, and 4 ft deep. Wooden stakes were placed at the edges of the feature to monitor future growth. Radon gas concentration and radiation dose rate surveys were completed near the erosional area by an LMS radiological control technician. The measurements collected near the erosional area were consistent with background levels. LM will continue to observe the erosional area. No immediate maintenance needs were identified.

1.4.2.3 Area Between the Disposal Cells and the Site Perimeter

Other areas inside the site were inspected by driving the site perimeter road and other roads and tracks. Much of the southern and western portions of the site are inaccessible by vehicle because they are covered by basalt flows.

Small ephemeral ponds often form in an area along the east side of the main tailings disposal cell and in other low spots following storms. The areas of ponding are far enough from the main tailings disposal cell that they do not have any impact. The ponded areas were dry during the inspection.

A new ephemeral pond area was observed near the southwest side slope of the main tailings disposal cell near perimeter sign P50 (PL-24). The ephemeral pond was dry when observed. This pond is not currently a concern but will be observed at least 1 additional year.

Scattered tamarisk shrubs and other plants listed as noxious weeds by the State of New Mexico are onsite. Noxious weeds were treated with herbicide following the inspection.

Additional rilling and animal burrows are present in the area between the disposal cell and site perimeter but do not threaten any site features.

The decommissioned mill process-fluid injection well near the northeast corner of the site features a monument consisting of a steel well casing set in concrete. Information pertaining to the well is welded onto the monument. No other maintenance needs were identified.

Several utility companies have rights-of-way that cross the site. These rights-of-way are bordered by stock fences with locked gates where the rights-of-way cross the site boundary. Roads along the rights-of-way typically are covered with crushed basalt to provide the utility companies with all-weather access. LM is not responsible for maintaining the right-of-way roads or fences. An electric power substation, enclosed by a security fence, is near the center of the site. Utility company personnel visit the substation frequently. LM is not responsible for maintaining the substation or its security fence and access road.

1.4.2.4 Site Perimeter and Outlying Areas

Surrounding land is used for livestock grazing and wildlife habitat. The area beyond the site boundary for 0.25 mile was visually observed for erosion, development, changes in land use, or other phenomena that might affect conformance with LTSP requirements. No such changes were observed.

1.5 Follow-Up Inspections

LM will conduct follow-up inspections if (1) a condition is identified during the annual inspection or other site visit that requires a return to the site to evaluate the condition or (2) LM is notified by a citizen or outside agency that conditions at the site are substantially changed. No need for a follow-up inspection was identified during the inspection.

1.6 Routine Maintenance and Emergency Measures

Inspectors documented the following minor maintenance needs that were addressed following the inspection:

- Repair the loose T-post near monitoring well I(SG) and boundary monument BM-12
- Treat the noxious weeds
- Minor interior road repair was completed by LMS contractor staff in both April and August 2023

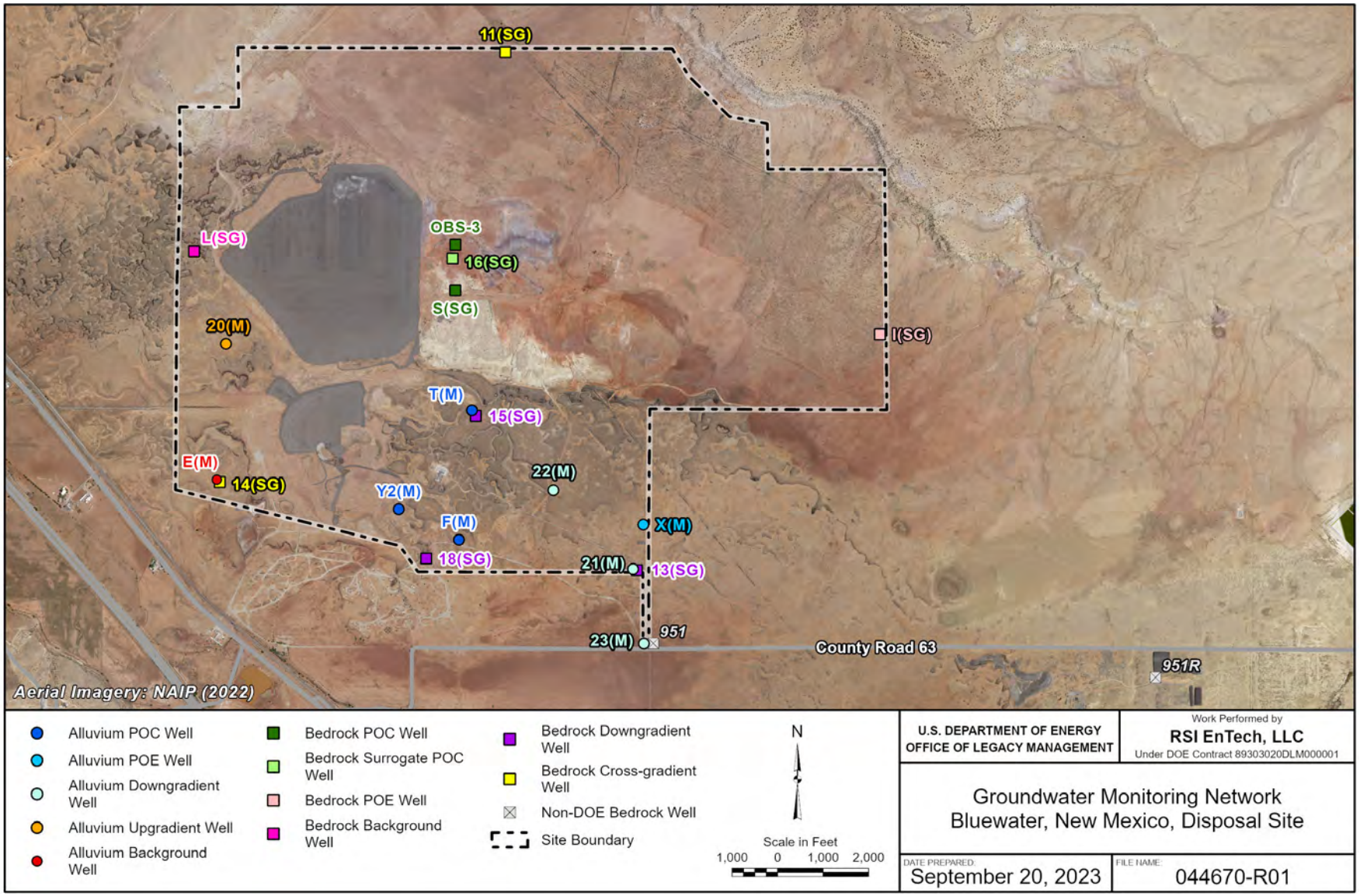
No other maintenance needs were identified.

Emergency measures are corrective actions that LM will take in response to unusual damage or disruption that threatens or compromises site health and safety, security, integrity, or compliance with 40 CFR 192. No emergency measures were identified.

1.7 Environmental Monitoring

Groundwater monitoring is required at the site (DOE 1997). The monitoring well network acquired by LM at the time of site transition and included in the LTSP consisted of wells E(M), F(M), T(M), X(M), Y2(M), L(SG), OBS-3, S(SG), and I(SG). Wells with an "(M)" suffix are screened in the alluvial aquifer, while wells with an "(SG)" suffix and well OBS-3 are screened in the San Andres – Glorieta (SAG) or bedrock aquifer. The LTSP requires triennial sampling for molybdenum, selenium, and uranium in the alluvial aquifer background and point of compliance (POC) wells. The LTSP also requires triennial sampling of the SAG (bedrock) aquifer background and POC wells for selenium and uranium. Alluvial aquifer well X(M) and bedrock aquifer well I(SG)—point of exposure (POE) wells along the east property boundary—are to be sampled only if specified ACLs are exceeded at POC wells (DOE 1997). The current groundwater monitoring network, including the 10 additional wells installed in 2011–2012, is shown in Figure 1-3.

LM has increased the sampling frequency in support of on-going evaluation initiatives. Currently, all 19 site wells, including POC and POE wells, are sampled semiannually for an expanded list of constituents as described in the following sections. The fall semiannual sampling event addressed in this report occurred November 29 and 30, 2022. The 2023 spring semiannual sampling occurred during the week of May 1, 2023. Results from the fall 2023 sampling event, conducted the week of November 13, 2023, will be documented in the 2024 Annual Inspection and Monitoring Report. Table 1-2 lists the monitoring wells routinely sampled at the Bluewater site along with their network application. ACLs for molybdenum (alluvial aquifer only), selenium, and uranium are listed in Table 1-3.



Note: Well T(M) has been dry or had insufficient water to sample since November 2012; well X(M) has been dry since 2021.

Figure 1-3. Groundwater Monitoring Network at Bluewater, New Mexico, Disposal Site

Table 1-2. Groundwater Monitoring Network at the Bluewater, New Mexico, Disposal Site

Monitoring Well	Network Application	Monitoring Well	Network Application
E(M)	Alluvium background well	I(SG)	Bedrock POE well
F(M)	Alluvium POC well	L(SG)	Bedrock background well
T(M)	Alluvium POC well	OBS-3	Bedrock POC well
X(M)	Alluvium POE well	S(SG)	Bedrock POC well
Y2(M)	Alluvium POC well	11(SG)	Bedrock cross-gradient well
20(M)	Alluvium upgradient well	13(SG)	Bedrock downgradient well
21(M)	Alluvium downgradient well	14(SG)	Bedrock cross-gradient well
22(M)	Alluvium downgradient well, surrogate POC well replacing T(M)	15(SG)	Bedrock downgradient well
23(M)	Alluvium downgradient well	16(SG)	Bedrock surrogate POC well
		18(SG)	Bedrock downgradient well

Table 1-3. Groundwater ACLs at the Bluewater, New Mexico, Disposal Site

POC Well	Constituent	ACL (mg/L)[a]
Alluvial aquifer wells F(M) and T(M)	Molybdenum Selenium Uranium	0.10 0.05 0.44[b]
Bedrock aquifer wells OBS-3 and S(SG)	Selenium Uranium	0.05 2.15[b]

Notes:
[a] Source: Table 3-4 of the LTSP (DOE 1997).
[b] The uranium ACL is based on a human health-based risk standard of 0.44 mg/L at the site boundary as approved by NRC in the Atlantic Richfield Company's ACL application (Applied Hydrology Associates Inc. 1995).

Abbreviation:
mg/L = milligrams per liter

In 2008, NMED requested LM's assistance in investigating and evaluating regional groundwater contamination associated with the former Grants Mineral Belt uranium mining industry. NMED suspected that contaminants from the site had migrated offsite. In response to NMED, LM reinitiated annual sampling at most onsite monitoring wells, including the POE wells, in fall 2008. To support NMED's regional groundwater investigation, in 2009, LM began reevaluating the hydrogeology and groundwater quality at the site and also expanded the analytical scope to include a larger suite of constituents than required by the LTSP.[1] To address stakeholder concerns and in consultation with NRC, LM installed 10 additional monitoring wells in 2011–2012 and, in response to the initial exceedance of the uranium ACL in alluvial well T(M) in 2010 (discussed further in Section 1.7.1), began semiannual (versus annual) sampling at all wells at that time.

Subsequent evaluations included an assessment of the main tailings disposal cell performance (DOE 2013) and development of a conceptual model of contaminant transport processes in the

[1] In addition to the constituents listed in Table 1-3 (EPA's SW-846 Method 6020 used as the analytical test method [EPA 2015]), groundwater samples are analyzed routinely for chloride, nitrate + nitrite as nitrogen, sulfate, total dissolved solids, major cations (EPA's SW 846 Method 6010 used as the analytical test method [EPA 2015]), and field parameters (e.g., total alkalinity and dissolved oxygen).

aquifers impacted by the Bluewater site (DOE 2014). LM updated the uranium plume maps for both the alluvial aquifer and the SAG aquifer in a 2019 report (DOE 2019). This analysis was followed by an evaluation of the influence of high-volume pumping wells near the site on groundwater flow and contaminant trends in the SAG aquifer (DOE 2020). LM continues to update the site conceptual model describing groundwater flow and contaminant transport using three-dimensional data visualization approaches and regularly updates stakeholders as to the findings of these ongoing evaluations.

1.7.1 Alluvial Aquifer

Water-bearing alluvium underlies the southern portion of the site. The alluvium, deposited by the ancestral Rio San Jose, is covered by basalt lava flows. The alluvium consists of coarse sands and gravels in the main ancestral river channel and finer-grained floodplain deposits outside the channel (DOE 2014).

Alluvial aquifer analytical results from sampling events in November 2022 and May 2023 are provided in Table 1-4. POC well T(M) and POE well X(M) were not sampled during either event because they were dry or had insufficient water to sample. Well T(M) has been dry since 2012; well X(M) was dry at the time of the last five semiannual sampling events (since May 2021).

Because concentrations of molybdenum and selenium continue to be several orders of magnitude below corresponding ACLs as shown in Figure 1-4, the remainder of this section focuses mainly on uranium concentration trends.

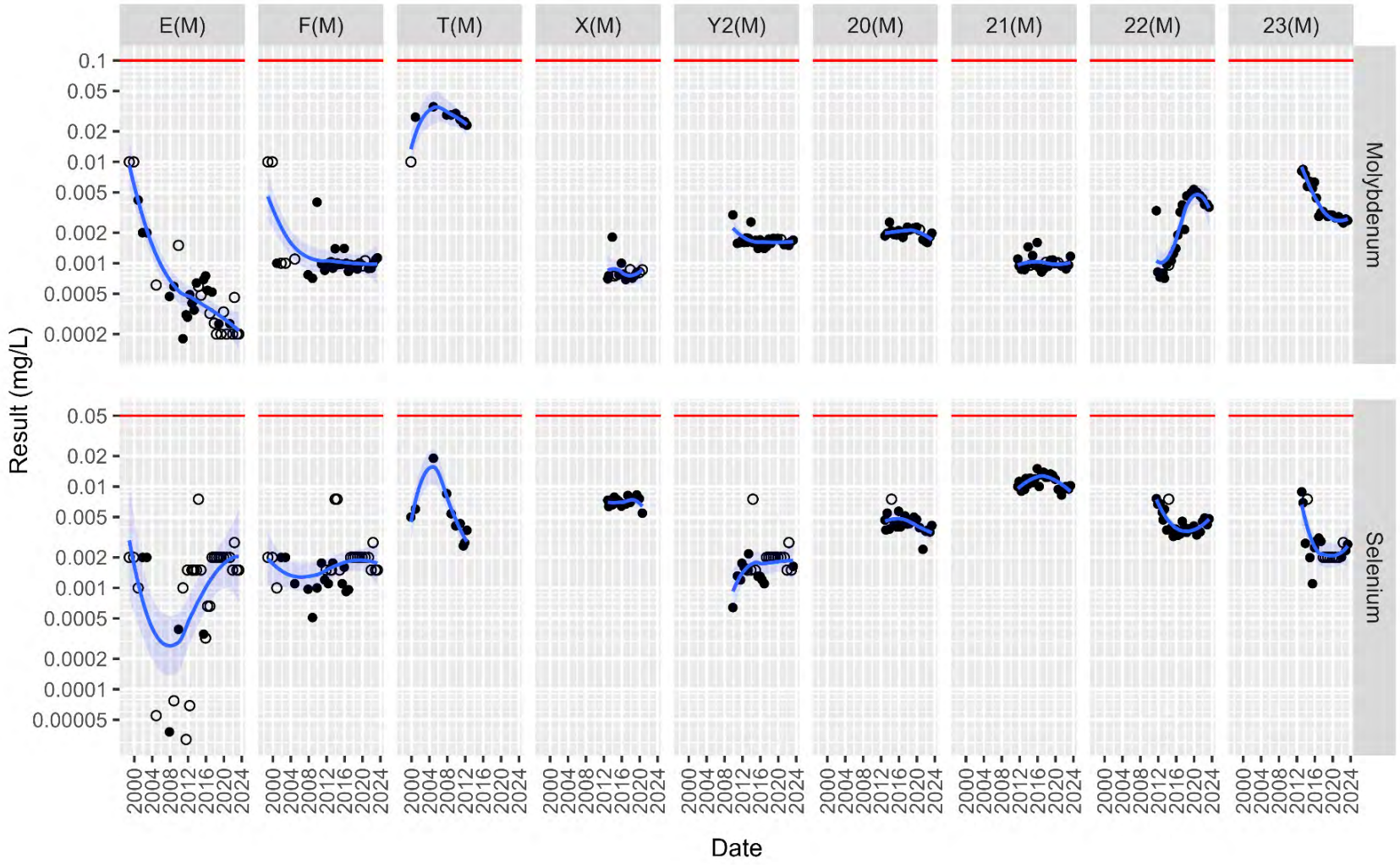
Table 1-4. Alluvial Aquifer Monitoring Results from November 2022 and May 2023 at the Bluewater, New Mexico, Disposal Site

Monitoring Well	Molybdenum (mg/L) ACL = 0.10 mg/L		Selenium (mg/L) ACL = 0.05 mg/L		Uranium (mg/L) ACL = 0.44 mg/L	
	November 2022	May 2023	November 2022	May 2023	November 2022	May 2023
E(M)	<0.0002	<0.0002	<0.0015	<0.0015	<0.000067	<0.000067
F(M)	0.00108	0.00113	<0.0015	<0.0015	0.00549	0.00593
T(M)[a]	Not sampled (last sampled in May 2012)					
X(M)[a]	Not sampled (last sampled in August 2020)					
Y2(M)	0.00164	0.00169	<0.0015	0.00163	0.00411	0.00441
20(M)	0.00182	0.00198	0.00356	0.00413	0.0108	0.0113
21(M)	0.00096	0.00117	0.00945	0.0102	0.0875	0.0874
22(M)	0.00382	0.00357	0.00383	0.0048	0.325	0.326
23(M)	0.00273	0.00264	0.00234	0.00269	0.0135	0.0135

Notes:

Shaded cells denote results below the corresponding ACL but exceeding the 0.03 mg/L EPA standard for uranium.
For duplicate analyses, the maximum result is listed (raw data can be found at https://gems.lm.doe.gov/#site=BLU).
[a] Wells X(M) and T(M) were not sampled during this reporting period because they were dry or there was insufficient water to sample.

Abbreviation:
mg/L = milligrams per liter



● Detect ○ Nondetect
Locally estimated scatterplot smoothing (LOESS) line and 95% confidence interval
ACL from Table 1-3

Note: Data are plotted from November 1998 to May 2023.
Abbreviation: mg/L = milligrams per liter

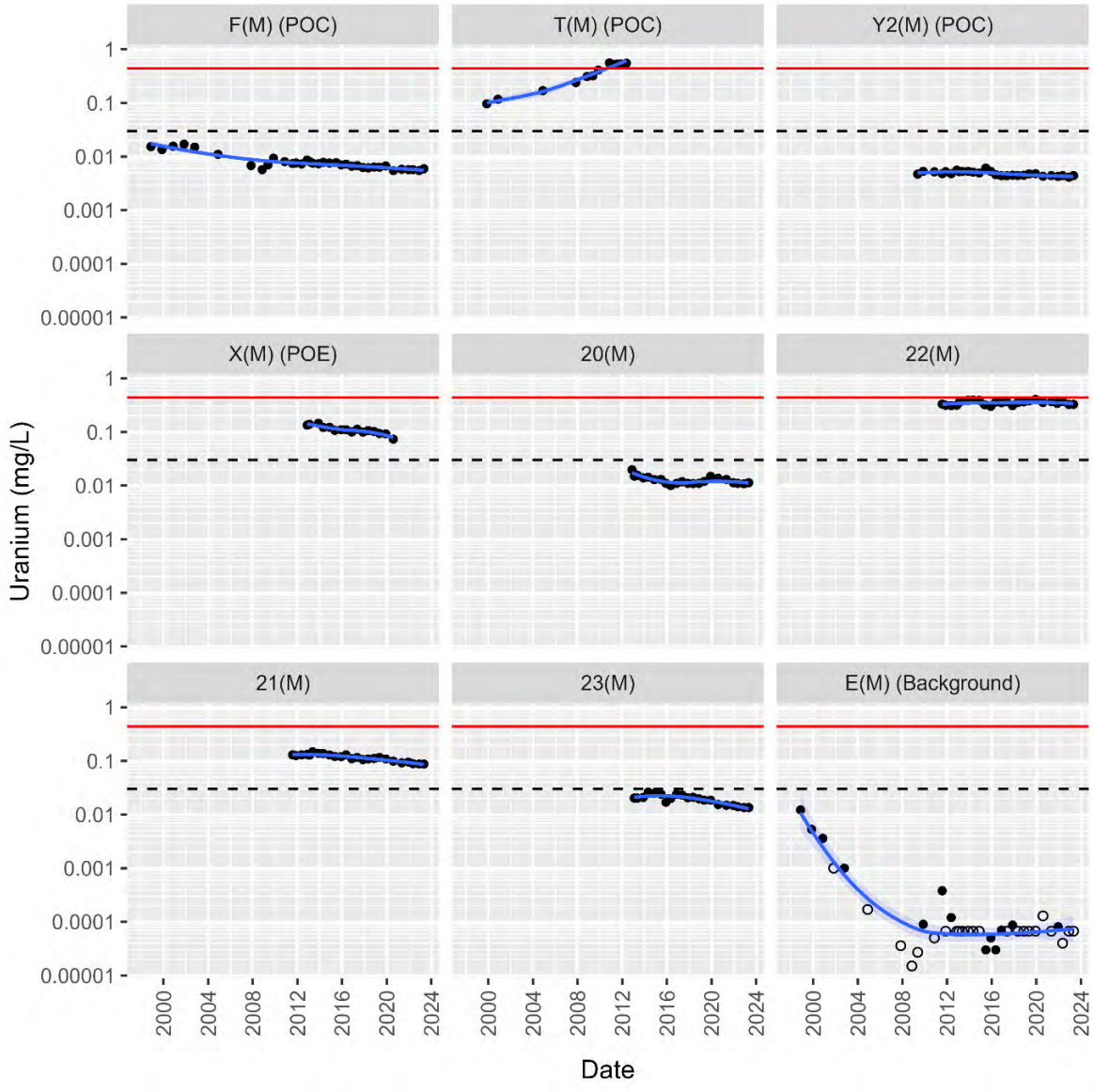
Figure 1-4. Molybdenum and Selenium Concentrations in Alluvial Aquifer Monitoring Wells at the Bluewater, New Mexico, Disposal Site: 1998–2023

Figure 1-5 shows historical uranium concentrations measured in all Bluewater site wells screened in the alluvial aquifer and listed in Table 1-2. In contrast to previous annual reports, Figure 1-4 and Figure 1-5 (and remaining time-concentration plots presented in this section) use a faceting approach, whereby data are partitioned into a matrix of panels, with each panel plotting data for a single well. In each facet plot, a nonparametric smoothing method—locally estimated scatterplot smoothing (LOESS)—is used. The surrounding shaded area represents the 95% pointwise confidence interval. Using this approach, overall trends in the data are more apparent and not obscured by "noise" or random variation.[2] To support interpretation of these figures, Mann-Kendall trend analysis was performed for each well-parameter combination to characterize whether trends in uranium (the primary site contaminant), molybdenum, or selenium are upward, stable (no trend), or declining. Detailed Mann-Kendall trend test results for Bluewater site alluvial wells are documented in Table 1-5.

Uranium concentrations in alluvial wells are currently below the corresponding ACL and NRC-approved health-based standard of 0.44 milligram per liter (mg/L) (Table 1-4). The only well in which the uranium ACL has been exceeded is POC well T(M), where uranium concentrations in well T(M) began trending upward in 1999, from 0.096 mg/L to 0.5–0.6 mg/L (Figure 1-5). The November 2010 concentration of 0.56 mg/L was the first of five results from this well that exceeded the ACL of 0.44 mg/L. LM notified NRC of the exceedance upon receiving the 2010 results from the laboratory. NRC requested that LM evaluate the performance of the main tailings disposal cell to assess whether the increase in uranium concentrations at well T(M) could be attributed to seepage from the cell. LM's subsequent evaluations (DOE 2014; SRNL 2014) concluded that this was not the case. There was no evidence of compromised disposal cell performance, nor any indication of seepage (DOE 2014). Rather, the increase in uranium concentrations was attributed to a concomitant decrease in water levels in the well between 2008 and 2012, during which time the groundwater elevation decreased to levels below the contact between the alluvium and underlying Chinle Formation (DOE 2014). Well T(M) was last sampled in May 2012, and the well has since been dry.

Wells 21(M) and 22(M) were installed in 2011 as a direct response to the ACL exceedance in well T(M) and to better monitor the alluvial aquifer downgradient of well T(M) (Figure 1-3). Although below the ACL, uranium concentrations in these two wells continue to exceed the 0.03 mg/L EPA drinking water standard (Table 1-4; Figure 1-5). Uranium concentrations in well 22(M), at the approximate midpoint between POC well T(M) (Figure 1-3), have been stable between 0.3 and 0.40 mg/L (just below the ACL). Uranium concentrations in downgradient well 21(M), at the southeast corner of the site, have been slightly lower (0.09–0.15 mg/L) and have (along with most other alluvial wells) a statistically significant decreasing trend (Table 1-5). Uranium concentrations in well X(M) have also been consistently above the EPA standard, with levels ranging from 0.073–0.145 mg/L (Figure 1-5). This well has not been sampled since August 2020 because it has been dry or had insufficient water to sample. Uranium concentrations in five of the nine alluvial wells have been consistently below the 0.03 mg/L EPA standard: POC wells F(M) and Y2(M), well 20(M), southeasternmost well 23(M), and background well E(M). Statistically significant decreasing trends in uranium concentrations were identified for all wells except T(M) (increasing trend before going dry) and well 22(M) (no trend) (Table 1-5).

[2] All facet plots provided in this section were developed using R, version 4.3.1 (The R Foundation 2023) and the ggplot2 package, version 3.4.2 (Wickham 2016).



Notes: The date scale begins in 1998, the first sampling event after the LTSP was issued (DOE 1997). Wells are ordered by purpose as follows: POC and POE wells are listed first, followed by the remaining alluvial wells listed in Table 1-2, ordered by flow direction (upgradient to downgradient) as shown in Figure 1-3. Data for background well E(M) are plotted last. Based on observations and measurements during semiannual sampling events, POC well T(M) has been dry since November 2012. POE well X(M) has been dry or had insufficient water to sample since May 2021. Statistically significant decreasing trends in uranium concentrations were identified for all wells except T(M) (increasing trend) and well 22(M) (no trend) (Table 1-5).

Figure 1-5. Uranium Concentrations in Alluvial Aquifer Monitoring Wells at the Bluewater, New Mexico, Disposal Site

Table 1-5. Mann-Kendall Trend Analysis Results for Uranium, Molybdenum, and Selenium in Bluewater Site Alluvial Monitoring Wells

Well[c]	Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Number of Nondetects	Kendall's tau[d]	p-value[d]	Trend[d]
Uranium							
20(M)	11/14/2012	5/2/2023	22	0	−0.377	0.015	Decreasing
21(M)	7/27/2011	5/3/2023	25	0	−0.753	<0.0001	Decreasing
22(M)	7/27/2011	5/2/2023	25	0	0.117	0.43	No Trend
23(M)	1/28/2013	5/3/2023	21	0	−0.648	<0.0001	Decreasing
E(M)	11/14/1998	5/2/2023	36	23	−0.235	0.031	Decreasing
F(M)[a]	11/14/1998	5/3/2023	36	0	−0.654	<0.0001	Decreasing
T(M)[a]	11/11/1999	5/15/2012	12	0	0.879	<0.0001	Increasing
X(M)	11/15/2012	8/5/2020	16	0	−0.758	<0.0001	Decreasing
Y2(M)	5/13/2009	5/3/2023	28	0	−0.492	0.00025	Decreasing
Molybdenum							
20(M)	11/14/2012	5/2/2023	22	1	−0.0606	0.71	No Trend
21(M)	7/27/2011	5/3/2023	25	4	0.0467	0.76	No Trend
22(M)[a]	7/27/2011	5/2/2023	25	1	0.603	<0.0001	Increasing
23(M)	1/28/2013	5/3/2023	21	0	−0.838	<0.0001	Decreasing
E(M)	11/14/1998	5/2/2023	35	16	−0.333	0.0041	Decreasing
F(M)	11/14/1998	5/3/2023	35	9	0.151	0.20	No Trend
T(M)	11/11/1999	5/15/2012	10	1	−0.267	0.32	No Trend
X(M)[b]	11/15/2012	8/5/2020	16	5	0	1	No Trend
Y2(M)	11/10/2009	5/3/2023	27	1	−0.0883	0.53	No Trend
Selenium							
20(M)	11/14/2012	5/2/2023	22	1	−0.238	0.12	No Trend
21(M)	7/27/2011	5/3/2023	25	0	0	1	No Trend
22(M)	7/27/2011	5/2/2023	25	1	−0.193	0.18	No Trend
23(M)	1/28/2013	5/3/2023	21	9	−0.238	0.12	No Trend
E(M)	11/14/1998	5/2/2023	35	30	−0.0807	0.47	No Trend
F(M)	11/14/1998	5/3/2023	35	21	−0.0538	0.64	No Trend
T(M)	11/11/1999	5/15/2012	10	0	−0.556	0.032	Decreasing
X(M)[b]	11/15/2012	8/5/2020	16	0	0.208	0.28	No Trend
Y2(M)[a]	11/10/2009	5/3/2023	27	16	−0.0142	0.93	No Trend

Notes:

[a] POC well.

[b] POE well.

[c] Results for uranium are listed first as concentrations of molybdenum and selenium have been well below corresponding ACLs in all wells as shown in Figure 1-4.

[d] Trend tests were performed using the "NADA: Nondetects and Data Analysis for Environmental Data" package in R, version 1.6-1.1 (Lee 2020). The NADA trend test is similar to the traditional Mann-Kendall trend test except that it accounts for the presence of nondetects at multiple detection limits. Trend analyses were conducted at the 0.05 significance (or alpha) level using a two-sided test. The test statistic, Kendall's tau, is a measure of the strength of the association between two variables, with values always falling between −1 and +1.

The continued elevated uranium concentrations in downgradient wells 22(M) and 21(M) and POE well X(M) (before the well went dry) indicate that alluvial groundwater with uranium concentrations exceeding the EPA drinking water standard (0.03 mg/L) is moving downgradient

from the site boundary to the southeast. The extent of uranium contamination in the alluvial aquifer was evaluated as part of a conceptual model developed for the Bluewater site (DOE 2014) and in a subsequent updated map of the uranium plume (DOE 2019). The updated evaluations indicated that groundwater flows preferentially east-southeast through coarse-grained sediments (clean sands and gravels) in a paleochannel of the ancestral Rio San Jose (DOE 2019). Approximately 1 mile downgradient of the site, Bluewater site-derived contaminated groundwater in the paleochannel merges with other contaminated alluvial groundwater in another paleochannel at the base of the San Mateo Creek alluvial aquifer flowing westward from the Homestake Mining Company (Homestake) mill site. Downgradient of the confluence of the Rio San Jose and San Mateo Creek alluvial aquifers, groundwater flow is to the southeast toward the village of Milan (DOE 2014; DOE 2017).

To support ongoing site reclamation activities, Homestake continually monitors an extensive network of alluvial wells in the region as documented in annual monitoring reports (e.g., HMC and Hydro-Engineering, 2021). Although some non-LM alluvial-aquifer wells downgradient of the Bluewater site (e.g., wells 636, 637 and 686, intermittently monitored by Homestake) have had uranium concentrations exceeding the EPA standard (e.g., Figure 53 in DOE 2014), the provenance of this contamination is not known. Also, there is no evidence that these wells are used for domestic purposes. The New Mexico Office of the State Engineer implemented a prohibition on new wells within the alluvial aquifer in May 2018. The prohibition applies to new private use wells near and downgradient of the Bluewater site (Romero 2018).

1.7.2 SAG Bedrock Aquifer

Table 1-6 lists analytical results for selenium and uranium in the SAG aquifer wells for groundwater samples collected in November 2022 and May 2023. As has been the case historically, selenium and uranium concentrations did not exceed corresponding ACLs in any of the site wells during the 2022–2023 reporting period.

To gain a better understanding of the hydrogeological characteristics of the SAG aquifer at the site, wells 11(SG), 13(SG), 14(SG), 15(SG), 16(SG), and 18(SG) were installed in summer 2012 at the locations shown in Figure 1-3. Wells 11(SG) and 14(SG) are cross gradient of the disposal cell; all the other new wells are downgradient. Before installation of the new SAG wells, POC wells OBS−3 and S(SG) were found to have highly corroded well screens, resulting in samples with anomalously low uranium concentrations. Therefore, well 16(SG) was installed in the same vicinity (Figure 1-3) and intended as a surrogate or replacement POC well. Although wells OBS–3 and S(SG) continue to be sampled in accordance with the LTSP (DOE 2014), they are no longer considered representative of aquifer conditions in this region.

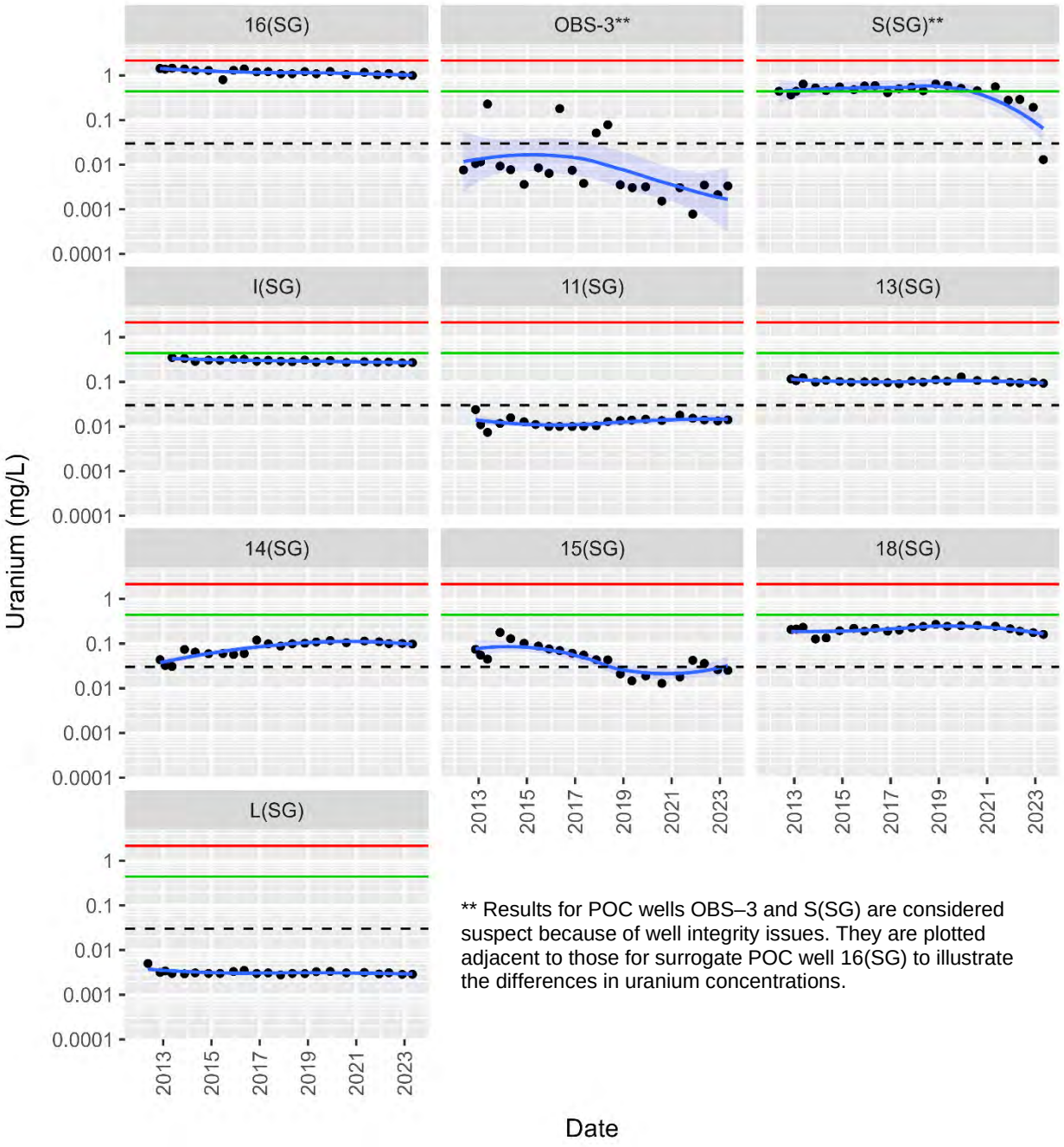
As shown in Table 1-6, selenium results for half of the 10 SAG wells currently monitored were below detection limits; the remainder were (and have been) below the 0.05 mg/L ACL. Uranium concentrations in site wells continue to be below the 2.15 mg/L ACL. For all wells except surrogate POC well 16(SG), with current levels of about 1 mg/L, uranium concentrations are also below the 0.44 mg/L NRC-approved health-based standard. Before discussing uranium and selenium concentration trends in Bluewater site SAG wells, a brief discussion is warranted about the changes in the SAG aquifer monitoring network since the LTSP was issued.

Table 1-6. SAG Aquifer Monitoring Results for November 2022 and May 2023 at the Bluewater, New Mexico, Disposal Site

Monitoring Well	Selenium (mg/L) ACL = 0.05 mg/L		Uranium (mg/L) ACL = 2.15 mg/L	
	November 2022	May 2023	November 2022	May 2023
11(SG)	<0.0015	<0.0015	0.0133	0.0141
13(SG)	0.00664	0.00734	0.0988	0.0928
14(SG)	<0.0015	<0.0015	0.101	0.098
15(SG)	<0.0015	<0.0015	0.026	0.0252
16(SG)[a]	0.0131	0.0146	1.01	0.994
18(SG)	0.0053	0.00581	0.176	0.161
I(SG)[b]	0.00617	0.00674	0.265	0.271
L(SG)	<0.0015	<0.0015	0.00286	0.00288
OBS−3[a,c]	<0.0015	<0.0015	0.00213	0.00334
S(SG)[a,c]	0.00375	<0.0015	0.193	0.013

Notes:
For duplicate analyses, the maximum result is listed.
[a] Surrogate POC well (for wells OBS-3 and S(SG)).
[b] POE well.
[c] Results for POC wells OBS–3 and S(SG) (shaded cells) are not considered representative of aquifer conditions due to corrosion in the well screen and other factors. Results for surrogate POC well 16(SG) are considered most representative of aquifer conditions in this region of the site.

Figure 1-6 plots uranium concentrations in the SAG aquifer monitoring wells for 2012–2023. This time frame was chosen because (1) monitoring at most of the wells—11(SG) through 18(SG)—did not begin until November 2012 and (2) some results for remaining wells with a longer monitoring history are considered erroneous due to either insufficient sample depths or well integrity issues. For example, previous results for well I(SG) are not shown because incorrect sampling depths in the well led to erroneously low results from 2008 to 2013 (DOE 2014). Although results are shown in Figure 1-6, uranium concentrations measured in POC wells S(SG) and OBS−3, in particular, are not considered representative of aquifer conditions. These results are plotted alongside those for surrogate POC well 16(SG) in Figure 1-6 to facilitate comparisons but are not used in the following interpretations.



** Results for POC wells OBS–3 and S(SG) are considered suspect because of well integrity issues. They are plotted adjacent to those for surrogate POC well 16(SG) to illustrate the differences in uranium concentrations.

● Detect ○ Nondetect
LOESS line and 95% confidence interval
2.15 mg/L ACL; 0.44 mg/L NRC health-based standard; - - - 0.03 mg/L EPA standard

Notes: The date scale begins in 2012, coinciding with the installation of the 11–18(SG) well series. Data for wells with a longer monitoring history (e.g., POE well I[SG] and background well L[SG]) are not shown because previous incorrect sample depths at times yielded erroneously low results. Wells are ordered by purpose: POC and POE wells are listed first, followed by the remaining wells listed in Table 1-2; data for background well L(SG) are plotted last. Statistically significant increasing trends in uranium concentrations were found for wells 11(SG), 14(SG), and 18(SG). Significant decreasing trends were found for all remaining wells except 13(SG) and background well L(SG), both with no trend (Table 1-7).

Figure 1-6. Uranium Concentrations in the SAG Aquifer at the Bluewater, New Mexico, Disposal Site

Uranium concentrations in all Bluewater site SAG wells have been consistently below the 2.15 mg/L ACL (Figure 1-6). Uranium concentrations have also been below the site-specific NRC-approved health-based standard of 0.44 mg/L, with the exception of well 16(SG), with concentrations ranging from 0.8–1.45 mg/L. However, onsite SAG wells, including SAG wells near the downgradient site boundary, have consistently exceeded the 0.03 mg/L EPA drinking water standard for uranium. Exceptions are well 11(SG) at the northern site boundary, background well L(SG), and, periodically, well 15(SG) (Figure 1-6). Mann-Kendall trend analysis identified statistically significant decreasing uranium trends in well 15(SG), installed near alluvial well T(M), well 16(SG), and POE well I(SG) (Table 1-7). Uranium concentrations in well I(SG), at the eastern site boundary, have ranged from 0.15–0.35 mg/L; the most recent (May 2023) result was 0.271 mg/L (Table 1-6).

Statistically significant increasing trends in uranium concentrations were identified for two SAG wells: cross-gradient well 11(SG) (northern site boundary) and 14(SG), at the southwestern site boundary. The significant increase in well 14(SG) reflects an increase from 0.031 mg/L in 2013 to 1.2 mg/L in November 2016, but since then, concentrations have remained relatively constant at about 0.l mg/L (most recent result of 0.098 mg/L). No significant trend was found for three wells: 13(SG), 18(SG), and background well L(SG) (Table 1-6).

Uranium concentration trends in offsite wells, including privately owned and nearby municipal drinking water wells monitored by Homestake or NMED, were described in *Evaluating the Influence of High-Production Pumping Wells on Impacted Groundwater at the Bluewater, New Mexico, Disposal Site* (DOE 2020). Offsite wells either had a decreasing statistically significant trend or no statistical trend in uranium concentration between 2012 and 2018. At that time, all offsite wells had uranium concentrations below the EPA standard of 0.03 mg/L except for two wells (951 and 951R) owned by Homestake Mining Company, with uranium concentrations slightly exceeding the EPA standard. Well 951 is just outside the southeastern boundary of the Bluewater site (Figure 1-3) and is routinely monitored by LM (and was previously intermittently monitored by Homestake). Using validated data since 2013, uranium concentrations in this well have been stable (no significant trend), with a mean and standard deviation of 0.032 ± 0.005 mg/L. Uranium concentrations in 2022 and 2023 were at or slightly below the standard (0.0278–0.0295 mg/L). Monitoring well 951R also had no trend (DOE 2020) and is approximately 2 miles southeast of the site, nearer to the Homestake site (Figure 1-3). LM continues to monitor groundwater quality in offsite wells completed in the SAG aquifer as part of the cooperative agreement between DOE and NMED and to assess potential offsite migration of contaminants.

