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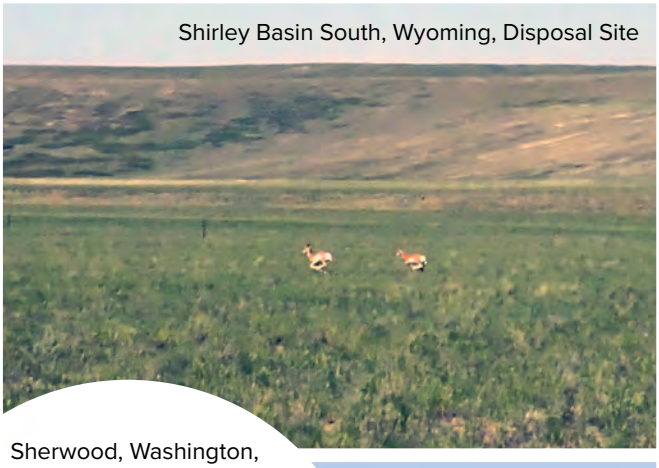
U.S. DEPARTMENT OF ENERGY

Legacy Management

2021 Annual Site Inspection and Monitoring Report for Uranium Mill Tailings Radiation Control Act Title II Disposal Sites

December 2021


L-Bar, New Mexico, Disposal Site


Shirley Basin South, Wyoming, Disposal Site


Edgemont, South Dakota, Disposal Site


Sherwood, Washington, Disposal Site


Maybell West, Colorado, Disposal Site


Bluewater, New Mexico, Disposal Site

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Contents

Abbreviations

AAS	alternate abatement standard
ACL	alternate concentration limit
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
FTH	First Tres Hermanos
IC	institutional control
lidar	light detection and ranging
LM	Office of Legacy Management
LMS	Legacy Management Support
LTS&M	long-term surveillance and maintenance
LTSP	Long-Term Surveillance Plan
mg/L	milligrams per liter
NMED	New Mexico Environment Department
NRC	U.S. Nuclear Regulatory Commission
PCB	polychlorinated biphenyl
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
SOARS	system operation analysis at remote sites
TDS	total dissolved solids
^{232}Th	thorium-232
UMTRCA	Uranium Mill Tailings Radiation Control Act
USACE	U.S. Army Corps of Engineers
WDEQ	Wyoming Department of Environmental Quality
WDOH	Washington Department of Health

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 2021 at six uranium mill tailings disposal sites reclaimed under Title II of the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA). These activities verified that the UMTRCA Title II disposal sites remain in compliance with license requirements. 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) in Title 10 *Code of Federal Regulations* Section 40.28 (10 CFR 40.28). Reclamation and site transition activities continue at other sites, and LM anticipates managing 30 Title II disposal sites.

LTS&M activities and services for these disposal sites include inspecting and maintaining the sites; monitoring environmental media and institutional controls; conducting any necessary corrective action; 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; to identify changes or new conditions that might affect the long-term performance of the site; and to determine whether maintenance and follow-up inspections or corrective actions are needed in accordance with the LTSP.

All of 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 2021:

- **Novel Coronavirus and Other Challenges:** At the Bluewater, New Mexico Disposal Site, the 2020 spring and fall semiannual sampling events were delayed from the typical May and November time frames due to coronavirus-related travel restrictions. As a result, the spring semiannual sampling was completed in August 2020. The fall semiannual sampling was planned for early 2021 but was further delayed due to coronavirus-related travel restrictions and ultimately canceled. The 2021 spring semiannual sampling occurred during the week of May 3, 2021. The 2021 fall semiannual sampling event took place the week of November 15, 2021.
- **Baseline Aerial Survey Quality Control Monuments:** Permanent quality control monuments were installed at all six sites to verify the accuracy and quality of baseline aerial survey data. Baseline aerial surveys were completed in 2021 for the following sites: Bluewater site (aerial survey performed by U.S. Army Corps of Engineers [USACE]); Edgemont, South Dakota, Disposal Site; and Sherwood, Washington, Disposal Site.

[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.

A routine aerial survey was also conducted at the L-Bar, New Mexico, Disposal Site, to assist in the design of stormwater erosion control structures.

A baseline aerial survey is tentatively planned at the Shirley Basin South, Wyoming, Disposal Site in fiscal year 2022, along with nonbaseline aerial surveys at the L-Bar site and the Maybell West, Colorado, Disposal Site.

- **Maybell West, Colorado:** On July 27, 2021, plastic fence markers were installed along the top two strands of the site's perimeter fence to serve as a visual aid for greater sage-grouse and other wildlife in an effort to help prevent wildlife from striking the fence. This effort supported LM's initiative to optimize land use and promote conservation activities and habitat restoration.
- **Shirley Basin South, Wyoming:** NRC comments from the 2020 Annual Inspection and Monitoring report have been addressed in the Shirley Basin South Environmental Monitoring section of the 2021 report. The 2021 annual groundwater sampling was conducted July 12–14, 2021. The lab to which the samples were sent is experiencing operational challenges and is still working on the analysis. LM will validate the data once it is received and will report it in the 2022 annual report. No risks to human health and the environment were identified. Groundwater monitoring will continue in accordance with the LTSP.

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. 2021 Summary of UMTRCA Title II Site Issues and Actions

Site	Chapter	Page	Issues and Actions
Bluewater, New Mexico	1	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 2022 through an interagency agreement with USACE.
		1-6	Settlement continues to be observed on the north side slope of the disposal cell.
		1-7	A minor depression was observed for the first time on the south side slope of the main tailings disposal cell.
		1-10	The 2020 spring and fall semiannual sampling events were delayed from the typical May and November time frames due to coronavirus-related travel restrictions. The spring semiannual sampling was completed in August 2020 and the fall semiannual sampling was cancelled. The spring 2021 semiannual sampling occurred in May 2021 and the fall sampling occurred in November 2021.
		1-12	Alluvial aquifer groundwater monitoring results do not exceed established ACLs; however, two wells indicate groundwater leaving the site with uranium concentrations exceeding EPA drinking water standards.
		1-15	Uranium concentrations in downgradient SAG bedrock wells along the site boundary do not exceed the site-specific NRC-approved health-based standard.
Edgemont, South Dakota	2	2-2	The entrance sign was missing and replaced after the inspection.
		2-5	A baseline aerial survey was conducted August 8–10, 2021.
		2-5	Two small depressions were observed on the containment dam side slope during the inspection, they were also observed in the subsequent aerial survey and will continue to be monitored.
		2-6	No groundwater monitoring is required by the LTSP.
		2-6	Conducted visual inspection of vegetation conditions.
L-Bar, New Mexico	3	3-2	Filled in an animal burrow along a site access road.
		3-5	A broken fence stile was removed, and minor fence repairs were conducted.
		3-19	Conducted erosion monitoring of the disposal cell cover, which indicates the surface of the disposal cell is accreting instead of eroding.
		3-21	Conducted annual vegetation monitoring and comparison of perennial plant cover on the disposal cell cover.
Maybell West, Colorado	4	4-5	Wildlife-friendly fence flagging was installed along the entire perimeter fence.
		4-6	Continued to observe three small depressions on the Disposal Cell with no observed changes.
		4-7	Continued to observe small depressions on the ancillary cell with no observed changes.
		4-8	Gullies near the rock berm west of the ancillary cell were observed and do not threaten the integrity of the ancillary cell.
Sherwood, Washington	5	5-2	Perimeter sign P2 was replaced.
		5-5	Observed minor erosion near perimeter sign P2.
		5-6	Observed evidence of vehicle tracks near perimeter sign P5 to the edge of Pond 1.
		5-6	Conducted annual dam safety inspection.
		5-6	Conducted water level measurements in piezometers atop containment dam.
		5-9	Conducted groundwater monitoring. Groundwater constituent concentrations continue to be less than the action levels for confirmatory sampling in all wells.
		5-11	Conducted annual visual inspection of the disposal cell's vegetated cover.

Table ES-1. 2021 Summary of UMTRCA Title II Site Issues and Actions (continued)

Site	Chapter	Page	Issues and Actions
Shirley Basin South, Wyoming	6	6-6 6-7 6-18–6-21	Observed erosion gullies on the western side of the site. Conducted groundwater monitoring at 14 wells; analysis pending. Addressed 2020 NRC comments regarding selenium ACL exceedance and potential additional evaluation of aquifer seepage.

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 (site) was inspected on March 17 and March 18, 2021. A minor depression was observed for the first time on the south side slope of the main tailings disposal cell. Settlement on the north side slope of the main tailings disposal cell continues to be observed. Depressions continue to be observed on the north portion of the 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 December 2019, August 2020, and May 2021, a shift from the typical time frames due to coronavirus-related travel restrictions. Analytical results from the three sampling events indicate that alternate concentration limits (ACLs) were not exceeded. However, groundwater leaving the site in both the alluvial and bedrock aquifers has uranium concentrations exceeding the U.S. Environmental Protection Agency (EPA) drinking water standard. No known domestic wells within the contaminant plumes have uranium concentrations exceeding the drinking water standard, and the plumes are not expected to impact local municipal water supplies (DOE 2019). The fall 2021 sampling event occurred the week of November 15, 2021.

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 (LTSP) (DOE 1997) and in accordance with procedures established to comply with requirements of 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 U.S. Nuclear Regulatory Commission (NRC) general license (10 CFR 40.28) 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 17 and 18, 2021. The inspection was conducted by J. Cario, D. Marshall, D. Ravelojaona, and D. Traub of the Legacy Management Support (LMS) contractor. B. Tsosie (LM site manager) and A. Rheubottom (New Mexico Environment Department [NMED]) attended the inspection both days, G. Kuntz (LM), L. Carleo (LMS), and Kurt Vollbrecht (NMED) attended the inspection the morning of March 17, and J. Bale (RSI EnTech, LLC) attended the inspection the afternoon of March 18. 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 additional 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. 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 type, and new observations are shown in red type. Inspection results and recommended maintenance activities associated with site surveillance features are included in the following subsections. Photographs to support specific observations are identified 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 (PL-1). The site access road is surfaced with crushed basalt and extends northward along a narrow strip of LM property for approximately 1700 feet 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-2 and PL-3). In 2017 riprap was added to repair a gully intersecting this section of the road. Additional erosion was noted along the road paralleling the northern perimeter of the site. LM is planning to repair the roads in 2022 through the interagency agreement with the U.S. Army Corps of Engineers (USACE). No other maintenance needs were identified.

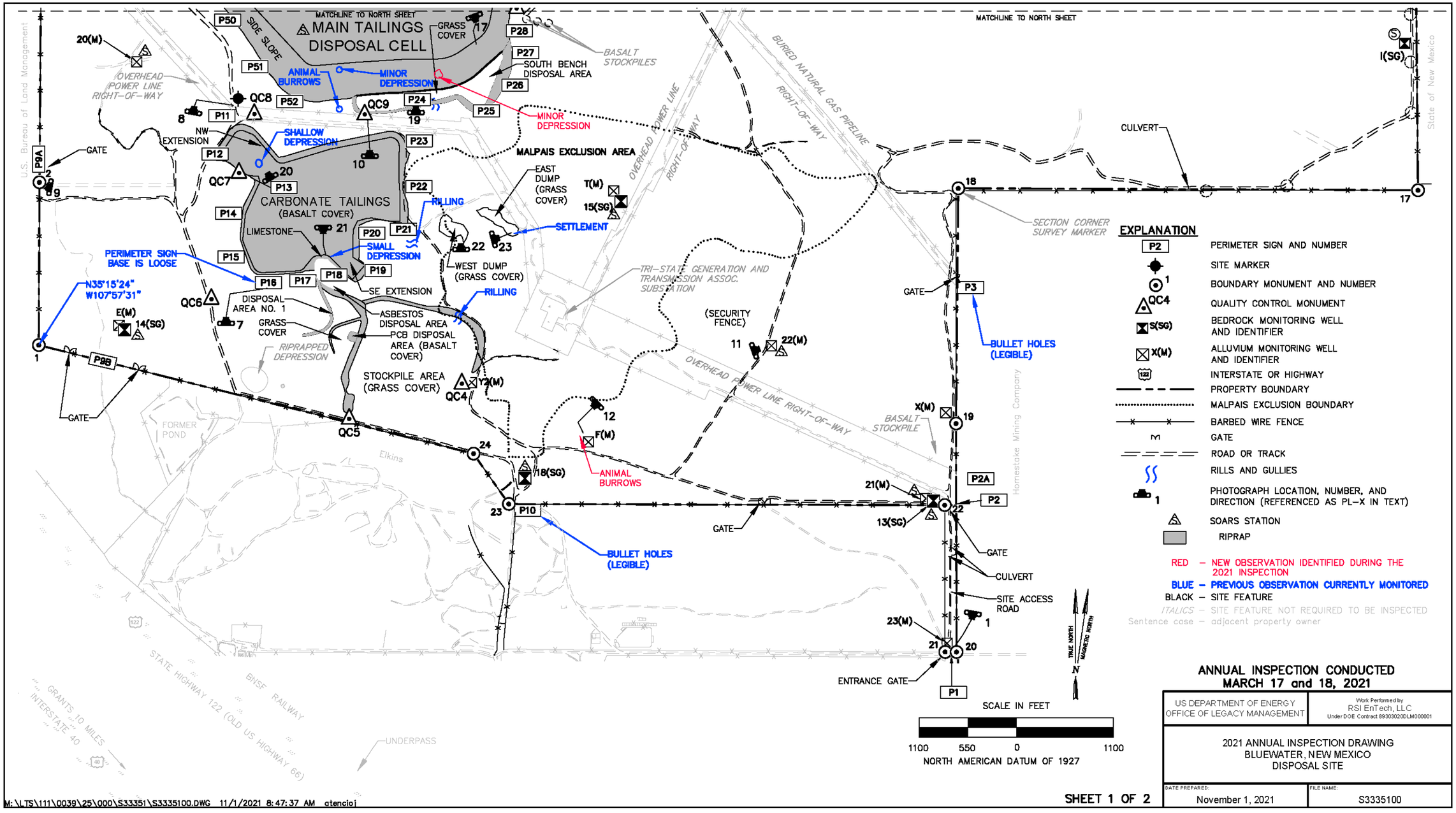


Figure 1-1. 2021 Annual Inspection Drawing for the Bluewater, New Mexico, Disposal Site (South Area)

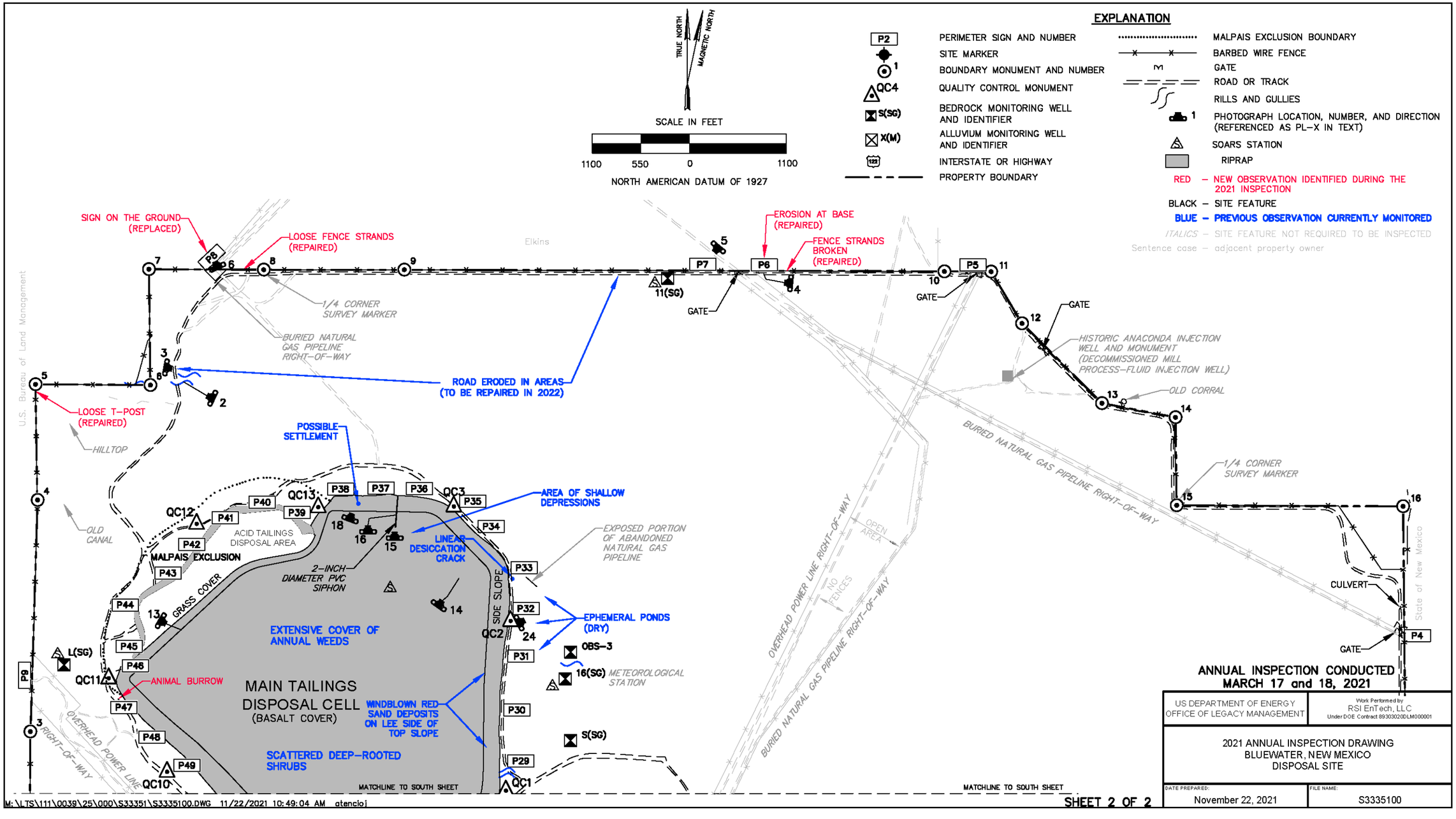


Figure 1-2. 2021 Annual Inspection Drawing for the Bluewater, New Mexico, Disposal Site (North Area)

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 broken fence strands near perimeter sign P6 (PL-4), loose fence strands near perimeter sign P8, and loose T-posts near boundary monument BM-5. All were repaired in a subsequent maintenance trip. Inspectors observed the gullies, which were identified in the 2019 inspection, paralleling the perimeter fence northwest of the main tailings disposal cell. No significant changes were observed. Inspectors 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-5). Perimeter sign P8 was out of the ground (PL-6) and the base of perimeter sign P16 was loose (PL-7); both were repaired in a subsequent maintenance trip. Perimeter signs P3 and P10 have bullet hole damage but are legible. 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-8). No maintenance needs were identified.

1.4.1.4 Boundary Monuments

Twenty-four boundary monuments define the site boundary (PL-9). 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 inspectors find them. Other monuments are in remote sections of the site and cannot be observed from site access roads. All boundary monuments were inspected during the 2021 inspection. No maintenance needs were identified.

1.4.1.5 Aerial Survey Quality Control Monuments

Thirteen aerial survey quality control monuments, installed in 2019, were inspected during the 2021 annual inspection (PL-10). An aerial survey was conducted by USACE in 2021. No maintenance needs were identified.

1.4.1.6 Monitoring Wells

The site's groundwater monitoring network consisted of nine monitoring wells when the site was transferred to LM. 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. Several wells have telemetry towers, known as System Operation Analysis at Remote Sites (SOARS) stations, to transmit groundwater level and weather data to the LM Field Support Center at Grand Junction, Colorado (PL-11). The wellhead protectors and telemetry towers were

undamaged and locked. New animal burrows were identified near well F(M) but do not threaten the well integrity (PL-12). 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 the site's 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 and forbs, and scattered perennial shrubs) continues on the main tailings disposal cell top and side slopes (PL-13). Siberian elm saplings on the top slope are managed to prevent the establishment of trees that could damage the main tailings disposal cell cover materials.

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 (PL-14). 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 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 continues and is up to 4 feet in places. However, the rate of settlement since 2012 (an average of 0.72 inches 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. Data from this survey will be compared to previous surveys to calculate the current rate of settlement.

Ponds often develop in the depressions from stormwater and occasionally coalesce into one large pond after a series of storms. 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-15). 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 disposal cell's north side slope. Water would start to spill at the lowest point along the north edge of the top slope, and that could initiate erosion at that spot. 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. 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, and it successfully removes nearly all the water; the remaining water evaporates. All the water cannot drain from one location because of the unevenness of the depressions. The siphon has not been operated in 2021 because of minimal ponded water. 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-16). The discharged water ponds over a large area north of the main tailings disposal cell and eventually dissipates through infiltration into soil and through evaporation. The discharged water does not flow off the site.

The side slopes and toe of the main tailings disposal cell were inspected for signs of erosion or sediment deposition. A new area of minor depression was observed on the south side slope with an approximate length of 10 feet, width of 20 feet, and depth of 10 to 12 inches (PL-17). Another area of minor depression was observed on the south side slope during the 2018 annual inspection, but it could not be identified during the 2021 inspection. The minor depression will be removed from future inspection maps unless it is identified in subsequent inspections or in the 2021 lidar survey. An area of potential settlement was observed on the north side slope during the 2020 annual inspection. Inspectors observed the area, but no apparent changes were noted (PL-18). The side slopes will continue to be observed for depressions. Identified depressions and settlement 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; minor rills with a maximum depth of 8 inches were observed at the base of the main tailings disposal cell south bench. The rills did not appear to increase in depth or extent (PL-19). During the 2020 annual inspection, a linear desiccation crack was observed along the base of the east side slope. The desiccation crack did not appear to increase in depth or extent. LM will continue to monitor the rills and crack for potential impact to the main tailings disposal cell and south bench area. No sediment deposits were present along the toe. No maintenance needs for the side slopes or acid tailings and 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 very shallow depression exists on the northwest extension, and stormwater runoff occasionally ponds at this location; the depression was dry during the 2021 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. Annual weeds, perennial grasses, and scattered woody shrubs were present 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 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 (PL-21). The depressions repaired in May 2018 were observed, and no changes were apparent. As no changes have been identified in the past three inspections, the repair depression will be removed from future inspection maps. LM observed the depression identified during the 2019 annual inspection on the north side slope; no changes were apparent. 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. Two grass-covered dumps, totaling about 2 acres, are east of the carbonate tailings disposal cell (PL-22). Inspectors observed the fill material settled into the basalt in an area at the southern interface of the east dump; it was first identified during the 2019 annual inspection (PL-23). No changes were apparent. LM will continue to observe the settlement and make repairs as necessary. 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 to not impact it. The ponded areas were dry during the inspection (PL-24).

Scattered tamarisk shrubs and other plants listed as noxious weeds by the state of New Mexico are present onsite. Noxious weeds were treated with herbicide by the LMS contractor in August 2021.

Additional rilling and animal burrows are present onsite 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.

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. No other maintenance needs were identified.

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 in a subsequent site visit in April 2021:

- Broken fence strands near perimeter sign P6
- Loose fence strands near perimeter sign P8
- Loose T-posts near boundary monument BM-5
- Downed perimeter sign P8
- Loose base of perimeter sign P6

Treatment of noxious weeds was addressed in a subsequent site visit.

Inspectors also identified the need to repair erosion along the interior road. This work is proposed for 2022.

No other maintenance needs were identified.

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.

1.7 Environmental Monitoring

Groundwater monitoring is required at the site. 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), Y2(M), X(M), L(SG), OBS-3, S(SG), and I(SG). 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 San Andres/Glorieta (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. Currently, all site wells (including POE wells) are sampled semiannually for an expanded list of

constituents as described in the following sections. The 2020 spring and fall semiannual sampling events were delayed from the typical May and November time frames due to coronavirus-related travel restrictions. As a result, the spring semiannual sampling was completed in August 2020. The fall semiannual sampling was planned for early 2021 but was further delayed due to coronavirus-related travel restrictions and ultimately canceled. The 2021 spring semiannual sampling occurred during the week of May 3, 2021. The fall semiannual sampling event occurred the week of November 15, 2021. The groundwater monitoring network is described in Figure 1-3 and Table 1-2. ACLs are listed in Table 1-3.

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

Monitoring Well	Network Application
E(M)	Alluvium background well
F(M)	Alluvium POC well
T(M)	Alluvium POC well
X(M)	Alluvium POE well
Y2(M)	Alluvium POC well
20(M)	Alluvium upgradient well
21(M)	Alluvium downgradient well
22(M)	Alluvium downgradient well
23(M)	Alluvium downgradient well
I(SG)	Bedrock POE well
L(SG)	Bedrock background well
OBS-3	Bedrock POC well
S(SG)	Bedrock POC well
11(SG)	Bedrock cross-gradient well
13(SG)	Bedrock downgradient well
14(SG)	Bedrock cross-gradient well
15(SG)	Bedrock downgradient well
16(SG)	Bedrock replacement 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)
Alluvial aquifer wells F(M) and T(M)	Molybdenum	0.10
	Selenium	0.05
	Uranium	0.44[a]
Bedrock aquifer wells OBS-3 and S(SG)	Selenium	0.05
	Uranium	2.15[a]

Note:
[a] The uranium ACL is based on a human-health-based risk standard of 0.44 milligrams per liter (mg/L) at the site boundary as approved by NRC in the Atlantic Richfield Company's ACL application (Applied Hydrology Associates Inc. 1995).

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 all onsite monitoring wells, including the POE wells, in fall 2008.

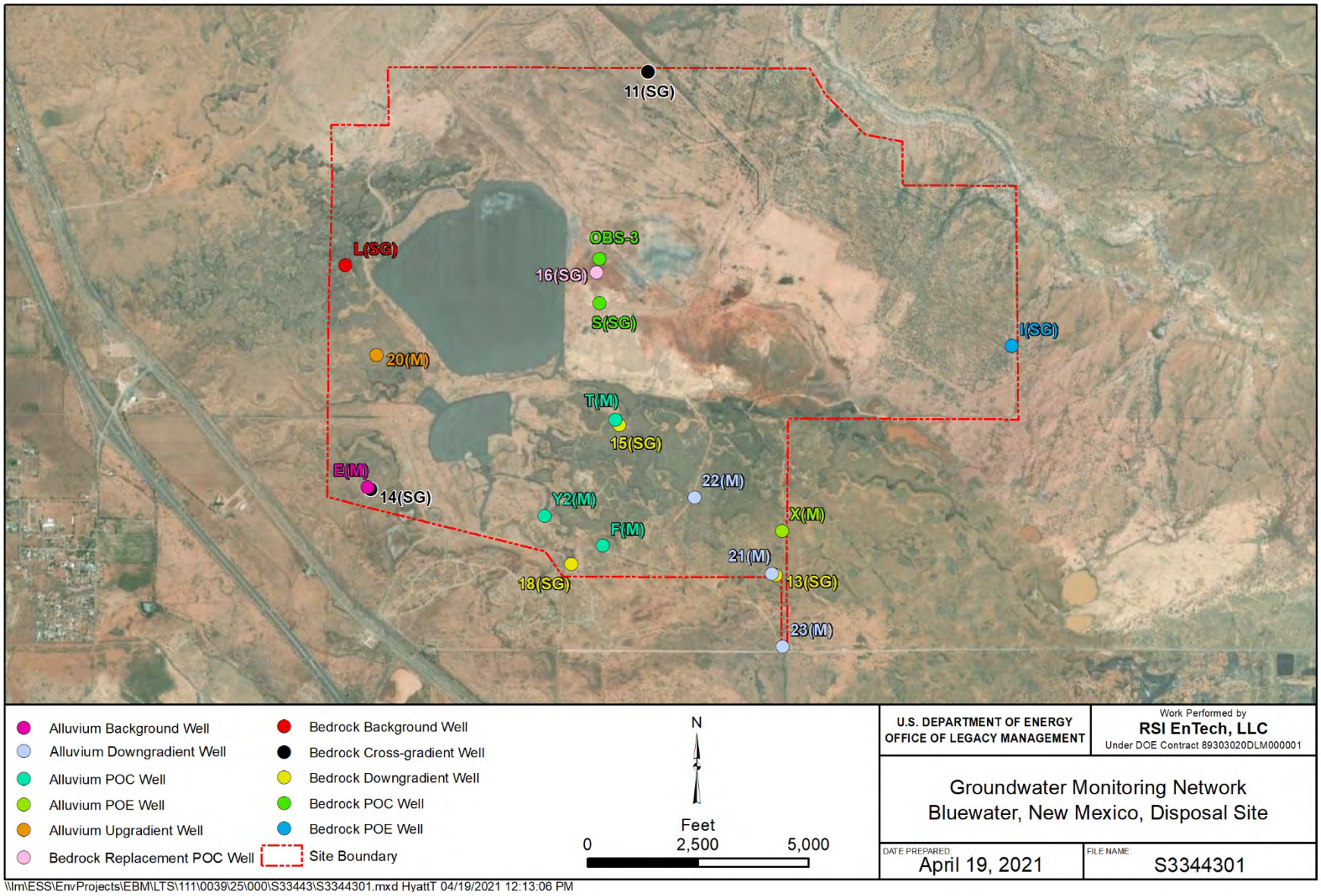


Figure 1-3. Groundwater Monitoring Network at Bluewater, New Mexico, Disposal Site

Semiannual sampling was initiated in 2011 in response to an ACL exceedance for uranium in well T(M). LM also began evaluating the hydrogeology and groundwater quality at the site in 2009 and started analyzing a larger suite of constituents than the LTSP requires to characterize the site aquifers and support NMED's regional groundwater investigation. In consultation with NRC, LM installed additional monitoring wells in 2011 and 2012, evaluated the main tailings disposal cell performance, and developed a groundwater conceptual model to address uranium contamination concerns (DOE 2014).

LM updated the uranium plume maps and groundwater conceptual model in both the alluvial aquifer and SAG aquifer in a 2019 report (DOE 2019). In 2020 LM completed an evaluation on the influence of high-volume pumping wells near the site on groundwater flow and contaminant trends in the SAG aquifer (DOE 2020).

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.

Alluvial aquifer analytical results from sampling events in December 2019, August 2020, and May 2021 are provided in Table 1-4 through Table 1-6, respectively. POC well T(M) was not sampled in any of the sampling events because it was dry. Well 22(M) is downgradient from well T(M) and is at the approximate midpoint between POC well T(M) and downgradient well 21(M) at the southern site boundary. Uranium concentrations in wells 21(M) and 22(M) during the recent sampling events were less than the uranium ACL and the NRC-approved health-based standard of 0.44 mg/L, but they were above the 0.03 mg/L EPA drinking water standard in each sampling event. No other alluvial aquifer wells exceeded the established ACLs for molybdenum, selenium, or uranium.

Table 1-4. Alluvial Aquifer Monitoring Results in December 2019 at the Bluewater, New Mexico, Disposal Site

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
E(M)	0.000331	Non-detect	Non-detect
F(M)	0.000939	Non-detect	0.00668
T(M)	Not sampled	Not sampled	Not sampled
X(M)	0.00081	0.00759	0.092
Y2(M)	0.00176	Non-detect	0.0048
20(M)	0.00227	0.00473	0.0149
21(M)	0.00101	0.0118	0.109
22(M)	0.00535	0.00408	0.402
23(M)	0.00298	Non-detect	0.0185

Table 1-5. Alluvial Aquifer Monitoring Results in August 2020 at the Bluewater, New Mexico, Disposal Site

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
E(M)	Non-detect	Non-detect	0.000129
F(M)	0.00106	ND	0.00548
T(M)	Not sampled	Not sampled	Not sampled
X(M)	0.000862	0.00546	0.0734
Y2(M)	0.00171	Non-detect	0.00429
20(M)	0.00214	0.00393	0.0137
21(M)	0.00101	0.00937	0.099
22(M)	0.00502	0.00333	0.353
23(M)	0.00281	Non-detect	0.0154

Table 1-6. Alluvial Aquifer Monitoring Results in May 2021 at the Bluewater, New Mexico, Disposal Site

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
E(M)	0.000253	Non-detect	Non-detect
F(M)	0.000887	Non-detect	0.00578
T(M)	Not sampled	Not sampled	Not sampled
X(M)	Not sampled	Not sampled	Not sampled
Y2(M)	0.00152	Non-detect	0.00441
20(M)	0.00171	0.0024	0.013
21(M)	0.00094	0.00823	0.0924
22(M)	0.00464	0.00357	0.368
23(M)	0.00287	Non-detect	0.0149

Figure 1-4 shows historical uranium concentrations measured at POC well T(M) and four additional wells screened in the alluvial aquifer. Uranium concentrations in well T(M) trended upward since LM began monitoring the well in 1999, and the November 2010 concentration of 0.557 mg/L was the first of five uranium concentrations that exceeded the ACL of 0.44 mg/L. LM notified NRC of the exceedance upon receiving the 2010 results from the laboratory. Well T(M) was last sampled in May 2012, and the well has since been dry. NRC requested that LM evaluate the performance of the main tailings disposal cell to assess whether seepage from the cell between 2005 and 2010 had increased to the extent it was responsible for the elevated uranium concentrations measured at POC well T(M). Evaluations performed in the *Site Status Report: Groundwater Flow and Contaminant Transport in the Vicinity of the Bluewater, New Mexico, Disposal Site* (DOE 2014) concluded that the increase in uranium concentration at well T(M) was not attributed to seepage from the disposal cell.

