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 September 10 and September 11, 2020. Possible settlement was observed on the north side slope of the main tailings disposal cell. Depressions continue to be observed on the north portion of the top slope of the main tailings disposal cell. A siphon is operated to remove the runoff water that accumulates in the depressions. The U.S. Department of Energy (DOE) Office of Legacy Management (LM) entered into an interagency agreement with the U.S. Army Corps of Engineers (USACE) in October 2019 to design a repair to the depressions and ensure continued positive drainage from the main tailings disposal cell. The U.S. Nuclear Regulatory Commission (NRC) will be involved in reviewing designs as they are developed and will concur on the final design before construction. Inspectors identified several routine maintenance needs but found no cause for a follow-up or contingency inspection.

Groundwater was sampled in December 2019 and August 2020. Analytical results indicate that alternate concentration limits (ACLs) were not exceeded from either sampling event. 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). A report evaluating the influences of high-volume pumping wells near the site was completed in August 2020 and provided to NRC and posted to the LM and NRC websites (DOE 2020).

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 procedures DOE 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 NRC general license (10 CFR 40.28) in 1997. DOE is the licensee and, in accordance with the requirements for UMTRCA Title II sites, 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 September 10–11, 2020. The annual inspection, which routinely occurs in March, was delayed by coronavirus-related travel restrictions. The inspection was conducted by J. Cario, N. Keller, and D. Traub of the Legacy Management Support (LMS) contractor. B. Tsosie (LM site manager), B. Frazier (LM), and A. Rheubottom (New Mexico Environment Department [NMED]) 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 determine the need, if any, for maintenance or additional inspection and monitoring.

1.4.1 Site Surveillance Features

Figure 1-1 and Figure 1-2 show the locations of site features in black and gray font, including site surveillance features and inspection areas. 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 text, 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. While the entrance gate remained functional, the top hinge pin on one side of the entrance gate was broken and was subsequently repaired following the inspection in September 2020. 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 (PL-1). 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. 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 2021 through the interagency agreement with USACE. Vegetation was also overgrown along the road paralleling the north perimeter of the site, which LM cut back in a subsequent visit in September 2020. No other maintenance needs were identified.

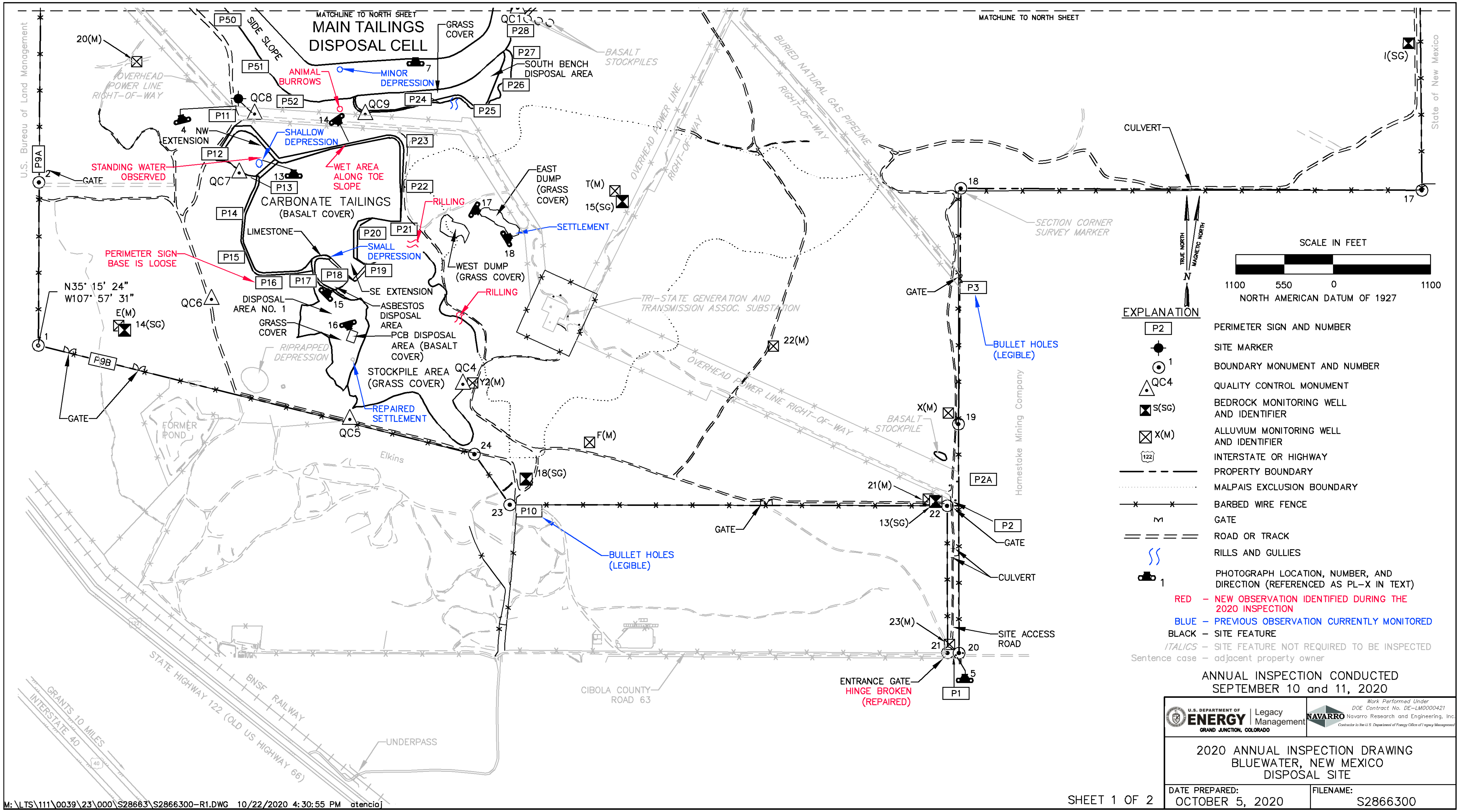

Figure 1-1. 2020 Annual Inspection Drawing for the Bluewater, New Mexico, Disposal Site (South Area)