Although monitoring of the SAG aquifer at the site has focused on uranium, selenium is also a required analyte in accordance with the LTSP (Table 1-3). To conclude this section and to demonstrate that selenium concentrations in SAG aquifer wells at the site have been consistently below the ACL, Figure 1-7 plots selenium data from 2012–2023. Selenium concentrations in most wells continue to be well below the 0.05 mg/L ACL and are often below detection limits. The highest selenium concentrations have been measured in well 16(SG), where results have ranged from 0.01–0.02 mg/L (most recent result of 0.0146 mg/L) and a statistically significant decreasing trend was identified (Table 1-7). A statistically significant decreasing trend in selenium concentrations was also identified for well I(SG), reflecting the trend in results after the initial nondetect observation (Figure 1-7). No significant trends in selenium concentrations were found for the remaining SAG aquifer wells.

Table 1-7. Mann-Kendall Trend Analysis Results for Uranium and Selenium in Bluewater Site SAG Monitoring Wells

Well[a]	Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Number of Nondetects	Kendall's tau[b]	p-value[b]	Trend[b]
Uranium							
11(SG)	11/14/2012	5/2/2023	22	0	0.325	0.037	Increasing
13(SG)	11/15/2012	5/3/2023	22	0	−0.234	0.13	No Trend
14(SG)	11/14/2012	5/2/2023	22	0	0.528	0.00064	Increasing
15(SG)	11/13/2012	5/2/2023	22	0	−0.619	<0.0001	Decreasing
16(SG)[c]	11/13/2012	5/1/2023	22	0	−0.619	<0.0001	Decreasing
18(SG)	11/14/2012	5/3/2023	22	0	0.143	0.37	No Trend
I(SG)[d]	5/15/2013	5/2/2023	20	0	−0.642	<0.0001	Decreasing
L(SG)	5/15/2012	5/2/2023	23	0	−0.261	0.085	No Trend
Selenium							
11(SG)	11/14/2012	5/2/2023	22	21	−0.0303	0.84	No Trend
13(SG)	11/15/2012	5/3/2023	22	1	0.203	0.19	No Trend
14(SG)	11/14/2012	5/2/2023	22	21	−0.0173	0.92	No Trend
15(SG)	11/13/2012	5/2/2023	22	21	−0.0563	0.70	No Trend
16(SG)[c]	11/13/2012	5/1/2023	22	0	−0.468	0.0025	Decreasing
18(SG)	11/14/2012	5/3/2023	22	1	0.152	0.33	No Trend
I(SG)[d]	5/15/2012	5/2/2023	21	1	−0.467	0.0034	Decreasing
L(SG)	5/15/2012	5/2/2023	23	22	0.00395	1	No Trend

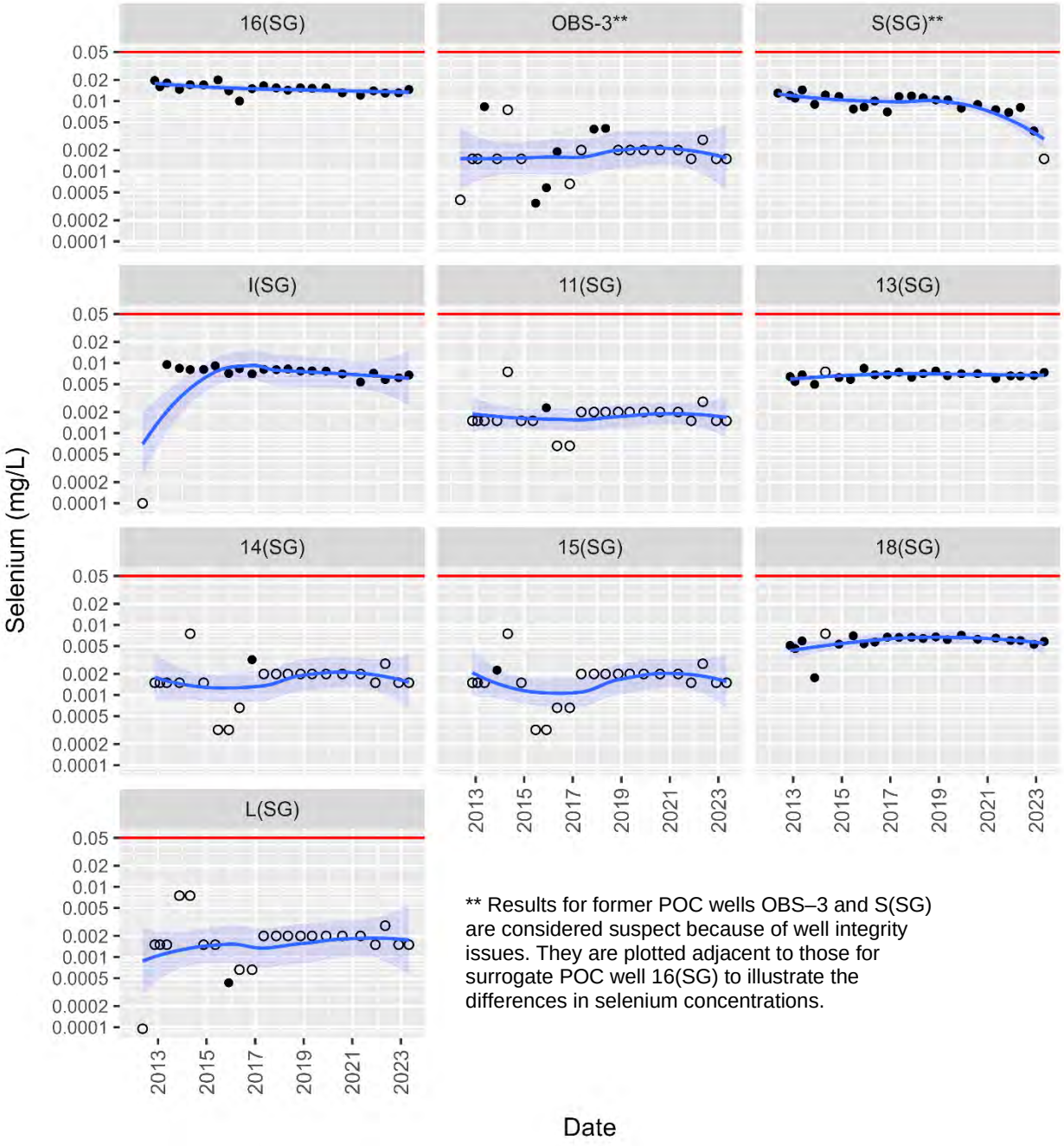
Notes:

[a] Trend analyses were not conducted for initial POC wells OBS–3 and S(SG) because these wells are no longer considered representative of aquifer conditions. Results for surrogate POC well 16(SG) are considered most representative of aquifer conditions in this region of the site.

[b] Trend tests were performed using the "NADA: Nondetects and Data Analysis for Environmental Data" package in R, version 1.6-1.1 (Lee 2020). The NADA trend test is similar to the traditional Mann-Kendall trend test except that it accounts for the presence of nondetects at multiple detection limits. Trend analyses were conducted at the 0.05 significance (or alpha) level using a two-sided test. The test statistic, Kendall's tau, is a measure of the strength of the association between two variables, with values always falling between −1 and +1.

[c] Surrogate POC well for wells OBS-3 and S(SG).

[d] POE well.



Notes: The date scale begins in 2012, coinciding with the installation of the 11–18(SG) well series. Refer to notes supporting Figure 1-6 for additional details. Wells are ordered by purpose: POC and POE wells are listed first, followed by the remaining wells listed in Table 1-2; data for background well L(SG) are plotted last. Mann-Kendall trend analysis identified a significant decreasing trend in selenium concentrations for surrogate POC well 16(SG). No significant trends were found for remaining wells (Table 1-7).

Figure 1-7. Selenium Concentrations in the SAG Aquifer at the Bluewater, New Mexico, Disposal Site

1.8 References

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40 CFR 192. U.S. Environmental Protection Agency, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," *Code of Federal Regulations.*

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1.9 Photographs

Photograph Location Number	Azimuth	Photograph Description
PL−1	250	Erosion of Site Road Along Northwestern Corner
PL−2	90	Wind Erosion on Eastern Fence Line (Hanging T-Post)
PL−3	350	Hanging T-Posts Between Boundary Monuments BM-12 and BM-11
PL−4	180	Perimeter Sign P36
PL−5	—	Site Marker
PL−6	300	Boundary Monument BM-2
PL−7	300	Perimeter Sign P28 and Quality Control Monument QC-1
PL−8	0	SOARS Station
PL−9	340	Abandoned Animal Burrows near Monitoring Well F(M)
PL−10	0	Main Tailings Disposal Cell Top Slope Vegetation
PL−11	170	Overview of Siphon and Vegetation on Disposal Cell Top Slope
PL−12	180	Siphon Outlet on Main Tailings Disposal Cell North Side Slope
PL−13	70	Potential Depression Area on Top Slope at Top Slope/Side Slope Boundary
PL−14	160	Potential Depression Area on Main Tailings Disposal Cell Southwest Side Slope
PL−15	290	Minor Depression on Main Tailings Disposal Cell South Side Slope
PL−16	220	Minor Depression on Main Tailings Disposal Cell South Side Slope
PL−17	290	Rilling Between Perimeter Signs P31 and P30
PL−18	150	Rilling near Perimeter Sign P24
PL−19	290	Animal Burrow on Acid Tailings Disposal Area
PL−20	340	Shallow Depression on Northwest Extension of Carbonate Tailings

Photograph Location Number	Azimuth	Photograph Description
PL−21	330	Minor Depression with Vegetation Growth on Carbonate Tailings Disposal Cell Top Slope
PL−22	85	PCB Disposal Area Cover
PL−23	—	East Dump Minor Erosion Area
PL−24	0	Dry Ephemeral Pond

Note:
— = Photograph taken vertically from above.

PL−1. Erosion of Site Road Along Northwestern Corner

PL−2. Wind Erosion on Eastern Fence Line (Hanging T-Post)

PL−3. Hanging T-Posts Between Boundary Monuments BM-12 and BM-11

PL−4. Perimeter Sign P36

PL−5. Site Marker

PL−6. Boundary Monument BM-2

PL−7. Perimeter Sign P28 and Quality Control Monument QC-1

PL−8. SOARS Station

PL−9. Abandoned Animal Burrows near Monitoring Well F(M)

PL−10. Main Tailings Disposal Cell Top Slope Vegetation

PL−11. Overview of Siphon and Vegetation on Disposal Cell Top Slope

PL−12. Siphon Outlet on Main Tailings Disposal Cell North Side Slope

PL−13. Potential Depression Area on Top Slope at Top Slope/Side Slope Boundary

PL−14. Potential Depression Area on Main Tailings Disposal Cell Southwest Side Slope

PL−15. Minor Depression on Main Tailings Disposal Cell South Side Slope

PL−16. Minor Depression on Main Tailings Disposal Cell South Side Slope

PL−17. Rilling Between Perimeter Signs P31 and P30

PL−18. Rilling near Perimeter Sign P24

PL−19. Animal Burrow on Acid Tailings Disposal Area

PL−20. Shallow Depression on Northwest Extension of Carbonate Tailings

PL−21. Minor Depression with Vegetation Growth on Carbonate Tailings Disposal Cell Top Slope

PL−22. PCB Disposal Area Cover

PL−23. East Dump Minor Erosion Area

PL−24. Dry Ephemeral Pond

2.0 Edgemont, South Dakota, Disposal Site

2.1 Compliance Summary

The Edgemont, South Dakota, Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II Disposal Site was inspected on July 26, 2023. No changes were observed in the disposal cell cover. In addition to the two previously identified depressions, a small new depression feature was noted on the riprap-armored containment dam. Inspectors identified no maintenance needs or cause for a follow-up inspection. Groundwater monitoring is not required at the site.

2.2 Compliance Requirements

Requirements for the long-term surveillance and maintenance of the site are specified in the site-specific Long-Term Surveillance Plan (DOE 1996) (LTSP) in accordance with procedures established to comply with the requirements of the U.S. Nuclear Regulatory Commission (NRC) general license at Title 10 *Code of Federal Regulations* Section 40.28 (10 CFR 40.28). Table 2-1 lists these requirements.

Table 2-1. License Requirements for the Edgemont, South Dakota, Disposal Site

Requirement	LTSP	This Report	10 CFR 40.28
Annual Inspection and Report	Sections 3.3 and 3.4	Section 2.4	(b)(3)
Follow-Up Inspections	Section 3.5	Section 2.5	(b)(4)
Routine Maintenance and Emergency Measures	Section 3.6	Section 2.6	(b)(5)
Environmental Monitoring	Section 3.7	Section 2.7	(b)(3)

2.3 Institutional Controls

The 360-acre site, identified by the property boundary shown in Figure 2-1, is owned by the United States and was accepted under the NRC general license in 1996. The U.S. Department of Energy (DOE) is the licensee and, in accordance with the requirements for UMTRCA Title II sites, the Office of Legacy Management (LM) is responsible for the custody and long-term care of the site. Institutional controls (ICs) at the site include federal ownership of the property, administrative controls, and the following physical ICs that are inspected annually: the disposal cell, entrance gate and sign, perimeter fence and signs, site marker, and boundary monuments.

2.4 Inspection Results

The site, approximately 2 miles south of Edgemont, South Dakota, was inspected on July 26, 2023. The inspection was conducted by J. Cario and T. Santonastaso of the Legacy Management Support (LMS) contractor. J. Hugo (LMS) participated in the inspection to evaluate the depression features that were observed on the containment dam in 2021. M. Guziak (LMS) and N. Keller (LM site manager), as well as T. Johnson and M. LaFranzo (NRC), attended the inspection. The purposes of the inspection were to confirm the integrity of visible features at the site, identify changes in conditions that might affect conformance with the LTSP, and evaluate whether maintenance or follow-up inspection and monitoring are needed.

A grazing license granted by LM allows a local rancher to graze his cattle on the site. The LM site manager met with the grazing licensee during the inspection to discuss any issues or concerns the licensee might have. The grazing licensee did not identify any concerns.

2.4.1 Site Surveillance Features

Figure 2-1 shows the locations of site features, including site surveillance features and inspection areas, in black and gray font. Some site features that are present but not required to be inspected are shown in italic font. Observations from previous inspections that are currently monitored are shown in blue, and new observations identified during the 2023 annual inspection are shown in red. Inspection results and recommended maintenance activities associated with site surveillance features are described in the following subsections. Photographs to support specific observations are noted in the text and in Figure 2-1 by photograph location (PL) numbers. The photographs and photograph log are presented in Section 2.9.

2.4.1.1 Site Access and Entrance Gate

Access to the site is from Fall River County Road 6N. The entrance sign, which is mounted on a steel post set in concrete, was in good condition (PL-1). The tubular metal entrance gate was secured by a locked chain and was intact. The perimeter fence features three additional wire gates at the following locations: (1) the northwest corner of the property, (2) approximately 700 feet north of the southeast corner (PL-2), and (3) the southeast corner of the site. All gates were closed, locked, and intact. No maintenance needs were identified.

2.4.1.2 Perimeter Fence and Signs

A four-strand barbed-wire fence encloses the site, truncating at the southeast corner to allow livestock access to a preexisting stock pond. There are two perimeter signs. Perimeter sign P1 attached at the northwest corner of the perimeter fence was missing and perimeter sign P2 (PL-3) is attached to the perimeter fence on the east side. By the 2024 inspection, perimeter sign P1 will be reattached to the perimeter fence.

The grazing licensee monitors site security and maintains the perimeter fence. An erosional feature is present along the northwest side of the fence but is not compromising the fence. No maintenance needs were identified.

The licensee proposed removing the unmaintained interior fence that was installed to prevent grazing during vegetation establishment following closure of the disposal cell. The LM site manager concurred with this proposal. The fence will be removed by the grazing licensee at a later date.

2.4.1.3 Site Marker

The granite site marker is inside the entrance gate (PL-4). No maintenance needs were identified during the inspection.

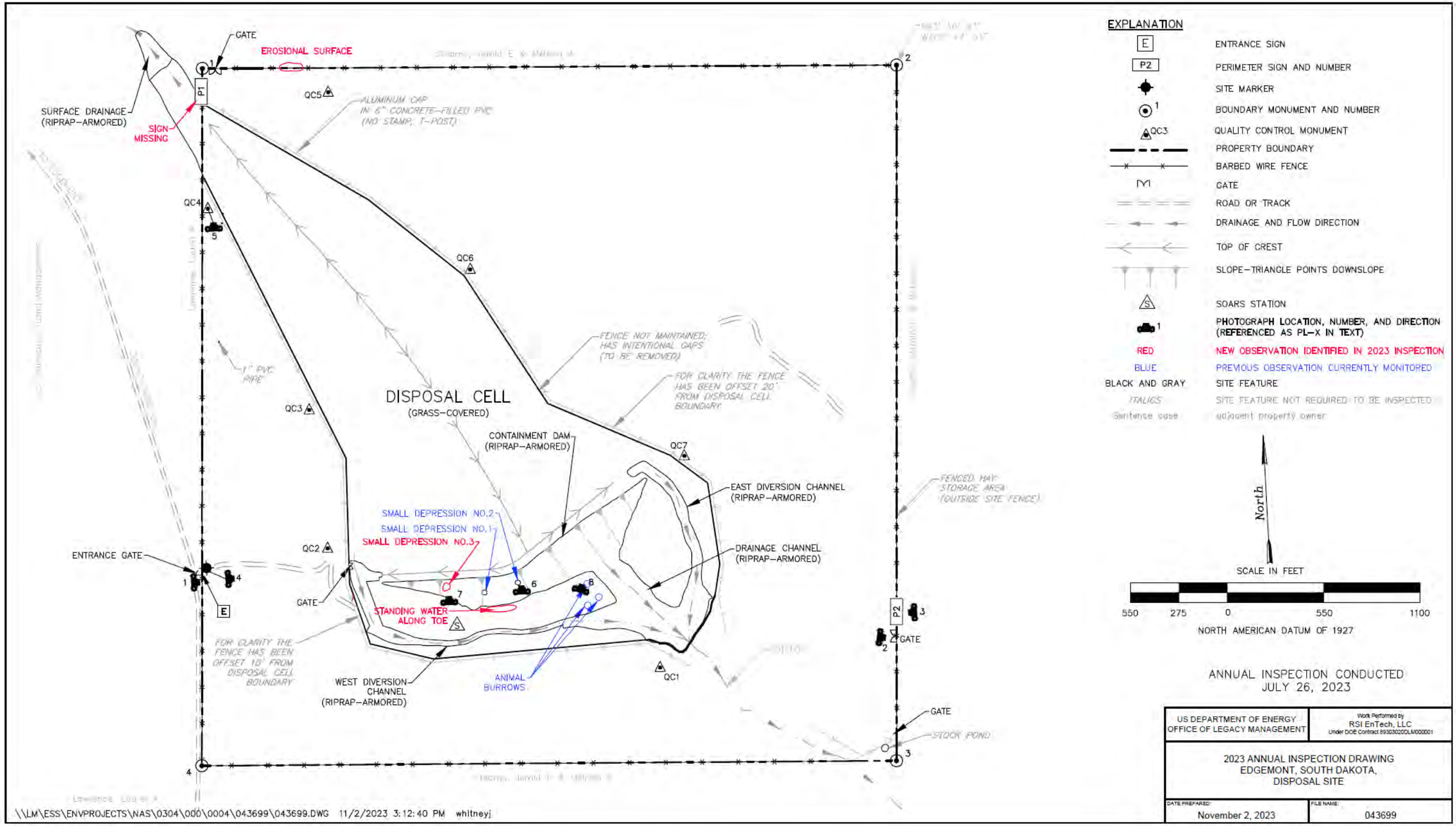


Figure 2-1. 2023 Annual Inspection Drawing for the Edgemont, South Dakota, Disposal Site

2.4.1.4 Boundary Monuments

There are four boundary monuments, one at each corner of the site. The stock pond was observed to be encroaching BM-3 at the time of inspection. Saturated soils could eventually displace the boundary monument. No maintenance needs were identified.

2.4.1.5 Aerial Survey Quality Control Monuments

LM installed seven aerial survey quality control monuments in 2019 and conducted a baseline aerial survey in 2021. The quality control monuments were inspected during the 2023 annual inspection (PL-5). No maintenance needs were identified.

2.4.2 Inspection Areas

In accordance with the LTSP, the site is divided into three inspection areas (referred to as "transects" in the LTSP) to ensure a thorough and efficient inspection. The inspection areas are (1) the cover of the disposal cell; (2) the containment dam and diversion channels; and (3) the site perimeter, outlying areas, and balance of the site. Inspectors examined specific site surveillance features within each area and looked for evidence of erosion, settling, slumping, or other modifying processes that might affect conformance with LTSP requirements.

2.4.2.1 Cover of the Disposal Cell

The grass-covered disposal cell, completed in 1989, occupies 100 acres. No signs of erosion, settling, or other modifying processes were found that could affect its integrity. No maintenance needs were identified.

2.4.2.2 Containment Dam and Diversion Channels

The face of the containment dam is armored with riprap. Two small depressions were observed on the containment dam during the 2021 annual inspection and measured during the 2023 inspection. Small Depression No. 1 measures approximately 25-inches long, 30-inches wide, and 17-inches deep. Small Depression No. 2 (PL-6) measures approximately 48-inches long 37-inches wide, and 9.5-inches deep. No changes to the two depressions were identified since their discovery. A new depression, Small Depression No. 3, was identified during the 2023 inspection and was measured to be about 32-inches long, 24-inches wide, and 1-foot deep (PL-7). No evidence of sediment deposition, human intervention, or other modifying processes were observed near these depressions. The three depressions do not threaten the integrity or performance of the disposal cell; however, monitoring of the depressions will continue during annual inspections and subsequent surveys. There was standing water at the toe of the containment dam consistent with the above-average water year. Grasses and annual weeds were growing in the riprap in several places. The presence of plants and standing water do not threaten the stability or function of the containment dam.

The diversion and drainage channels are covered with grass on the upslope portions and armored with riprap on the downslope portions and on steep slopes. Sparse vegetation in the riprap helps to stabilize these areas and does not impair the function of the channels. Wetland vegetation is at the base of the drainage channel outflow. No maintenance needs were identified.

In August 2023, a remote telemetry meteorological station, also known as a System Operation and Analysis at Remote Sites (SOARS) station, was installed near the containment dam to monitor local weather conditions at the site and view conditions using a web camera.

2.4.2.3 Site Perimeter, Outlying Areas, and Balance of the Site

The site is surrounded by private land used primarily for grazing and wildlife habitat. The area approximately 0.25 mile beyond the site boundary—including a surface drainage area just outside the northwest corner of the property that is riprap armored to prevent headward erosion onto the site—was visually observed for erosion, changes in land use, or other phenomena that might affect the long-term integrity of the site. No such changes were identified.

The balance of the site consists of undisturbed areas covered with native shrubs, grasses, and forbs and formerly disturbed areas covered primarily with seeded grasses and annual weeds. Three animal burrows have been observed on the southwestern side of the drainage channel between the riprap-armored containment dam and the west diversion channel. During the 2023 inspection, the burrows were overgrown with vegetation, indicating use has been minimal or nonexistent. The animal burrows are not impacting the functionality of the disposal cell or drainage features (PL-8). Some minor erosional features are on steep slopes in an area isolated from the disposal cell; these features were stable. No maintenance needs were identified.

2.5 Follow-Up Inspections

LM will conduct follow-up inspections if (1) a condition is identified during the annual inspection or other site visit that requires a return to the site to evaluate the condition or (2) LM is notified by a citizen or outside agency that conditions at the site are substantially changed. No need for a follow-up inspection was identified.

2.6 Routine Maintenance and Emergency Measures

Noxious weeds were treated in September 2022. No other maintenance needs were identified.

Emergency measures are corrective actions that LM will take in response to unusual damage or disruption that threatens or compromises site health and safety, security, integrity, or compliance with 40 CFR 192. No emergency measures were identified.

2.7 Environmental Monitoring

In accordance with the LTSP, groundwater monitoring is not required at this site because a 300–700-foot-thick layer of competent shale bedrock lies between the encapsulated tailings and the uppermost confined aquifer. Additionally, clay liners were constructed to isolate the tailings from the shallower, unconfined, perched groundwater that is present because of local precipitation. There is no evidence of any direct hydraulic connection between the perched groundwater and the underlying confined bedrock aquifer.

An annual visual inspection of vegetation conditions required by the LTSP was conducted during the annual inspection. No additional vegetation management is required; however, LM conducts periodic rangeland health assessments as a best management practice to measure ecological health at the site. No cattle were grazing on the site during the inspection.

2.8 References

10 CFR 40.28. U.S. Nuclear Regulatory Commission, "General License for Custody and Long-Term Care of Uranium or Thorium Byproduct Materials Disposal Sites," *Code of Federal Regulations.*

40 CFR 192. U.S. Environmental Protection Agency, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," *Code of Federal Regulations.*

DOE (U.S. Department of Energy), 1996. *Long-Term Surveillance Plan for the DOE Tennessee Valley Authority (UMTRCA Title II) Disposal Site, Edgemont, South Dakota,* NRC Docket File No. 040-01341, June.

2.9 Photographs

Photograph Location Number	Azimuth	Photograph Description
PL-1	90	Entrance Sign
PL-2	100	Southeastern Side Perimeter Fence Gate
PL-3	270	Perimeter Sign P2
PL-4	90	Site Marker
PL-5	—	Quality Control Monument QC-4
PL-6	—	Small Depression No. 2: Depth Measurement
PL-7	—	Small Depression No. 3: New
PL-8	20	Animal Burrow

Note:
— = Photograph taken vertically from above.

PL-1. Entrance Sign

PL-2. Southeastern Side Perimeter Fence Gate

PL-3. Perimeter Sign P2

PL-4. Site Marker

PL-5. Quality Control Monument QC-4

PL-6. Small Depression No. 2: Depth Measurement

PL-7. Small Depression No. 3: New

PL-8. Animal Burrow

3.0 L-Bar, New Mexico, Disposal Site

3.1 Compliance Summary

The L-Bar, New Mexico, Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II Disposal Site was inspected on March 9, 2023. Previous inspections performed in 2021 and 2022, as required by the Long-Term Surveillance Plan (DOE 2004) (LTSP), and associated follow-up site visits, identified numerous surface degradation features on the disposal cell top slope. Two new degradation features on the top slope were identified during the March 2023 inspection. These features represent changes in cell cover characteristics, and an evaluation of the cause and need for repair is ongoing. Additionally, during an Applied Studies and Technology (AS&T) investigation in September and October of 2022, several piping features were discovered on the side slope of the disposal cell. They will continue to be monitored and do not affect the performance of the side slope at this time. Inspectors also identified several routine maintenance needs.

Erosion and vegetation measurements to monitor the condition of the disposal cell top slope were conducted in August 2023, and results are included in Section 3.7.2. The next erosion and vegetation monitoring event is scheduled for August 2024.

Groundwater is monitored every 3 years in accordance with the site-specific U.S. Department of Energy (DOE) Office of Legacy Management (LM) LTSP (DOE 2004). The most recent groundwater sampling event was conducted on November 2, 2022; analytical results from this sampling event are presented in Section 3.7.1.

3.2 Compliance Requirements

Requirements for the long-term surveillance and maintenance of the site are specified in the site-specific LTSP (DOE 2004) in accordance with procedures established to comply with the requirements of the U.S. Nuclear Regulatory Commission (NRC) general license at Title 10 *Code of Federal Regulations* Section 40.28 (10 CFR 40.28). Table 3-1 lists these requirements.

Table 3-1. License Requirements for the L-Bar, New Mexico, Disposal Site

Requirement	LTSP	This Report	10 CFR 40.28
Annual Inspection and Report	Sections 3.3 and 3.4	Section 3.4	(b)(3)
Follow-Up Inspections	Section 3.5	Section 3.5	(b)(4)
Routine Maintenance and Emergency Measures	Section 3.6	Section 3.6	(b)(5)
Environmental Monitoring	Section 3.7	Section 3.7	(b)(3)

3.3 Institutional Controls

The 738-acre site, identified by the property boundary shown in Figure 3-1, is owned by the United States and was accepted under the NRC general license in 2004. DOE is the licensee and, in accordance with the requirements for UMTRCA Title II sites, LM is responsible for the custody and long-term care of the site. Institutional controls (ICs) at the site include federal ownership of the property, administrative controls, and the following physical ICs that are

inspected annually: disposal cell, entrance gate and sign, perimeter fence and signs, site marker, boundary monuments, and monitoring well head protectors.

3.4 Inspection Results

The site, approximately 15 miles north of Laguna, New Mexico, was inspected on March 9, 2023. The inspection was conducted by J. Cario, C. Murphy, T. Santonastaso, and J. Graham of the Legacy Management Support (LMS) contractor. In addition, W. Frazier, M. Young, and N. Olin (LM), as well as A. Rheubottom (New Mexico Environment Department [NMED]) attended the inspection. The erosion and vegetation monitoring event was conducted in August 2023. The purposes of the inspection were to confirm the integrity of visible features at the site, identify changes in conditions that might affect conformance with the LTSP, and evaluate whether maintenance or follow-up inspection and monitoring are needed.

3.4.1 Site Surveillance Features

Figure 3-1 shows the locations of site features, including site surveillance features and inspection areas, in black and gray font. Some site features that are present but not required to be inspected are shown in italic font. Observations from previous inspections that are currently monitored are shown in blue, and new observations identified during the 2023 annual inspection are shown in red. Inspection results and recommended maintenance activities associated with site surveillance features are described in the following subsections. Photographs to support specific observations are noted in the text and in Figure 3-1 by photograph location (PL) numbers. The photographs and photograph log are presented in Section 3.9.

3.4.1.1 Site Access and Entrance Gate

Access to the site is from a public gravel road (Cibola County Road 1). Approximately 300 feet (ft) of Cebolleta Land Grant property is crossed to enter the site. Documentation of access is provided and described in the warranty and quitclaim deed for the site. The entrance gate is a tubular-steel stock gate. The gate was secured by a non-DOE lock without a DOE lock present. The unidentified lock was removed, and the gate was left secured with a DOE lock.

Interior roads used to access LM assets consist of two-track dirt roads with drainage culverts to convey stormwater in key locations. A gully that formed on a side slope of the G3 channel has encroached on the east site access road. Culverts were installed along the access road in 2016 to prevent washout of the road and to control erosion. Sediment is accumulating around one of the three culvert inlets and erosion is also undercutting the outlets, but they are functioning as designed, and no maintenance needs were identified (PL-1).

Access roads are susceptible to erosion and are repaired when they become impassable. In 2023, through an interagency agreement with the U.S. Army Corps of Engineers (USACE), LM is planning to repair access roads and construct low-water crossings in areas impacted by erosion. No additional maintenance needs were identified.

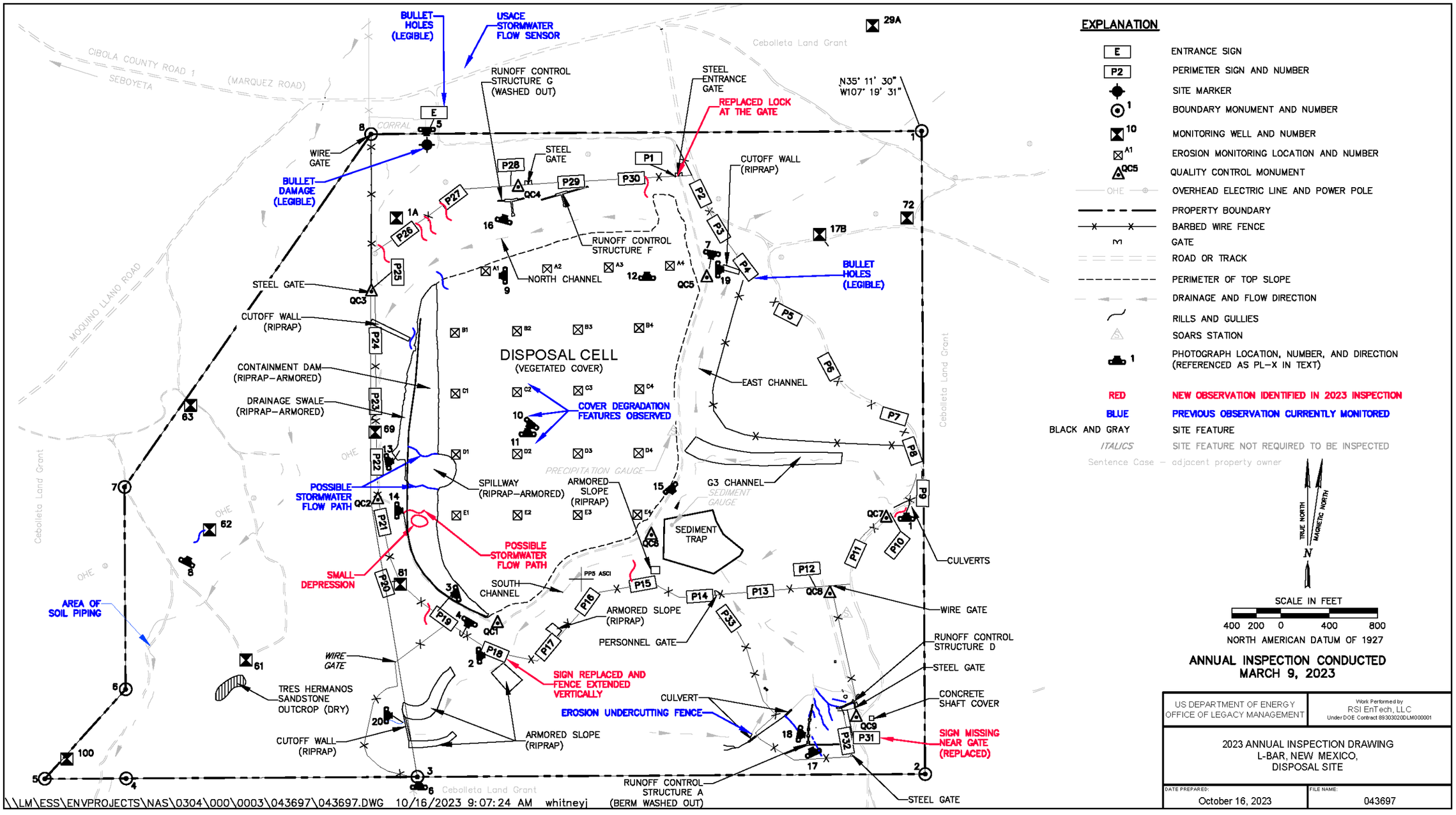


Figure 3-1. 2023 Annual Inspection Drawing for the L-Bar, New Mexico, Disposal Site

3.4.1.2 Fence and Perimeter Signs

A barbed-wire fence encloses the disposal cell and associated drainage structures and is intended to prohibit trespassing and livestock intrusion on the disposal cell to prevent gullies from developing from the livestock trails. The fence is about 3300 ft inside the property boundary, and the area between the fence and the boundary is grazed in accordance with an LM grazing license with the Cebolleta Land Grant stakeholders, who collectively own and manage the surrounding property. Sediment is accumulating along the fence line near perimeter sign P18, and the fence was extended vertically due to the sedimentation. Perimeter sign P18 was replaced during the 2023 annual maintenance trip (PL-2). Erosion is undercutting the perimeter fence in several locations where the fence was extended to prohibit livestock from entering the site (PL-3). New erosion features were noted along the northern fence line. Two tubular steel gates were installed to allow personnel to cross the fence line safely. One gate was installed in 2021 on the west side near perimeter sign P23, and the other gate was installed in 2022 on the south side near perimeter sign P19 (PL-4).

The entrance sign is on the main site access road near the site marker. It has several bullet holes but is legible. Thirty-three warning or perimeter signs are attached to the barbed-wire fence that surrounds the disposal site structures, as well as an area of excessive gully erosion in the southeast portion of the site. Perimeter sign P31 was observed to be missing and was replaced during annual maintenance conducted on April 24, 2023.

3.4.1.3 Site Marker

The site has one granite site marker north of the disposal cell adjacent to the site access road. Bullet damage was observed on the site marker, but it remains legible (PL-5). No maintenance needs were identified.

3.4.1.4 Boundary Monuments

Eight boundary monuments define the site boundary (PL-6). All eight boundary monuments were observed during the 2023 inspection. No maintenance needs were identified.

3.4.1.5 Aerial Survey Quality Control Monuments

Nine aerial survey quality control monuments were inspected during the 2023 inspection (PL-7). Quality control monument QC-8 was covered in sediment. The sediment was removed during the inspection and T-posts were installed near this monument to help locate it. No additional maintenance needs were identified.

3.4.1.6 Monitoring Wells

The site groundwater monitoring network consists of 10 wells. Nine of the wells are on DOE property; monitoring well 29A is outside the northeast property boundary of the site. The wellhead protectors observed during the 2023 inspection were undamaged and locked. No maintenance needs were identified. Erosion is propagating upstream near monitoring well 62 and will continue to be monitored to ensure that erosion does not impact the integrity of the well (PL-8).

3.4.2 Inspection Areas

In accordance with the LTSP, the site is divided into four inspection areas (referred to as "transects" in the LTSP) to ensure a thorough and efficient inspection. The inspection areas are (1) the cover of the disposal cell; (2) the containment dam; (3) the diversion channels; and (4) the site perimeter, outlying areas, and balance of the site. Inspectors examined the specific site surveillance features within each area and looked for evidence of erosion, settling, slumping, or other modifying processes that might affect site conformance with LTSP requirements.

3.4.2.1 Cover of the Disposal Cell

The disposal cell, completed in 2000, occupies approximately 100 acres. The disposal cell top slope surface is minimally sloped to the west toward the central portion of the containment dam; this promotes drainage and minimizes runoff water velocities to prevent erosion. Although the top slope was not seeded because plant growth was not expected to be successful, vegetation is occurring naturally with native and early successional weedy species. Vegetation was slow to establish in the southeast portion of the top slope, so a native seed mix was applied in 2009. This area has successfully vegetated, although several years of below-average precipitation have stressed the vegetation. The establishment and maturing of vegetation is expected to reduce wind and water erosion of the surface and help prevent precipitation from percolating into the tailings. In accordance with the LTSP, erosion and vegetation are monitored on the disposal cell top slope. Section 3.7.2 describes the erosion monitoring program and presents the results to date.

During the LTSP-required vegetation and erosion monitoring activity in August 2021, inspectors observed a single degradation feature on the top slope of the disposal cell. Subsequent visits to the site were conducted to further identify and document these features and resulted in the observations of several cover degradation features (PL-10). Each surface degradation feature varied in overall size and depth with the deepest feature measuring 8 ft both vertically and horizontally during the April 2022 site visit. A total of 32 features were identified across the entire top slope of the disposal cell. Depth measurements of one of the surface degradation features indicate the potential for erosion of the radon barrier. During the February 2022 site visit, field radiological screening was performed using an alphaNUCLEAR Model 597-PX3 radon gas concentration monitor and a handheld sodium iodide scintillometer. Measurement results did not indicate release of radon gas above 10 CFR 835 or DOE Order 458.1 Chg 4 (LtdChg) actionable limits, or elevated radiation levels.

During the 2023 inspection, two more degradation features were identified (PL-9), and the most prominent degradation feature designated E-004 (PL-10) was measured and documented to track the size and erosional condition of the degradation feature. Degradation feature E-004 was previously measured in 2022 to have a surface expression of 8 ft in length and also extend vertically 8 ft below ground surface. The measurements taken during the 2023 inspection show that degradation feature E-004 has collapsed vertically and horizontal piping occurred, which nearly connects it to a nearby erosional feature (P-11). However, E-004 measured to have a surface expression of less than 2 ft in width and extend vertically around 2 ft below the ground surface.

These features represent a change in the characteristics of the condition of the disposal cell cover and may require maintenance. Preliminary evaluations suggest that surface degradation features

were caused by stormwater flows penetrating the disposal cell cover via desiccation cracking (PL-12), animal burrows, and vegetation root systems.

Evaluation of the surface degradation features is ongoing, and a geophysical investigation was performed in 2023 to support further evaluation of cover degradation conditions. Multiple methods of nonintrusive geophysical techniques were implemented to analyze the subsurface tailings, radon attenuation barrier, and the common fill layer for potential void spaces. Initial findings did not indicate the potential for significant void spaces to be present. Based on the results of the recent inspection and currently available information, the disposal cell cover continues to function as designed.

3.4.2.2 Containment Dam

The disposal cell was constructed during mill operations by damming the head of a natural drainage basin. The face of the earthen containment dam has a 20% slope and is riprap armored to prevent erosion and degradation. Large-diameter riprap was used to protect the spillway in the central portion of the containment dam where precipitation runoff would discharge from the disposal cell cover. Native vegetation is well-established on the spillway face, which is desirable for increasing the erosion protection of the surface. A potential stormwater flow path was observed during the 2022 inspection on the northern and southern edge of the spillway where the armored spillway and armored containment dam meet. Inspectors visually inspected the spillway during the 2023 annual inspection, and the stormwater pathways do not appear to affect the integrity of the spillway and maintenance is not needed at this time (PL-13). A small depression or potential stormwater pathway in the containment dam side slope was observed during the 2023 inspection and will continue to be monitored (PL-14). A geotechnical investigation was performed by USACE in September 2022 to characterize surface and subsurface erosion along a transect of the containment dam side slope. This effort was in support of an AS&T project to characterize and inform erosion risks across the LM portfolio. During this investigation, five erosional piping features were identified in an observation area focused near the riprap spillway on the western side slope. These features are very difficult to identify, and the longest piping feature extended roughly 5 ft into the side slope. No defined sediment outlets or evidence that mill tailings have been exposed or mobilized were identified. Indications of erosion, settlement, mounding, or other modifying processes that might affect the integrity of the containment dam will continue to be visually monitored and do not affect the performance of the disposal cell side slope at this time. No other maintenance needs were identified.

3.4.2.3 Diversion Channels

The surface water diversion system consists primarily of the east, north, and south channels that divert runoff water away from the disposal cell. The system is designed to accommodate probable maximum flood discharges. Cutoff walls composed of large-diameter riprap were constructed at the outlet of each channel. The cutoff walls are designed to prevent headward erosion into the diversion channels that could eventually impact the disposal cell. Runoff from an upgradient watershed east of the disposal cell is designed to be conveyed away from the site to a northeastward-flowing drainage via the east channel. The east channel is separated from the disposal cell by a dike that serves as an onsite access road. Gullies are present along the east slope of the east channel, but the erosion and sediment deposition are not impairing the function of the east-channel. Runoff flow in the channel could potentially erode the adjacent weathered

shale and fill materials and thus bypass the cutoff wall, causing headward erosion into the channel. This feature will continue to be monitored. The east channel was dry at the time of the inspection.

A tributary channel (G3) was constructed to divert runoff from a smaller watershed into the east channel. The erosion and sediment deposition are not impairing the function of the channel.