Well 21(M) in the southeast corner of the site and POE well X(M) near the site's east boundary show an apparent decreasing trend in uranium concentration since 2013 (Figure 1-4). However,

the continued elevated uranium concentrations at these two wells indicate that alluvial groundwater with uranium concentrations exceeding the EPA drinking water standard (0.03 mg/L) is discharging from the site toward the southeast.

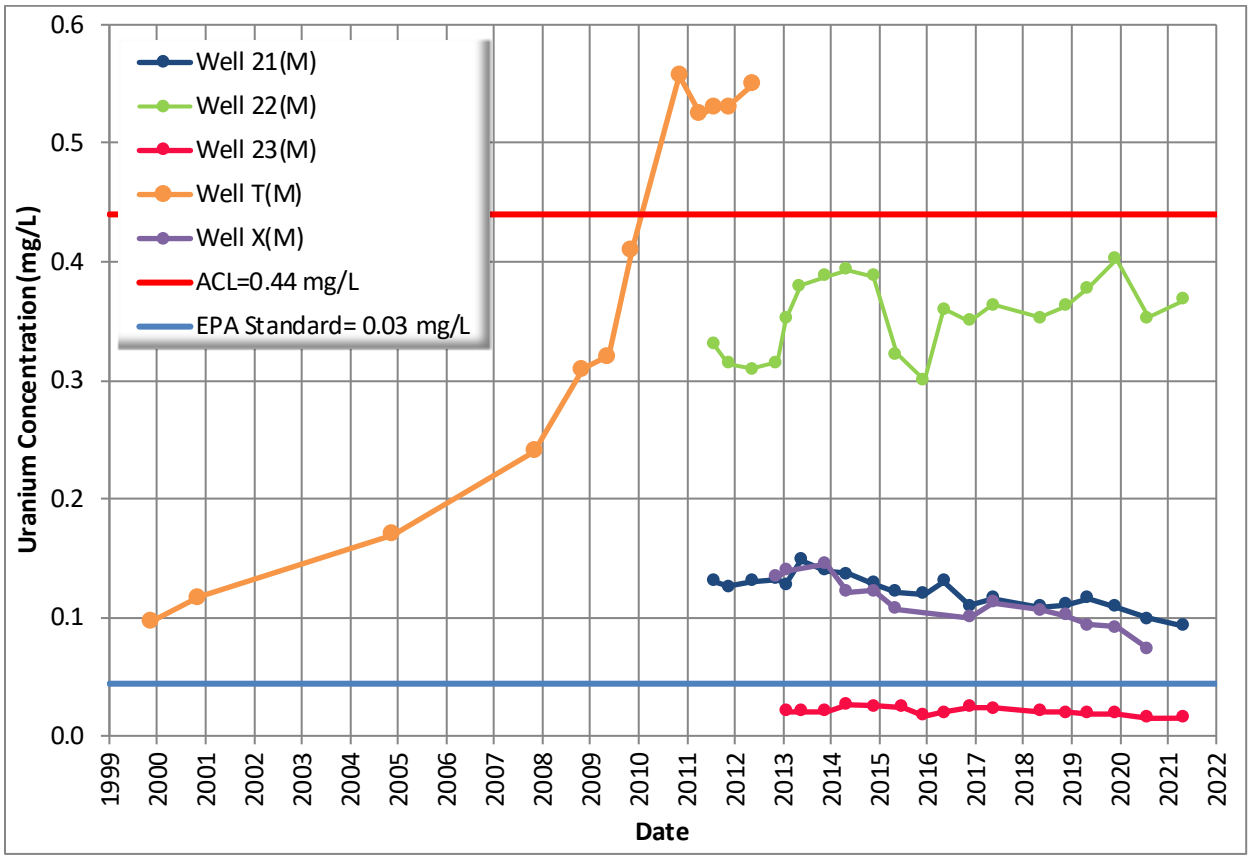


Figure 1-4. Uranium Concentrations in Alluvial Aquifer POC Well T(M) and Downgradient Wells at the Bluewater, New Mexico, Disposal Site

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-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 mill site. The combined plume resulting from the confluence of uranium plumes in the respective paleochannels then turns southeast toward the village of Milan.

Although some non-LM alluvial-aquifer monitoring wells downgradient of the site have uranium concentrations exceeding the EPA standard of 0.03 mg/L, the contaminant plume does not extend to Milan, and there are no known domestic wells within the contaminant plume. 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 wells near and downgradient of the Bluewater site (Romero 2018).

1.7.2 San Andres/Glorieta (SAG) Bedrock Aquifer

Table 1-7 through Table 1-9 provides analytical results for selenium and uranium in SAG aquifer wells for samples collected in December 2019, August 2020, and May 2021, respectively. Selenium and uranium concentrations did not exceed ACLs in any of the site wells. POC wells OBS-3 and S(SG) were found to have highly corroded well screens, resulting in samples with anomalously low uranium concentrations. Consequently, sample results from wells OBS-3 and S(SG) are not considered representative of aquifer conditions; however, they continue to be sampled in accordance with the LTSP until decommissioning is approved by NRC. Well 16(SG) was installed in 2012 to provide a location to sample the SAG aquifer that would be representative of aquifer conditions in the vicinity of the POC wells.

SAG aquifer wells 11(SG), 13(SG), 14(SG), 15(SG), 16(SG), and 18(SG) were installed in summer 2012 to gain a better understanding of the hydrogeological characteristics of the SAG aquifer at the site. There were no bedrock wells in the southern portion of the site before these wells were installed in 2012. Wells 11(SG) and 14(SG) are cross-gradient of the disposal cells, and all the other new wells are downgradient. Uranium concentrations in downgradient wells 13(SG), 18(SG), and I(SG), located along the site boundary, meet the site-specific NRC-approved health-based standard of 0.44 mg/L at the site boundary.

Table 1-7. SAG Aquifer Monitoring Results for December 2019 at the Bluewater, New Mexico, Disposal Site

Well	Selenium (mg/L) ACL = 0.05 mg/L	Uranium (mg/L) ACL = 2.15 mg/L
11(SG)	Non-detect	0.0146
13(SG)	0.00703	0.129
14(SG)	Non-detect	0.117
15(SG)	Non-detect	0.0189
16(SG)	0.0154	1.22
18(SG)	0.00714	0.252
I(SG)	0.00769	0.3
L(SG)	Non-detect	0.00332
OBS-3	Non-detect[1]	0.0032[1]
S(SG)	0.00793[1]	0.512[1]

Note:
[1] Erroneous values due to corrosion in the well screen.

Table 1-8. SAG Aquifer Monitoring Results for August 2020 at the Bluewater, New Mexico, Disposal Site

Well	Selenium (mg/L) ACL = 0.05 mg/L	Uranium (mg/L) ACL = 2.15 mg/L
11(SG)	Non-detect	0.0136
13(SG)	0.00704	0.107
14(SG)	Non-detect	0.105
15(SG)	Non-detect	0.0129
16(SG)	0.0131	1.04
18(SG)	0.00625	0.255
I(SG)	0.00698	0.272
L(SG)	Non-detect	0.00309
OBS-3	Non-detect[1]	0.00153[1]
S(SG)	0.00892[1]	0.455[1]

Note:
[1] Erroneous values due to corrosion in the well screen.

Table 1-9. SAG Aquifer Monitoring Results for May 2021 at the Bluewater, New Mexico, Disposal Site

Well	Selenium (mg/L) ACL = 0.05 mg/L	Uranium (mg/L) ACL = 2.15 mg/L
11(SG)	Non-detect	0.0179
13(SG)	0.00603	0.107
14(SG)	Non-detect	0.114
15(SG)	Non-detect	0.0179
16(SG)	0.0121	1.17
18(SG)	0.00649	0.244
I(SG)	0.00535	0.283
L(SG)	Non-detect	0.00315
OBS-3	Non-detect[1]	0.00305[1]
S(SG)	0.00752[1]	0.555[1]

Note:
[1] Erroneous values due to corrosion in the well screen.

Figure 1-5 shows uranium concentrations in the SAG aquifer. Uranium concentrations in well I(SG) before 2013 are not shown because an incorrect sampling depth in the well led to erroneously low results. Uranium concentrations at POC wells OBS-3 and S(SG) are not shown because of the well integrity issues leading to erroneously low uranium concentration measurements. According to the 2019-2021 sampling results none of the onsite wells exceeded the 2.15 mg/L ACL, and none of the wells exceeded the 0.44 mg/L NRC-approved health-based standard except for surrogate POC well 16(SG). Well 16(SG) was previously reported to have a statistically significant decreasing uranium trend, according to Mann-Kendall trend analysis, from 2013 to 2018 (DOE 2020). Uranium concentration data from 2019 to 2021 suggests that uranium continues to have an apparent decreasing trend in well 16(SG).

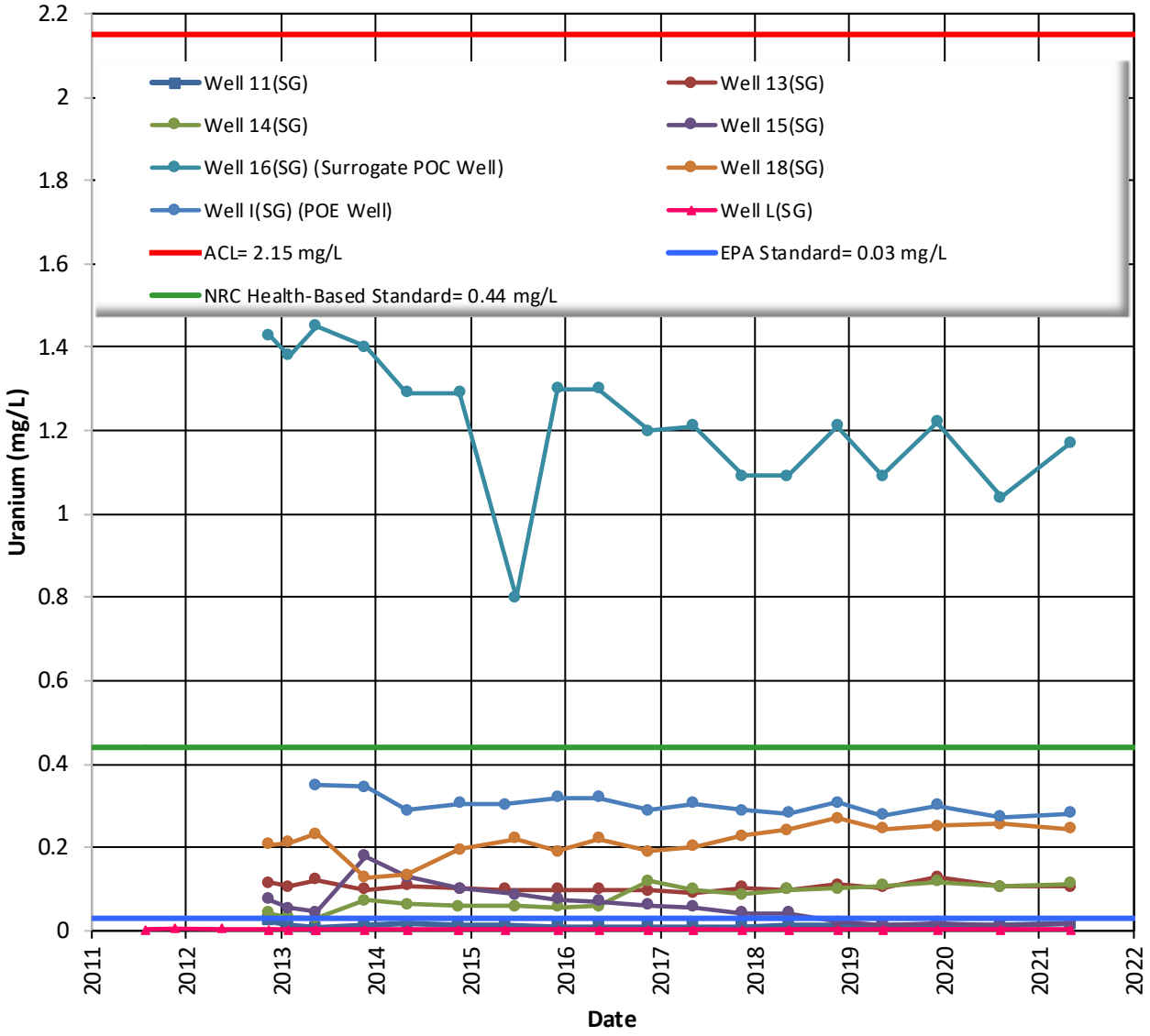


Figure 1-5. Uranium Concentrations in the San Andres/Glorieta Aquifer at the Bluewater, New Mexico, Disposal Site

POE well I(SG), at the eastern site boundary, had no statistical trend in uranium concentration from 2013 to 2018 (DOE 2020) and had no significant increases in uranium between December 2019 (0.3 mg/L) and May 2021 (0.283 mg/L). Well 14(SG) near the southwestern site boundary was the only onsite well to have a statistically significant increasing uranium trend between 2013 and 2018 (DOE 2020). Uranium concentrations in well 14(SG) were relatively constant in recent sampling events, from 0.117 mg/L in December 2019 to 0.114 mg/L in May 2021.

Uranium concentration trends in offsite wells, including privately owned and nearby municipal drinking water wells, 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. All offsite wells had uranium concentrations below the EPA standard of 0.03 mg/L except for two wells owned by Homestake Mining Company; well 951 and well 951R were just above the EPA standard in 2018. Well 951 is just outside the southeastern boundaries of the Bluewater site and had no statistically significant uranium trend since 2012. Well 951R also had no trend and is approximately 2 miles southeast of the site, nearer to the Homestake site. Both wells were concluded to have concentration trends correlated to the timing of pumping activity in the valley (DOE 2020). Groundwater quality in offsite wells completed in the SAG aquifer will continue to be monitored as part of the cooperative agreement between DOE and NMED for potential offsite migration of contaminants.

Uranium isoconcentration contour maps were not produced for this report. Contour maps generated for previous reports (DOE 2014; DOE 2019) erroneously included Homestake Mining Company well 928, just north of the large tailings pile at the Homestake site and distally east of the Bluewater site. Well 928 had since been shown to have well integrity issues and was abandoned. LM is updating plume mapping calculations and assumptions for the Bluewater site to be consistent and accurate for future reporting.

1.8 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*.

Applied Hydrology Associates Inc., 1995. *Corrective Action Program and Alternate Concentration Limits Petition for Uranium, Molybdenum and Selenium, Bluewater Uranium Mill Near Grants, New Mexico,* prepared for Atlantic Richfield Company, April.

DOE (U.S. Department of Energy), 1997. *Long-Term Surveillance Plan for the DOE Bluewater (UMTRCA Title II) Disposal Site Near Grants, New Mexico*, LTSM003407, July.

DOE (U.S. Department of Energy), 2014. *Site Status Report: Groundwater Flow and Contaminant Transport in the Vicinity of the Bluewater, New Mexico, Disposal Site,* LMS/BLU/S11381, November.

DOE (U.S. Department of Energy), 2017. *Evaluation of Disposal Cell Topography Using LiDAR Surveys, Bluewater, New Mexico, Disposal Site*, LMS/BLU/S14703, April.

DOE (U.S. Department of Energy), 2019. *2017 Uranium Plumes in the San Andres-Glorieta and Alluvial Aquifers at the Bluewater, New Mexico, Disposal Site*, LMS/BLU/S19565, February.

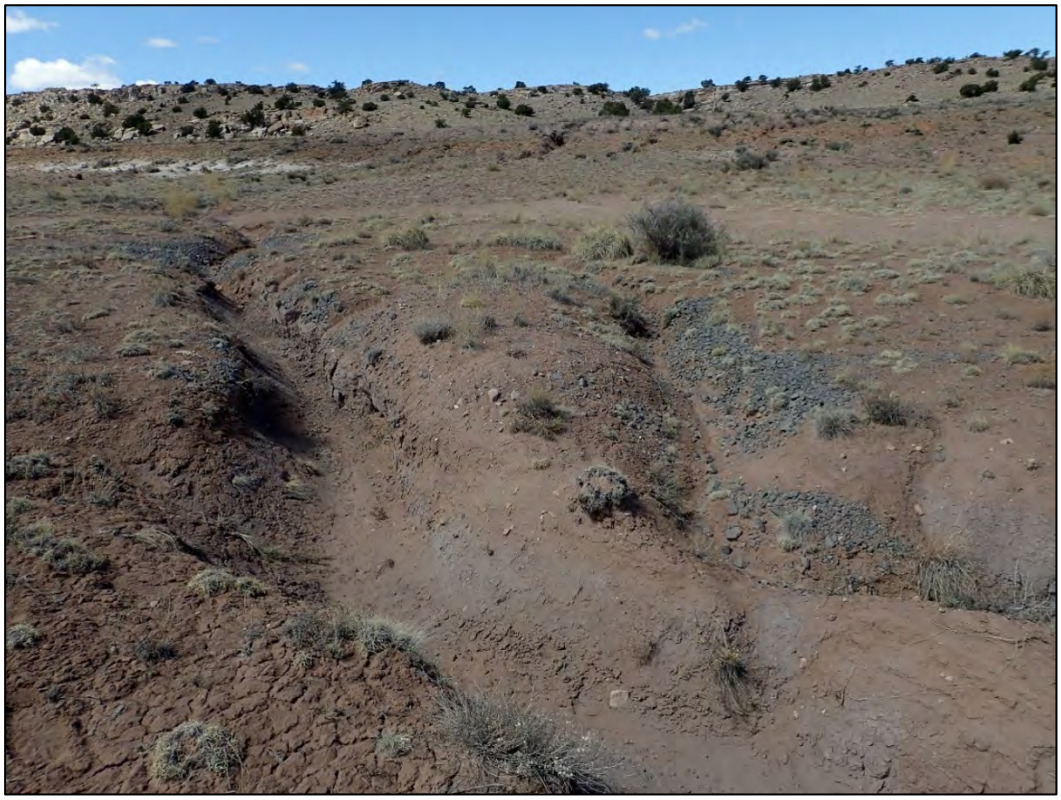
DOE (U.S. Department of Energy), 2020. *Evaluating the Influence of High-Production Pumping Wells on Impacted Groundwater at the Bluewater, New Mexico, Disposal Site*, LMS/BLU/S24765, August.

Romero, 2018. John T. Romero, PE, director, Water Rights, State of New Mexico Office of the State Engineer, letter ("Request for Well Drilling Prohibition Associated with the Remedial Action at the Former Homestake and Bluewater Mill Sites, Cibola County, New Mexico") to Bruce Yurdin, director, Water Protection Division, New Mexico Environment Department, May 3.

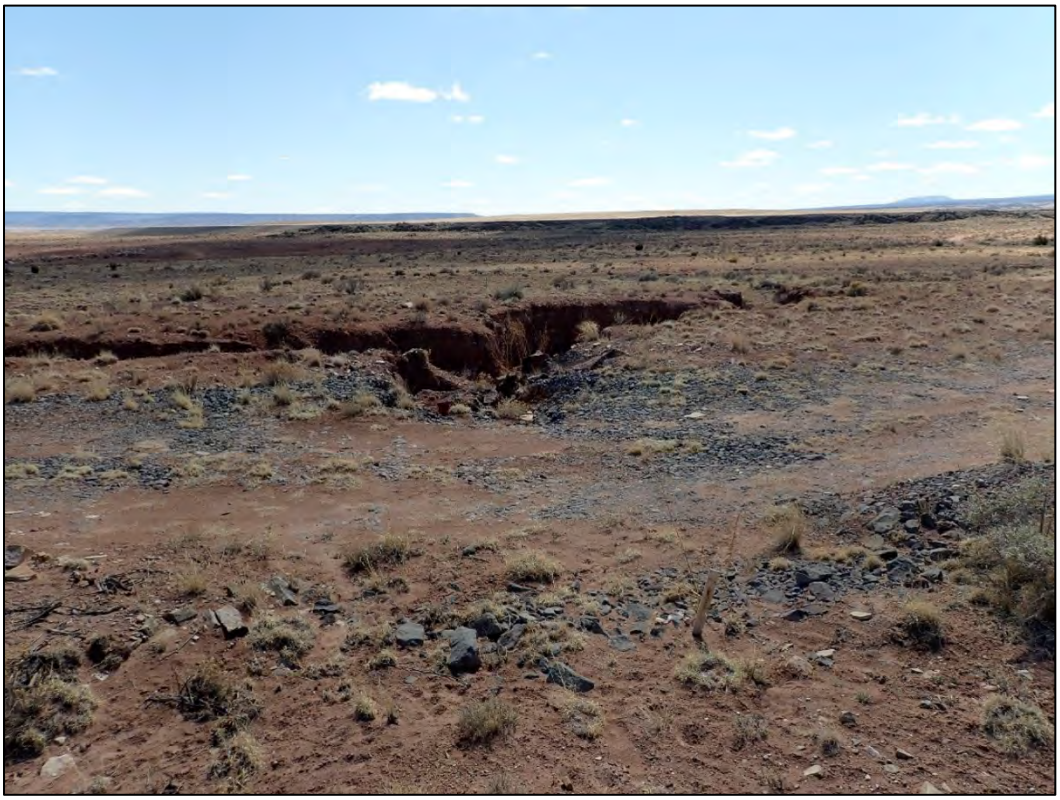
1.9 Photographs

Photograph Location Number	Azimuth	Photograph Description
PL-1	190	Entrance Gate
PL-2	295	Rilling Near Access Road, Road Repair Area
PL-3	100	Gully Near Access Road, Road Repair Area
PL-4	275	Broken Fence Strands Near Perimeter Sign P6 (Repaired)
PL-5	220	Perimeter Sign P7
PL-6	335	Perimeter Sign P8
PL-7	0	Perimeter Sign P16
PL-8	10	Granite Site Marker
PL-9	280	Boundary Monument BM-2
PL-10	0	Aerial Survey Quality Control Monument QC-9
PL-11	70	Well 22(M) and SOARS Station
PL-12	225	Well F(M) and Three Animal Burrows
PL-13	120	Main Tailings Disposal Cell Top Slope
PL-14	35	Main Tailings Disposal Cell Top Slope Depressed Area with Evaporites
PL-15	0	Siphon on Top Slope of Main Tailings Disposal Cell
PL-16	0	Siphon on North Side Slope of Main Tailings Disposal Cell
PL-17	160	Area of Possible Depression on Main Tailings Disposal Cell South Side Slope
PL-18	20	Potential Settlement on the North Side Slope of the Main Tailings Disposal Cell
PL-19	0	Rilling North of Perimeter Sign P24
PL-20	330	Shallow depression on the Northwest Extension of the Carbonate Tailings Disposal Cell (Dry)
PL-21	180	Asbestos Disposal Area
PL-22	0	West Dump (Grass Cover)
PL-23	75	Settlement Along Natural Basalt and Limestone Riprap Interface at East Dump
PL-24	65	Ephemeral Pond Area (Dry)

PL-1. Entrance Gate



PL-2. Rilling Near Access Road, Road Repair Area



PL-3. Gully Near Access Road, Road Repair Area

PL-4. Broken Fence Strands Near Perimeter Sign P6 (Repaired)

PL-5. Perimeter Sign P7

PL-6. Perimeter Sign P8

PL-7. Perimeter Sign P16

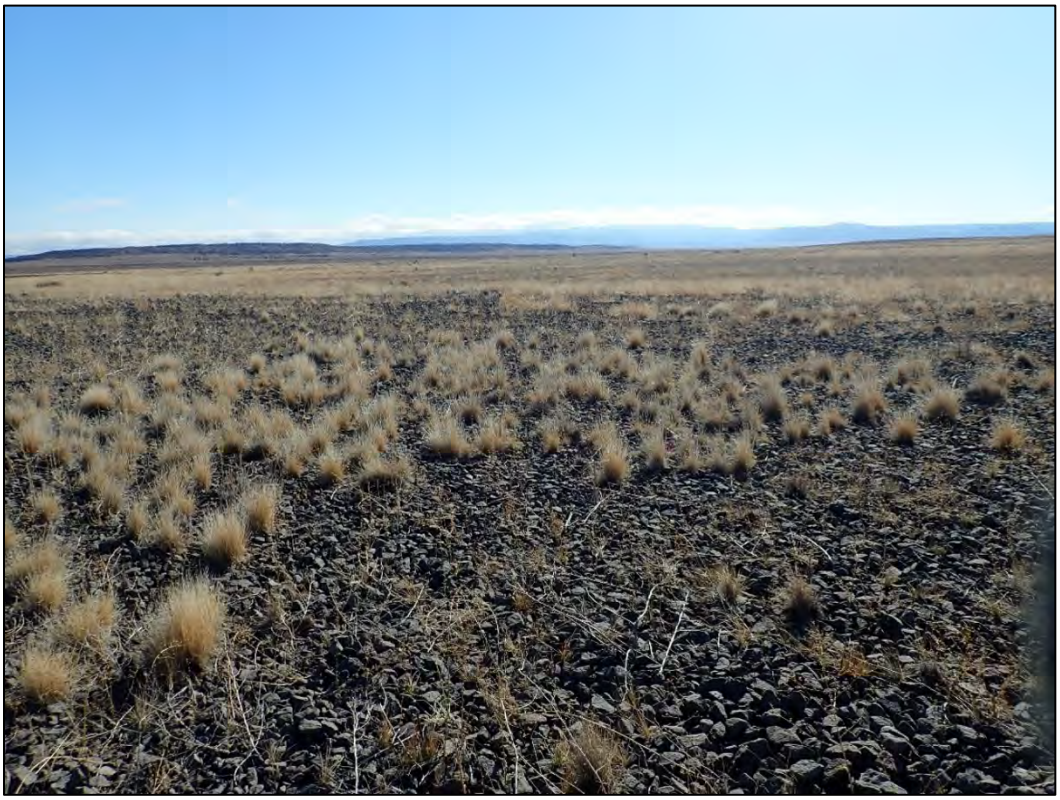
PL-8. Granite Site Marker

PL-9. Boundary Monument BM-2

PL-10. Aerial Survey Quality Control Monument QC-9

PL-11. Well 22(M) and SOARS Station

PL-12. Well F(M) and Three Animal Burrows



PL-13. Main Tailings Disposal Cell Top Slope

PL-14. Main Tailings Disposal Cell Top Slope Depressed Area with Evaporites

PL-15. Siphon on Top Slope of Main Tailings Disposal Cell

PL-16. Siphon on North Side Slope of Main Tailings Disposal Cell

PL-17. Area of Possible Depression on Main Tailings Disposal Cell South Side Slope

PL-18. Potential Settlement on the North Side Slope of the Main Tailings Disposal Cell

PL-19. Rilling North of Perimeter Sign P24

PL-20 Shallow Depression on the Northwest Extension of the Carbonate Tailings Disposal Cell (Dry)

PL-21. Asbestos Disposal Area

PL-22. West Dump (Grass Cover)

PL-23. Settlement Along Natural Basalt and Limestone Riprap Interface at East Dump

PL-24. Ephemeral Pond Area (Dry)

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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 (site) was inspected on July 13, 2021. Two, small depressions were observed on the riprap-armored containment dam side slope and will continue to be monitored during the annual site inspection. No changes were observed in the disposal cell drainage features. The grazing licensee will remove the unmaintained interior fence; however, the fence was present during the time of the inspection. Inspectors identified no other 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 U.S. Department of Energy (DOE) Office of Legacy Management (LM) Long-Term Surveillance Plan (LTSP) (DOE 1996) and in accordance with procedures established to comply with the requirements of 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 U.S. Nuclear Regulatory Commission general license (10 CFR 40.28) in 1996. 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: 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 13, 2021. The inspection was conducted by D. Traub and J. Cario of the Legacy Management Support (LMS) contractor. C. Boger (LM site manager) 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 additional 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 and LMS site lead met with the grazing licensee during the inspection to discuss any issues or concerns the licensee might have. As presented in Section 2.4.1.2, the grazing licensee will remove the unmaintained interior fence from the site. No other concerns were identified by the grazing licensee.

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. Site features that are present but not required by the LTSP to be inspected are shown in italic font. Observations from previous inspections that are currently monitored are shown in blue type, and new observations identified during the 2021 annual inspection are shown in red type. Inspection results and recommended maintenance activities associated with site surveillance features are included in the following subsections. Photographs to support specific observations are identified 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 missing and was subsequently replaced by the grazing licensee. 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, and (3) the southeast corner of the site. All gates were closed 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. Two perimeter signs are attached to the perimeter fence (PL-1). No maintenance needs were identified.

The grazing licensee monitors site security and maintains the perimeter fence. The licensee proposed removing the unmaintained interior fence that was installed to prevent grazing during vegetation establishment following closure of the disposal cell (PL-2). The LM site manager concurred with this proposal, as this fence is no longer required. The fence will be removed by the grazing licensee.

2.4.1.3 Site Marker

One granite site marker is present just inside the entrance gate (PL-3). No maintenance needs were identified.

2.4.1.4 Boundary Monuments

Boundary monuments are present at each of the property's four corners. All boundary monuments were inspected, and no maintenance needs were identified.

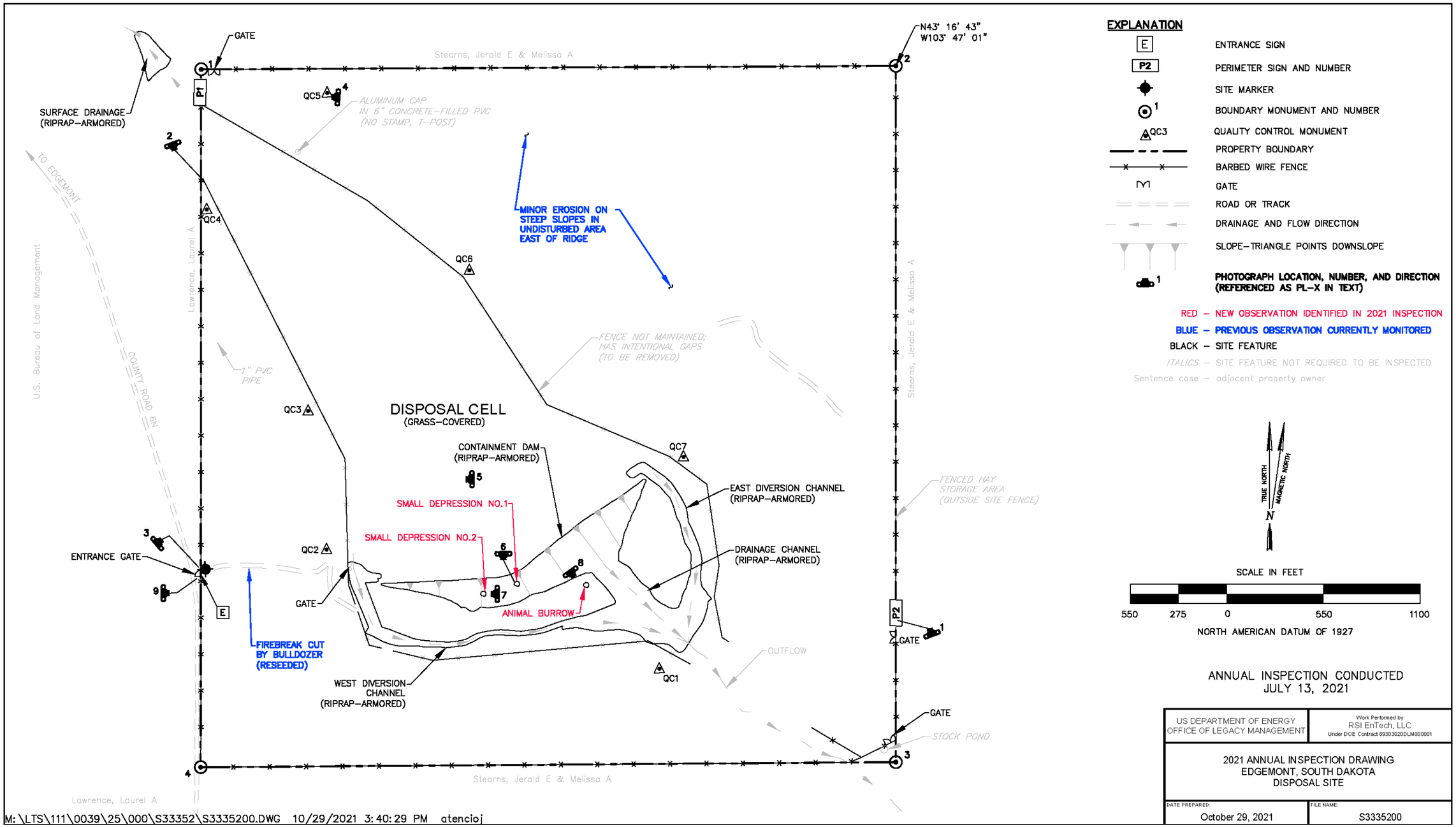

Figure 2-1. 2021 Annual Inspection Drawing for the Edgemont, South Dakota, Disposal Site

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2.4.1.5 Aerial Survey Quality Control Monuments

Seven aerial survey quality control monuments, installed in 2019, were inspected during the 2021 annual inspection (PL-4). No maintenance needs were identified.

