FY-23 DOE-LM
BLUEWATER DISPOSAL SITE
BLUEWATER, NM

SUBSURFACE INVESTIGATION PLAN
June 2023

Prepared by:

U.S. ARMY CORPS OF ENGINEERS
ALBUQUERQUE DISTRICT
GEOTECHNICAL ENGINEERING SECTION

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1.0 Background

1.1 Bluewater Disposal Site

The Bluewater disposal site is located approximately 10 miles northwest of Grants, New Mexico. The Bluewater site is a Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II site that is managed by the Department of Energy Office of Legacy Management (DOE-LM) office out of Grand Junction, Colorado. The Bluewater disposal site is owned by DOE and has a total area of 3,300 acres; the main tailings disposal cell has an area of 354 acres and contains an estimated 23 million tons of uranium mill tailings and other contaminated materials having a total activity of about 11,200 curies of radium-226. Management of the site was transferred to DOE in 1997. A vicinity map indicating the location of the Bluewater site is included as Figures 1 and 2 of **Appendix A**.

At the time that responsibility for the site transitioned to DOE it was noted that depressions were forming on the top of the main tailings disposal cell. These depressions become filled with precipitation runoff which results in large seasonal ponds of up to 4.3 million gallons in volume. There is a risk that if the ponds exceed 7.1 million gallons they will drain spontaneously by overtopping the disposal cell top slope at the lowest point, potentially eroding the cover and releasing residual radioactive material. To mitigate this risk DOE-LM has proposed that the top slope be re-graded and a new spillway constructed to control drainage of accumulated precipitation from the top of the disposal cell. Fill material used to repair the cell cover will be a Vegetative Soil-Rock Matrix cover unless otherwise necessary. DOE-LM has requested design and construction support from the U.S. Army Corps of Engineers (USACE), Albuquerque District.

1.2 Subsurface Investigation Work Plan

The purpose of this subsurface investigation work plan is to outline the investigation scope and procedures that will be used to support the future design and construction objectives of the disposal cell repair. Key elements of this work plan include the design and investigation objectives and the scope and methodology of investigation activities detailing activity phasing and site restoration procedures.

2.0 Objectives

2.1 Design Objectives

The design objectives for the repair of the Bluewater disposal cell are provided in the project scope of work and are provided below:

A. Construct a new disposal cell spillway at the Bluewater, New Mexico, Disposal Site Main Tailings Disposal Cell and ensure positive drainage of the entire disposal cell cover.
B. Areas of disposal cell cover on the top slope that are disturbed shall be replaced with a Vegetative Soil-Rock Matrix cover (vegetative cover) unless otherwise necessary.
C. Determine how a planted soil-rock admixture, placed over areas of cell disturbance, will perform as a water balance cover.

D. Identify what can be done to improve the performance of the redesign to maximize evapotranspiration and minimize infiltration for long-term cost savings.
E. Work with Legacy Management/Legacy Management Support (LM/LMS) to integrate lessons learned.
F. Use data collected during subsurface investigation to estimate potential for future settlement of the cell and inform the design alternatives as how to address the potential settlement. Future settlement will be analyzed as secondary consolidation or “creep settlement”.

2.2 Investigation Objectives

The objectives of this subsurface investigation are aligned to support the design objectives outlined above and include:

A. Determine the profile thickness of the radon barrier overlaying the tailings both within and surrounding the area of the depression on the disposal cell.
B. Determine the stratigraphy, nature, and geotechnical properties of subsurface materials within the disposal cell.
C. Determine the pore water pressures present within the tailings below the depressions and the surrounding area.
D. Determine the suitability of potential onsite borrow material for use in the vegetative cover.

The primary objective of this subsurface investigation is to determine the profile thickness of the radon barrier overlaying the tailings within the area of the existing depression and the immediate area surrounding this depression. Construction of a new spillway will require excavation into the radon barrier and this layer must be accurately characterized as part of design.

This Subsurface Investigation Plan for design includes cone penetrometer testing (CPT) of the disposal cell and sampling and testing of onsite potential borrow material to characterize soil conditions for use as a vegetative soil-rock matrix cover. The subsurface investigation and related geotechnical portions of the project shall comply with, but not be limited to, the following referenced material and criteria:

- Engineering Manual (EM) 1110-2-1906, Engineering and Design, Laboratory Soils Testing, 30 November 1970, updated 20 August 86.
- EM 1110-1-1804, Engineering and Design, Geotechnical Investigations, 1 January 2001.

In the event a conflict of criteria occurs, the more stringent requirement shall apply.

3.0 Exploration Team

The following table list members of the exploration team used in developing the subsurface investigation plan.

TEAM MEMBER	ORGANIZATION (DISCIPLINE)	PHONE NUMBER
Michael Mills, P.E.	CESPA-EC-GG (Geotechnical Section Chief)	(505) 342-3157
Matt Bonner, P.E.	CESPA-EC-GG (Geotechnical Engineer)	(505) 342-3173
Chris Carroll, P.G.	CESPA-EC-GG (Geologist)	(505) 342-3663

4.0 Existing Information

4.1 Site History

Anaconda Copper Mining Company signed a contract with the Atomic Energy Commission (AEC) in December 1951 for the production of uranium concentrate at a mill site near Bluewater, NM (McLemore and others, 2020). The original Bluewater carbonate-leach uranium mill was constructed by Anaconda to process ore from the nearby mines in the middle Jurassic age Todilto Limestone, also known as Pony Express Limestone. The mill began operations in October 1953 with a capacity of 300 tons of ore per day; by March 1955 the mill capacity was expanded to 1,200 tons per day. Tailings disposal from this carbonate process was in natural depressions in the basalt-flow surface just northeast of the mill site.

Discovery of adjacent Jurassic sandstone uranium ores and development of the Jackpile and Paguate mines resulted in construction of an acid leach mill with a capacity after completion in December 1955 of 2,000 tons of ore per day. Tailings from the acid leach process were placed in a natural basin area north of the carbonate tailings, and dikes were constructed on the northern, eastern, southern, and southwestern boundaries of what presently is the main tailings disposal cell. In 1957, a northwestern dike was constructed to fully contain the tailings. Prior to that time, the tailings that had drained northward beyond the dike were called the old acid tailings. The dikes around the main tailings pile were raised several times to increase the capacity of the tailings area.

In May 1959, the carbonate leach mill was closed and the acid mill capacity was reduced for economic reasons. In December 1967, the acid leach mill resumed full production, which continued until August 1980. In November 1978, the capacity of the acid leach mill was increased to 6,000 tons per day. Milling operations ended at the site on 14 February 1982.

Migration of contaminated mill process water from the main tailings pile into the principal aquifer (San Andres Limestone) had become a problem by the late 1950s. After much research regarding acceptable effluent disposal methods, the Anaconda Company began deep underground disposal. A disposal well, now referred to as "the injection well", about 1 mile (1.6 km) northeast of the main tailings pile was drilled, tested, and developed in 1959 and 1960. The well was cored to a depth of approximately 2,500 ft (770 m) and, from test data, sandstone of the Yeso Formation of Permian age from depths of 950 to 1,423 ft (289.8 to 434 m) was selected to accept the injected effluent. Details of the well drilling, coring, and analysis are in the U.S. Geological Survey Professional Paper 386-D by West (1972). Fluid disposal by injection into this well began in December 1960 and continued until late 1977 at a rate of 200 to 400 gallons (750 to 1500 liters) per minute. A filtration system was used to control the uranium concentration to less than 5 parts per million. ARCO abandoned and plugged the disposal well in October 1995 in accordance with regulations and requirements of the State Engineer and the New Mexico Water Quality Control Commission. The plugging and abandonment procedure used for the injection well are given in Section 4.17 of the Completion Report (ARCO, 1996). After liquid disposal by well injection ceased, seven synthetically lined evaporation ponds covering about 300 acres (120 ha) were constructed to the north and northeast of the main tailings pile to contain the liquid effluent from the milling process. After milling operations ended, dewatering of the main tailings pile began and continued until September 1985. Wells were installed in the sands portion of the tailings, and tailings liquids were pumped back to the mill where dissolved uranium was removed by solvent extraction. The barren raffinate was at first pumped back to the main tailings pile and distributed, but from November 1983 to September 1985, it was pumped directly to the evaporation ponds.

The AEC was the first to regulate the Bluewater mill. Later, the State of New Mexico regulated the mill activities under authority of Section 274 of the Atomic Energy Act of 1954. The State relinquished this authority in June 1986, at which time the Nuclear Regulatory Commission (NRC), Region IV, assumed regulatory authority. The site came under Title II of UMTRCA, after passage of the Act in 1978, and subsequent rulemaking by the NRC, beginning in 1988.

From March 1981 to 1984, Anaconda submitted technical licensing documents to the New Mexico Environmental Improvement Division to support various licensing actions. These numerous technical documents consisted of tailings reclamation designs, environmental settings and analyses, and assessments of environmental impacts; all these documents are available in the site file. Together, these multiple-volume technical documents are considered an Environmental Report (ER) by the NRC. In 1984, the ER supported a license renewal application and mill modification proposal. This application was approved as was the mill modification; however, milling operations never resumed, and in 1985 Anaconda ceased operations and began to decommission the mill.

In January 1986, Anaconda changed its name to ARCO Coal Company and later that year, the NRC assumed regulatory authority over the site. In 1987, houses were removed from the old Anaconda housing area south of the mill site. In November 1986, ARCO submitted a Reclamation Plan for the mill facilities to the NRC for review and approval. In early 1989, while the Reclamation Plan was undergoing NRC review, the NRC revised its slope stabilization and rock specifications, which in turn required modifications to the Plan. ARCO revised the *Reclamation Plan, Bluewater Mill* and resubmitted the three-volume Plan to the NRC in March 1990 (ARCO, 1990b). The NRC approved the Reclamation Plan in August 1990.

In December 1987, ARCO submitted a Decommissioning Plan for the Bluewater Mill (ARCO, 1987) to the NRC for approval. Included as Appendix 1 in the Decommissioning Plan (ARCO, 1987) is a report on *Radiological Characterization of the Bluewater Uranium Millsite* completed by Roy F. Weston, Inc., in October 1987. The Decommissioning Plan was approved by the NRC in September 1989, and ARCO commenced demolition of the facility. Decommissioning, which was completed in January 1991, involved demolition, disposal or decontamination, and salvage of all structures and equipment from designated areas in the mill site. Unsalvageable material was buried in three disposal areas located on site in and near the carbonate tailings. Details of the composition and plan and profile structure of each of the disposal cells are presented in the *Bluewater Mill Decommissioning Report* prepared by ARCO (1991b), which was submitted to the NRC for approval in March 1991. The Decommissioning Report was approved by the NRC in June 1991.

After NRC approval of the Reclamation Plan, reclamation began in January 1991. From then until August 1992, windblown tailings and residues from four of the seven evaporation ponds were removed, placed, and compacted on the slimes portion of the main tailings pile in accordance with the Reclamation Plan. Approximately a 210-acre (85 ha) area of windblown tailings on the malpais surface could not be reclaimed because the rough, hard surface of the basalt made reclamation impractical. A total of approximately 623,000 cubic yards (480,000 cubic meters) of windblown contaminated material were excavated; details of the windblown tailings reclamation are presented in the *Windblown Contamination Cleanup Report* completed by ARCO (1992a) in October 1992.

In October 1992, the NRC requested that ARCO prepare and submit a new or supplemental ER for the site. In April 1993, ARCO submitted to the NRC a *Supplement to Environmental Report for Decommissioning and Reclamation of the Bluewater Uranium Mill* (Environmental Restoration Group, Inc. 1993).

After milling activity, ground-water protection standards for uranium, selenium, and molybdenum were exceeded at points of compliance monitor wells near the main tailings pile. The NRC required ARCO to prepare a ground-water Corrective Action Program (CAP) with the objective of returning uranium, selenium, and molybdenum to the legislated protection standards. In May 1989, ARCO submitted a CAP and an Alternative Concentration Limit (ACL) petition to the NRC; in the CAP, ARCO proposed using a wicks-and-drain system to reduce contaminant seepage during reclamation. After review, NRC required that ARCO submit a revised CAP in which several existing wells with elevated levels of hazardous constituents would be pumped to reduce hazardous constituent concentrations in the aquifer. In August 1989, ARCO submitted to NRC a revised CAP in which pumping wells would be used. NRC approved the CAP and ARCO began implementing the CAP.

Statistical evaluation by ARCO in May 1990 indicated that there was no significant reduction of hazardous constituents in the groundwater as a result of pumping. Therefore, with NRC concurrence, in June 1990 ARCO submitted to NRC *the Corrective Action Program and Alternative Concentration Limits Petition for Uranium, Molybdenum, and Selenium, Bluewater Mill Near Grants, New Mexico* (ARCO 1990a). In October 1992, the NRC requested that ARCO submit a supplemental CAP that described ongoing and future corrective actions regarding removal of hazardous ground-water constituents or treating them in place. In November 1992, ARCO responded by submitting to the NRC for its approval *the Supplemental Ground Water Corrective Action Program, Bluewater Uranium Mill near Grants, New Mexico* (ARCO, 1992b). The NRC responded in November 1990 to the ARCO ACL petition and requested that ARCO propose Points of Exposure (POEs) adjacent to the future restricted area (within the area to be transferred to the DOE following closure). In response, ARCO submitted to NRC in August 1991, *the Alternate Concentration Limits Petition Addendum for Bluewater Uranium Mill Near Grants, New Mexico* (ARCO, 1991a) in which ACLs were revised based on an analysis of POEs at the future government property boundary.

The NRC completed its review of ARCO's ACL petition, supplements, and addendums in January 1995. The review was based on guidelines and criteria from the *Alternate Concentration Limits for Title II Uranium Mills* draft final staff technical position (NRC, 1994). The review resulted in seven open issues that were resolved by ARCO in a revised ACL petition, which was completed and submitted to the NRC in April 1995 (ARCO, 1995a). In February 1996, the revised ACL petition was approved by the NRC as Amendment 30 to the source material license.

In May 1995, ARCO applied to the NRC for a license amendment to allow on-site disposal of radioactive waste contaminated by polychlorinated biphenyls (PCBs). The radioactive waste was soil from a uranium processing area that was contaminated by a leaking PCB electrical transformer. This waste was classified as "PCB by-product material" subject to the Toxic Substance Control Act, which is under the jurisdiction of the U.S. Environmental Protection Agency (EPA). The EPA evaluated ARCOs proposed landfill disposal method (ARCO 1996e) and granted approval. The NRC subsequently approved the PCB disposal as Amendment 33 to the source material license.

4.2 Construction of Main Tailings Pile

Materials within the existing main tailings pile include sands, slimes, and windblown tailings. The southern portion of the tailings pile consists primarily of sands and is outside the scope of this investigation. The northern portion of the tailings pile below the area of depression, the area of interest for this subsurface investigation plan, was constructed of slime tailings overlain with windblown tailings. See **Appendix A**, Figure 4 for a typical cross section of the tailings pile. The slimes were placed in a super saturated state in lifts between three and five feet thick with a woven geofabric spread over soft areas to provide support hauling and dozing equipment. Contaminated windblown materials were placed in 12-inch lifts and compacted on top of the slime tailings. Surveys of settlement monuments indicated that the slimes experience the majority of their consolidation during construction. To accelerate the completion of 90% consolidation, wick drains were installed in the slimes and resulting consolidation was submitted to the NRC who subsequently provided approval to proceed with placement of the overlying radon barrier in 1994.

Following NRC approval of consolidation of the tailings pile, the wick drains were abandoned in place. Each wick drain was cut approximately three feet below the surface and remaining voids were filled with soil cement.

Prior to placement of the radon barrier, surface materials were moisture conditioned and compacted to between 90 and 95 percent of maximum dry density in accordance with ASTM D-698. Quality control testing was performed continually during placement of the radon barrier with in-place densities verified via sand cone testing in accordance with ASTM D-1556.

Riprap for erosion protection was placed over the entire surface of the tailings pile and consisted of rock materials from an adjacent quarry. Prior to placement, each area to receive riprap was prepared by fine grading and testing soil density. Riprap was placed by bottom dump trailers and spread with motor graders. The final surface of the radon barrier grades below the riprap were verified by survey.

4.3 General Geology

The Bluewater site is located in Cibola County, northwestern New Mexico, 39.8 mi (64 km) west of Laguna, New Mexico, adjacent east of I-40. The Bluewater site is in the Acoma-Zuni section of the southeast edge of the Colorado Plateau physiographic province adjacent to the Zuni-Bandera volcanic field. Elevation of the site ranges from approximately 6,555 ft (1,999 m) in the east-central part of the site to approximately 6,770 ft (2,065 m) in the northeast part of the site where a northwest-striking mesa slope bounds the site. Most of the site is near 6,600 ft (2,013 m) in elevation and local relief is usually less than 100 ft (31 m). The Zuni Mountains, which reach an elevation of about 9,000 ft (2,750 m), flank the Grants-Bluewater Valley to the southwest. About 15 to 20 mi (24 to 32 km) east of the site are the San Mateo Mountains, which reach an elevation of up to about 11,300 ft (3,450 m) at Mount Taylor to the east of Bluewater.

A Quaternary basalt flow (El Tintero) covers part of the western and southern portions of the site (Rawlings, 2013). This volcanic flow resulted from El Tintero cinder cone approximately 5 miles (8 km) north of the Bluewater facility. There are up to five individual basalt flows with an aggregate thickness of 122 ft (37 m; Rawlings, 2013).Topography in the basalt flow area is rough and irregular in places, local relief can be up to 40 ft (12 m), and numerous closed depressions occur on the surface. The rough surface of basalt flows in this area is referred to as "the malpais.", named by Spanish explorers for ‘the bad country’. Much of the remainder of the site area is flat to gently sloping and is covered by fine-grained alluvial and eolian material. Bedrock of sandstone, siltstone and limestone is exposed in two small areas north and east of the main tailings pile where these rocks dip gently north to northeasterly and form cuestas about 75 ft (23 m) high.