Some erosion was also observed in a watershed that encompasses the southeast portion of the site and adjacent property. Stormwater runoff from this watershed discharges into a sediment trap where the sediment load settles out. If runoff overtops the sediment trap, the flow is diverted to the east channel. Standing water was observed in the sediment trap at the time of the inspection (PL-15).

Multiple high-intensity storms since the completion of site reclamation have caused deep gullies to form in the highly erodible soils and fill materials upgradient of the sediment trap. Construction of runoff control structures to reduce the rate of erosion in the area and prevent headward migration of gullies into adjoining private property was completed in December 2009. Runoff from a storm event in September 2011 overtopped an earthen runoff control berm of Runoff Control Structure A and caused substantial damage to the berm. Subsequent runoff events have caused erosion adjacent to gabion drop structures associated with Runoff Control Structure A and nearby Runoff Control Structure D. Because of continued excessive erosion, an interagency agreement was established with USACE to repair these structures and construct additional structures in the watershed. Runoff water from the area north of the disposal cell is captured by the north channel. The water is diverted away from the site to the west. Deep gullies had formed in the alluvium and weathered shale along a portion of the north bank of the channel, and headward erosion was rapidly migrating to the north toward the site access road and property boundary. The eroded channel bank was restored to the original design configuration, and two runoff control structures were constructed in 2009 to reduce erosion and sedimentation. Runoff Control Structure F is showing signs of undermining erosion but was stable and functional at the time of the inspection. However, Runoff Control Structure G suffered severe erosion during runoff events in August and September 2011 and continues to erode (PL-16). Runoff Control Structure A is experiencing gully erosion (PL-17) and undermining at portions of the gabion block sections (PL-18), and it is likely that continued erosion will lead to failure of the structure. DOE will continue to monitor these structures and, as part of the interagency agreement, USACE will complete a design for repairs and modifications to these structures.

The north channel cutoff wall does not extend to the toe of the containment dam slope, allowing runoff to bypass the cutoff wall; minimal erosion in the form of rills has occurred at this location. This area will continue to be monitored for erosion and other impacts to the north channel and containment dam.

The east channel diverts stormwater runoff from the G3 channel and higher terrain immediately east of the disposal cell toward the sediment trap to the south. A northern riprap cutoff wall exists to inhibit erosion and sedimentation north of the east channel northern cutoff wall. Minimal erosion in the form of rills has occurred at this location (PL-19).

The south channel diverts stormwater runoff from higher terrain immediately south of the disposal cell toward the channel outlet to the west. Two riprap structures are on the north-facing

slope (south bank) to inhibit erosion along natural drainage swales. Erosion is occurring on the unprotected slope surfaces, resulting in sediment accumulation in the south channel. The erosion and sediment deposition are not impairing the function of the south channel. Erosion headcutting that has migrated to the edge of the riprap cutoff wall at the outlet of the channel was monitored during the inspection. The cutoff wall is functioning as designed and will continue to be monitored (PL-20).

Erosion in diversion channels and other features will continue to be monitored through aerial surveys using photogrammetry and light detection and ranging (lidar). A baseline survey was conducted in 2018 using photogrammetry to obtain accurate site topography for future comparison. The most recent aerial survey was conducted in November 2022.

3.4.2.4 Site Perimeter, Outlying Areas, and Balance of the Site

The site is surrounded by open private land that is used primarily for grazing. Uranium mine reclamation activities occur periodically, and access road repairs have occurred in recent years in areas adjacent to the site. These activities have not been detrimental to site security.

The access road to monitoring well 100 in the southwest corner of the site is damaged by subsurface erosion (soil piping) near the head of an arroyo. The affected area has been mapped, metal fence posts have been installed next to soil collapse features, and the information has been identified on the inspection and sampling maps to prevent injury or vehicle damage. Consequently, monitoring well 100 is accessed by foot or all-terrain vehicle during sampling events.

A Tres Hermanos Sandstone unit of the Mancos Shale crops out in the southwest corner of the site. This unit is reported to be hydraulically connected to contaminated groundwater under the disposal cell, and the outcrop is considered a potential evapotranspiration area. The outcrop was dry at the time of the inspection, and there is no evidence that seepage has occurred. This location will continue to be monitored for seepage and recommended for sampling if seep water is present.

Several legacy features, including concrete pads (e.g., a large pad covers the mine shaft) and abandoned sewer manholes, are near the southeast corner of the site. These features were observed as stable and secure and do not require attention at this time. These features will continue to be monitored to ensure that they do not present a safety hazard and continue to prevent access to the underground mine structures.

3.5 Follow-Up Inspections

LM will conduct follow-up inspections if (1) a condition is identified during the annual inspection or other site visit that requires a return to the site to evaluate the condition or (2) LM is notified by a citizen or outside agency that conditions at the site are substantially changed. Engineering and technical staff conducted site visits to observe the degradation features in April and July 2022. AS&T investigated in September and October 2022, including collecting samples on the top slope cover and riprap-covered side slopes of the tailings impoundment. Evaluation of the disposal cell degradation features are ongoing, and plans are being developed to further understand the extent and cause of these features.

3.6 Routine Maintenance and Emergency Measures

Vertical extension of the fence near perimeter sign P18 due to sedimentation and the replacement of perimeter sign P18 were performed during routine site maintenance. The missing perimeter sign P31 was also replaced, and a new DOE lock was used to secure the steel entrance gate. No additional maintenance needs were identified during the inspection.

Emergency measures are corrective actions that LM will take in response to unusual damage or disruption that threatens or compromises site health and safety, security, integrity, or compliance with 40 CFR 192. No emergency measures were identified.

3.7 Environmental Monitoring

3.7.1 Groundwater Monitoring

In accordance with the LTSP, groundwater monitoring is required at the site once every 3 years. The most recent sampling event was conducted on November 2, 2022. An evaluation of the 2022 results and an updated analysis of corresponding groundwater flow patterns and trends in water quality is provided below. The monitoring network consists of 10 LM wells on or adjacent to the site and two Moquino Water Users Association wells approximately 2 miles west of the site in the village of Moquino. Table 3-2 lists these wells along with their network application as defined in the LTSP. Corresponding locations are shown in Figure 3-2. All monitoring wells are screened within the First Tres Hermanos Sandstone, which is the uppermost permeable unit within the Mancos Shale beneath the site.

Table 3-2. Groundwater Monitoring Network for the L-Bar, New Mexico, Disposal Site

Monitoring Well	Network Application
1A	POC source zone well
17B	POC source zone well
29A	Background well
61	Seepage indicator well
62	Seepage affected area indicator well
63	POE seepage indicator well
69	POC source zone well
72	POE well on east property boundary
81	POC source zone well
100	POE well on west property boundary
Moquino New[a]	Public water supply well in Moquino
Moquino Old[b]	Backup public water supply well in Moquino

Notes:

[a] The Moquino New well has been sampled four times: in 2005, 2007, 2013, and 2022. LM was unable to access this well in 2016 and 2019.

[b] The backup water supply well (Moquino Old) has never been sampled by LM, initially because of inability to access the well and more recently because the well is no longer operational.

Abbreviations:

POC = point of compliance
POE = point of exposure

Previous groundwater-level elevation evaluations for the L-Bar site (Kennecott 1996) showed that groundwater generally flowed to the southwest on the western side of the former tailings impoundment. Three-point vector analysis using 2005 and 2022 water-level elevations show that groundwater still generally flows to the southwest on the western side of the disposal cell, which was constructed over the former tailings impoundment (Figure 3-3). On the eastern side of the disposal cell, three-point vector analysis shows groundwater generally flowing to the northeast. The 180-degree difference in horizontal flow direction between wells on opposite sides of the disposal cell suggests the presence of a groundwater divide somewhere between the two groups of wells (Figure 3-3). Horizontal hydraulic gradients at the site range from 3.0×10^{-4} ft/ft relative to up to 0.03 ft/ft.

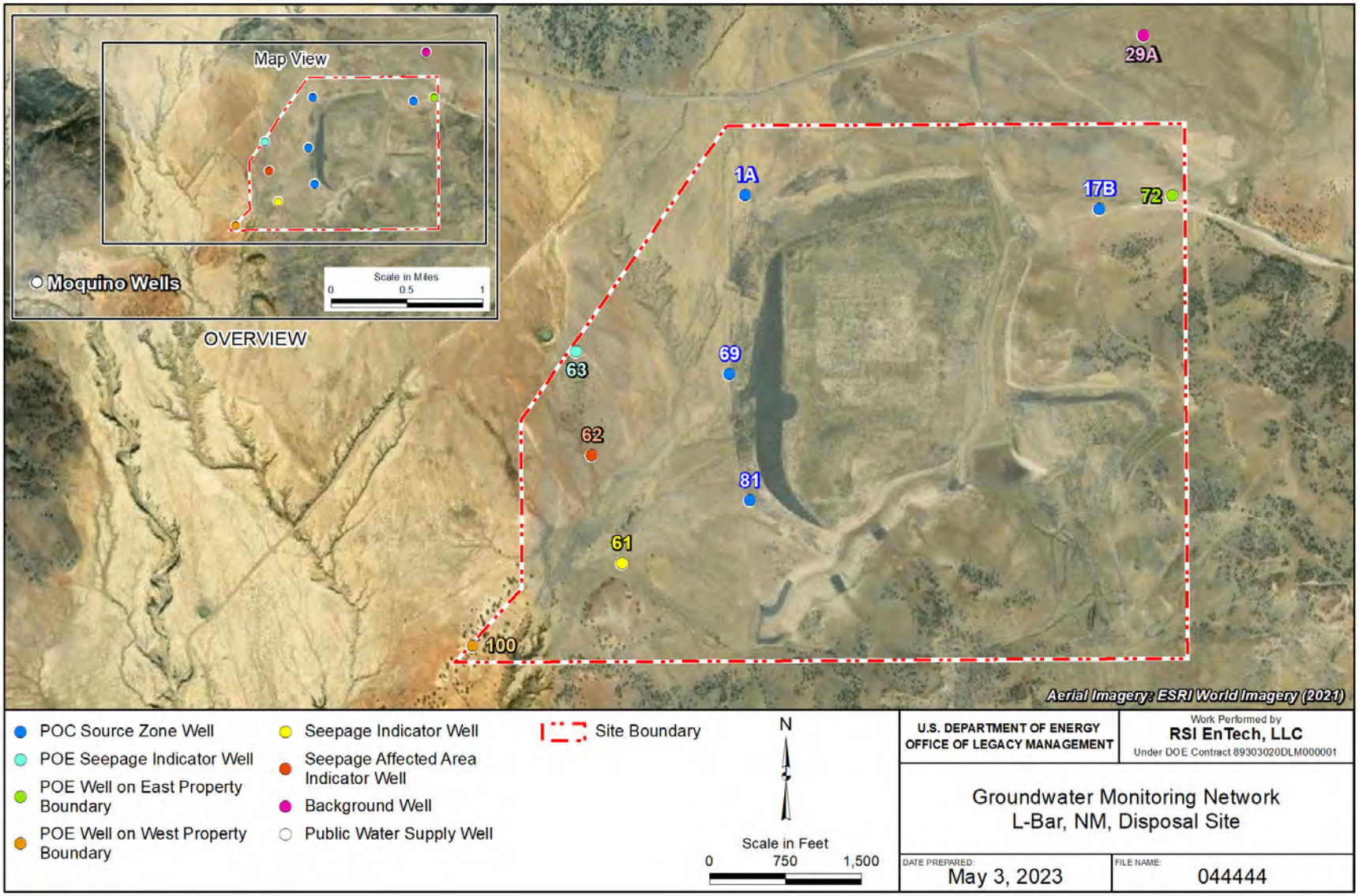
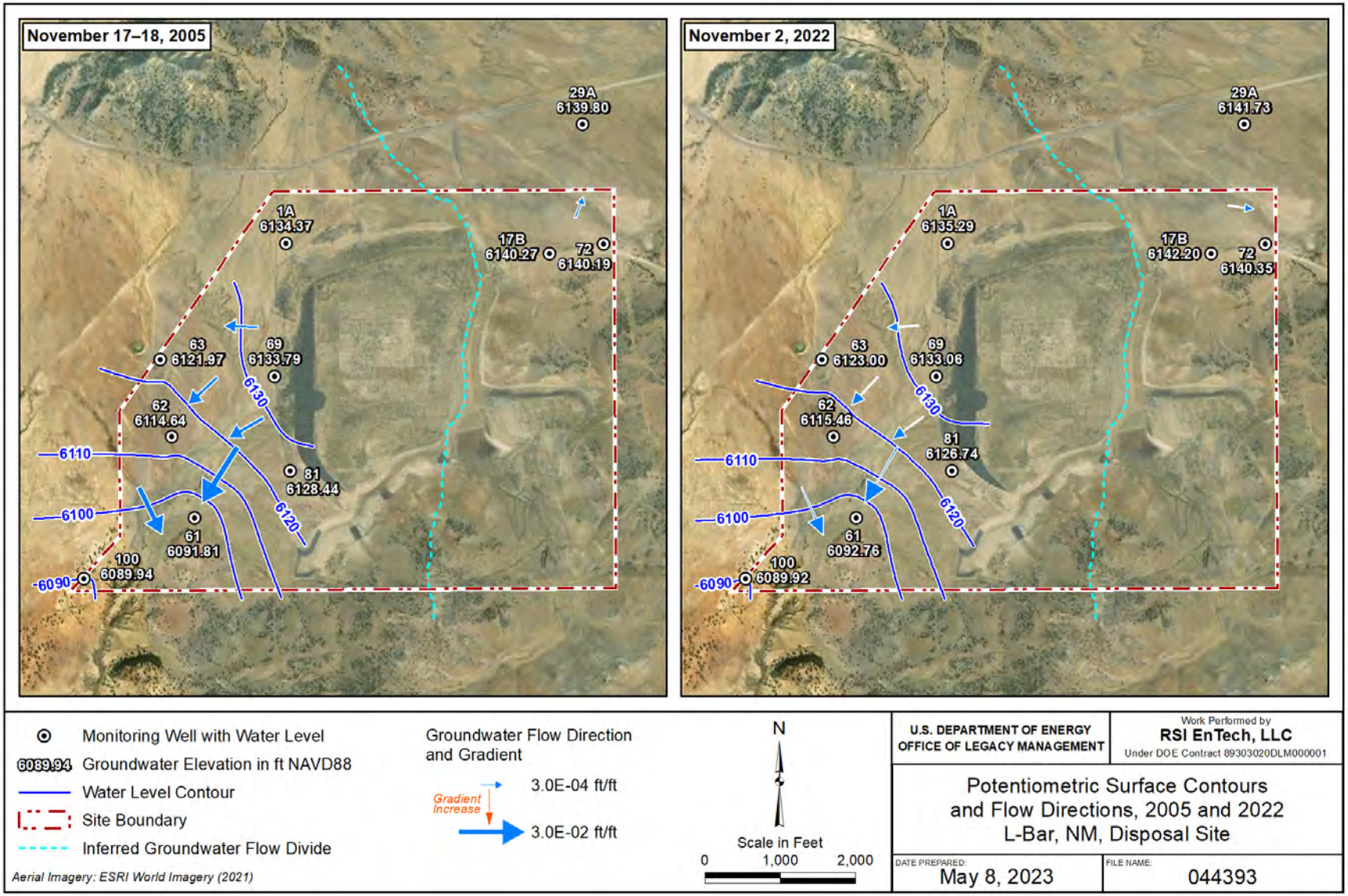


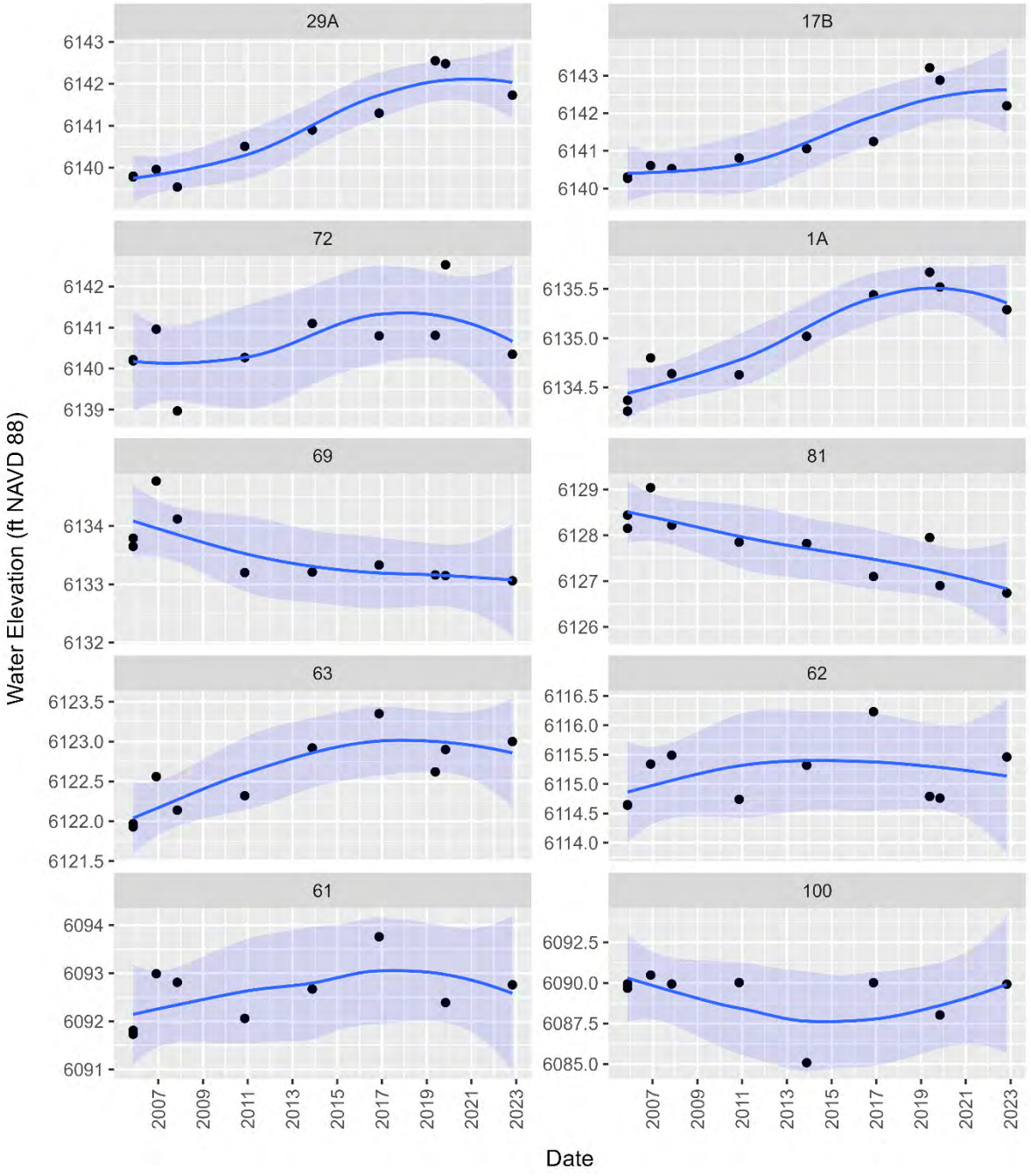
Figure 3-2. Groundwater Monitoring Network at L-Bar, New Mexico, Disposal Site



Abbreviation: NAVD 88 = North American Vertical Datum of 1988

Figure 3-3. Potentiometric Contours and Groundwater Flow Directions in the First Tres Hermanos Sandstone in 2005 and 2022

In general, groundwater levels have been stable or increasing in L-Bar site monitoring wells (Figure 3-4). Exceptions are wells 69 and 81, at the western edge of the disposal cell, which have declining water levels. These groundwater elevation declines likely reflect a reduction in the rate of gravity drainage of tailings fluid from the disposal cell.



Notes: Because of the approximate 60 ft range in groundwater elevations across site wells (highest in well 17B at 6143 ft NAVD 88 and lowest in well 100 at 6085 ft NAVD 88, y-axis scales are unique to facilitate interpretation of water elevation trends. Groundwater elevation trends for individual wells are shown in approximate order of decreasing groundwater elevations; data for background well 29A are plotted first.
Abbreviation: NAVD 88 = North American Vertical Datum of 1988

Figure 3-4. Groundwater Elevation Trends in L-Bar Monitoring Wells, 2005–2022

Samples collected during the November 2022 sampling event were analyzed for chloride, nitrate, selenium, sulfate, total dissolved solids (TDS), and uranium. Analytical results are measured in milligrams per liter (mg/L) and compared to the LTSP required- concentration limits listed in Table 3-3 that consist of alternate concentration limits (ACLs) granted by NRC and alternative abatement standards (AASs) stipulated by NMED.

Table 3-3. Groundwater Alternate Concentration Limits and Alternative Abatement Standards for the L-Bar, New Mexico, Disposal Site[a]

Analyte	New Mexico Standard	ACL (Wells 1A, 17B, 69, 81)	AAS Source Zone (Wells 1A, 17B, 69, 81)	AAS Affected Area (Well 62)
Chloride (mg/L)	250	NA	1127	NA
Nitrate (mg/L)	10.0	NA	1180	NA
Selenium (mg/L)	0.05	2.0	2.0	NA
Sulfate (mg/L)	4000[a]	NA	13,110	5185
TDS (mg/L)	5880[a]	NA	20,165	7846
Uranium (mg/L)	0.03[b]	13.0	13.0	NA

Notes:
Standards are from Table 3-3 of the LTSP (DOE 2004).
[a] Background value approved by the State of New Mexico for the L-Bar site.
[b] The LTSP listed the former State of New Mexico standard of 5.0 mg/L.

Abbreviation:
NA = not applicable

The LTSP states that if an ACL or AAS is exceeded in any monitoring well, LM will inform NRC of the exceedance and conduct confirmatory sampling. If confirmatory sampling verifies the exceedance, LM will develop an evaluative monitoring work plan and submit that plan to NRC for review before initiating the evaluative monitoring program. Results of the evaluative monitoring program will be used, in consultation with NRC, to determine if corrective action is necessary (DOE 2004). ACLs require both point of compliance (POC) and point of exposure (POE) locations, with the ACL being applied to the POC and applicable groundwater standards or background concentrations being applied to the POE. While not explicitly stated in the LTSP, by extension, POE exceedances also require verification monitoring and, if the exceedance is confirmed, reporting of the results to NRC.

Groundwater monitoring results for the November 2022 sampling event are listed in Table 3-4. All historical groundwater monitoring results for the site are reported and published on the LM Geospatial Environmental Mapping System (GEMS) website.[1] The requirements for annual groundwater monitoring stipulated in the LTSP were met in 2007, when the sampling frequency changed to once every 3 years. In accordance with the LTSP, groundwater monitoring will continue for as long as groundwater contamination, defined as exceeding New Mexico standards or background concentrations (Table 3-4), is present at the site (DOE 2004).

[1] https://gems.lm.doe.gov/#site=BAR.

Table 3-4. November 2022 Groundwater Monitoring Results for the L-Bar, New Mexico, Disposal Site

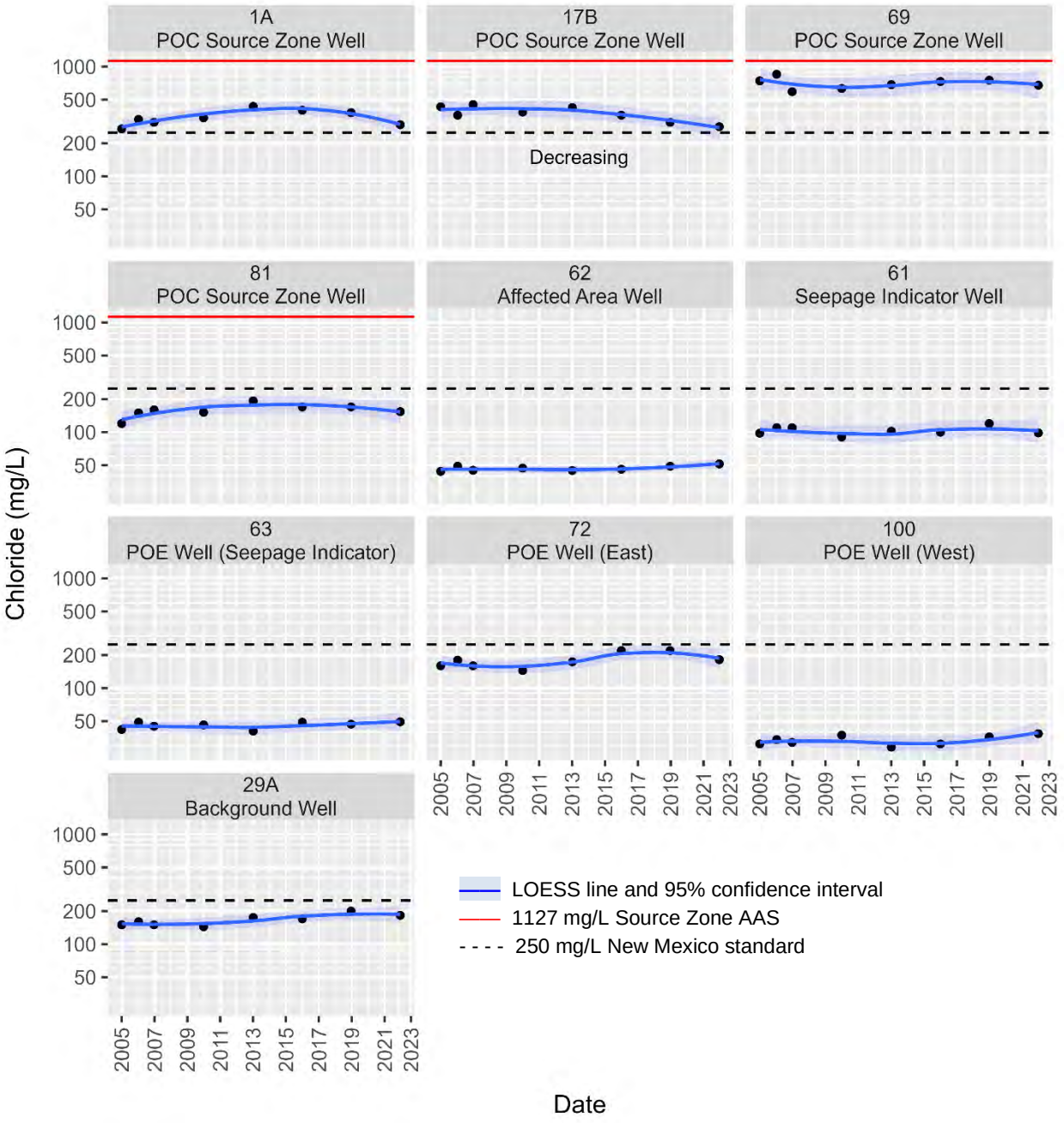
Monitoring Well	Analyte (mg/L)[a,b]					
	Chloride	Nitrate[c]	Selenium	Sulfate	TDS	Uranium
1A	***295***	0.144	ND	3500	***6490***	0.00344
17B	***283***	***838***	***0.26***	***4630***	***12,100***	***0.0322***
29A	183	ND	ND	***5280***	***7970***	ND
61	98.6	0.0696	ND	3120	5090	ND
62	51.4	ND	ND	534	1540	ND
63	49.4	ND	ND	487	1420	ND
69	***675***	ND	ND	***8010***	***16,400***	***1.55***
72	182	9.88	0.0323	***4820***	***7820***	0.017
81	154	***28.8***	***0.0723***	***4090***	***7360***	0.0168
100	38.5	0.227	ND	2160	3570	0.00138
Moquino New	6.34	0.164	ND	102	454	ND

Notes:
[a] Significant digits are reported by the laboratory and are based on detection limits.
[b] ***Bold italicized*** results exceed the corresponding New Mexico standard (from Table 3-3):
250 mg/L chloride, 10 mg/L nitrate (as nitrogen [N]), 0.05 mg/L selenium, 4000 mg/L sulfate, 5880 mg/L TDS, and 0.03 mg/L uranium.
[c] Nitrate plus nitrite as nitrogen (NO_3 + NO_2 as N).

Abbreviation:
ND = not detected (below laboratory detection limit)

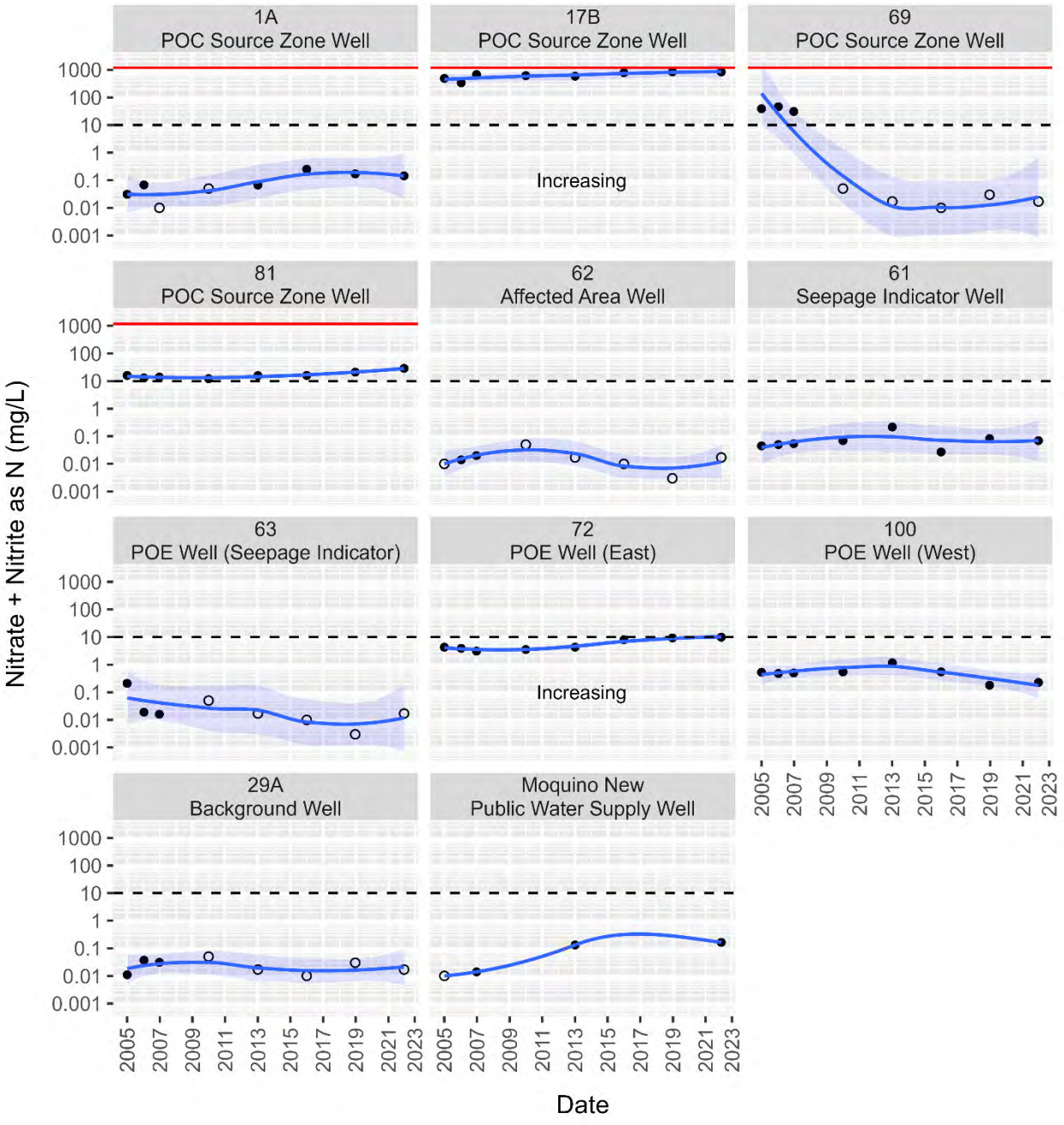
Figure 3-5 through Figure 3-10 plot results for the six analytes from 2005–2022 and relative to the limits and standards listed in Table 3-3. Although the focus of the monitoring program is to demonstrate compliance with LTSP requirements (i.e., to ensure that no ACL or AAS source zone levels are exceeded), results are also plotted relative to corresponding New Mexico standards to facilitate review. Consistent with previous annual reports (e.g., DOE 2022), since sampling commenced in 2005, no ACL or AAS source zone levels have been exceeded in any of the POC wells, and no AAS affected area levels have been exceeded in monitoring well 62. Sulfate and TDS background values approved by the State of New Mexico for the L-Bar site have been exceeded in POE well 72 in four and seven (respectively) of the eight sampling events. The sulfate background value (4000 mg/L) was exceeded in 2006 and then in the last three consecutive sampling events (2016, 2019, and 2022) (Figure 3-8). The TDS background value (5880 mg/L) has been consistently exceeded in well 72, except in 2016 (Figure 3-9). In background well 29A, approved background concentrations for sulfate and TDS have been exceeded in all eight sampling events except one: 3900 mg/L sulfate in 2010.

The time-concentration plots provided in this section were generated using a faceting approach, whereby data for each well are plotted separately. A nonparametric locally estimated scatterplot smoothing (LOESS) method is applied to facilitate interpretation of the figures. Using this approach, overall trends in the data are more apparent and not obscured by "noise" or random variation. To support interpretation of these figures, Mann-Kendall trend analysis was performed for each well-parameter combination to characterize whether trends in analyte concentrations are upward, stable (no trend), or declining. Detailed Mann-Kendall trend test results are provided in Table 3-5.



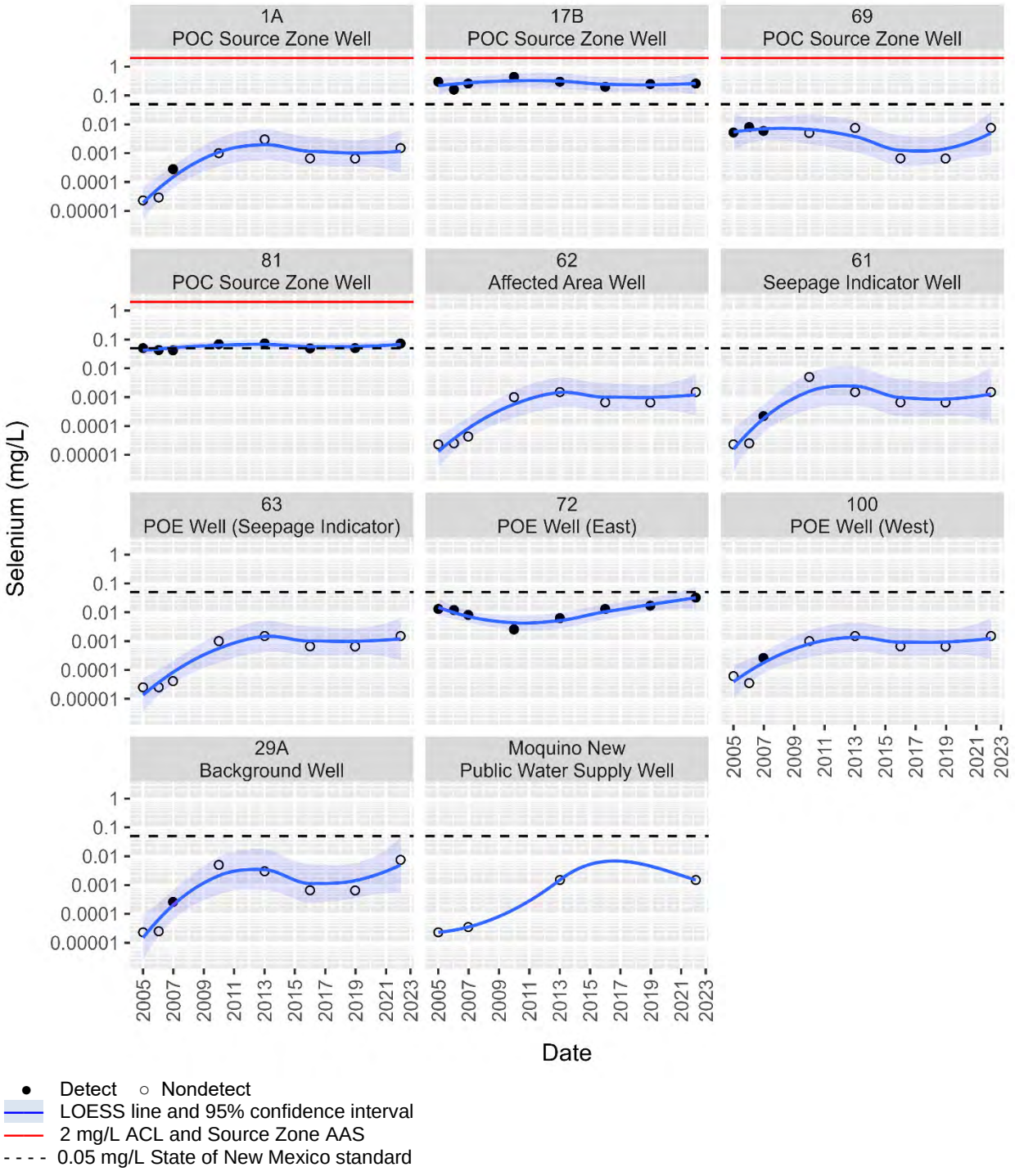
Notes: Wells are ordered by purpose: POC source zone wells are listed first, followed by affected area seepage indicator well 62, and remaining indicator and POE wells. Data for background well 29A are plotted last.
Data are not plotted for the Moquino New public water supply well because the historically low chloride concentrations (3.9–6.4 mg/L) affect the scaling of this figure. The most recent chloride result in the Moquino New well was 6.34 mg/L (Table 3-4). For wells with statistically significant trends based on Mann-Kendall trend analysis (alpha of 0.05; p-value <0.05), the direction of the trend is indicated on the plot.

Figure 3-5. Chloride Concentrations in Groundwater at the L-Bar Disposal Site, 2005–2022



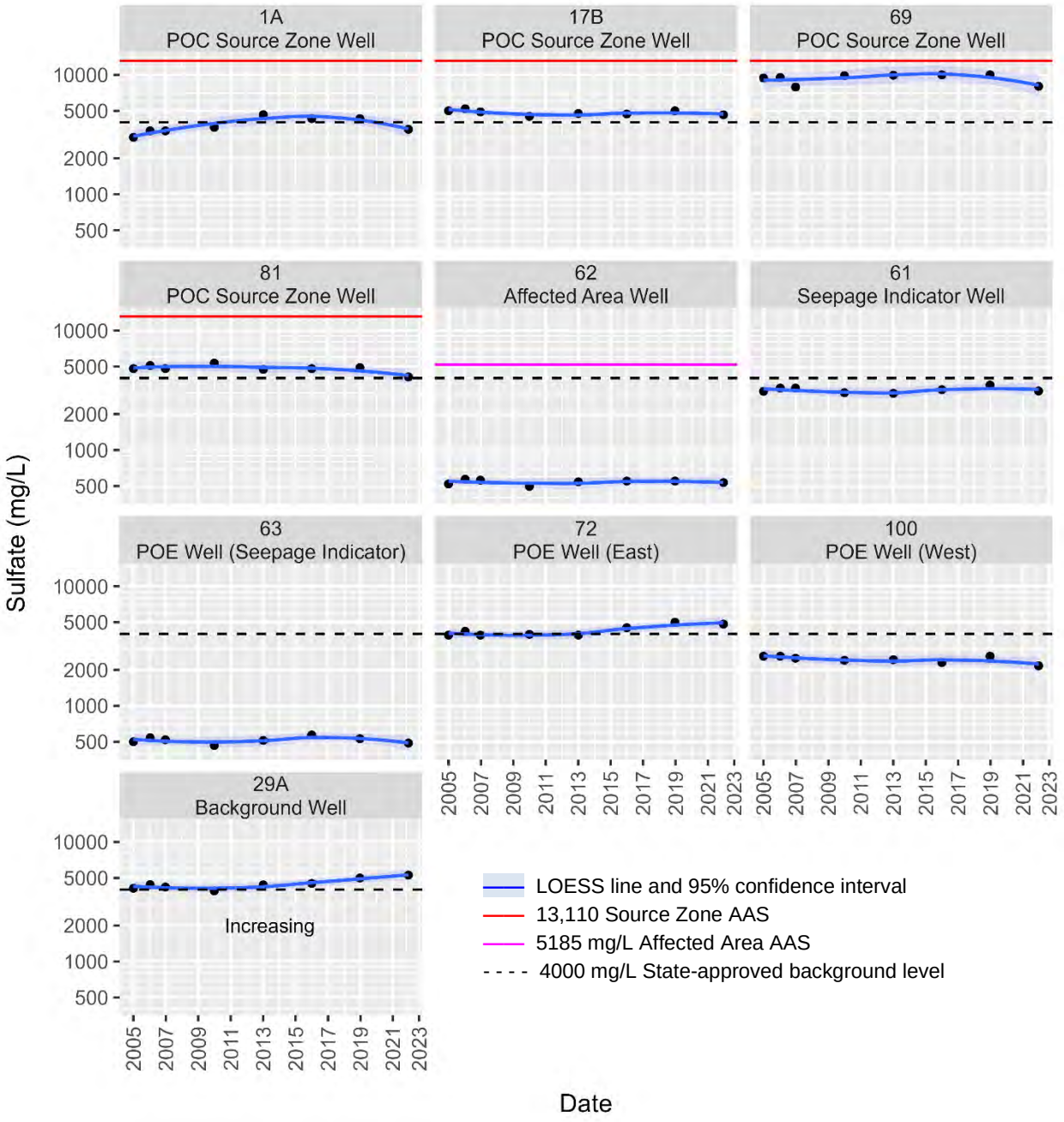
Notes: Wells are ordered by purpose: POC source zone wells are listed first, followed by affected area seepage indicator well 62, and remaining indicator and POE wells. Data for background well 29A and the Moquino New well are plotted last. For wells with statistically significant trends based on Mann-Kendall trend analysis (alpha of 0.05; p-value <0.05), the direction of the trend is indicated on the plot. Although a significant decreasing trend was identified for well 69, this result is not considered meaningful because of the high proportion of nondetects.