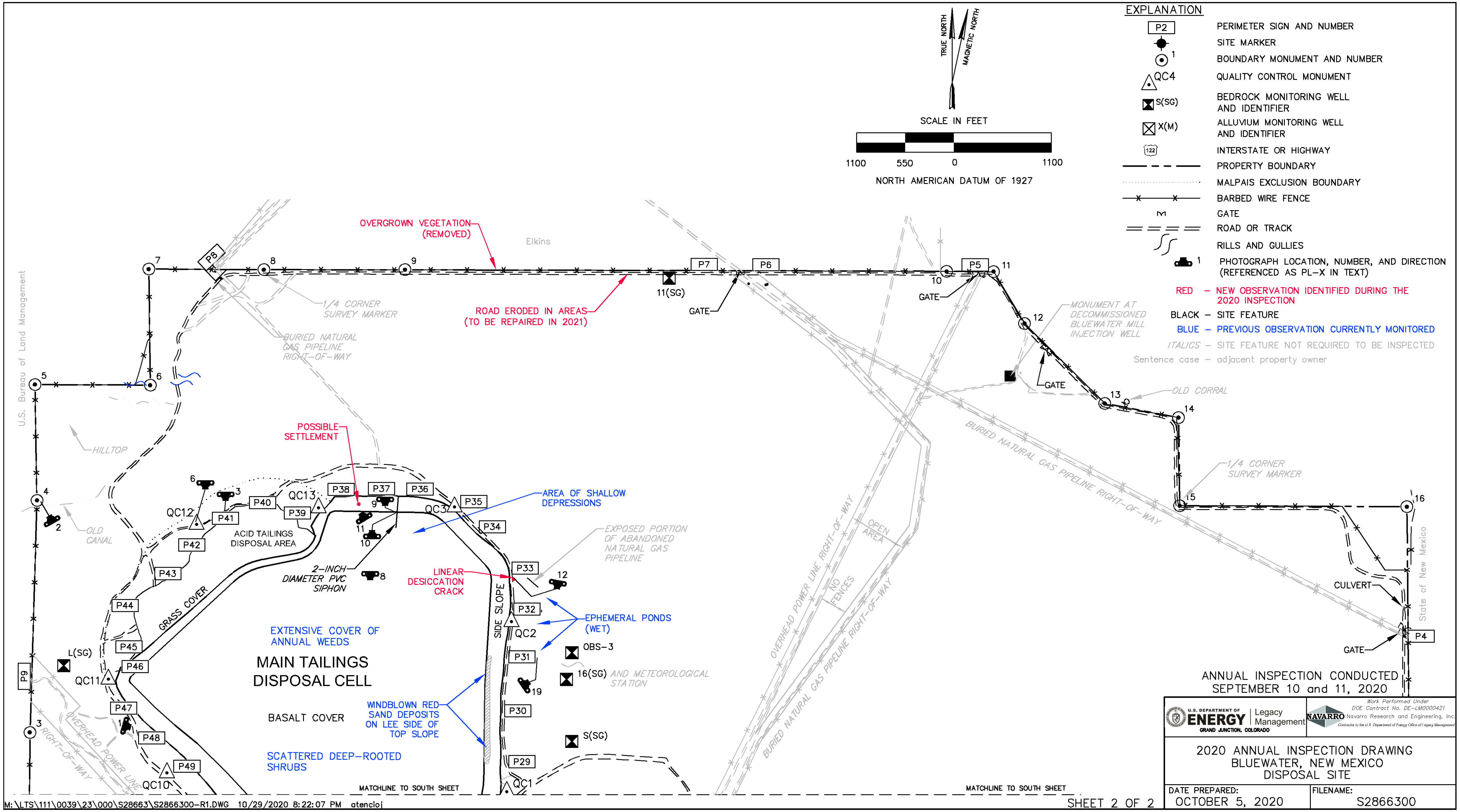

Figure 1-2. 2020 Annual Inspection Drawing for the Bluewater, New Mexico, Disposal Site (North Area)

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 (PL-2). Minor fence repairs are conducted as needed. Numerous sections of the fence are in remote areas of the site and cannot be observed from site access roads. Inspectors observed the gullies paralleling the perimeter fence northwest of the main tailings disposal cell, which were identified in the 2019 inspection. 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-3). Perimeter signs P3 and P10 have bullet hole damage but are legible. The base of perimeter sign P16 was loose, though immediate maintenance is not required. Inspectors will continue to monitor the condition of the sign. 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-4). No maintenance needs were identified.

1.4.1.4 Boundary Monuments

Twenty-four boundary monuments define the site boundary (PL-5). 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 either during the 2020 inspection or in a subsequent maintenance trip at the end of September 2020. No maintenance needs were identified.

1.4.1.5 Aerial Survey Quality Control Monuments

Thirteen aerial survey quality control (QC) monuments, installed in 2019, were inspected during the 2020 annual inspection (PL-6). 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 to transmit groundwater level and weather data to the LM office at Grand Junction, Colorado. The wellhead protectors and telemetry towers were undamaged and locked. 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-7). 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 were identified and flagged to be treated during a subsequent vegetation management trip.

Several depressions are evident on the north end of the top slope of the main tailings disposal cell and along the east and northwest edges of the top slope. This portion of the top slope overlies predominantly clay-rich tailings referred to as "slimes." Although the former licensee attempted to dewater the slimes to consolidate them, that portion of the top slope continued to settle after the site transitioned to LM. Annual inspections indicated that the depressions 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 is planned for 2021.