Drainage from the main tailings disposal cell is generally northward from the crest of the disposal cell. In the area of the former evaporation ponds northeast of the main tailings pile, a channel was constructed to drain water to the southeast away from the tailings disposal areas. North and-east of the main tailings disposal cell and east of the area covered by basalt, drainage on alluvium and sedimentary rocks is toward the south or southwest. Eventually. this drainage direction turns toward the southeast in the area east of the limestone hills east of the main tailings pile and generally follows the gentle gradient of the southeast-draining Grants-Bluewater Valley.

Geology of the Bluewater site is shown in **Appendix A**, Figure 3, which has been compiled and modified from the *Geologic Map of the Bluewater Quadrangle, Valencia and McKinley Counties, New Mexico* (Thaden and Ostling, 1967; revised by Rawlings, 2013) and from the geologic map, Plate 1, in *Geology and Ground Water Resources of the Grants-Bluewater Area, Valencia County, New Mexico* (Gordon 1961). The following discussion of geologic conditions at the site is summarized mainly from the section on “Geology and Geoseismicity” in Volume II of *Licensing Documentation* prepared by Dames and Moore (ARCO, 1981).

The site bedrock geology consists of early Mesozoic and late Paleozoic sedimentary strata. A small, but prominent hill near the main tailings disposal cell consists of the oldest rocks exposed on the project area, the Permian San Andres Limestone. This limestone is grayish-yellow to brownish red, dense, interbedded with yellow fine to medium grained sandstone in the upper part. The red outcrops on the north side of the San Andres Limestone hill are the younger Triassic

Moenkopi Formation, which is composed of red-brown and gray-red arkosic and micaceous sandstone interbedded with pebble conglomerate and mudstone balls. A thickness of only about 26 ft (8 m) of the Moenkopi is present; this is the only exposure of the formation on the site. Regionally unconformably overlying the Moenkopi Formation is the thick Chinle Formation which crops out mainly on the sides of mesas (cuestas) in the extreme northwest and northeast parts of the site. The Chinle member that outcrops in the extreme northwest and northeast parts of the site is mapped as the Sonsela Sandstone Bed of the Petrified Forest Member (Rawlings, 2013), which consists of white, yellow-brown, and brown conglomeratic sandstone. Rocks of the Sonsela Bed are about 300 ft (92 m) above the base of the Chinle Group. The lowermost rocks of the Chinle consist of clayey and sandy siltstone interbedded with lenticular conglomeratic sandstone. These rocks are mostly nonresistant and are covered by alluvial material or dune sand. The only exposure of these lower Chinle rocks is in a small area referred to as “White Rock” in the southeast quarter of Section 7 and the southwest quarter of Section 8.

Much of the main tailings disposal cell and approximately one-third of the site (in the southern and western parts) is underlain by basalt. The basalt consists of several flows that originated at a cinder cone, El Tintero, about 5 mi (8 km) north of the site. Basalt flows from the source cinder cone were originally named the Bluewater flows by Nichols (1934), and they may be as young as 3,000-4,000 years old. The basalt flows appear to have flowed south and southeast and filled the ancestral drainage channel of the Rio San Jose. The flows continued for about 4 mi (6.5 km) southeast of the site, to the basalt quarry in Section 27, T12N, R10W, that supplied cover rock for the tailings pile. Thickness of the basalt is typically 80 to 100 ft (22 to 31 m) but can be as much as 130 ft (40 m). Texture of the basalt varies from dense to vesicular, and the surface is usually vesicular and rough which produces a malpais-type topography.

Alluvium and eolian deposits cover more than one-third of the surface of the site. In Quaternary time prior to emplacement of the basalt flows, alluvial material accumulated along the course of the Rio San Jose. This material consists mainly of coarse sand and gravel and is present in thicknesses of up to 30 ft (9 m) beneath the Bluewater basalt flows. North and northeast of the mill site and main tailings pile, alluvial material is up to 60 ft (18 m) thick and is composed mainly of fine sand and silt with interbedded clay units. Eolian material occurs as a thin veneer over much of the surface of the site and it also occurs as interbeds in the alluvial material. One small area of dune sand occurs on the site in the southwest quarter of Section 8 on the leeward side of White Rock.

4.4 Regional Faulting and Seismicity

Several faults and two folds are present in the site area. These structures are those shown in Plate 1 of the "Geology and Geoseismicity" section of Volume II, *Licensing Documentation,* prepared by Dames and Moore (ARCO, 1981). A field investigation by Dames and Moore evaluated the numerous faults mapped by Thaden and Ostling (1967) in the site area. The faults are normal faults, trend in northerly and easterly directions, have displacements that range from several tens of feet to several hundred feet, are related to the uplift of the nearby Zuni Mountains, and along with associated folds, are probably of middle Tertiary age (Hunt, 1936).

Active seismicity in New Mexico is controlled by the faults along the Rio Grande Rift (RGR), 62 miles (100 km) east of Bluewater. The closest Quaternary-aged fault is the Sand Hill Fault, which trends north-south along the western margin of the RGR, offsets early Pleistocene sand and gravel of the Santa Fe Group, but not younger sediments.

The most significant structural feature at the site is an easterly trending fault just south of the main tailings pile and the San Andres Limestone hill that has a displacement of about 370 ft (115 m) in the area of the main tailings disposal cell (ARCO, 1981). Displacement along this fault decreases to approximately 270 ft (80 m) about 6,000 ft (1,830 m) east of the main tailings disposal cell. Geomorphic expression of this fault is the south-facing escarpment of the San Andres Limestone hill east of the main tailings disposal cell that extends for approximately 1 mile (1.6 km). Just south of the hill, alluvial material and Bluewater Basalt flows cover the fault; however, in the subsurface, San Andres Limestone and Glorieta Sandstone are juxtaposed against the Moenkopi and Chinle Formations to the south. In the document prepared by Dames and Moore on "Geology and Geoseismicity" (ARCO, 1981) two geologic cross sections are identified that are oriented north-northeast parallel to the regional dip of the bedrock formations and extend from the fault to the south to the slopes of the mesa bordering the site to the north.

Two north-trending folding structures occur in the west part of the site in the main tailings disposal cell area. These folds, a syncline to the west and anticline to the east, both plunge northward and probably formed from drag folding adjacent to the normal fault between them.

4.5 Soils

Soils in the site area are generally classified as two types: Viuda-Penistaja and Penistaja-San Mateo-Sparank, according to the *Soil Survey of Cibola Area, New Mexico, Pans of Cibola, McKinley, and Valencia Counties* (Parham, 1993). Viuda-Penistaja soils are in the mill site and southwest part of the site and are developed on basalt. Viuda soil is shallow, well-drained, and on hills and ridges. Penistaja soil is deep, well-drained, and in valleys between basalt ridges. Penistaja-San Mateo Sparank soils are mainly in the eastern part of the site on alluvial material developed over sandstone and siltstone bedrock; soils are deep, well-drained, and are moderately susceptible to erosion by wind.

4.6 Real Estate

The lands within the Bluewater Site are owned by DOE-LM and will require their approval of all activities.

4.7 Existing Site Conditions

The Bluewater Disposal Site is inspected annually in accordance with the Long-Term Surveillance Plan (DOE, 1997) and in compliance with the requirements of Title 10 *Code of Federal Regulations* Section 40.28 (10 CFR 40.28). Inspection findings and existing site conditions are including in the 2019 Annual Site Inspection and Monitoring Report provided in **Appendix C**.

5.0 Scope and Methodology

The scope of this investigation plan consists of initial and final gamma surface surveys, CPT, Shelby Tube sampling, and vegetation characterization, sampling, and testing of onsite potential borrow materials.

The USACE Kansas City District shall be the CPT Services Provider and is responsible for providing all the necessary equipment required to execute this Subsurface Investigation Plan. The CPT push system shall be in accordance with ASTM D5778 and shall have current calibration test results. The CPT push system shall be capable of up to 20 tons push capacity and shall be capable of stabilization by gross vehicle weight. The CPT push system shall have a minimum continuous stroke of 44-inches. Sufficient push-rod and other necessary equipment shall be at the work site to push to the maximum depth as specified in this plan. All CPT operations shall be performed under the direct supervision of a qualified Registered Professional Geologist or Professional Engineer, experienced in this activity.

The boundary of the CPT investigation has been selected to allow for the collection of subsurface data and direct comparison of the geotechnical properties both within the depressed area and the adjacent areas surrounding the depression where no unexpected settlement has occurred.

Because CPT probe operations will and Shelby Tube sampling activities could potentially penetrate the radon barrier, thus compromising its integrity, both an initial and final surface radon survey will be performed. Subsurface radiological monitoring will be performed in conjunction with CPT probe operation using a gamma probe capable of detecting in-situ subsurface radioactivity. The initial radon surface survey will be performed to establish baseline radon flux levels which will be compared against the post-investigation levels after restoration procedures of the radon barrier are complete. Each CPT location will be sealed with grout to ensure surface level radon flux levels do not exceed the established baseline levels. In the event that the post-investigation surface level radon flux is higher than the baseline and higher than the threshold of 20 pCi/m^2-s established by NUREG CR-3166, the location will be regrouted and subsequent surface level radon measurements taken.

Shelby tube sampling is not expected to penetrate through the radon barrier and into the tailings. Shelby tube samples will be surveyed for radioactivity to ensure no uranium tailings are present due to the radon barrier being inadvertently penetrated,

All bulk samples shall be tested at a USACE approved laboratory-testing facility. Soil laboratory tests shall be performed in accordance with EM 1110-2-1906, "Laboratory Soils Testing", dated 30 November 1970 (incl. Change 2 dated 20 Aug 1986). A database of approved laboratories can be found at the following url: https://mtc.erdc.dren.mil/searchvalidation.aspx

Mud boards shall be placed beneath the CPT rig wheels to protect against rutting of the top of the cell.

USACE is responsible for the protection of all underground utilities, overhead utilities, structures, etc. from damage by field investigations. Utility checks will be conducted before any drilling or excavation work proceeds.

All Shelby tube samples will be collected and packaged by USACE personnel and transferred to LMS staff who shall be responsible for all subsequent sample handling and characterization.

Tasks to be performed will be conducted in two Phases.

Phase 1: Initial Gamma Surface Survey – Disposal Cell and Test Pit Locations
CPT – Disposal Cell
Shelby Tube Sample Collection – Disposal Cell
Final Gamma Surface Survey – Disposal cell

Phase 2: Test Pits
Bulk Sample Collection
Laboratory Testing

Each phase will be performed independently and Phase 2 will not be performed until the Initial Gamma Surface Survey is complete and the report assessed. Additional changes to the locations for Phase 2 of the Test Pits and sampling requirements may change due to information found in the completed Gamma Survey report. However, the final locations of all test pits will be within the proposed borrow areas and as close as possible to the currently planned locations.

5.1 Phase 1

Estimated duration of Phase 1 activities is approximately 60 days.

5.1.1 Initial Gamma Surface Survey – Disposal Cell and Test Pit Locations

A Gamma Surface Survey shall be performed at both the main tailings disposal cell and the potential borrow areas prior to the start of any CPT or soil sampling activities. The gamma/CPT probe and a CPT rig will subsequently be utilized in the initial phase to determine Geotechnical properties and the radioactivity levels of radionuclides within the main tailings disposal cell.

The Gamma survey will be conducted under the guidelines of a scoping survey around the locations of all planned investigations as described in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). The primary survey instrument used will be a micro-R meter or equivalent. A GPS unit will be used to log survey locations.

Surface gamma readings in micro-Roentgen per hour (μR/h) shall be taken at 1 (one) meter above the ground encompassing a 100 m^2 area centered around each of the sample locations that are designated for CPT and Test Pit sampling activities. This area will consist of a measurement at the sample location and four additional measurements 5 m from the center to bound the area (typically a cross or plus configuration). Where it is found that the readings are at or above 20 μR/h at potential borrow areas, a soil sample (0 to 6-inch core) shall be taken in accordance with ASTM

C 998 and analyzed to ensure soil < 5 pCi/g Radium-226 above background, and to establish a correlation between surface soil lab results and instrument readings taken above the surface. This allows for future direct scanning to be used in lieu of laboratory analysis of samples resulting in a substantial cost savings. These areas may require further investigation to determine suitability for use on the main tailings disposal cell, and may include radon grid sampling and walkover gamma surveys. Surface gamma reading shall be taken at 1 (one) meter above the ground encompassing a 100 m^2 area centered around each of the sites that are designated for CPT and Test Pits. This area will consist of 100% walk over and read in micro-Roentgen per hour (μR/h).

Any measurement that is at or above 20 uR/h (above background) on the main tailings disposal cell is a possible indication that there has been a breach of the radon barrier and will need to be investigated further and is outside the scope of this investigation. If such an area is encountered on the main tailings pile, work in the area will cease and the USACE HTRW section chief Justin Reale (505-342-3138) will be contacted immediately. Borrow areas where readings are at or above 20 uR/h may be unsuitable for use on the main tailings disposal cell due to radium-226 concentrations possibly exceeding 5 pCi/g which could cause radon emissions to exceed limits established for the main tailings disposal cell.

5.1.2 Cone Penetration Test (CPT) – Disposal Cell

A total of 86 CPT's will be performed in locations shown in Figures 2-1 through 2-5 at coordinates shown in Table 1 in **Appendix B**, each to a depth of 40-feet. Penetrating to this depth will allow for the probe to pass through and characterize the entire layer of tailings as well as characterize the upper 10 to 20 feet of the foundation soils. The Cone Penetration Test (CPT) shall be used to evaluate detailed soil stratigraphy and estimate geotechnical engineering properties of the tailings pile, pore water pressures (u), and below ground Gamma survey information relative to depth. The CPT involves hydraulically pushing a 1.4-in. diameter special probe into the earth while performing two measurements, cone resistance and sleeve friction resistance. The probe shall be pushed from a specialized CPT vehicle weighing approximately 50,000 pounds and measuring 36 feet long, 8 feet wide, and 13.5 feet tall. The total disturbed area of all CPT soundings is anticipated to be approximately 11.25 square feet. The maximum displacement of in-situ materials resulting from all CPT soundings, assuming no collapse of the cavities created by the CPT probe, is estimated to be a total volume of 450 cubic feet.

Riprap at each CPT location shall be removed and stockpiled prior to each CPT sounding to prevent obstruction of the CPT probe. No materials beneath the riprap will be removed as part of the CPT investigation. All riprap removed to facilitate penetration of the CPT probe will be returned to its original location after completion of each sounding.

The abandoned wick drain system is not anticipated to interfere with the CPT investigation. However, the investigation team is aware of its presence and will monitor data collected for any overt signs of erroneous readings potentially caused by interference from a wick drain.

5.1.2.1 CPT Geotechnical Data

The purpose of the CPT investigation is to characterize the geotechnical properties of the tailings within the disposal cell without the collection of physical samples of the subsurface materials. The following geotechnical data will be collected by CPT for the radon barrier and tailings:

- Classification of soil using CPT soil behavior type (SBT)
- In-place relative density
- Pore Pressure
- Friction Angle
- Correlated SPT N_{60}
- Shear Modulus

5.1.2.2 CPT Gamma Survey

As described previously, the primary objective of this CPT gamma survey is to determine the profile thickness of the radon barrier overlaying the tailings within the area of the existing depression and the immediate area surrounding this depression. Gamma radiation logging will be performed simultaneously with each CPT sounding and correlated with depth to locate the interface between the radon barrier and tailings. This logging will be performed using a sodium iodide (NaI) gamma scintillator located within the tool string and behind the CPT head. A comparative analysis of the radiation log will be performed to determine the radon barrier thickness profile throughout the investigation area. This comparison will be made with the findings of a 2016 DOE investigation (DOE 2016a), which determined that the thickness of the radon barrier varies between 24 to 28 inches with very low activity windblown materials immediately underneath.

The secondary objective of this gamma survey is to characterize the radioactive profile of the tailings relative to depth within the disposal cell. This information will be used to inform the future project design alternatives.

5.1.2.3 CPT Decontamination

Due to the nature of the radioactive tailings within the disposal cell decontamination of the CPT probe and pushrod will be required. This will be achieved using the decontamination system onboard the CPT vehicle. The decontamination system consists of a trailer-mounted hot water heater with a high-pressure pump and water jets used to remove contaminants and soil particles from the CPT probe and pushrod before they are retracted into the cab of the CPT vehicle. The water jets are enclosed in a box with replaceable seals which collects and contain the wastewater. The wastewater is drained to and stored in a containment drum from where it will then be mixed into the grout mixture used for backfill of each CPT location. No more than 10 gallons of wastewater is anticipated to be collected after completion of all grouting and will be held in an open container on top of the cell and allowed to evaporate on site. It is anticipated the wastewater will contain extremely low levels of radioactive contamination and that after the wastewater has evaporated the container itself will be radiologically inspected and is expected to be safely disposable by traditional landfill. Radiological monitoring and surveys will be performed during and after CPT probe operations. Surveys of the SCAPS truck will be done prior to the vehicle exiting the area.

It is anticipated that no more than 10 gallons of water will be required for decontamination at each CPT sounding and the total volume of water used will be recorded at the end of each work day. Due to the remote location, no water is available on site and must be brought in by truck. The closest municipality is the City of Grants, NM, 12 miles (19.3 km) east of Bluewater.