Figure 3-6. Nitrate Concentrations in Groundwater at the L-Bar Disposal Site, 2005–2022



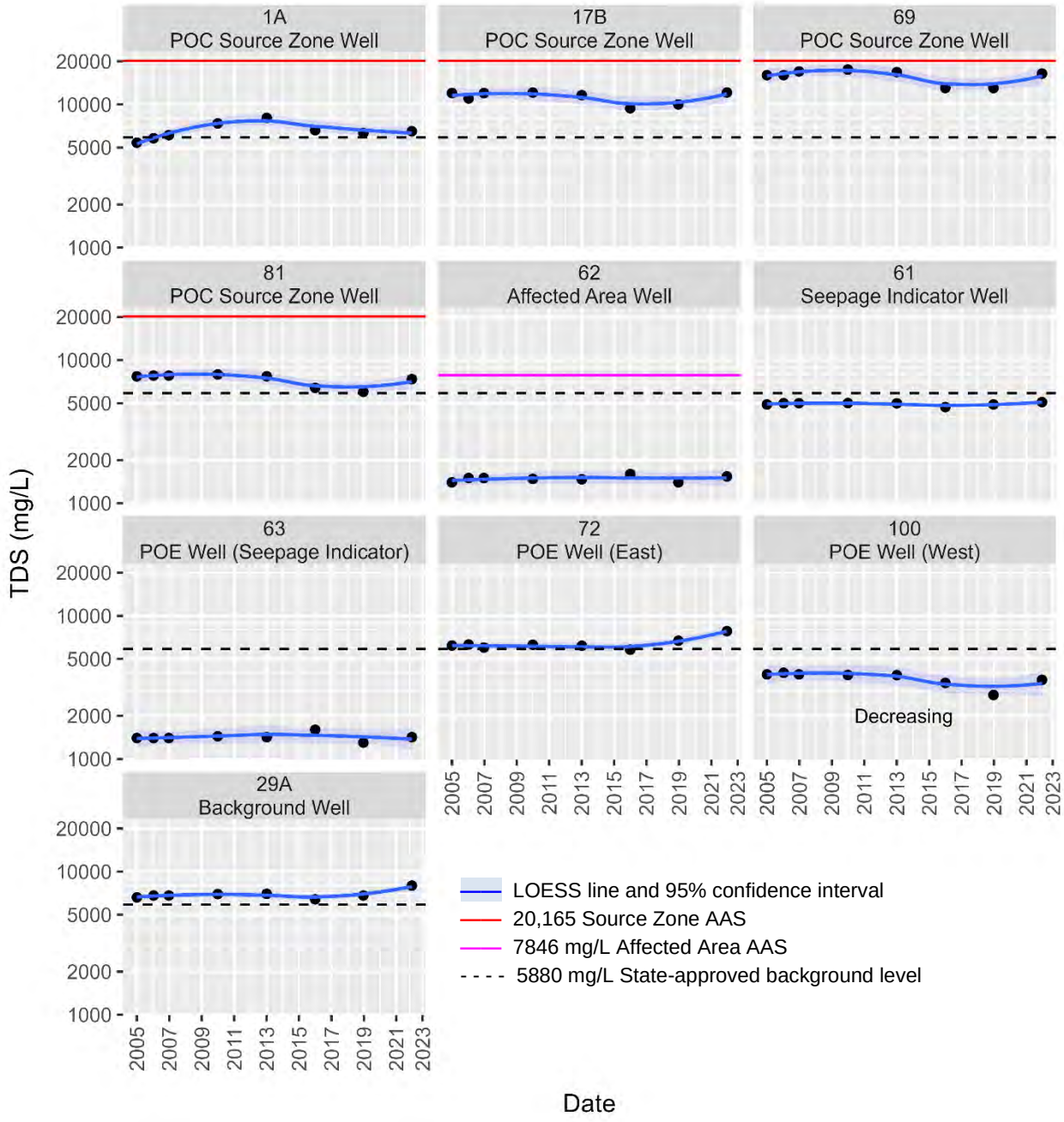
Notes: Wells are ordered by purpose: POC source zone wells are listed first, followed by affected area seepage indicator well 62, and remaining indicator and POE wells. Data for background well 29A and the Moquino New well are plotted last. For all wells, no statistically significant trend in selenium concentrations was found based on Mann-Kendall trend analysis (most wells have a high proportion of nondetects).

Figure 3-7. Selenium Concentrations in Groundwater at the L-Bar Disposal Site, 2005–2022



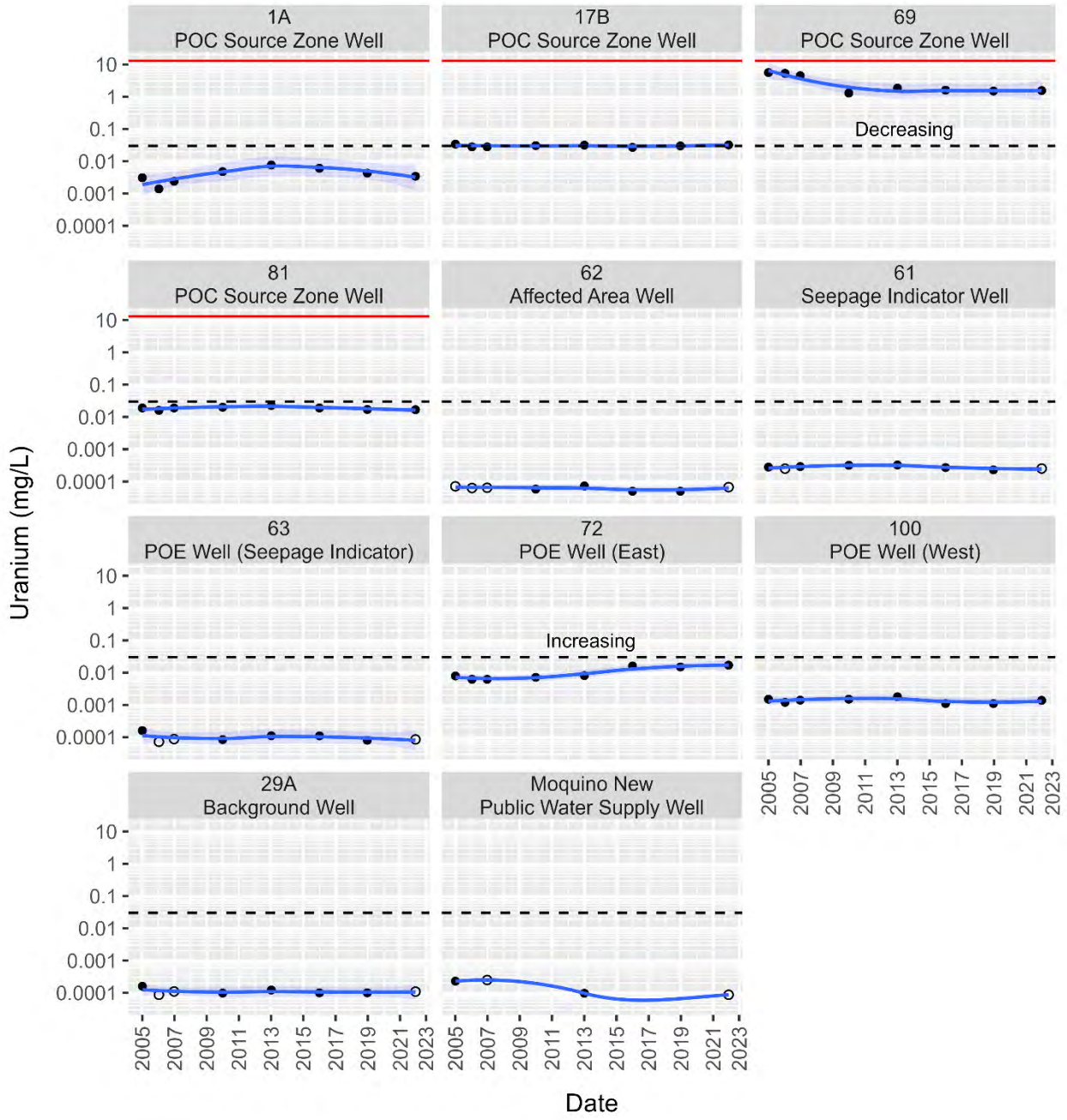
Notes: Wells are ordered by purpose: POC source zone wells are listed first, followed by affected area seepage indicator well 62, and remaining indicator and POE wells. Data for background well 29A are plotted last.
Data are not plotted for the Moquino New public water supply well because the historically low sulfate concentrations (91.9–120 mg/L) affect the scaling of this figure. The most recent sulfate result in the Moquino New well was 102 mg/L (Table 3-4). For wells with statistically significant trends based on Mann-Kendall trend analysis, the direction of the trend is indicated on the plot.

Figure 3-8. Sulfate Concentrations in Groundwater at the L-Bar Disposal Site, 2005–2022



Notes: Wells are ordered by purpose: POC source zone wells are listed first, followed by affected area seepage indicator well 62, and remaining indicator and POE wells. Data for background well 29A are plotted last.
Data are not plotted for the Moquino New public water supply well because the historically low TDS concentrations (454–530 mg/L) affect the scaling of this figure. The most recent TDS result in the Moquino New well was 454 mg/L (Table 3-4). For wells with statistically significant trends based on Mann-Kendall trend analysis, the direction of the trend is indicated on the plot.

Figure 3-9. TDS Concentrations in Groundwater at the L-Bar Disposal Site, 2005–2022



Notes: Wells are ordered by purpose: POC source zone wells are listed first, followed by affected area seepage indicator well 62, and remaining indicator and POE wells. Data for background well 29A and the Moquino New well are plotted last. For wells with statistically significant trends based on Mann-Kendall trend analysis, the direction of the trend is indicated on the plot.

Figure 3-10. Uranium Concentrations in Groundwater at the L-Bar Disposal Site, 2005–2022

Table 3-5. Mann-Kendall Trend Analysis Results for Analytes in L-Bar Site Monitoring Wells, 2005–2022

Well[a]	Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Number of Nondetects[b]	Kendall's tau[c]	p-value[d]	Trend[c,d]
Chloride							
1A[e]	11/17/2005	11/2/2022	8	0	0.286	0.39	No Trend
17B[e]	11/18/2005	11/2/2022	8	0	−0.607	0.046	Decreasing
29A	11/18/2005	11/2/2022	8	0	0.536	0.081	No Trend
61	11/17/2005	11/2/2022	8	0	0.107	0.80	No Trend
62	11/17/2005	11/2/2022	8	0	0.464	0.14	No Trend
63[f]	11/17/2005	11/2/2022	8	0	0.357	0.27	No Trend
69[e]	11/17/2005	11/2/2022	8	0	0	1	No Trend
72[f]	11/18/2005	11/2/2022	8	0	0.429	0.17	No Trend
81[e]	11/17/2005	11/2/2022	8	0	0.464	0.14	No Trend
100[f]	11/17/2005	11/2/2022	8	0	0.321	0.32	No Trend
Nitrate + Nitrite as N							
1A[e]	11/17/2005	11/2/2022	8	2	0.464	0.13	No Trend
17B[e]	11/18/2005	11/2/2022	8	0	0.643	0.035	Increasing
29A	11/18/2005	11/2/2022	8	5	NA		
61	11/17/2005	11/2/2022	8	0	0.429	0.17	No Trend
62	11/17/2005	11/2/2022	8	6	NA		
63[f]	11/17/2005	11/2/2022	8	5	NA		
69[e]	11/17/2005	11/2/2022	8	5	NA		
72[f]	11/18/2005	11/2/2022	8	0	0.643	0.035	Increasing
81[e]	11/17/2005	11/2/2022	8	0	0.536	0.081	No Trend
100[f]	11/17/2005	11/2/2022	8	0	−0.107	0.80	No Trend
Selenium							
1A[e]	11/17/2005	11/2/2022	8	7	NA		
17B[e]	11/18/2005	11/2/2022	8	0	−0.071	0.90	No Trend
29A	11/18/2005	11/2/2022	8	7	NA		
61	11/17/2005	11/2/2022	8	7	NA		
62	11/17/2005	11/2/2022	8	8	NA		
63[f]	11/17/2005	11/2/2022	8	8	NA		
69[e]	11/17/2005	11/2/2022	8	5	NA		
72[f]	11/18/2005	11/2/2022	8	0	0.321	0.32	No Trend
81[e]	11/17/2005	11/2/2022	8	0	0.321	0.32	No Trend
100[f]	11/17/2005	11/2/2022	8	7	NA		
Sulfate							
1A[e]	11/17/2005	11/2/2022	8	0	0.536	0.081	No Trend
17B[e]	11/18/2005	11/2/2022	8	0	−0.393	0.21	No Trend
29A	11/18/2005	11/2/2022	8	0	0.643	0.035	Increasing
61	11/17/2005	11/2/2022	8	0	0.036	1	No Trend
62	11/17/2005	11/2/2022	8	0	−0.107	0.80	No Trend
63[f]	11/17/2005	11/2/2022	8	0	−0.036	1	No Trend
69[e]	11/17/2005	11/2/2022	8	0	0.393	0.21	No Trend
72[f]	11/18/2005	11/2/2022	8	0	0.536	0.075	No Trend
81[e]	11/17/2005	11/2/2022	8	0	−0.25	0.45	No Trend
100[f]	11/17/2005	11/2/2022	8	0	−0.536	0.075	No Trend

Table 3-5. Mann-Kendall Trend Analysis Results for Analytes in L-Bar Site Monitoring Wells, 2005–2022 (continued)

Well[a]	Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Number of Nondetects[b]	Kendall's tau[c]	p-value[d]	Trend[c,d]
TDS							
1A[e]	11/17/2005	11/2/2022	8	0	0.429	0.17	No Trend
17B[e]	11/18/2005	11/2/2022	8	0	−0.071	0.90	No Trend
29A	11/18/2005	11/2/2022	8	0	0.393	0.20	No Trend
61	11/17/2005	11/2/2022	8	0	0.071	0.90	No Trend
62	11/17/2005	11/2/2022	8	0	0.143	0.71	No Trend
63[f]	11/17/2005	11/2/2022	8	0	0.214	0.52	No Trend
69[e]	11/17/2005	11/2/2022	8	0	−0.143	0.71	No Trend
72[f]	11/18/2005	11/2/2022	8	0	0.214	0.54	No Trend
81[e]	11/17/2005	11/2/2022	8	0	−0.393	0.21	No Trend
100[f]	11/17/2005	11/2/2022	8	0	−0.75	0.013	Decreasing
Uranium							
1A[e]	11/17/2005	11/2/2022	8	0	0.286	0.39	No Trend
17B[e]	11/18/2005	11/2/2022	8	0	0.036	1	No Trend
29A	11/18/2005	11/2/2022	8	3	−0.071	0.89	No Trend
61	11/17/2005	11/2/2022	8	2	−0.179	0.61	No Trend
62	11/17/2005	11/2/2022	8	4	−0.036	1	No Trend
63[f]	11/17/2005	11/2/2022	8	3	−0.179	0.60	No Trend
69[e]	11/17/2005	11/2/2022	8	0	−0.643	0.035	Decreasing
72[f]	11/18/2005	11/2/2022	8	0	0.679	0.025	Increasing
81[e]	11/17/2005	11/2/2022	8	0	−0.107	0.80	No Trend
100[f]	11/17/2005	11/2/2022	8	0	−0.214	0.53	No Trend

Notes:

[a] Trend tests were performed using the "NADA: Nondetects and Data Analysis for Environmental Data" package in R, version 1.6-1.1 (Lee 2020). The NADA trend test is similar to the traditional Mann-Kendall trend test except that it accounts for the presence of nondetects at multiple detection limits. Trend analyses were conducted at the 0.05 significance (or alpha) level using a two-sided test.

[b] Mann-Kendall trend analysis results are not reported for well-parameter combinations with a detection frequency less than 50% (applies to nitrate and selenium).

[c] The test statistic Kendall's tau is a measure of the strength of the association between two variables, with values always falling between −1 and +1. A tau value of 1.0 corresponds to a perfect strong association between the time series, indicating a significant increasing trend. Conversely, a perfect association in the negative direction (for decreasing trends) will have a tau value of −1.0. Time-series data with no statistically significant trend will have a tau value closer to 0.0.

[d] A calculated p-value of <0.05 indicates that the null hypothesis is rejected and a significant trend in the time series exists.

[e] POC well.

[f] POE well.

Abbreviation:

NA = not applicable (trend analysis results are not meaningful given the high proportion of nondetects)

For most well-parameter combinations that were evaluated, no statistically significant increasing or decreasing trend was found (Table 3-5). Exceptions to the latter are identified in Figure 3-5 through Figure 3-9 and the information is presented below.

Chloride concentrations in POC source zone wells 1A, 17B, and 69 continue to exceed the 250 mg/L State of New Mexico standard but are below the corresponding 1127 mg/L AAS (Figure 3-5). The highest chloride concentrations have been measured in well 69 (590–850 mg/L). Chloride concentrations have decreased in well 17B (Table 3-5), from a maximum of 450 mg/L in 2007 to 283 mg/L in 2022, just slightly above the 250 mg/L standard. The remaining POC well (81) has chloride concentrations below the State of New Mexico standard (120–193 mg/L).

The three POE wells (63, 72, and 100) have chloride concentrations below the State of New Mexico standard (Figure 3-5). Temporal chloride concentrations in background well 29A mimic those in POE well 72 and have ranged from 140 to 200 mg/L.

Nitrate (+ nitrite as nitrogen [N]) concentrations in all but three site monitoring wells have been below the 10 mg/L New Mexico standard (Figure 3-6). The highest nitrate concentrations have been measured in POC source zone well 17B (340–850 mg/L); Mann-Kendall trend analysis indicates a statistically significant increasing trend (Table 3-5). The most recent (2022) result, 838 mg/L, is below the 1180 mg/L AAS, but if the increasing trend continues, the AAS could be met or potentially exceeded.

Nitrate levels in POC source zone well 69 exceeded the 10 mg/L standard between 2005 and 2007 (31–46 mg/L), then declined to nondetectable levels (≤0.05 mg/L) (Figure 3-6). Nitrate concentrations in POC source zone well 81 have remained at levels slightly exceeding the 10 mg/L standard (12.2–28.8 mg/L) but well below the 1180 mg/L AAS. The maximum concentration was measured in November 2022.

In addition to POC well 17B, a statistically significant increasing trend was also found for eastern POE well 72 (Table 3-5), where the nitrate concentration in November 2022 (9.88 mg/L) was approximately equal to the 10 mg/L State of New Mexico standard. If the increasing concentration trend continues, the State of New Mexico nitrate standard will soon be exceeded.

Consistent with previous annual reports (DOE 2021; DOE 2022), except for POC source zone wells 17B and 81 (0.16–0.44 and 0.042–0.073 mg/L, respectively), selenium concentrations in all site monitoring wells have been below the 0.05 mg/L New Mexico standard (Figure 3-7). Results for most remaining wells have been below the detection limit. An exception is POE well 72, where selenium concentrations are approaching the 0.05 mg/L standard; the most recent (2022) result was 0.032 mg/L. Although concentrations in this well are trending upward (as indicated by a positive tau value), the trend is not statistically significant (Table 3-5). However, if concentration trends continue as observed since 2013, the 0.05 mg/L State of New Mexico selenium standard will likely soon be exceeded.

Mann-Kendall trend analysis identified no statistically significant trends in selenium concentrations in any of the monitoring wells (most wells have a high proportion of nondetects). Selenium concentrations in POC source zone wells have been below the corresponding 2 mg/L ACL and AAS (Figure 3-7).

Sulfate concentrations in the four POC source zone wells continue to be below the corresponding 13,110 mg/L AAS. The highest concentrations (7900–10,000 mg/L) have been measured in well 69. Sulfate concentrations in remaining POC source zone wells (1A, 17B, and 81) are comparable to (usually just slightly exceeding) the 4000 mg/L state-approved background

level (Figure 3-8). Sulfate concentrations in AAS affected area well 62 (496–570 mg/L) have been well below the corresponding AAS of 5185 mg/L. Similar levels (465–570 mg/L) have been measured in POE seepage indicator well 63 (Figure 3-8), while concentrations in seepage indicator well 61 have been stable (non-trending) at levels just below the 4000 mg/L standard (2980–3500 mg/L).

Sulfate concentrations in eastern POE well 72 have exceed this standard since 2016 (4500–5000 mg/L) and are trending upward (as indicated by a positive tau value), but the trend is not statistically significant (Table 3-5). A statistically significant increasing trend was identified for background well 29A, where sulfate concentrations have exceeded the state-approved background level in all but one sample, with the maximum (5280 mg/L) measured in November 2022. As shown in Figure 3-8, sulfate concentrations in POE well 72 are very similar to those measured in well 29A. Both wells have concentrations now exceeding those measured in upgradient POC well 17B as shown in Figure 3-11.

Figure 3-11 was developed to satisfy a requirement in Section 3.7.1 of the LTSP, which states that annual inspection reports are to include a groundwater level contour map (provided in Figure 3-3) and a sulfate isoconcentration map for the years that sampling has been conducted (DOE 2004). As discussed in previous annual reports (DOE 2021; DOE 2022), bubble plot maps for sulfate were generated in lieu of isoconcentration maps because of the limited number of well locations. No water quality measurements have been taken directly beneath the tailings impoundment, so interpolated isoconcentrations would likely not be representative of site conditions. All site monitoring wells are screened within the First Tres Hermanos Sandstone unit and do not represent contaminant levels in porous media above or below this stratigraphic unit. Sulfate concentrations continue to be highest in POC source zone well 69 (8080 mg/L). The state-approved background level is also currently exceeded in POC well 81 and the three easternmost wells: POC source zone well 17B, POE well 72, and background well 29A.

General observations for TDS in L-Bar site wells are very similar to those discussed above for sulfate. TDS levels in POC source zone wells have exceeded the state-approved background level of 5880 mg/L but have been below the corresponding AAS of 20,165 mg/L (Figure 3-9). TDS levels have been highest in POC source zone well 69 (13,000–17,500 mg/L) and lowest in affected area well 62 (1400–1600 mg/L, well below the corresponding AAS of 7846 mg/L) and POE seepage indicator well 63 (1300–1600 mg/L).

As observed for sulfate, TDS concentrations in eastern POE well 72 are similar to those in background well 29A (>5880 mg/L for the last two sampling events), and the trend in both wells is slightly increasing but not statistically significant (Table 3-5). TDS concentrations in background well 29A have exceeded 5880 mg/L in all eight samples, with the maximum (like sulfate), 7970 mg/L, measured in November 2022. The only statistically significant trend in TDS concentrations was found for western POE well 100, with a decreasing trend (Table 3-5).

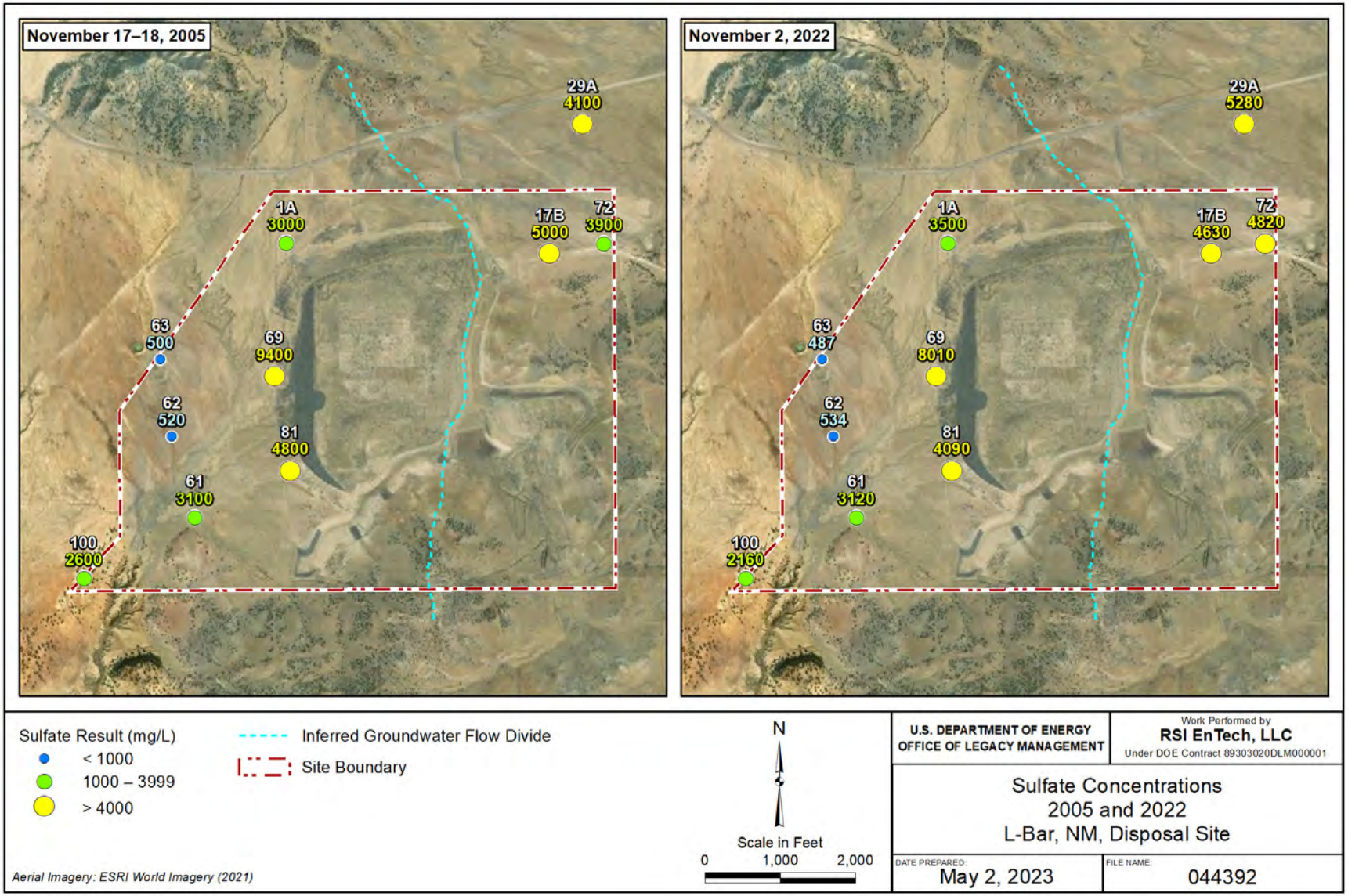


Figure 3-11. Sulfate Concentrations in 2005 and 2022, L-Bar Site Monitoring Wells

Uranium concentrations in POC wells 17B and 69 were above the 0.03 mg/L State of New Mexico standard in 2022 (Figure 3-10). Historically, uranium concentrations in POC source zone well 17B have remained stable at or slightly exceeding the standard (0.027–0.034 mg/L), while concentrations in well 69 have exceeded the standard by 1 to 2 orders of magnitude (1.3–5.6 mg/L). Although Mann-Kendall trend analysis yielded a statistically significant decreasing trend for well 69 from 2005–2022 (Table 3-5), the trend appears to have stabilized since 2010 (Figure 3-10). Uranium concentrations in all POC source zone wells continue to be below the 13 mg/L ACL and AAS.

Uranium concentrations in eastern POE well 72, although historically below the 0.03 mg/L standard, are increasing and approaching this value (most recent maximum result of 0.017 mg/L). If this increasing trend continues, uranium concentrations in POE well 72 may exceed the State of New Mexico standard in the future.

3.7.2 Erosion Monitoring Program

An erosion monitoring program (EMP) was developed to address potential erosion of the disposal cell cover over time and was incorporated as an LTSP requirement. Sohio Western Mining Company developed the plan at the request of the New Mexico Water Quality Control Commission as a condition for granting AASs for groundwater at the site. In accordance with Appendix C of the LTSP, erosion measurements will be performed annually for 20 years, through 2023, and then once every 10 years for the following 80 years. In accordance with the EMP, erosion will be considered excessive when 2 ft of erosion is noted at more than half of the monitoring locations.

The cover of the disposal cell consists of several feet of clay-rich soil materials and a 4.1 foot thick (minimum) compacted layer of clay that functions as a radon barrier. The total thickness of the cover ranges from 6–10 ft. The EMP has two requirements: (1) measure surface soil erosion and (2) measure the progress of revegetation. Erosion and vegetation monitoring was done on August 22, 2023.

3.7.2.1 Erosion Monitoring

In accordance with the EMP, the former licensee installed a grid of 20 evenly spaced monitoring locations on the cover in November 2003 (Figure 3-1). The locations were initially measured in December 2003 by the former licensee to establish baseline values.

Each monitoring location consists of a 5-foot length of half-inch-diameter, epoxy-coated rebar surrounded by three metal T-posts. The rebar was driven at each location so that approximately 1 ft remained above the soil surface. The three T-posts are set approximately 6 ft from the rebar and form an equilateral triangle, with one point of the triangle due east of the rebar. An 8-foot length of PVC pipe was mounted over the east T-post at each monitoring location in 2016 to aid in finding the monitoring locations in the increasingly tall vegetation.

Erosion measurement is accomplished by placing a 4-foot-long level centered at the base of the rebar (and on the north side of the rebar) so the east end of the level points to the easternmost T-post. The height of the rebar is measured from the base of the level to the top of the rebar and

is recorded to the nearest 1/16 inch, using the method established during baseline measurements in 2003.

Results of the 2023 measurements are presented in Table 3-6. The surface elevation has increased by 0.13–2.4 inches at the monitoring locations when compared to the baseline measurements taken in 2003. These results indicate that the surface of the disposal cell is rising compared to 2003. Since 2003, the surface has risen an average of 1.040 inches and decreased an average of 0.413 inch since 2022. The decreased surface is most likely due to loss of vegetation at monitoring locations. As vegetation declines on the disposal cell cover, the surface elevation drops through lack of underground root growth and the accumulation of organic matter in the soil. Vegetation prevents or slows surface erosion, and windborne sediment deposition can also increase in vegetated areas as the plants' foliage and stems slow wind speeds, which allows sediment to accumulate more quickly. The slight reduction since 2022 is probably also because soils were very dry from drought conditions at the site during monitoring. Cover soils were wetter during last year's monitoring, and heavy clay soils, such as those on the disposal cell cover, tend to expand when wet.

Table 3-6. Surface Elevation Changes on the L-Bar, New Mexico, Disposal Cell Cover Between 2003 and 2023

Monitoring Location	Length of Rebar Above Surface (inches)				Change in Surface Elevation[a] Baseline to Present (decimal inches)
	2003 (Baseline)		2023		
	(fraction)	(decimal)	(fraction)	(decimal)	
A1	12 10/16	12.625	10 4/16	10.250	2.375
A2	12 7/16	12.438	11 12/16	11.750	0.688
A3	12 15/16	12.938	11 9/16	11.563	1.375
A4	12 6/16	12.375	11 3/16	11.188	1.187
B1	12 10/16	12.625	10 10/16	10.625	2
B2	12 8/16	12.500	11 14/16	11.875	0.625
B3	13 0/16	13.000	12 6/16	12.375	0.625
B4	12 15/16	12.938	11 14/16	11.875	1.063
C1	12 8/16	12.500	10 10/16	10.625	1.875
C2	13 1/16	13.063	12 10/16	12.625	0.438
C3	12 2/16	12.125	11 8/16	11.500	0.625
C4	12 6/16	12.375	12 0/16	12.000	0.375
D1	12 7/16	12.438	11 12/16	11.750	0.688
D2	12 12/16	12.750	12 10/16	12.625	0.125
D3	12 3/16	12.188	10 13/16	10.813	1.375
D4	12 12/16	12.750	12 8/16	12.500	0.25
E1	13 1/16	13.063	11 13/16	11.813	1.25
E2	12 14/16	12.875	12 0/16	12.000	0.875
E3	12 9/16	12.563	11 8/16	11.500	1.063
E4	12 15/16	12.938	11 0/16	11.000	1.938

Note:

[a] A positive change indicates that the surface elevation at that monitoring point increased; a negative change indicates that the surface elevation at that location decreased. Negative changes were apparent in 2023.

3.7.2.2 Vegetation Monitoring

Vegetation monitoring plots were established at 10 of the erosion monitoring locations to record changes in the vegetation over time. Plots were established at locations A1, A3, B2, B4, C1, C3, D2, D4, E1, and E3. At each plot, the three existing T-posts were used to form three corners of the plot, and a fourth point was projected south of the three T-posts to form a parallelogram covering approximately 100 square ft. An ecologist visually estimated the percent foliar cover of each species of live vegetation within each plot. Percent foliar cover is the vertical projection of leaf area onto the ground surface. Foliar cover would equal the shadow cast by the vegetation if the sun was directly overhead, excluding openings or overlaps in the canopy.

In accordance with the EMP, LM will perform annual vegetation monitoring until at least 20% average foliar cover is achieved, and when more than half of the monitoring plots exceed 20% cover by perennial plants. In 2023, the average cover of perennial plants was 16%. Four of the 10 plots contained 20% or more perennial cover. The decrease in cover was probably due to drought conditions at the site. The success criterion was not met in 2023, so annual monitoring will be required until a significant increase in plant density is noted during future annual site inspections.

Perennial plant species observed in the plots in 2023 include, in order of abundance: four-wing saltbush (*Atriplex canescens)*, broom snakeweed (*Gutierrezia sarothrae*), and James' galleta (*Pleuraphis jamesii*), with traces of dropseed (*Sporobolus* spp.), rubber rabbitbrush (*Ericameria nauseosa*), and squirreltail (*Elymus elymoides*).

3.8 References

10 CFR 40.28. U.S. Nuclear Regulatory Commission, "General License for Custody and Long-Term Care of Uranium or Thorium Byproduct Materials Disposal Sites," *Code of Federal Regulations.*

10 CFR 835. U.S. Department of Energy, "Occupational Radiation Protection Program," *Code of Federal Regulations*.

40 CFR 192. U.S. Environmental Protection Agency, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," *Code of Federal Regulations.*

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3.9 Photographs

Photograph Location Number	Azimuth	Photograph Description
PL-1	70	Culvert Outlets Along Access Road near Perimeter Sign P9
PL-2	85	Partially Buried Fence from Sedimentation near Perimeter Sign P18
PL-3	255	Erosional Feature on Southwest Fence Between Perimeter Signs P19 and P20 (Looking from Top to Bottom)
PL-4	210	Personnel Gate Along Southwestern Perimeter Fence
PL-5	180	Site Marker
PL-6	0	Boundary Monument BM-3
PL-7	190	Quality Control Monument QC-5
PL-8	27	Erosive Channeling Around Monitoring Well 62
PL-9	270	Degradation Feature Roughly 120 Feet East of Erosion Monitoring Location A1
PL-10	220	Degradation Feature E-004 on Disposal Cell Top Slope
PL-11	—	Degradation Feature E-004 on Disposal Cell Top Slope Horizontal Piping
PL-12	—	Deep Desiccation Cracking of Surface Soils
PL-13	80	Overview of Stormwater Route in Spillway with Cattails Noted at Base
PL-14	90	Additional Overview of Potential Depression Formation
PL-15	140	Water in Sediment Trap
PL-16	15	Gully Erosion at Erosion Control Structure G
PL-17	335	Erosion at Structure A
PL-18	100	Erosion at Structure A Along Second Block Structure
PL-19	90	East Channel Cutoff Wall
PL-20	90	Rilling Contacting South Channel Cutoff Wall

Note:
— = Photograph taken vertically from above.

PL-1. Culvert Outlets Along Access Road near Perimeter Sign P9

PL-2. Partially Buried Fence from Sedimentation near Perimeter Sign P18

PL-3. Erosional Feature on Southwest Fence Between Perimeter Signs P19 and P20 (Looking from Top to Bottom)

PL-4. Personnel Gate Along Southwestern Perimeter Fence

PL-5. Site Marker

PL-6. Boundary Monument BM-3

PL-7. Quality Control Monument QC-5

PL-8. Erosive Channeling Around Monitoring Well 62

PL-9. Degradation Feature Roughly 120 Feet East of Erosion Monitoring Location A1

PL-10. Degradation Feature E-004 on Disposal Cell Top Slope

PL-11. Degradation Feature E-004 Horizontal Piping

PL-12. Deep Desiccation Cracking of Surface Soils

PL-13. Overview of Stormwater Route in Spillway with Cattails Noted at Base

PL-14. Additional Overview of Potential Depression Formation

PL-15. Water in Sediment Trap

PL-16. Gully Erosion at Erosion Control Structure G

PL-17. Erosion at Structure A

PL-18. Erosion at Structure A Along Second Block Structure

PL-19. East Channel Cutoff Wall

PL-20. Rilling Contacting South Channel Cutoff Wall

4.0 Maybell West, Colorado, Disposal Site

4.1 Compliance Summary

The Maybell West, Colorado, Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II Disposal Site was inspected on September 5, 2023. Several depressions were observed and evaluated by a geotechnical engineer. None of the depressions threaten the integrity or performance of the disposal cells; and monitoring of the depressions will continue. No changes were observed in associated drainage features. Groundwater monitoring is not required at the site. Five minor maintenance needs were identified and completed in 2023. Inspectors identified no cause for a follow-up inspection.

4.2 Compliance Requirements

Requirements for the long-term surveillance and maintenance of the site are specified in the site-specific *Long-Term Surveillance Plan for the Maybell West (UMTRCA Title II) Disposal Site, Moffat County, Colorado* (DOE 2010) (LTSP) in accordance with procedures established to comply with the requirements of the U.S. Nuclear Regulatory Commission (NRC) general license at Title 10 *Code of Federal Regulations* Section 40.28 (10 CFR 40.28). Table 4-1 lists these requirements.

Table 4-1. License Requirements for the Maybell West, Colorado, Disposal Site

Requirement	LTSP	This Report	10 CFR 40.28
Annual Inspection and Report	Sections 3.3 and 3.4	Section 4.4	(b)(3)
Follow-Up Inspections	Section 3.5	Section 4.5	(b)(4)
Routine Maintenance and Emergency Measures	Section 3.6	Section 4.6	(b)(5)
Environmental Monitoring	Section 3.7	Section 4.7	(b)(3)

4.3 Institutional Controls

The 180-acre site, identified by the property boundary shown in Figure 4-1, is owned by the United States and was accepted under the NRC general license in 2010. The U.S. Department of Energy (DOE) is the licensee and, in accordance with the requirements for UMTRCA Title II sites, the Office of Legacy Management (LM) is responsible for the custody and long-term care of the site. Institutional controls (ICs) at the site include federal ownership of the property and the following physical ICs that are inspected annually: disposal cell, ancillary cell, entrance gate and sign, perimeter fence and signs, site marker, and boundary monuments.

4.4 Inspection Results

The site, approximately 4 miles northeast of Maybell, Colorado, was inspected on September 5, 2023. The inspection was conducted by Z. Aldous and C. Murphy of the Legacy Management Support (LMS) contractor. W. Frazier (LM) and M. Cosby (Colorado Department of Public Health and Environment) attended the inspection. Geotechnical engineer, C. Mueller (LMS) also attended the inspection to assess the disposal cell depressions. The purposes of the inspection

were to confirm the integrity of visible features at the site, identify changes in conditions that might affect conformance with the LTSP, and evaluate whether maintenance or follow-up inspection and monitoring are needed.

4.4.1 Site Surveillance Features

Figure 4-1 shows the locations of site features, including site surveillance features and inspection areas, in black and gray font. Some site features that are present but not required to be inspected are shown in italic font. Observations from previous inspections that are currently monitored are shown in blue, and new observations identified during the 2023 annual inspection are shown in red. Inspection results and recommended maintenance activities associated with site surveillance features are described in the following subsections. Photographs to support specific observations are noted in the text and in Figure 4-1 by photograph location (PL) numbers. The photographs and photograph log are presented in Section 4.9.

4.4.1.1 Site Access and Entrance Gate

Access to the site is from Moffat County Road 53, which runs north from U.S. Highway 40 approximately 8 miles east of Maybell, Colorado. County Road 53 ends at an unlocked gate near the northeast corner of the Maybell, Colorado, UMTRCA Title I Disposal Site (approximately 3 miles from U.S. Highway 40). LM is responsible for maintenance of the road from the end of County Road 53 to the site and has access under a U.S. Bureau of Land Management (BLM) right-of-way permit.

The dirt two-track access road continues west from the end of County Road 53 on BLM property and through a second unlocked gate. Just past the second gate, the access road turns south and continues for approximately 0.5 mile past an abandoned open pit uranium mine known as Rob Pit; it then bends north, following the route of the former haul road for approximately 0.25 mile to the site entrance gate.

The access road was passable, and no maintenance needs were identified. The entrance gate, a standard tubular metal stock gate, is near the southeast corner of the site. No maintenance needs were identified.

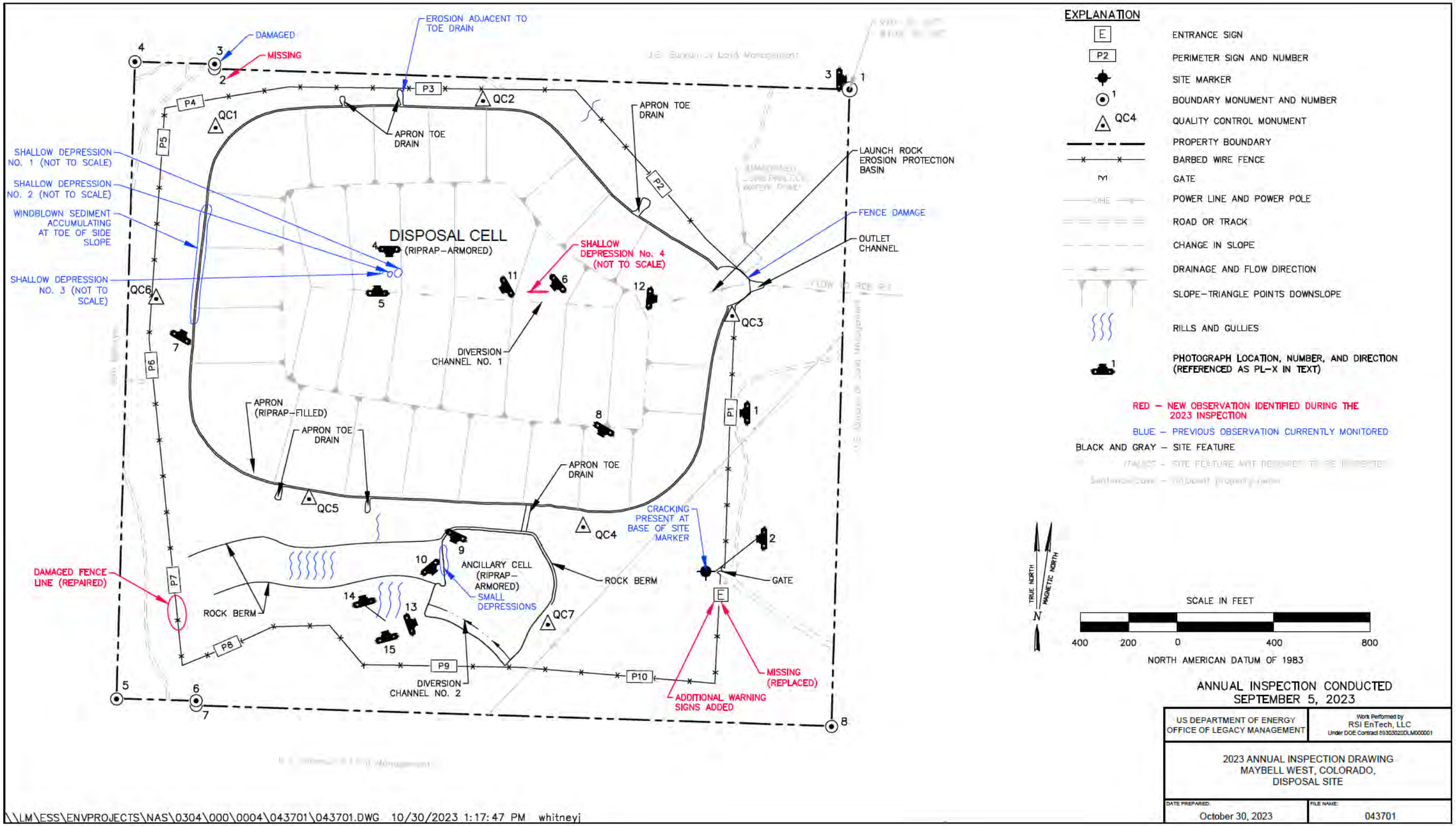


Figure 4-1. 2023 Annual Inspection Drawing for the Maybell West, Colorado, Disposal Site

4.4.1.2 Perimeter Fence and Signs

A four-strand barbed-wire fence encloses the disposal cell, the ancillary cell, the drainage structures, and much of the site. The fence primarily serves to prevent livestock from trespassing because the site is surrounded by open rangeland used for cattle grazing. Minor damage to the perimeter fence occurs periodically because the site is in wintering grounds frequented by big game animals (primarily pronghorn, deer, and elk). A small section of fence line on the western side was damaged and repaired during the 2023 maintenance trip. Plastic fence flags are attached to the top two strands of the perimeter fence to serve as a visual marker to wildlife to reduce entanglement or striking the fence lines. The majority of the fence line is heavily covered in brush. Clearing brush provides access to the fence for maintenance and repair and increases its visibility, which hopefully will reduce the likelihood of an animal becoming entangled. During the 2023 maintenance trip, the entire interior fence line was cleared, except for two small areas that could not be accessed with the equipment. Work on the exterior of the fence was started and the southern fence line was cleared. This work will continue until the fence lines are cleared on both sides.