Ponds often develop in the depressions after rainfall and occasionally coalesce into one large pond after a series of rainstorms. The area of depressions is monitored continuously using a remotely operated webcam to detect the presence of ponded water (PL-8). 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-9). 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 was not operated in 2020 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-10). 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. An area of minor depression was observed on the south side slope during the 2018 annual inspection and was observed from the base of the main tailings disposal cell during the 2020 annual inspection, but it could not be identified from the top slope. An additional area of potential settlement was observed on the north side slope (PL-11). The side slopes will continue to be observed for depressions 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. A linear desiccation crack was observed along the base of the east side slope (PL-12). 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, for the most part, 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 rainfall runoff occasionally ponds at this location; minor ponding was observed in the depression during the 2020 inspection (PL-13). This depression does not appear to be enlarging but will continue to be visually inspected and evaluated using periodic lidar survey results. An additional wet area was observed along the north toe slope (PL-14); this is believed to be a topographic low point. 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-15). The depressions repaired in May 2018 were observed, and no changes were apparent. 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 (PL-16). Two grass-covered dumps, totaling about 2 acres, are east of the carbonate tailings disposal cell (PL-17). 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-18). 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 wet during the inspection (PL-19).

Scattered tamarisk shrubs and other plants listed as noxious weeds by the State of New Mexico are present onsite. Noxious weeds will be sprayed with herbicide by the LMS contractor in a subsequent site visit.

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 following the inspection:

- Repairing the hinge pin on the entrance gate
- Cutting vegetation along the road paralleling the north perimeter of the site

Additionally, inspectors identified the following minor maintenance needs that will be addressed in a subsequent site visit:

- Management of Siberian elm saplings on the top slope of the main tailings disposal cell
- Treatment of noxious weeds

Inspectors also identified the need to repair erosion along the interior road. This work is proposed for 2021.

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 and the fall semiannual sampling is planned for early 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.

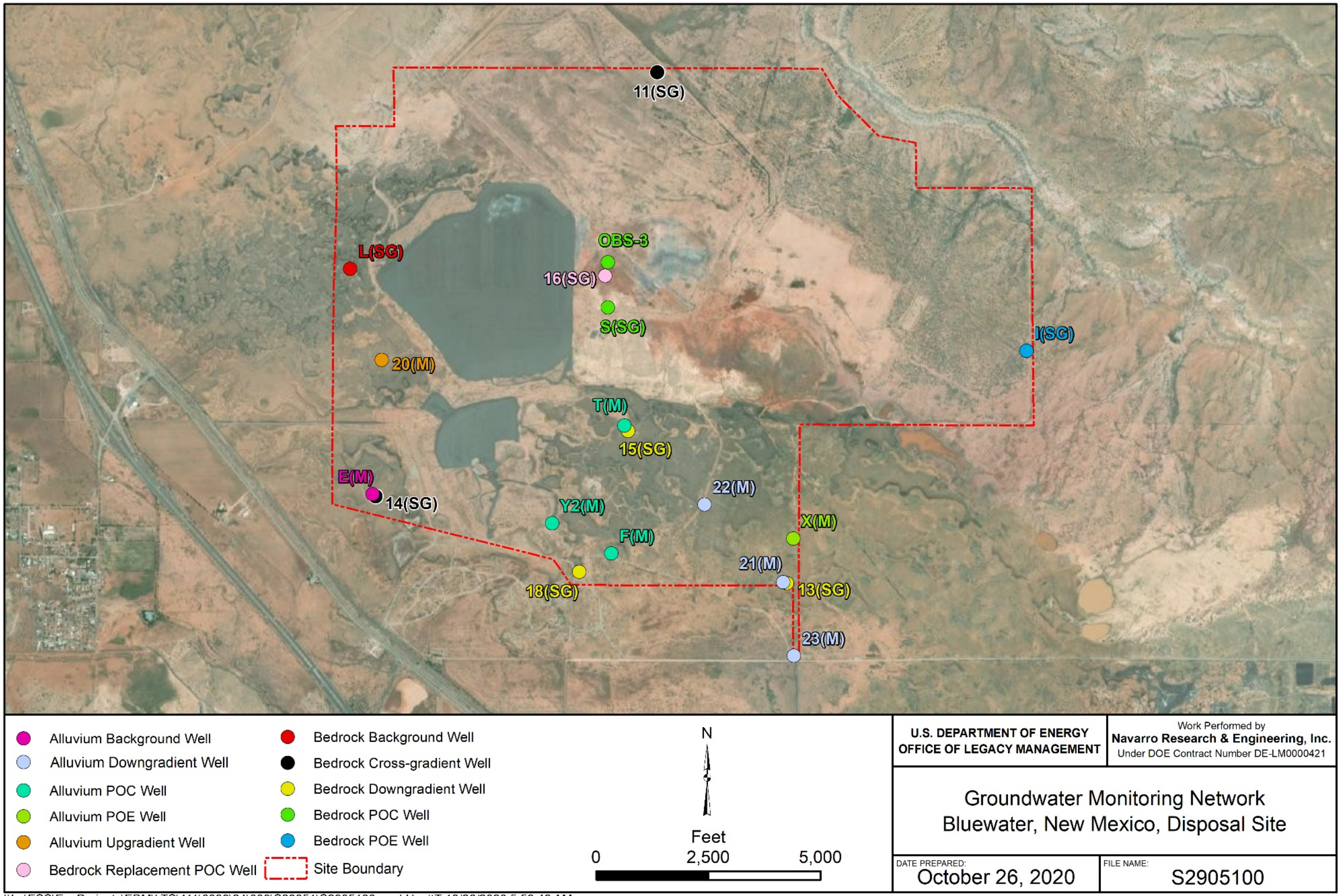

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Figure 1-3. Groundwater Monitoring Network at Bluewater, New Mexico, Disposal Site

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 in both the alluvial aquifer and SAG aquifer in a 2019 report (DOE 2019). In 2020 LM completed an evaluation of how high-volume pumping wells near the site influence groundwater flow and contaminant trends (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 and August 2020 are provided in Table 1-4. Onsite well 21(M), installed in 2011, is adjacent to the southern site boundary and penetrates a thicker section of the alluvial aquifer. Onsite well 22(M), also installed in 2011, is approximately halfway between POC well T(M) and downgradient well 21(M). The uranium concentrations in samples from these two wells (21[M] and 22[M]) during the recent sampling events were less than the uranium ACL (Table 1-4) and the NRC-approved health-based standard of 0.44 mg/L; however, the concentrations exceeded the New Mexico groundwater standard of 0.03 mg/L. Molybdenum and selenium concentrations in all onsite monitoring wells in the alluvial aquifer remain less than their respective ACLs.