A baseline aerial survey was conducted August 8–10, 2021. The purpose of the survey was to establish updated site topography for comparison with future aerial surveys to better understand and quantify changes to the site, including monitoring the depressions observed on the containment dam side slope.

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 the site's conformance with LTSP requirements.

2.4.2.1 Cover of the Disposal Cell

The grass-covered disposal cell, completed in 1989, occupies 100 acres (PL-5). 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, the steepest man-made slope onsite, is armored with riprap. Two small depressions, approximately 2 feet in diameter, were observed on the containment dam (PL-6; PL-7). Since this was the first time these depressions were observed, inspectors documented the location of the depressions with a GPS unit and inspected the areas around the depressions to look for evidence of sediment mobilization or other process that would explain the formation of the depressions. No evidence of sediment deposition, human intervention, or other modifying process was observed. The depressions do not threaten the integrity or performance of the disposal cell, and monitoring of the depressions will continue during annual inspections and subsequent aerial surveys. Grasses and annual weeds were growing in the riprap in several places. These plants do not threaten the stability or function of the containment dam.

The diversion and drainage channels are covered with grass on their upslope portions (gentle swales on each side of the disposal cell) and armored with riprap on their downslope portions and on steep slopes. Sparse vegetation is present in the riprap, which helps to stabilize these areas and does not impair the function of the channels. Wetland vegetation is present at the base of the drainage channel outflow. No maintenance needs were identified.

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. An animal burrow was observed adjacent to the riprap-armored drainage channel but does not impact the functionality of the channel (PL-8). 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. Some minor erosional features are present 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

The grazing licensee will remove the unmaintained interior fence. A new entrance sign was mailed to the grazing licensee and installed (PL-9). 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 as a result 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. Noxious weed treatment was conducted September 30, 2021. 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	340	Perimeter Sign P2
PL-2	160	View Along Western Fence Line
PL-3	50	Granite Site Marker
PL-4	275	Quality Control Monument QC-5
PL-5	270	Vegetated Disposal Cell Top Slope
PL-6	180	Small Depression #1 on Disposal Cell Side Slope
PL-7	270	Small Depression #2 on Disposal Cell Side Slope
PL-8	145	Animal Burrow Adjacent to Toe of Armored Disposal Cell Side Slope
PL-9	90	Entrance Sign

PL-1. Perimeter Sign P2

PL-2. View Along Western Fence Line

PL-3. Granite Site Marker

PL-4. Quality Control Monument QC-5

PL-5. Vegetated Disposal Cell Top Slope

PL-6. Small Depression #1 on Disposal Cell Side Slope

PL-7. Small Depression #2 on Disposal Cell Side Slope

PL-8. Animal Burrow Adjacent to Toe of Armored Disposal Cell Side Slope

PL-9. Entrance Sign

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 (site) was inspected on March 16, 2021. No changes were observed on the disposal cell or in associated drainage structures. Inspectors found no cause for a follow-up inspection.

Erosion and vegetation measurements to monitor the condition of the disposal cell top slope conducted on August 17, 2021, indicated that no erosion is occurring, and perennial foliar cover at the measurement plots continues to fluctuate with 4 of the 10 plots containing more than 20% perennial foliar cover in 2021. The success criterion of 20% foliar cover in more than half of the measurement plots has not been achieved.

Groundwater is monitored every 3 years in accordance with the site-specific U.S. Department of Energy (DOE) Office of Legacy Management (LM) Long-Term Surveillance Plan (LTSP) (DOE 2004). The most recent groundwater monitoring data are from a sampling event conducted in November 2019. There are no trends that suggest a compliance limit or standard will be exceeded. Groundwater sampling results from the November 2019 sampling event are included in Section 3.7.1 of this report along with a performance review evaluating the observed data and any trends in water quality and water level data. The next sampling event is scheduled for 2022.

3.2 Compliance Requirements

Requirements for the long-term surveillance and maintenance of the site are specified in the LTSP (DOE 2004) and in accordance with procedures established to comply with the requirements of 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 U.S. Nuclear Regulatory Commission (NRC) general license (10 CFR 40.28) 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 wellhead protectors.

3.4 Inspection Results

The site, approximately 15 miles north of Laguna, New Mexico, was inspected on March 16 and August 17, 2021. The inspection was conducted by J. Cario, D. Traub, D. Marshall, and D. Ravelojaona of the Legacy Management Support (LMS) contractor. In addition, B. Tsosie (LM), S. Woods (LM), B. Frazier (LM), and A. Rheubottom (New Mexico Environment Department [NMED]) attended the inspection. M. Kastens of the LMS contractor conducted the vegetation and erosion monitoring on August 17, 2021. The purposes of the inspections were to confirm the integrity of visible site features, identify changes in conditions that might affect conformance with the LTSP, and evaluate whether maintenance or additional 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. 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 type, and new observations identified in the 2021 annual inspection are shown in red type. Inspection results and recommended maintenance activities associated with site surveillance features are included in the following subsections. Photographs to support specific observations are identified 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 with a locked chain. No maintenance needs were identified.

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 G3 channel had 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 (PL-1). The culverts appear to be settling since their installation but are functioning as designed, and no maintenance needs were identified (PL-2).

Access roads are susceptible to erosion and are repaired when they become impassable. LM is planning to repair access roads and construct low-water crossings in areas impacted by erosion in 2022 through the interagency agreement with the U.S. Army Corps of Engineers (USACE). An animal burrow was observed on an interior access road and was filled during the annual inspection (PL-3). No additional maintenance needs were identified.

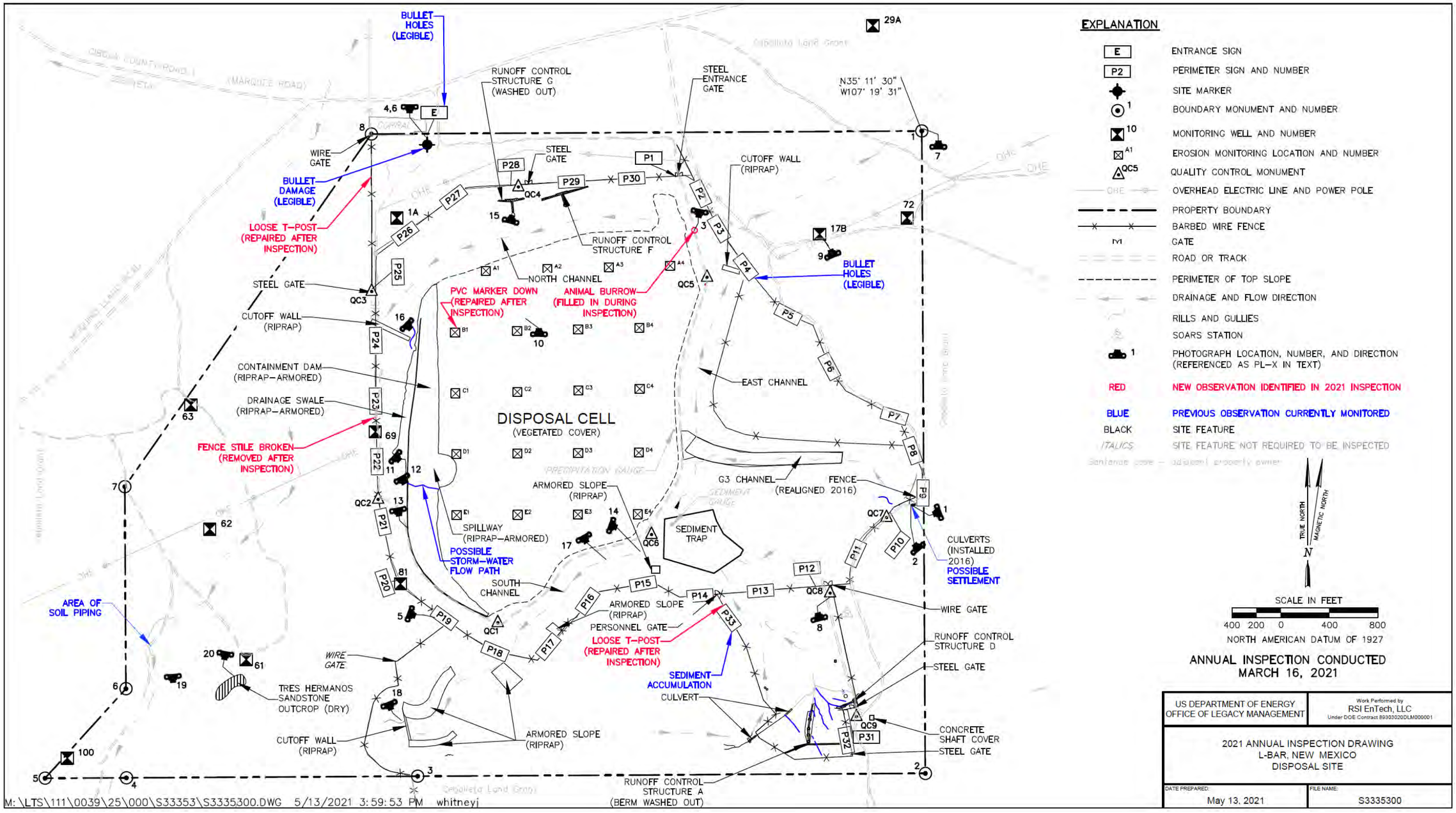

Figure 3-1. 2021 Annual Inspection Drawing for the L-Bar, New Mexico, Disposal Site

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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 structures (because livestock trails would initiate gully erosion). 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 P33, but it is not impacting the function of the fence. A loose T-post near perimeter sign P33 and south of boundary monument BM-8, and a broken fence stile near P23 was observed during the inspection and removed during a subsequent maintenance trip on April 21, 2021.

The entrance sign is on the main site access road near the site marker. It has several bullet holes but was legible (PL-4). Thirty-three warning or perimeter signs (PL-5) are attached to the barbed-wire fence that surrounds the disposal site structures and an area of excessive gully erosion in the southeast portion of the site. No perimeter sign maintenance needs were identified.

3.4.1.3 Site Marker

The site has one granite site marker north of the disposal cell adjacent to the site access road. Additional bullet damage was observed on the site marker, but it remains legible (PL-6). No maintenance needs were identified.

3.4.1.4 Boundary Monuments

Eight boundary monuments define the site boundary (PL-7). All eight boundary monuments were observed during the 2021 inspection. No maintenance needs were identified.

3.4.1.5 Aerial Survey Quality Control Monuments

Nine aerial survey quality control monuments, installed in 2018, were inspected during the 2021 inspection. Two of the quality control monuments–QC-8 and QC-9—were covered in windblown sediment. The sediment was removed during the inspection (PL-8). T-posts were installed near these monuments during a subsequent maintenance trip on April 21, 2021, to help locate the monuments in the future. No additional maintenance needs were identified.

3.4.1.6 Monitoring Wells

The site's 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 2021 inspection were undamaged and locked (PL-9). No maintenance needs were identified.

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 the site's conformance with LTSP requirements.

3.4.2.1 Cover of the Disposal Cell

The disposal cell, completed in 2000, occupies approximately 100 acres. Its 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 (PL-10). 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 vegetation. The establishment and maturing of vegetation are expected to reduce wind and water erosion of the surface and help prevent precipitation from percolating into the tailings.

Cracks are usually present in the surface soil of the disposal cell top slope. They are confined within the top 2 ft of cover soil, which averages 6 ft in thickness across the cell, and appear to result from the drying of the gypsum-rich soil after precipitation. The cracks tend to fill with windblown and runoff-borne sediment and as perennial vegetation continues to establish. The cover of the disposal cell showed no signs of erosion, settling, or other modifying processes that might affect the integrity of the disposal cell. The animal burrow observed north of erosion monitoring location C2 in 2019 could not be located during the 2021 inspection. The animal burrow will be removed from future inspection maps. In accordance with the LTSP, erosion and vegetation are monitored on the disposal cell top slope. Section 3.7.2 describes the monitoring program and presents the results to date. A PVC pipe identifying the position of erosion monitoring location B1 was found on the ground. The PVC pipe was reestablished during a subsequent maintenance trip on April 21, 2021. No additional maintenance needs were identified.

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 (PL-11). Native vegetation is well established on the face, which is desirable for increasing the erosion protection of the surface. A potential stormwater flow path was observed on the southern edge of the spillway (PL-12) where the armored spillway and armored containment dam meet. Inspectors will continue to visually monitor the spillway during the annual inspections, and the stormwater pathway does not appear to affect the integrity of the spillway. Slight variations in the containment dam side slope were observed and will continue to be monitored (PL-13). A geotechnical investigation is proposed to better characterize surface and subsurface erosion along the containment dam side slope. 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. No 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. Because the ends of the riprap cutoff wall are not keyed into stable materials, runoff flow in the channel potentially could 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. Gullies have formed along the side slopes of the G3 channel. The erosion and sediment deposition are not impairing the function of the channel.

Some erosion was expected to occur in a watershed that encompasses the southeast portion of the site and adjacent property. Stormwater runoff from this watershed discharges into a sediment trap (PL-14) where the sediment load settles out. If runoff overtops the sediment trap, the flow is diverted to the east channel. The sediment trap was dry at the time of the inspection.

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 to repair these structures and construct additional structures in the watershed. USACE will complete the stormwater control design.

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 its original design configuration, and two runoff control structures were constructed in 2009 to reduce erosion and sedimentation. The east structure (Runoff Control Structure F) was stable and functional at the time of the inspection. However, the west structure (Runoff Control Structure G) suffered severe erosion during runoff events in August and September 2011 and continues to erode (PL-15). As a 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 (PL-16). This area will continue to be monitored for erosion and other impacts to the north channel and containment dam.

The south channel diverts storm runoff from the higher terrain immediately south of the disposal cell toward the channel outlet to the west. Two riprap structures are present 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 (PL-17). The erosion and sediment deposition are not impairing the function of the south channel. Erosion headcutting migrating toward the riprap cutoff wall at the outlet of the channel was monitored during the inspection. The cutoff wall is functioning as designed but will continue to be monitored (PL-18).

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 next aerial survey is scheduled for 2023.

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 (PL-19). The affected area has been mapped, metal fence posts have been installed next to soil collapse features, and the information is shown 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 (PL-20), 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 will 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. No need for a follow-up inspection was identified during the inspection.

3.6 Routine Maintenance and Emergency Measures

Minor fence repair, removal of a fence stile, and reinstallation of the PVC post marking an erosion monitoring location were completed during the April 21, 2021, maintenance trip. 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. Monitoring data from the November 2019 sampling event is provided in Table 3-4 below. A performance review evaluating the observed data and any trends in water quality and water level data is discussed 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. The next sampling event is scheduled for 2022.

Table 3-2 lists the monitoring network wells; Figure 3-2 shows all wells that are monitored except for the Moquino wells. Samples collected during the November 2019 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 alternate abatement standards (AASs) stipulated by NMED. If an ACL or AAS is exceeded in any monitoring well (Table 3-3), 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.

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	Public water supply well in Moquino
Moquino Old	Backup public water supply well in Moquino

Abbreviations: POC = point of compliance; POE = point of exposure

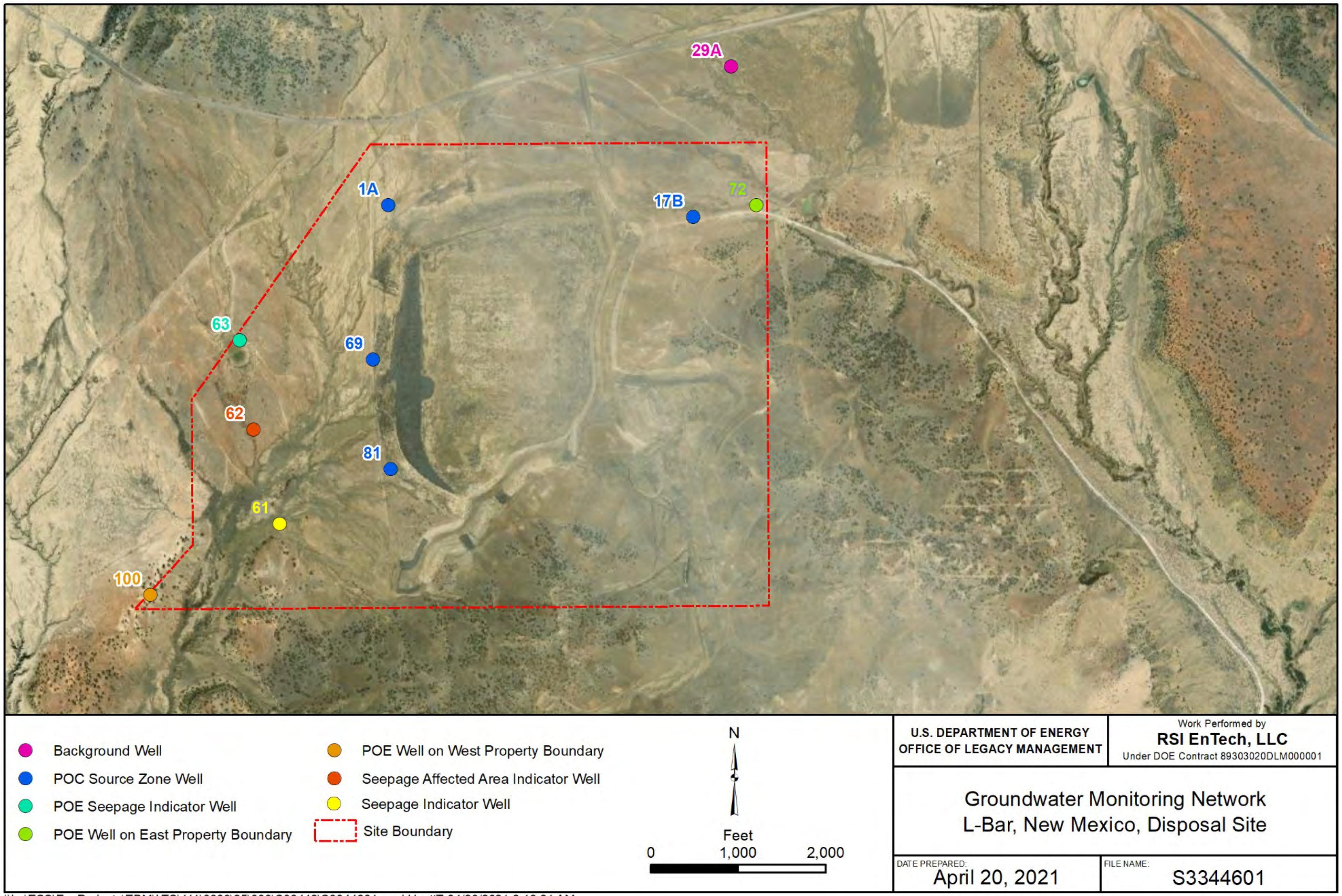

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Figure 3-2. Groundwater Monitoring Network at L-Bar, New Mexico, Disposal Site

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

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:
[a] Background value approved by the State of New Mexico for L-Bar.
[b] LTSP listed the former State of New Mexico standard of 5.0 mg/L.

Abbreviation:
NA = not applicable

Groundwater monitoring results for the November 2019 sampling event are provided in Table 3-4. Access to the Moquino wells was not provided by the owner, so those wells could not be sampled.

Table 3-4. November 2019 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	***380***	0.17	ND	***4300***	***6300***	0.0043
17B	***310***	***850***	***0.25***	***5000***	***10,000***	0.03
29A	200	ND	ND	***4900***	***6800***	0.0001
61	120	0.082	ND	3500	4900	0.00023
62	49	ND	ND	550	1400	0.00005
63	47	ND	ND	530	1300	0.00008
69	***750***	ND	ND	***10,000***	***13,000***	***1.5***
72	220	9.3	0.017	***5000***	***6700***	0.015
81	170	***21***	0.05	***4900***	***6000***	0.017
100	36	0.18	ND	2600	2800	0.0011
Moquino New	NS	NS	NS	NS	NS	NS
Moquino Old	NS	NS	NS	NS	NS	NS

Notes:
[a] Significant digits are reported by the laboratory and are based on detection limits.
[b] ***Bold italicized*** results exceed a New Mexico standard.
[c] Nitrate plus nitrite as nitrogen ($NO_3 + NO_2$ as N).

Abbreviations:
ND = not detected (below laboratory detection limit)
NS = not sampled

As stipulated in the LTSP, the requirements for annual groundwater monitoring were met in 2007. Consequently, the sampling frequency changed to once every 3 years beginning in fall 2010 in accordance with the LTSP. Groundwater monitoring will continue as long as a New Mexico standard is exceeded in any monitoring well (Table 3-4).

A total of seven sampling events occurred at the L-Bar site since 2005; this was not enough to denote a significant statistical trend using Mann Kendall trend analysis or linear regression. Apparent concentration trends analyzed in this document are only observational and do not imply any statistical significance over time.

Since sampling commenced in 2005, no ACL or AAS source zone levels have been exceeded in any of the point-of-compliance (POC) wells, and no AAS affected area levels have been exceeded in monitoring well 62. Therefore, groundwater at the site complies with the LTSP requirements. Results from the 2019 sampling are consistent with historical results. When compared to 2016 analytical results, chloride concentration increased in well 69 (Figure 3-3). Nitrate, selenium, and sulfate concentrations also increased in wells 81 and 17B (Figure 3-4, Figure 3-5, and Figure 3-7). Uranium and TDS concentrations increased in well 17B (Figure 3-6 and Figure 3-9). Constituent levels for the other POC (source zone) wells with ACL and AAS standards remained the same or decreased. Sulfate concentration remained stable (Figure 3-12), and TDS concentration decreased in the AAS affected area well 62 (Figure 3-8 and Figure 3-10). No trends suggest that an ACL, AAS source zone, or AAS affected area concentration will be exceeded.

At least one New Mexico standard was exceeded in six of the monitoring wells in 2019, including background well 29A, where the standards for sulfate and TDS were exceeded (Table 3-4).

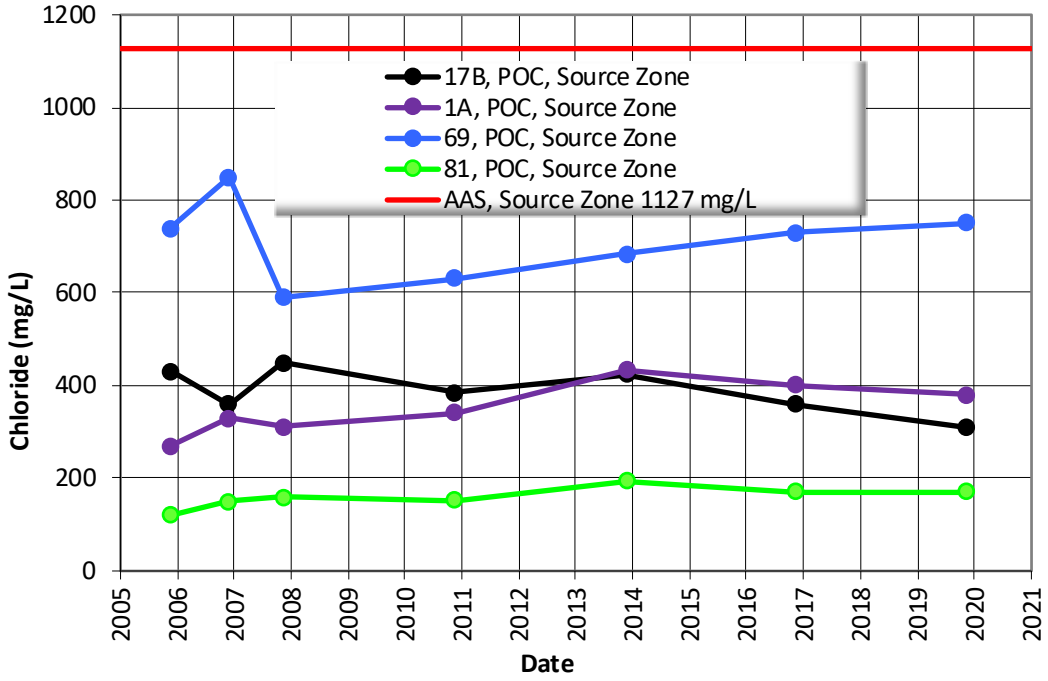


Figure 3-3. Chloride Concentrations in Groundwater at the L-Bar Disposal Site

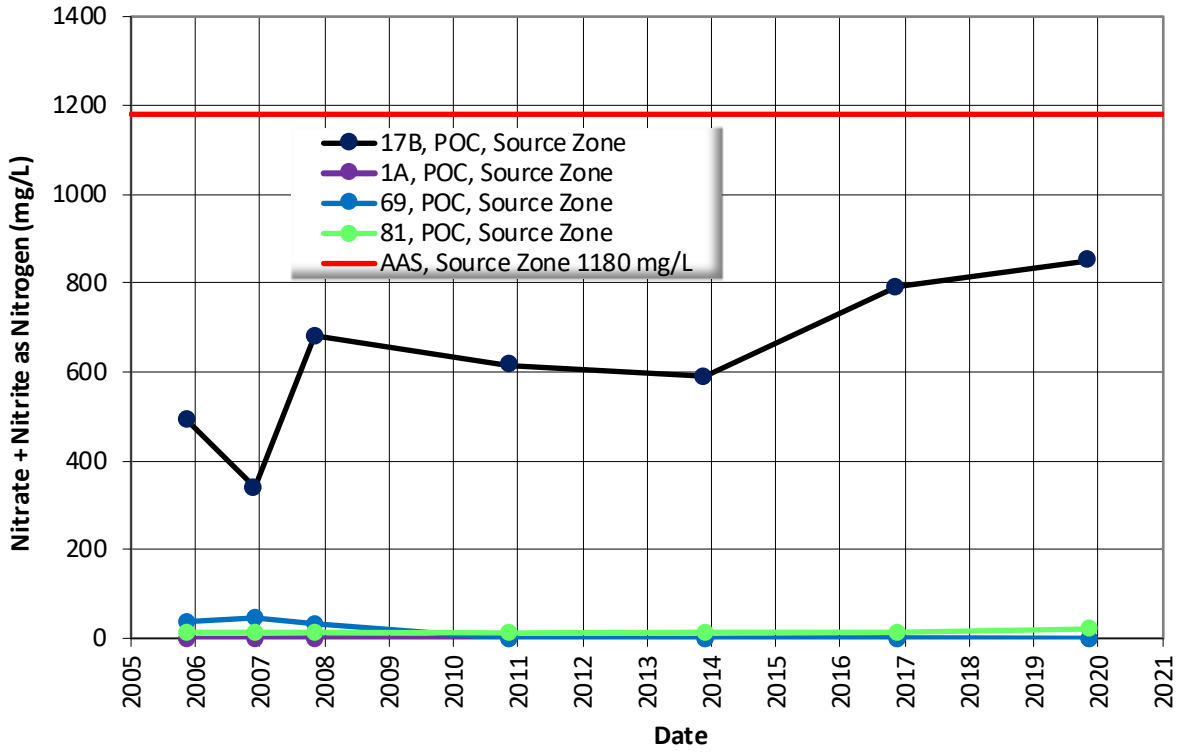


Figure 3-4. Nitrate Concentrations in Groundwater at the L-Bar Disposal Site

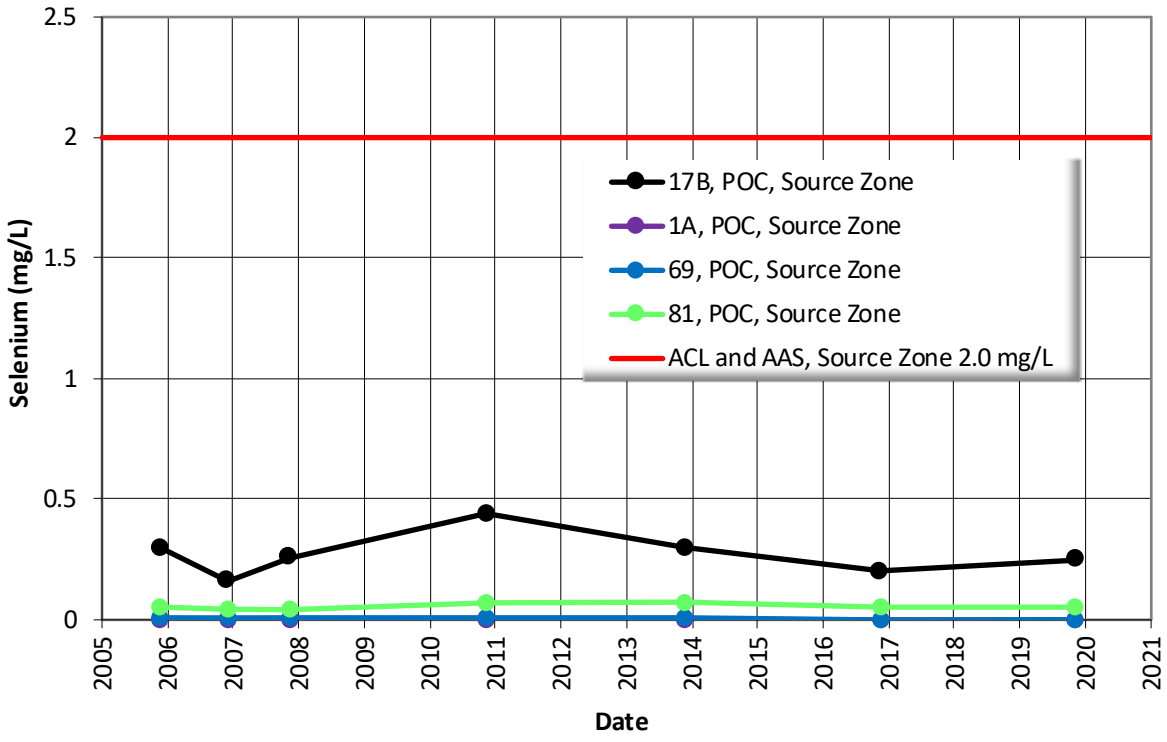


Figure 3-5. Selenium Concentrations in Groundwater at the L-Bar Disposal Site

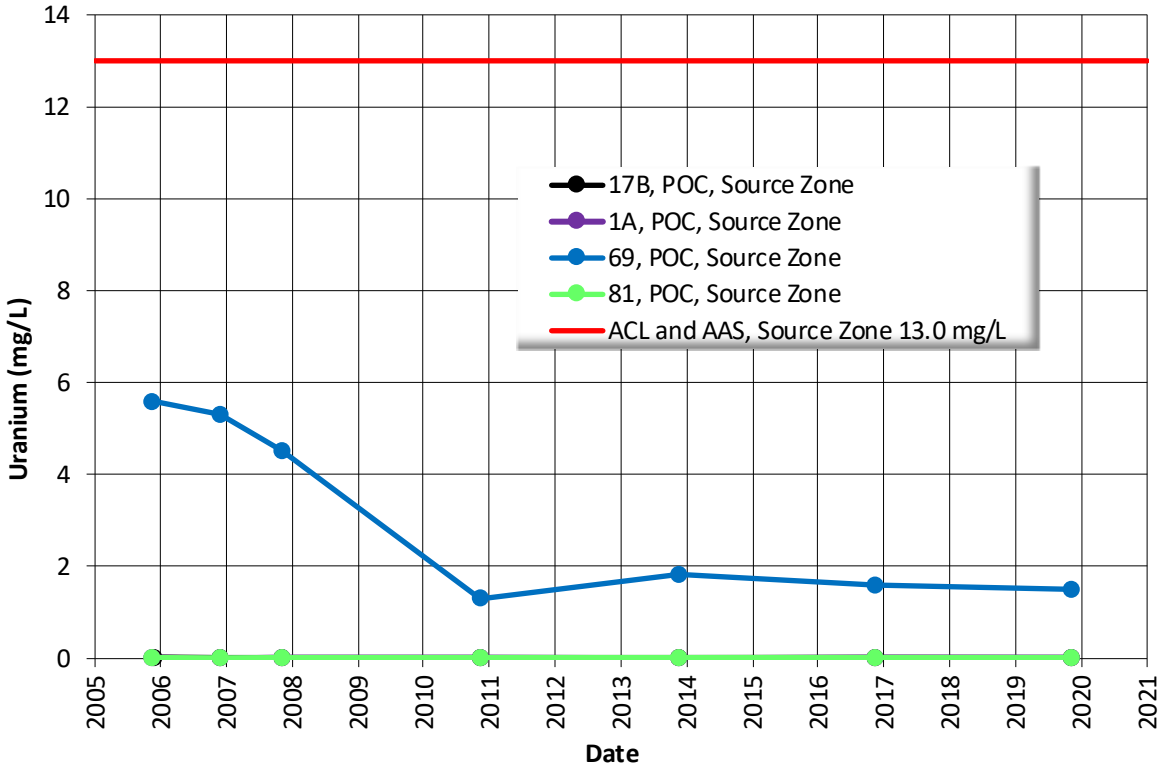


Figure 3-6. Uranium Concentrations in Groundwater at the L-Bar Disposal Site

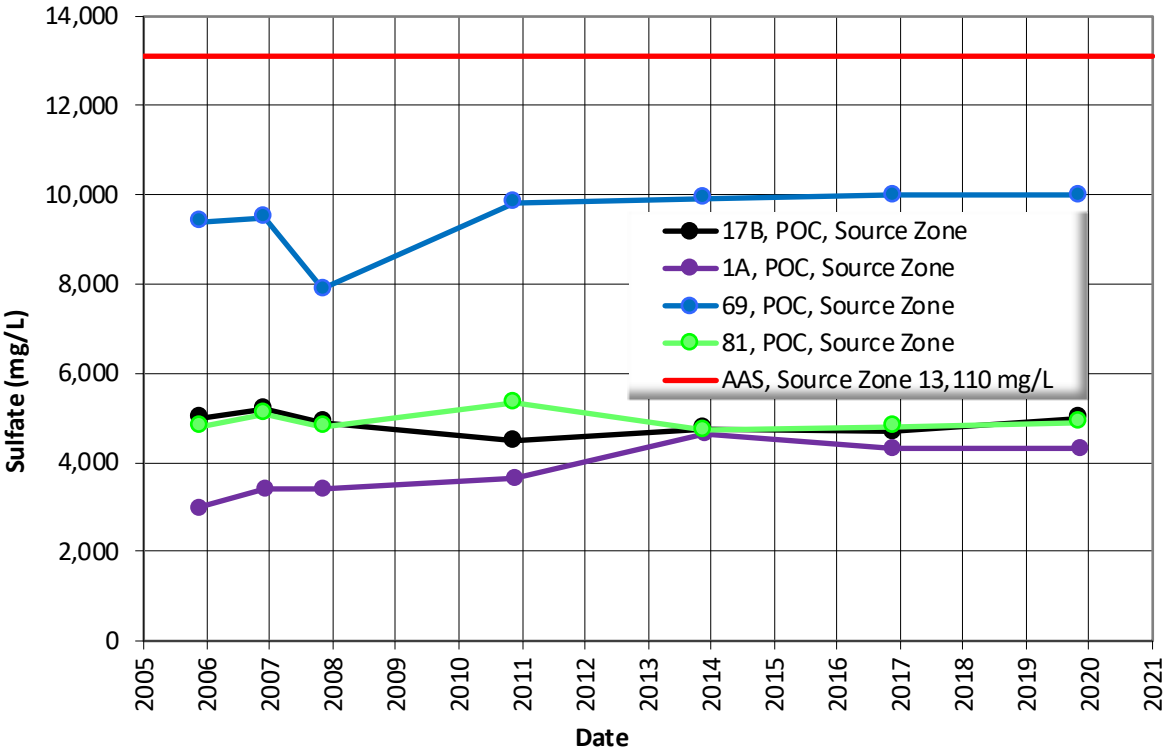


Figure 3-7. Sulfate Concentrations in Groundwater at the L-Bar Disposal Site (Source Zone Wells)