The entrance sign is mounted on a metal T-post directly south of the entrance gate. It was missing during the 2022 inspection. A generic perimeter sign was hung in its place in 2022 and was replaced with the site-specific new entrance sign in 2023. Ten warning or perimeter signs are mounted on metal T-posts around the site (PL-1). Additional warning signs were added to the entrance gate during the 2023 maintenance trip. No other maintenance needs were identified.

4.4.1.3 Site Marker

The site has one granite site marker near the entrance gate (PL-2). There is minimal cracking in the cement at the base of the site marker. It does not affect the integrity of the marker. No maintenance needs were identified.

4.4.1.4 Boundary Monuments

Eight boundary monuments are on the site boundary outside the fenced area (PL-3). Four of the monuments are at the property corners, and the other four define an approximate 20-foot offset along the north and south boundaries where the private land that LM acquired in fee adjoins the BLM withdrawal area on the western portion of the site. Boundary monuments BM-3 and BM-6 (capped pieces of rebar) define the two 20-foot offsets. Boundary monument BM-3 remains bent, but the boundary monument is still in place; attempts to straighten the boundary monument were not successful, and it is missing its cap. Boundary monument BM-2 is missing. It will be surveyed and reinstalled in 2024. No additional maintenance needs were identified.

4.4.1.5 Aerial Survey Quality Control Monuments

The seven aerial survey quality control monuments were inspected during the 2023 inspection. No maintenance needs were identified.

4.4.2 Inspection Areas

In accordance with the LTSP, the site is divided into five inspection areas (referred to as "transects" in the LTSP) to ensure a thorough and efficient inspection. The inspection areas are (1) the top slope of the disposal cell, (2) the side slopes of the disposal cell, (3) the ancillary cell, (4) the diversion and drainage channels, and (5) the site perimeter and balance of the site.

4.4.2.1 Top Slope of the Disposal Cell

The disposal cell is on the reclaimed site of a former heap leach processing area. The top slope of the riprap-armored disposal cell occupies about 60 acres of the site. The top of the disposal cell showed no signs of significant erosion, settling, or other modifying processes that would affect disposal cell integrity. However, four small, shallow depressions have been observed (just north of Diversion Channel No. 1) since the site transitioned to DOE in 2010. These depressions appear to be the result of settlement of the underlying materials since completion of the disposal cell. Depression No. 1 was discovered during the initial annual inspection in 2010. A second smaller and shallower depression (Depression No. 2) was first noted just west of the first depression during the 2016 annual inspection (PL-4). A third depression (Depression No. 3) was first observed during the 2018 annual inspection (PL-5). A fourth depression (Depression No. 4), east of the previous three depressions, was noted during the 2023 inspection (PL-6). Depression No. 4 does not appear new, but it was not specifically noted during previous inspections. During the 2023 inspection, Depressions Nos. 1–3 appeared to be approximately the same size, as observed during the 2022 annual inspection.

An LMS engineer participated in the inspection to evaluate the depressions on the top of the cell. Depressions No. 1, 3, and 4 are shallow and widespread; these are likely settlement made more evident by accumulating surface water that is infiltrating and forcing additional consolidation as it flushes through the cover and waste profile. This is not a concern from a risk standpoint, and it is anticipated that additional features become more prominent and easier to identify with each inspection. Several minimally visible depression features were noticed while inspectors walked the western half of the cover. These features might become more noticeable over the years. Depression No. 2 is a very localized but deep depression that is concerning due to its depth to relative size. It is recommended to continue monitoring it and to perform localized light detection and ranging (lidar) testing or even standard land surveying of the area.

All four depressions will continue to be measured during annual inspections to determine if additional, more significant settlement is occurring. Aerial surveys are currently scheduled to be conducted every 5 years to assist in monitoring the depressions. No standing water was observed in any of the depressions during the inspection. These depressions currently do not threaten the integrity or performance of the disposal cell. No maintenance needs were identified.

While various species of plants were present on the top slope of the disposal cell, no deep-rooted vegetation was observed. If encroachment of deep-rooted vegetation is observed, an evaluation will be conducted as required by the LTSP to determine if any action is necessary. Bull thistle (noxious weed) was present on the disposal cell and was treated, in accordance with the LTSP, following the inspection.

4.4.2.2 Side Slopes of the Disposal Cell

The disposal cell was designed to control surface water runoff resulting from a probable maximum flood event. The side slopes of the disposal cell were constructed with a 20% slope and are covered with a 1-foot-thick layer of riprap. Minor sediment accumulation observed at the base of the apron below the northwest side slope appears to be windblown (PL-7), and there was no evidence of side slope instability, erosion, or settlement. This area of sediment accumulation will continue to be monitored to ensure that the toe drain and side slope are functioning properly.

Surface water runoff from the side slopes is conveyed by an apron at the toe of the slope to six riprap-armored toe drains at low points in the apron. The apron and toe drains are constructed channels filled with riprap. Minor erosion has occurred adjacent to a toe drain along the north side of the disposal cell, but that has not impacted the performance of the toe drain. No maintenance needs were identified.

4.4.2.3 Ancillary Cell

The ancillary cell (PL-8) was constructed to contain waste materials associated with the reclaimed evaporation pond area. It slopes gently toward the southwest. A rock berm wraps around its eastern and northern sides to protect it from surface water runoff. Small depressions were observed previously on the west end of the ancillary cell on the crest of the top slope (PL-9). These are very likely channelized flow from the cover eroding out areas of the top to side slope transition. Additional small depressions on the toe of the side slope (PL-10) were observed during the 2022 inspection. None of the depressions are impacting the performance of the cell, but they will continue to be monitored. Various species of deep-rooted vegetation are present on the top and side slopes of the ancillary cell. The side slopes and top of the ancillary cell were treated for brush following the inspection.

4.4.2.4 Diversion and Drainage Channels

Final surface conditions at the site include a combination of rock armoring and contouring to achieve the surface water drainage control and erosion protection necessary to satisfy the design longevity requirements. The top slope of the disposal cell was designed to drain surface water runoff to the center and into riprap-armored Diversion Channel No. 1 (PL-11), which is graded toward and then down the east side slope of the disposal cell. Surface water runoff ultimately discharges into Rob Pit east of the site. An erosion protection structure, referred to as the Launch Rock Erosion Protection Basin (PL-12), was constructed at the outfall of Diversion Channel No. 1 to protect the disposal cell from headcutting that may occur from the deep channel that runs into Rob Pit. Diversion Channel No. 2 runs along the south side of the ancillary cell to convey surface water runoff away from the ancillary cell (PL-13). The diversion channels and outlet channel of the Launch Rock Erosion Protection Basin continue to function as designed.

The rock berm that runs along the northern edge of the ancillary cell continues west across the slope south of the disposal cell to protect the disposal cell against erosion and headcutting. Several gullies (PL-14) and rills (PL-15) have developed on this south slope but do not threaten the integrity of the disposal cell. The gullies will continue to be monitored and repaired as needed. No maintenance needs were identified.

4.4.2.5 Site Perimeter and Balance of the Site

Reclaimed surfaces at the site were planted with a mixture of native and adaptive grasses to provide soil stability, and the vegetation continues to improve. Noxious weeds are controlled with herbicide in accordance with the LTSP.

During each site inspection, the area surrounding the site for a distance of 0.25 mile is visually observed for erosion, changes in land use, or other phenomena that might affect the long-term integrity of the site. No such changes were identified.

4.5 Follow-Up Inspections

LM will conduct follow-up inspections if (1) a condition is identified during the annual inspection or other site visit that requires a return to the site to evaluate the condition or (2) LM is notified by a citizen or outside agency that conditions at the site are substantially changed. No need for a follow-up inspection was identified.

4.6 Routine Maintenance and Emergency Measures

The following maintenance actions were completed in September 2023:

- The noxious weeds identified on the top slope of the disposal cell were treated with herbicide
- The side slopes and top of the ancillary cell were treated for brush
- The missing entrance sign was replaced
- Additional warning signs were added to the entrance gate
- Brush was cleared from the interior of the perimeter fence and a small section of the exterior fence

Boundary monument BM-3 is damaged and will need to be repaired or replaced but continues to delineate the property. Boundary monument BM-2 is missing and will need to be replaced. A survey team will perform this maintenance in 2024. No other maintenance needs were identified.

Emergency measures are corrective actions that LM will take in response to unusual damage or disruption that threatens or compromises site health and safety, security, integrity, or compliance with 40 CFR 192. No emergency measures were identified.

4.7 Environmental Monitoring

In accordance with the LTSP, groundwater monitoring is not required at the site because the results of 30 years of historical groundwater monitoring performed at the site by the former licensee (20 years before reclamation and 10 years after reclamation) indicated that groundwater was not contaminated by site-related activities.

4.8 References

10 CFR 40.28. U.S. Nuclear Regulatory Commission, "General License for Custody and Long-Term Care of Uranium or Thorium Byproduct Materials Disposal Sites," *Code of Federal Regulations*.

40 CFR 192. U.S. Environmental Protection Agency, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," *Code of Federal Regulations.*

DOE (U.S. Department of Energy), 2010. *Long-Term Surveillance Plan for the Maybell West (UMTRCA Title II) Disposal Site, Moffat County, Colorado*, LMS/MAW/S01879, Office of Legacy Management, February.

4.9 Photographs

Photograph Location Number	Azimuth	Photograph Description
PL-1	270	Perimeter Sign P1 with Bullet Holes
PL-2	270	Site Marker
PL-3	90	Boundary Monument BM-1
PL-4	180	Shallow Depression No. 2
PL-5	—	Shallow Depression No. 3
PL-6	230	Shallow Depression No. 4
PL-7	30	Windblown Sediment Accumulation at Toe of Side Slope
PL-8	210	Ancillary Cell Overview
PL-9	205	Depressions on Crest of Ancillary Cell
PL-10	140	Depressions on Toe of Ancillary Cell
PL-11	240	Diversion Channel No. 1
PL-12	95	Launch Rock Erosion Protection Basin
PL-13	70	Diversion Channel No.2
PL-14	345	Largest Gully Below Rock Berm
PL-15	345	Erosion Rills Below Rock Berm

Note:
— = Photograph taken vertically from above.

PL-1. Perimeter Sign P1 with Bullet Holes

PL-2. Site Marker

PL-3. Boundary Monument BM-1

PL-4. Shallow Depression No. 2

PL-5. Shallow Depression No. 3

PL-6. Shallow Depression No. 4

PL-7. Windblown Sediment Accumulation at Toe of Side Slope

PL-8. Ancillary Cell Overview

PL-9. Depressions on Crest of Ancillary Cell

PL-10. Depressions on Toe of Ancillary Cell

PL-11. Diversion Channel No. 1

PL-12. Launch Rock Erosion Protection Basin

PL-13. Diversion Channel No. 2

PL-14. Largest Gully Below Rock Berm

PL-15. Erosion Below Rock Berm

5.0 Sherwood, Washington, Disposal Site

5.1 Compliance Summary

The Sherwood, Washington, Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II Disposal Site was inspected on June 8, 2023. No changes were observed to the disposal cell, containment dam, or associated drainage features. Inspectors identified several routine maintenance needs but found no cause for a follow-up or contingency inspection.

Groundwater monitoring is not required at the site; however, the U.S. Department of Energy (DOE) Office of Legacy Management (LM) conducts limited groundwater monitoring for chloride, sulfate, and total dissolved solids (TDS) at three wells as a best management practice in accordance with the site-specific Long-Term Surveillance Plan (DOE 2001) (LTSP). The most recent sampling event occurred on June 27, 2023. Concentrations for all constituents were below corresponding action levels for all three wells.

5.2 Compliance Requirements

Requirements for the long-term surveillance and maintenance of the site are specified in the site-specific LTSP (DOE 2001) in accordance with procedures established to comply with the requirements of the U.S. Nuclear Regulatory Commission (NRC) general license at Title 10 *Code of Federal Regulations* Section 40.28 (10 CFR 40.28). Table 5-1 lists these requirements.

Table 5-1. License Requirements for the Sherwood, Washington, Disposal Site

Requirement	LTSP	This Report	10 CFR 40.28
Annual Inspection and Report	Sections 3.3 and 3.4	Section 5.4	(b)(3)
Follow-Up Inspections	Section 3.5	Section 5.5	(b)(4)
Routine Maintenance and Emergency Measures	Section 3.6	Section 5.6	(b)(5)
Environmental Monitoring	Section 3.7	Section 5.7	(b)(3)

5.3 Institutional Controls

The 380-acre site, identified by the property boundary shown in Figure 5-1, is owned by the United States in trust for the Spokane Tribe of Indians. The site was accepted under the NRC general license in 2001. Because the site is on the Spokane Indian Reservation, no agreement of transfer was necessary to convey the property rights to DOE. However, an agreement was executed between the U.S. Bureau of Indian Affairs (BIA), the Spokane Tribe, NRC, and DOE for permanent right of access, which allows LM to fulfill its long-term surveillance and maintenance custodial responsibilities. Institutional controls (ICs) at the site include federal custody of the disposal cell and its engineered features, administrative controls, and the following physical ICs that are inspected annually: disposal cell, perimeter signs, site marker, boundary monuments, and monitoring wellhead protection.

5.4 Inspection Results

The site, approximately 5 miles west of Wellpinit, Washington, and 35 miles northwest of Spokane, Washington, was inspected on June 8, 2023. The inspection was conducted by Z. Aldous and M. Guziak of the Legacy Management Support (LMS) contractor. K. Kreie and, P. Kerl (LM) as well as J. Logan (Washington Department of Health) attended the inspection. The purposes of the inspection were to confirm the integrity of visible features at the site, identify changes in conditions that might affect conformance with the LTSP, and evaluate whether maintenance or follow-up inspection and monitoring are needed.

5.4.1 Site Surveillance Features

Figure 5-1 shows the locations of site features, including site surveillance features and inspection areas, in black and gray font. Some site features that are present but not required to be inspected are shown in italic font. Observations from previous inspections that are currently monitored are shown in blue. Inspection results and recommended maintenance activities associated with site surveillance features are described in the following subsections. Photographs to support specific observations are noted in the text and in Figure 5-1 by photograph location (PL) numbers. The photographs and photograph log are presented in Section 5.9.

5.4.1.1 Site Access and Entrance Gates

Access to the site is from Elijah Road, a gravel-surfaced, BIA-maintained road over which LM has permanent right of access. The entrance gates are present but no longer used. They are permanently open and allow unrestricted access to the site. A fallen tree is blocking the road on the access road south of the disposal cell (PL-1). The tree will be removed during the maintenance trip in 2024.

5.4.1.2 Perimeter Signs

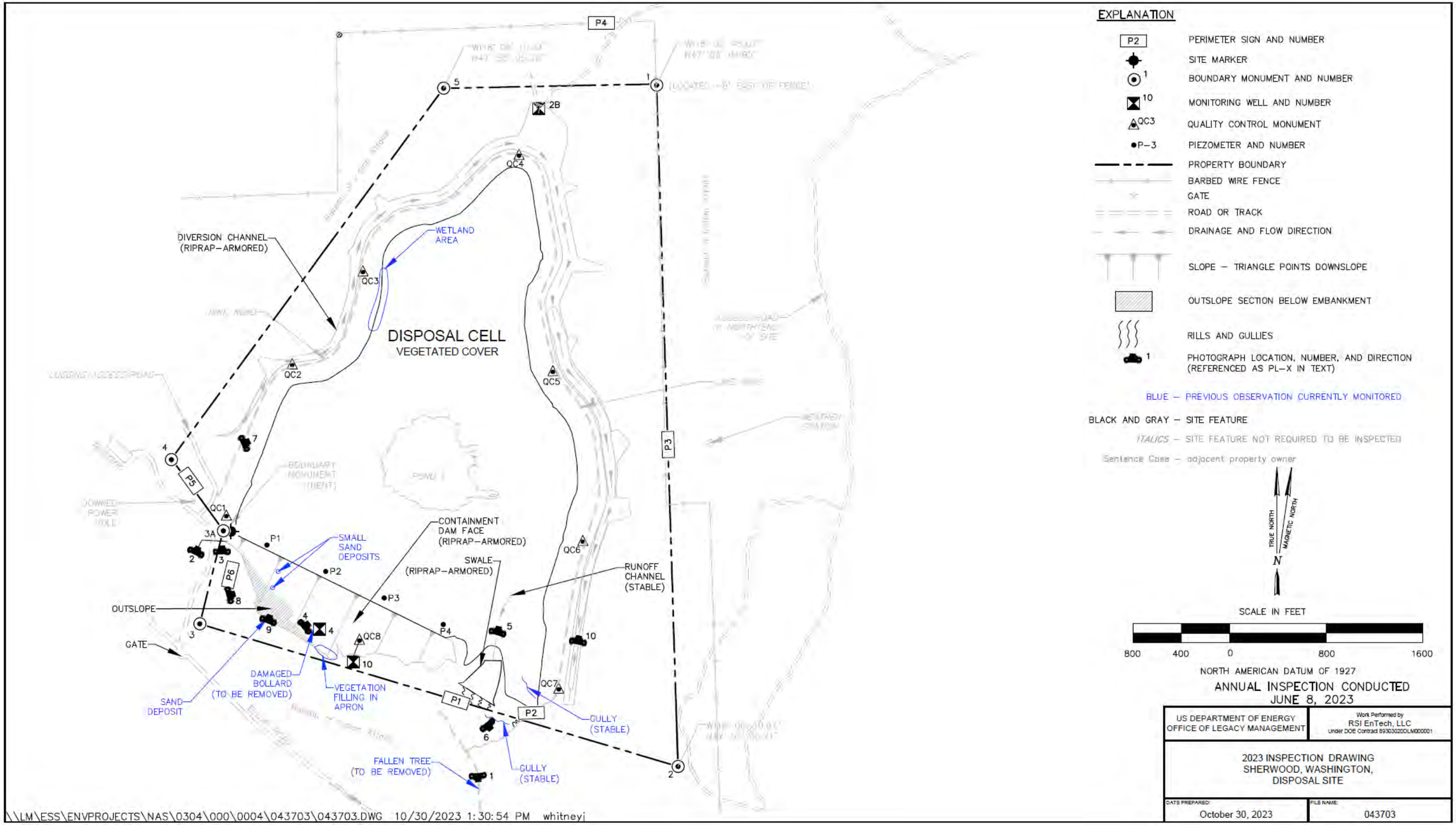
There are six warning or perimeter signs, attached to steel posts set in concrete, positioned along the site boundary at likely access points around the site. No maintenance needs were identified.

5.4.1.3 Site Marker

There is one granite site marker on the southwest side of the site where the access road lies closest to the site boundary (PL-2). No maintenance needs were identified.

5.4.1.4 Boundary Monuments

Six boundary monuments set in concrete define the site boundary. Because surrounding vegetation has made it difficult to locate some of the monuments, metal T-posts were installed at each boundary monument location. All boundary monuments were located during the inspection. Boundary monument BM-3A is bent but still visible and intact (PL-3). No maintenance needs were identified.



EXPLANATION

- P2 — PERIMETER SIGN AND NUMBER
- SITE MARKER
- 1 — BOUNDARY MONUMENT AND NUMBER
- 10 — MONITORING WELL AND NUMBER
- QC3 — QUALITY CONTROL MONUMENT
- P–3 — PIEZOMETER AND NUMBER
- PROPERTY BOUNDARY
- BARBED WIRE FENCE
- GATE
- ROAD OR TRACK
- DRAINAGE AND FLOW DIRECTION
- SLOPE – TRIANGLE POINTS DOWNSLOPE
- OUTSLOPE SECTION BELOW EMBANKMENT
- RILLS AND GULLIES
- 1 — PHOTOGRAPH LOCATION, NUMBER, AND DIRECTION (REFERENCED AS PL–X IN TEXT)

BLUE – PREVIOUS OBSERVATION CURRENTLY MONITORED

BLACK AND GRAY – SITE FEATURE

ITALICS – SITE FEATURE NOT REQUIRED TO BE INSPECTED

Sentence Case – adjacent property owner

TRUE NORTH
MAGNETIC NORTH
N

SCALE IN FEET

800 400 0 800 1600

NORTH AMERICAN DATUM OF 1927

ANNUAL INSPECTION CONDUCTED
JUNE 8, 2023

US DEPARTMENT OF ENERGY OFFICE OF LEGACY MANAGEMENT	Work Performed by RSI EnTech, LLC Under DOE Contract 89303020DLM000001
2023 INSPECTION DRAWING SHERWOOD, WASHINGTON, DISPOSAL SITE	
DATE PREPARED: October 30, 2023	FILE NAME: 043703

Figure 5-1. 2023 Annual Inspection Drawing for the Sherwood, Washington, Disposal Site

5.4.1.5 Aerial Survey Quality Control Monuments

Eight aerial survey quality control monuments were inspected during the 2023 inspection. LM conducted a baseline aerial survey in October 2021. No maintenance needs were identified.

5.4.1.6 Monitoring Wells and Piezometers

The site groundwater monitoring network consists of monitoring wells MW-2B, MW-4, and MW-10. Each monitoring well is protected by eight surrounding bollards. At monitoring well MW-4, one of the outermost bollards has been knocked over (PL-4). The LMS groundwater sampling team verified that the integrity of the well has not been affected. The fallen bollard will be removed in 2024. As part of the dam safety inspection program, four piezometers were installed in November 2000 along the crest of the containment dam at a depth equivalent to the base of the dam. All piezometers were undamaged and locked. None of the piezometer wellheads or concrete pads have any designation of their number. To avoid potential errors, it is suggested that the piezometers have their number punch stamped on the wellhead by the environmental monitoring organization during the 2024 sampling event. No further maintenance needs were identified.

5.4.2 Inspection Areas

In accordance with the LTSP, the site is divided into three inspection areas (referred to as "transects" in the LTSP) to ensure a thorough and efficient inspection. The inspection areas are (1) the site perimeter, outlying areas, and balance of site; (2) the cover of the disposal cell (tailings impoundment); and (3) the containment dam and diversion channel. Inspectors examined specific site surveillance features within each area and looked for evidence of erosion, settling, slumping, or other modifying processes that might affect conformance with LTSP requirements.

5.4.2.1 Site Perimeter, Outlying Areas, and Balance of Site

Most of the area outside of the diversion channel that encircles the disposal cell is ponderosa pine forest. The surrounding lands are part of the Spokane Indian Reservation and are used for timber harvesting, hunting, and wildlife habitat. The area approximately 0.25 mile beyond the site boundary showed no evidence of changes in land use, new construction or development, or other activities that might affect the site. A vacant metal building, left in place from earlier mining operations, is about 500 feet (ft) west of the site. The building has not changed significantly since the last inspection and remains vacant. Large boulders line the southwest border of the disposal cell outside of the site boundary along Elijah Road. These boulders are not part of the cell design, but they may reduce vehicle access to the cell**.** Boulders near boundary monument BM-3A have been moved in the past, making vehicle access possible. The area will continue to be monitored to ensure that vehicle traffic does not increase on the site.

A small, shallow runoff channel near the southeast corner of the disposal cell discharges water into a riprap-armored swale east of the containment dam (PL-5). The channel is stable and is not above the tailings impoundment. In previous inspections, rilling was found below the riprap-armored swale. These features will continue to be monitored to ensure that they do not affect the integrity of the disposal cell.

Two prominent gullies are present: one is outside the site boundary between perimeter sign P1 and P2 (PL-6) and the other is along the access road near the dike road on the southeast corner of the disposal cell. The erosion areas are stable and are not impacting site features but will continue to be monitored. No maintenance needs were identified.

5.4.2.2 Cover of Disposal Cell

The disposal cell, completed in 1996, occupies 100 acres. The cover consists of 12 to 20 ft of uncompacted soils. During site reclamation, the surface was seeded with native species, and live ponderosa pine trees were planted on portions of the cell.

As described in detail in the LTSP (DOE 2001), the disposal cell cover was designed to stabilize, and settlement was expected to occur. The largest area of settlement is at the center of the cell (PL-7) where plant species adapted to wetland environments are present. Four distinct ponds were mapped during past inspections, but these are merging into one distinct pond. An evaluation of topographic surveys conducted in 2016 and 2017 indicated that up to 4.4 ft of settlement has occurred near the pond since construction of the disposal cell. The cover design allowed for up to 10 ft of settlement (DOE 2018b). The disposal cell surface will continue to be monitored for unusual settlement features to ensure that the disposal cell is performing as designed. In October 2021, aerial light detection and ranging (lidar) surveys were conducted to collect high-resolution topographic data of the disposal cell and surrounding area. The data collected include natural color imagery and lidar elevation data to be used as a baseline. A follow-up aerial survey is scheduled for 2028. The data collected in the 2021 aerial survey confirm that settlement is less than the 10 ft allowance. No maintenance needs were identified.

5.4.2.3 Containment Dam and Diversion Channel

The tailings embankment on the site is classified as a containment dam because of the saturated condition of the impoundment; therefore, an annual dam safety inspection is required by the LTSP (DOE 2001) to ensure continued compliance with the National Dam Safety Program. The containment dam face was inspected during the June 2023 inspection, and water levels were measured in four piezometers during the June 2023 groundwater sampling event in accordance with the *Dam Inspection Checklist*, which is included at the end of this chapter.

The piezometers, installed in 2000, directly measure moisture conditions in the containment dam. Measurements collected on June 27, 2023, are listed in Table 5-2 and in the attached *Dam Inspection Checklist*. Figure 5-2 plots corresponding historical groundwater elevations. Because the scale in this initial figure spans approximately 50 ft, to provide greater resolution, Figure 5-3 plots the same data but using unique scales (results for piezometer P3 are not shown because this well has been predominantly dry). Since 2001, groundwater elevations have increased 0.6 ft in shallow piezometer P4; this slight increase is not considered indicative of potential performance issues. Between 2011 and 2022, water elevations increased 1.3 ft in piezometer P1, but, consistent with 2001–2010 observations, this location was dry in 2023. As presented in Section 5.7, no statistically significant increasing trends in water elevations were found in monitoring wells MW-4 and MW-10 near the base of the dam.

The containment dam face has a rock cover consisting primarily of highly durable quartz monzonite. The face was designed to allow for a vegetated cover, including mature trees, to

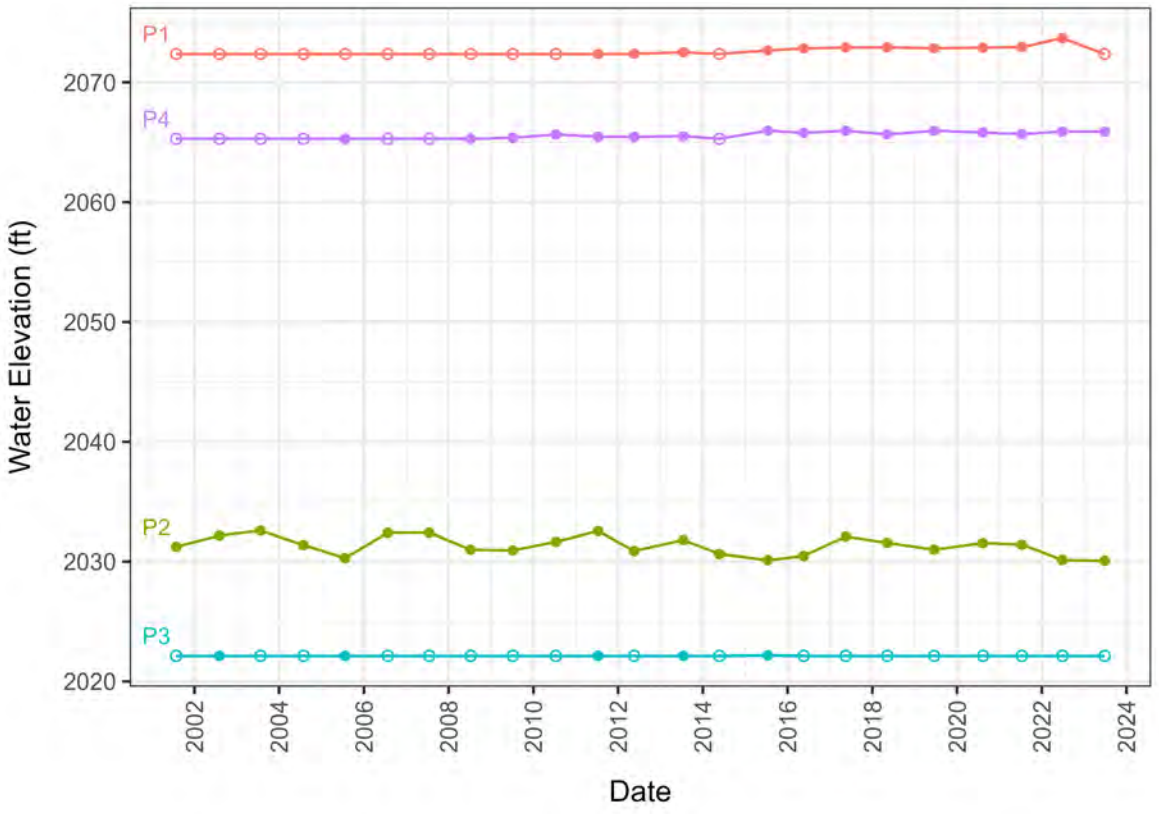
establish and, therefore, stabilize the surface and mitigate erosion. The dam face was heavily vegetated in 2023 (PL-8). No maintenance needs were identified.

Table 5-2. 2023 Sherwood, Washington, Disposal Site Piezometer Water Depths

Piezometer	Total Depth of Piezometer (ft)[a,b]	Water Level (ft btoc)[a]	Depth of Water in Well (ft)
P1	22.55	Dry	Dry
P2	63.07	62.22	0.85
P3	67.62	Dry	Dry
P4	22.70	21.9	0.80

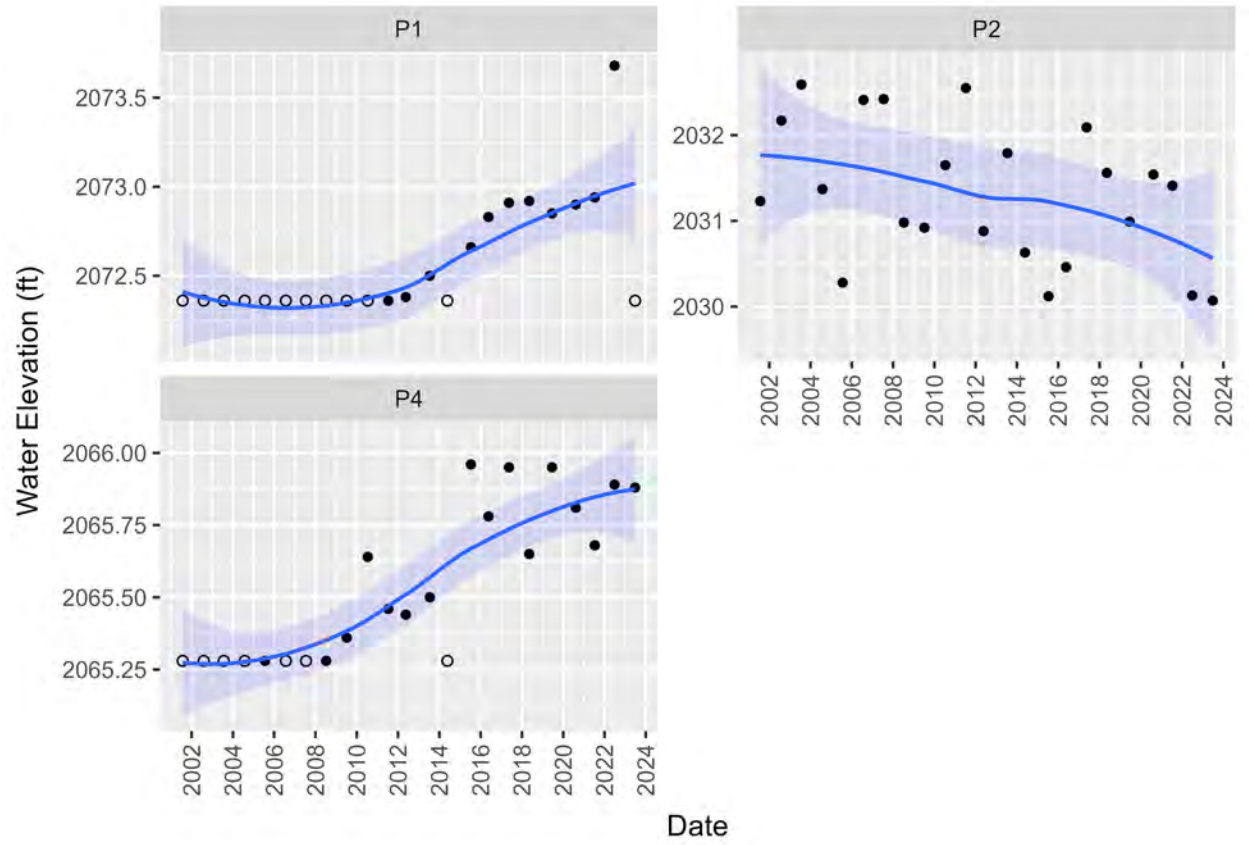
Notes:
[a] Measured from the top of the inner casing.
[b] Total piezometer depths based on measurements collected during the 2023 sampling event.

Abbreviation:
btoc = below top of casing



Note: Hollow symbols indicate that the well was dry or that the water level was below the pump (plotted values are corresponding bottom screen elevations).

Figure 5-2. Groundwater Elevations at Piezometer Locations P1 Through P4, Sherwood, Washington, Disposal Site



Locally estimated scatterplot smoothing (LOESS) line and 95% confidence interval
○ Dry well or water level below the pump (plotted value is corresponding bottom screen elevation)

Notes: To provide greater resolution, *y*-axis scales are unique for each well. Therefore, any between-well comparisons of groundwater elevations should be made with caution. Results for piezometer P3 are not shown because the well has been dry since 2016 and in most preceding sampling events (Figure 5-2). The vertical datum is North American Vertical Datum of 1988. Mann-Kendall trend analysis indicates statistically significant increasing trends in groundwater elevations in piezometers P1 and P4 (the shallowest piezometers). However, consistent with observations in 2001–2010 and in 2014, piezometer P1 was again dry during the June 2023 sampling event. A statistically significant decreasing trend in water levels was found for piezometer P2.

Figure 5-3. Groundwater Elevations in Piezometers P1, P2, and P4: Unique Scales
Sherwood, Washington, Disposal Site

During past inspections, areas of sand deposition have been described that indicate that materials have washed out from underneath the dam rock cover (DOE 2018a). The largest sand deposit (PL-9), measuring approximately 16 × 14 ft, was evaluated by a soil erosion specialist during the 2022 inspection. This area will be visually monitored and measured during future inspections and by periodic lidar surveys. Several smaller deposits on the dam, especially on the western half, were also evaluated, as were several areas along the toe of the dam. DOE will continue to monitor or implement repair options in consultation with NRC as necessary. Deposition is occurring in several areas along the toe of the containment dam. Continued deposition over time could lead to accumulation in amounts rendering the water-draining ability of the containment dam toe inefficient. This is not an issue currently, but inspectors will continue to monitor the areas.

A riprap-armored diversion channel surrounds the disposal cell, diverting runoff away from the cell. The diversion channel was designed to allow for sedimentation and for vegetation to establish over time. Trees, shrubs, grasses, and wetland plants have established in most areas of the diversion channel (PL-10). Sediment deposition is found in many places in the diversion channel, and trails in these areas indicate that wildlife frequently access the cell for forage and water. No evidence of erosion was observed downgradient of the diversion channel outlets. No maintenance needs were identified.

5.5 Follow-Up Inspections

LM will conduct follow-up inspections if (1) a condition is identified during the annual inspection or other site visit that requires a return to the site to evaluate the condition or (2) LM is notified by a citizen or outside agency that conditions at the site are substantially changed. No need for a follow-up inspection was identified.

5.6 Routine Maintenance and Emergency Measures

Inspectors documented minor maintenance during the 2023 inspection that will be completed during a 2024 maintenance trip:

- Removal of the bollard at monitoring well MW-4
- Removal of the fallen tree along the access road
- Trimming of vegetation along the dike road
- Numbering of piezometers

Emergency measures are corrective actions that LM will take in response to unusual damage or disruption that threatens or compromises site health and safety, security, integrity, or compliance with 40 CFR 192. No emergency measures were identified.

5.7 Environmental Monitoring

5.7.1 Groundwater Monitoring

Groundwater compliance monitoring is not required at the site; however, as a best management practice stipulated in the LTSP (DOE 2001), LM conducts limited groundwater monitoring for several indicator parameters. Samples are collected annually from background well 2B north of the disposal cell and from downgradient Point of Compliance (POC) monitoring wells MW-4 and MW-10 near the base of the containment dam (Figure 5-4). Groundwater samples are analyzed for chloride and sulfate, the primary indicator parameters identified in the LTSP (DOE 2001), and for TDS.

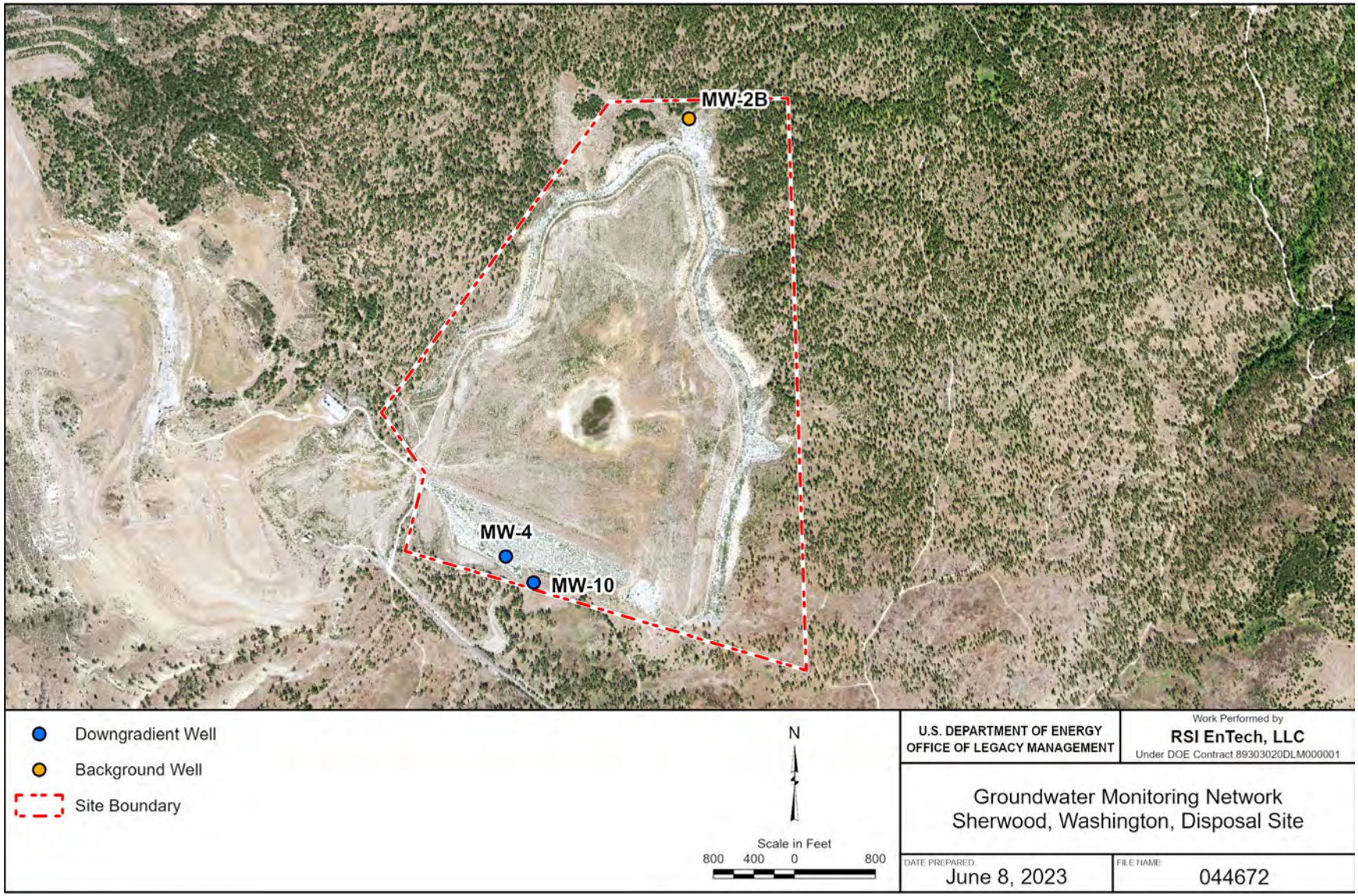


Figure 5-4. Groundwater Monitoring Network at Sherwood, Washington, Disposal Site

Groundwater quality results for the June 2023 sampling event are listed in Table 5-3. Chloride and sulfate concentrations in groundwater in monitoring wells MW-4 and MW-10 continue to be below the corresponding State of Washington groundwater quality criterion (250 milligrams per liter [mg/L] for both parameters), considered the action level for confirmatory sampling in the LTSP (DOE 2001).

Table 5-3. 2023 Groundwater Quality Results for the Sherwood, Washington, Disposal Site

Constituent	Groundwater Quality Criterion	Well		
		Background Well MW-2B	Downgradient POC Well MW-4	Downgradient POC Well MW-10
Chloride (mg/L)	250[a,b]	1.42	0.46	1.13
Sulfate (mg/L)	250[a,b]	2.9	13.5	29
TDS (mg/L)	NA	171	445	583

Notes:
[a] Criteria used as action levels for chloride and sulfate in accordance with the LTSP (DOE 2001).
[b] State of Washington groundwater quality criteria for secondary contaminants: https://app.leg.wa.gov/WAC/default.aspx?cite=173-200-040.