Table 1-4. Alluvial Aquifer Monitoring Results in December 2019 and 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)	0.000331, ND	ND, ND	ND, 0.000129
F(M)	0.000939, 0.00106	ND, ND	0.00668, 0.00548
T(M)	NS, NS	NS, NS	NS, NS
X(M)	0.00081, 0.000862	0.00759, 0.00546	0.092, 0.0734
Y2(M)	0.00176, 0.00171	ND, ND	0.0048, 0.00429
20(M)	0.00227, 0.00214	0.00473, 0.00393	0.0149, 0.0137
21(M)	0.00101, 0.00101	0.0118, 0.00937	0.109, 0.099
22(M)	0.00535, 0.00502	0.00408, 0.00333	0.402, 0.353
23(M)	0.00298, 0.00281	ND, ND	0.0185, 0.0154

Note:
December 2019 results are first and August 2020 results are second in each pair of results.

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

Figure 1-4 shows historical uranium concentrations measured at POC well T(M) and four additional wells screened in the alluvial aquifer. As this figure shows, the uranium concentration at 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 sampled in May 2012 as declining water levels due to drought indicated it would soon go dry. Well T(M) has remained dry since 2012. Well 21(M) in the southeast corner of the site and POE well X(M) near the site's east boundary show a slightly decreasing trend in uranium concentration since 2013 (Figure 1-4). However, the elevated uranium concentrations at these two wells in recent years indicate that alluvial groundwater with uranium concentrations exceeding the New Mexico groundwater standard (0.03 mg/L) is discharging from the site toward the southeast. 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) (see Figure 1-4) before it dried up. Based on an assessment of the disposal cell cover and an accompanying evaluation of the water balance for the main tailings disposal cell, the increase in uranium concentrations in well T(M) is not attributed to a compromise of the disposal cell's performance, and there was no surge of tailings-fluid seepage from the main tailings cell since it was closed (DOE 2014). It was further concluded that water levels in well T(M) decreased during the early 2000s below the contact between the alluvium and underlying Chinle Formation from 2008 to 2012. The simultaneous increase in uranium concentration was attributed to the declining water level and the influence of contaminated groundwater migrating through and interacting with weathered Chinle Formation materials, with the resulting fluids obscuring the water chemistry of groundwater in nearby portions of the alluvial aquifer that remained saturated (DOE 2014).

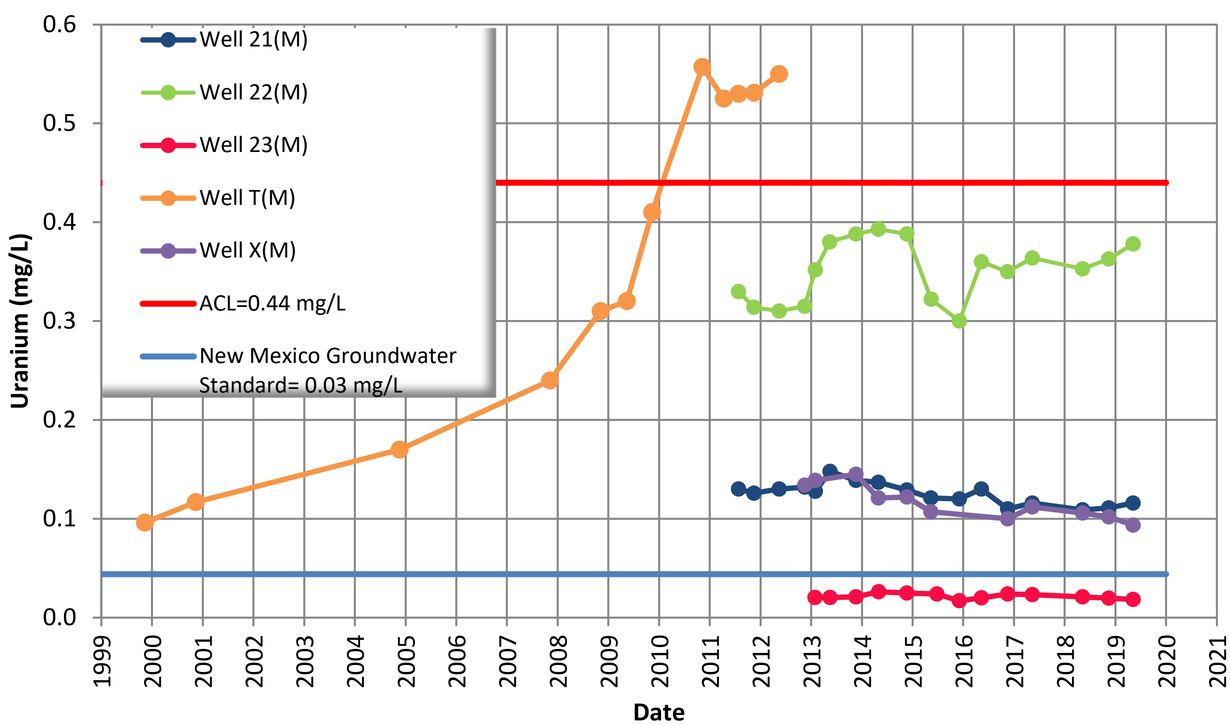

Figure 1-4. Uranium Concentrations in Alluvial Aquifer POC Well T(M) and Downgradient Wells at the Bluewater, New Mexico, Disposal Site

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 in 2017 (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 New Mexico drinking water standard (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 Bedrock Aquifer

Bedrock 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 and because a nearby offsite private well (HMC-951) just east of the site entrance gate and boundary completed in the same aquifer had elevated uranium concentrations. 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 groundwater flowing beneath the disposal cells, and all the other new wells are downgradient of the cells. Well 16(SG) was installed between POC wells OBS-3 and S(SG) because the well screens on those wells are highly corroded and their uranium concentrations seemed to be anomalously low. Because of the poor well conditions and unsuccessful rehabilitation efforts, 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.