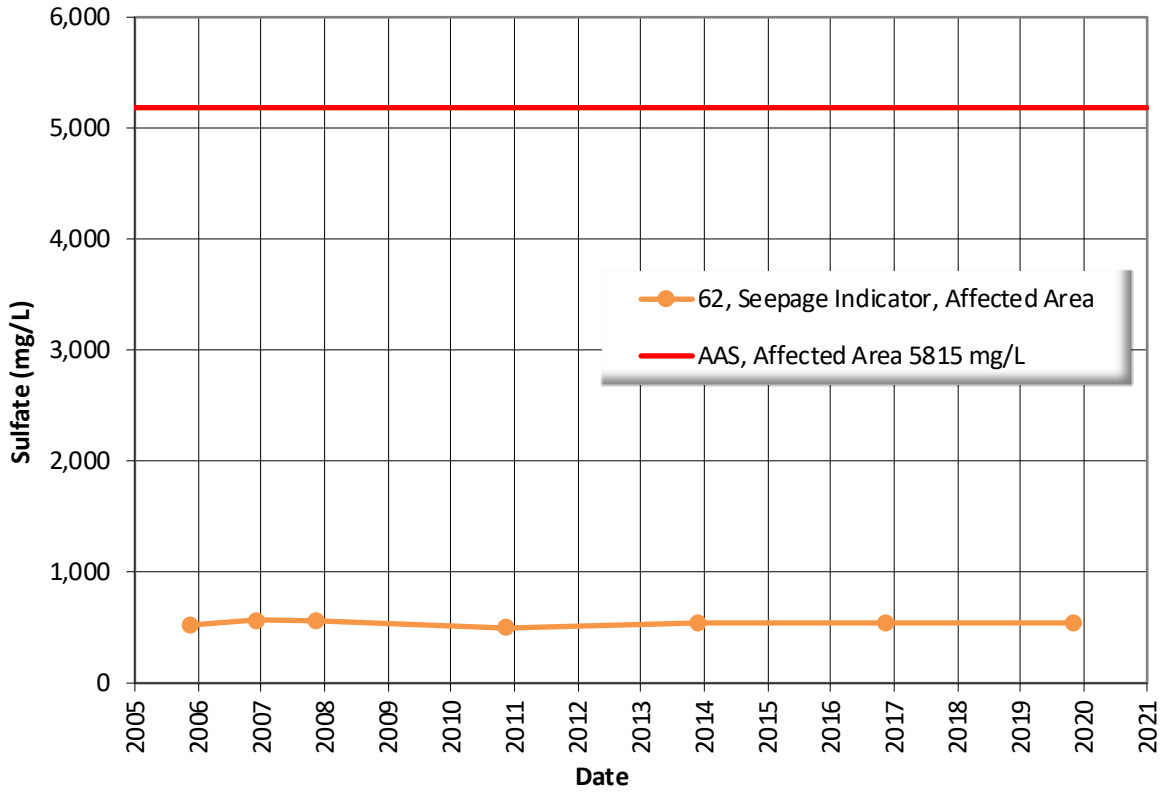


Figure 3-8. Sulfate Concentrations in Groundwater at the L-Bar Disposal Site (Affected Area Well)

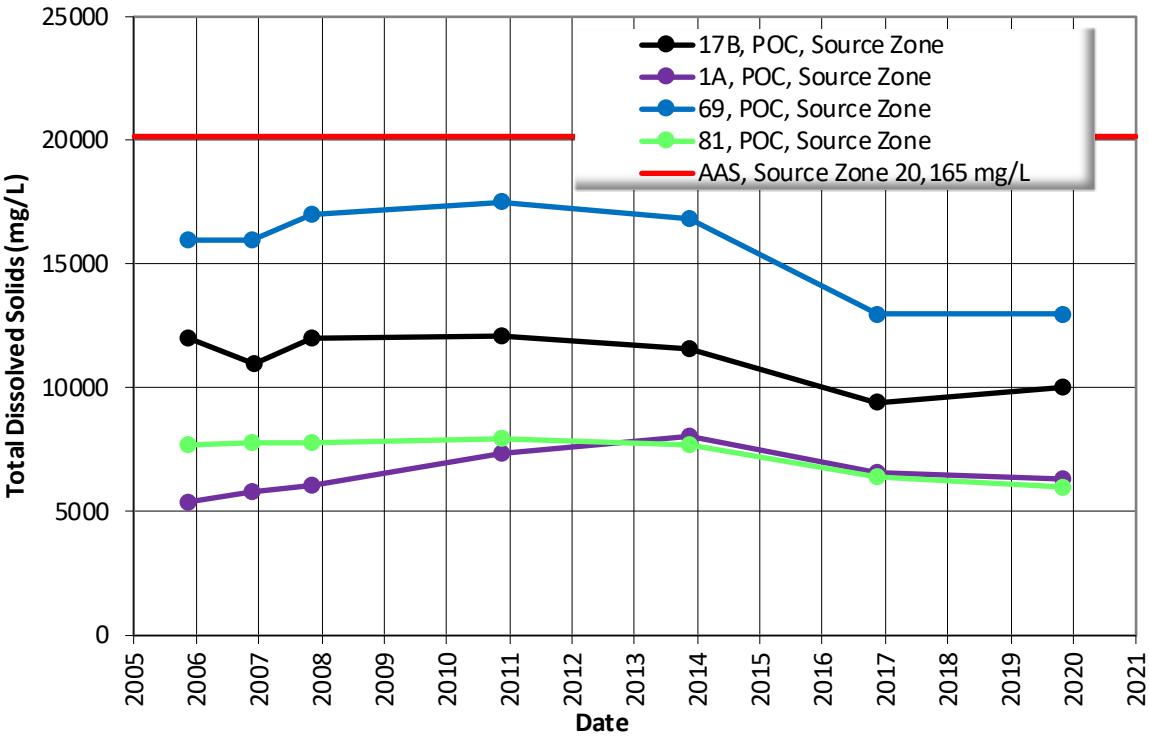


Figure 3-9. Total Dissolved Solids Concentrations in Groundwater at the L-Bar Disposal Site (Source Zone Wells)

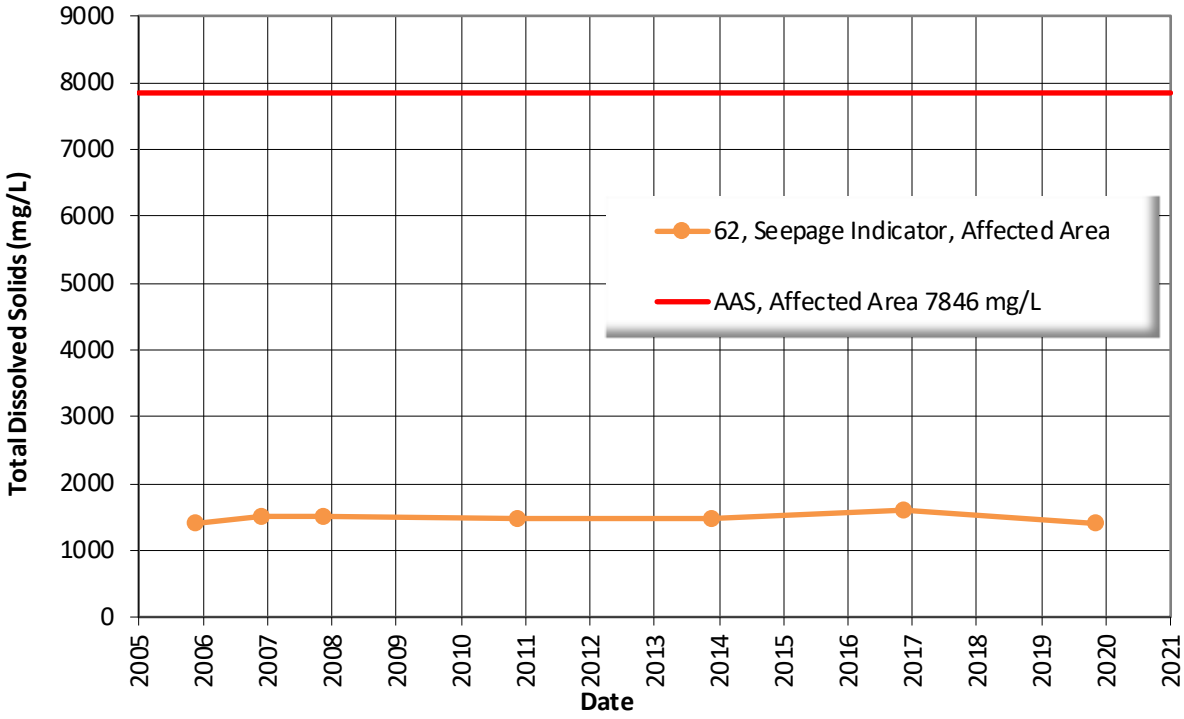


Figure 3-10. Total Dissolved Solids Concentrations in Groundwater at the L-Bar Disposal Site (Affected Area Well)

As stated in the LTSP, a groundwater contour map and a sulfate isoconcentration map for the years that sampling has been conducted are to be provided with the groundwater monitoring results; they are presented below (Figure 3-11 and Figure 3-12, respectively). Concentration location bubble maps were generated in lieu of isoconcentration maps because of the limited number of well locations where water quality was measured at the site. No water quality measurements were taken directly beneath the tailings impoundment, so interpolated isoconcentrations would likely not be representative of site conditions. Each monitoring well sample was taken within the First Tres Hermanos (FTH) sandstone unit and do not represent contaminant levels in porous media above or below this stratigraphic unit.

Measured depth-to-groundwater levels for all of monitoring wells at the L-Bar site in November 2005 and November 2019 are shown in Figure 3-11. A north-northwest-trending topographic drainage divide northeast of the tailings impoundment was interpreted to bifurcate groundwater the flow directions to (1) southwest beneath the impoundment and (2) east away from the northeastern corner of the site. Location of the groundwater divide line is estimated based on available water level and digital elevation model data, under the assumption that the water table is a subdued expression of surface topography.

Previous groundwater data for the L-Bar site (Kennecott 1996) showed a general horizontal flow gradient toward the southwest for the wells west of the tailings impoundment. The data in both 2005 and 2019 also reflect this trend. Only three wells are available to calculate flow direction northeast of the site. The gradient at this location is relatively small (3.0E-4 ft/ft) relative to up to 0.03 ft/ft southwest of the site, indicating this location is near the groundwater flow divide. The calculated flow direction seemed to have changed significantly from north-northeast in 2005 to

east-northeast in 2019, but this most likely resulted from having only one calculation with a very small gradient magnitude rather than representing a significant shift in regional flow direction.

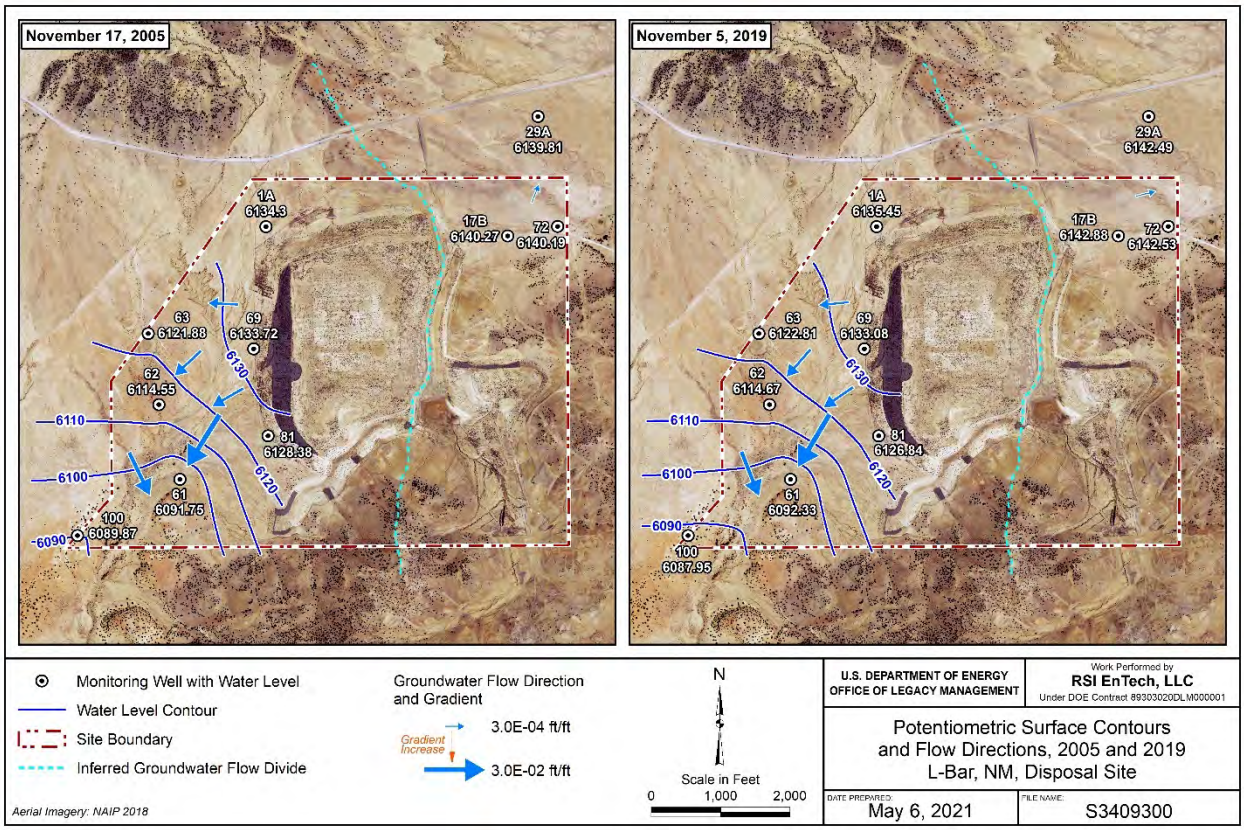


Figure 3-11. Potentiometric Contours and Groundwater Flow Directions in the FTH Sandstone in 2005 and 2019

Water levels in the three wells northeast of the site have increased an average of 2.54 ft between 2005 and 2019. Wells 69 and 81 are nearest to the tailings impoundment to the west, and each had an overall decrease in water elevation by about 0.5 and 1.3 ft, respectively. It is unknown whether the steady change in groundwater level is resulting from recharge from surface water diversions to the northeast or whether water levels are continuing to equilibrate from mounding below the tailings impoundment. Water level trends southwest of the tailings impoundment do not suggest the latter.

Groundwater levels are not measured frequently enough to determine whether the slight sitewide increase in groundwater elevation resulted from transient drainage from the tailings fluid, seasonal increase in the regional groundwater supply, or another process previously undocumented.

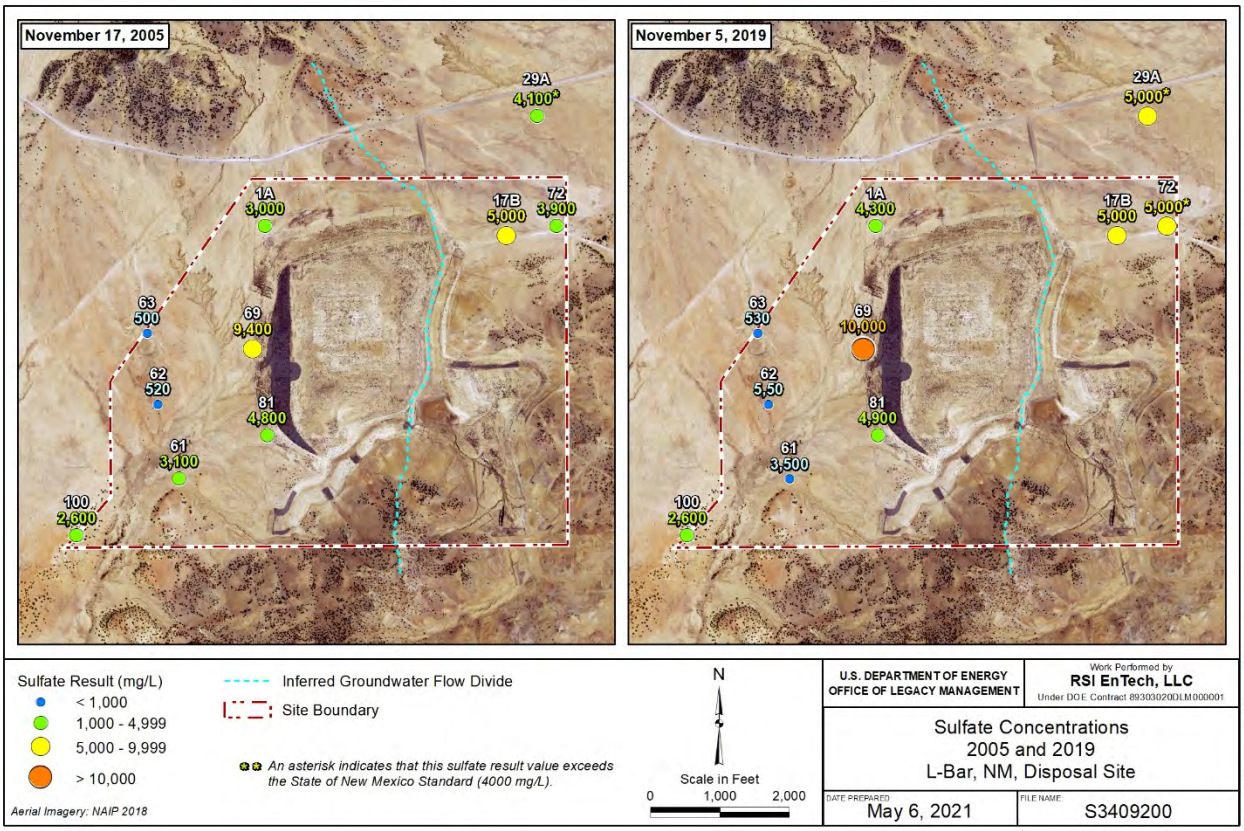


Figure 3-12. Sulfate Concentrations in 2005 and 2019

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. Erosion will be considered excessive when 2 ft of erosion is noted at more than half of the monitoring locations. If this occurs, LM will initiate discussions with NRC to assess likely remedial scenarios and develop an appropriate mitigation protocol, if required.

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. Total thickness of the cover ranges from 6 to 10 ft. The EMP has two requirements: (1) measure surface soil erosion and (2) measure the progress of revegetation. Measurements were taken on August 17, 2021.

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. These locations are shown in Figure 3-1. The locations were initially measured in December 2003 by the former licensee to establish a baseline dataset.

Each monitoring location consists of a 5-foot length of half-inch-diameter, epoxy-coated rebar surrounded by three metal T-posts that were installed to help locate the rebar and provide orientation for the measurements. The rebar was driven at each location so that approximately 1 ft remained above the cover surface. Each rebar stake has a metal tag indicating the location number. 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. During the annual inspection, the PVC pipe marking the location of monitoring plot B1 was found on the ground and was repaired during a subsequent maintenance activity conducted on April 21, 2021.

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 2021 measurements are presented in Table 3-5. Baseline measurements are included for comparison. The surface elevation has increased by 0.3 to 1.8 inches at all the monitoring locations when compared to the baseline measurements. These results indicate that the surface of the disposal cell is accreting instead of eroding. Since 2003, an average of 0.935 inches of soil has accreted. Accretion is likely due to the increasing vegetation density on the disposal cell cover, which in turn raises the surface elevation through underground root growth, organic matter accumulation in and on the surface soil, and windborne sediment deposition around the plants' foliage and stems.

Table 3-5. Surface Elevation Changes on the L-Bar, New Mexico, Disposal Cell Cover Between 2003 and 2021

Monitoring Location	Length of Rebar Above Surface (inches)				Change in Surface Elevation[a] Baseline to Present (decimal inches)
	2003 (baseline)		2021		
	(fraction)	(decimal)	(fraction)	(decimal)	
A1	12 10/16	12.625	10 15/16	10.938	1.687
A2	12 7/16	12.438	11 6/16	11.375	1.063
A3	12 15/16	12.938	12 0/16	12.000	0.938
A4	12 6/16	12.375	11 7/16	11.438	0.937
B1	12 10/16	12.625	10 15/16	10.938	1.687
B2	12 8/16	12.500	12 1/16	12.063	0.437
B3	13 0/16	13.000	12 8/16	12.500	0.500
B4	12 15/16	12.938	11 6/16	11.375	1.563
C1	12 8/16	12.500	11 5/16	11.312	1.188
C2	13 1/16	13.063	12 12/16	12.750	0.313
C3	12 2/16	12.125	11 9/16	11.563	0.562
C4	12 6/16	12.375	11 8/16	11.500	0.875
D1	12 7/16	12.438	11 13/16	11.812	0.626
D2	12 12/16	12.750	12 0/16	12.000	0.750
D3	12 3/16	12.188	10 6/16	10.375	1.813
D4	12 12/16	12.750	12 6/16	12.375	0.375
E1	13 1/16	13.063	11 12/16	11.750	1.313
E2	12 14/16	12.875	12 4/16	12.250	0.625
E3	12 9/16	12.563	11 15/16	11.938	0.625
E4	12 15/16	12.938	12 2/16	12.125	0.813

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.

3.7.2.2 Vegetation Monitoring

LM established 10 vegetation monitoring plots to measure the progress of revegetation over time (PL-21). Plots were established at existing erosion monitoring locations (A1, A3, B2, B4, C1, C3, D2, D4, E1, and E3) to streamline measurement activities at the site. At each plot, three T-posts were used to form three corners of the plot; the fourth point was projected south of the three T-posts to form a parallelogram covering approximately 100 square ft.

The primary vegetation monitoring requirement is to measure the percentage of foliar cover of all live vegetation within the plot. Percent foliar cover represents the approximate area under the vertical projection of exposed leaf area (i.e., foliar cover would equal the shadow cast if the sun was directly overhead; small openings in the canopy or overlap within the plant are excluded). The average foliar cover of live vegetation near the site, according to the U.S. Department of Agriculture and estimated from observation, is approximately 25%.

The predominant vegetation in the area consists of perennial grasses, forbs, and shrubs. In accordance with the EMP, LM will perform annual vegetation monitoring until at least 20% foliar cover is achieved, and this criterion will be satisfied when more than half of the monitoring plots exceed 20% cover. Because annual and biennial plants do not necessarily germinate each year and their germination is highly dependent upon weather conditions, it is assumed that this criterion is based on perennial plant cover only. Once the success criterion is met, annual monitoring will not be required unless a significant reduction in plant density is noted during an annual site inspection; in that case, vegetation cover in the plots will be measured again. Annual vegetation monitoring will continue until the success criterion has again been satisfied.

Results of the 2021 vegetation monitoring, compared with those from selected previous years, are presented in Table 3-6. Four of the 10 plots contained 20% or more perennial foliar cover in 2021. Large increases and decreases in perennial cover from year to year are mostly attributable to new growth and dieback in the shrub species (broom snakeweed, rubber rabbitbrush, and fourwing saltbush), which likely occur in response to wet and drought years, respectively. Since 2005, overall increases in perennial foliar cover have occurred in 7 of the 10 plots: A1, A3, B4, C3, D2, D4, and E1. Foliar cover in plot D4 has noticeably improved since it was seeded in 2009.[1] Annual vegetation monitoring will continue until six or more plots meet or exceed the 20% foliar cover requirement.

Table 3-6. Comparison of Perennial Plant Cover on the L-Bar, New Mexico, Disposal Cell Cover

Plot Location	Percent Perennial Plant Cover in 100-Square-Foot Plots[a]					
	2005	2009	2013	2017	2020	2021
A1	57	74	12	35	26	64
A3	11	15	7	8	17	32
B2	0	0	0	0	0	0
B4	20	48	13	28	20	23
C1	22	20	7	25	15	16
C3	0	2	2	8	12	13
D2	2	6	9	4	4	18
D4	0	0	1	18	17	15
E1	2	16	5	22	33	44
E3	8	10	6	13	8	5

Note:
[a] Green-shaded cells meet or exceed the success criterion of 20% total foliar cover.

Perennial plant species that have been observed within the monitoring plots include broom snakeweed, rubber rabbitbrush, fourwing saltbush, sand dropseed, squirreltail, James' galleta, Indian ricegrass, tumblegrass, copper globemallow, scarlet globemallow, Bigelow's tansyaster, silverleaf nightshade, white heath aster, spreading fleabane, field bindweed, and plains pricklypear.[2] Rubber rabbitbrush and fourwing saltbush are deep-rooted woody shrubs.

[1] Plot D4 is the only monitored plot that occurs within the 2009 seeded area.
[2] Common names of plants are consistent with those found in the U.S. Department of Agriculture "PLANTS Database" (USDA 2020).

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.*

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), 2004. *Long-Term Surveillance Plan for the U.S. Department of Energy L-Bar, New Mexico, (UMTRCA Title II) Disposal Site, Seboyeta, New Mexico,* DOE−LM/GJ709−2004, September.

Kennecott Corporation, 1996. *Final Report: Hydrogeology Investigation of the L-Bar Uranium Mill Tailings Pile, Cibola County, New Mexico,* prepared by Intera Inc., December.

USDA (U.S. Department of Agriculture), 2020. PLANTS Database, Natural Resources Conservation Service, https://plants.sc.egov.usda.gov/java/ accessed July 20, 2020.

3.9 Photographs

Photograph Location Number	Azimuth	Photograph Description
PL-1	250	Culverts Installed in 2016
PL-2	320	Sedimentation in Eastern-most Culvert (Installed in 2016)
PL-3	190	Animal Burrow on Access Road
PL-4	180	Entrance Sign
PL-5	110	Perimeter Sign P19
PL-6	—	Granite Site Marker
PL-7	—	Boundary Monument 1
PL-8	345	Quality Control Monument QC-8
PL-9	337	Monitoring Well 17B
PL-10	0	Disposal Cell Top Slope
PL-11	130	Containment Dam Spillway
PL-12	100	Potential Stormwater Flow Path Along Containment Dam Spillway
PL-13	130	Containment Dam Side Slope
PL-14	110	Sediment Trap
PL-15	15	Runoff Control Structure G
PL-16	175	Minor Rilling Near North Channel Cutoff Wall
PL-17	150	Erosion on South Side Slope of South Diversion Channel
PL-18	105	Minor Rilling Downgradient of South Diversion Channel Cutoff Wall
PL-19	175	Soil Piping Near Southwest Corner of Site Boundary
PL-20	190	Tres Hermanos Sandstone Outcrop, Dry

Note:
— = Photograph taken from directly above.

PL-1. Culverts Installed in 2016

PL-2. Sedimentation in Eastern-most Culvert (Installed in 2016)

PL-3. Animal Burrow on Access Road

PL-4. Entrance Sign

PL-5. Perimeter Sign P19

PL-6. Granite Site Marker

PL-7. Boundary Monument 1

PL-8. Quality Control Monument QC-8

PL-9. Monitoring Well 17B

PL-10. Disposal Cell Top Slope

PL-11. Containment Dam Spillway

PL-12. Potential Stormwater Flow Path Along Containment Dam Spillway

PL-13. Containment Dam Side Slope

PL-14. Sediment Trap

PL-15. Runoff Control Structure G

PL-16. Minor Rilling Near North Channel Cutoff Wall

PL-17. Erosion on South Side Slope of South Diversion Channel

PL-18. Minor Rilling Downgradient of South Diversion Channel Cutoff Wall

PL-19. Soil Piping Near Southwest Corner of Site Boundary

PL-20. Tres Hermanos Sandstone Outcrop, Dry

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 (site) was inspected on September 2, 2021. Depressions observed during previous inspections on the top of the disposal cell and ancillary cell were revisited in 2021. The dimensions of Depressions No. 1, No. 2, and No. 3 appeared to be approximately the same size when compared to measurements made in 2020. The small depressions on the ancillary cell did not appear to change since the 2020 inspection. None of the depressions threaten the integrity or performance of the disposal cells; monitoring of the depressions will continue, including aerial surveys that can detect small changes in depression size. No changes were observed in associated drainage features.

Gullies were observed west of Diversion Channel No. 2, and slight rilling under the northern and southwestern perimeter fence was also observed. None of this erosion threatens the integrity of the main disposal cell, ancillary cell, or associated surface water diversion structures; monitoring of this erosion will continue. No new observations or maintenance needs were identified for 2021. Inspectors identified no cause for a follow-up inspection. Groundwater monitoring is not required at the site.

4.2 Compliance Requirements

Requirements for the long-term surveillance and maintenance of the site are specified in the site-specific U.S. Department of Energy (DOE) Office of Legacy Management (LM) Long-Term Surveillance Plan (LTSP) (DOE 2010) and in accordance with procedures established to comply with the requirements of 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 U.S. Nuclear Regulatory Commission (NRC) general license in 2010. 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 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 2, 2021. The inspection was conducted by J. Cario and B. Mays of the Legacy Management Support contractor. M. Cosby (Colorado Department of Public Health and Environment) 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 any maintenance or additional inspection and monitoring are needed.