Abbreviation:
NA = not applicable

According to the LTSP (DOE 2001), should the concentration of chloride or sulfate exceed the action levels in Table 5-3, LM would conduct confirmatory sampling. If the confirmatory sampling verifies the exceedance, LM will develop an evaluative monitoring work plan, in consultation with the Spokane Tribe and BIA, and submit that plan to NRC for review before initiating an evaluative monitoring program. Results of the evaluative monitoring program would then be used to determine if corrective action is necessary.

Time-concentration plots of chloride and sulfate measured in monitoring wells MW-4 and MW-10, as well as background well MW-2B are shown in Figure 5-5 and Figure 5-6, respectively. Chloride concentrations in all wells have been consistently below the 250 mg/L water quality criterion and typically less than 10 mg/L. The exceptions shown in Figure 5-5 for monitoring well MW-4 correspond to higher sulfate concentrations measured at the same location. Sulfate concentrations in monitoring well MW-4 have been at or below the 250 mg/L criterion except for the May 2017 result of 260 mg/L (Kreie 2018). As acknowledged in previous annual reports, the elevated concentrations of chloride and sulfate measured in monitoring well MW-4 in 2006, 2011, and 2016–2018 correspond to increases in groundwater elevations in monitoring well MW-4 and in background well MW-2B. Sulfate concentrations in monitoring well MW-10 and background well MW-2B have been consistently below the 250 mg/L criterion (Figure 5-6). In 2022, concentrations of both chloride and sulfate were unusually low relative to historical measurements. Data validation eliminated laboratory error from consideration as a possible explanation for these outlier results. In 2023, chloride and sulfate concentrations in all wells returned to pre-2022 average levels (Figure 5-5; Figure 5-6).

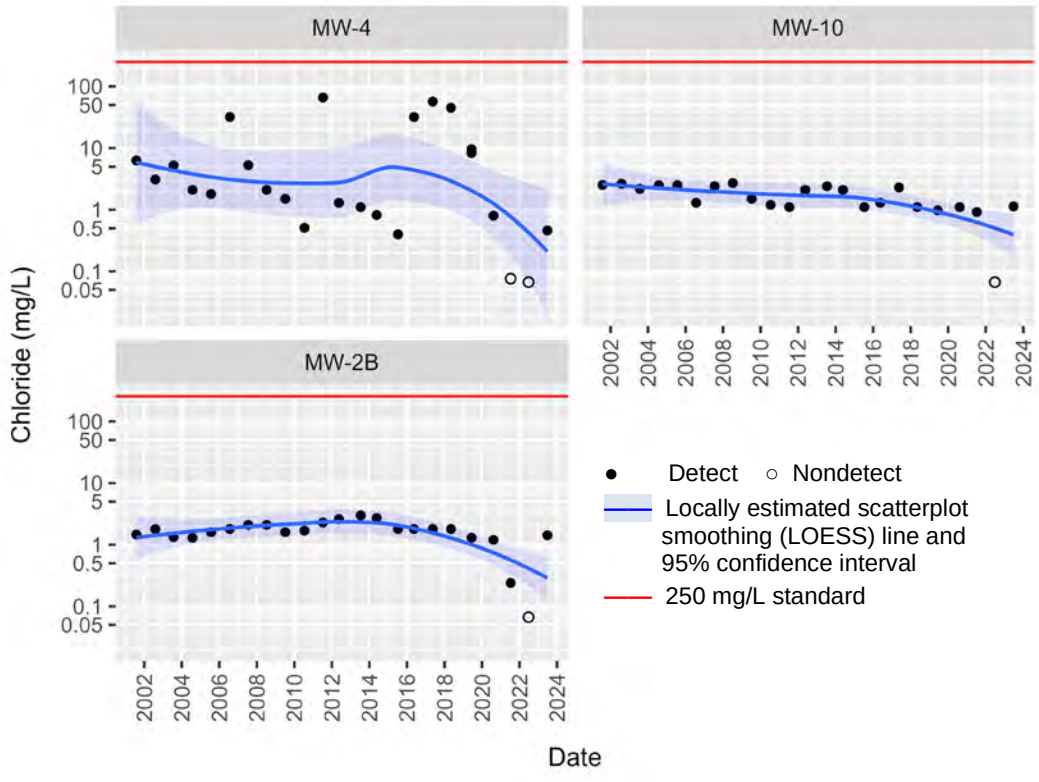


Figure 5-5. Chloride Concentrations in Monitoring Wells at the Sherwood, Washington, Disposal Site

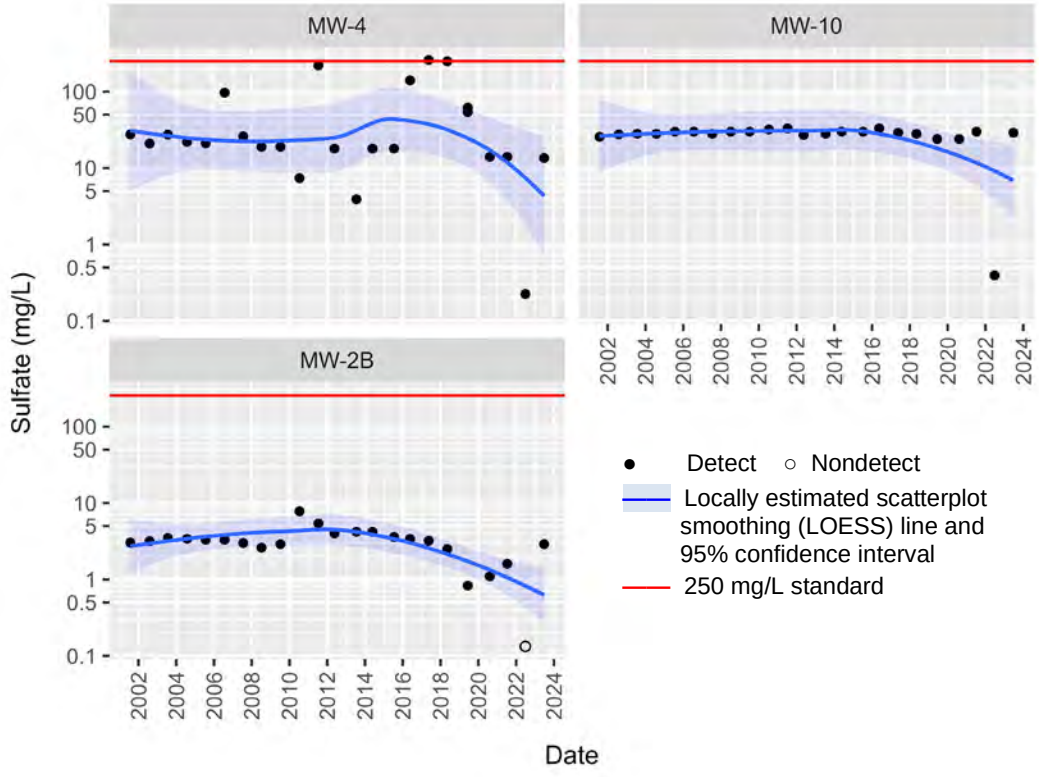


Figure 5-6. Sulfate Concentrations in Monitoring Wells at the Sherwood, Washington, Disposal Site

Although TDS is not considered an indicator parameter, this analyte is routinely monitored in accordance with the LTSP (DOE 2001; Table 5-3). TDS concentrations in monitoring wells MW-4 and MW-10 have consistently exceeded concentrations measured in background well MW-2B (Figure 5-7). In 2023, TDS concentrations in monitoring wells MW-4 and MW-10 were 445 and 583 mg/L, respectively. In background well MW-2B, the 2023 TDS measurement was 171 mg/L, slightly lower than the historical average concentration of about 210 mg/L.

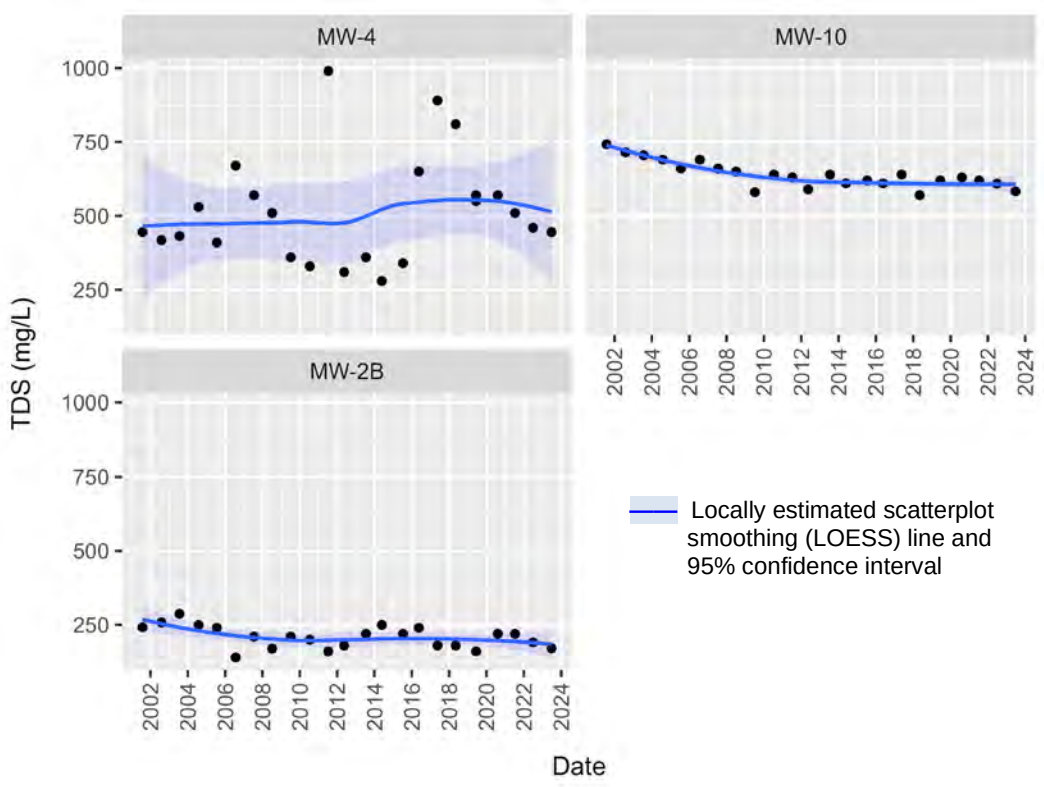


Figure 5-7. TDS Concentrations in Monitoring Wells at the Sherwood, Washington, Disposal Site

Regarding the observed fluctuations in indicator parameter concentrations in monitoring well MW-4, an early technical evaluation report prepared by the Washington State Department of Health attributed the variable water quality in this well to seasonal variation in annual infiltration (rainfall) and static water levels (WDOH 2000). More recently, annual precipitation totals measured at the Spokane, Washington, airport appear to be somewhat correlated with the increased sulfate and chloride concentrations discussed above. For example, in 2017, the annual precipitation was 22.14 inches, the highest annual rainfall recorded since 1996. The water level recorded in monitoring well MW-4 was also the highest at that time (refer to Figure 5-8 and Figure 5-9).

Groundwater elevations recorded at each of the monitoring wells are shown in Figure 5-8 (common *y*-axis) and Figure 5-9 (unique scaling). Groundwater occurs in two hydrostratigraphic units: (1) the alluvium that lies on top of the bedrock surface and (2) the conductive bedrock, including weathered bedrock in the upper portion and unweathered or competent bedrock below. Monitoring well MW-10 and MW-4 are completed in the alluvium, while background well MW-2B is screened across the alluvium, weathered bedrock, and competent bedrock.

Absolute values of water table elevations plotted in Figure 5-8 and Figure 5-9 differ slightly from those shown in annual reports issued before 2021, but the trends are the same. The reason for the offset is the recent (February 2021) transformation of vertical datum from National Geodetic Vertical Datum of 1929 to North American Vertical Datum of 1988 (NAVD 88) in LM's environmental database.

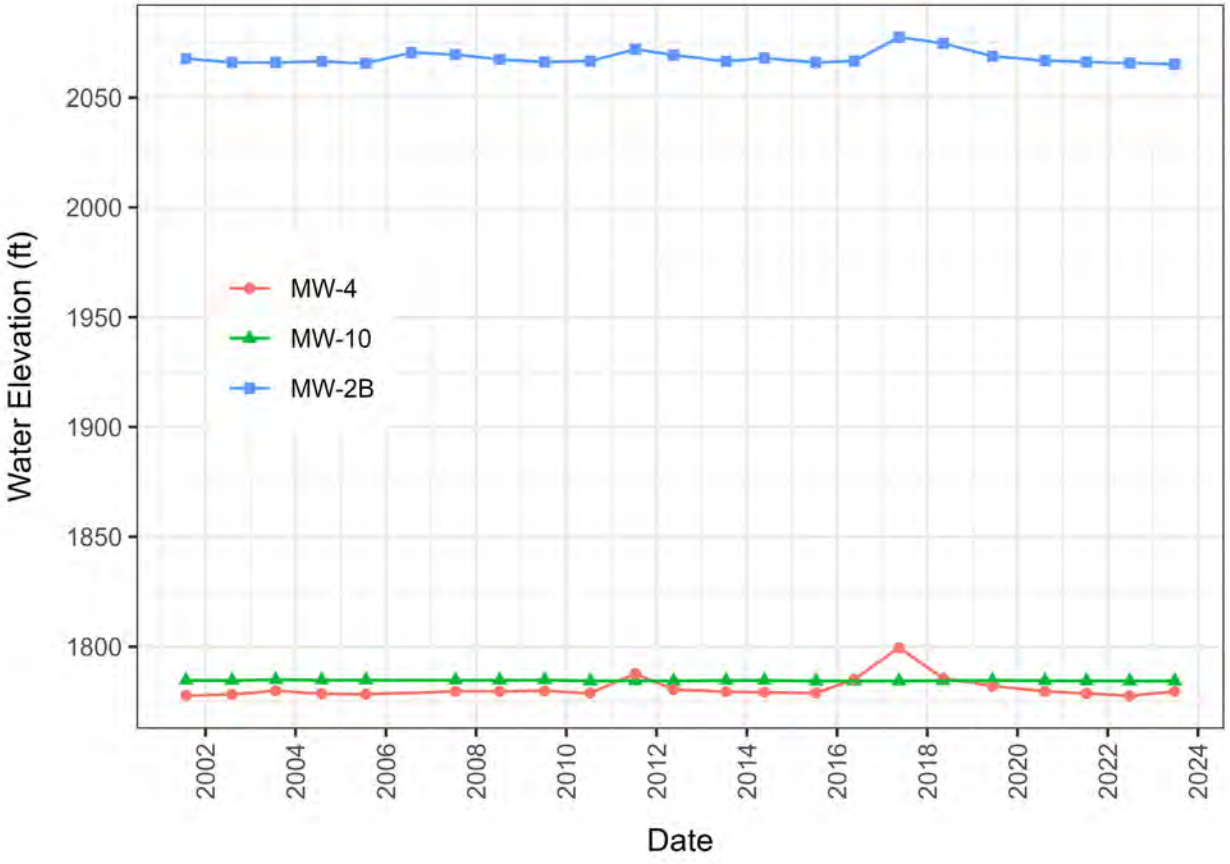
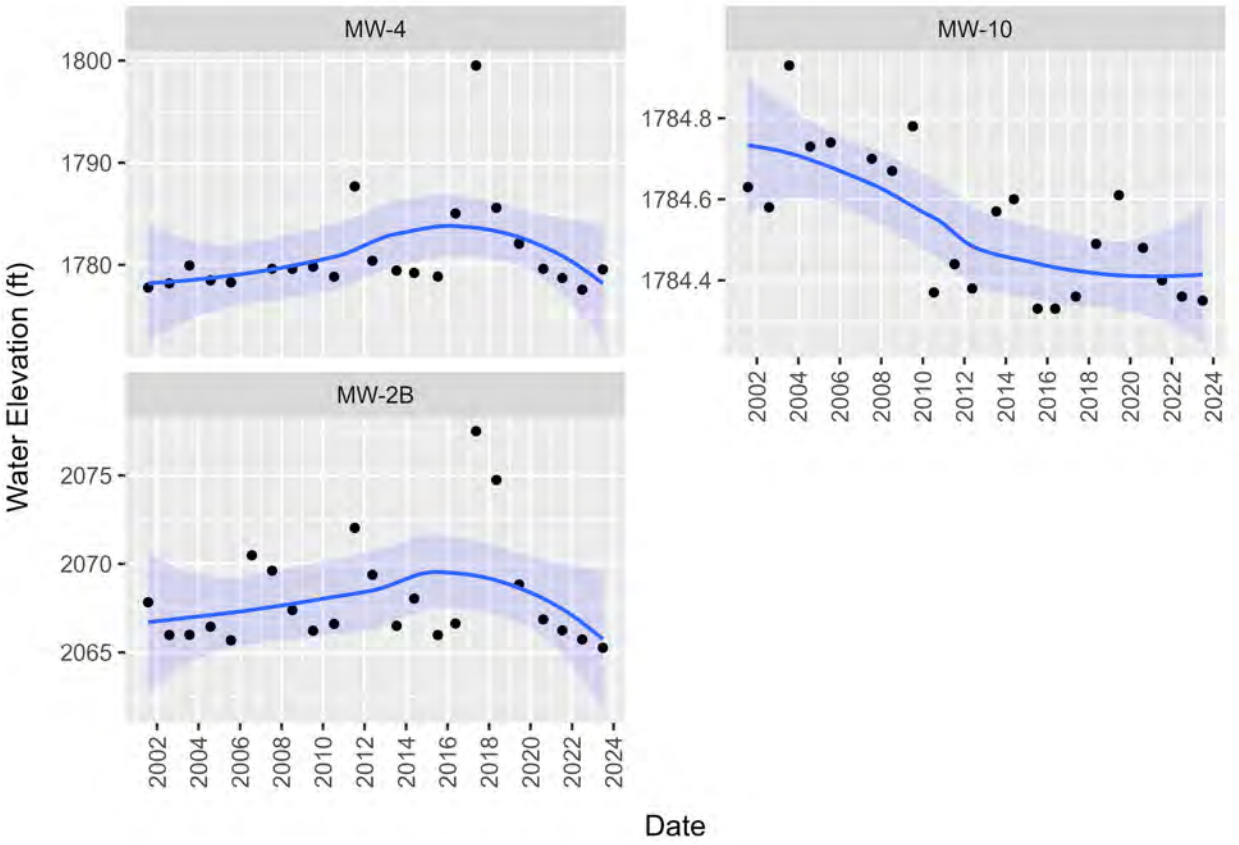


Figure 5-8. Groundwater Elevations in Monitoring Wells at the Sherwood, Washington, Disposal Site



Locally estimated scatterplot smoothing (LOESS) line and 95% confidence interval

Notes: To provide greater resolution, *y*-axis scales are unique for each well. Therefore, any between-well comparisons of groundwater elevations should be made with caution. The vertical datum is NAVD 88. Mann-Kendall trend analysis identified a statistically significant decreasing trend in groundwater elevations for monitoring well MW-10; no trend was found for monitoring wells MW-4 or MW-2B.

Figure 5-9.Groundwater Elevations in Monitoring Wells MW-4, MW-10, and MW-2B: Unique Scales Sherwood, Washington, Disposal Site

5.7.2 Vegetation Monitoring

The LTSP (DOE 2001) requires annual visual inspections of the disposal cell vegetated cover to ensure that it satisfies erosional stability criteria and stabilizes. Vegetation on the disposal cell cover includes trees (primarily ponderosa pine), shrubs, and a mixture of native and introduced grasses and forbs. No areas of concern, such as patterns of dead vegetation or erosional features, were identified during the 2023 annual inspection.

LM has released various biological control insects in the past to help control noxious weeds and periodically treats weed infestations with herbicide. No biological controls or herbicide applications were warranted in 2023.

5.8 References

10 CFR 40.28. U.S. Nuclear Regulatory Commission, "General License for Custody and Long-Term Care of Uranium or Thorium Byproduct Materials Disposal Sites," *Code of Federal Regulations.*

40 CFR 192. U.S. Environmental Protection Agency, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," *Code of Federal Regulations.*

DOE (U.S. Department of Energy), 2001. *Long-Term Surveillance Plan for the DOE Sherwood Project (UMTRCA Title II) Reclamation Cell, Wellpinit, Washington*, S00204, Office of Legacy Management, February.

DOE (U.S. Department of Energy), 2018a. *Follow-Up Inspection and Evaluation, Sherwood, Washington, Disposal Site*, LMS/SHE/S15417, Office of Legacy Management, March.

DOE (U.S. Department of Energy), 2018b. *Settlement Survey and Analysis, Sherwood, Washington, Disposal Site*, LMS/SHE/S19518, Office of Legacy Management, June.

Kreie, 2018. Ken Kreie, site manager, Office of Legacy Management, U.S. Department of Energy, letter (about Groundwater Monitoring Results at the Sherwood, Washington, Disposal Site Indicates Elevated Sulfate Concentration in Point of Compliance Well) to deputy director, U.S. Nuclear Regulatory Commission, November 5.

WDOH (Washington State Department of Health), 2000. *Sherwood Uranium Mill Project, Technical Evaluation Report, Monitoring and Stabilization Plan Supplement*, February.

5.9 Photographs

Photograph Location Number	Azimuth	Photograph Description
PL-1	175	Fallen Tree Along Road
PL-2	—	Site Marker
PL-3	25	Bent Boundary Monument BM-3A
PL-4	50	Monitoring Well MW-4 with Damaged Bollard
PL-5	15	Runoff Channel on Southeast Area of Disposal Cell
PL-6	140	Gully near Swale
PL-7	65	Pond on Disposal Cell
PL-8	75	Containment Dam Face
PL-9	20	Sand Deposit on Containment Dam
PL-10	10	Armored Diversion Channel

Note:
— = Photograph taken vertically from above.

PL-1. Fallen Tree Along Road

PL-2. Site Marker

PL-3. Bent Boundary Monument BM-3A

PL-4. Monitoring Well MW-4 with Damaged Bollard

PL-5. Runoff Channel on Southeast Area of Disposal Cell

PL-6. Gully near Swale

PL-7. Pond on Disposal Cell

PL-8. Containment Dam Face

PL-9. Sand Deposit on Containment Dam

PL-10. Armored Diversion Channel

Attachment 1

Dam Inspection Checklist

Dam Inspection Checklist
Sherwood, Washington, UMTRCA Title II Disposal Site

Date of Inspection: June 08, 2023
Inspector: Zoe Aldous Organization: RSI EnTech, LLC

Piezometer water levels measured during groundwater monitoring event:
(All depths in feet; TOC = top of casing)

Piezometer P-1 fluid level (TOC to top of fluid): dry Fluid amount: 22.7 dry
Total depth: 22.5

Piezometer P-2 fluid level (TOC to top of fluid): 62.22 Fluid amount: 0.85
Total depth: 63.07

Piezometer P-3 fluid level (TOC to top of fluid): dry Fluid amount: dry
Total depth: 67.62

Piezometer P-4 fluid level (TOC to top of fluid): 21.9 Fluid amount: 0.80
Total depth: 22.7

Was evidence of significant seepage observed on the dam face?
No

Was evidence of significant slumping observed on the dam?
No

Was evidence of significant erosion observed on the dam?
No

Was vegetative growth that could compromise dam stability observed?
No

Was any condition that presents an imminent hazard to human health and safety or to the environment observed?
No

Emergency Notification Contacts:

DOE Site Manager: Ken Kreie (970) 248-6036
NRC Operations Center: (301) 951-0550
Spokane Tribal Police/Sheriff: (509) 258-4400
State Department of Ecology—Dam Safety Office: (360) 407-6625

Following completion of the inspection, this Dam Inspection Checklist is to be sent to: Gustavo Ordonez at gord461@ecy.wa.gov and James DeMay at jade461@ecy.wa.gov of the Washington Department of Ecology, Dam Safety Office

Inspector Signature: ZOE ALDOUS (Affiliate) Digitally signed by ZOE ALDOUS (Affiliate) Date: 2023.10.12 15:32:04 -06'00' Date: _____

6.0 Shirley Basin South, Wyoming, Disposal Site

6.1 Compliance Summary

The Shirley Basin South, Wyoming, Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II Disposal Site was inspected on July 27, 2023. No major changes were observed on the disposal cell or in associated drainage features. Inspectors identified maintenance needs and found no cause for a follow-up inspection.

Groundwater is monitored annually in accordance with the site-specific U.S. Department of Energy (DOE) Office of Legacy Management (LM) Long-Term Surveillance Plan (DOE 2004) (LTSP). The most recent sampling event occurred in July 2023. The 2023 data indicate that alternate concentration limits (ACLs) continue to be exceeded in the point of compliance (POC) well 5-DC for radium-228 (^{228}Ra) and selenium. In contrast to previous years, the ACL for radium-226 (^{226}Ra) was not exceeded in any well in 2023. Groundwater protection standards for sulfate and total dissolved solids (TDS) also continue to be exceeded in three wells near the disposal cell but no exceedances were measured in livestock well K.G.S. #3 or in any of the wells near the site boundary. No risks to human health and the environment were identified.

6.2 Compliance Requirements

Requirements for the long-term surveillance and maintenance of the site are specified in the site-specific LTSP (DOE 2004) in accordance with procedures established to comply with the requirements of the U.S. Nuclear Regulatory Commission (NRC) general license at Title 10 *Code of Federal Regulations* Section 40.28 (10 CFR 40.28). Table 6-1 lists these requirements.

Table 6-1. License Requirements for the Shirley Basin South, Wyoming, Disposal Site

Requirement	LTSP	This Report	10 CFR 40.28
Annual Inspection and Report	Sections 3.3 and 3.4	Section 6.4	(b)(3)
Follow-Up Inspections	Section 3.5	Section 6.5	(b)(4)
Routine Maintenance and Emergency Measures	Section 3.6	Section 6.6	(b)(5)
Environmental Monitoring	Section 3.7	Section 6.7	(b)(3)

6.3 Institutional Controls

The 1527-acre site, identified by the property boundary shown in Figure 6-1, is owned by the United States and was accepted under the NRC general license in 2005. The LTSP disposal site description section states that the United States government owns 1512 acres (also known as Parcel 1) whereas Appendix A of the LTSP includes the deed that conveyed 1527 acres of Petrotomics land (Parcel 1 and Parcel 2). DOE is the licensee and, in accordance with the requirements for UMTRCA Title II sites, LM is responsible for the custody and long-term care of the site. Institutional controls (ICs) at the site include federal ownership of the property, administrative controls, and the following physical ICs that are inspected annually: disposal cell, entrance gate and sign, perimeter fence and signs, site marker, boundary monuments, and monitoring wellhead protectors.

6.4 Inspection Results

The site, approximately 60 miles south of Casper, Wyoming, was inspected by J. Cario and M. Guziak of the Legacy Management Support (LMS) contractor. J. Hugo (LMS) participated in the inspection to evaluate the erosional features in Pit 4 and around the riprap of the disposal cell, both reported first in 2022, as well as the arroyo under the site boundary fence reported by the grazing licensee to LM in spring 2023. N. Keller (LM site manager), T. Santonastaso (LMS), S. Loose (Wyoming Department of Environmental Quality [WDEQ]), and S. Cameron (Florida International University DOE Fellow) also attended the inspection. The purposes of the inspection were to confirm the integrity of visible features at the site, identify changes in conditions that might affect conformance with the LTSP, and evaluate whether maintenance or follow-up inspection and monitoring are needed.

6.4.1 Site Surveillance Features

Figure 6-1 shows the locations of site features, including site surveillance features and inspection areas, in black and gray font. Some site features that are present but not required to be inspected are shown in italic font. Observations from previous inspections that are currently monitored are shown in blue, and new observations identified during the 2023 annual inspection are shown in red. Inspection results and recommended maintenance activities associated with site surveillance features are described in the following subsections. Photographs to support specific observations are noted in the text and in Figure 6-1 by photograph location (PL) numbers. The photographs and photograph log are presented in Section 6.9.

6.4.1.1 Site Access and Entrance Gate

Access to the site is immediately off Carbon County Road 2E. The entrance gate is a barbed-wire gate in the perimeter fence. The gate, along the southern portion of the perimeter fence, was secured by a locked chain. The northeast gate accesses Wyoming state land and was not locked. The northwest gate accesses U.S. Bureau of Land Management (BLM) land and was not locked. The gates will be secured with standard LM locks by the 2024 inspection.

6.4.1.2 Perimeter Fence and Signs

A four-strand barbed-wire fence encloses the site. A grazing license LM granted to a local rancher allows him to graze livestock onsite in exchange for minor maintenance of the perimeter fence. An animal burrow is present under the fence near boundary monument BM-18, and a post is bent on the north side near boundary monument BM-24. These items are minor and will be addressed by the grazing licensee. A large erosional feature (arroyo) has formed underneath the fence on the southern portion of the west boundary (PL-1). The arroyo formed inline with the fence, damaging several sections. Sediment from the erosional event was deposited below the slope break. This section of the fence line was subsequently realigned approximately 30 feet inward (away from the arroyo) in October 2023. Another erosional feature is developing north of the arroyo but is not yet impacting the fence.

Nine perimeter signs (warning and no-trespassing signs) are posted along the site perimeter at potential points of access (PL-2), and another 25 signs are positioned around the disposal cell. Perimeter signs P1, P2, and P33 have bullet holes but remain legible. Several perimeter signs have exposed concrete at the base but remain stable. No maintenance needs were identified.

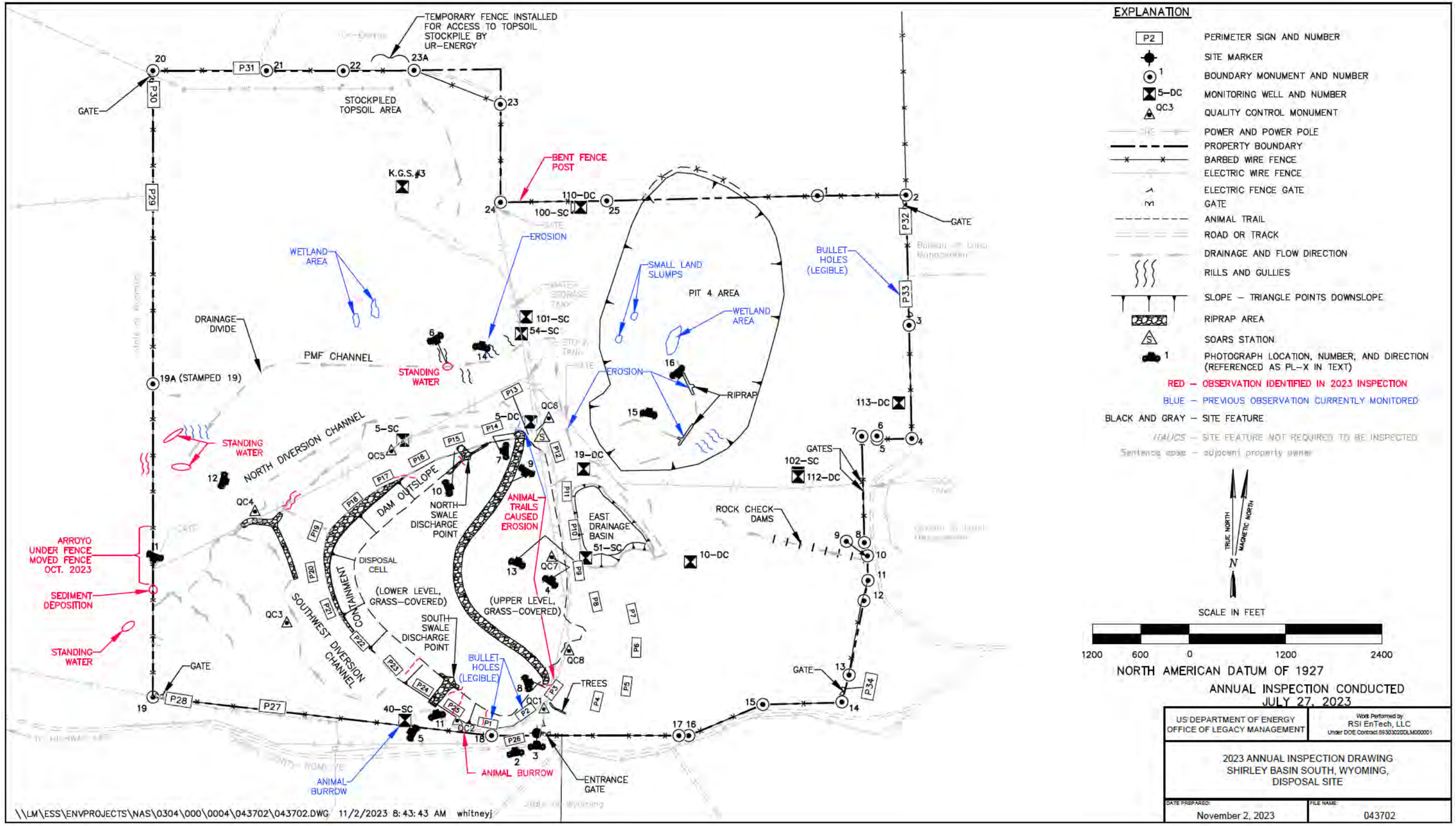


Figure 6-1. 2023 Annual Inspection Drawing for the Shirley Basin South, Wyoming, Disposal Site

6.4.1.3 Site Marker

The site has one granite site marker (PL-3) near the entrance gate. No maintenance needs were identified.

6.4.1.4 Boundary Monuments

There are 27 boundary monuments delineating the site property boundary. All boundary monuments were inspected. No maintenance needs were identified.

6.4.1.5 Aerial Survey Quality Control Monuments

In July 2019, eight permanent aerial survey quality control monuments were installed at the site for an aerial survey of the disposal cell. The quality control monument locations are shown in Figure 6-1. Quality control monument QC-7 was covered by sediment, which was removed during the inspection (PL-4). T-posts were placed near all quality control monuments prior to the 2023 inspection to improve visibility. Concrete is spalling around quality control monument QC-8, but it is still functioning as intended. No maintenance needs were identified.

6.4.1.6 Monitoring Wells

The site groundwater monitoring network consisted of eight monitoring wells when the site was transferred to LM. Six additional wells (100-SC, 101-SC, and 102-SC in the Upper Sand Aquifer and 110-DC, 112-DC, and 113-DC in the Main Sand Aquifer) were installed in 2008 to provide a better understanding of the characteristics and behavior of the affected aquifers at the site. The groundwater monitoring network now consists of 14 monitoring wells. The wellhead protectors were undamaged and locked. Monitoring well 40-SC has two small animal burrows under the concrete slab but remains stable (PL-5). No maintenance needs were identified.

6.4.2 Inspection Areas

In accordance with the LTSP, the site is divided into three inspection areas (referred to as "transects" in the LTSP) to ensure a thorough and efficient inspection. The inspection areas are (1) the cover of the disposal cell, (2) the containment dam and diversion channels, and (3) the site perimeter and balance of the site. Inspectors examined specific site surveillance features within each area and looked for evidence of erosion, settling, slumping, or other modifying processes that might affect conformance with LTSP requirements.

6.4.2.1 Cover of the Disposal Cell

The disposal cell, completed in 2000, occupies 142 acres. It has a soil cover and was revegetated primarily with rangeland and native grasses. The vegetation on the disposal cell and throughout the site is managed through the grazing license. The disposal cell surface is constructed at two elevations (the upper, eastern surface and the lower, western surface) that are separated by a riprap-armored slope (PL-6).

Cattle have worn trails around the riprap-armored slopes, which has caused erosion on the north (PL-7) and south (PL-8) ends of the eastern riprap-armored slope. These trails may need to be repaired in the future to prevent degradation of the as-built feature. No settlement, or other

modifying processes on the disposal cell cover or side slopes that might affect the integrity of the disposal cell were observed.

Gradual vegetation encroachment has been observed in the riprap on the slope that separates the two elevations (PL-9). The establishment of perennial vegetation enhances slope stability. Riparian vegetation is establishing at the toe of the slope in areas that accumulate snowmelt runoff and summer precipitation.

The upper surface is contoured to drain into a basin east of the disposal cell A and west over the riprap-protected slope to the lower surface. The lower surface is contoured to drain to a riprap-armored north swale discharge point (PL-10) and south swale discharge point (PL-11). The riprap dissipation basins at the discharge points usually hold runoff water in spring and early summer. Water was present in the north and south swale discharge points during the inspection. Vegetation is establishing in both the north swale and south swale discharge points. No maintenance needs were identified.

In August 2023, a remote telemetry meteorological station, also known as a System Operation and Analysis at Remote Sites (SOARS) station, was installed on the cover of the disposal cell to monitor local weather conditions at the site.

6.4.2.2 Containment Dam and Diversion Channels

The tailings pile was reclaimed in place and contained behind a horseshoe-shaped earthen dam, identified as the containment dam. The containment dam is predominantly grass covered, but the steeper portion (5:1 slope) of the dam out slope is protected by riprap. There were no signs of erosion, settlement, or other modifying processes that might affect the integrity of the dam. Encroaching vegetation on riprap surfaces enhances the stability of the slope.

The surface water diversion system consists of a combination of diversion channels, drainage basins, and contoured surfaces (PL-12). Two primary diversion channels, the north, and the southwest diversion channels, keep runoff away from the disposal cell. Rock armor was placed on the steeper slopes and flow concentration points where design flow velocities could erode surfaces and impact the disposal cell. A probable maximum flood (PMF) channel was constructed north of the disposal cell along the side of the reclaimed mine overburden soil pile. Part of the PMF channel drains to the west and discharges to a small, closed basin. Water was present during the inspection in this closed basin. The portion of the PMF channel that flows eastward and discharges into the East Drainage Basin (PL-13) captures stormwater from a larger drainage area. Water was present in the part of the PMF channel that drains to the east about 0.25 mile west of where it intersects the main road. These drainage basins are large enough to accommodate PMF water volumes.

Discharge plumbing from the water storage tank has caused minor erosion near monitoring well 54-SC (PL-14) and the PMF channel. This discharge is not impacting site features currently, but headcutting erosion could occur toward the well and well pad, causing the well pad to become destabilized. Inspectors will continue to monitor this area. No maintenance needs were identified.

6.4.2.3 Site Perimeter and Balance of Site

The site is surrounded by public land administered by BLM, the State of Wyoming, and private land. Land on three sides is used primarily for livestock grazing. Ur-Energy is the property owner north of the site and can access and use stockpiled topsoil on the site through sections of secured temporary fence along the northern site boundary. This access is in accordance with an agreement originally established between Petrotomics Company, the former site licensee, and Pathfinder Mines Corporation (Pathfinder), which was acquired by Ur-Energy. LM is the successor to Petrotomics, and the terms of the agreement remain in effect. WDEQ extended Pathfinder's mine area permit to include the soil stockpile area. In accordance with the permit, Ur-Energy will be required to reclaim the disturbed area, including replacing fences, when it has finished removing topsoil from the stockpile. No stockpiled topsoil has been removed.

A major site feature is the reclaimed Pit 4 area in the northeast portion of the site. Reclamation activities included rounding the side slopes, partially backfilling the pit to an elevation above the projected surface of the uppermost aquifer (the Upper Sand Aquifer), revegetating the surfaces, and protecting against potential erosion areas with riprap. Vegetation is well established, and a wetland area has formed at the bottom of the pit where standing water from runoff is often present (PL-15). Some minor slumps and displacement features are present on the west side slope of the pit, but they do not represent a significant slope stability concern. Rilling and a minor land slump is also occurring on the southeast side slope of the pit but does not represent a significant slope instability concern. A rock-armored drainage channel near the bottom of the pit, first reported to have eroded in 2016, has continued to grow, and in the lower section, most of the riprap has been eroded (PL-16). Repair of the rock armor is not necessary because potential erosion in that portion of the pit is not expected to impact slope stability.

Monitoring well K.G.S. #3 is completed in a deep formation (Lower Sand Aquifer). The grazing license allows the rancher to pump water from K.G.S. #3 to water livestock and to operate solar-powered electric fences to manage livestock rotation.

The area 0.25 mile beyond the site boundary was visually observed for erosion, changes in land use, or other phenomena that might affect the long-term integrity of the site. No such changes were observed. No maintenance needs were identified.

6.5 Follow-Up Inspections

LM will conduct follow-up inspections if (1) a condition is identified during the annual inspection or other site visit that requires a return to the site to evaluate the condition or (2) LM is notified by a citizen or outside agency that conditions at the site are substantially changed. No need for a follow-up inspection was identified.

6.6 Routine Maintenance and Emergency Measures

In accordance with the LTSP (DOE 2004), routine site maintenance will be performed by LM as needed. Realignment of the eroded disposal site fence was conducted in October of 2023. Unlocked gates will be secured during the 2024 inspection.

Emergency measures are corrective actions LM will take in response to unusual damage or disruption that threatens or compromises site health and safety, security, integrity, or compliance with 40 CFR 192. No emergency measures were identified.

6.7 Environmental Monitoring

In accordance with the LTSP (DOE 2004), annual groundwater monitoring is required at the site to verify that the ACLs are not exceeded at POC wells and to verify continued compliance with applicable groundwater protection standards. The most recent sampling event was completed in July 2023. The monitoring network described in the LTSP comprises seven wells in the uppermost (Upper Sand and Main Sand) aquifers. The uppermost aquifers consist of two sand units in the Wind River Formation. A third aquifer, the Lower Sand Aquifer, is separated by approximately 50 feet of claystone, siltstone, and bedded sandstone from the overlying Main Sand unit (DOE 2011b). In consultation with NRC, LM installed six additional monitoring wells in fall 2008 to provide a better understanding of the groundwater chemistry and flow direction in the Upper Sand and Main Sand Aquifers. The current monitoring network is described in Table 6-2 and shown in Figure 6-2.

Table 6-2. Groundwater Monitoring Network at the Shirley Basin South, Wyoming, Disposal Site

Monitoring Well	Network Application
5-SC	POC well; Upper Sand Aquifer
40-SC	Upgradient well; Upper Sand Aquifer
51-SC	POC well; Upper Sand Aquifer
54-SC	Downgradient well; Upper Sand Aquifer
100-SC*	Downgradient well; Upper Sand Aquifer
101-SC*	Downgradient well; Upper Sand Aquifer
102-SC*	Downgradient well; Upper Sand Aquifer
5-DC	POC well; Main Sand Aquifer
10-DC	Downgradient well; Main Sand Aquifer
19-DC	POC well; Main Sand Aquifer
110-DC*	Downgradient well; Main Sand Aquifer
112-DC*	Downgradient well; Main Sand Aquifer
113-DC*	Downgradient well; Main Sand Aquifer
K.G.S. #3	Lower Sand Aquifer

Note:
* Installed by LM in 2008.