City of Grants Water Department
Director
Melissa Lopez
505.287.7927 ext. 2015

5.1.3 Shelby Tube Sample Collection – Disposal Cell

The top of the radon barrier, beginning at the riprap boundary layer, will be sampled by direct pushing 3 to 5-inch diameter, 18-inch long thin-walled Shelby Tubes. Shelby Tubes and caps will be provided to USACE. Prior to sampling, the surface of the radon barrier shall be free of any riprap or gravel debris. After sampling, the Shelby tubes will be surveyed for radioactivity and capped on either end with the provided plastic caps and sealed with tape to preserve in situ moisture. Each Shelby Tube will be labeled with a sample area number, type of material, sample number, date of collection. (i.e. CPT-21-33, radon barrier, BLU01-XXXX, date). LMS will provide the sample numbers. Collected Shelby Tubes will be stored out of direct sunlight to preserve sample integrity (preferably in a trailer) until transferred to LMS.

Up to 22 individual locations will be sampled adjacent to 22 CPT sounding locations. See Section 8.1.1 for a listing of each CPT sounding location and those adjacent to which a Shelby Tube sample will be collected. The total disturbed area of Shelby Tube sampling is anticipated to be approximately 3 square feet at a total volume of 4.5 cubic feet.

5.1.4 Final Gamma Surface Survey

Surface gamma readings shall be taken at 1 (one) meter above the ground encompassing a 100 m^2 area centered around each of the sites that are designated for CPT and Test Pits. This area will consist of 100% walk over and read in micro-Roentgen per hour (μR/h). Where it is found that the readings are at or above 20 uR/h the location will be documented and DOE-LM will be notified.

5.2 Phase 2

Estimated duration of Phase 2 activities is approximately 30 days.

5.2.1 Test Pits

Hand tools or small excavation equipment shall be used to collect disturbed samples that are suitable for laboratory testing from proposed borrow areas. Each sample is estimated to consist of two full 5-gallon buckets of material collected from an area measuring 1.5’ x 1.5’ and 2 feet deep.

Northern Berm

- Five (5), test pits spaced approximately 500 ft apart along berm as shown in Figure 3-1 and at the locations specified in Table 2 of **Appendix B,** excavated to a max depth of 2 feet. The total disturbed area of the Northern Berm is anticipated to be approximately 11.25 square feet.

Eastern Borrow Area

- Twelve (12), test pits spaced approximately 500 ft apart in a gridded pattern as shown in Figure 3-2 and at the locations specified in Table 2 of **Appendix B**, excavated to a max depth of 2 feet. The total disturbed area of the Eastern Borrow Area is anticipated to be approximately 27 square feet.

5.2.2 Vegetation Characterization

Local vegetation will be characterized at each test pit location. Characterization will include landscape photographs, estimated total foliar cover, and dominant/secondary species. The purpose of this characterization will be to aid in the development of seed mixes, act as an analog comparison for future cell conditions, and help reduce noxious weed infestations.

5.3 Fluids for Cone Penetrometer Testing

CPT does not require the use of water or any other drilling fluids. However, given the nature of the radioactive tailings within the disposal cell, water will be required for the decontamination of CPT equipment. Water used for decontamination after each CPT sounding will be obtained and handled in accordance with the paragraph "CPT Decontamination" above.

5.4 Field Logging

A field inspector shall be present during the subsurface investigation and shall be an experienced engineering geologist or geotechnical engineer. The duties shall include observing, classifying, and describing geologic materials; selecting and preserving samples; completing the CPT logs; and recording information and data from field tests in accordance with ASTM D2488 Visual Classification of Soils. The field inspector shall also be responsible for photographing both the initial and post-investigation site conditions.

A detailed subsurface investigation report shall be provided including a CPT report in accordance with ASTM D5778. The final report, for inclusion in design documents and in plans and specifications, will provide the pertinent data for the borings including, but not limited to:

- Name of project
- CPT location (GPS Coordinates)
- CPT number
- CPT data collected
- Name of operator
- Inclination of CPT sounding
- Date sounding was started, and date completed

- Elevation of top of sounding
- Type and manufacturer's designation of CPT equipment
- Location and Number of samples obtained
- Observations of groundwater levels
- USCS Soil classification
- Plasticity and Liquid limits
- Depth of ground water

5.5 Restoration Procedures

5.5.1 CPT Sounding Restoration

After collection of CPT data, the CPT probe will be fully retracted and each CPT sounding will be backfilled with a neat cement grout in compliance with NUREG/CR 5432 “Construction Methods and Guidance for Sealing Penetrations in Soil Covers”.

A dummy probe with a disposable tip will be advanced to the previous push depth. Once the dummy probe reaches the previous depth, the disposable tip will be removed and the grout mixture pumped through the dummy probe as the probe is being retracted. Grout will consist of a mixture of Type I or Type II Portland cement and water at a proportion of 6 gallons of water per 94 lb. sack of cement. Grout will be mixed and poured into a hopper outside of the CPT vehicle and will then be pumped at low pressure through the dummy probe to the bottom of the sounding cavity. The cavity will be grouted from the bottom up to the surface of the radon barrier. As the dummy probe is being retracted, it will be decontaminated following the same procedure as the instrumented CPT probe. A maximum of 450 cubic feet of material will be displaced as a result of the voids created by CPT soundings, assuming no collapse of the cavities created by the CPT probe. An equivalent volume of water and Portland cement will be mobilized to the site to fill these voids. The total volume of grout placed will be recorded separately for each CPT sounding.

Because no in-place materials other than riprap will be removed for each CPT sounding performed and each sounding will be fully grouted to the ground surface, no backfill materials will be required for surface completion.

5.5.2 Test Pit Backfill

Each test pit shall be backfilled immediately following sample collection. Backfill shall consist of onsite soil adjacent to each test pit and shall be compacted by hand tamping.

5.5.3 Shelby Tube Radon Barrier Restoration

The same volume of sampled radon barrier will be replaced with suitable materials and be restored as closely as possible to the as-constructed condition of the disposal cell using appropriate materials and methods. The radon barrier material will be provided by LMS. The material will be moisture conditioned to the optimum moisture content (+4% to -1%) per ASTM Standard D698 and stored in sealed containers until used for restoration.

Replacement materials will be placed and compacted with hand tools in 6 inch lifts. Hand tamping will occur until deflecting is minimal. In all cases, the restored radon barrier will be compacted level with the surrounding undisturbed barrier. A photograph of the surface of the repaired radon barrier shall be taken at each sample point. A maximum of 4.5 cubic feet of material will be collected from the radon barrier and the same volume will be required for replacement.

An onsite radon barrier stockpile is the intended source of restoration material for the radon barrier. LMS will source sufficient material for restoration prior to project mobilization and store the material at the LM Field Support Center at Grand Junction, Colorado for moisture conditioning until required by USACE. LMS will ensure that the material meets the specifications detailed in the closure report (ARCO 1996a). Restoration materials will be moisture conditioned and sealed in 3.5-gallon buckets by LMS prior to transfer to USACE. In the event sufficient or suitable restoration material cannot be identified at Bluewater, LMS will source material from an alternative source at the Grand Junction Disposal Site (GJDS) prior to the USACE field investigation.

In the event that borrow materials from onsite or GJDS become unavailable, an alternative restoration method utilizing hydrated bentonite will be provided. Bentonite materials will be provided by USACE. Each Shelby Tube location will be backfilled with dry bentonite pellets placed in 6-inch lifts. Sufficient water will be placed over each lift to provide approximately 0.5-inch of cover over the bentonite pellets. Each lift will be allowed to hydrate for up to 30 minutes before the subsequent lift is placed. Hydration of the bentonite will be noted as complete when the water surface is no longer visible. This process will be repeated until the bentonite backfill is level with or slightly above the surrounding undisturbed radon barrier. No compaction of the bentonite will be required as the material will swell during hydration and provide a watertight seal free of any void spaces.

5.5.4 Riprap Replacement

All riprap removed and stockpiled to facilitate penetration of the CPT probe and Shelby Tube sampling will be returned to its original location immediately after grouting of each CPT sounding and immediately after radon barrier restoration is complete subsequent to Shelby Tube sample collection.

6.0 Laboratory Testing

6.1 Bulk Samples

All bulk samples shall be characterized using the following tests:

- USCS Classification (ASTM D 2487)
- Sieve Analysis (ASTM D6913)
- Atterberg Limits (ASTM D4318)
- Density and Unit Weight (ASTM D7263)
- Specific Gravity (ASTM D854)

- Saturated Hydraulic Conductivity (ASDM D5084)
- pH (ASTM D5778)
- Double Hydrometer (ASTM D4221)
- Pinhole Test (ASTM D4647)
- Crumb Test (ASTM D6572)

LMS staff scientists will aid in sample interpretation and coordinate with USACE on the use of standard risk assessments for erodibility of soils, and the edaphic suitability of rock-soil mixtures for vegetation suitability. As part of this assessment, all bulk samples collected from the eastern borrow area shall be characterized using the following tests:

- Extractable ions by saturated paste (using agricultural method to account for calcium interference)
- Exchange complex and cation exchange capacity (using agricultural method to account for calcium interference)

6.2 Shelby Tube Sample Testing

All Shelby Tube testing shall be the responsibility of LMS.

All Shelby Tube samples shall be tested at a laboratory at the discretion of LMS scientists in accordance with the following standards:

- USCS Classification (ASTM D 2487)
- Sieve Analysis (ASTM D6913)
- Atterberg Limits (ASTM D4318)
- Dry Density (ASTM D7263)
- Proctor Density (ASTM D698/D1557)
- Double Hydrometer (ASTM D4221)
- Pinhole Test (ASTM D4647)
- Crumb Test (ASTM D6572)

Specialized testing listed in the table below shall be performed at University of California, Davis (UC Davis).

Test(s)	UC Davis Code	Reference ID
Soil Salinity Group 1 (SP, pH, EC, Ca, Mg, Na, Cl, B, HCO3, CO3)	G-SALIN	
Potassium (K) – Saturated Paste Extract	K-SOLS	
Sulfate-Sulfur (SO4-S) – Saturated Paste Extract	SO4-SP	
Sodium Adsorption Ratio (SAR)*	SAR-S	
Exchangeable Sodium Percentage (ESP)*	ESP-S	
Nitrate & Ammonium Group (NO3-N, NH4-N)	G-NAF-S	
Phosphate – Bray Extraction (Bray-P) – acidic soil	BRAY-P	

Cation Exchange Capacity – Barium Replacement Method (CEC)	CEC	
Calcium Carbonate (CaCO3)	CACO3	
Organic Matter – Walkley-Black Method *	OM	
Organic Carbon (Calculated from W-B OM)*	CORG	
XRD – whole fraction (<2.00mm)	*NOT UC DAVIS*	

7.0 Environmental Compliance

7.1 Investigation Derived Waste

Soil and decontamination rinsate IDW will he handled as previously described in this plan. It is anticipated that all other waste generated in performance of this investigation, including personnel protective equipment (PPE), will be non-hazardous and non-radiologically contaminated and readily disposable by traditional landfill. In the event that hazardous waste is generated it will be handled in accordance with the Accident Prevention Plan Addendum provided in **Appendix D**.

7.2 Areas of Disturbance

Areas of land and vegetation disturbance will be limited to the areas where CPT soundings are performed and Shelby Tube and bulk samples are collected as shown in **Appendix B**. Vehicle travel will be limited to existing travel routes. The SCAPS truck will operate on mud boards to distribute wheel loads and prevent rutting while on top of the cell. The SCAPS truck will be removed from the cell during off hours.

7.3 Excavation Equipment and Onsite Refueling

All excavation and boring equipment shall be washed and clear of mud and seeds prior to arrival at the site to control potential cross-contamination and noxious weed spread. Refueling of any kind is prohibited on top of the cell.

7.4 Migratory Bird Treaty Act

Personnel shall not work or travel in areas outside of the designated work areas or access routes without approval. Personnel shall not harass or otherwise disturb nesting birds; remove nests, eggs, or young birds; or in any way “take” or disturb a migratory bird. Collecting parts of any species of bird, nests or eggs is prohibited. If workers encounter birds, nests, eggs, or young that could be disturbed or destroyed by the work, activity near the nest will cease, and the subcontractor shall notify the project manager immediately. Staff wildlife or compliance specialists shall provide the workers with avoidance or mitigation measures that must be implemented before work may continue.

7.5 National Environmental Policy Act

National Environmental Policy Act (NEPA) will be required for this project. Compliance with NEPA will be conducted following DOE LM NEPA requirements and processes. Specifically, an environmental review will be conducted and the appropriate level of required NEPA will be determined. The applicable NEPA documentation will be prepared prior to initiating project field activities.

7.6 Spill Prevention and Response

A spill kit must be onsite at all times during work on the project. If any spills of fluids from equipment operations, maintenance, or repair (fuel, hydraulic fluids, coolant, lubricants, cleaning solvents, used oil, etc.) or fueling occur, personnel shall immediately notify the project manager and immediately follow directions to clean up the spill.

Equipment leaks, and other types of spills shall be diapered, contained, absorbed, or otherwise blocked to prevent contamination of the ground, surface water, or groundwater until the leak is repaired or the equipment is replaced. Personnel shall clean up and make any necessary notifications and subsequently manage spilled materials and associated wastes (e.g., contaminated soils), including storage, transport, and offsite disposal, in compliance with applicable federal, state, and local regulations.

7.7 Equipment Maintenance

Personnel may perform equipment maintenance and repairs on location with approval of the project manager. Performance of equipment maintenance shall not be allowed on the disposal cell. Any waste materials resulting from equipment maintenance and repair must be taken off the site and managed or disposed in accordance with all applicable federal, state, and local regulations by the subcontractor as subcontractor-owned waste.

7.8 Cultural and Environmental Management

In accordance with Section 106 of the National Historic Preservation Act, a consultation will be conducted with the New Mexico State Historic Preservation Office and Federally-recognized tribes with an interest in the area prior to performing any land disturbance associated with this work. Known areas to be avoided during field work in the eastern borrow area are shown in Figure 5 of **Appendix A**. If, during excavation or other construction activities, any previously unidentified or unanticipated suspected historical, archaeological, and cultural resources are discovered or found, activities that may damage or alter such resources will be suspended. Resources covered by this paragraph include, but are not limited to: any human skeletal remains or burials; artifacts; shell, midden, bone, charcoal, or other deposits; rock or coral alignments, pavings, wall, or other constructed features; and any indication of agricultural or other human activities. Upon such discovery or find, USACE will immediately notify DOE-LM so that the appropriate authorities may be notified, and a determination made as to their significance and what, if any, special disposition of the finds should be made. Immediately Cease all activities that may result in impact to or the destruction of these resources. Secure the area and prevent employees or other persons from trespassing on, removing, or otherwise disturbing such resources.

Two suspected archaeological sites have been identified by DOE-LM and the coordinates of their general locations are provided in Figure 5 of **Appendix A**. No work activities or vehicle traffic shall be conducted within 100 yards of these coordinates.

Work in potential wetland areas is prohibited.