4.4.1 Site Surveillance Features

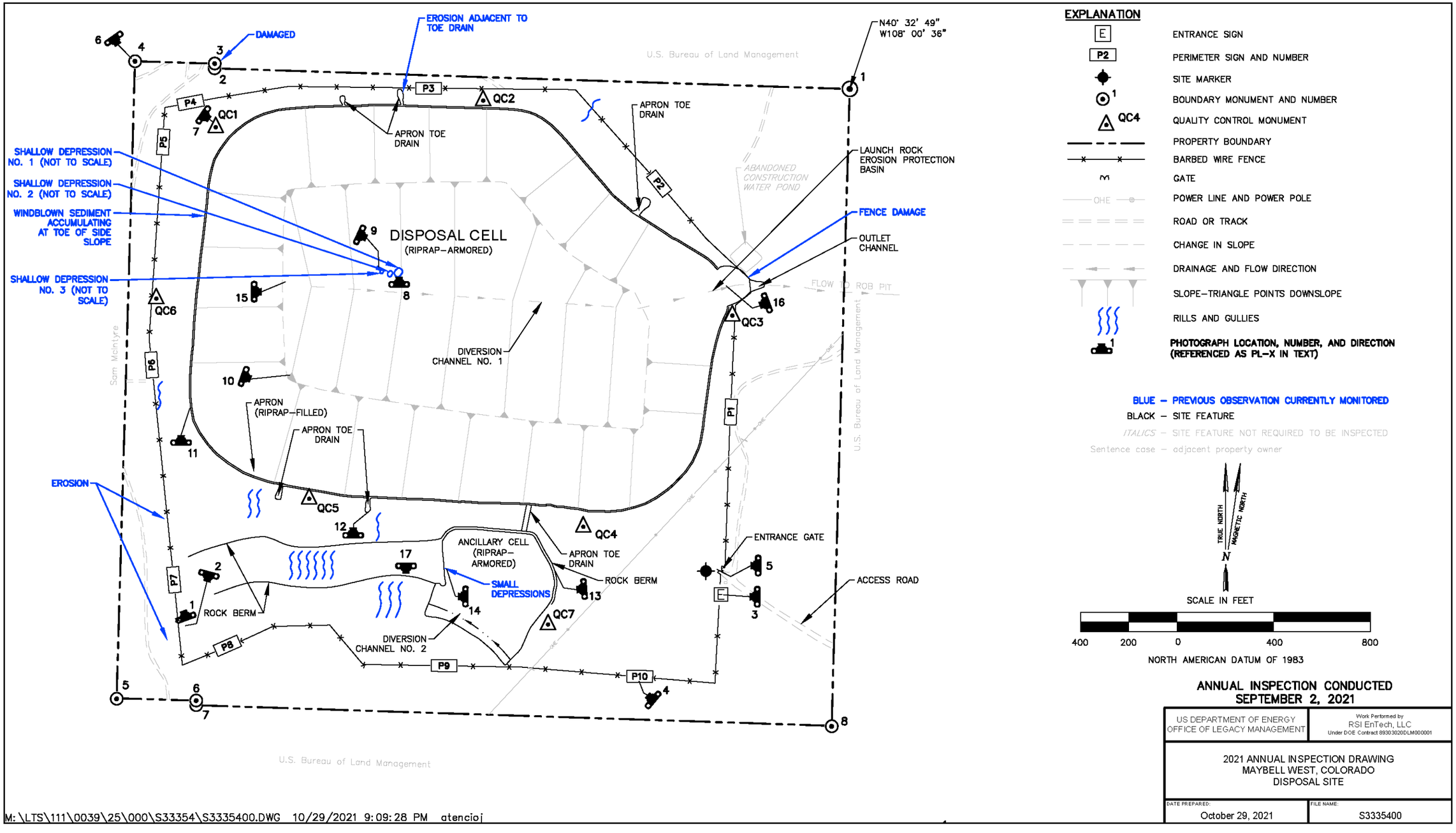
Figure 4-1 shows the locations of site features, including site surveillance features and inspection areas, in black and gray font. Site features that are present but not required to be inspected are shown in italic font. Observations from previous inspections that are currently monitored are shown in blue type. No new observations were identified in the 2021 annual inspection. Inspection results and recommended maintenance activities associated with site surveillance features are included in the following subsections. Photographs to support specific observations are identified 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 site's 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. The gate was locked, and no maintenance needs were identified.



EXPLANATION

- E — ENTRANCE SIGN
- P2 — PERIMETER SIGN AND NUMBER
- SITE MARKER
- 1 — BOUNDARY MONUMENT AND NUMBER
- QC4 — QUALITY CONTROL MONUMENT
- PROPERTY BOUNDARY
- BARBED WIRE FENCE
- GATE
- OHE — POWER LINE AND POWER POLE
- ROAD OR TRACK
- CHANGE IN SLOPE
- DRAINAGE AND FLOW DIRECTION
- SLOPE–TRIANGLE POINTS DOWNSLOPE
- RILLS AND GULLIES
- 1 — **PHOTOGRAPH LOCATION, NUMBER, AND DIRECTION (REFERENCED AS PL–X IN TEXT)**

BLUE – PREVIOUS OBSERVATION CURRENTLY MONITORED
BLACK – SITE FEATURE
ITALICS – SITE FEATURE NOT REQUIRED TO BE INSPECTED
Sentence case – adjacent property owner

ANNUAL INSPECTION CONDUCTED SEPTEMBER 2, 2021

US DEPARTMENT OF ENERGY OFFICE OF LEGACY MANAGEMENT	Work Performed by RSI EnTech, LLC Under DOE Contract 89303020DLM000001
2021 ANNUAL INSPECTION DRAWING MAYBELL WEST, COLORADO DISPOSAL SITE	
DATE PREPARED: October 29, 2021	FILE NAME: S3335400

Figure 4-1. 2021 Annual Inspection Drawing for the Maybell West, Colorado, Disposal Site

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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 trespass, 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). No damage to the perimeter fence was observed during the 2021 annual inspection. Minor erosion continues to be observed between perimeter signs P6 and P8 (PL-1). The erosion will continue to be monitored and repairs to the fence will be made as needed. Plastic fence flags were attached to the top two strands of the perimeter fence to serve as a visual marker to wildlife in order to reduce entanglement or striking the fence lines (PL-2). The fence flags were installed July 27, 2021. No maintenance needs were identified at the time of the inspection.

The entrance sign is mounted on a metal T-post directly south of the entrance gate (PL-3). Ten warning or perimeter signs are mounted on metal T-posts around the site (PL-4). No other maintenance needs were identified.

4.4.1.3 Site Marker

The site has one granite site marker near the entrance gate (PL-5). No maintenance needs were identified.

4.4.1.4 Boundary Monuments

Eight boundary monuments are on the site boundary outside the fenced area (PL-6). 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 was first observed to be bent during the 2017 annual inspection; since then attempts to straighten the monument were not successful; however the monument is still in place. No additional maintenance needs were identified.

4.4.1.5 Aerial Survey Quality Control Monuments

Seven aerial survey quality control (QC) monuments, installed in 2018, were inspected during the 2021 inspection (PL-7). 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 the cell's integrity. However, three 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 (PL-8). A second smaller and shallower depression (Depression No. 2) was first noted just west of the first depression during the 2016 annual inspection. A third, depression (Depression No. 3 [PL-9]) was first observed during the 2018 annual inspection. All three depressions appeared during the 2021 inspection to be approximately the same size as observed during the 2020 annual inspection. Measurements taken annually vary by the methodology employed (i.e., using a handheld tape measure), and the individual taking the measurements.

All three depressions will continue to be measured during annual inspections to determine if additional, more significant settlement is occurring. The comparison of 2018 baseline aerial survey data with data from future aerial surveys will help LM measure and monitor the depressions. The next aerial survey is anticipated to take place in summer 2022.

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. Noxious weeds were identified and controlled (treated with herbicide) on the disposal cell and ancillary cell top slopes in accordance with the LTSP on July 27, 2021.

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 (PL-10). Minor sediment accumulation observed in the toe drain apron below the northwest side slope appears to be windblown (PL-11), and there was no evidence of side slope instability, erosion, or settlement. This area of sediment accumulation will continue to be monitored to ensure 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 (PL-12) 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-13) 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 observed on the west end of the ancillary cell top scope are not impacting the performance of the cell, but it will continue to be monitored (PL-14). Various species of plants were present on the top slope of the ancillary cell. Noxious weeds were also treated during the July 27, 2021, noxious weed treatment event.

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-15), 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-16), 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. 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 against erosion. Several gullies and rills have developed on this south slope but do not threaten the integrity of the disposal cell (PL-17). The gullies will continue to be monitored and repaired as needed. The rock berm effectively controls headcutting from these gullies and protects the disposal cell. 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 (treated with herbicide) in accordance with the LTSP.

During each site inspection, the area surrounding the site is checked to ensure that changes in land or water use do not affect site protectiveness. The area beyond the site boundary for a distance of 0.25 mile 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.

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 July 27, 2021:

- Noxious weeds treated with herbicide.
- Wildlife-friendly fence flagging was installed along the entire perimeter fence.

Boundary monument BM-3 is damaged and will need to be repaired or replaced but continues to delineate the property. 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, February.

4.9 Photographs

Photograph Location Number	Azimuth	Photograph Description
PL-1	340	Erosion Under the Perimeter Fence Southwest of the Disposal Cell
PL-2	195	Wildlife Fence Flagging Along Perimeter Fence
PL-3	270	Site Entrance Sign
PL-4	310	Perimeter Sign P-10
PL-5	270	Granite Site Marker
PL-6	145	Boundary Monument BM-4
PL-7	125	Quality Control Monument QC-1
PL-8	0	Shallow Depression No. 1
PL-9	115	Shallow Depression No. 3
PL-10	110	View Southeast of Southern Disposal Cell Side Slope
PL-11	0	Windblown Material Along Western Toe Slope of Disposal Cell
PL-12	0	Apron Toe Drain on the South Side of Disposal Cell
PL-13	265	View West of Ancillary Cell Top Slope
PL-14	270	Small Depressions on Ancillary Cell Top Slope
PL-15	90	View East of Diversion Channel No. 1
PL-16	250	View Southwest of the Launch Rock Erosion Protection Basin
PL-17	180	Erosion South of Rock Berm Near Diversion Channel No. 2

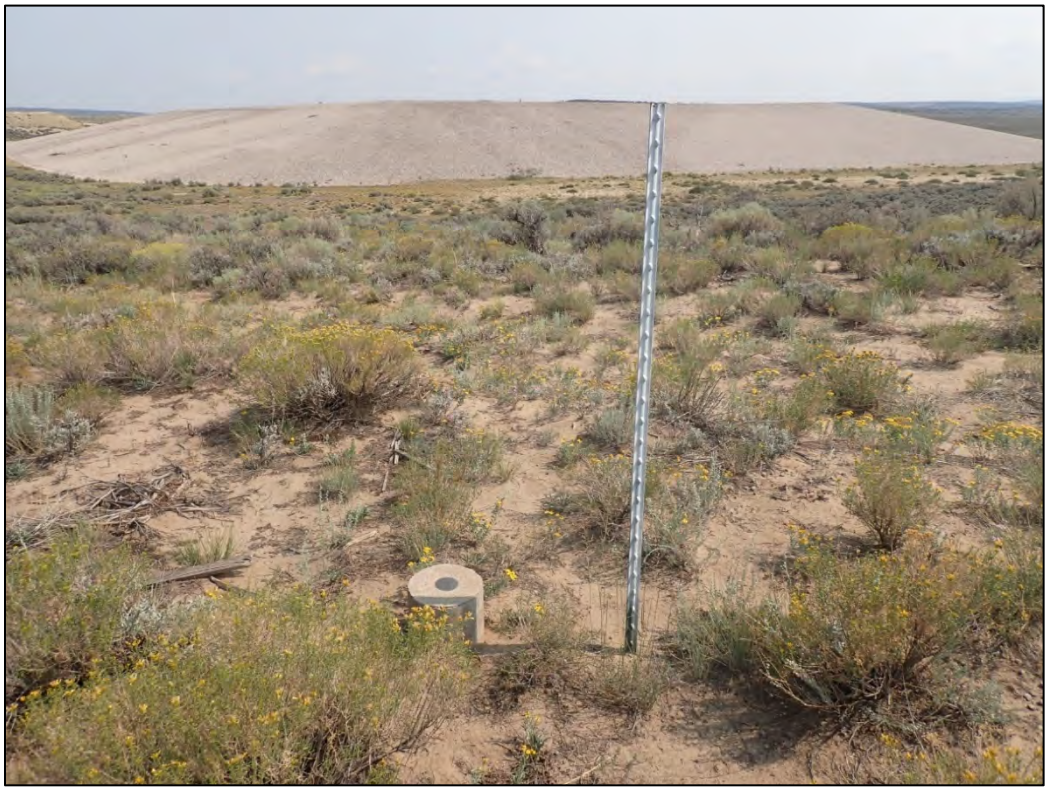
PL-1. Erosion Under the Perimeter Fence Southwest of the Disposal Cell

PL-2. Wildlife Fence Flagging Along Perimeter Fence

PL-3. Site Entrance Sign

PL-4. Perimeter Sign P-10

PL-5. Site Marker



PL-6. Boundary Monument BM-4

PL-7. Quality Control Monument QC-1

PL-8. Shallow Depression No. 1

PL-9. Shallow Depression No. 3

PL-10. View Southeast of Southern Disposal Cell Side Slope

PL-11. Windblown Material Along Western Toe Slope of Disposal Cell

PL-12. Apron Toe Drain on the South Side of Disposal Cell

PL-13. View West of Ancillary Cell Top Slope

PL-14. Small Depressions on Ancillary Cell Top Slope

PL-15. View East of Diversion Channel No. 1

PL-16. View Southwest of the Launch Rock Erosion Protection Basin

PL-17. Erosion South of Rock Berm Near Diversion Channel No. 2

5.0 Sherwood, Washington, Disposal Site

5.1 Compliance Summary

The Sherwood, Washington, Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II Disposal Site (site) was inspected June 9, 2021. The disposal cell, containment dam, and associated drainage features were functioning as designed. Inspectors identified one missing perimeter sign, which was replaced during the subsequent groundwater sampling event in July 2021. No additional maintenance needs or cause for a follow-up inspection were identified.

Groundwater monitoring is not required at the site. However, the U.S. Department of Energy (DOE) Office of Legacy Management (LM) conducts groundwater monitoring at three wells as a best management practice in accordance with the site-specific Long-Term Surveillance Plan (LTSP) (DOE 2001). The sulfate action level criteria (250 milligrams per liter [mg/L]) was exceeded at monitoring well 4 in 2017 (260 mg/L) but was met in 2018 (250 mg/L) based on the 2018 sampling event. In 2019, the well was redeveloped, and the bladder pump was raised slightly so it would not be buried in possible debris. The well was sampled before and after development, and analytical results for sulfate were similar for both samples (54 mg/L before, and 62 mg/L after development). The most recent sampling event occurred in July 2021, and the sulfate concentration (14 mg/L) remained below the action level criteria.

5.2 Compliance Requirements

Requirements for the long-term surveillance and maintenance of the site are specified in the LTSP (DOE 2001) and in accordance with procedures established to comply with the requirements of 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 U.S. Nuclear Regulatory Commission (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 ownership of the property, 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 June 9, 2021. The inspection was conducted by B. Mays and D. Ravelojaona of the Legacy Management Support contractor. K. Kreie (LM site manager); B. Stasney (Washington Department of Health [WDOH]); and J. Caruso and W. McCart (Stevens County) 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 additional 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. 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 type, and new observations identified in the 2021 annual inspection are shown in red type. Inspection results and recommended maintenance activities associated with site surveillance features are included in the following subsections. Photographs to support specific observations are identified 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, an all-weather, BIA-maintained road over which LM has permanent right of access. Road maintenance activities were occurring at the time of the inspection. The site and adjacent lands are part of the Spokane Indian Reservation. The entrance gates are no longer used and allow open access to the site.

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 (PL-1). Perimeter sign P2 was missing and was replaced during the subsequent groundwater sampling event in July 2021. No additional 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 monument location (PL-3). All boundary monuments were inspected. No maintenance needs were identified.

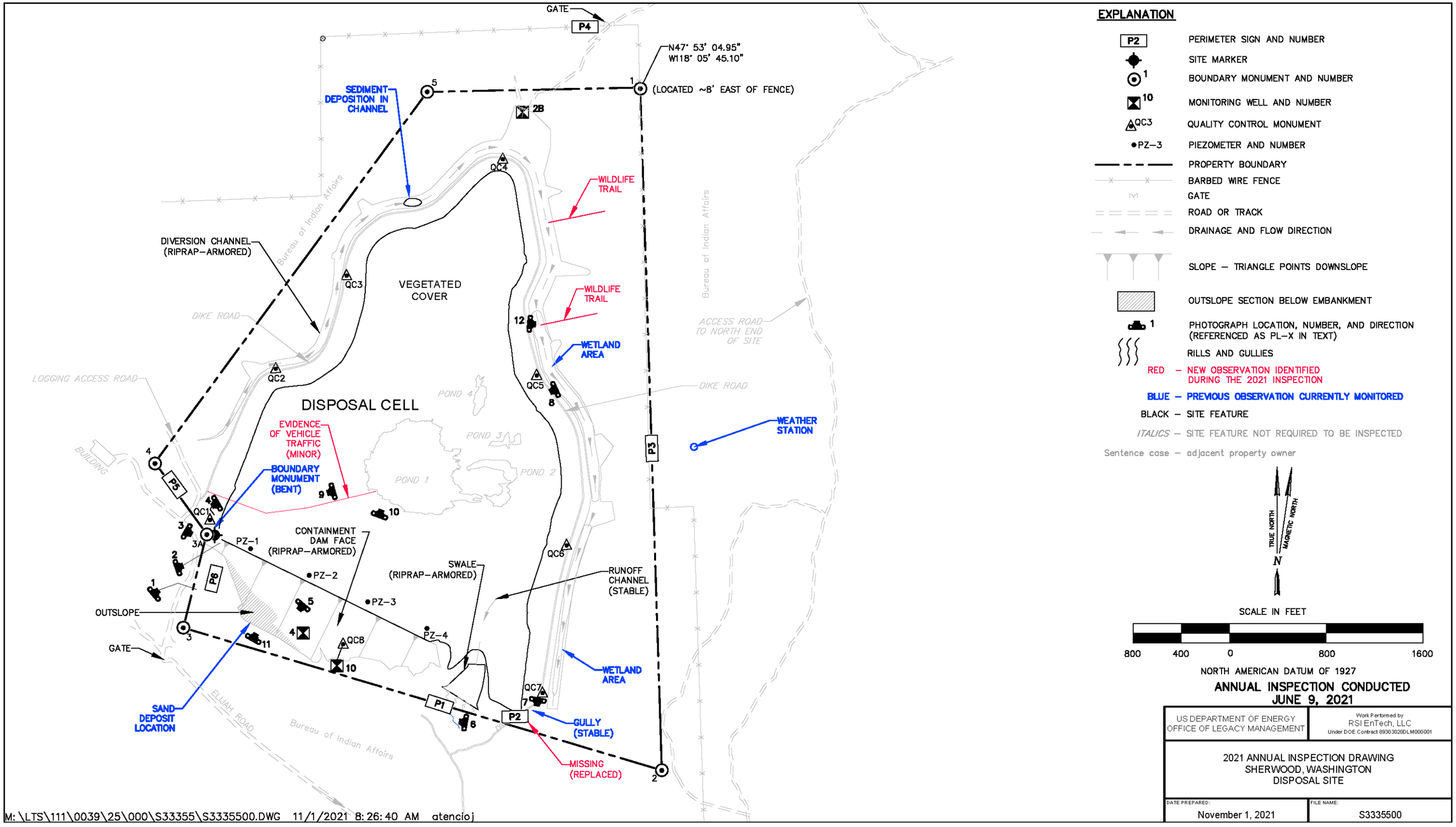


Figure 5-1. 2021 Annual Inspection Drawing for the Sherwood, Washington, Disposal Site

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5.4.1.5 Aerial Survey Quality Control Monuments

Eight aerial survey quality control (QC) monuments, installed in 2019, were inspected during the 2021 inspection (PL-4). A baseline aerial survey was conducted 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 2B, 4, and 10 (PL-5). As part of the dam safety inspection program, four piezometers, designated piezometers PZ-1 through PZ-4, were installed in November 2000 along the crest of the containment dam at a depth equivalent to the base of the dam. All piezometers and wellhead protectors were undamaged and locked. No 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 the site's conformance with LTSP requirements.

5.4.2.1 Site Perimeter, Outlying Areas, and Balance of Site

A ponderosa pine forest constitutes most of the area outside of the diversion channel that encircles the disposal cell. The surrounding lands are part of the Spokane Indian Reservation and are used for timber harvesting and wildlife habitat. The area approximately 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 identified. A vacant metal building, left in place from earlier mining operations, is about 500 feet (ft) west of the western site boundary. A weather station was identified during the 2020 inspection approximately 400 ft east of the eastern site boundary on BIA property. The weather station is not an LM asset. No new development was evident east of the site along Elijah Road. Large boulders line the east side of Elijah Road to the southwest of the disposal cell outside of the site boundary. These boulders keep vehicle traffic on the road and prevent unnecessary vehicle access to the cell**.** Inspectors noticed boulders had been moved near boundary monument BM-3A, but no evidence of vehicle access was identified in that area. The boulders are not part of the cell design, but the area will continue to be monitored to ensure that vehicle traffic does not increase on the site.

A gully offsite, downgradient of the riprap-armored swale near perimeter sign P1, was first observed in 2009. The gully is photographed periodically to monitor its development (PL-6). Although erosion continues to occur because of site drainage, the gully is not impacting site features or access but will continue to be monitored. Additionally, minor erosion was identified during the 2021 inspection adjacent the two-track on the southeast side of the cell near perimeter sign P2 (PL-7). The erosion areas are not impacting site features or access and 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 and planted with native shrubs, forbs, grasses, and trees (PL-8).

A small, shallow channel developed by runoff from the top slope of the disposal cell is near the southeast corner of the disposal cell. Runoff has scoured the channel down to the quartz monzonite bedrock and discharges into a riprap-armored swale east of the containment dam. The channel is stable and is not above an area containing tailings; however, it will continue to be monitored to ensure that it does not affect the integrity of the disposal cell.

Evidence of vehicle travel was identified on the southwest side of the disposal cell. Minor vehicle tracks were observed from the road intersection near perimeter sign P5 to the edge of Pond 1 (PL-9). The area will continue to be monitored, and strategies to prevent unnecessary vehicle traffic on the cell will be evaluated in consultation with Spokane tribal leadership.

Designers of the disposal cell predicted that some settlement would continue after the uncompacted cover was put in place. As explained on pages 2–14 of the LTSP, the cover was designed to be self-stabilizing with regard to impacts from freezing and thawing, biointrusion, and settlement (DOE 2001). The largest area of settlement is referred to as Pond 1 (PL-10). The plant species present indicate the presence of year-round moisture below the surface of the pond area. Other minor depressions—designated as Ponds 2, 3, and 4—were dry at the time of inspection. An evaluation of topographic surveys conducted in 2016 and 2017 indicated that up to 4.4 ft of settlement has occurred near the ponds since construction of the disposal cell. The cover was designed to withstand up to 10 ft of settlement (DOE 2018a). The shallow ponds are considered favorable features on the disposal cell cover, but LM will continue to monitor the surface for unusual settlement features to verify the cover's integrity and ensure that the disposal cell is performing as designed. Baseline aerial remote sensing surveys to collect high-resolution topographic data were conducted in October 2021 to monitor the surface of the disposal cell, and data are currently being processed. Data will be reviewed in 2022 and a summary of the survey findings will be included in the 2022 inspection report. 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 to ensure continued compliance with the National Dam Safety Program Act. The containment dam face was inspected in accordance with the *Dam Inspection Checklist*, which is included at the end of this chapter. No concerns were observed.

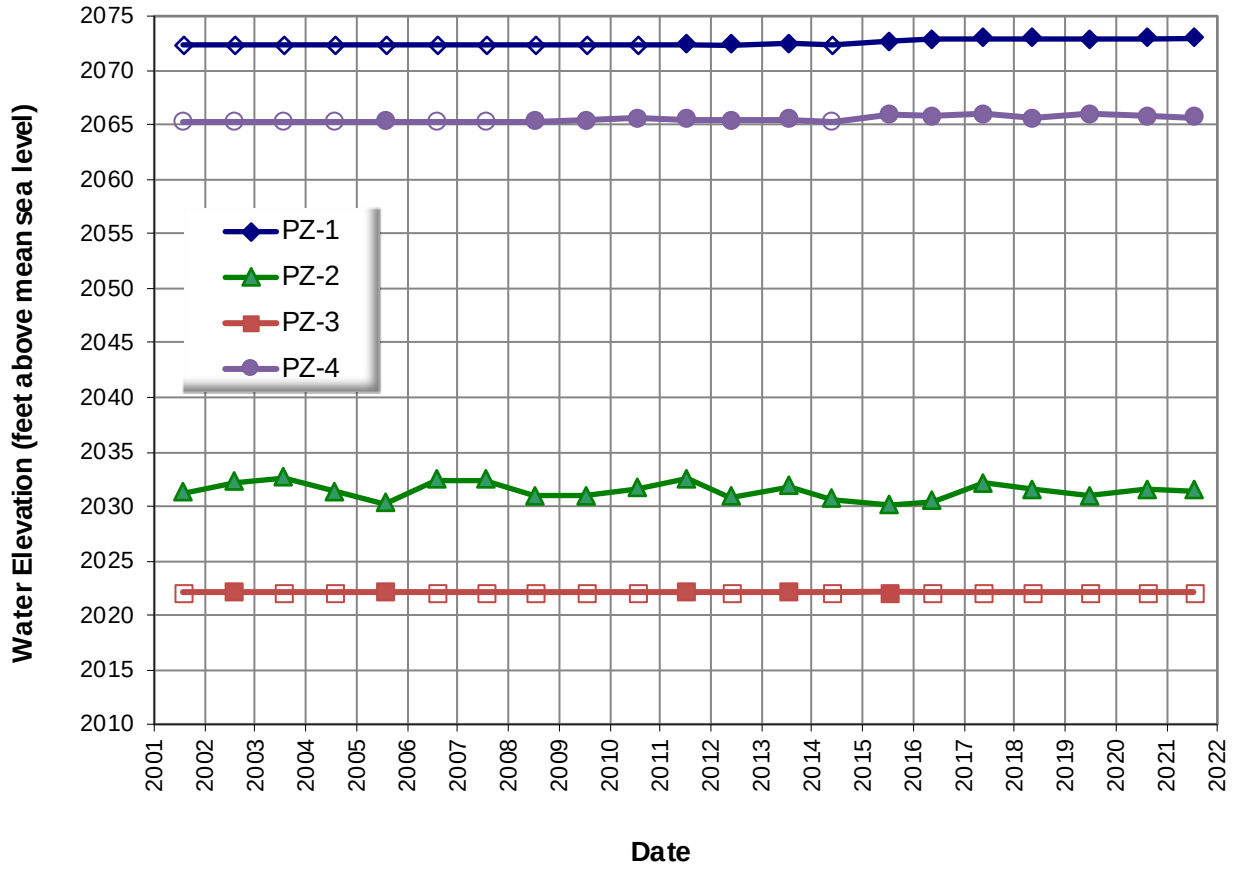
Measurements of water levels in four piezometers atop the containment dam are collected during the annual groundwater sampling events as part of the annual dam inspection. These annual measurements, collected since the piezometers were installed in 2000, provide a direct means of determining moisture conditions in the containment dam. Steadily increasing water levels in any of the piezometers could indicate a potential problem with the dam's performance. Measurements collected July 13, 2021—provided in Table 5-2, Figure 5-2, and the attached *Dam Inspection Checklist*—do not indicate an increase in water levels. Variations in the amount of water in the four piezometers are thought to be seasonal responses to precipitation. The minor

amount of water in piezometer PZ-2 is the result of a small, perched lens of water that exists because of localized differences in permeability. While the lateral extent of the lens is unknown, it is estimated, based on water levels in piezometer PZ-2 and monitoring wells 4 and 10, that more than 200 ft of unsaturated material is beneath the piezometer PZ-2 perched zone. Based on the recent water levels observed in the piezometers and monitoring wells, the containment dam is considered to be unsaturated.

Table 5-2. 2021 Sherwood, Washington, Disposal Site Piezometer Water Depths

Piezometer	Total Depth of Piezometer (ft)[a,b]	Water Level (ft)[a]	Depth of Water (ft)
PZ-1	22.55	21.81	0.70
PZ-2	63.07	60.88	2.32
PZ-3	67.62	Dry	Dry
PZ-4	22.70	22.10	0.73

Notes:
[a] Measured from the top of the inner casing.
[b] Total depths were adjusted based on measurements collected during the 2019 sampling event.



Note: Hollow symbols indicate dry water level measurement events.

Figure 5-2. Sherwood, Washington, Disposal Site Piezometer Water Elevations

The containment dam face has a rock cover consisting primarily of highly durable quartz monzonite. The face was designed to allow a vegetated cover, including mature trees, to establish to stabilize the surface and mitigate erosion. Consequently, the presence of this vegetation does not harm the function of the containment dam. The containment dam face is thickly vegetated. No maintenance needs were identified.

During the 2016 annual inspection, one location at the base of the rock-covered containment dam face was found to have a deposit of sand that had washed out from underneath the rock cover, as evidenced by a shallow rock-filled erosion feature upgradient of the deposit (Figure 5-1). A subsequent follow-up inspection and evaluation identified that the sandy material was the same as natural undisturbed material nearby. During reclamation, this area of the site was used as a source for fill material used to contour the area below the toe of the containment dam. Review of original reclamation and as-built drawings showed that the toe of the containment dam is upslope from the area of erosion, which was confirmed during the follow-up investigations. Therefore, it was concluded that the sand deposit location is in a portion of the dam defined as the outslope in the construction completion report and does not impact the containment dam (DOE 2018b).

The sand deposit location was examined during the inspection, and there was no apparent change in the deposit or the upgradient erosion feature (PL-11). The area will be visually monitored during future inspections and by periodic aerial remote sensing surveys. Repair options will be evaluated and implemented, in consultation with NRC, if the erosion area increases such that the containment dam could be affected.

A riprap-armored diversion channel surrounds the disposal cell and diverts runoff away from the disposal cell surface. The diversion channel was designed to allow trees to grow and stabilize the surfaces, and the presence of trees in the diversion channel is not expected to hinder the diversion channel's ability to convey design flows. The establishment of volunteer plants, including trees, is evident in most areas of the diversion channel. Sediment deposition is found in places on the west leg of the diversion channel but does not interfere with the diversion channel's design function. Upslope areas that have contributed to the sedimentation have stabilized with vegetation. Wildlife trails cross the diversion channel at numerous locations and have displaced the diversion channel riprap in several places (PL-12). These disturbances will be visually monitored for erosion but are not in areas that would impact the disposal cell. No evidence of erosion was observed downgradient of the diversion channel outlet. 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

Perimeter sign P2 was identified as missing and was replaced during the subsequent groundwater sampling event in July 2021. No additional routine 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.

5.7 Environmental Monitoring

5.7.1 Groundwater Monitoring

Groundwater quality results for the July 2021 sampling event are in Table 5-3. Groundwater constituent concentrations continue to be less than the action level criteria for confirmatory sampling in monitoring wells 2B, 4, and 10. Should the concentration of chloride or sulfate exceed the action level criteria (state of Washington water quality criteria value of 250 mg/L), 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 an evaluative monitoring program would be used to determine if corrective action is necessary.

Groundwater compliance monitoring is not required at the site. However, as a best management practice stipulated in the LTSP, LM conducts limited groundwater monitoring for several indicator parameters. Samples are collected annually from background monitoring well 2B north of the disposal cell and from downgradient wells 4 and 10 near the base of the containment dam (Figure 5-3). Groundwater samples are analyzed for chloride and sulfate, which are primary indicator constituents, and for total dissolved solids.

Table 5-3. 2021 Groundwater Quality Results for the Sherwood, Washington, Disposal Site

Constituent	Water Quality Criterion[a]	Well		
		Background Well 2B	Downgradient Well 4	Downgradient Well 10
Chloride (mg/L)	250	0.24	Nondetect	Nondetect
Sulfate (mg/L)	250	1.6	14	30
TDS (mg/L)	NA	220	510	620

Note:
[a] State of Washington water quality criteria used as action levels.