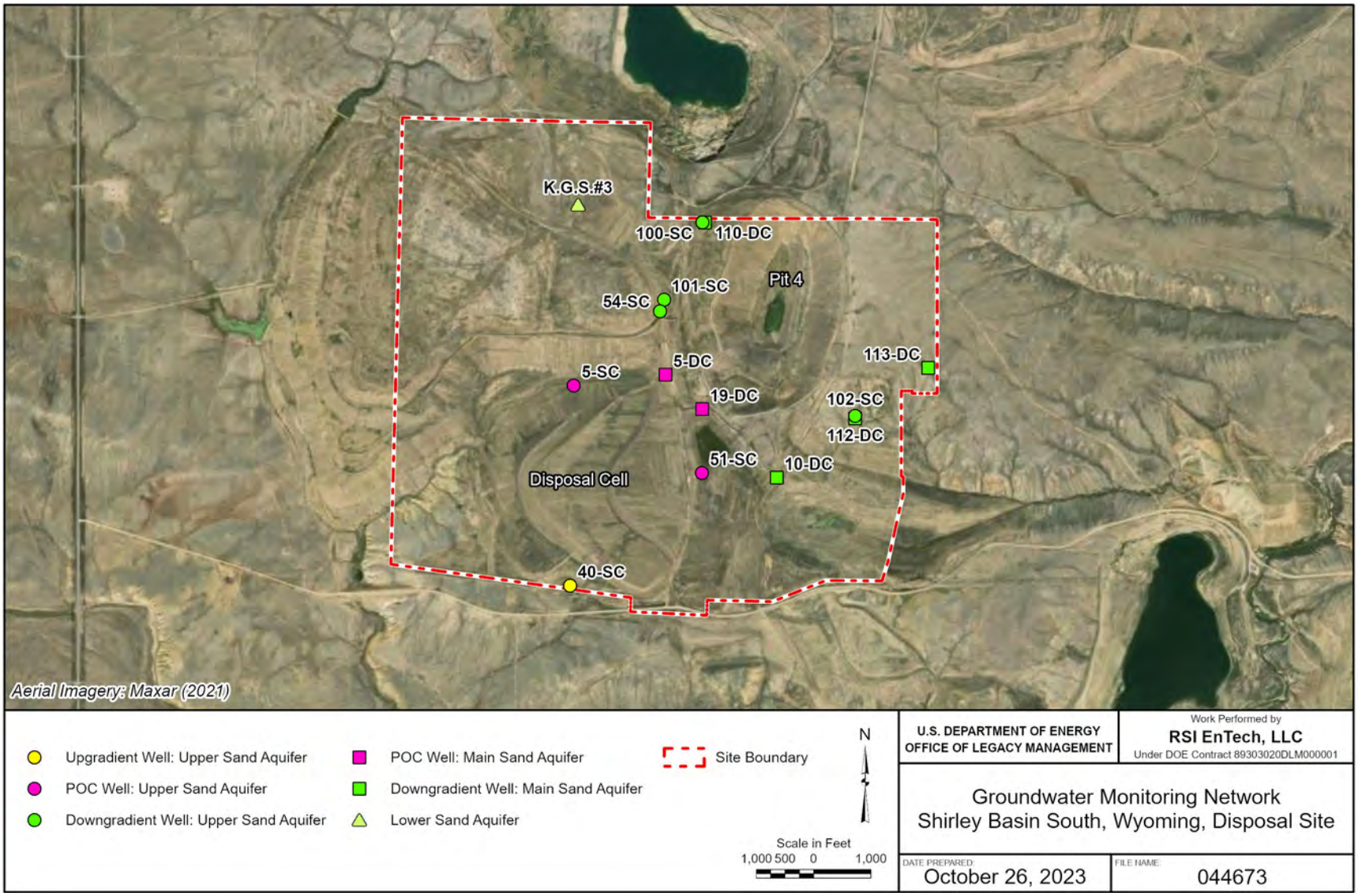


Figure 6-2. Groundwater Monitoring Network at Shirley Basin South, Wyoming, Disposal Site

Although no monitoring wells are designated as points of exposure, groundwater chemistry at downgradient wells 100-SC, 102-SC, 110-DC, and 113-DC are considered most representative of groundwater quality for groundwater flowing offsite in the Upper Sand and Main Sand Aquifers. Monitoring well 54-SC had been identified as screened across the Upper Sand and Main Sand Aquifers following review of boring logs and downhole video logs taken in 2008 (DOE 2009). In 2010, DOE submitted a request to decommission the well, stating that it represented a conduit for potential contamination migration between the Upper Sand and Main Sand aquifers. DOE withdrew this request in 2011 based on a determination that, although difficult to discern the exact unit the screen is located within, groundwater elevations and updated hydrogeological evaluations indicated that well 54-SC is most likely screened in the Upper Sand Aquifer (Surovchak 2011). The reclassification of well 54-SC in this annual report represents a change relative to past annual reports (e.g., DOE 2022).

Water level, pH, and electrical conductivity are measured at the time of sampling, and samples are analyzed for cadmium, chloride, chromium, lead, nickel, nitrate + nitrite as nitrogen (N), ^{226}Ra, ^{228}Ra, selenium, sulfate, thorium-230 (^{230}Th), TDS, and uranium.[1] Analytical results are compared to the ACLs and Wyoming Class III groundwater protection standards listed in Table 6-3.

Table 6-3. ACLs and Groundwater Protection Standards for the Shirley Basin South, Wyoming, Disposal Site

Analyte	ACL	Groundwater Protection Standard[a]
Cadmium	0.079 mg/L	0.05 mg/L[b]
Chloride	NA	2000 mg/L
Chromium	1.83 mg/L	0.05 mg/L[b]
Lead	0.05 mg/L	0.1 mg/L[b]
Nickel	6.15 mg/L	NA
Nitrate + Nitrite as N	NA	100 mg/L[b]
^{226}Ra	91.3 pCi/L	5 pCi/L[b,c] (combined total ^{226}Ra and ^{228}Ra)
^{228}Ra	25.7 pCi/L	
Selenium	0.12 mg/L	0.05 mg/L
Sulfate	NA	3000 mg/L
^{230}Th	2409 pCi/L	NA
TDS	NA	5000 mg/L
Uranium	9.2 mg/L	NA

Notes:
[a] This column shows the current Wyoming Class III groundwater protection standard values for livestock use, which apply to this site (WAR 020.0011.8.06292018).
[b] Standard has been updated since the LTSP was issued.
[c] The combined standard for radium (^{226}Ra + ^{228}Ra) is not used as a point of comparison in this chapter because the two isotopes are addressed separately in the LTSP.

Abbreviations:
mg/L = milligrams per liter
NA = not applicable
pCi/L = picocuries per liter

[1] In 2023, additional constituents (including major ions, iron, and ferrous iron) were analyzed to help in LM's ongoing updated evaluation of the site conceptual model.

Water level elevations are measured at the monitoring wells to evaluate flow direction as the Upper Sand and Main Sand Aquifers recover from mining and reclamation activities. Groundwater flow direction in the Upper Sand and Main Sand Aquifers at the site has been influenced primarily by dewatering and recovery at Pathfinder Pit 33 north of the site boundary and at Pit 4 (Petrotomics 1996). The Upper Sand unit and Main Sand unit coalesced and formed the main ore body at Pit 4, which was partially backfilled with overburden materials during reclamation, raising the bottom of the pit to an elevation above the projected recovered phreatic surface of the Upper Sand aquifer. The backfill operation did not recreate the hydrogeologic characteristics of the original formation, and the aquifers are no longer confined at Pit 4.

The site map showing July 2023 groundwater level elevations for the Upper Sand Aquifer wells is provided in Figure 6-3. Corresponding water elevations over time are plotted in Figure 6-4.

The LTSP (DOE 2004) specifies the inclusion of groundwater contour maps with the annual inspection report. However, as concluded in annual reports since 2005, the well network does not provide a spatial distribution of data points necessary to generate contours without significant uncertainty. For the same reasons (insufficient data), flow directions were not calculated using well triangles or any other numerical method; therefore, all references to flow directions discussed in this report are generalized.

The apparent groundwater flow direction within the Upper Sand Aquifer at the site is in the direction of structural dip and toward the eastern site boundary (Figure 6-3). Increasing water levels in wells 100-SC and 102-SC (Figure 6-4) are possibly due to groundwater recovery from Pit 4 dewatering activities. Water levels in the remaining Upper Sand Aquifer wells have been relatively constant (Figure 6-4). Well 51-SC was dry and has not recorded a water level since November 2010. Well 101-SC has been dry since its installation in 2008.

The map in Figure 6-5 shows the groundwater elevations measured in wells screened in the Main Sand Aquifer in July 2023. Figure 6-6 plots corresponding groundwater elevations over time. Since 2010, water levels measured in the Main Sand Aquifer wells near the disposal cell indicate that the flow direction has shifted to the south-southeast. This shift in flow direction (e.g., based on 2023 head data) is different than reported flow directions reported in past hydrogeological evaluations (DOE 2011b; DOE 2013) and predicted by the former licensee's model (Petrotomics 1996).

Piezometric heads have been gradually rising at all Main Sand Aquifer wells since 2000, with an average rate of increase of approximately 0.8 foot per year since LM began monitoring water levels in 2005 (Figure 6-6). The rising levels indicate a gradual recovery of the aquifer. However, the altered conditions at Pit 4 might prevent a return to premining elevations of the water table because the Upper Sand and Main Sand units now coalesce at this location.

In response to recent NRC comments on recent annual inspection reports (Orlando 2021; Bolz 2022), DOE will continue monitoring and evaluating groundwater elevations as recovery continues in the Main Sand Aquifer. Once groundwater conditions have stabilized, LM will determine if the monitoring program remains adequate. Groundwater elevations, apparent trends in flow directions, and water quality evaluations from existing Main Sand Aquifer wells will inform LM future actions to track potential offsite migration of site contaminants.

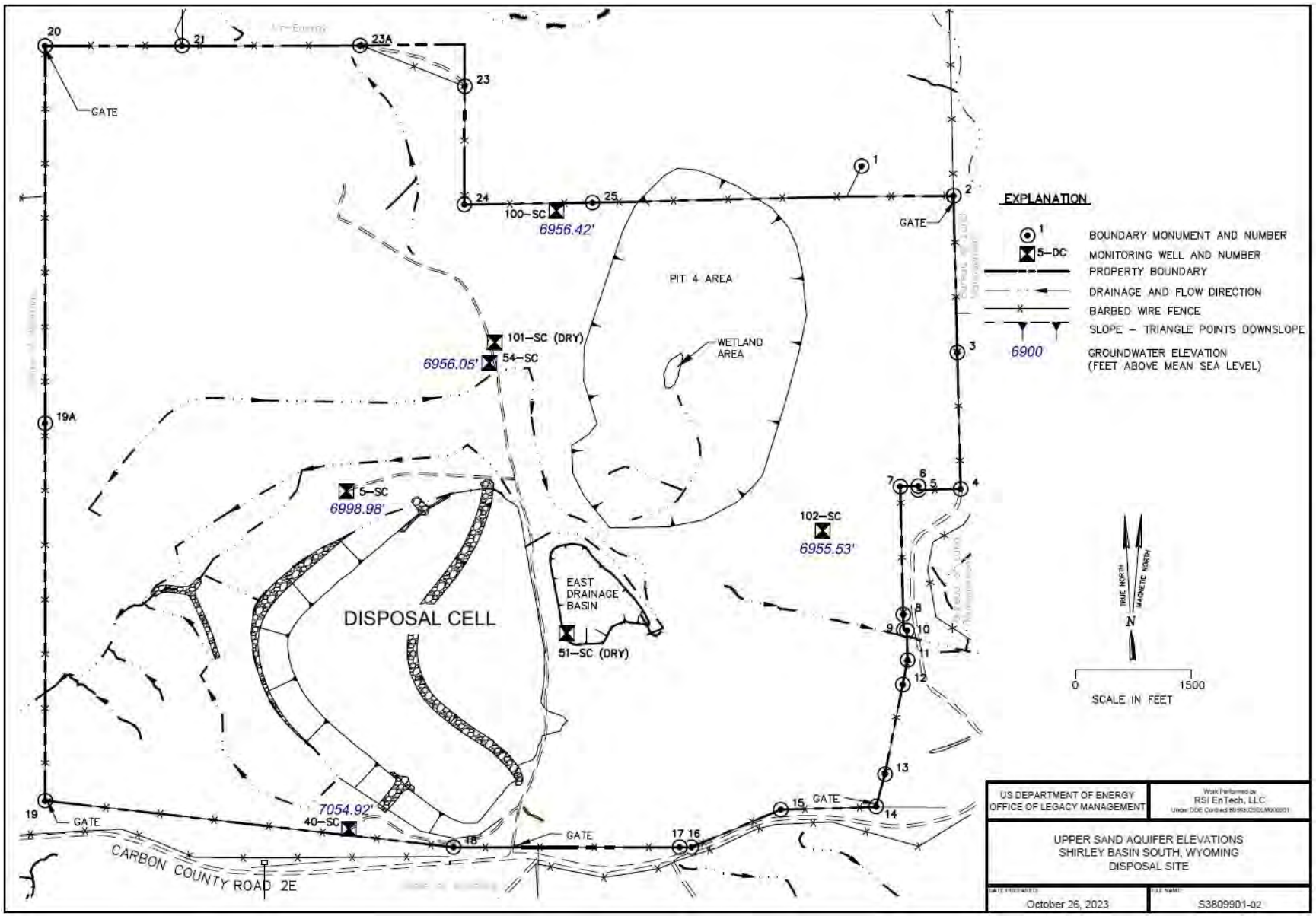
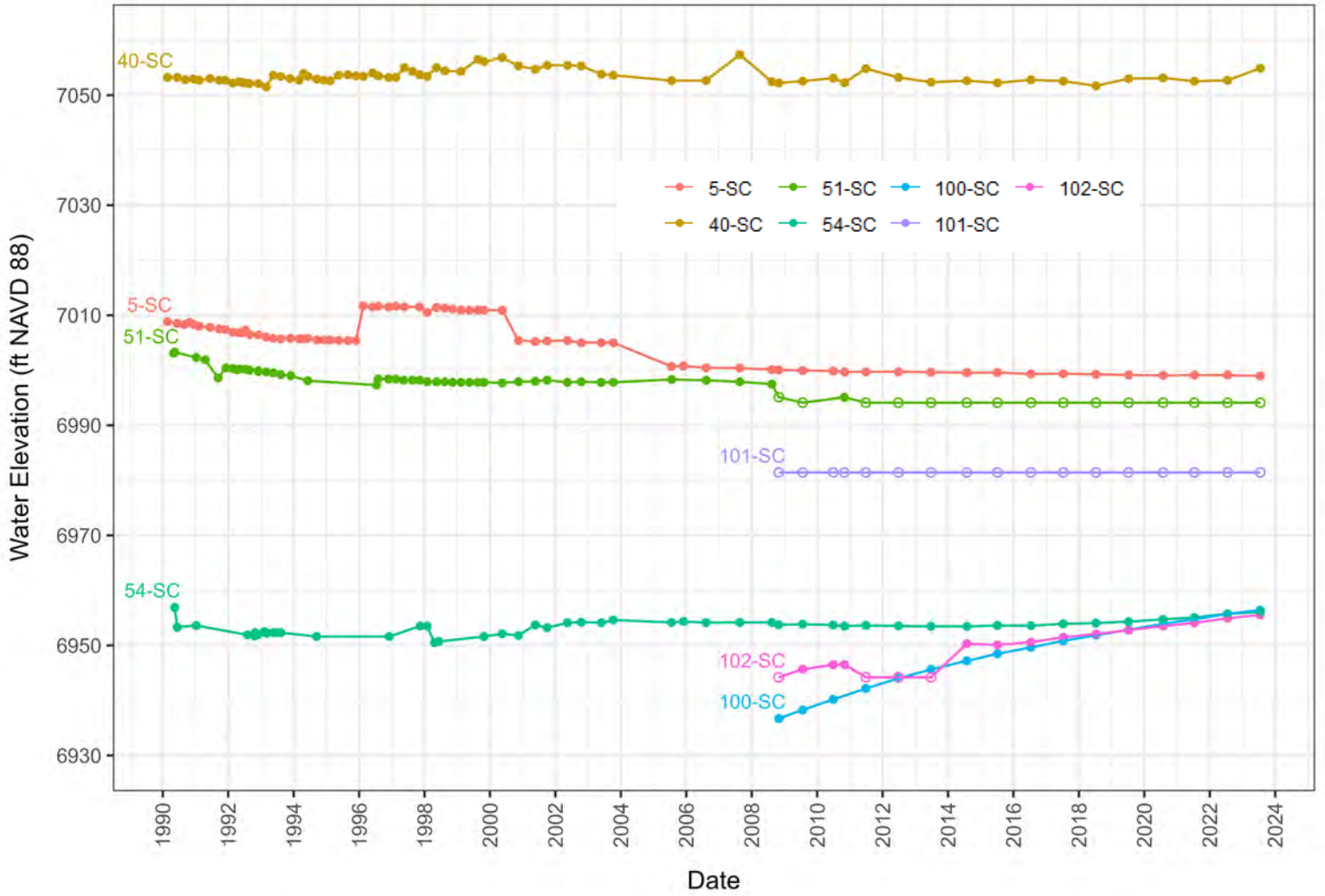


Figure 6-3. July 2023 Groundwater Elevations in the Upper Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site



Notes: Hollow symbols indicate that the well was dry or that the water level was below the pump. For these observations, plotted values are the corresponding bottom screen elevations or, for well 51-SC (with no available well construction information), the minimum recorded water elevation. POC well 51-SC has been dry since 2011, and well 101-SC has been dry since its installation in 2008.
Abbreviations: ft = feet, NAVD 88 = North American Vertical Datum of 1988

Figure 6-4. Hydrographs for Upper Sand Aquifer Wells at the Shirley Basin South, Wyoming, Disposal Site

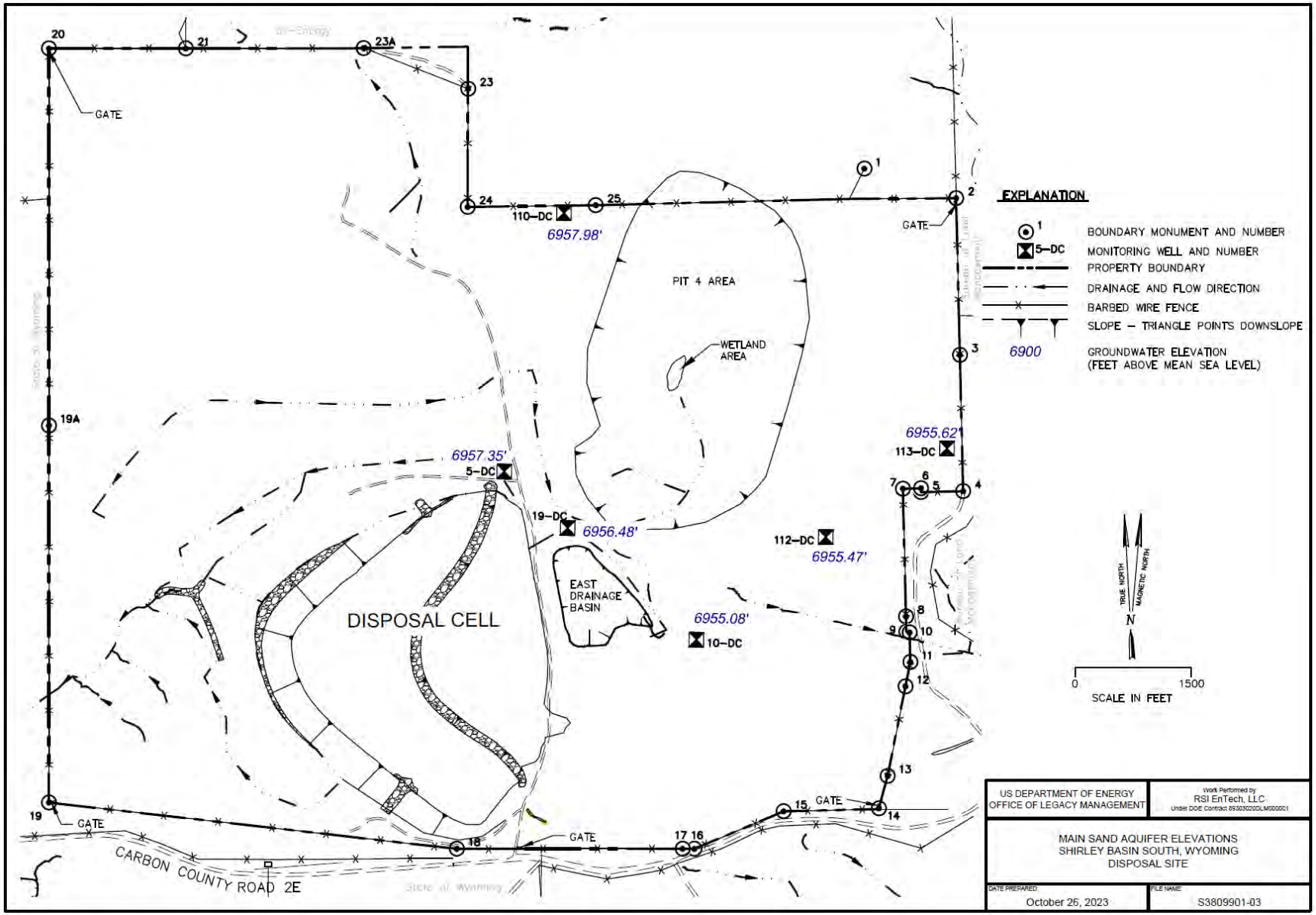
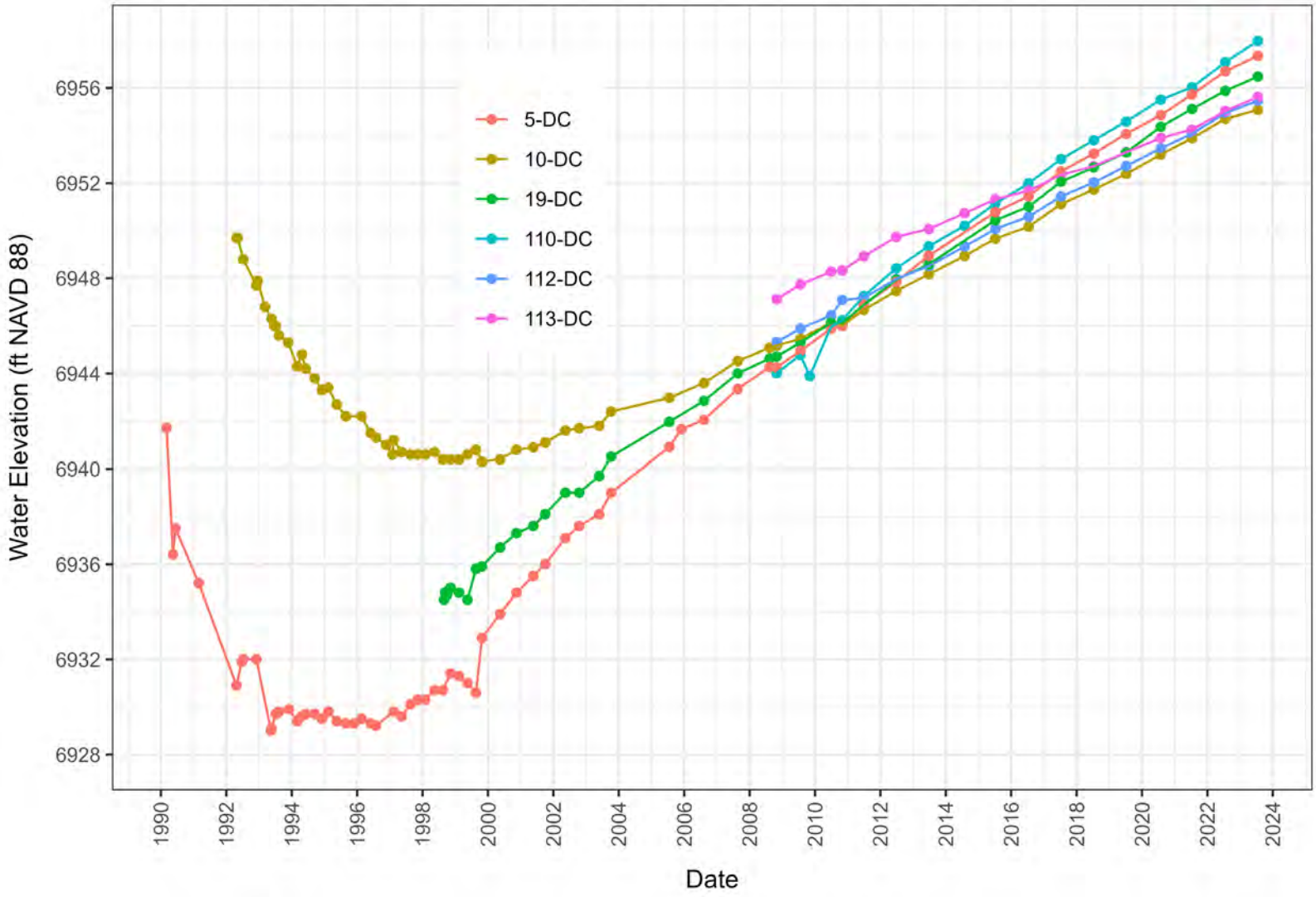


Figure 6-5. July 2023 Groundwater Elevations in the Main Sand Aquifer Wells at the Shirley Basin South, Wyoming, Disposal Site



Abbreviations: ft = feet, NAVD 88 = North American Vertical Datum of 1988

Figure 6-6. Hydrographs for Main Sand Aquifer Wells at the Shirley Basin South, Wyoming, Disposal Site

To better understand the increasing water level trends in several of the onsite wells, LM is planning to further evaluate potential regional impacts on water level trends in both the Upper Sand and Main Sand aquifers at the site. In particular, temporal water level data from the Ur-Energy pit lake and Ur-Energy groundwater wells north of the site boundary is a current, key data gap that would greatly inform water level trend uncertainties (e.g., time for water levels to equilibrate, or stabilize) at the Shirley Basin South site.

Analytical results from the July 2023 groundwater monitoring event are provided in Table 6-4 for the Upper Sand Aquifer, Table 6-5 for the Main Sand Aquifer, and Table 6-6 for well K.G.S. #3, which is screened in the Lower Sand Aquifer. Recent exceedances of the ACLs or groundwater protection standards listed Table 6-3 are clearly noted in these tables.

Samples could not be collected from Upper Sand Aquifer wells 51-SC and 101-SC because they continue to be dry. POC well 51-SC has been dry since 2011 and well 101-SC has been dry since its installation in 2008 (Figure 6-4).

Table 6-4. 2023 Groundwater Monitoring Results in the Upper Sand Aquifer Wells at the Shirley Basin South, Wyoming, Disposal Site

Analyte	Limit or Standard[b]	Well[a]				
		5-SC (POC)	40-SC	54-SC	100-SC	102-SC
Cadmium	0.079 mg/L 0.05 mg/L[c]	0.030	ND	ND	ND	ND
Chloride	2000 mg/L[c]	509	8.29	403	128	38.2
Chromium	1.83 mg/L 0.05 mg/L[c]	***0.325***[e]	0.0012	***0.61***[e]	ND	ND
Lead	0.05 mg/L 0.1 mg/L[c]	ND	ND	ND	ND	ND
Nickel	6.15 mg/L	3.22	0.008	4.42	ND	ND
Nitrate + Nitrite as N	100 mg/L[c]	ND	1.91	ND	ND	0.044
^{226}Ra	91.3 pCi/L	ND	ND	9.97	4.05	2.98
^{228}Ra	25.7 pCi/L	3.05	1.99	***64.2***[d]	4.53	2.66
Selenium	0.12 mg/L 0.05 mg/L[c]	***0.102***[e]	0.0065	***0.088***[e]	ND	ND
Sulfate	3000 mg/L[c]	***14,300***[e]	1400	***11,900***[e]	1000	560
^{230}Th	2409 pCi/L	465	ND	54.2	ND	ND
TDS	5000 mg/L[c]	***16,500***[e]	1740	***15,200***[e]	2030	1000
Uranium	9.2 mg/L	2.95	0.000087	0.028	0.0015	0.0013

Notes:
[a] ***Bold italicized*** results exceed a standard or limit. Well-analyte combinations with at least one exceedance in 2023 are shaded. Upper Sand Aquifer wells 51-SC and well 101-SC are not listed in this table because these wells have been dry for over a decade (refer to text above).
[b] ACL or groundwater protection standard from Table 6-3.
[c] Wyoming Class III groundwater protection standard (WAR 020.0011.8.06292018).
[d] Result exceeds an ACL.
[e] Result exceeds the corresponding Wyoming Class III groundwater protection standard.

Abbreviations:
mg/L = milligrams per liter
ND = not detected (below method detection limit)
pCi/L = picocuries per liter

Table 6-5. 2023 Groundwater Monitoring Results in the Main Sand Aquifer Wells at the Shirley Basin South, Wyoming, Disposal Site

Analyte	Limit or Standard[b]	Well[a]					
		5-DC (POC)	10-DC	19-DC (POC)	110-DC	112-DC	113-DC
Cadmium	0.079 mg/L 0.05 mg/L[c]	ND	ND	ND	ND	ND	ND
Chloride	2000 mg/L[c]	549	59	146	181	49.0	10.4
Chromium	1.83 mg/L 0.05 mg/L[c]	***0.18***[e]	ND	ND	ND	ND	ND
Lead	0.05 mg/L 0.1 mg/L[c]	ND	0.0007	ND	ND	ND	ND
Nickel	6.15 mg/L	2.57	ND	0.56	ND	ND	ND
Nitrate + Nitrite as N	100 mg/L[c]	ND	ND	ND	ND	ND	0.104
^{226}Ra	91.3 pCi/L	15.6	18.2	6.59	82.7	12.2	2.27
^{228}Ra	25.7 pCi/L	***93.8***[d]	4.16	7.57	6.17	9.33	1.73
Selenium	0.12 mg/L 0.05 mg/L[c]	***0.20***[d,e]	ND	ND	ND	ND	ND
Sulfate	3000 mg/L[c]	***22,100***[e]	995	2760	1870	972	620
^{230}Th	2409 pCi/L	109	ND	1.51	ND	ND	0.31
TDS	5000 mg/L[c]	***27,800***[e]	1800	4420	3070	1770	1040
Uranium	9.2 mg/L	0.015	0.012	0.0001	0.014	0.013	0.0009

Notes:

[a] ***Bold italicized*** results exceed a standard or limit. Analytes and wells with at least one exceedance in 2023 are shaded.

[b] ACL or groundwater protection standard from Table 6-3.

[c] Wyoming Class III groundwater protection standard (WAR 020.0011.8.06292018).

[d] Result exceeds an ACL.

[e] Result exceeds the corresponding Wyoming Class III groundwater protection standard.

Abbreviations:

mg/L = milligrams per liter
ND = not detected (below method detection limit)
pCi/L = picocuries per liter

Table 6-6. 2023 Groundwater Monitoring Results for Well K.G.S. #3 in the Lower Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

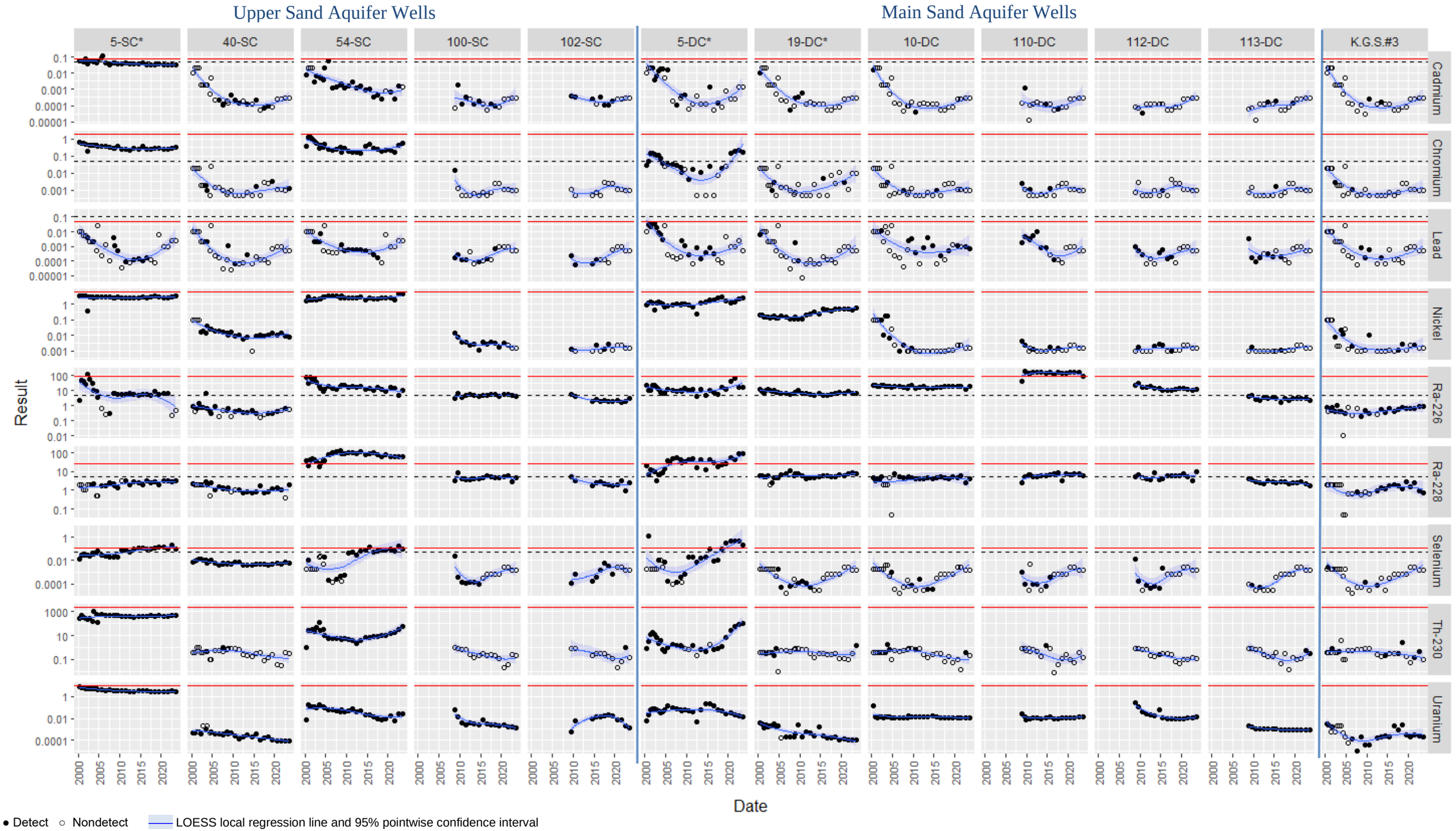
Analyte	Limit or Standard[a]	K.G.S. #3 Result
Cadmium	0.079 mg/L 0.05 mg/L[b]	ND
Chloride	2000 mg/L[b]	4.82
Chromium	1.83 mg/L 0.05 mg/L	ND
Lead	0.05 mg/L 0.1 mg/L[b]	ND
Nickel	6.15 mg/L	ND
Nitrate + Nitrite as N	100 mg/L[b]	ND
^{226}Ra	91.3 pCi/L	0.939
^{228}Ra	25.7 pCi/L	0.716
Selenium	0.12 mg/L 0.05 mg/L[b]	ND
Sulfate	3000 mg/L[b]	229
^{230}Th	2409 pCi/L	ND
TDS	5000 mg/L[b]	479
Uranium	9.2 mg/L	0.0002

Note:
[a] ACL or groundwater protection standard from Table 6-3.
[b] Wyoming Class III groundwater protection standard (WAR 020.0011.8.06292018).

Abbreviations:
mg/L = milligrams per liter
ND = not detected (below method detection limit)
pCi/L = picocuries per liter

As a prelude to the discussion of results that follows, Figure 6-7 and Figure 6-8 provide matrices of time-concentration plots for each Shirley Basin South site monitoring well and analyte combination. Because of the large number of plots (168 distinct well and analyte combinations are represented), these figures are broken out based on the categorization of analytes applied in Sections 6.1 and 6.2 of the 2011 groundwater monitoring evaluation report (DOE 2011b). Figure 6-7 shows time-concentration plots for the nine hazardous constituents, that is, all analytes with ACLs as listed in Table 6-3. Figure 6-8 shows time-concentration plots of the indicator parameters: chloride, nitrate, pH, sulfate, and TDS. In both figures, all data since 2000 are plotted, including data from Petrotomics for the period 2000–2004.

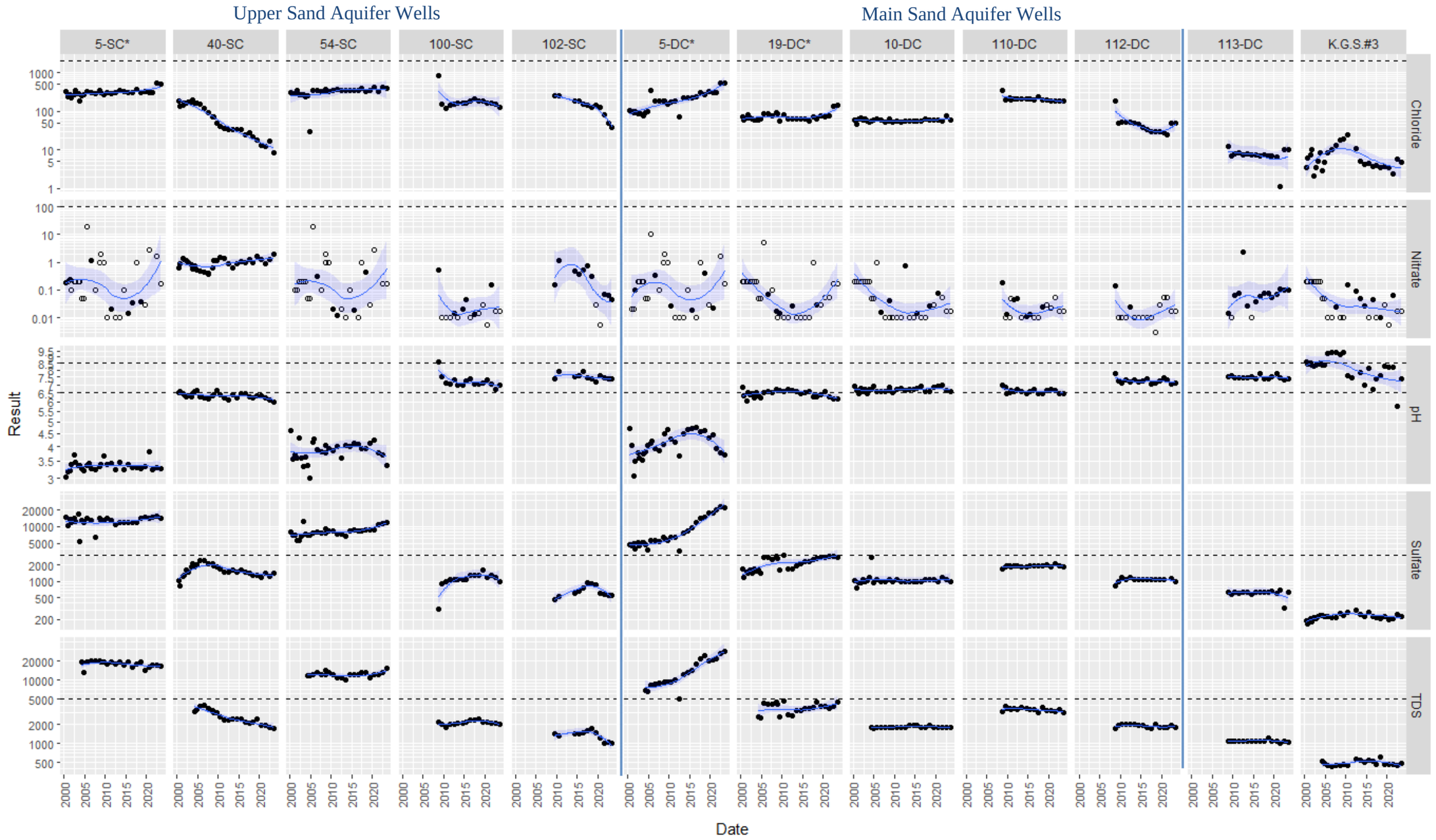
Consistent with the presentation in the previous annual report (DOE 2022), and in response to NRC's comments on the 2020 annual inspection report (Orlando 2021), Mann-Kendall trend analysis was performed for the monitored constituents. Mann-Kendall trends were calculated from 2005, when the site was transferred to LM and low-flow sampling of constituents was first recorded, to 2023. Mann-Kendall trend analyses characterize the direction of concentration trends using a 0.05 significance level, meaning a calculated p-value of less than 0.05 indicates the null-hypothesis is rejected and a significant trend in the time series exists. Table 6-7 identifies the analyte-well combinations with statistically significant increasing (or decreasing) trends based on the detailed Mann-Kendall trend test summary.



● Detect ○ Nondetect LOESS local regression line and 95% pointwise confidence interval
------ ACL from Table 6-3; - - - Groundwater protection standard from Table 6-3.

Notes: Units in milligrams per liter except for Ra-226, Ra-228, and Th-230 (in picocuries per liter). Well names followed by an asterisk (*) denote POC wells (shown first for each aquifer). A semilogarithmic scale is used because of the wide range in analyte concentrations across site wells.

Figure 6-7. Time-Concentration Plots of Hazardous Constituents (Analytes with ACLs) in Monitoring Wells, Shirley Basin South, Wyoming, Disposal Site: 2000–2023



● Detect ○ Nondetect —— LOESS local regression line and 95% pointwise confidence interval

- - - Groundwater protection standard from Figure 6-3, except for pH which, although not an analyte addressed in the LTSP, is an important indicator parameter where the groundwater protection standard is a range (6.5–8.5 standard units).

Notes: Units in milligrams per liter except for pH (in standard units). Well names followed by an asterisk (*) denote POC wells (shown first for each aquifer). A semilogarithmic scale is used because of the wide range in analyte concentrations across site wells.