8.0 Applicable Publications

The publications listed below form a part of this specification to the extent referenced. These are referred to by basic designation only. Work performed shall be in accordance with the latest editions of following documents:

8.1 American Society for Testing Materials (ASTM)

ASTM D854	Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D4221	Standard Test Method for Dispersive Characteristics of Clay Soil by Double Hydrometer
ASTM D4220	Practices for Preserving and Transporting Soil Samples
ASTM D4318	Standard Test Methods for Liquid Limits, Plastic Limit, and Plasticity Index of Soils
ASTM D4647	Standard Test Methods for Identification and Classification of Dispersive Clay Soils by the Pinhole Test
ASTM D5084	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
ASTM D5778	Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils
ASTM D6572	Standard Test Methods for Determining Dispersive Characteristics of Clayey Soils by the Crumb Test
ASTM D6913	Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
ASTM D7263	Standard Test Methods for Laboratory Determination of Density and Unit Weight of Soil Specimens

8.2 Code of Federal Regulations (CFR)

29 CFR 1926	Safety and Health in Construction

8.3 U.S. Army Corps of Engineers (USACE)

EM 385-1-1	U.S. Army Corps of Engineers Safety and Health Requirements Manual

EM 1110-1-1804	Geotechnical Investigations
EM 1110-2-1906	Laboratory Soils Testing

8.4 U.S. Nuclear Regulatory Commission

NUREG-1575	Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)
NUREG/CR-5432	Construction Methods and Guidance for Sealing Penetrations in Soil Covers

9.0 Consolidated Subsurface Investigation Plan

9.1 CPT, Shelby Tube, and Test Pit Sampling

9.1.1 Cone Penetrometer Test (CPT)

*** Denotes CPT locations adjacent to which a Shelby Tube sample will be collected**

Name	Latitude	Longitude	Depth (ft.)	Sample Diameter (in.)
CPT-21-01	35.275776°	-107.947554°	40	-
***CPT-21-02**	35.275772°	-107.947212°	40	**3**
CPT-21-03	35.275760°	-107.946872°	40	-
CPT-21-04	35.275750°	-107.946549°	40	-
***CPT-21-05**	35.275744°	-107.946205°	40	**5**
CPT-21-06	35.275729°	-107.945879°	40	-
CPT-21-07	35.275736°	-107.945548°	40	-
***CPT-21-08**	35.275715°	-107.945206°	40	**5**
CPT-21-09	35.275715°	-107.944885°	40	-
CPT-21-10	35.275705°	-107.944527°	40	-
***CPT-21-11**	35.275689°	-107.944192°	40	**3**
***CPT-21-12**	35.275502°	-107.947556°	40	**5**
CPT-21-13	35.275497°	-107.947213°	40	-
CPT-21-14	35.275487°	-107.946878°	40	-
***CPT-21-15**	35.275484°	-107.946559°	40	**5**
CPT-21-16	35.275474°	-107.946216°	40	-
CPT-21-17	35.275472°	-107.945892°	40	-
***CPT-21-18**	35.275467°	-107.945563°	40	**3**
CPT-21-19	35.275460°	-107.945221°	40	-
CPT-21-20	35.275452°	-107.944899°	40	-
***CPT-21-21**	35.275446°	-107.944537°	40	**5**
CPT-21-22	35.275441°	-107.944200°	40	-
CPT-21-23	35.275426°	-107.943880°	40	-
***CPT-21-24**	35.275419°	-107.943539°	40	**5**
CPT-21-25	35.275223°	-107.947564°	40	-
CPT-21-26	35.275218°	-107.947216°	40	-
***CPT-21-27**	35.275211°	-107.946889°	40	**3**
CPT-21-28	35.275203°	-107.946577°	40	-
CPT-21-29	35.275194°	-107.946228°	40	-
***CPT-21-30**	35.275187°	-107.945903°	40	**5**
CPT-21-31	35.275178°	-107.945576°	40	-
CPT-21-32	35.275169°	-107.945230°	40	-

Name	Latitude	Longitude	Depth (ft.)	Sample Diameter (in.)
***CPT-21-33**	35.275163°	-107.944910°	40	**5**
CPT-21-34	35.275155°	-107.944554°	40	-
CPT-21-35	35.275144°	-107.944212°	40	-
***CPT-21-36**	35.275138°	-107.943901°	40	**3**
CPT-21-37	35.275128°	-107.943556°	40	-
CPT-21-38	35.274943°	-107.947574°	40	-
***CPT-21-39**	35.274941°	-107.947218°	40	**5**
CPT-21-40	35.274936°	-107.946897°	40	-
CPT-21-41	35.274931°	-107.946593°	40	-
***CPT-21-42**	35.274927°	-107.946243°	40	**5**
CPT-21-43	35.274918°	-107.945933°	40	-
CPT-21-44	35.274907°	-107.945603°	40	-
***CPT-21-45**	35.274912°	-107.945249°	40	**3**
CPT-21-46	35.274910°	-107.944928°	40	-
CPT-21-47	35.274904°	-107.944569°	40	-
***CPT-21-48**	35.274898°	-107.944228°	40	**5**
CPT-21-49	35.274894°	-107.943911°	40	-
CPT-21-50	35.274888°	-107.943566°	40	-
***CPT-21-51**	35.274675°	-107.947576°	40	**5**
CPT-21-52	35.274668°	-107.947222°	40	-
CPT-21-53	35.274664°	-107.946906°	40	-
***CPT-21-54**	35.274658°	-107.946602°	40	**3**
CPT-21-55	35.274652°	-107.946252°	40	-
CPT-21-56	35.274646°	-107.945941°	40	-
***CPT-21-57**	35.274640°	-107.945614°	40	**5**
CPT-21-58	35.274632°	-107.945260°	40	-
CPT-21-59	35.274627°	-107.944938°	40	-
***CPT-21-60**	35.274620°	-107.944579°	40	**5**
CPT-21-61	35.274615°	-107.944238°	40	-
CPT-21-62	35.274594°	-107.943922°	40	-
***CPT-21-63**	35.274578°	-107.943575°	40	**3**
CPT-21-64	35.274411°	-107.948702°	40	-
CPT-21-65	35.274407°	-107.948271°	40	-
CPT-21-66	35.274398°	-107.947586°	40	-
CPT-21-67	35.274381°	-107.946915°	40	-
CPT-21-68	35.274365°	-107.946266°	40	-
CPT-21-69	35.274348°	-107.945584°	40	-
CPT-21-70	35.274331°	-107.944905°	40	-
CPT-21-71	35.274315°	-107.944242°	40	-

Name	Latitude	Longitude	Depth (ft.)	Sample Diameter (in.)
CPT-21-72	35.274298°	-107.943584°	40	-
CPT-21-73	35.274282°	-107.942921°	40	-
CPT-21-74	35.273919°	-107.950278°	40	-
CPT-21-75	35.273902°	-107.949608°	40	-
CPT-21-76	35.273885°	-107.948938°	40	-
CPT-21-77	35.273866°	-107.948270°	40	-
CPT-21-78	35.273852°	-107.947599°	40	-
CPT-21-79	35.273838°	-107.946931°	40	-
CPT-21-80	35.273824°	-107.946263°	40	-
CPT-21-81	35.273810°	-107.945602°	40	-
CPT-21-82	35.273799°	-107.944917°	40	-
CPT-21-83	35.273786°	-107.944268°	40	-
CPT-21-84	35.273770°	-107.943602°	40	-
CPT-21-85	35.273765°	-107.942939°	40	-
CPT-21-86	35.273748°	-107.942257°	40	-

9.1.2 Test Pits

Name	Location	Latitude	Longitude
TP-21-01	Northern Berm	35.281599°	-107.949528°
TP-21-02	Northern Berm	35.280647°	-107.948281°
TP-21-03	Northern Berm	35.279546°	-107.947090°
TP-21-04	Northern Berm	35.278489°	-107.945808°
TP-21-05	Northern Berm	35.277433°	-107.944536°
TP-21-06	Eastern Borrow Area	35.277144°	-107.922999°
TP-21-07	Eastern Borrow Area	35.275770°	-107.923646°
TP-21-08	Eastern Borrow Area	35.275995°	-107.919310°
TP-21-09	Eastern Borrow Area	35.274388°	-107.920181°
TP-21-10	Eastern Borrow Area	35.274878°	-107.915729°
TP-21-11	Eastern Borrow Area	35.273368°	-107.916931°
TP-21-12	Eastern Borrow Area	35.271896°	-107.917946°
TP-21-13	Eastern Borrow Area	35.273820°	-107.912536°
TP-21-14	Eastern Borrow Area	35.272146°	-107.913590°
TP-21-15	Eastern Borrow Area	35.270593°	-107.914635°
TP-21-16	Eastern Borrow Area	35.268771°	-107.916816°
TP-21-17	Eastern Borrow Area	35.267991°	-107.914622°

10.0 Laboratory Testing Program

10.1 Bulk Samples

Name	USCS Classification	Sieve Analysis	Atterberg Limits	Density & Unit Wt.	Specific Gravity	Saturated Hydraulic Conductivity	pH	Double Hydrometer	Pinhole Test	Crumb Test
ALL BULK SAMPLES	X	X	X	X	X	X	X	X	X	X

11.0 References

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Long-Term Surveillance Plan for the DOE Bluewater (UMTRCA Title II) Disposal Site Near Grants, New Mexico, Prepared for U.S. Department of Energy, Grand Junction Office, Grand Junction, Colorado

APPENDIX A

Subsurface Investigation Plan

General Site Information

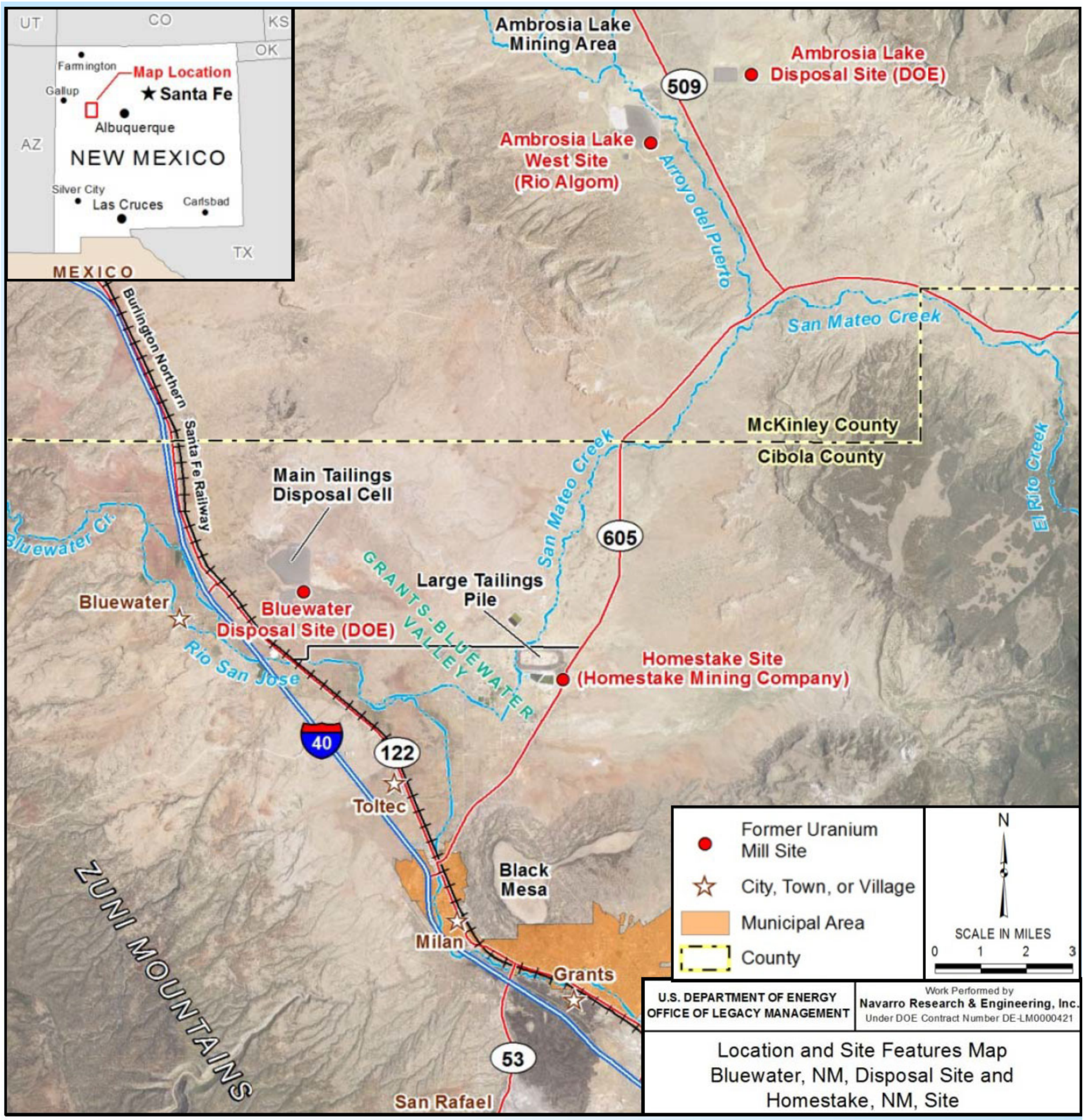


Figure 1: Vicinity Map of Bluewater Property (Map Provided by DOE LM)

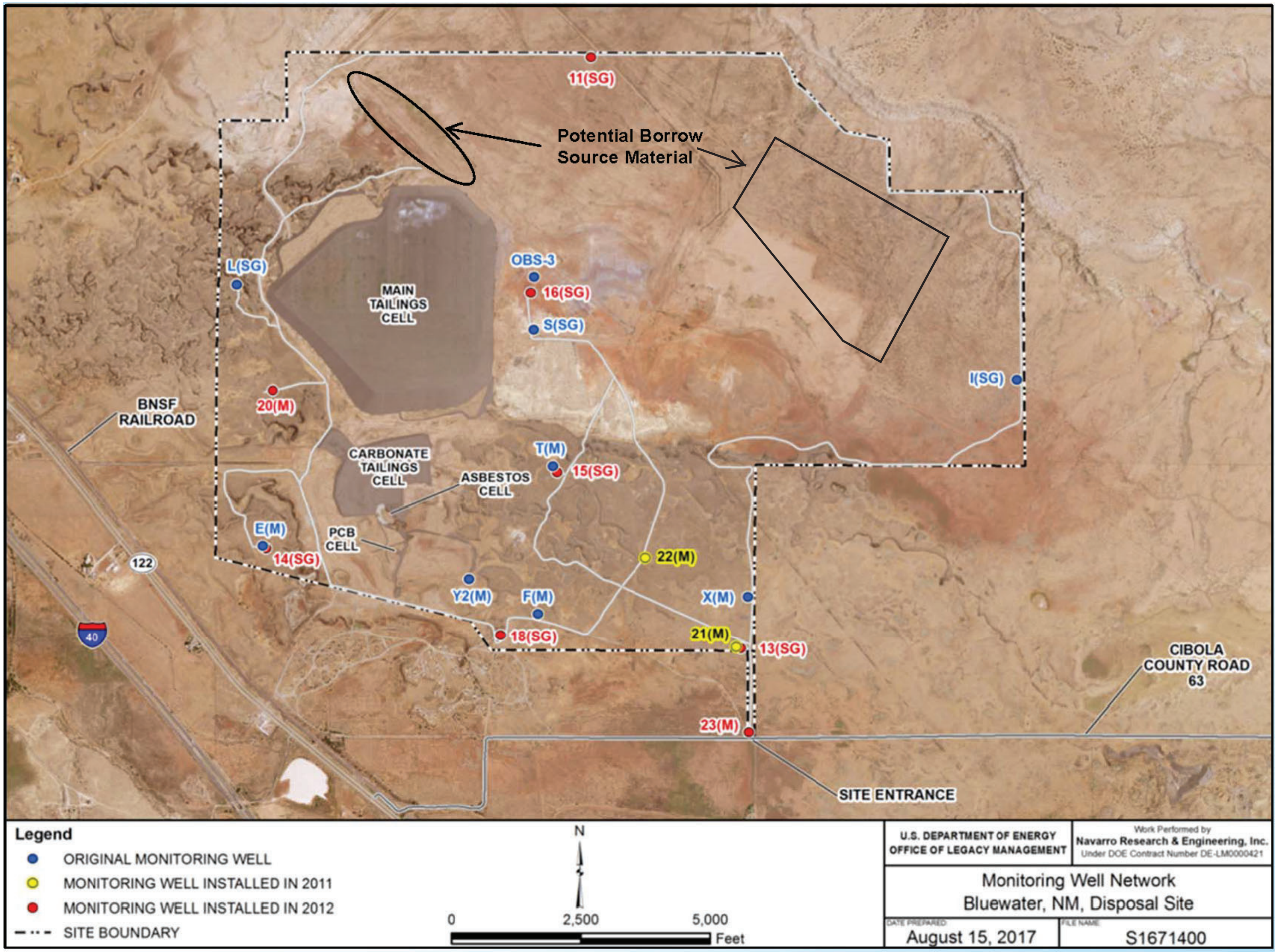
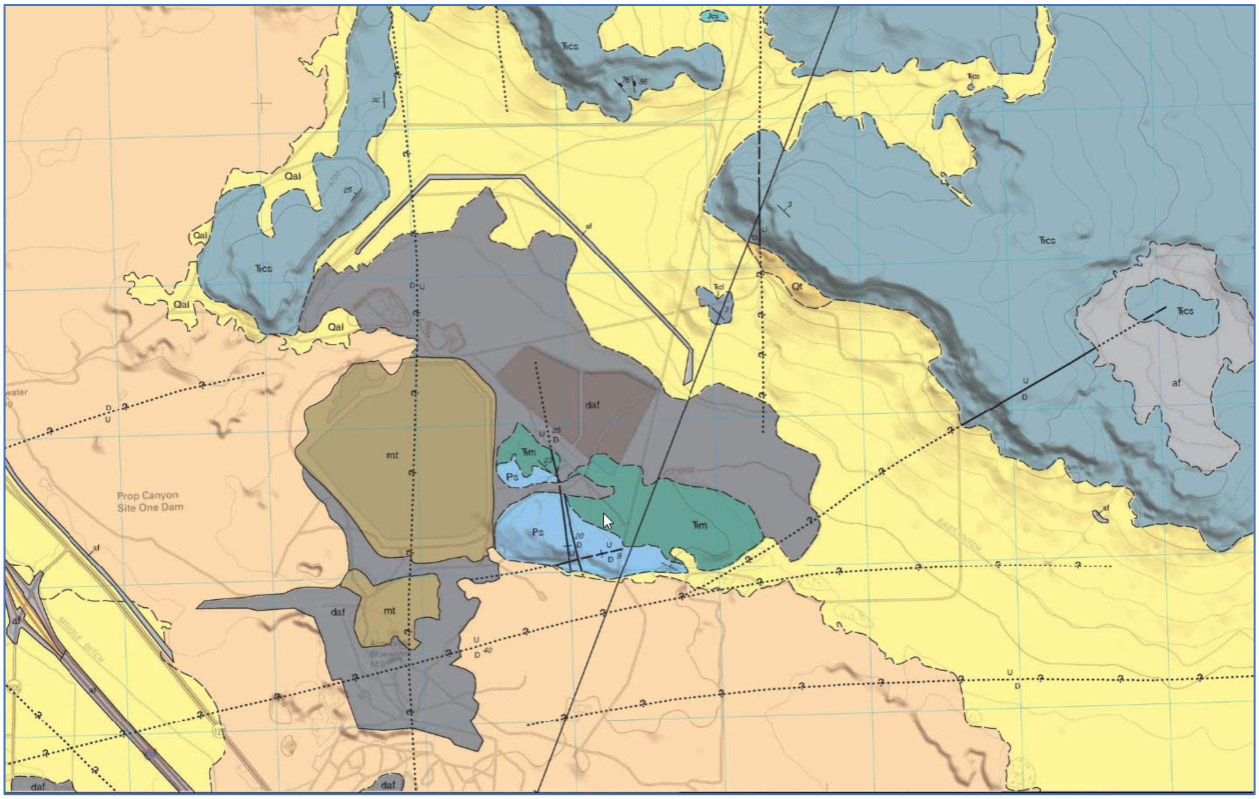


Figure 2: Site Map of Bluewater Disposal Site (Map Provided by DOE LM)



Key

Geology

- mt   Mine Tailings
- daf   disturbed area
- af   artificial fill
- Trm   Moenkopi Fm
- Trcs   Sonsela SS Mbr Chinle Fm
- Trcsl   Sonsela SS lower Mbr
- Qt   Talus and landslide block
- Qbt   Basalt flows from El Tinero
- Qal   Alluvium
- Ps   San Andres Ls

Faults

- Certain
- Approximate
- Buried
- Uncertain

Figure 3: Geologic Map of the Bluewater UMTRCA Site, Bluewater, NM.