Abbreviations:
NA = not applicable
TDS = total dissolved solids

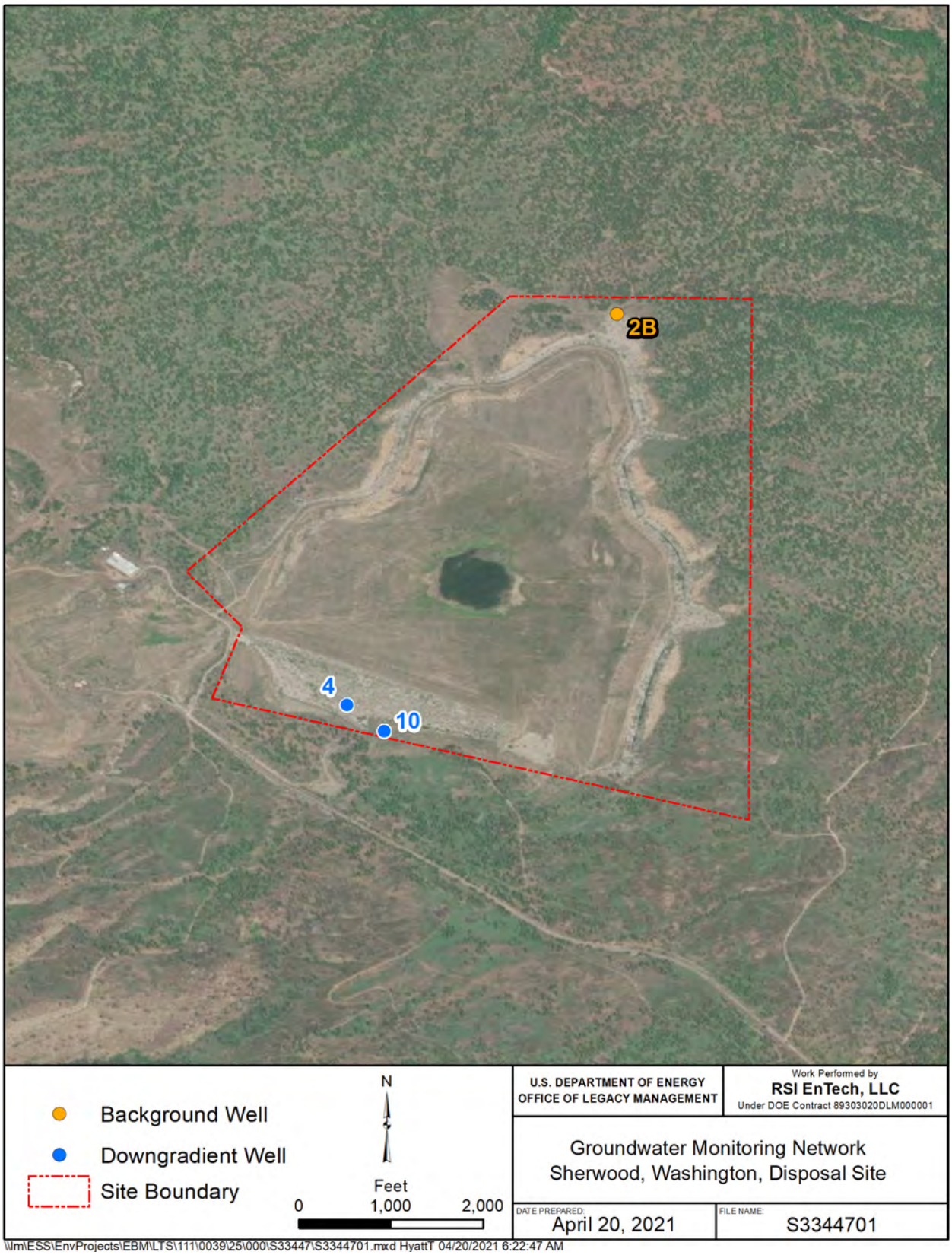


Figure 5-3. Groundwater Monitoring Network at Sherwood, Washington, Disposal Site

Time-concentration plots of chloride and sulfate for the three monitoring wells are shown in Figure 5-4 and Figure 5-5, respectively. Occurrences of slightly elevated chloride levels in well 4 correspond with the higher sulfate levels measured at the same location. Water elevations for each of the monitoring wells are shown in Figure 5-6 and Figure 5-7. 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 10 is completed in the alluvium, and wells 2B and 4 are completed in the bedrock. Absolute values of water table elevations reported in Figure 5-6 and Figure 5-7 differ slightly from those in previous reports, but the trends are the same. The reason for the offset is the recent transformation of vertical datum from National Geodetic Vertical Datum of 1929 to North American Vertical Datum of 1988 in LM's environmental database.

Increases in water table height in wells 2B and 4 correspond with the elevated levels of chloride and sulfate measured in well 4 in 2006 and 2011 and from 2016 to 2018. As stated by WDOH in the February 2000 *Sherwood Uranium Mill Project, Technical Evaluation Report, Monitoring and Stabilization Plan Supplement* (WDOH 2000), "One of the downgradient point-of-compliance wells, well 4, has seasonal variation in water quality, represented by late spring and summer peaks that are consistent with annual infiltration and the rise in static water levels. This seasonal trend has been evaluated closely and ground water monitoring increased as established by the MSP [Monitoring and Stabilization Plan]." Annual precipitation totals measured in Spokane, Washington, show a correlation with the increased sulfate and chloride concentrations. Years with higher precipitation totals are also years with higher sulfate concentrations.

A borehole camera was used in 2018 to evaluate conditions in the three monitoring wells, specifically to determine if any well issues contributed to the sulfate exceedance in monitoring well 4. The video showed that the inlet of the dedicated bladder pump used for low-flow sampling was buried in debris at the bottom of well 4. The well was redeveloped during the 2019 sampling event, and the debris was removed; samples were collected before and after redevelopment with similar results for sulfate (54 and 62 mg/L, respectively). After sampling, a datalogger was placed in the well to collect periodic water level, temperature, and specific conductivity data until removal during the 2020 sampling event. After further analysis, if the data indicate a correlation between higher water levels and increased specific conductivity, LM may propose to cease the best management practice annual water sampling (Kreie 2018).

5.7.2 Vegetation Monitoring

The LTSP requires annual visual inspections of the disposal cell's vegetated cover to ensure that it satisfies erosional stability criteria and is self-sustaining. 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 2021 annual inspection.

Seven species of state-listed noxious weeds historically have been found, six of which are "List B" species and, by law, must be controlled. No "List A" species, which must be eradicated, have been found at the site. LM has released various biological control insects in the past and periodically treats weed infestations with herbicide. Herbicide applications were not warranted in 2021.

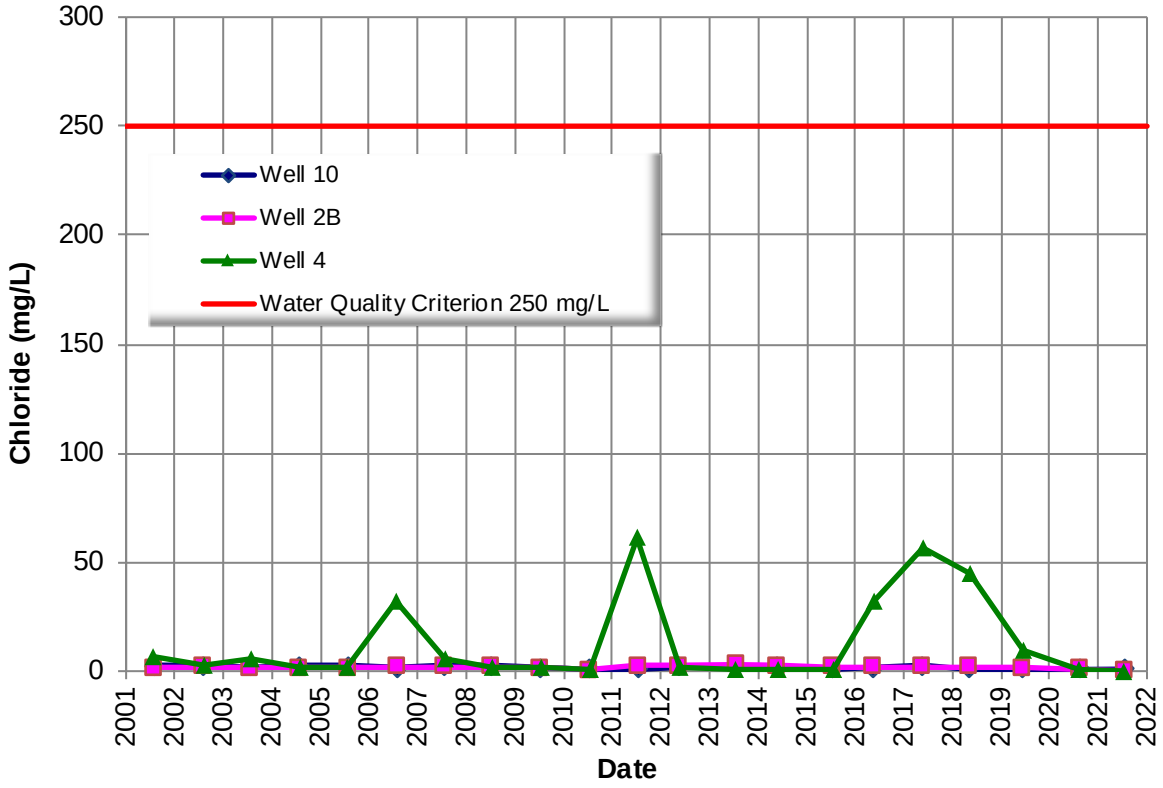


Figure 5-4. Chloride Concentrations at the Sherwood, Washington, Disposal Site

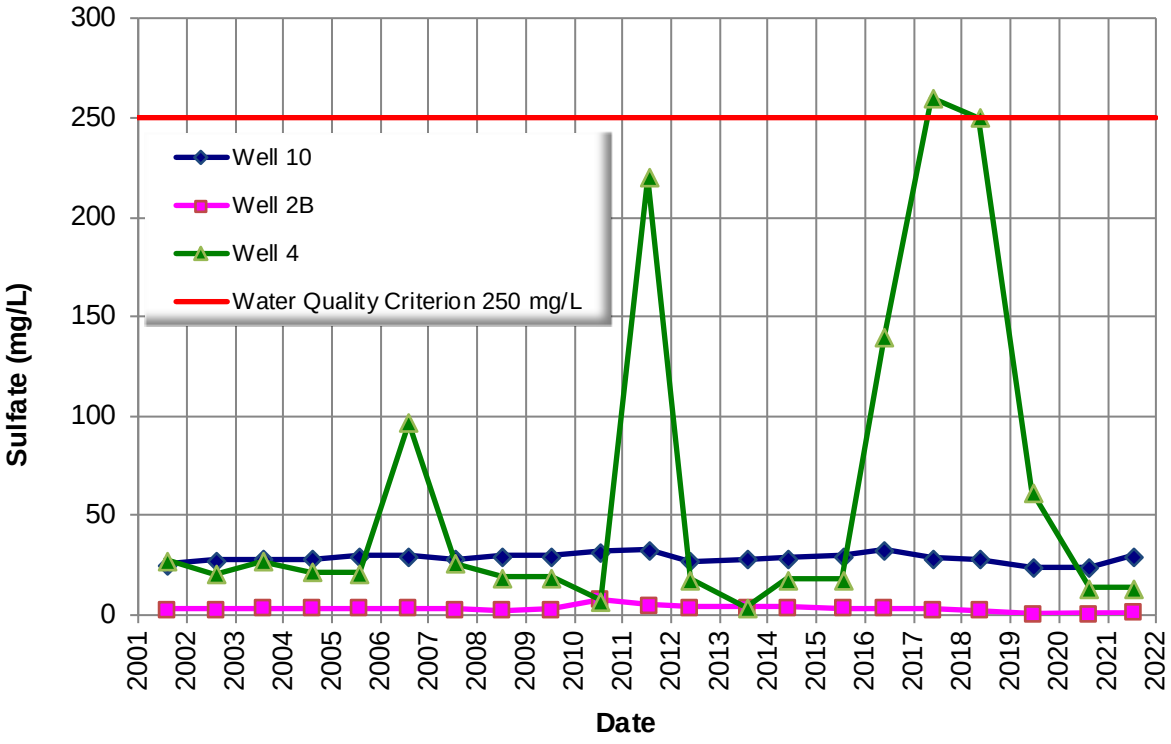


Figure 5-5. Sulfate Concentrations at the Sherwood, Washington, Disposal Site

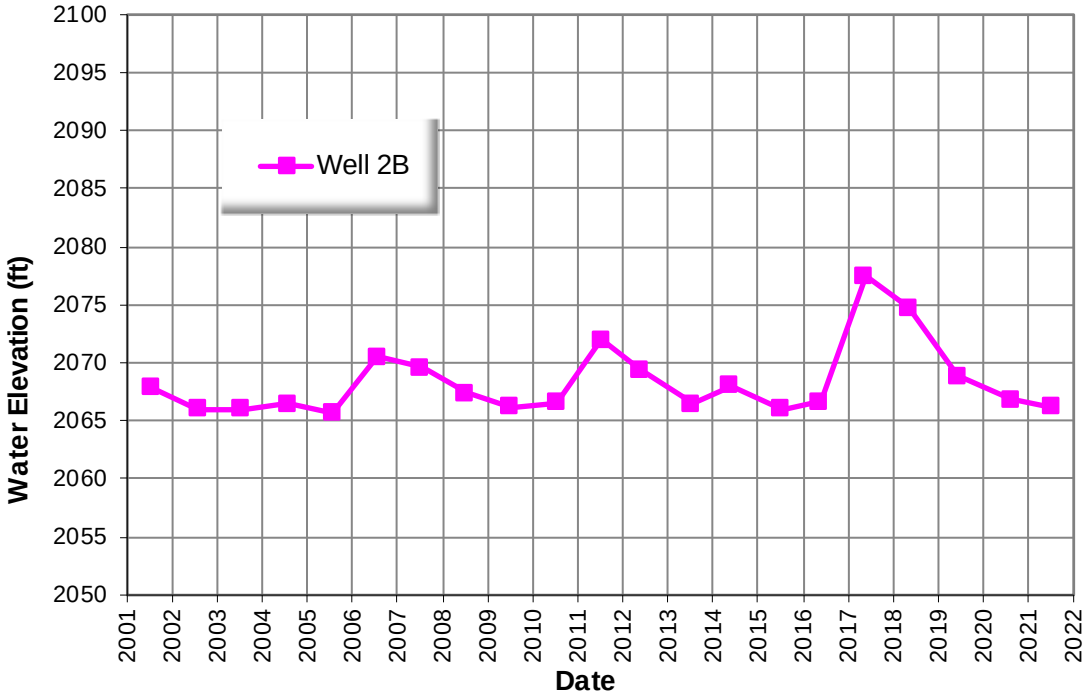


Figure 5-6. Well 2B Water Elevation Measurements at the Sherwood, Washington, Disposal Site

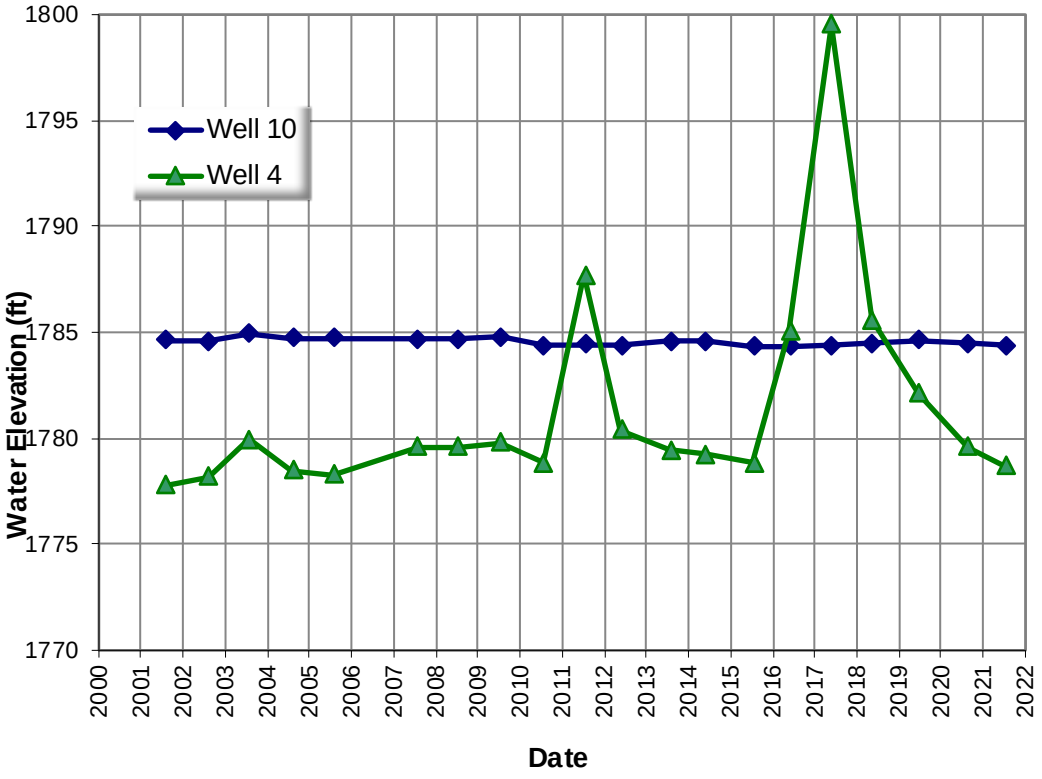


Figure 5-7. Wells 4 and 10 Water Elevation Measurements at the Sherwood, Washington, Disposal Site

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. *Settlement Survey and Analysis, Sherwood, Washington, Disposal Site*, LMS/SHE/S19518, Office of Legacy Management, June.

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

Kreie, 2018. Ken Kreie, site manager, Office of Legacy Management, U.S. Department of Energy, letter ("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	50	Perimeter Sign P6
PL-2	70	Granite Site Marker
PL-3	120	Boundary Monument BM-3A
PL-4	240	Quality Control Monument QC-1
PL-5	220	Monitoring Well 4
PL-6	280	Gully Downgradient of Riprap-Armored Swale Near Perimeter Sign P1
PL-7	190	Gully Near Perimeter Sign P2 (Stable)
PL-8	245	Disposal Cell
PL-9	255	Evidence of Vehicle Tracks to Disposal Cell Pond 1
PL-10	20	Disposal Cell Pond 1
PL-11	30	Sand Deposit at Toe of Containment Dam Outslope
PL-12	95	Wildlife Trail Adjacent the Disposal Cell

PL-1. Perimeter Sign P6

PL-2. Granite Site Marker

PL-3. Boundary Monument BM-3A

PL-4. Quality Control Monument QC-1

PL-5. Monitoring Well 4

PL-6. Gully Downgradient of Riprap-Armored Swale Near Perimeter Sign P1

PL-7. Gully Near Perimeter Sign P2 (Stable)

PL-8. Disposal Cell

PL-9. Evidence of Vehicle Tracks to Disposal Cell Pond 1

PL-10. Disposal Cell Pond 1

PL-11. Sand Deposit at Toe of Containment Dam Outslope

PL-12. Wildlife Trail Adjacent the Disposal Cell

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

Date of Inspection: June 09, 2021
Inspector: Brackett Mays Organization: RSI EnTech, LLC
Piezometer water levels measured during groundwater monitoring event: August 11, 2020
(All depths in feet; TOC = top of casing)

Piezometer PZ-1 fluid level Total depth: 22.55	(TOC to top of fluid):	21.85	Fluid amount:	0.70
Piezometer PZ-2 fluid level Total depth: 63.07	(TOC to top of fluid):	60.75	Fluid amount:	2.32
Piezometer PZ-3 fluid level Total depth: 67.62	(TOC to top of fluid):	Dry	Fluid amount:	Dry
Piezometer PZ-4 fluid level Total depth: 22.70	(TOC to top of fluid):	21.97	Fluid amount:	0.73

Was evidence of significant seepage observed on the dam face? No
If yes discuss in report.

Was evidence of significant slumping observed on the dam? No
If yes discuss in report.

Was evidence of significant erosion observed on the dam? No
If yes discuss in report.

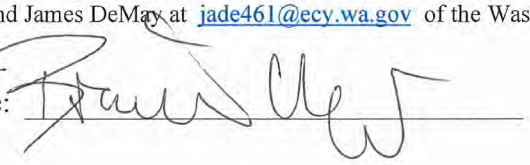
Was vegetative growth that could compromise dam stability observed? No
If yes discuss in report.

Was any condition that presents an imminent hazard to human health and safety or to the environment observed? No
If yes immediately contact the following:

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:  Date: 6/09/2021

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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 (site) was inspected July 27, 2021. No changes were observed on the disposal cell or in associated drainage features. Some erosion gullies were observed on the western side of the site. Inspectors identified no 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 (LTSP) (DOE 2004). The most recent sampling event occurred in July 2021, the results of which will be included in the 2022 report. The 2020 data showed that alternate concentration limits (ACLs) continue to be exceeded for radium-226 (^{226}Ra), radium-228 (^{228}Ra), and selenium. 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 LTSP (DOE 2004) and in accordance with procedures established to comply with requirements of 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 U.S. Nuclear Regulatory Commission (NRC) general license in 2005. 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 D. Traub and D. Ravelojaona, of the Legacy Management Support (LMS) contractor. N. Keller (LM site manager) 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 additional 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. 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 type, and new observations are shown in red type. Inspection results and recommended maintenance activities associated with site surveillance features are included in the following subsections. Photographs to support specific observations are identified 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 south portion of the perimeter fence, was secured by a locked chain. No maintenance needs were identified.

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 maintaining the perimeter fence. No maintenance needs were identified.

Nine perimeter signs (warning and no-trespassing signs) are posted along the site perimeter at potential points of access (PL-1), 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.

6.4.1.3 Site Marker

The site has one granite site marker near the entrance gate (PL-2). No maintenance needs were identified.

6.4.1.4 Boundary Monuments

There are 27 boundary monuments delineating the site property boundary (PL-3). All boundary monuments were inspected. No maintenance needs were identified.

6.4.1.5 Aerial Survey Quality Control Monuments

In July 2019, eight permanent quality control (QC) monuments were installed at the site in preparation for a baseline aerial survey of the disposal cell. The quality control monument locations are shown in Figure 6-1. Quality control monument QC-7 was unearthed for inspection and rocks were placed around it for easier identification (PL-4). A baseline aerial survey is tentatively scheduled for 2022. No maintenance needs were identified.

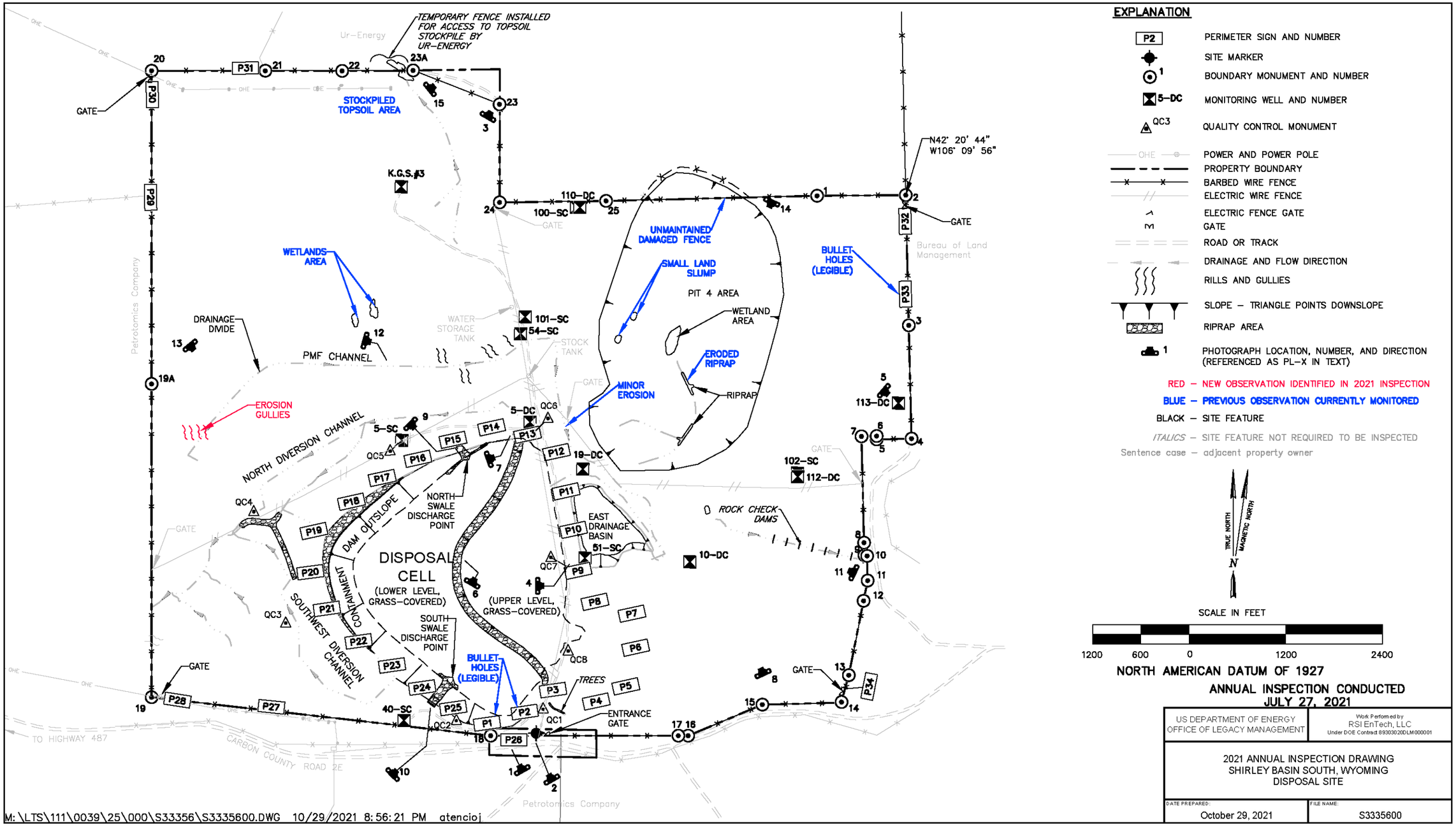

Figure 6-1. 2021 Annual Inspection Drawing for the Shirley Basin South, Wyoming, Disposal Site

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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 Lower 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 (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 the site's 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 a path around the north end of the riprap-armored slope (PL-7). There were no signs of erosion, settlement, or other modifying processes on the disposal cell cover or side slopes that might affect the integrity of the disposal cell.

Gradual vegetation encroachment has been observed in the riprap on the slope that separates the two elevations. The establishment of perennial vegetation enhances the slope's 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 (PL-8) 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-9) and south swale discharge point (PL-10). The riprap dissipation basins at the discharge points usually hold runoff water in spring and early summer. Runoff was present in the north swale discharge point during the inspection. The south swale discharge point was dry. Vegetation is establishing in both the north swale and south swale discharge points. No maintenance needs were identified.

6.4.2.2 Containment Dam and Diversion Channels

The tailings pile was reclaimed in place and contained behind a horseshoe-shaped earthen dam, the containment dam. The containment dam is predominantly grass covered, but the steeper portion (5:1 slope) of the dam outslope 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 the 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-11). 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 (PL-12). Part of the PMF channel drains to the southwest through the north and southwest channels and discharges to a basin. The portion of the PMF channel that flows eastward and discharges into the east drainage basin captures stormwater from a larger drainage area. These drainage basins are large enough to accommodate PMF water volumes. Erosion gullies were observed on the western side of the site (PL-13) but are not impacting site features.
No maintenance needs were identified.

6.4.2.3 Site Perimeter and Balance of Site

The other 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-14). 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. A riprap-armored drainage channel near the bottom of the pit has eroded. Repair of the displaced riprap armor is not considered necessary, because potential erosion in that portion of the pit will not cut deeper than the floor of the pit and is not expected to impact slope stability.

The site is surrounded by public land administered by the U.S. Bureau of Land Management and by private land. Land on three sides is used primarily for livestock grazing. Ur-Energy is the property owner north of the site (PL-15) 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, which was acquired by Ur-Energy. LM is the successor to Petrotomics, and the terms of the agreement remain in effect. The Wyoming Department of Environmental Quality (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.

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, routine site maintenance will be performed by LM where and when needed based on best management practices. No maintenance needs were identified during the 2021 annual 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, annual groundwater monitoring is required at the site to verify that the ACLs are not exceeded at point-of-compliance (POC) wells and to verify continued compliance with applicable groundwater protection standards. LM conducted monitoring in July 2021 and the validated data will be reported in the 2022 report. The monitoring network described in the LTSP comprises seven wells in the site's 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 confined from the site's uppermost aquifer (DOE 2011a). 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. Although no monitoring wells are designated as points of exposure, groundwater chemistry at downgradient wells 100-SC, 102-SC, 110-DC, and 113-DC represents groundwater quality (for groundwater flowing offsite) in the Upper Sand and Main Sand Aquifers.

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 and Main Sand Aquifers
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

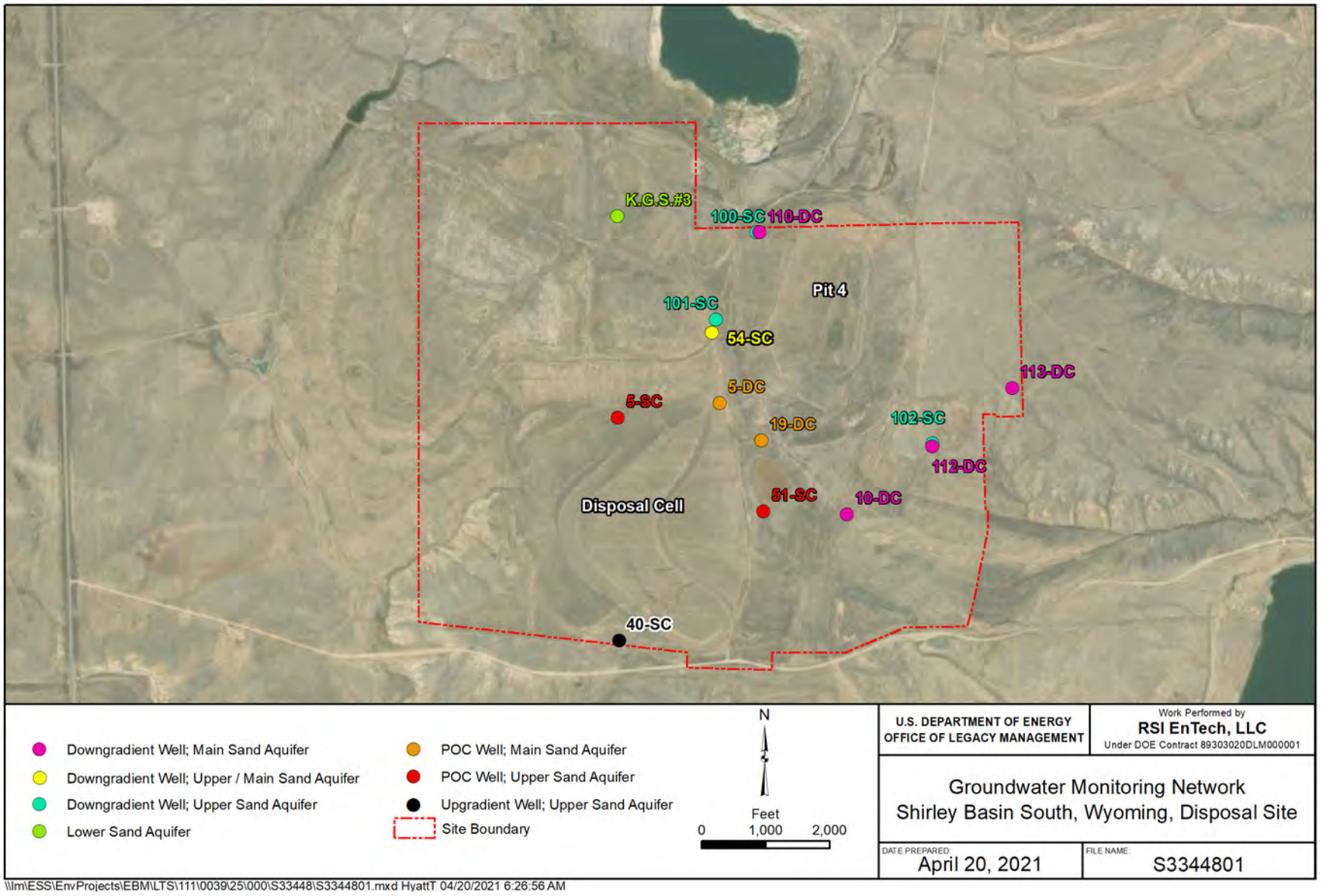


Figure 6-2. Groundwater Monitoring Network at Shirley Basin South, Wyoming, Disposal Site

Water level, pH, and electrical conductivity are measured at the time of sampling, and samples are analyzed for cadmium, chloride, chromium, lead, nickel, nitrate, ^{226}Ra, ^{228}Ra, selenium, sulfate, thorium-230, total dissolved solids (TDS), and uranium. Analytical results are compared to the ACLs and Wyoming Class III groundwater protection standards (WAR 020.0011.8.06292018) provided in Table 6-3. Nitrate is not included in Table 6-3 because there are no applicable limits or standards for nitrate at this site. However, nitrate is included as a sampled analyte (see Table 6-4) because it can indicate contaminant migration. 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.