Figure 6-8. Time-Concentration Plots of Indicator Parameters in Monitoring Wells, Shirley Basin South, Wyoming, Disposal Site: 2000–2023

Table 6-7. Mann-Kendall Trend Analysis Results for Shirley Basin South Site Monitoring Wells, 2005–2023

Well[a]	Initial Trend Analysis Date	Final Trend Analysis Date	No. of Samples (No. of Nondetects)[b]	Most Recent Result[c]	Kendall's tau[d]	Trend[e]
Hazardous Constituents (Analytes with ACLs)						
Cadmium (mg/L)						
5-SC*	7/20/2005	7/18/2023	21	0.03	−0.633	Decreasing
54-SC	7/20/2005	7/18/2023	20 (2)	<0.0015	−0.500	Decreasing
102-SC	7/23/2009	7/18/2023	12 (5)	<0.0003	−0.439	Decreasing
Chromium (mg/L)						
5-SC*	7/20/2005	7/18/2023	20	*0.325*	−0.205	No Trend
54-SC	7/20/2005	7/18/2023	20	*0.61*	0.089	No Trend
5-DC*	7/20/2005	7/18/2023	20 (6)	*0.182*	0.089	No Trend
Lead (mg/L)						
10-DC	7/20/2005	7/19/2023	20 (9)	0.0007	0.116	No Trend
110-DC	10/30/2008	7/18/2023	17 (8)	<0.0005	−0.529	Decreasing
Nickel (mg/L)						
5-SC*	7/20/2005	7/18/2023	20	3.22	0.184	No Trend
40-SC	7/21/2005	7/19/2023	20 (1)	0.008	−0.263	No Trend
54-SC	7/20/2005	7/18/2023	20	4.42	−0.184	No Trend
100-SC	10/30/2008	7/18/2023	16 (3)	<0.0015	−0.55	Decreasing
5-DC*	7/20/2005	7/18/2023	20	2.57	0.563	Increasing
19-DC*	7/20/2005	7/19/2023	20	0.56	0.679	Increasing
^{226}Ra (pCi/L)						
5-SC*	7/20/2005	7/18/2023	20 (4)	<0.51	0.111	No Trend
40-SC	7/21/2005	7/19/2023	20 (7)	<0.58	−0.121	No Trend
54-SC	7/20/2005	7/18/2023	20	*9.97*	−0.416	Decreasing
100-SC	10/30/2008	7/18/2023	16	4.05	0.133	No Trend
102-SC	7/23/2009	7/18/2023	12	2.98	−0.303	No Trend
5-DC*	7/20/2005	7/18/2023	20	*15.6*	0.258	No Trend
10-DC	7/20/2005	7/19/2023	20	*18.2*	0.037	No Trend
19-DC*	7/20/2005	7/19/2023	20	*6.59*	0.021	No Trend
110-DC	10/30/2008	7/18/2023	18	*82.7*	−0.046	No Trend
112-DC	10/30/2008	7/18/2023	16	*12.2*	−0.5	Decreasing
11 3-DC	10/30/2008	7/18/2023	16	2.27	−0.292	No Trend
K.G.S. #3	7/21/2005	7/24/2023	18 (4)	0.94	0.601	Increasing
^{228}Ra (pCi/L)						
5-SC*	7/20/2005	7/18/2023	20 (1)	3.05	0.363	Increasing
40-SC	7/21/2005	7/19/2023	20 (3)	1.99	−0.079	No Trend
54-SC	7/20/2005	7/18/2023	21	*64.2*	−0.457	Decreasing
100-SC	10/30/2008	7/18/2023	16	4.53	0.183	No Trend
102-SC	7/23/2009	7/18/2023	12	2.66	−0.333	No Trend
5-DC*	7/20/2005	7/18/2023	21	*93.8*	0.067	No Trend
10-DC	7/20/2005	7/19/2023	20	4.16	−0.147	No Trend
19-DC*	7/20/2005	7/19/2023	20	*7.57*	−0.037	No Trend
110-DC	10/30/2008	7/18/2023	17	*6.17*	0.397	Increasing
112-DC	10/30/2008	7/18/2023	16 (1)	*9.33*	0.242	No Trend
113-DC	10/30/2008	7/18/2023	16	1.73	−0.55	Decreasing
K.G.S. #3	7/21/2005	7/24/2023	13	0.72	0.418	Increasing
Selenium						
5-SC*	7/20/2005	7/18/2023	20	0.102	0.626	Increasing
40-SC	7/21/2005	7/19/2023	20	0.0065	0.137	No Trend
54-SC	7/20/2005	7/18/2023	20 (2)	0.089	0.732	Increasing
102-SC	7/23/2009	7/18/2023	12 (4)	<0.0015	0.091	No Trend
5-DC*	7/20/2005	7/18/2023	20 (2)	*0.20*	0.716	Increasing

Table 6-7. Mann-Kendall Trend Analysis Results for Shirley Basin South Site Monitoring Wells, 2005–2023 (continued)

Well[a]	Initial Trend Analysis Date	Final Trend Analysis Date	No. of Samples (No. of Nondetects)[b]	Most Recent Result[c]	Kendall's tau[d]	Trend[e]
^{230}Th (pCi/L)						
5-SC*	7/20/2005	7/18/2023	20	465	−0.168	No Trend
54-SC	7/20/2005	7/18/2023	20	54.2	0.605	Increasing
5-DC*	7/20/2005	7/18/2023	20 (4)	109	0.316	No Trend
Uranium (mg/L)						
5-SC*	7/20/2005	7/18/2023	20	2.95	−0.653	Decreasing
40-SC	7/21/2005	7/19/2023	20	0.00009	−0.621	Decreasing
54-SC	7/20/2005	7/18/2023	20	0.028	−0.563	Decreasing
100-SC	10/30/2008	7/18/2023	16	0.0015	−0.75	Decreasing
102-SC	7/23/2009	7/18/2023	12	0.0013	−0.015	No Trend
5-DC*	7/20/2005	7/18/2023	20	0.015	−0.432	Decreasing
10-DC	7/20/2005	7/19/2023	20	0.012	−0.063	No Trend
19-DC*	7/20/2005	7/19/2023	20 (1)	0.0001	−0.437	Decreasing
110-DC	10/30/2008	7/18/2023	18	0.014	0.294	No Trend
112-DC	10/30/2008	7/18/2023	16	0.013	−0.45	Decreasing
113-DC	10/30/2008	7/18/2023	16	0.0009	−0.742	Decreasing
K.G.S. #3	7/21/2005	7/24/2023	18 (1)	0.0002	0.51	Increasing
Indicator Parameters						
Chloride (mg/L)						
5-SC*	7/20/2005	7/18/2023	20	509	0.247	No Trend
40-SC	7/21/2005	7/19/2023	20	8.29	−0.916	Decreasing
54-SC	7/20/2005	7/18/2023	20	403	0.279	No Trend
100-SC	10/30/2008	7/18/2023	16	128	0.083	No Trend
102-SC	7/23/2009	7/18/2023	12	38.2	−0.894	Decreasing
5-DC*	7/20/2005	7/18/2023	20	549	0.568	Increasing
10-DC	7/20/2005	7/19/2023	20	59	0.258	No Trend
19-DC*	7/20/2005	7/19/2023	20	146	0.037	No Trend
110-DC	10/30/2008	7/18/2023	18	181	−0.484	Decreasing
112-DC	10/30/2008	7/18/2023	16	49	−0.592	Decreasing
113-DC	10/30/2008	7/18/2023	16	10.4	−0.283	No Trend
K.G.S. #3	7/21/2005	7/24/2023	18	4.82	−0.497	Decreasing
Nitrate (mg/L)						
40-SC	7/21/2005	7/19/2023	20	1.91	0.453	Increasing
102-SC	7/23/2009	7/18/2023	12 (2)	0.044	-0.47	Decreasing
113-DC	10/30/2008	7/18/2023	16 (2)	0.10	0.45	Increasing
Sulfate (mg/L)						
5-SC*	7/20/2005	7/18/2023	20	*14,300*	0.311	No Trend
40-SC	7/21/2005	7/19/2023	20	1400	−0.795	Decreasing
54-SC	7/20/2005	7/18/2023	20	*11,900*	0.532	Increasing
100-SC	10/30/2008	7/18/2023	16	1000	0.475	Increasing
102-SC	7/23/2009	7/18/2023	12	560	0.015	No Trend
5-DC*	7/20/2005	7/18/2023	20	*22,100*	0.832	Increasing
10-DC	7/20/2005	7/19/2023	20	995	0.068	No Trend
19-DC*	7/20/2005	7/19/2023	20	2760	0.221	No Trend

Table 6-7. Mann-Kendall Trend Analysis Results for Shirley Basin South Site Monitoring Wells, 2005–2023 (continued)

Well[a]	Initial Trend Analysis Date	Final Trend Analysis Date	No. of Samples (No. of Nondetects)[b]	Most Recent Result[c]	Kendall's tau[d]	Trend[e]
Sulfate (continued)						
110-DC	10/30/2008	7/18/2023	18	1870	0.32	No Trend
112-DC	10/30/2008	7/18/2023	15	972	0.038	No Trend
113-DC	10/30/2008	7/18/2023	16	620	0.083	No Trend
K.G.S. #3	7/21/2005	7/24/2023	18	229	−0.327	No Trend
TDS (mg/L)						
5-SC*	7/20/2005	7/18/2023	20	*16,500*	−0.553	Decreasing
40-SC	7/21/2005	7/19/2023	20	1740	−0.879	Decreasing
54-SC	7/20/2005	7/18/2023	20	*15,200*	0.089	No Trend
100-SC	10/30/2008	7/18/2023	16	2030	0.233	No Trend
102-SC	7/23/2009	7/18/2023	12	1000	−0.258	No Trend
5-DC*	7/20/2005	7/18/2023	20	*27,800*	0.853	Increasing
10-DC	7/20/2005	7/19/2023	20	1800	−0.005	No Trend
19-DC*	7/20/2005	7/19/2023	20	4420	0.037	No Trend
110-DC	10/30/2008	7/18/2023	18	3070	−0.412	Decreasing
112-DC	10/30/2008	7/18/2023	16	1770	−0.25	No Trend
113-DC	10/30/2008	7/18/2023	16	1040	−0.15	No Trend
K.G.S. #3	7/21/2005	7/24/2023	18	479	0.203	No Trend

Notes:
* POC well
64.2 Result exceeds corresponding ACL (and, for ^{228}Ra and selenium, corresponding groundwater protection standard).
0.61 Result exceeds corresponding groundwater protection standard from Table 6-3.

[a] Trend analysis results are only listed for well-analyte combinations with frequent (≥50%) detections. No statistically significant trend was found for the remaining 59 records with detection frequencies <50% (applying to cadmium, chromium, lead, nickel, nitrate, selenium, and ^{230}Th). For these well-analyte combinations, the majority (67%) had negative tau values, indicating decreasing (though not statistically significant) trends. Although results are not listed above, trend analysis was also applied to pH because it is an indicator parameter (DOE 2011b). Statistically significant decreasing trends were identified for three wells: 100-SC, 19-DC, and K.G.S. #3.

[b] The number of nondetects is only indicated for well-parameter combinations with nondetect results.

[c] The data in this column (most recent result) duplicates information included in Table 6-4 through Table 6-6 but is repeated here as a context for evaluating analyte-well combinations with increasing trends.

[d] Trend tests were performed using the "NADA: Nondetects and Data Analysis for Environmental Data" package in R, version 1.6-1.1 (Lee 2020). The NADA trend test is similar to the traditional Mann-Kendall trend test except that it accounts for the presence of nondetects at multiple detection limits. Trend analyses were conducted at the 0.05 significance (or alpha) level using a two-sided test. The test statistic, Kendall's tau, is a measure of the strength of the association between two variables, with values always falling between −1 and +1.

[e] In their review of the 2022 annual compliance report (DOE 2022), NRC observed that the Mann-Kendall trend analyses could be biased by varying minimum detection limits for the contaminants of concern (Hayes 2023). In response to this comment, for each well-parameter combination shown Figure 6-7 and Figure 6-8 (excluding pH), LM also plotted the corresponding method detection limits and analyzed the relationship between those variations and the variation in corresponding analytical results. For most well-parameter combinations, the method detection limits (MDLs) show a slightly increasing trend since 2005, but these increases are not likely to account for the increasing trends observed for some analytes (e.g., the increasing selenium concentration trends found for wells 5-SC, 54-SC, and 5-DC). Changes in the MDLs would most likely impact trend analysis results for the well-parameter combinations with a moderate to high percentage of nondetects, but (as noted above), no significant trend was found for any well-analyte combination with detection frequencies less than 50%. Furthermore, as indicated in Note "d", the NADA package used to perform the trend analyses was developed to account for varying detection limits.

Abbreviations:
mg/L = milligrams per liter
pCi/L = picocuries per liter

As stipulated in the LTSP (DOE 2004), LM is required to notify NRC and WDEQ of any exceedances in constituent ACLs. Since DOE acquired the site in 2005, exceedances of ACLs have been limited to the following wells and parameters:

- Upper Sand Aquifer POC well 5-SC — cadmium (2005 only) and selenium (2019–2020, 2022)
- Upper Sand Aquifer well 54-SC — ^{228}Ra (consistent), selenium (2015 and 2022 only)
- Main Sand Aquifer POC well 5-DC — ^{228}Ra (consistent), selenium (since 2019)
- Main Sand Aquifer well 110-DC — ^{226}Ra only, 2009–2022 (no exceedance in 2023)

Recent or historical exceedances of State of Wyoming groundwater protection standards have been limited to the following wells and parameters:

- Upper Sand Aquifer POC well 5-SC — cadmium (2000–2005 only), selenium, sulfate, and TDS
- Upper Sand Aquifer well 54-SC — cadmium (2005 only), selenium, sulfate, and TDS
- Main Sand Aquifer POC well 5-DC — selenium, sulfate, and TDS

These exceedances are discussed in the following paragraphs, along with an updated analysis of the concentration trends identified in Table 6-7. The discussion focuses on parameters for which exceedances have been identified and those exhibiting statistically significant increasing concentration trends. As such, chromium and lead are not discussed (refer to Figure 6-7).

Hazardous Constituents

In LM's initial July 2005 sampling, the results for cadmium in POC well 5-SC exceeded the respective ACL of 0.079 milligrams per liter (mg/L). Cadmium concentrations in well 5-SC have since declined to below the ACL (most recent result of 0.03 mg/L) and concentrations in most remaining wells have been below the detection limit (Figure 6-7). For the three wells with detection frequencies greater than 50% (5-SC, 54-SC, and 102-SC), Mann-Kendall trend analysis identified statistically significant decreasing trends in cadmium concentrations (Table 6-7).

Nickel concentrations in Upper Sand Aquifer wells 5-SC and 54-SC have been just below the 6.15 mg/L ACL (Figure 6-7), but trends have been stable (non-trending). The most recent (2023) results were 3.22 and 4.42 mg/L, respectively (Table 6-4). Although statistically significant increasing trends were identified for Main Sand Aquifer wells 5-DC and 19-DC, nickel concentrations are below the ACL (most recent results of 2.57 and 0.56 mg/L, respectively).

Radium-226 concentrations in well 110-DC, installed in 2008, consistently exceeded the 91.3 picocuries per liter (pCi/L) ACL between 2009 and 2022 (Figure 6-7). In 2023, the ^{226}Ra concentration in this well was 82.7 pCi/L, versus approximately 150 pCi/L in 2021–2022. Well 110-DC was considered a downgradient well at the time of installation in 2008, when groundwater flow direction in the Main Sand Aquifer was generally to the north-northeast. However, due to the recent changes in flow direction noted previously, well 110-DC is currently hydraulically upgradient from well 5-DC near the disposal cell. Although below the ACL, ^{226}Ra concentrations in most remaining wells (54-SC, 5-DC, 19-DC, and 112-DC) have been elevated

relative to background (40-SC) and to the 5 pCi/L groundwater protection standard for combined ^{226}Ra and ^{228}Ra.

Since 2005, ^{228}Ra concentrations have consistently exceeded the 25.7 pCi/L ACL in well 54-SC and, with few exceptions (2012, 2014, and 2017–2018), also in well 5-DC. Mann-Kendall trend analysis (Table 6-7) indicates statistically significant increasing trends for ^{228}Ra in wells 5-DC and 54-DC and, for both ^{226}Ra and ^{228}Ra, in Lower Sand Aquifer K.G.S. #3. Significant decreasing trends were identified for well 54-SC (^{226}Ra and ^{228}Ra), well 112-DC (^{226}Ra), 113-DC (^{228}Ra).

Radium-228 is a decay product of thorium-232 (^{232}Th), which is highly immobile. Because the half-life of ^{228}Ra is relatively short, the data suggest the possible presence of ^{232}Th sources near monitoring wells 54-SC and 5-DC. Elevated levels of ^{226}Ra and ^{228}Ra in wells 54-SC and 5-DC were previously attributed to mobilization of contaminants near the Pit 4 area where the Upper Sand and Main Sand units coalesce (DOE 2011a). Constituent mass loading from either naturally occurring mineralization or from tailings pile seepage into the groundwater has not been directly measured or quantified at the Shirley Basin South site.

Selenium concentrations have exceeded the 0.12 mg/L ACL (and the 0.05 mg/L groundwater protection standard) in wells 5-SC, 54-SC, and 5-DC (Figure 6-7). Consistent with findings presented in the previous annual report (DOE 2022), Mann-Kendall trend analysis continues to indicate statistically significant increasing selenium trends in these wells (Table 6-7). LM previously noted that selenium is a relatively poor early indicator constituent for tailings seepage, as selenium levels were measured to be relatively low in tailings water and attenuated easily (DOE 2011b).

Thorium-230 concentrations have been below detection limits in most wells as shown in Figure 6-7. Exceptions are wells 5-SC, 54-SC, and 5-DC, but ^{230}Th levels have been well below the corresponding 2409 pCi/L ACL. Although a statistically significant increasing trend is indicated for well 54-SC based on data since 2005, current levels are sufficiently low (most recent result of 54.2 pCi/L) such that exceedances are not expected in the foreseeable future.

Uranium concentrations have been consistently below the 9.2 mg/L ACL in all wells (Figure 6-7), with statistically significant decreasing trends identified for most wells (Table 6-7). Consistent with trend analysis findings for ^{226}Ra and ^{228}Ra, a statistically significant increasing trend was identified for uranium in well K.G.S. #3. However, the most recent uranium result (0.0002 mg/L) is well below the ACL. Radium-226 and ^{228}Ra concentrations are below corresponding ACLs and the combined ^{226}Ra plus ^{228}Ra groundwater protection standard of 5 pCi/L (most recent results of 0.94 and 0.72 pCi/L, respectively). As indicated in Table 6-4 through Table 6-7, concentrations of all monitored parameters in well K.G.S. #3 are below applicable standards, both the ACLs and groundwater protection standards for livestock listed in Table 6-3.

Consistent with conclusions drawn in the groundwater monitoring evaluation report (DOE 2011b), water quality in well K.G.S. #3 is still considered unaffected by mill-related activity. This conclusion is supported by the lack of tailing-derived indicator contaminants, such as sulfate, chloride, nitrate, TDS, and pH (Figure 6-8). The increasing concentration trend observed for ^{226}Ra since 2013 is likely attributed to natural groundwater processes or reestablishment of groundwater

equilibrium from pumping influence. Although a statistically significant increasing trend was found for ^{228}Ra for the 2005–2023 monitoring period, concentrations have declined since 2019, from 2.87 pCi/L to 0.72 pCi/L (most recent result).

As indicated above, both ^{226}Ra and ^{228}Ra concentrations in well K.G.S. #3 are below respective ACLs of 91.3 pCi/L and 25.7 pCi/L, respectively, and are not expected to reach those ACLs in the near future. Under Class III groundwater protection standards, the threshold value of 5 pCi/L represents the summation of ^{226}Ra and ^{228}Ra concentrations (Table 6-3). However, this threshold value was updated after completion of the LTSP and is not used as a comparison because both analytes are addressed and classified independently in the LTSP (DOE 2004). Regardless, the summed ^{226}Ra and ^{228}Ra concentrations in well K.G.S. #3 have historically been below the 5 pCi/L threshold and are not expected to exceed it in the near future. LM will continue to monitor this well to ensure that applicable standards are not exceeded and that the well continues to be safe for livestock watering purposes. Similarly, despite a statistically significant increasing trend for uranium, uranium concentrations have remained generally stable (<0.00033 mg/L) since 2019 (Table 6-7); the most recent (2023) result was 0.0002 mg/L.

Indicator Parameters

In 2023, Wyoming Class III groundwater protection standards for indicator parameters (chloride, nitrate, sulfate, and TDS) were met at downgradient site boundary wells (100-SC, 102-SC, 110-DC, 112-DC, and 113-DC), but standards continue to be exceeded for sulfate and TDS in wells 5-SC, 54-SC, and 5-DC near the disposal cell (Table 6-4, Table 6-5, and Figure 6-8). Statistically significant increasing trends were identified for several well-indicator parameter combinations as shown in Table 6-7, most notably well 5-DC, where chloride, sulfate, and TDS have also been significantly increasing since 2005 and pH has been decreasing since approximately 2015 (Figure 6-8).

Well 5-SC is apparently downgradient from the disposal cell, but additional water level measurements in the Upper Sand Aquifer would be required to accurately determine flow directions in the vicinity of this well. Data for other potential seepage indicators do not support the potential mechanism of seepage from the tailings pile leaking into the Upper Sand Aquifer in the vicinity of well 5-SC. Regarding observed trends in well 5-DC, groundwater levels in Main Sand Aquifer wells indicate the apparent regional flow direction is to the south-southeast (Figure 6-5), which places well 5-DC upgradient from the disposal cell. However, as indicated previously, the current monitoring well network within the Main Sand Aquifer is insufficient for determining accurate flow directions in the vicinity of well 5-DC. As a result, the reasons for the increasing contaminant trends observed in well 5-DC (and decreasing pH) are still unknown.

Additional Considerations

The following concluding discussion reiterates information provided in recent previous annual reports (e.g., DOE 2022) because some of this information is still germane to LM's ongoing evaluations at the site.

In 2014, NRC staff concluded that the groundwater monitoring data do not demonstrate tailings impoundment leakage. Additionally, DOE's ACL evaluation program should be suspended so DOE will no longer conduct additional evaluations concerning ACL exceedances at the site

(Orlando 2014). NRC staff based this conclusion on three factors: (1) the source of radium in the site groundwater is uncertain, (2) the groundwater is not a current or potential near-term source of drinking water, and (3) livestock water at the site originates from an aquifer (the Lower Sand Aquifer) that is not impacted by former milling operations. For these reasons, there is no imminent threat to public health and safety, or the environment posed by site groundwater contamination.

In response to NRC 2020 annual inspection report comments (Orlando 2021), DOE considered whether it would be appropriate to install an additional well at the southern site boundary to monitor potential seepage of contaminants from the tailings pile into the Main Sand Aquifer. As discussed earlier in this section and concluded in the previous annual report (DOE 2022), groundwater levels continue to increase in the Main Sand Aquifer throughout the site (Figure 6-6), indicating that the aquifer has not yet equilibrated from site-related activities. A more comprehensive evaluation of flow directions will be best conducted once the aquifer reaches a quasi-steady state regarding groundwater elevations.

The LTSP (DOE 2004) specifies that this report will include isoconcentration maps for uranium and sulfate in each aquifer; however, the monitoring well network does not provide sufficient data points to interpolate a statistically defensible contaminant plume for either aquifer. Uranium concentrations from 2023 are shown in Figure 6-9 and Figure 6-10 for the Upper Sand and Main Sand Aquifers, respectively. Corresponding sulfate concentration data are plotted in Figure 6-11 and Figure 6-12. Uranium concentrations remain below the ACL; however, as stated above, sulfate concentrations exceeded the State of Wyoming groundwater protection standard of 3000 mg/L in Upper Sand Aquifer wells 5-SC and 54-SC and Main Sand Aquifer well 5-DC. Measured concentrations of all constituents remained below standards in well K.G.S. #3, which is screened in the Lower Sand Aquifer north of the tailings impoundment (Table 6-6).

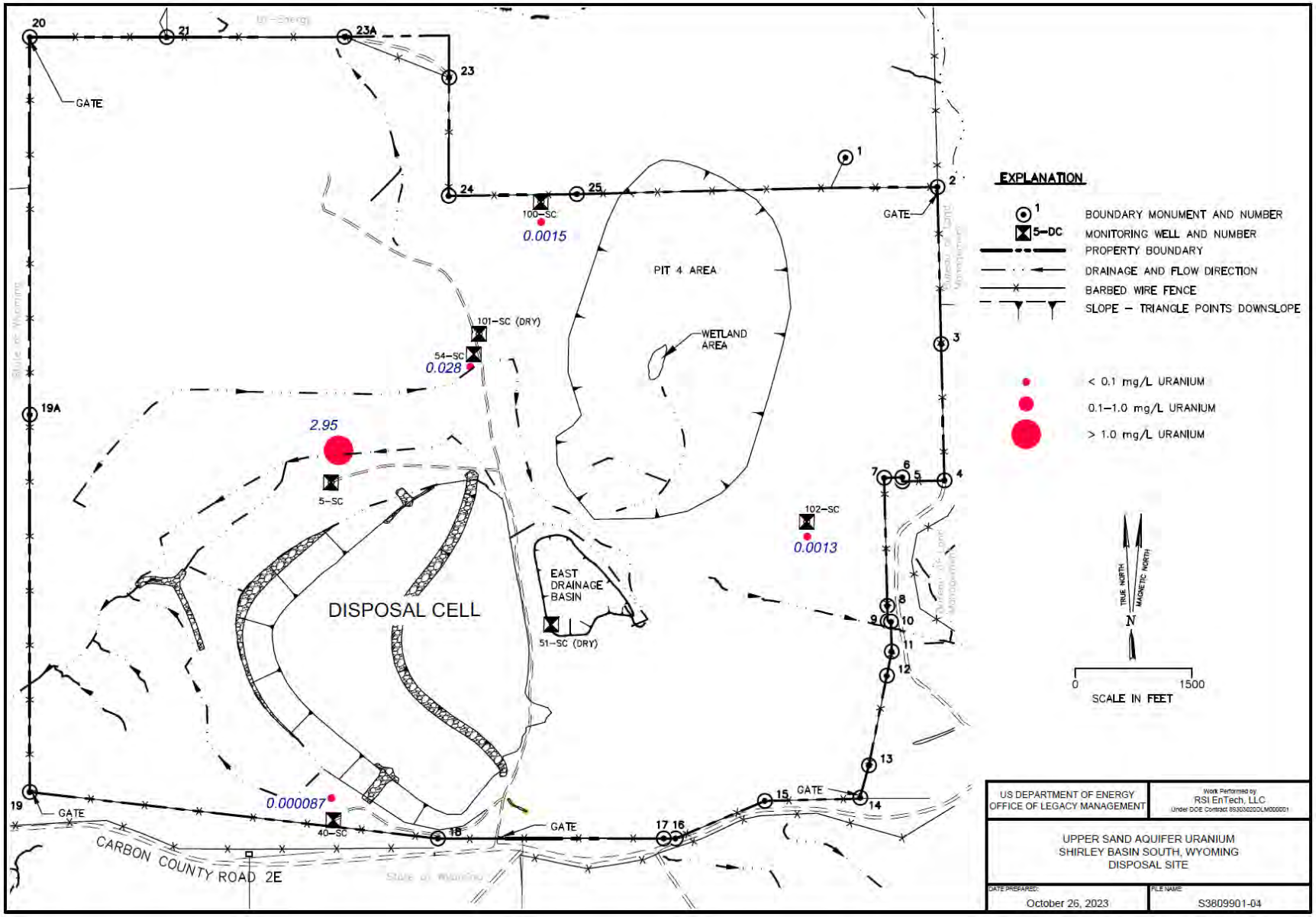


Figure 6-9. July 2023 Uranium Concentrations in the Upper Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

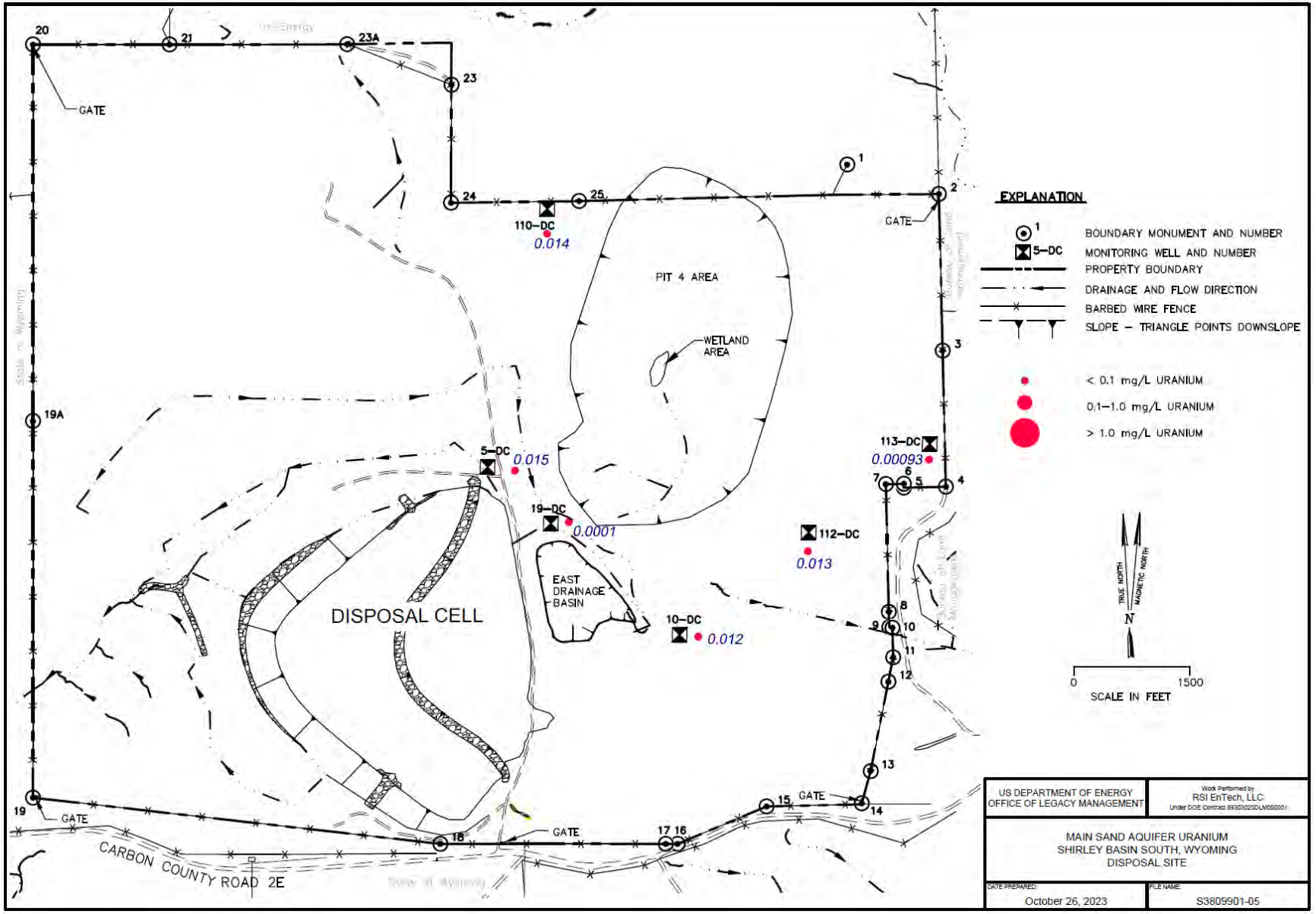


Figure 6-10. July 2023 Uranium Concentrations in the Main Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

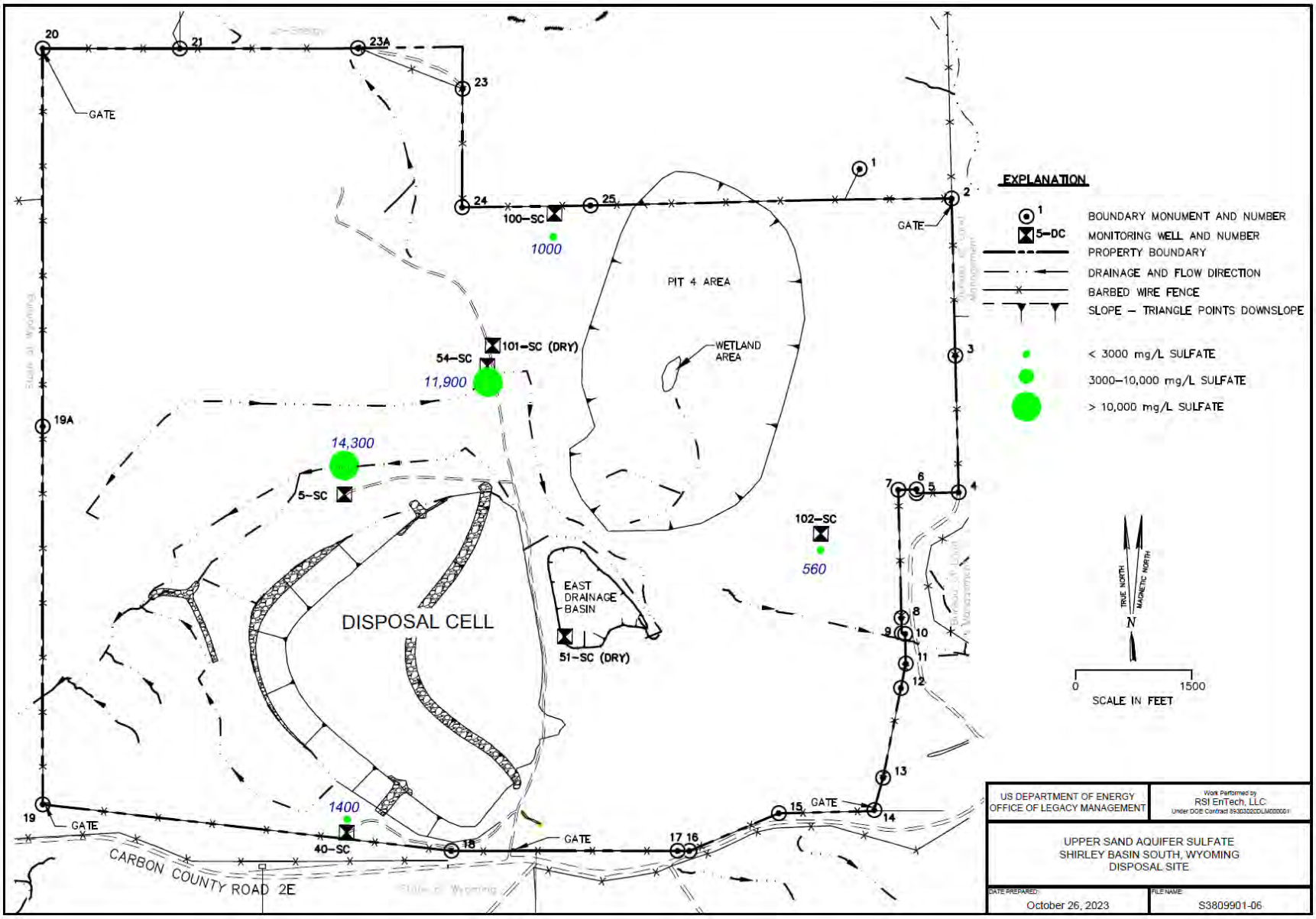


Figure 6-11. July 2023 Sulfate Concentrations in the Upper Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

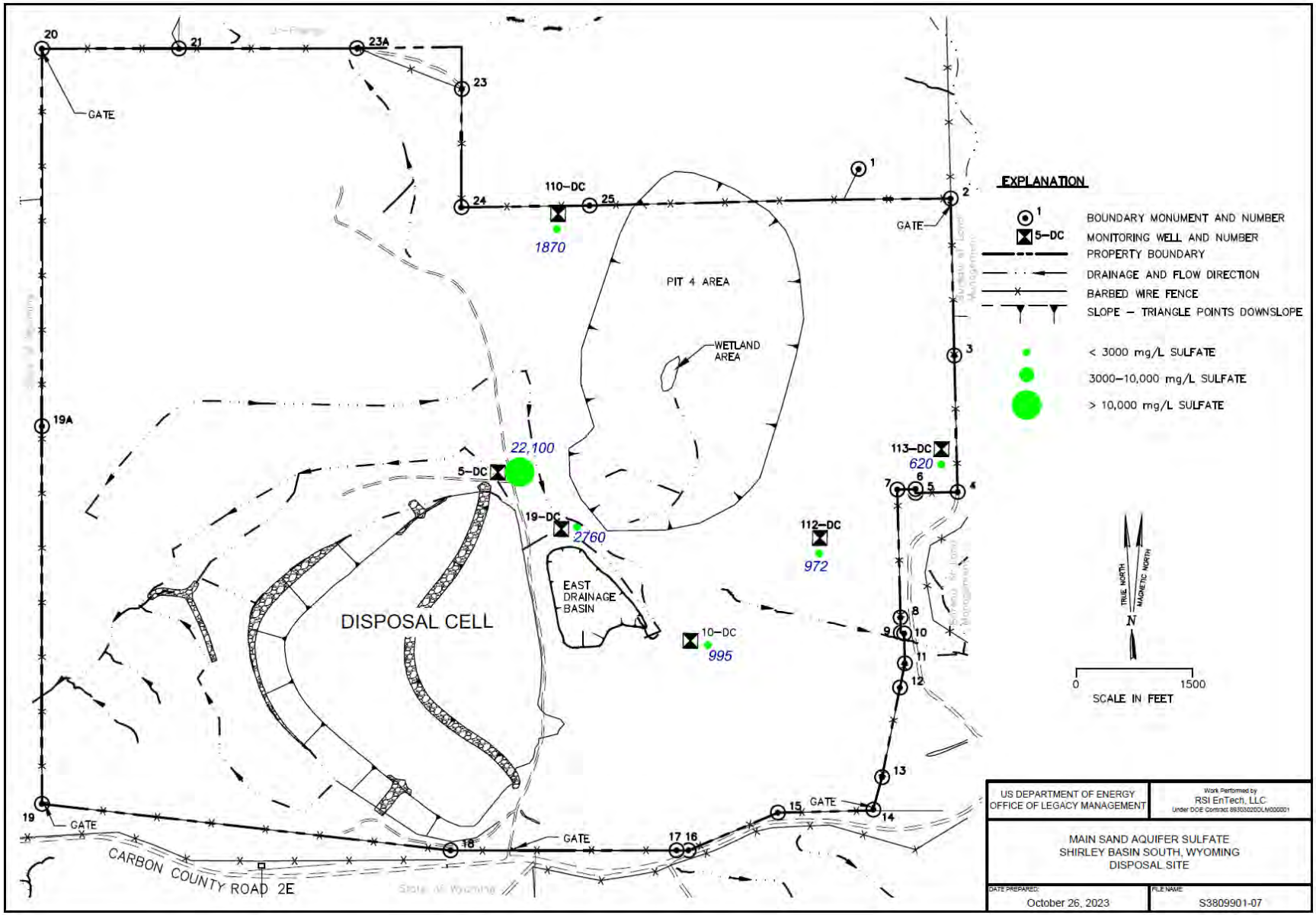


Figure 6-12. July 2023 Sulfate Concentrations in the Main Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

6.8 References

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6.9 Photographs

Photograph Location Number	Azimuth	Photograph Description
PL-1	200	Arroyo Under Fence on Lower Reclaimed Slopes
PL-2	350	Perimeter Sign P26
PL-3	—	Site Marker at Entrance Gate
PL-4	35	Quality Control Monument QC-7
PL-5	300	Burrowing near Monitoring Well 40-SC
PL-6	150	Overview North Side of Disposal Cell and North Swale Discharge Point
PL-7	270	Erosion Caused by Animal Trail North of Upper Riprap Slope
PL-8	70	Erosion Caused by Animal Trail South of Upper Riprap Slope
PL-9	210	Vegetation Encroachment on Upper Riprap Slope
PL-10	70	North Swale Discharge Point
PL-11	345	South Swale Discharge Point
PL-12	105	Overview of Diversion Channels and Contoured Surfaces West of Disposal Cell
PL-13	20	East Drainage Basin
PL-14	10	Erosion Caused from Overflowing Water Storage Tank
PL-15	10	Pit 4 Overview and Wetland Area
PL-16	140	Pit 4 Lower Riprap Armored Drainage Channel Erosion

Note:
— = Photograph taken vertically from above.

PL-1. Arroyo Under Fence on Lower Reclaimed Slopes

PL-2. Perimeter Sign P26

PL-3. Site Marker at Entrance Gate

PL-4. Quality Control Monument QC-7

PL-5. Burrowing Near Monitoring Well 40-SC

PL-6. Overview North Side of Disposal Cell and North Swale Discharge Point

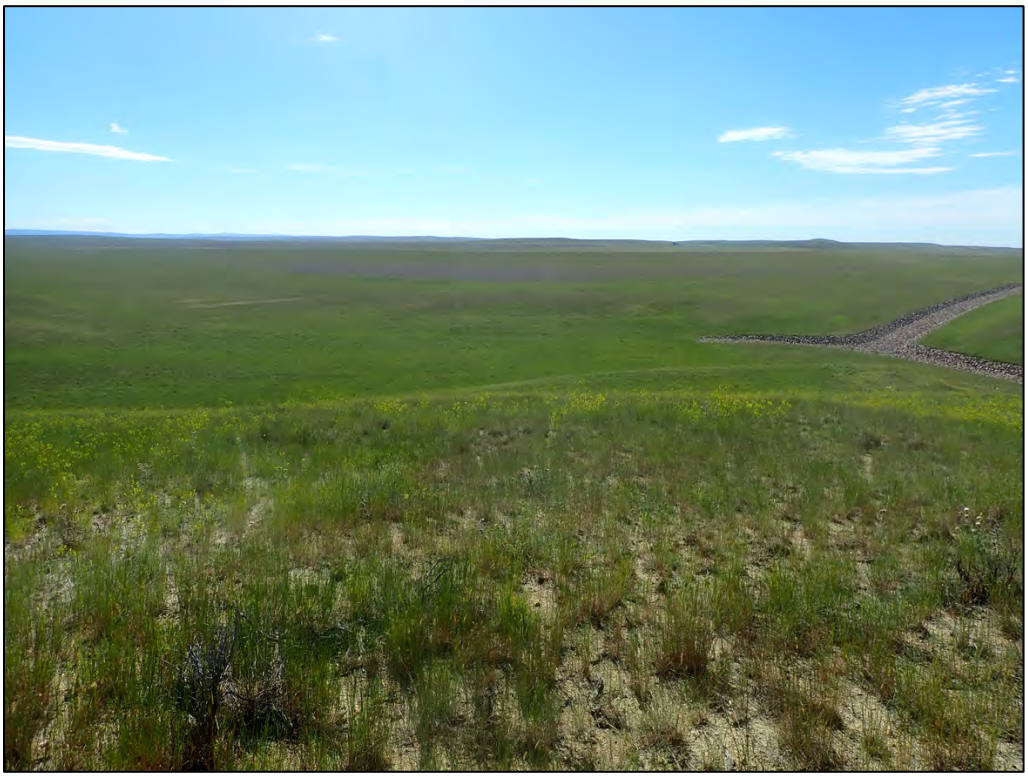
PL-7. Erosion Caused by Animal Trail North of Upper Riprap Slope

PL-8. Erosion Caused by Animal Trail South of Upper Riprap Slope

PL-9. Vegetation Encroachment on Upper Riprap Slope

PL-10. North Swale Discharge Point

PL-11. South Swale Discharge Point



PL-12. Overview of Diversion Channels and Contoured Surfaces West of Disposal Cell

PL-13. East Drainage Basin

PL-14. Erosion Caused from Overflowing Water Storage Tank

PL-15. Pit 4 Overview and Wetland Area

PL-16. Pit 4 Lower Riprap Armored Drainage Channel Erosion