Modified from Rawlins, G.C., 2013, Geologic map of the Bluewater 7.5-minute quadrangle, Cibola and McKinley counties, New Mexico: New Mexico Bureau of Geology and+ Mineral Resources Open-File Geologic Map OF-GM 236, 1:24,000 scale.

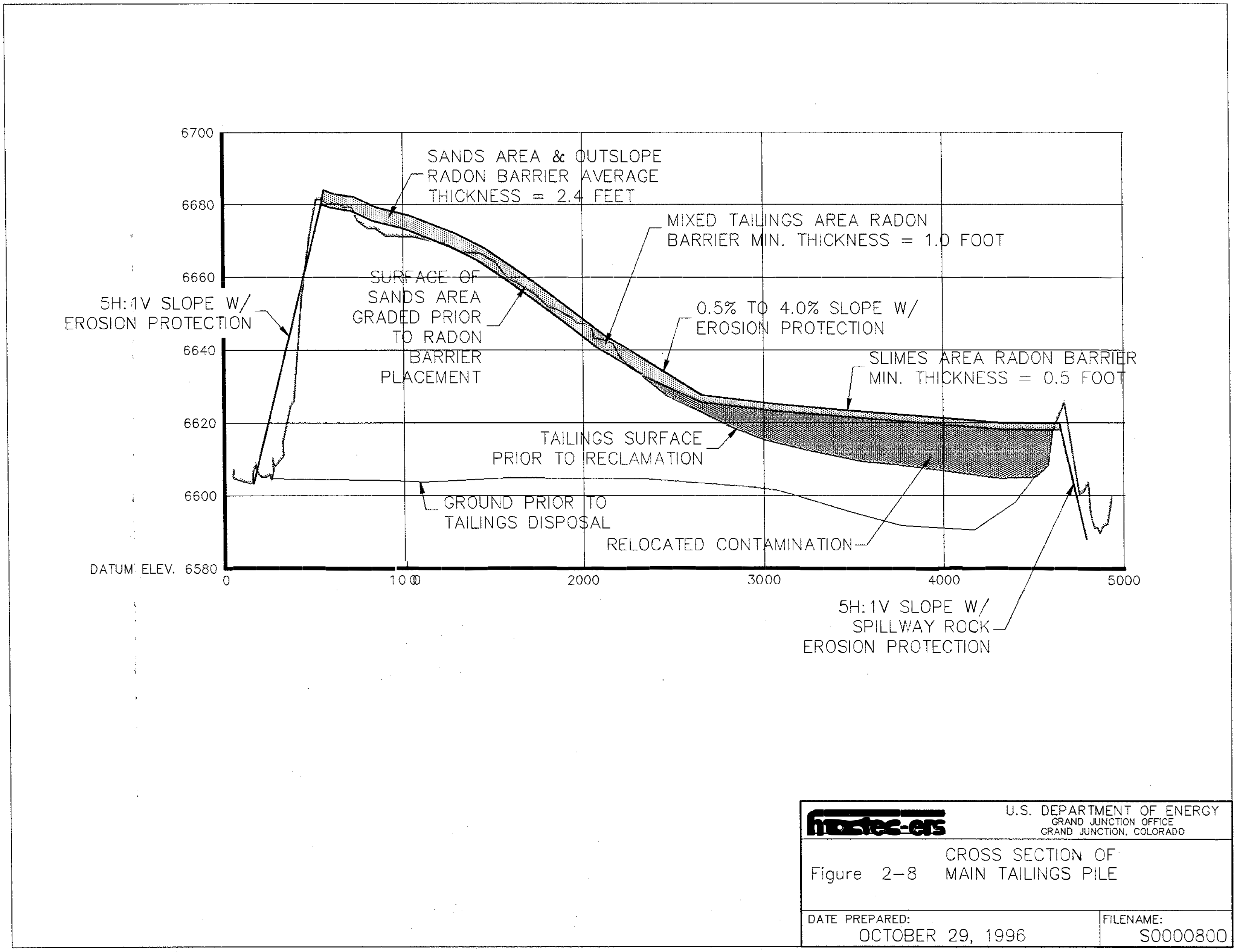


Figure 4: Cross Section of Main Tailings Pile

Figure 5: Potential Archaeological Sites (Locations Provided by DOE LM)

Coordinates	Lat.	Long.
Site 1	35°16'40.60"N	107°55'29.02"W
Site 2	35°16'08.48"N	107°54'50.96"W