Bedrock wells I(SG) and L(SG) were completed with open-borehole construction through the entire thickness of the San Andres Limestone and Glorieta Sandstone formations, which comprise the SAG aquifer (the formations are hydraulically connected). All the new SAG aquifer wells, except well 16(SG), are screened in the upper 50 feet of the San Andres Limestone, as are most SAG aquifer wells in the region, because this is the most productive zone of the aquifer. Well 16(SG) is screened in the Glorieta Sandstone because the water elevation is below the San Andres Limestone at that location.

Table 1-5 provides analytical results for the required constituents in bedrock wells for samples collected in December 2019 and August 2020. The selenium and uranium concentrations did not exceed ACLs in the POC wells. 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 1-5. Bedrock Aquifer Monitoring Results for December 2019 and 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)	ND, ND	0.0146, 0.0136
13(SG)	0.00703, 0.00704	0.129, 0.107
14(SG)	ND, ND	0.117, 0.105
15(SG)	ND, ND	0.0189, 0.0129
16(SG)	0.0154, 0.0131	1.22, 1.04
18(SG)	0.00714, 0.00625	0.252, 0.255
I(SG)[a]	0.00769, 0.00698	0.3, 0.272
L(SG)	ND, ND	0.00332, 0.00309
OBS-3	ND, ND	0.0032, 0.00153
S(SG)	0.00793, 0.00892	0.512, 0.455

Notes:
December 2019 results are first and August 2020 results are second in each pair of results.
[a] Sample collected at 265 feet below the top of the casing at the depth of highest conductivity.

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

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 in Figure 1-5 because the well screens are encrusted with iron scale that has resulted in erroneously low uranium concentrations since LM began sampling the wells.

As part of the ongoing monitoring program, LM continues to partner with NMED to sample offsite private wells. Most of the private wells near the site are completed in the SAG aquifer because of the limited extent of the alluvial aquifer near the site. A stock well (B-3) near the south boundary of the site, which had been a production well for the Bluewater mill, had a uranium concentration above the New Mexico drinking water standard in 2013 but below limits considered safe for livestock consumption (0.57 mg/L as recommended by the National Research Council of the National Academy of Sciences and 0.2 mg/L as recommended by the Food and Agriculture Organization of the United Nations). All other private SAG wells sampled by NMED, whether permitted for drinking water or agricultural use, had uranium concentrations below the New Mexico drinking water standard. The nearest downgradient municipal wells are along the New Mexico Highway 122 corridor and are operated by the Village of Milan. They produce water from the SAG aquifer. Municipal sampling results have not had uranium concentrations exceeding the drinking water standard or shown upward trends.

The extent of uranium contamination in the SAG aquifer and the potential risk to downgradient groundwater users was evaluated in LM's groundwater conceptual model (DOE 2014) and in an update to the plume maps (DOE 2019). Evaluation of previous groundwater studies in the region and available groundwater data indicated that the ambient flow path of the groundwater in the aquifer from the site is to the east-southeast. The groundwater from the site passes under the Homestake mill site and turns south toward Grants because of the influence of a major fault that passes under Grants (San Rafael Fault). The flow path from the site is to the north of the Milan municipal wells (Figure 1-6).