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

Analyte	ACL	Groundwater Protection Standard[a]
Cadmium (mg/L)	0.079	NA
Chloride (mg/L)	NA	2000
Chromium (mg/L)	1.83	NA
Lead (mg/L)	0.05	NA
Nickel (mg/L)	6.15	NA
^{226}Ra (pCi/L)	91.3	NA
^{228}Ra (pCi/L)	25.7	NA
Selenium (mg/L)	0.12	NA
Sulfate (mg/L)	NA	3000
Thorium-230 (pCi/L)	2409	NA
TDS (mg/L)	NA	5000
Uranium (mg/L)	9.2	NA

Note:
[a] This column shows Wyoming Class III groundwater protection standard values for livestock use, which apply to this site (WAR 020.0011.8.06292018).

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

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 re-create the hydrogeologic characteristics of the original formation, and the aquifers are no longer confined at Pit 4.

The site map showing 2020 water level elevations for the Upper Sand Aquifer are shown in Figure 6-3, and water elevations over time are plotted in Figure 6-4. The LTSP specifies the inclusion of groundwater contour maps with the annual inspection report; however, as indicated in annual reports since 2005, the well network does not provide a spatial distribution of data points necessary to generate contours without significant uncertainty. 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. Flow directions were not calculated using well triangles or any other numerical method; therefore, all flow directions discussed in this report are generalized. Water levels were increasing in wells 100-SC and 102-SC, but levels remained constant in the other Upper Sand Aquifer wells. Wells 51-SC was dry and has not recorded a water level since 2010. Well 101-SC has been dry since its installation in 2008. Water level trends in the Upper Sand Aquifer wells indicate the aquifer is still recovering from mining activities near the site.

Figure 6-5 shows piezometric head measured in wells screened in the Main Sand Aquifer, and Figure 6-6 shows these water level trends over time. According to the water levels in the Main Sand Aquifer, the apparent flow direction in the aquifer is to the south-southeast. The apparent flow direction from 2020 head data is different than the generally west flow direction reported in 2010 (DOE 2013) and the flow direction predicted for 2020 by the former licensee's model (Petrotomics 1996).

Piezometric heads have been gradually rising at all wells since 2000, with an average rate of increase of approximately 0.9 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. In response to NRC comment #2 on the 2020 annual inspection report (Orlando 2021), 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.

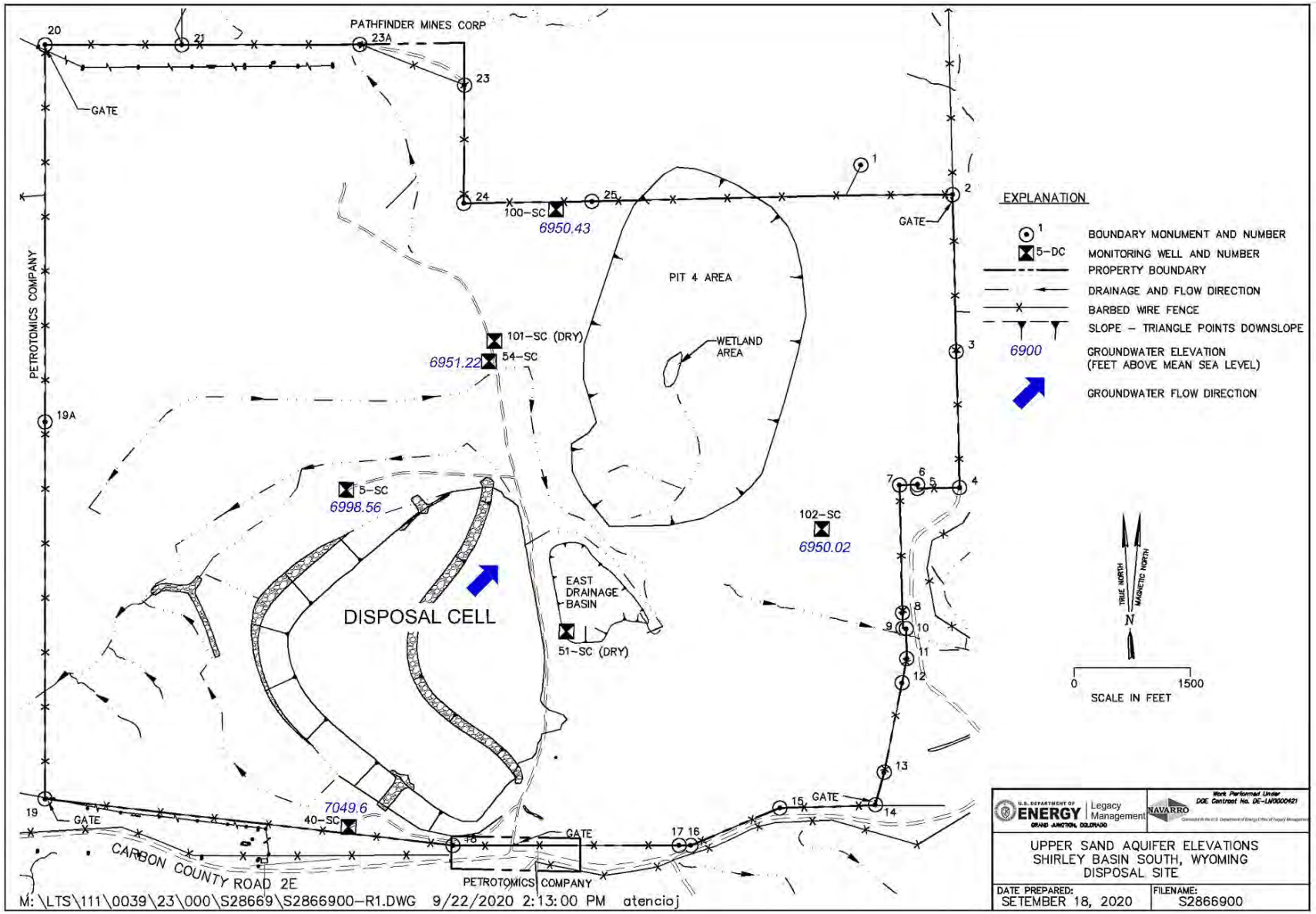


Figure 6-3. July 2020 Groundwater Elevations in the Upper Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

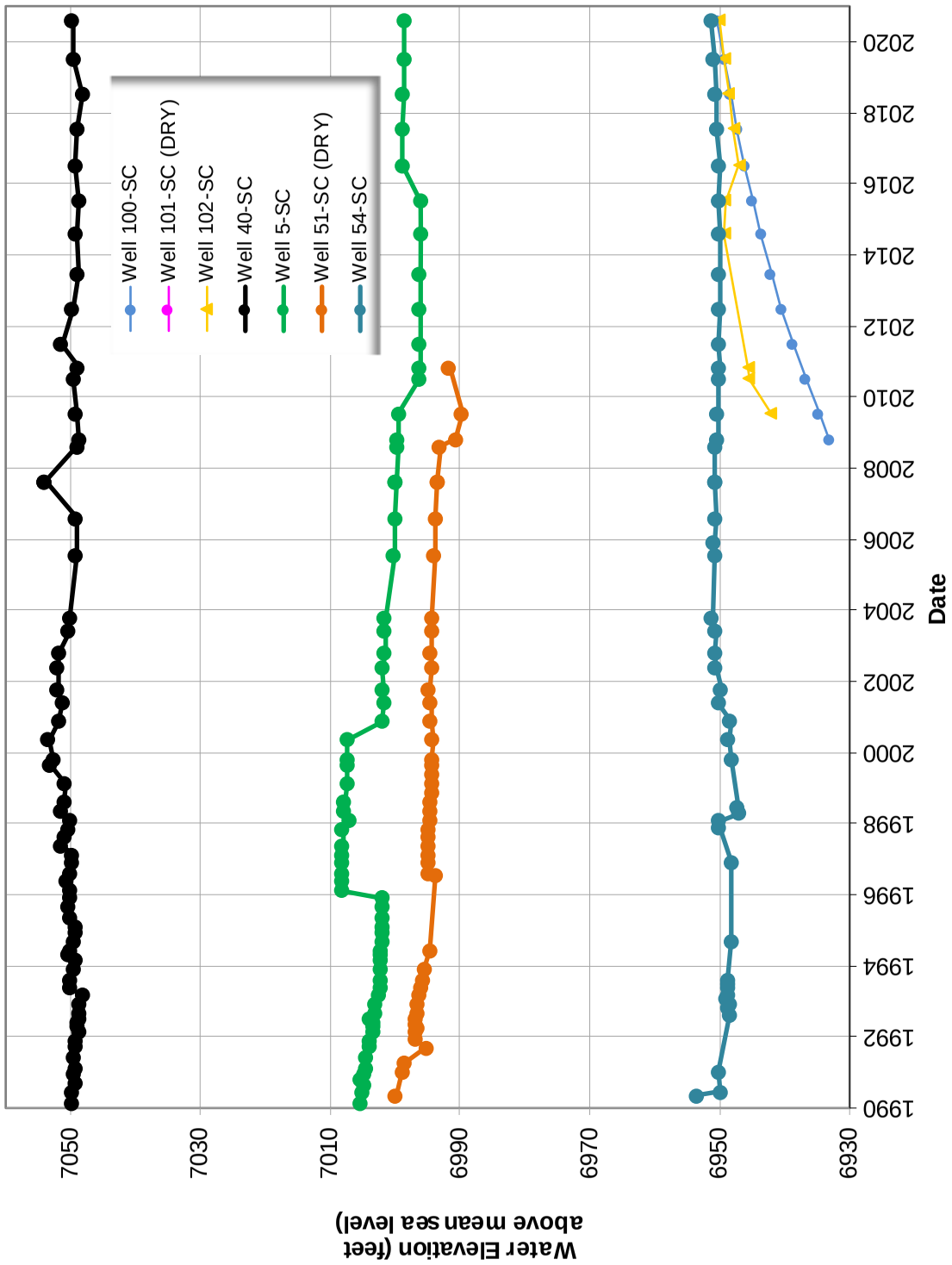


Figure 6-4. Hydrographs for Upper Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

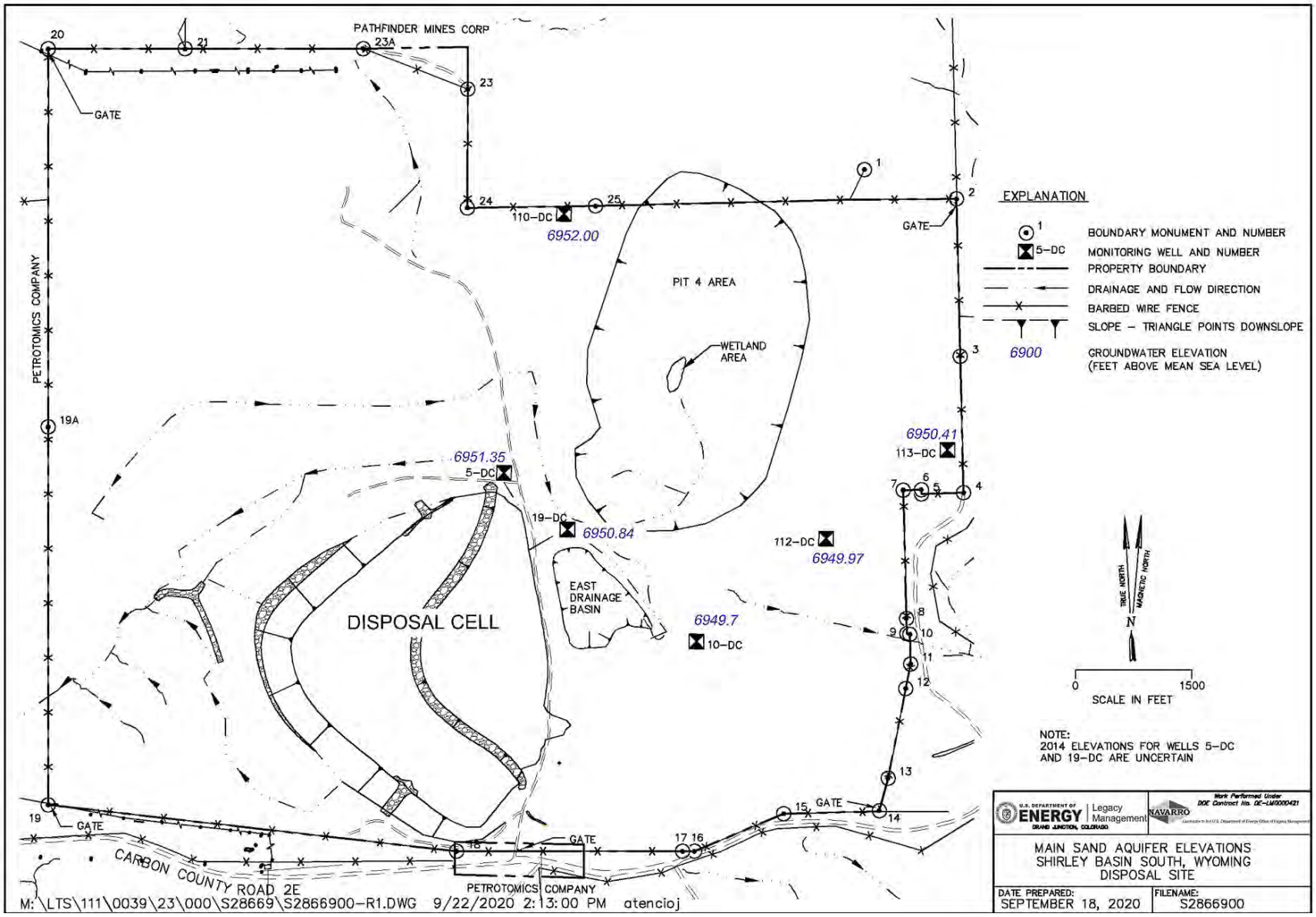


Figure 6-5. July 2020 Groundwater Elevations in the Main Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

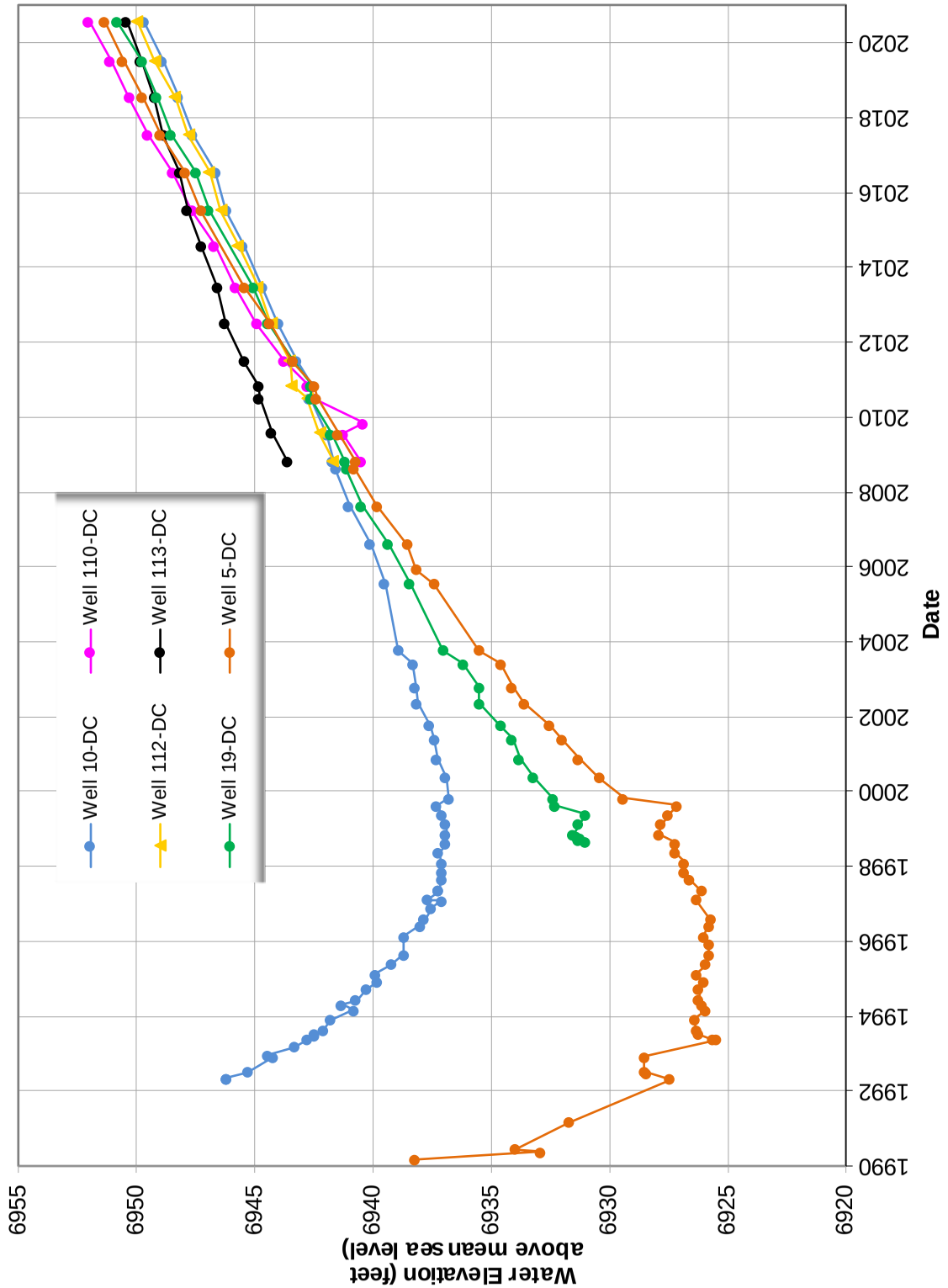


Figure 6-6. Hydrographs for Main Sand Aquifer Wells at the Shirley Basin South, Wyoming, Disposal Site

Analytical results from 2020 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. Samples could not be collected in wells 51-SC and 101-SC, because they continue to be dry. Well 51-SC has been dry since 2011, and well 101-SC has been dry since its installation in 2008.

Table 6-4. 2020 Groundwater Monitoring Results in the Upper Sand Aquifer Wells at the Shirley Basin South, Wyoming, Disposal Site

Analyte (Limit or Standard)	Well[a]						
	5-SC (POC)	40-SC	51-SC (POC)	54-SC	100-SC	101-SC	102-SC
Cadmium (0.079 mg/L)	0.032	ND	NS	0.00068J	ND	NS	ND
Chloride (2000 mg/L)	300	13	NS	420	160	NS	130
Chromium (1.83 mg/L)	0.27	ND	NS	0.22	ND	NS	ND
Lead (0.05 mg/L)	ND	ND	NS	ND	ND	NS	ND
Nickel (6.15 mg/L)	2.6	0.011J	NS	2.7	0.0029J	NS	ND
Nitrate/nitrite as N (mg/L)[b]	ND	1.3	NS	ND	ND	NS	ND
^{226}Ra (91.3 pCi/L)	5.96	0.433	NS	17.1	5.63	NS	2.15
^{228}Ra (25.7 pCi/L)	3.22	1.32	NS	***64.5***[c]	5.35	NS	1.97
Selenium (0.12 mg/L)	***0.14***[c]	0.0059J	NS	0.094	ND	NS	ND
Sulfate (3000 mg/L)	***14,000***[d]	1200	NS	***8900***[d]	1200	NS	600
Thorium-230 (2409 pCi/L)	436	ND	NS	15	ND	NS	ND
TDS (5000 mg/L)	***16,000***[d]	1900	NS	***12,000***[d]	2200	NS	1200
Uranium (9.2 mg/L)	2.8	0.00008J	NS	0.017	0.0023	NS	0.0079

Notes:
[a] ***Bold italicized*** results exceed a standard or limit.
[b] No designated limit or standard.
[c] Result exceeds an ACL.
[d] Result exceeds a Wyoming Class III groundwater protection standard.

Abbreviations:
J = the reported result is an estimated value (e.g., matrix interference was observed, or the analyte was detected at a concentration outside the quantitation range); mg/L = milligrams per liter;
ND = not detected (below method detection limit); NS = no sample collected (dry); pCi/L = picocuries per liter

The results for cadmium in POC well 5-SC and ^{228}Ra in POC well 5-DC exceeded their respective ACLs in LM's initial sampling in July 2005. Cadmium levels in both wells have since declined to below the ACL.

Table 6-5. 2020 Groundwater Monitoring Results in the Main Sand Aquifer Wells at the Shirley Basin South, Wyoming, Disposal Site

Analyte (Limit or Standard)	Well[a]					
	5-DC (POC)	10-DC	19-DC (POC)	110-DC	112-DC	113-DC
Cadmium (0.079 mg/L)	ND	ND	ND	ND	ND	ND
Chloride (2000 mg/L)	310	58	70	190	28	6.6
Chromium (1.83 mg/L)	0.14	ND	0.0028J	ND	ND	ND
Lead (0.05 mg/L)	ND	0.0011J	ND	ND	ND	ND
Nickel (6.15 mg/L)	1.3	ND	0.47	ND	ND	ND
Nitrate/nitrite as N (mg/L)[b]	0.023	0.076	ND	0.022	ND	0.073
^{226}Ra (91.3 pCi/L)	38.2	19.3	6.16	***157***[c]	13.6	2.76
^{228}Ra (25.7 pCi/L)	***52.4***[c]	4.92	6.02	6.59	7.37	2.42
Selenium (0.12 mg/L)	***0.45***[c]	ND	ND	ND	ND	ND
Sulfate (3000 mg/L)	***18,000***[d]	1000	2700	1800	1100	610
Thorium-230 (2409 pCi/L)	25.8	ND	ND	ND	ND	ND
TDS (5000 mg/L)	***21,000***[d]	1800	3800	3300	1800	1100
Uranium (9.2 mg/L)	0.03	0.011	0.00012	0.012	0.01	0.00097

Notes:
[a] ***Bold italicized*** results exceed a standard or limit.
[b] No designated limit or standard.
[c] Result exceeds an ACL.
[d] Result exceeds a Wyoming Class III groundwater protection standard.

Abbreviations:
J = the reported result is an estimated value (e.g., matrix interference was observed, or the analyte was detected at a concentration outside the quantitation range); mg/L = milligrams per liter;
ND = not detected (below method detection limit); pCi/L = picocuries per liter

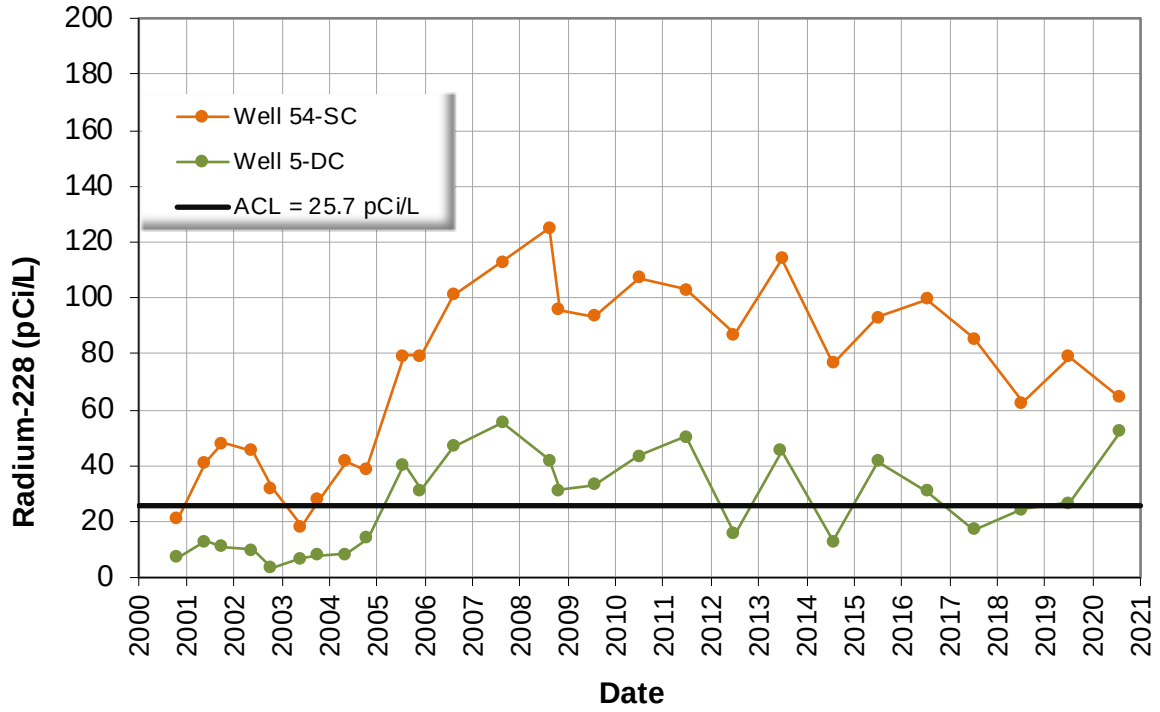
Table 6-6. Analytical Data for Well K.G.S #3 in the Lower Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

Analyte (Limit or Standard)	K.G.S. #3
Cadmium (0.079 mg/L)	ND
Chloride (2000 mg/L)	3.4
Chromium (1.83 mg/L)	ND
Lead (0.05 mg/L)	ND
Nickel (6.15 mg/L)	ND
Nitrate/nitrite as N (mg/L)[a]	ND
^{226}Ra (91.3 pCi/L)	0.593
^{228}Ra (25.7 pCi/L)	1.57
Selenium (0.12 mg/L)	ND
Sulfate (3000 mg/L)	200
Thorium-230 (2409 pCi/L)	ND
TDS (5000 mg/L)	460
Uranium (9.2 mg/L)	0.00021

Note:
[a] No designated limit or standard.

Abbreviations:
J = the reported result is an estimated value (e.g., matrix interference was observed, or the analyte was detected at a concentration outside the quantitation range); mg/L = milligrams per liter;
ND = not detected (below method detection limit); pCi/L = picocuries per liter

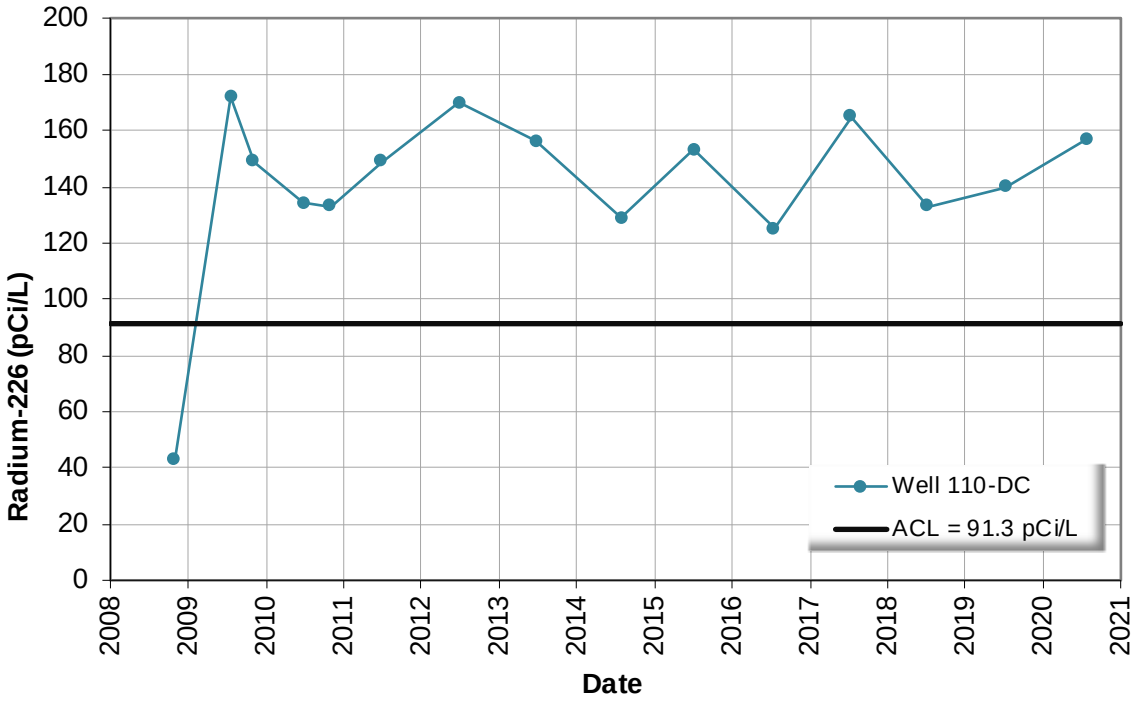
Time-concentration plots of ^{228}Ra are shown for wells 5-DC and 54-SC in Figure 6-7. Well 5-DC first exceeded the ACL for ^{228}Ra in 2005, after which concentrations have fluctuated above and below the ACL since 2012. As stipulated by the LTSP, NRC and WDEQ were notified of any exceedances in constituent ACLs. ^{228}Ra concentrations above the current ACL of 25.7 pCi/L were reported in well 54-SC since 1988 and were as high as 185 pCi/L during site groundwater remediation activities (Petrotomics 1996). 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, it is likely ^{232}Th sources are near monitoring wells 5-DC and 54-SC.



Abbreviation: pCi/L = picocuries per liter

Figure 6-7. Radium-228 Concentrations in Wells 5-DC and 54-SC Since Completion of the Disposal Cell at the Shirley Basin South, Wyoming, Disposal Site

Figure 6-8 shows ^{226}Ra concentrations in well 110-DC since the well's installation in 2008. ^{226}Ra concentrations have been consistently above the ACL in well 110-DC since 2009. Well 110-DC was considered a downgradient well at the time of installation, when groundwater flow direction in the Main Sand Aquifer was generally to the north-northeast. However, due to the recent changes in flow direction, well 110-DC is currently hydraulically upgradient from well 5-DC near the disposal cell. Elevated levels of ^{228}Ra and ^{226}Ra in wells 5-DC and 54-SC were previously attributed to mobilization of contaminants near the Pit 4 area where the Upper Sand and Main Sand units coalesce (DOE 2011b). 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.



Abbreviation: pCi/L = picocuries per liter

Figure 6-8. Radium-226 Concentrations in Well 110-DC at the Shirley Basin South, Wyoming, Disposal Site

Selenium time-concentration plots for wells 5-SC and 5-DC are shown in Figure 6-9. In 2019, the selenium ACL of 0.12 milligrams per liter (mg/L) was exceeded in POC well 5-SC and Main Sand Aquifer well 5-DC, and selenium levels remained elevated above the ACL in 2020. In response to NRC comment #1 on the 2020 annual inspection report (Orlando 2021) that suggested DOE perform evaluation of these ACL exceedances, Mann-Kendall trends were calculated for selenium and other potential tailings seepage indicator constituents: thorium-230 (^{230}Th), chloride, specific conductance, sulfate, and uranium. Time-concentration plots for each constituent and their respective Mann-Kendall trend are shown in Figure 6-10 and Figure 6-11 for wells 5-SC and 5-DC, respectively. Mann-Kendall trends were calculated from 2005, when low-flow sampling of constituents was first recorded, to 2020. Mann-Kendall trend analyses characterized 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.