APPENDIX B

Subsurface Investigation Plan

Proposed CPT & Test Pit Locations

Figure 1: Boundary of Proposed CPT Locations

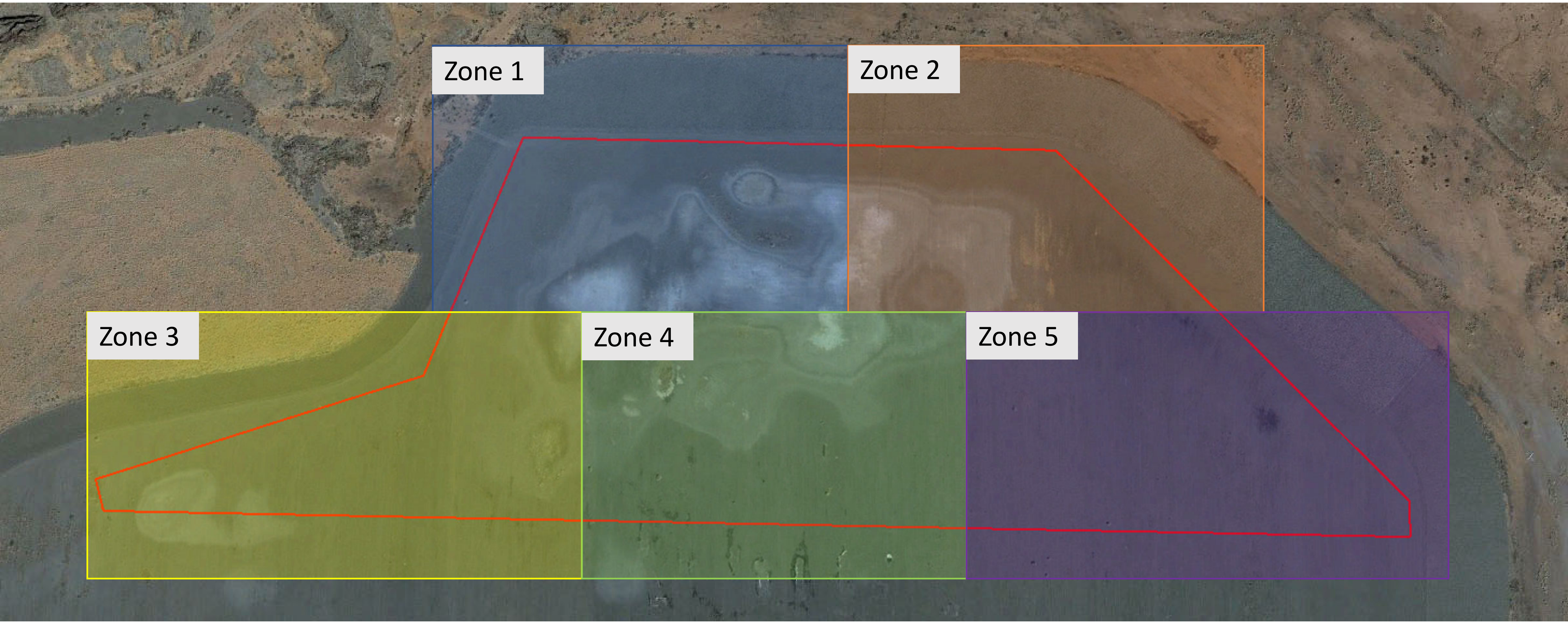


Figure 2: CPT Reference Zones

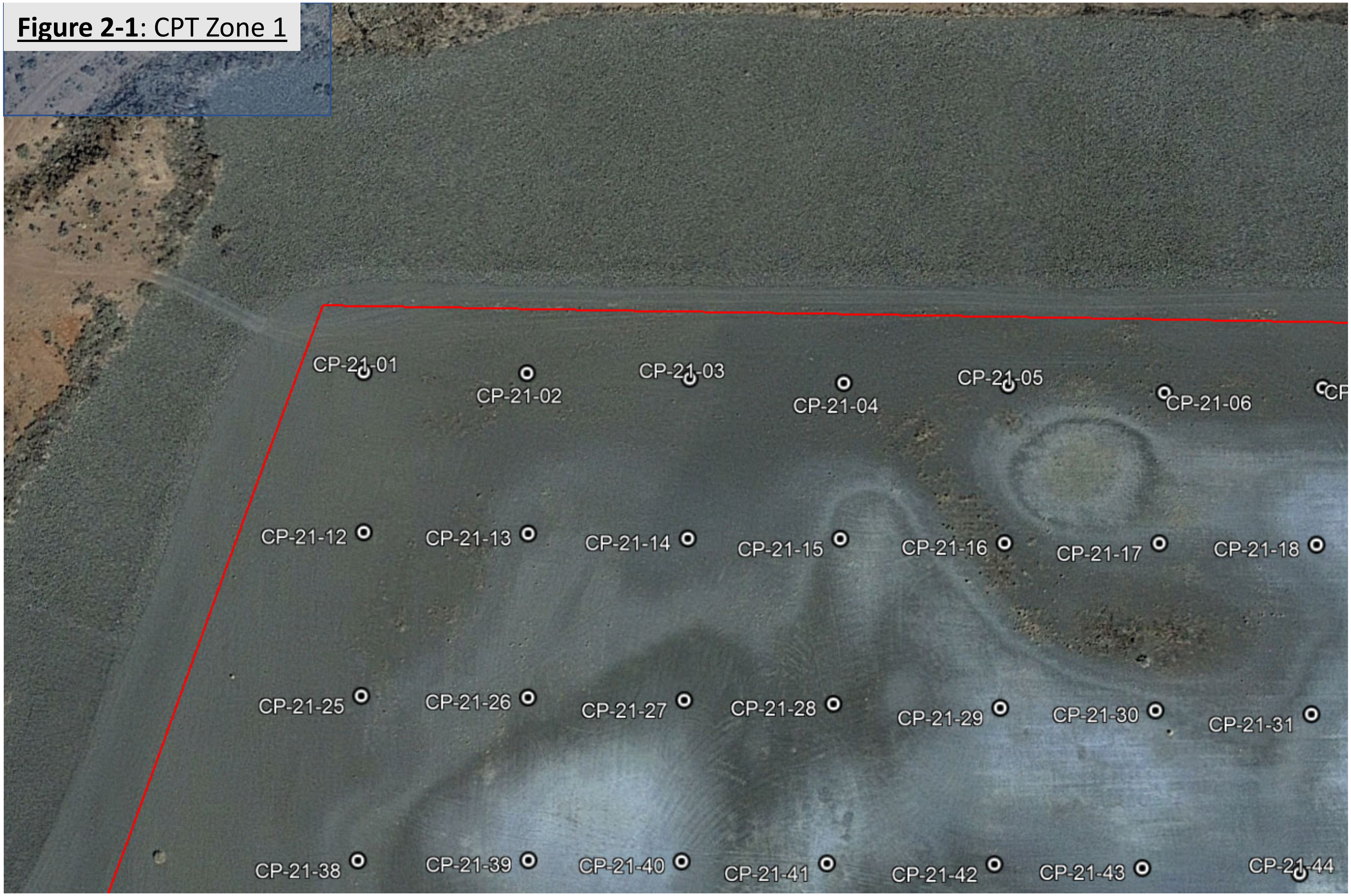


Figure 2-1: CPT Zone 1

Figure 2-2: CPT Zone 2

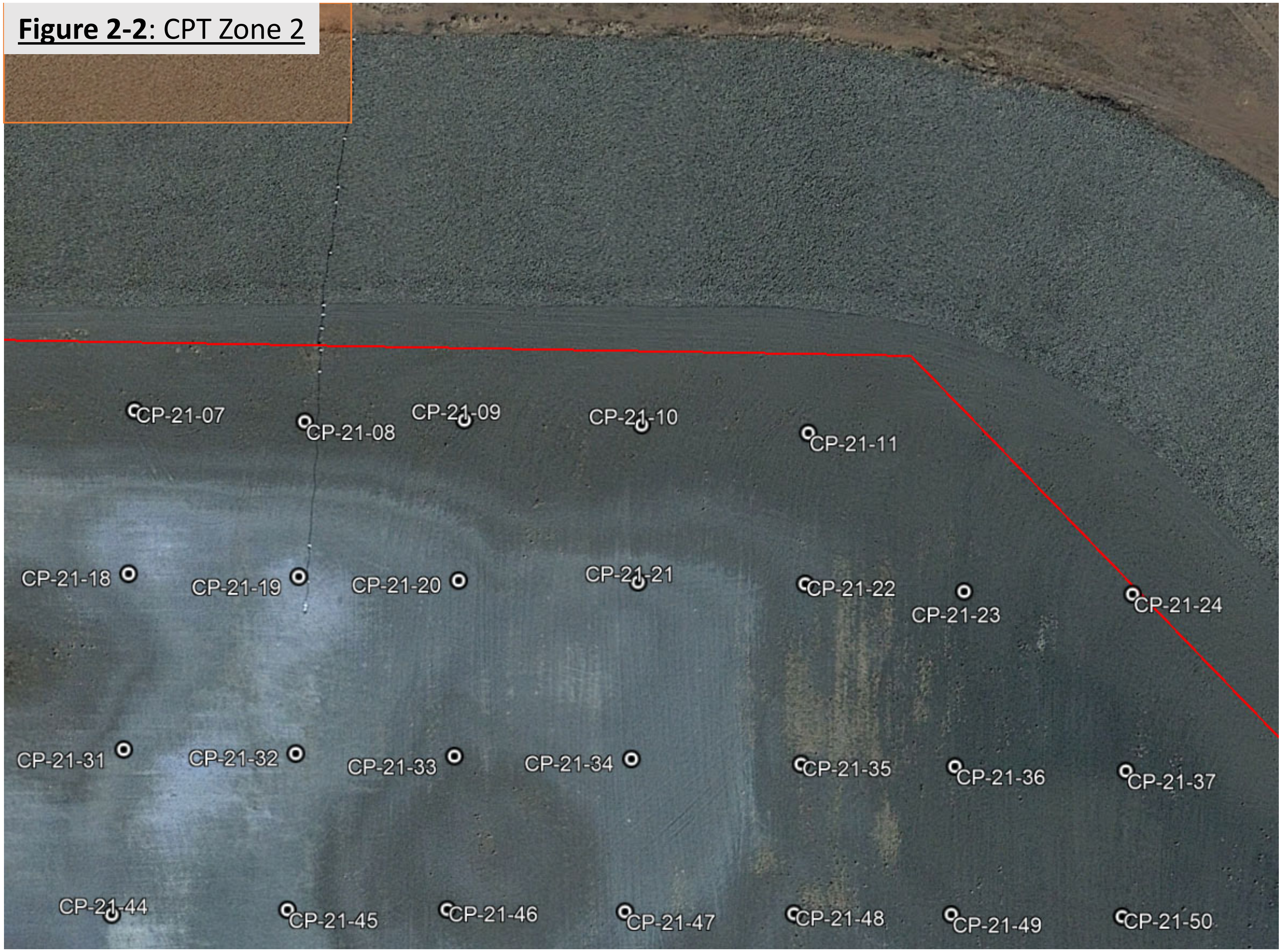


Figure 2-3: CPT Zone 3

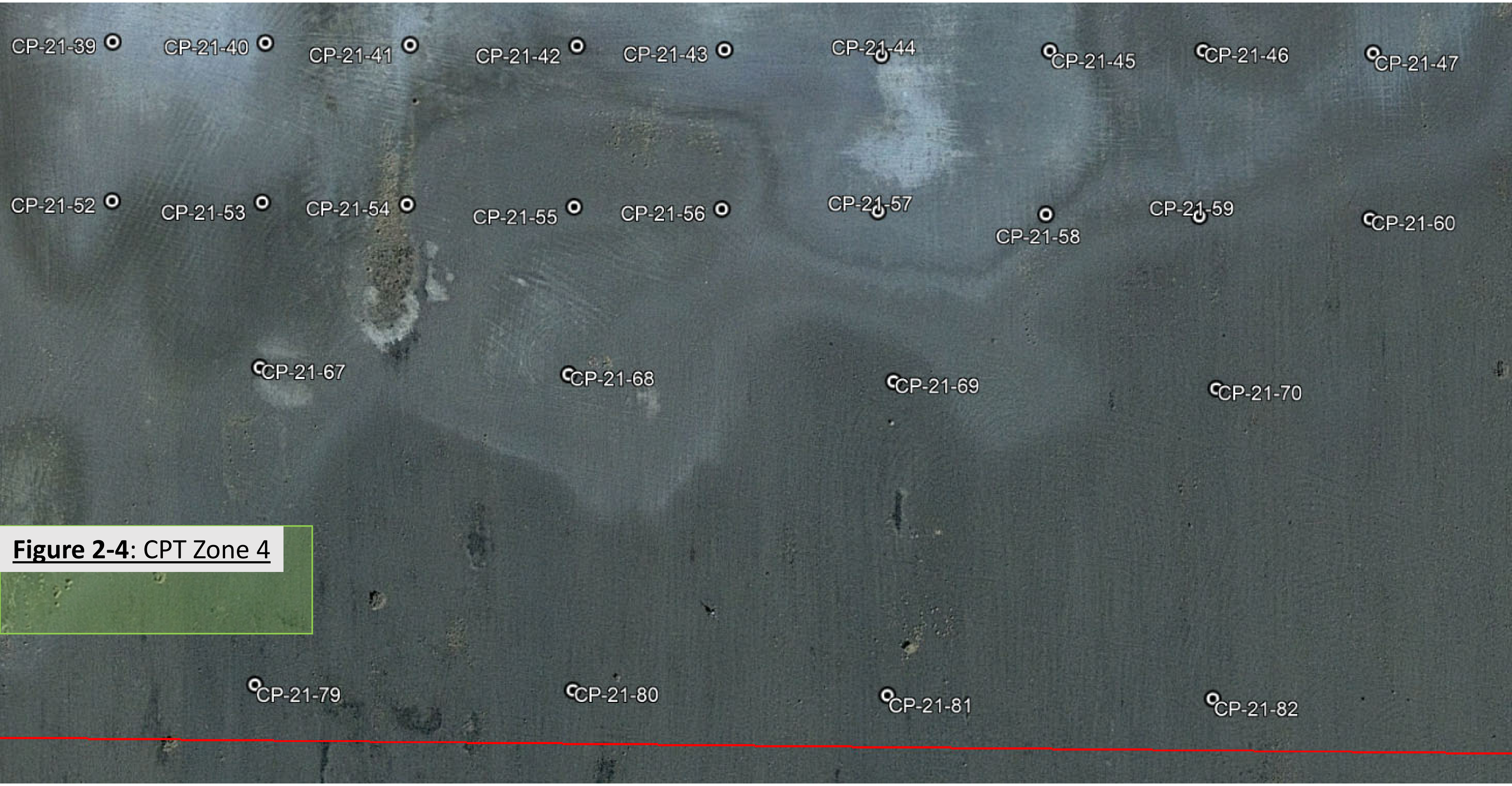


Figure 2-4: CPT Zone 4

Figure 2-5: CPT Zone 5

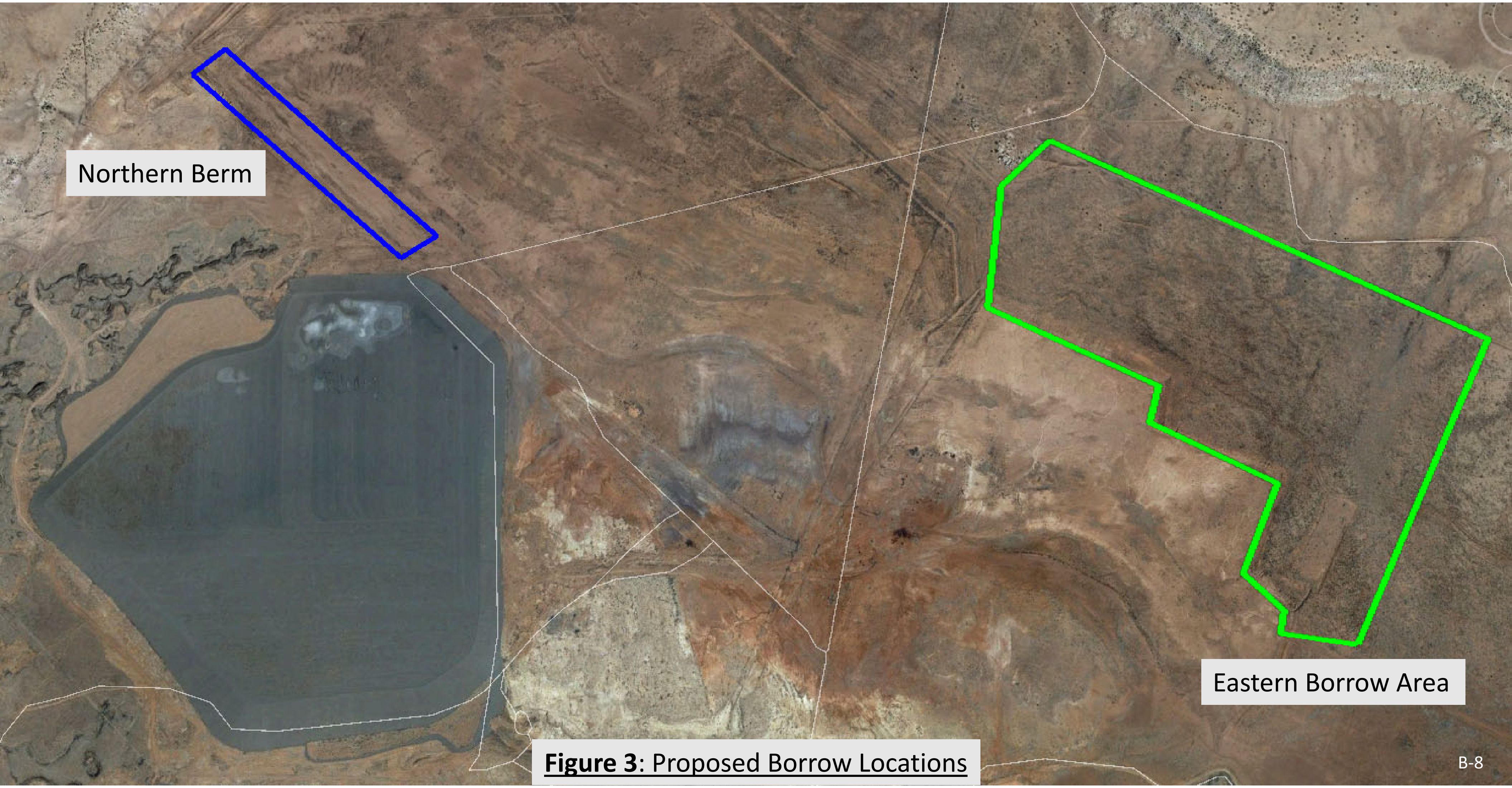


Figure 3: Proposed Borrow Locations

Figure 3-1: Northern Berm Test Pit Locations

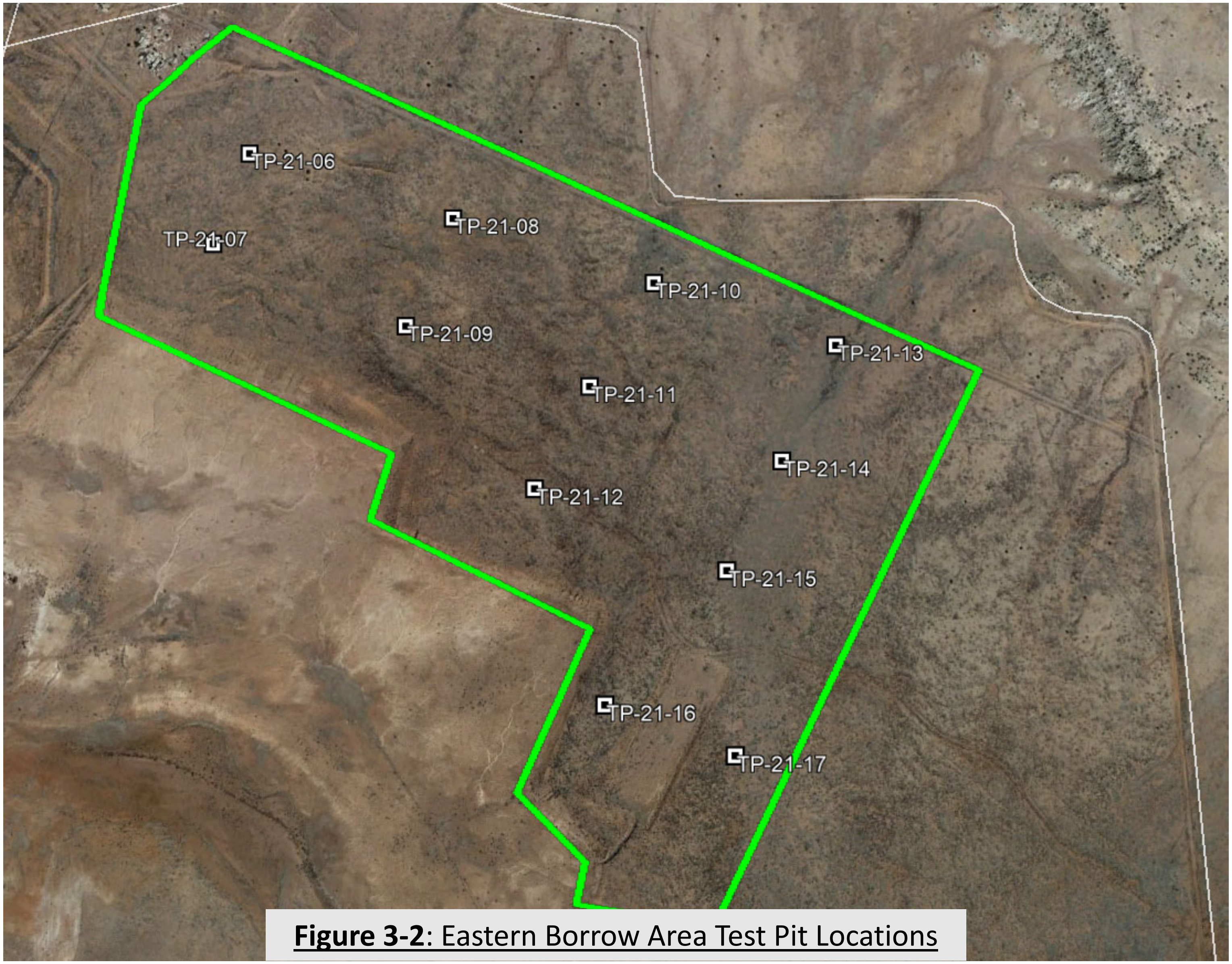


Figure 3-2: Eastern Borrow Area Test Pit Locations

CPT ID	Latitude	Longitude
CPT-21-01	35.275776°	-107.947554°
***CPT-21-02**	35.275772°	-107.947212°
CPT-21-03	35.275760°	-107.946872°
CPT-21-04	35.275750°	-107.946549°
***CPT-21-05**	35.275744°	-107.946205°
CPT-21-06	35.275729°	-107.945879°
CPT-21-07	35.275736°	-107.945548°
***CPT-21-08**	35.275715°	-107.945206°
CPT-21-09	35.275715°	-107.944885°
CPT-21-10	35.275705°	-107.944527°
***CPT-21-11**	35.275689°	-107.944192°
***CPT-21-12**	35.275502°	-107.947556°
CPT-21-13	35.275497°	-107.947213°
CPT-21-14	35.275487°	-107.946878°
***CPT-21-15**	35.275484°	-107.946559°

CPT ID	Latitude	Longitude
CPT-21-16	35.275474°	-107.946216°
CPT-21-17	35.275472°	-107.945892°
***CPT-21-18**	35.275467°	-107.945563°
CPT-21-19	35.275460°	-107.945221°
CPT-21-20	35.275452°	-107.944899°
***CPT-21-21**	35.275446°	-107.944537°
CPT-21-22	35.275441°	-107.944200°
CPT-21-23	35.275426°	-107.943880°
***CPT-21-24**	35.275419°	-107.943539°
CPT-21-25	35.275223°	-107.947564°
CPT-21-26	35.275218°	-107.947216°
***CPT-21-27**	35.275211°	-107.946889°
CPT-21-28	35.275203°	-107.946577°
CPT-21-29	35.275194°	-107.946228°
***CPT-21-30**	35.275187°	-107.945903°

Table 1: CPT Coordinates

*** Denotes CPT locations adjacent to which a Shelby Tube sample will be collected**

CPT ID	Latitude	Longitude
CPT-21-31	35.275178°	-107.945576°
CPT-21-32	35.275169°	-107.945230°
***CPT-21-33**	35.275163°	-107.944910°
CPT-21-34	35.275155°	-107.944554°
CPT-21-35	35.275144°	-107.944212°
***CPT-21-36**	35.275138°	-107.943901°
CPT-21-37	35.275128°	-107.943556°
CPT-21-38	35.274943°	-107.947574°
***CPT-21-39**	35.274941°	-107.947218°
CPT-21-40	35.274936°	-107.946897°
CPT-21-41	35.274931°	-107.946593°
***CPT-21-42**	35.274927°	-107.946243°
CPT-21-43	35.274918°	-107.945933°
CPT-21-44	35.274907°	-107.945603°
***CPT-21-45**	35.274912°	-107.945249°

CPT ID	Latitude	Longitude
CPT-21-46	35.274910°	-107.944928°
CPT-21-47	35.274904°	-107.944569°
***CPT-21-48**	35.274898°	-107.944228°
CPT-21-49	35.274894°	-107.943911°
CPT-21-50	35.274888°	-107.943566°
***CPT-21-51**	35.274675°	-107.947576°
CPT-21-52	35.274668°	-107.947222°
CPT-21-53	35.274664°	-107.946906°
***CPT-21-54**	35.274658°	-107.946602°
CPT-21-55	35.274652°	-107.946252°
CPT-21-56	35.274646°	-107.945941°
***CPT-21-57**	35.274640°	-107.945614°
CPT-21-58	35.274632°	-107.945260°
CPT-21-59	35.274627°	-107.944938°
***CPT-21-60**	35.274620°	-107.944579°

Table 1 (contd.): CPT Coordinates

*** Denotes CPT locations adjacent to which a Shelby Tube sample will be collected**

CPT ID	Latitude	Longitude
CPT-21-61	35.274615°	-107.944238°
CPT-21-62	35.274594°	-107.943922°
***CPT-21-63**	35.274578°	-107.943575°
CPT-21-64	35.274411°	-107.948702°
CPT-21-65	35.274407°	-107.948271°
CPT-21-66	35.274398°	-107.947586°
CPT-21-67	35.274381°	-107.946915°
CPT-21-68	35.274365°	-107.946266°
CPT-21-69	35.274348°	-107.945584°
CPT-21-70	35.274331°	-107.944905°
CPT-21-71	35.274315°	-107.944242°
CPT-21-72	35.274298°	-107.943584°
CPT-21-73	35.274282°	-107.942921°
CPT-21-74	35.273919°	-107.950278°
CPT-21-75	35.273902°	-107.949608°

CPT ID	Latitude	Longitude
CPT-21-76	35.273885°	-107.948938°
CPT-21-77	35.273866°	-107.948270°
CPT-21-78	35.273852°	-107.947599°
CPT-21-79	35.273838°	-107.946931°
CPT-21-80	35.273824°	-107.946263°
CPT-21-81	35.273810°	-107.945602°
CPT-21-82	35.273799°	-107.944917°
CPT-21-83	35.273786°	-107.944268°
CPT-21-84	35.273770°	-107.943602°
CPT-21-85	35.273765°	-107.942939°
CPT-21-86	35.273748°	-107.942257°

Table 1 (contd.): CPT Coordinates

*** Denotes CPT locations adjacent to which a Shelby Tube sample will be collected**

Northern Berm		
Test Pit ID	**Latitude**	**Longitude**
TP-21-01	35.281600°	-107.949500°
TP-21-02	35.280647°	-107.948281°
TP-21-03	35.279544°	-107.947089°
TP-21-04	35.278489°	-107.945808°
TP-21-05	35.277433°	-107.944536°

Eastern Borrow Area		
Test Pit ID	**Latitude**	**Longitude**
TP-21-06	35.277144°	-107.922999°
TP-21-07	35.275770°	-107.923646°
TP-21-08	35.275995°	-107.919310°
TP-21-09	35.274388°	-107.920181°
TP-21-10	35.274878°	-107.915729°
TP-21-11	35.273368°	-107.916931°
TP-21-12	35.271896°	-107.917946°
TP-21-13	35.273820°	-107.912536°
TP-21-14	35.272146°	-107.913590°
TP-21-15	35.270593°	-107.914635°
TP-21-16	35.268771°	-107.916816°
TP-21-17	35.267991°	-107.914622°

Table 2: Test Pit Coordinates

APPENDIX C

Subsurface Investigation Plan

2019 Annual Site Inspection and Monitoring Report

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 20 and March 21, 2019. No changes were observed on the disposal cells, although depressions and resultant ponding 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. A conceptual design to repair the top slope and modify the spillway on the north side slope of the disposal cell was prepared in 2018 and will be finalized by the U.S. Army Corps of Engineers (USACE) and provided to the U.S. Nuclear Regulatory Commission (NRC) for review. Inspectors identified several routine maintenance needs but found no cause for a follow-up or contingency inspection.

Groundwater was sampled in November 2018 and May 2019. Analytical results 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 New Mexico groundwater standard. No known domestic wells within the contaminant plumes have uranium concentrations exceeding the drinking water standard (equivalent to the groundwater standard), and the plumes are not expected to impact local municipal water supplies (DOE 2019). A final report reevaluating the extent of the plumes was completed in 2019 and provided to NRC and posted to the U.S. Department of Energy (DOE) Office of Legacy Management (LM) and NRC websites.