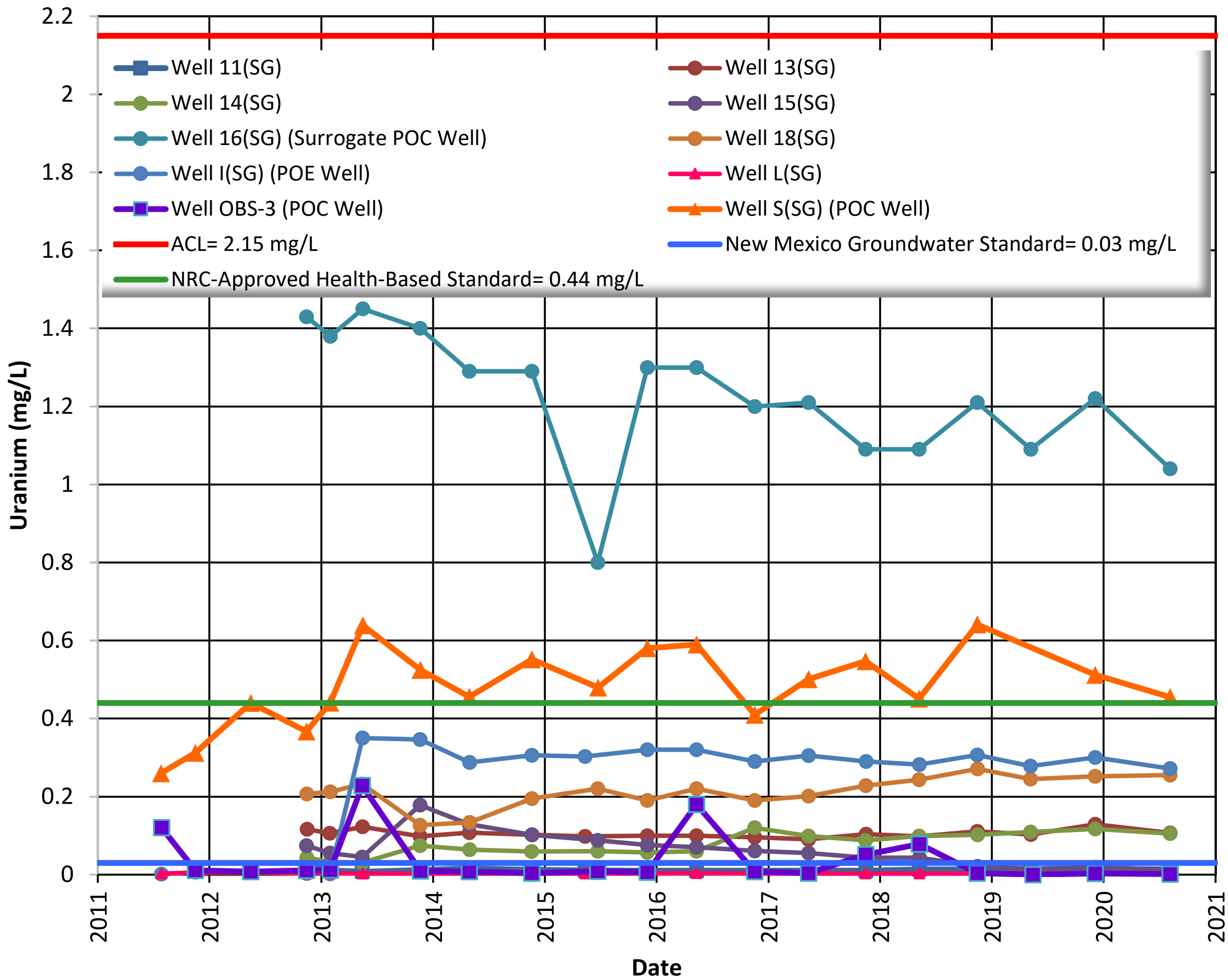

Figure 1-5. Uranium Concentrations in the San Andres/Glorieta Aquifer at the Bluewater, New Mexico, Disposal Site

The estimated extent of the uranium plume based on data collected primarily in 2017, described in the updated groundwater model (DOE 2019), is shown in Figure 1-7. The uranium plume follows the groundwater flow path, and the leading portion is near the Homestake site. Groundwater monitoring results obtained by various entities over the last several decades indicate that uranium contamination from Bluewater mill operations reached the Homestake site by 1980 and that the plume has essentially stabilized (i.e., it is not continuing to migrate to the east). Uranium concentrations attenuate with distance from the site primarily through dispersion instead of chemical reduction because of the absence of a reducing environment in the aquifer formations (DOE 2014). No known drinking water wells are completed within the uranium plume, and site-derived uranium contamination in the SAG aquifer is not expected to impact the Milan or Grants municipal water supplies that are pumped from SAG aquifer wells (DOE 2014; DOE 2019).

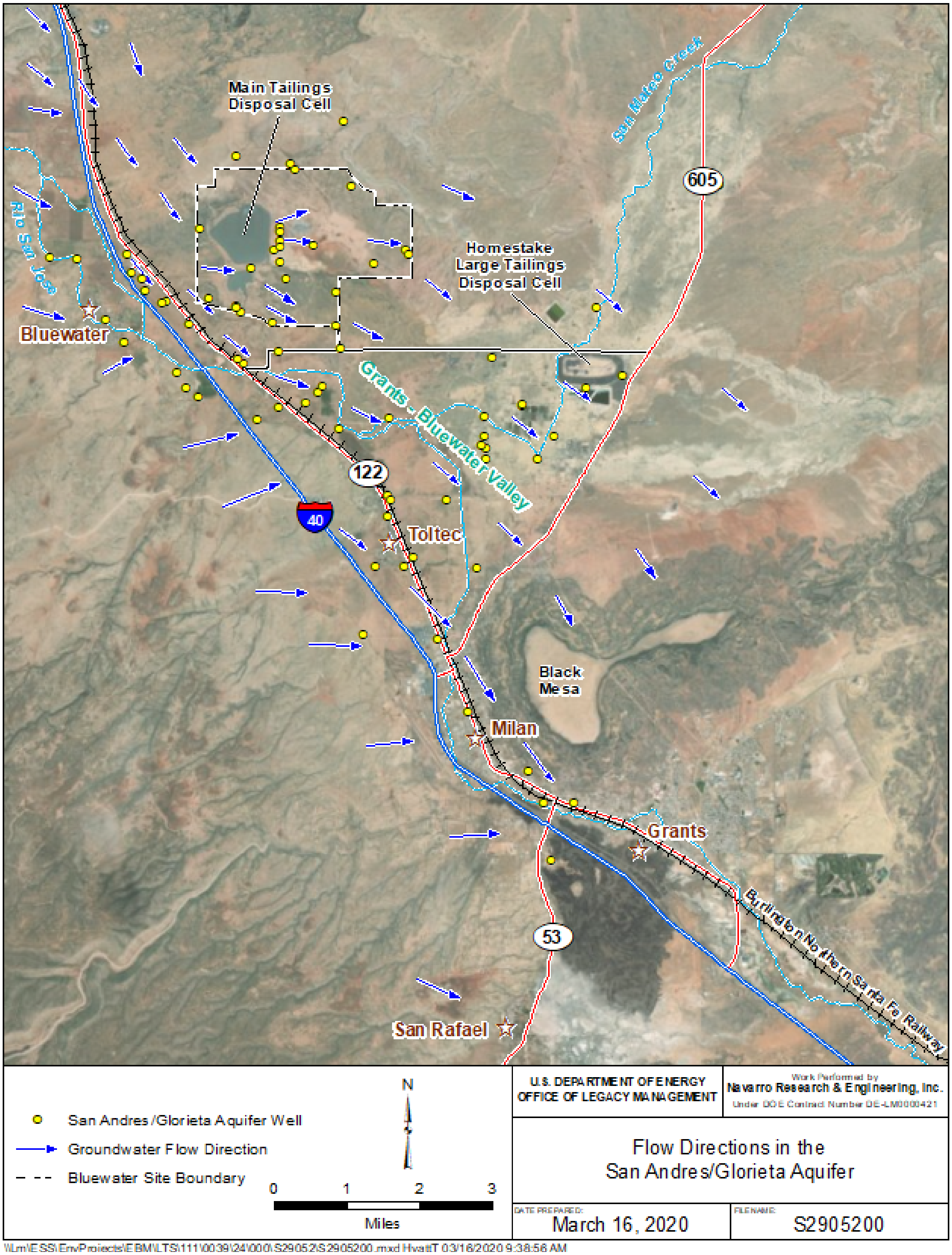

Figure 1-6. Groundwater Flow Directions in the San Andres/Glorieta Aquifer at the Bluewater, New Mexico, Disposal Site