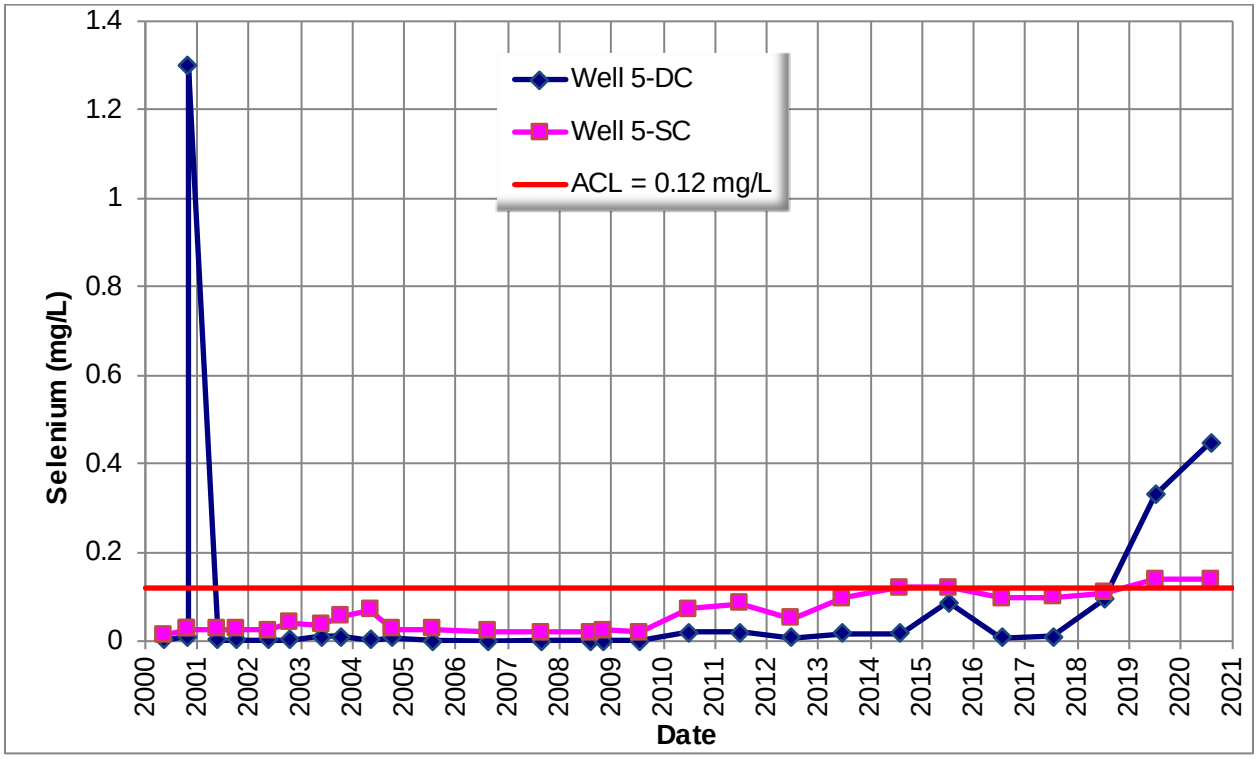
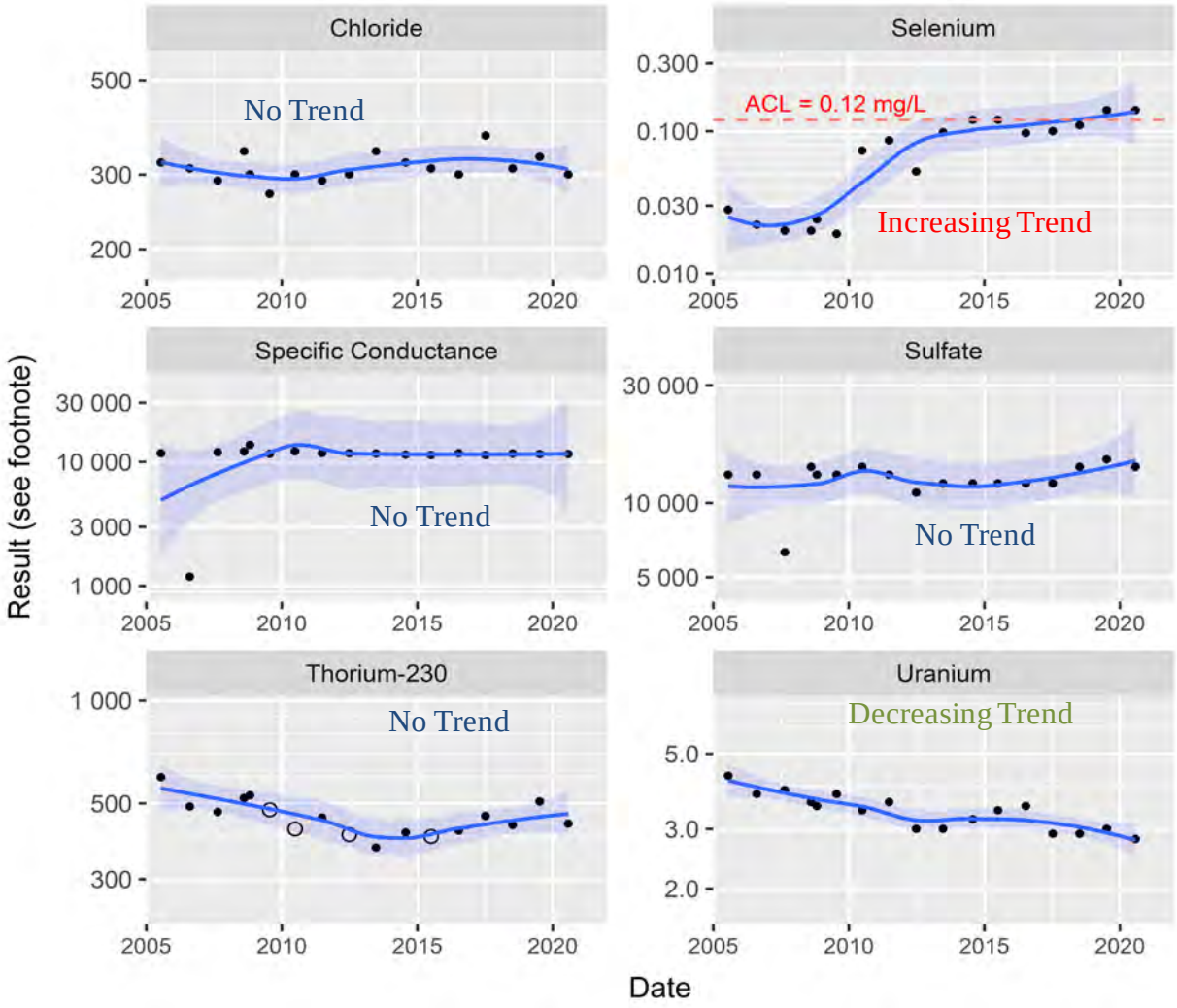


Figure 6-9. Selenium Concentrations at the Shirley Basin South, Wyoming, Disposal Site

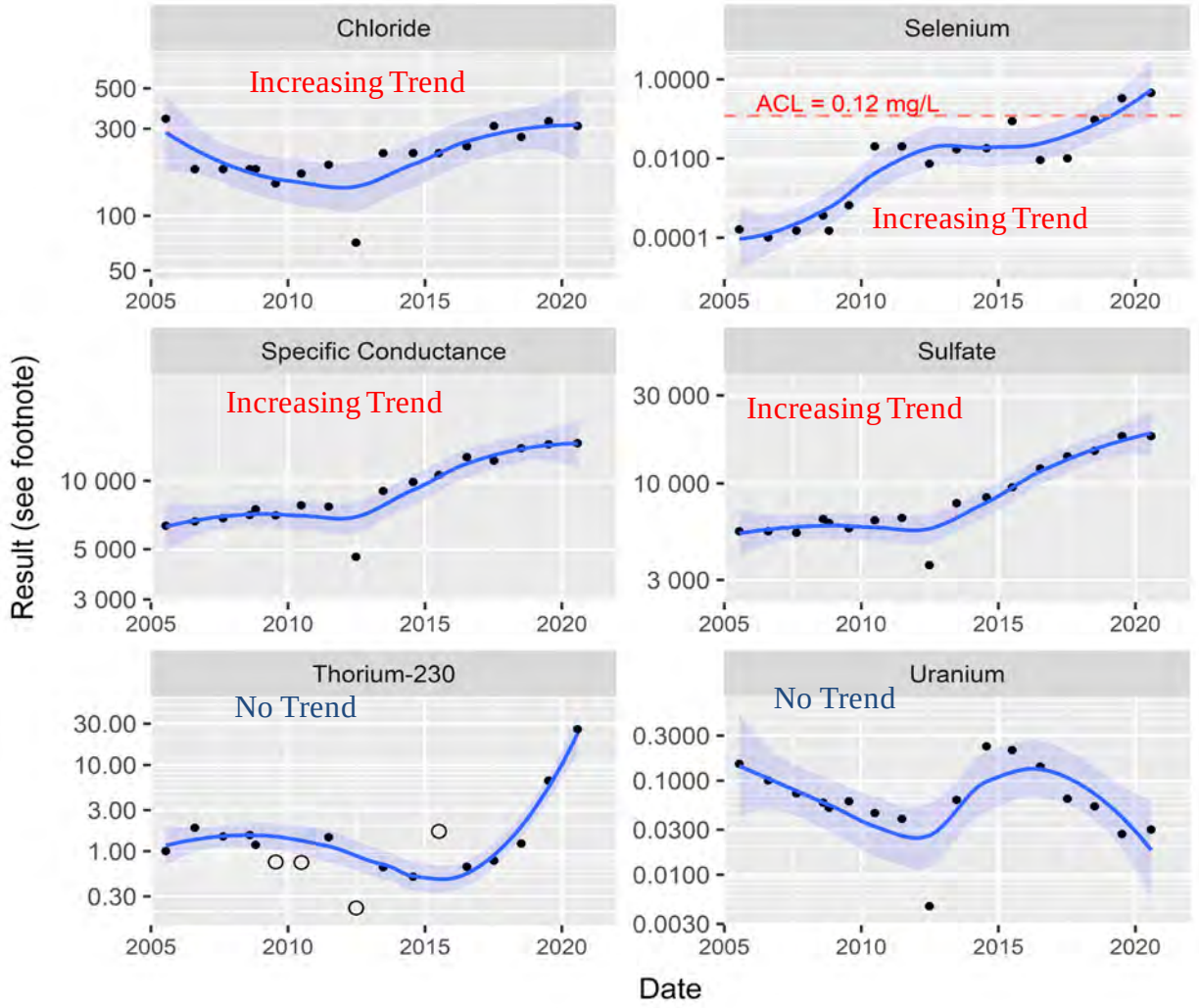
Selenium had a statistically significant increasing trend in well 5-SC, but all other constituents either had no statistically significant trend, or in the case of uranium, a decreasing trend (Figure 6-10). Well 5-SC is apparently downgradient from the disposal cell, but additional water level measurements in the Upper Sand Aquifer would be required to accurately determine flow directions in the vicinity of well 5-SC. DOE also previously noted that selenium is a relatively poor indicator constituent for tailings seepage, as selenium levels were measured to be relatively low in tailings water and attenuated easily (DOE 2011a). The source of increasing selenium in well 5-SC continues to be unknown, but Mann-Kendall trend results 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.

In addition to selenium having a statistically significant increasing trend in well 5-DC, chloride, specific conductance, and sulfate all had increasing trends in well 5-DC since 2005 (Figure 6-11). Thorium-230 and uranium each had no statistically significant trend, but ^{230}Th levels have been apparently increasing since 2016. 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, 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, potential sources of increasing contaminant trends in well 5-DC are still unknown.



Notes:
LOESS local regression line and 95% confidence interval
Units for Specific Conductance = µmho/cm
Units for Thorium-230 = pCi/L
Units for all other constituents = mg/L

Figure 6-10. Mann-Kendall Trend Analyses for Constituents in Well 5-SC, 2005-2020



Notes:
LOESS local regression line and 95% confidence interval
Units for Specific Conductance = µmho/cm
Units for Thorium-230 = pCi/L
Units for all other constituents = mg/L

Figure 6-11. Mann-Kendall Trend Analyses for Constituents in Well 5-DC, 2005-2020

In NRC comment #2 on the 2020 annual inspection report, NRC asked DOE to consider 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. Their concern is that a point-of-exposure well would be required to monitor potential seepage of contaminants from the tailings pile at the southern site boundary, given the current apparent flow direction in the Main Sand Aquifer. As discussed earlier in this section, groundwater levels continue to increase in the Main Sand Aquifer throughout the site (Figure 6-6), indicating the aquifer has not yet equilibrated from site-related activities. Groundwater elevation trends in Figure 6-6 also indicate that levels in well 113-DC are increasing at a lesser rate than those increasing in other Main Sand Aquifer wells. If groundwater elevation trends remain constant over time, well 113-DC will be the apparent point-of-exposure well within 2-3 years, based on the distribution of wells and groundwater elevations in the current monitoring well network. Groundwater elevations will continue to be monitored throughout the site with respect to

apparent flow directions in the Main Sand Aquifer to determine potential sources to contaminants in well 5-DC, and flow direction of contaminants potentially leaving the site. A more comprehensive evaluation of flow directions will be best conducted once the aquifer reaches a quasi-steady-state regarding groundwater elevations.

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.

Wyoming Class III groundwater protection standards (applicable only to chloride, sulfate, and TDS) also apply to water quality at the site boundary. The standards were met at downgradient site boundary wells (100-SC, 102-SC, 110-DC, 112-DC, and 113-DC), but the standards were exceeded for sulfate and TDS in wells 5-SC, 54-SC, and 5-DC (Table 6-4 and Table 6-5). The 2020 exceedances for sulfate and TDS were found in wells near the disposal cell.

The LTSP 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 are shown in Figure 6-12 and Figure 6-13 for the Upper Sand and Main Sand Aquifers, respectively. Figure 6-14 and Figure 6-15 show sulfate concentrations for the 2020 sampling event. 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 for 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).

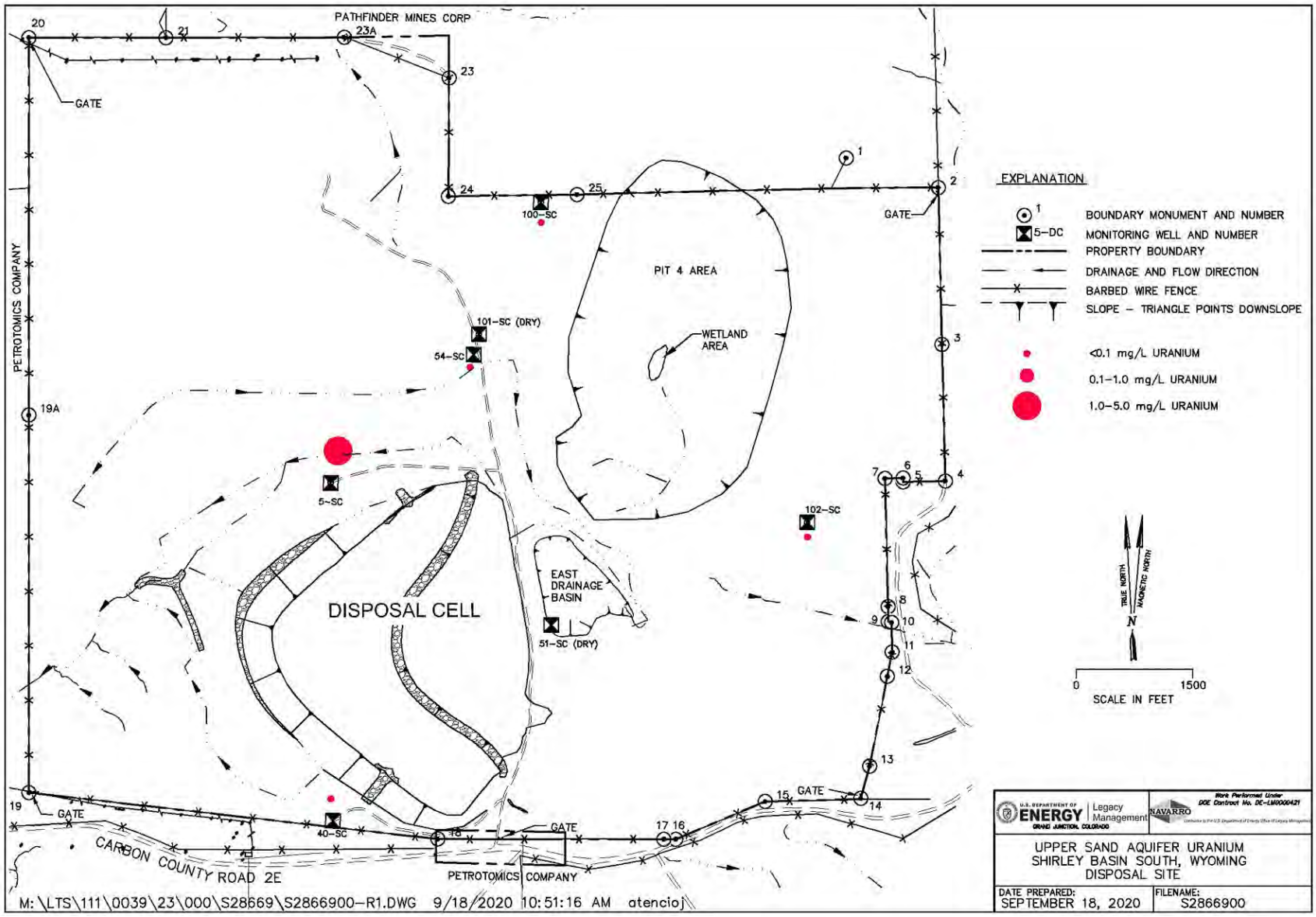


Figure 6-12. July 2020 Uranium Concentrations in the Upper Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

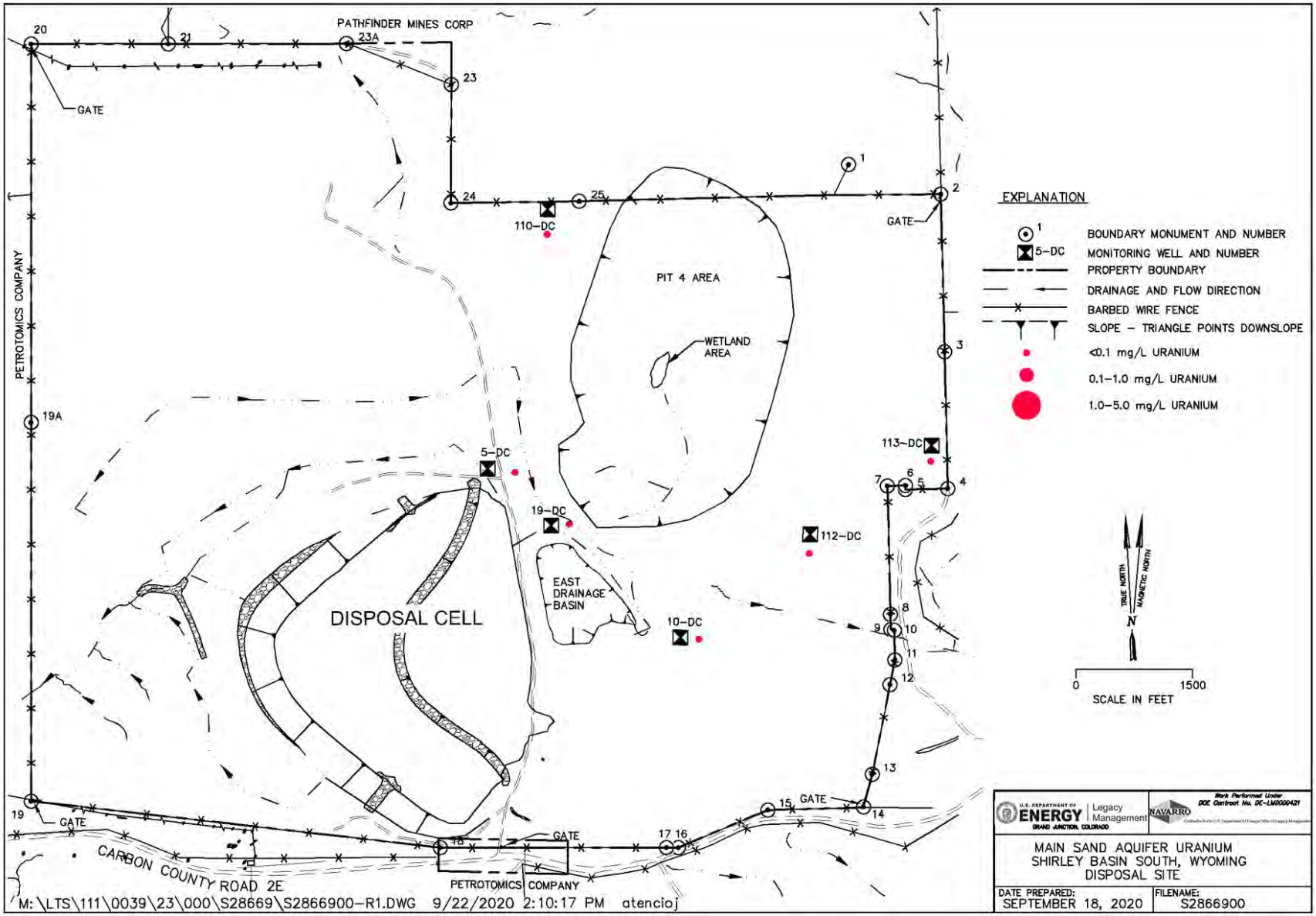


Figure 6-13. July 2020 Uranium Concentrations in the Main Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

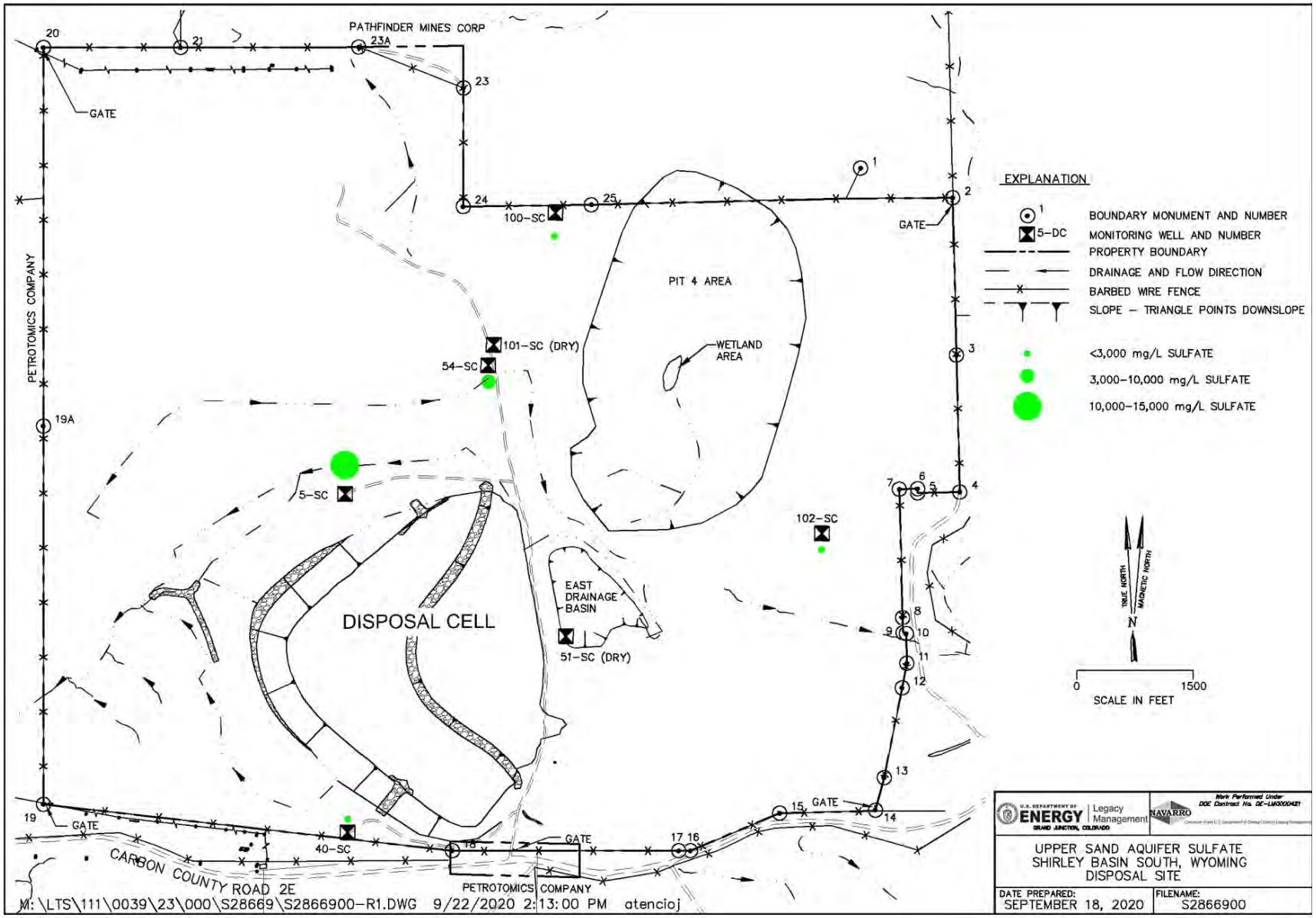


Figure 6-14. July 2020 Sulfate Concentrations in the Upper Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

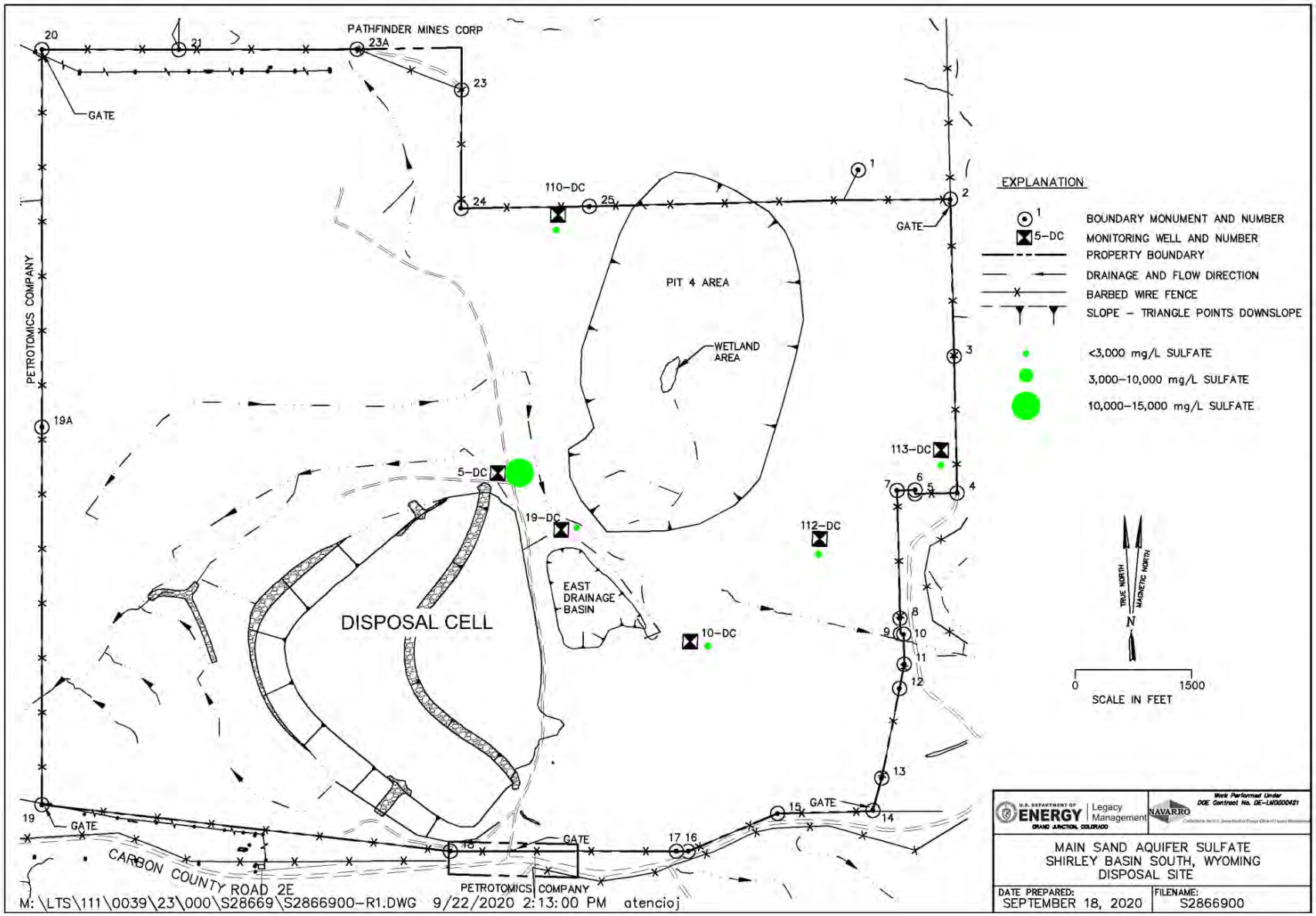


Figure 6-15. July 2020 Sulfate Concentrations in the Main Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

6.8 References

10 CFR 40.28. U.S. Nuclear Regulatory Commission, "General License for Custody and Long-Term Care of Residual Radioactive Material 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*.

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Orlando, 2021. Dominick Orlando, senior project manager, Special Projects Branch, Decommissioning and Uranium Recovery Licensing Directorate, Division of Waste Management and Environmental Protection, Office of Federal and State Materials and Environmental Management Programs, letter ([February 4, 2021] letter about U.S. Nuclear Regulatory Commission staff review of U.S. Department of Energy report titled "2020 Annual Inspection Report for Uranium Mill Tailings Radiation Control Act Title II Sites" comments on the Shirley Basin South, Wyoming, Disposal Site section) to Mark Kautsky, Program Manager, Office of Legacy Management, U.S. Department of Energy, February 4.

Petrotomics (Petrotomics Company), 1996. *Petrotomics Tailings Facility Application for Alternate Concentration Limits to Amend USNRC Source Material License SUA-551*, prepared by Shepherd Miller Inc., September.

WAR 020.0011.8.06292018. "Quality Standards for Wyoming Groundwaters," *Wyoming Administrative Rules*.

6.9 Photographs

Photograph Location Number	Azimuth	Photograph Description
PL-1	330	Perimeter Sign P26
PL-2	330	Granite Site Marker
PL-3	30	Boundary Monument 23
PL-4	90	Quality Control Monument QC7, Usually Buried Under Soil
PL-5	130	Monitoring Well 113-DC
PL-6	30	Disposal Cell Riprap Between Upper and Lower Level
PL-7	70	Cattle-Caused Path Along Riprap Near P13
PL-8	335	Basin, Southeast Corner of Site
PL-9	135	Base of North Swale Discharge Point
PL-10	45	Base of South Swale Discharge Point
PL-11	295	Rock Check Dams, Southeast Corner of Site
PL-12	105	Western Drainage Feature
PL-13	140	Erosion Feature, Western Edge of Site
PL-14	205	Pit 4 and Wetland Area
PL-15	50	Shirley Basin North Pit Lake

PL-1. Perimeter Sign P26

PL-2.Granite Site Marker

PL-3. Boundary Monument 23

PL-4. Quality Control Monument QC7, Usually Buried Under Soil

PL-5. Monitoring Well 113-DC

PL-6. Disposal Cell Riprap Between Upper and Lower Level

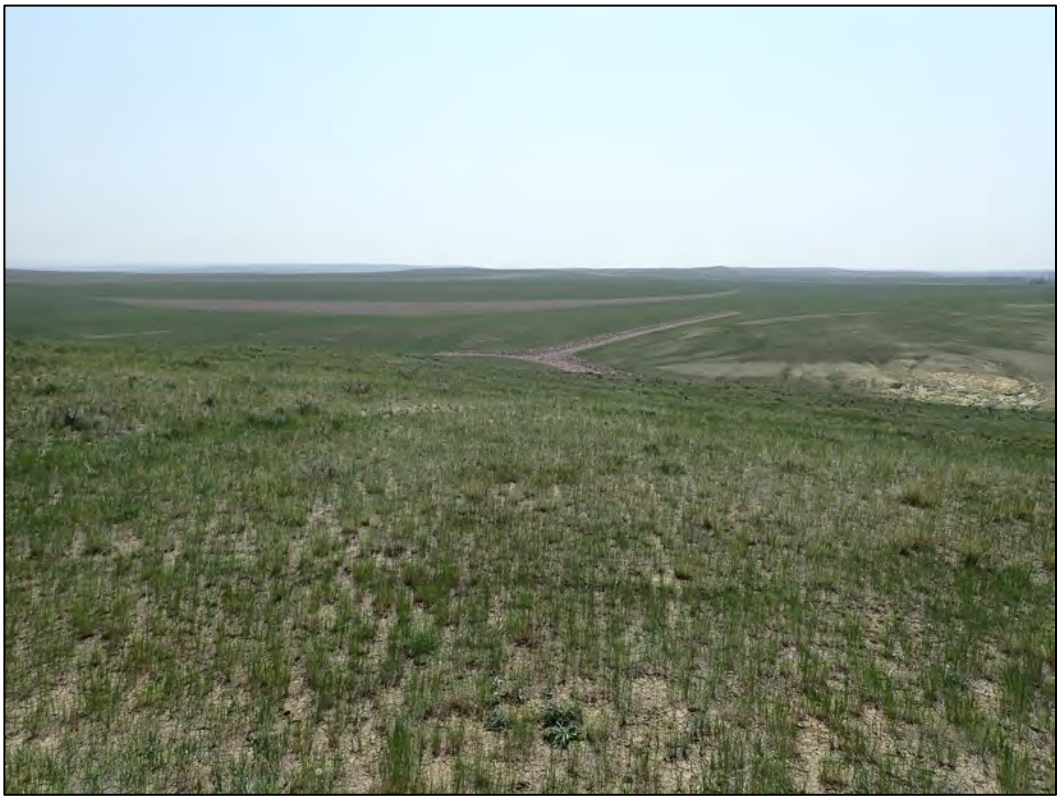
PL-7. Cattle-Caused Path Along Riprap Near P13

PL-8. Basin, Southeast Corner of Site

PL-9. Base of North Swale Discharge Point

PL-10. Base of South Swale Discharge Point

PL-11. Rock Check Dams, Southeast Corner of Site



PL-12. Western Drainage Feature

PL-13. Erosion Feature, Western Edge of Site

PL-14. Pit 4 and Wetland Area

PL-15. Shirley Basin North Pit Lake