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 that 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 on March 20 and March 21, 2019. The inspection was moved to earlier in the year to avoid hazards posed by weather and snakes later in the year. The inspection was conducted by R. Johnson, A. Kuhlman, and D. Traub of the Legacy Management Support (LMS) contractor. B. Tsosie (LM site manager), E. Holland (LM), and A. Rheubottom (New Mexico Environment Department [NMED]) attended the inspection. The purposes of the inspection were to confirm the integrity of the 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, 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 identified in the 2019 annual inspection are shown in red. 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. 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. Increased erosion continued to be observed on a road northwest of the main tailings disposal cell (PL-1 and PL-2). A gully intersecting the road at this location required maintenance in the past. Riprap previously was added to repair this section of the road; other repair options were evaluated in 2019. LM is proposing to repair the road in 2020 and to construct two armored low-level crossings to protect against future erosion. No other maintenance needs were identified.

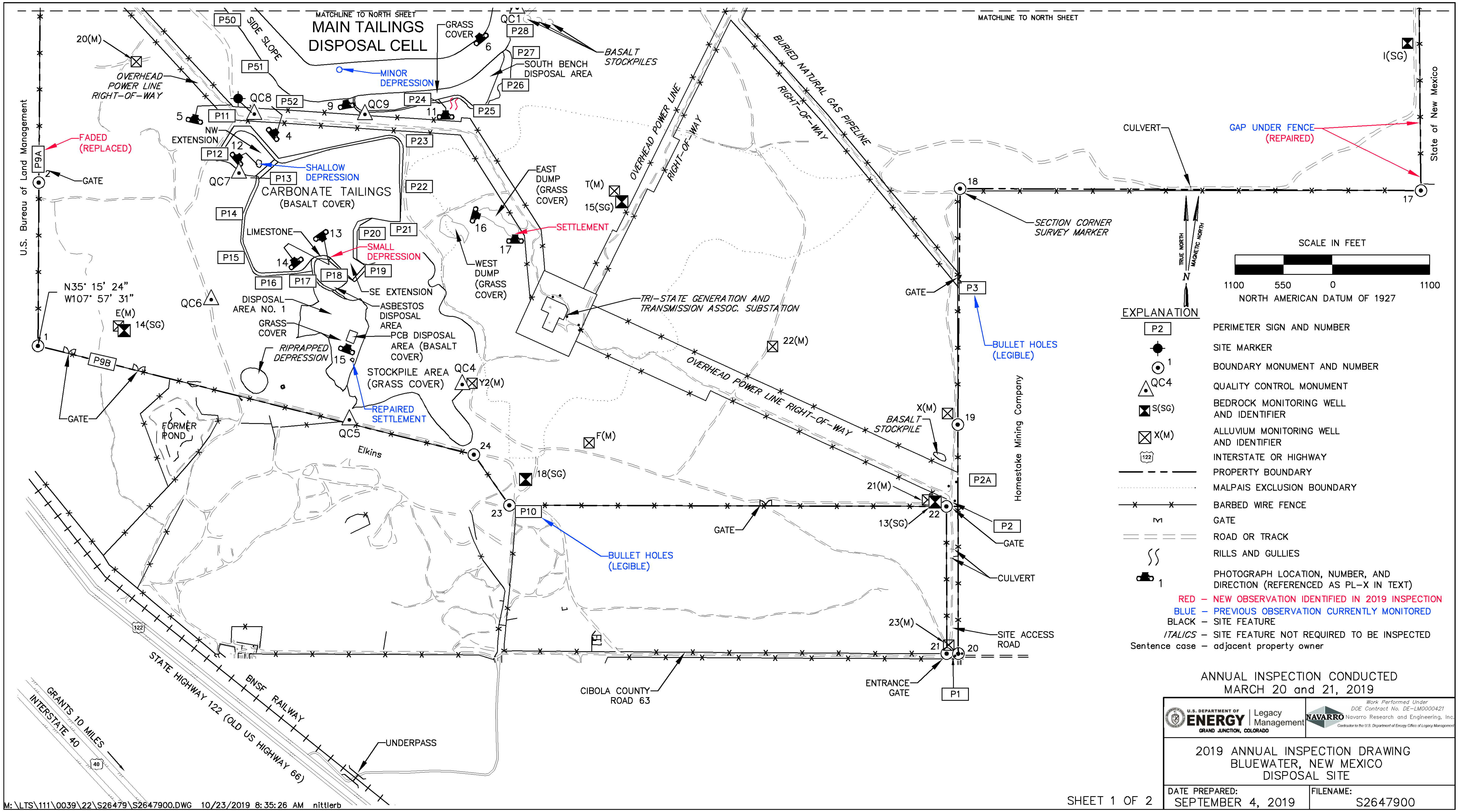


Figure 1-1. 2019 Annual Inspection Drawing for the Bluewater, New Mexico, Disposal Site (South Area)

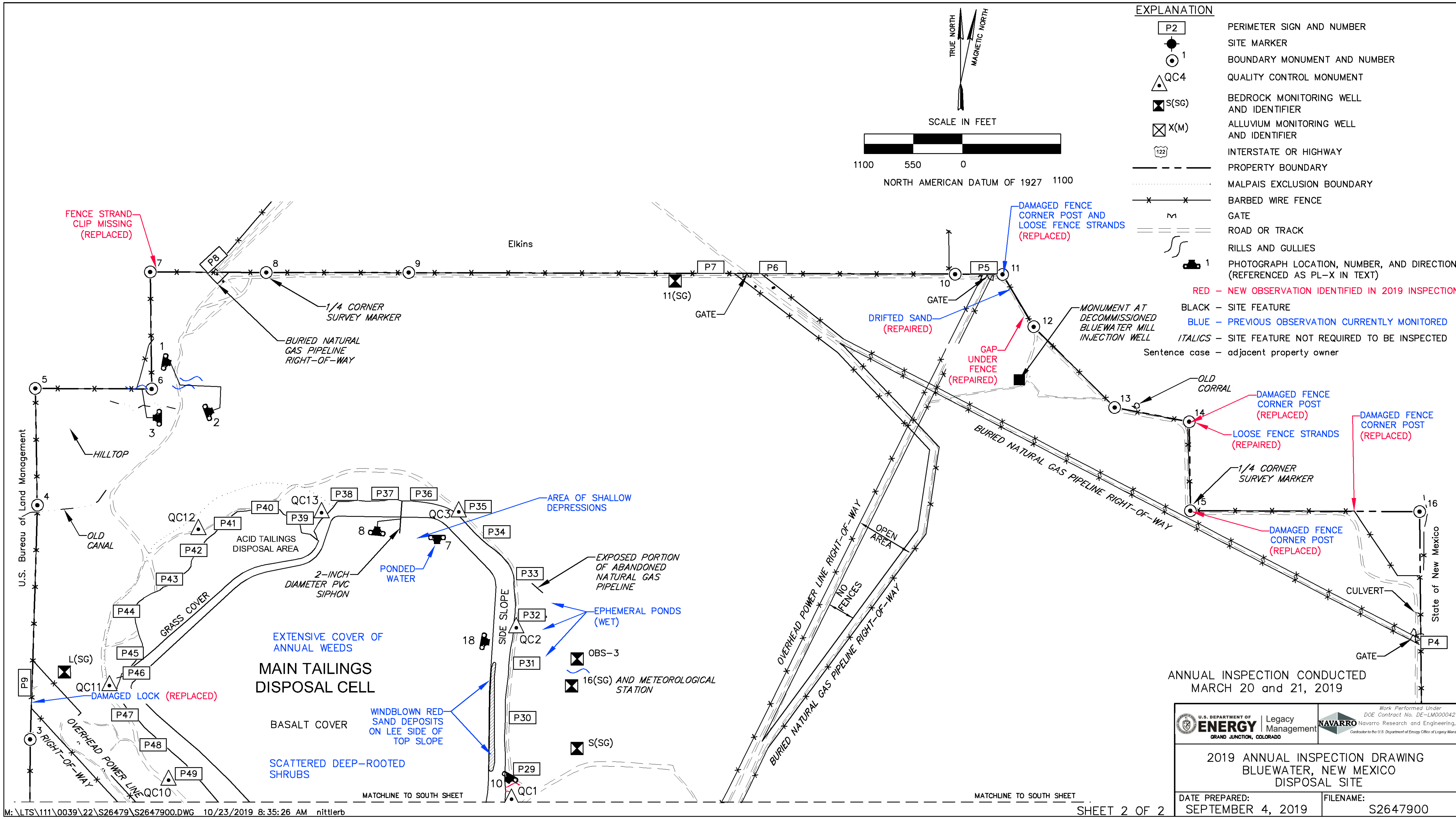


Figure 1-2. 2019 Annual Inspection Drawing for the Bluewater, New Mexico, Disposal Site (North Area)

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. 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. The 2018 annual inspection report identified that fence repairs were needed in the northeast portion of the site where drifted sand had either accumulated or caused a large enough gap under the fence that cattle would be able to access the site. These gaps were repaired in 2019. During the 2019 inspection, damaged corner fence posts in the northeast portion of the site and several broken fence strands were identified as needing to be repaired. In April 2019 these areas of the perimeter fence were repaired including replacing two of the corner posts. Three additional corner posts were replaced in August 2019. An area of erosion was also identified northwest of the main tailings disposal cell where gullies from erosion parallel the perimeter fence line (PL-3). 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-4). Perimeter signs P3 and P10 have bullet hole damage but are legible. Perimeter sign P9A was faded and replaced following the inspection. No other maintenance needs were identified.

1.4.1.3 Site Marker

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

1.4.1.4 Boundary Monuments

Twenty-four boundary monuments define the site boundary. These monuments are typically inside the perimeter fence and several feet inside the true corner or boundary line. Some monuments tend to get 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. Thirteen of the 24 boundary monuments were inspected in April, October, and November 2019. The remaining nine boundary monuments (BM-1 through BM-7; BM-23 and BM-24) were unable to be inspected due to weather conditions. All boundary monuments will be inspected in 2020. No maintenance needs were identified.

1.4.1.5 Monitoring Wells

The site 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 and the 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-6). 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; none were observed during the inspection.

Several depressions are evident on the north end of the top slope of the main tailings disposal cell and along the east and northwest edges of the top slope. This portion of the top slope overlies predominantly clay-rich tailings referred to as "slimes." Although the former licensee attempted to dewater the slimes to consolidate them, that portion of the top slope continued to settle after the site transitioned to LM. Annual inspections indicated that the depressions 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 continues 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, as much as 4 feet in some locations, continues. 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 2020.

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. The top slope had minor ponding at the time of the inspection (PL-7). No algae was present during the inspection even though algae was noted in previous reports.

A 2-inch-diameter siphon was installed in fall 2015 to dewater as much of the ponded water as possible. The siphon is manually started when the webcam indicates that a large pond has developed. The intent is to avoid potential erosion of the main tailings disposal cell cover materials if the pond surface reaches an elevation high enough to spill over the north side slope of the disposal cell. Water would start to spill at the lowest point along the north edge of the top slope, and that could initiate erosion at that location. In 2018, LM developed a conceptual design to repair the depressions, regrade the north portion of the top slope, and construct a spillway on the north side slope to ensure positive drainage. LM will finalize the conceptual design through an interagency agreement with USACE.

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 2019 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-8). 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.

NRC requested that LM evaluate the performance of the radon barrier because of a concern that the ponded water could be degrading the main tailings disposal cell performance (i.e., releasing radon and allowing percolation of water through the cover materials and into the encapsulated tailings). Radon flux measurements were collected in July 2013 on top of the radon barrier in the area of the depressions. All radon measurements were below the detection limit, indicating that the radon barrier in that portion of the main tailings disposal cell was performing as designed. Based on the integrity of the radon barrier and the persistence of ponded water, dissipation of the ponded water was determined to be most likely due to evaporation rather than percolation through the cover materials.

Additional investigation of the cover was conducted in 2016 as part of a joint NRC/LM radon study investigating the effects of soil-forming processes on disposal cell cover properties (DOE 2016). The 2016 study confirmed that while the radon barrier continues to meet regulatory requirements, various soil-forming processes are occurring. In addition to measuring radon flux through the radon barrier, analysis of soil properties will help determine the permeability and other soil properties of the radon barrier materials. Field research conducted in June 2016 included exposing the radon barrier for radon measurements, excavating samples of the radon barrier for field and laboratory analysis of soil properties and exposing the surface immediately under the radon barrier to measure radon flux. Thirteen test pits were dug and sampled on the top slope of the main tailings disposal cell, and two more were dug on the acid tailings disposal area. The test pits were reclaimed after completion of filed investigations, and the locations were observed and photographed during the 2016 and 2017 annual inspections. No indications of settlement or erosion were visible, and annual inspections of the reclaimed test pits were discontinued after the 2017 inspection. Results of the disposal cell cover investigations will be used to determine, in consultation with NRC, if additional monitoring, removal of the ponded water, or cover enhancements are necessary.

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 during the 2018 annual inspection but could not be identified during the 2019 annual inspection (PL-9). No abnormalities or irregularities were observed on the side slopes. The side slopes will continue to be observed for depressions and will be evaluated using LiDAR. Minor rills, with a maximum depth of 6 inches, were observed at the base of the east side slope (PL-10). The rills appear to be headcutting away from the main tailings disposal cell. Additional rills with a maximum depth of 8 inches (PL-11) were observed at the base of the main tailings disposal cell's south bench. The rills did not appear to be impacting the south bench disposal area. LM will continue to monitor the rills 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 2019 inspection (PL-12). This depression does not appear to be enlarging but will continue to be 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 grass-covered. The depressions repaired in May 2018 were observed, and no negative impacts were apparent (PL-13). An additional depression was identified on the north side slope (PL-14). The depression was approximately 6 inches deep and 3 × 6 feet in area. LM will continue to observe the depression and make repairs as necessary. No immediate maintenance needs were identified.

There is an 11-acre grass-covered disposal area south of the asbestos disposal area. A small riprap-covered PCB cell (less than 1 acre) is within the disposal area (PL-15). Two grass-covered dumps, totaling about 2 acres, are east of the carbonate tailings disposal cell (PL-16). Fill material had settled into the basalt in an area at the southern interface of the east dump (PL-17). 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 observed to be wet during the inspection (PL-18).

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

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. A new gas line was installed northwest of the site in 2019.

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 minor maintenance needs that were addressed following the inspection, including:

- Repairing the northwest perimeter fence section, including adjusting the perimeter fence to address gaps and sediment deposition
- Replacing damaged fence corner posts and fence strands
- Replacing a damaged lock near P9
- Replacing perimeter sign P9A
- Spraying noxious weeds
- Repairing the perimeter fence including replacing additional fence corner posts

Inspectors also identified the need to repair erosion along the interior road. This work is currently proposed for 2020.

No other maintenance needs were identified.

In June 2019, following the inspection, 13 permanent quality control monuments were installed at the site in preparation for the upcoming LiDAR survey. The quality control monument locations are shown in Figure 1-1 and Figure 1-2.

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 annual sampling for PCBs (for 20 years beginning in 1997) and 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. PCB monitoring was discontinued in 2018 in accordance with the LTSP; no detects apart from laboratory errors were observed. The groundwater monitoring network is described in Figure 1-3 and Table 1-2. ACLs are listed in Table 1-3. ACLs were determined based upon an NRC-approved health-based standard of 0.44 milligrams per liter (mg/L) at POE wells at the site boundary (Applied Hydrology Associates Inc. 1995).

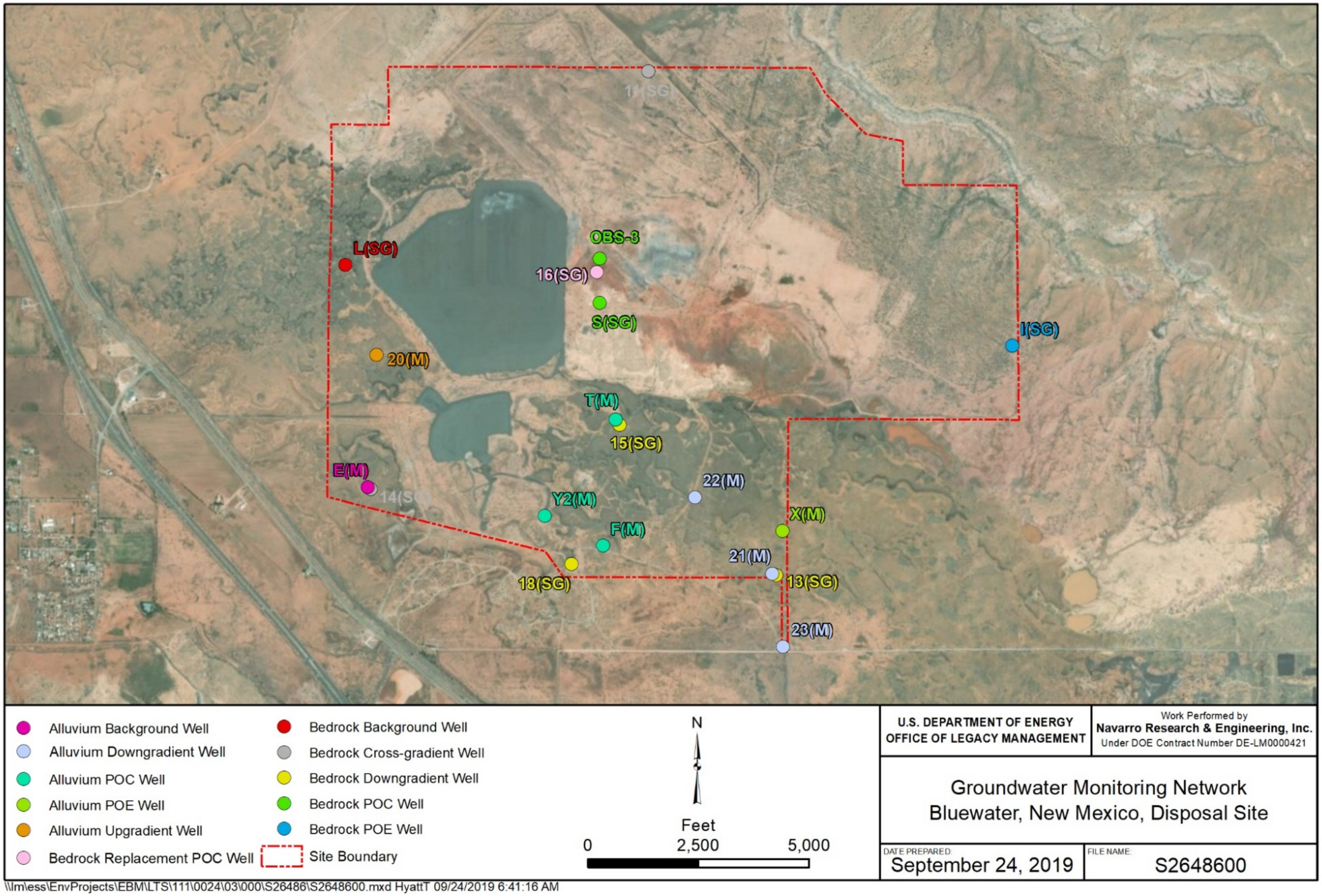


Figure 1-3. Groundwater Monitoring Network at Bluewater, New Mexico, Disposal Site

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

Monitoring Well	Network Application
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
Bedrock aquifer wells OBS-3 and S(SG)	Selenium	0.05
	Uranium	2.15

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's concerns, LM reinitiated annual sampling at all onsite monitoring wells, including the POE wells, in fall 2008. 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 what is required by the LTSP to characterize the site aquifers and to 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 the SAG aquifer in a 2019 report (DOE 2019).