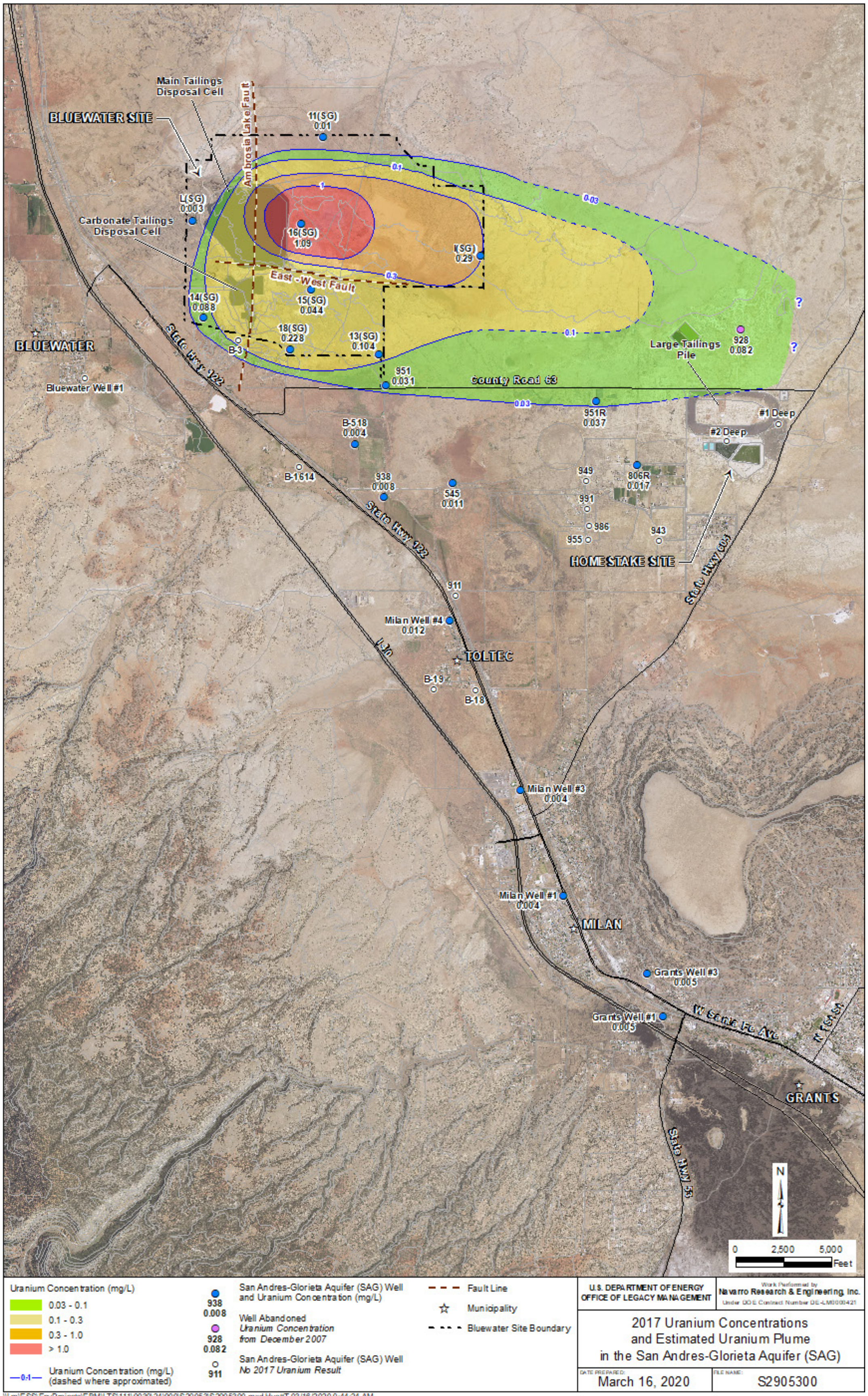

Figure 1-7. 2017 Estimated Uranium Plume in the San Andres/Glorieta Aquifer (DOE 2019)

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.

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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	105	Access Road and West Side Slope of the Main Tailings Disposal Cell
PL-2	330	Fence Line Near Boundary Monument BM-4
PL-3	180	Perimeter Sign P41
PL-4	345	Site Marker
PL-5	—	Boundary Monument BM-20
PL-6	180	Quality Control Monument QC12
PL-7	0	Main Tailings Disposal Cell Top Slope
PL-8	180	Main Tailings Disposal Cell Webcam
PL-9	180	Siphon on the Top Slope of the Main Tailings Disposal Cell
PL-10	0	Siphon on North Side Slope of the Main Tailings Disposal Cell
PL-11	330	Potential Settlement on the North Side Slope of the Main Tailings Disposal Cell
PL-12	190	Linear Desiccation Crack
PL-13	—	Ponded Water Near Shallow Depression on the Northwest Extension of the Carbonate Tailings Disposal Cell
PL-14	145	Wet Area Near North Toe Slope of the Carbonate Tailings Disposal Cell
PL-15	45	Asbestos Disposal Area
PL-16	165	PCB Disposal Area
PL-17	120	East Dump
PL-18	60	Settlement in Fill Covering Basalt at the Interface of the East Dump Cover
PL-19	55	Wet Ephemeral Ponds

Note:
— = Photograph taken from directly above.

PL-1. Access Road and West Side Slope of the Main Tailings Disposal Cell

PL-2. Fence Line Near Boundary Monument BM-4

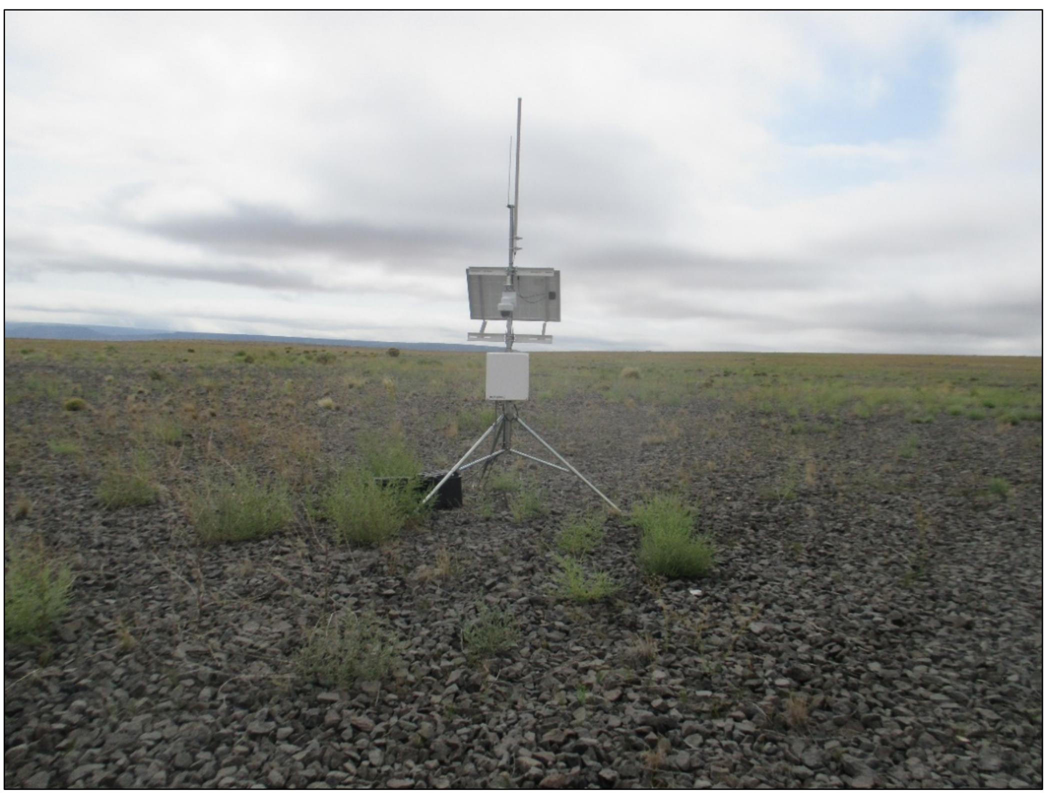
PL-3. Perimeter Sign P41

PL-4. Site Marker

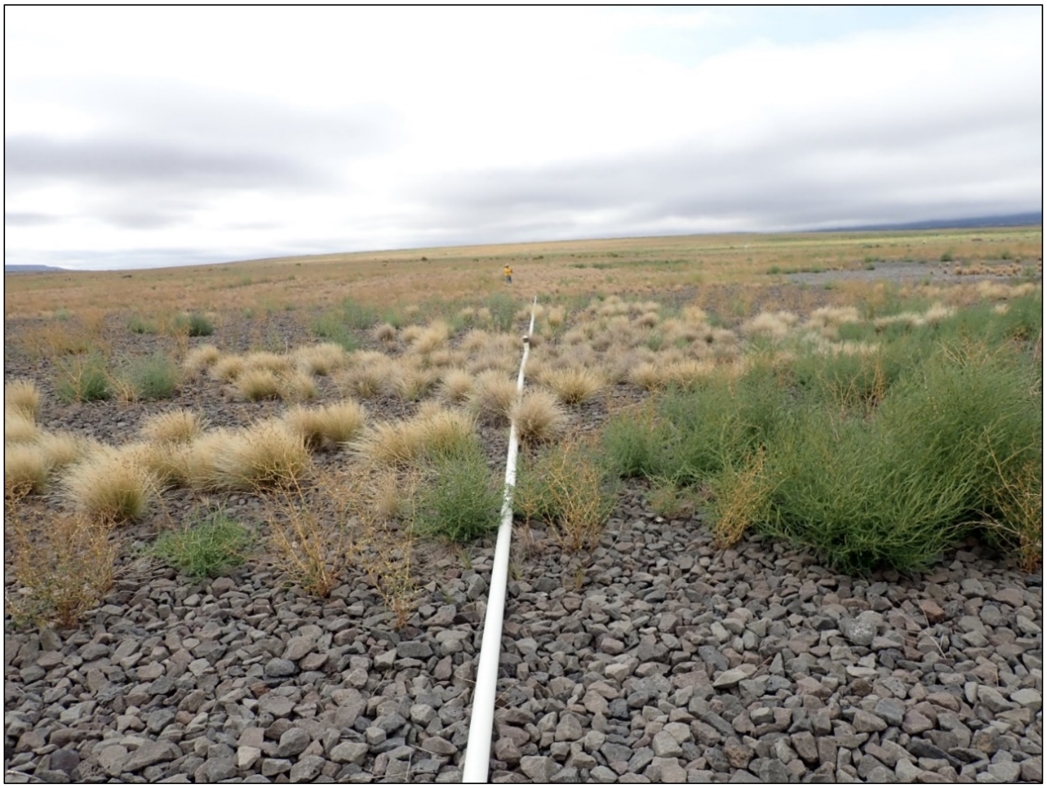
PL-5. Boundary Monument BM-20

PL-6. Quality Control Monument QC12

PL-7. Main Tailings Disposal Cell Top Slope



PL-8. Main Tailings Disposal Cell Webcam



PL-9. Siphon on the Top Slope of the Main Tailings Disposal Cell

PL-10. Siphon on North Side Slope of the Main Tailings Disposal Cell

PL-11. Potential Settlement on the North Side Slope of the Main Tailings Disposal Cell

PL-12. Linear Desiccation Crack

PL-13. Ponded Water Near Shallow Depression on the Northwest Extension of the Carbonate Tailings Disposal Cell

PL-14. Wet Area Near North Toe Slope of the Carbonate Tailings Disposal Cell

PL-15. Asbestos Disposal Area

PL-16. PCB Disposal Area

PL-17. East Dump

PL-18. Settlement in Fill Covering Basalt at the Interface of the East Dump Cover

PL-19. Wet Ephemeral Ponds