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 November 2018 and May 2019 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 in 22(M). 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 November 2018 and May 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)	0.000252, ND	ND, ND	ND, ND
F(M)	0.000876, 0.00101	ND, ND	0.00637, 0.00633
T(M)	NS, NS	NS, NS	NS, NS
X(M)	0.000755, 0.000811	0.00768, 0.00826	0.102, 0.0937
Y2(M)	0.00176, 0.00175	ND, ND	0.00448, 00473
20(M)	0.00218, 0.00223	0.00476, 0.00499	0.011, 0.0119
21(M)	0.00107, 0.00108	0.0133, 0.0129	0.111, 0.116
22(M)	0.00462, 0.00497	0.00382, 0.00382	0.363, 0.378
23(M)	0.00289, 0.003	ND, ND	0.0197, 0.0185

Note:
November 2018 results are first, and May 2019 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) dried up following a May 2012 sampling because of drought and continuing declines of water levels in the well, and the well has since remained dry. 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).

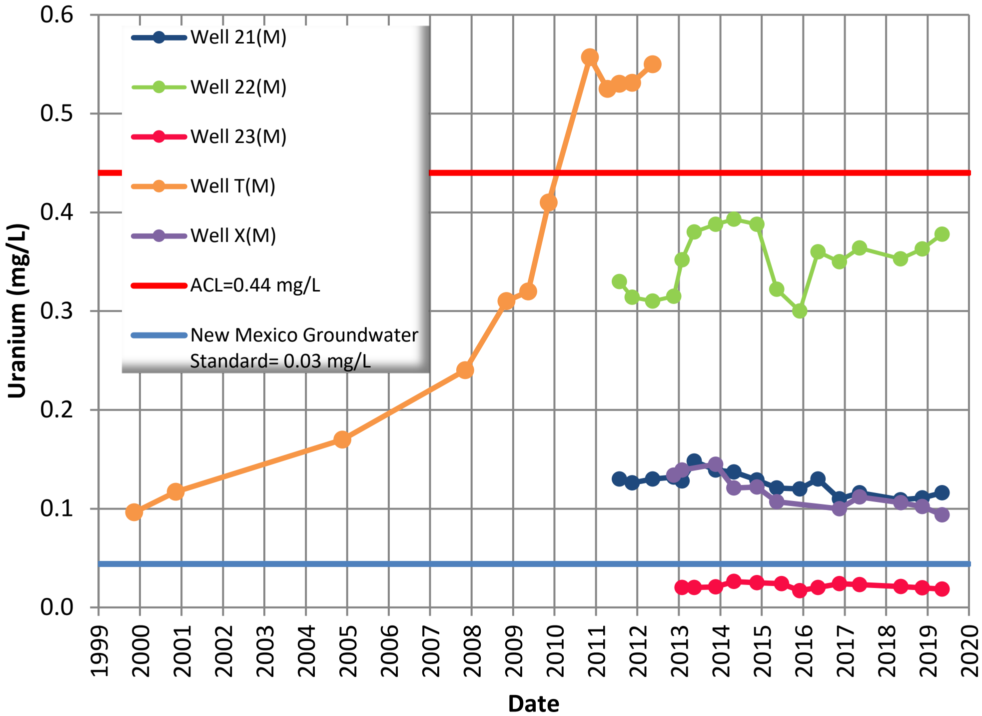


Figure 1-4. Uranium Concentrations in Alluvial Aquifer POC Well T(M) and Downgradient Wells at the Bluewater, New Mexico, Disposal Site

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 evaluation of the uranium plume indicates 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 November 2018 and May 2019. 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 but exceed the New Mexico groundwater standard (0.03 mg/L).

Table 1-5. Bedrock Aquifer Monitoring Results for November 2018 and May 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)	ND, ND	0.0136, 0.0139
13(SG)	0.00769, 0.0066	0.111, 0.103
14(SG)	ND, ND	0.102, 0.109
15(SG)	ND, ND	0.0209, 0.0147
16(SG)	0.0154, 0.0152	1.21, 1.09
18(SG)	0.00676, 0.00618	0.271, 0.245
I(SG)[a]	0.0077, 0.00774	0.307, 0.278
L(SG)	ND, ND	0.00298, 0.00328
OBS-3	ND, ND	0.00354, 0.00306
S(SG)	0.0104, 0.0104	0.641, 0.593

Notes:
November 2018 results are first, and May 2019 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 they were erroneously low because of an incorrect sampling depth in the well. 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.

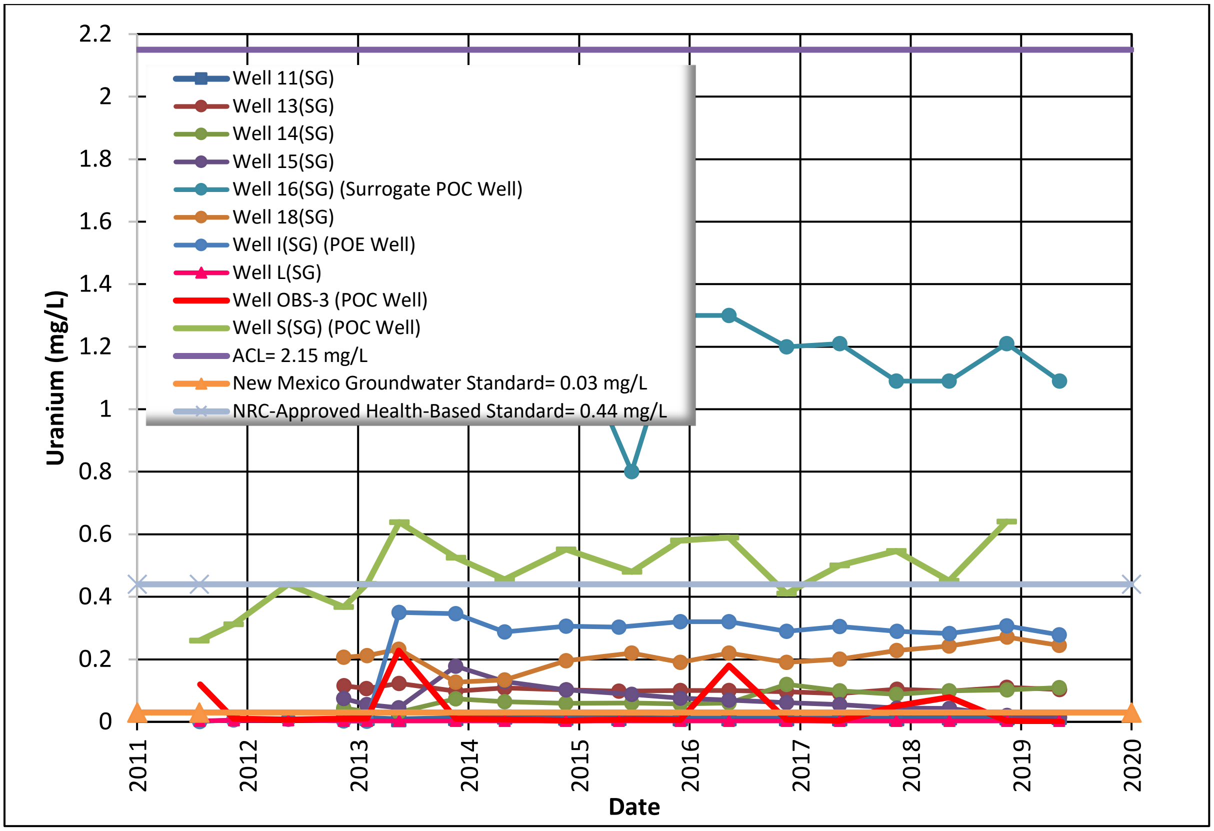


Figure 1-5. Uranium Concentrations in the San Andres/Glorieta Aquifer at the Bluewater, New Mexico, Disposal Site

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).

The estimated extent of the uranium plume, 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).

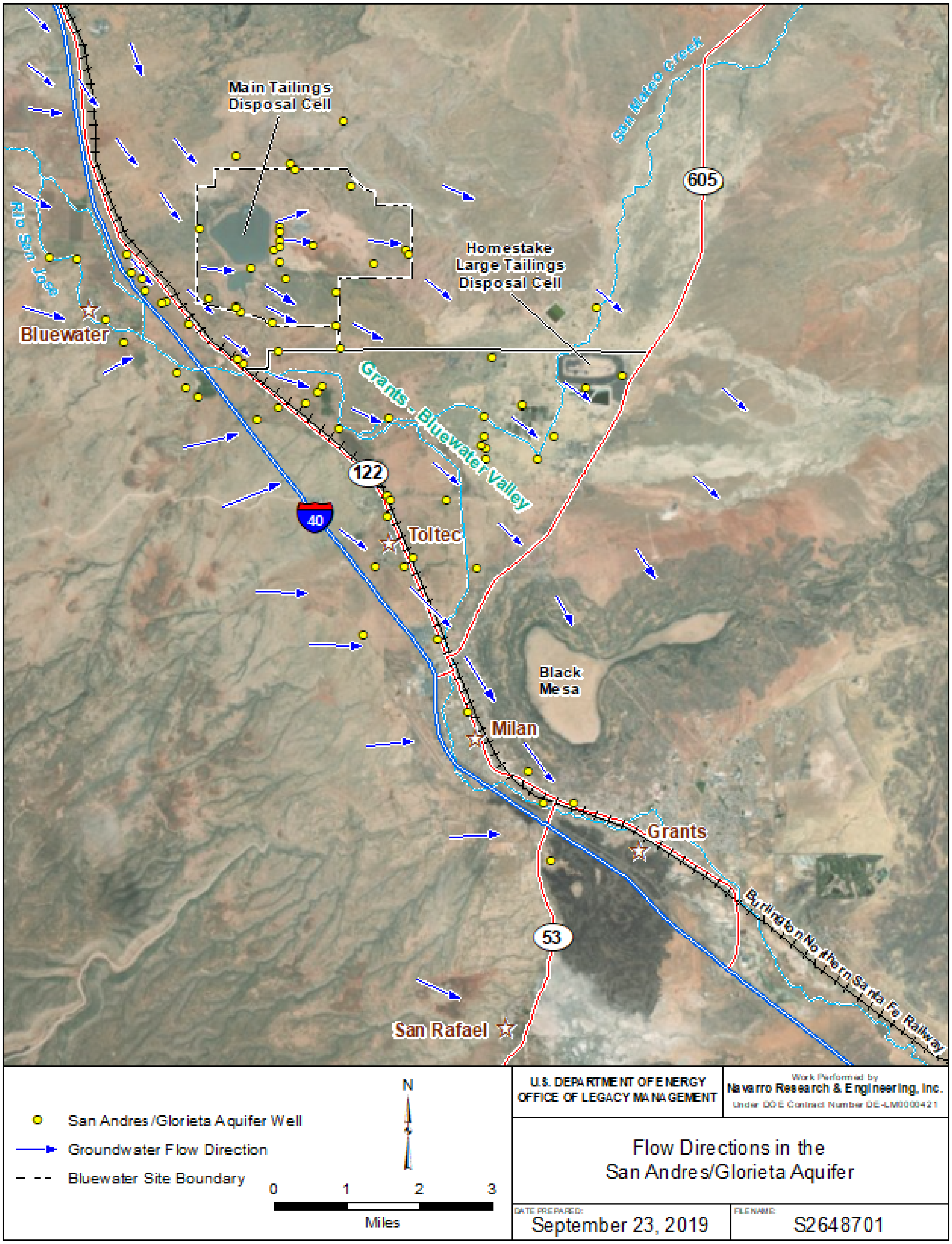


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Figure 1-6. Groundwater Flow Directions in the San Andres/Glorieta Aquifer at the Bluewater, New Mexico, Disposal Site

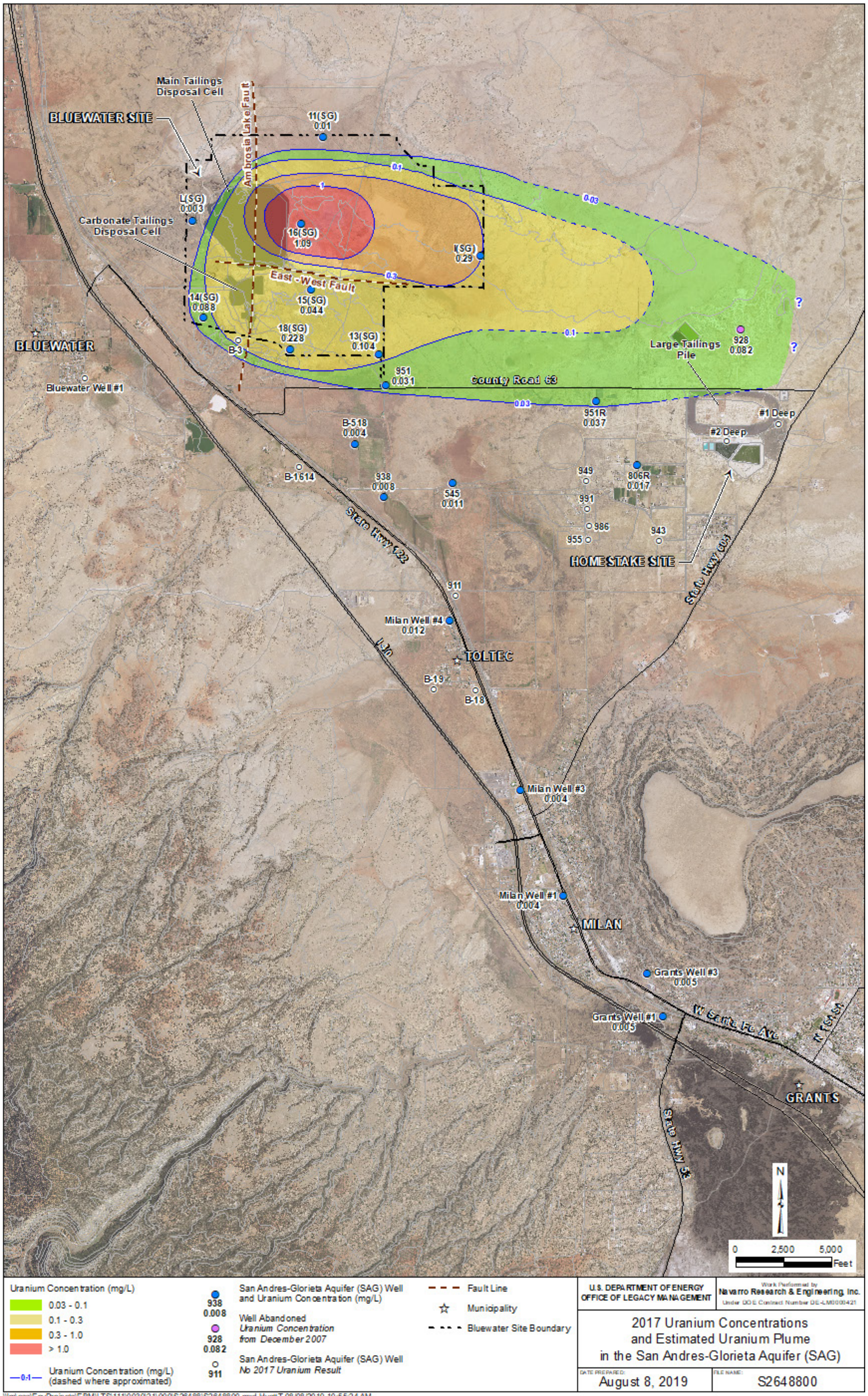

Figure 1-7. 2017 Estimated Uranium Plume in the San Andres/Glorieta Aquifer (DOE 2019)

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), 2017. *Evaluation of Disposal Cell Topography Using LiDAR Surveys, Bluewater, New Mexico, Disposal Site*, LMS/BLU/S14703, April.

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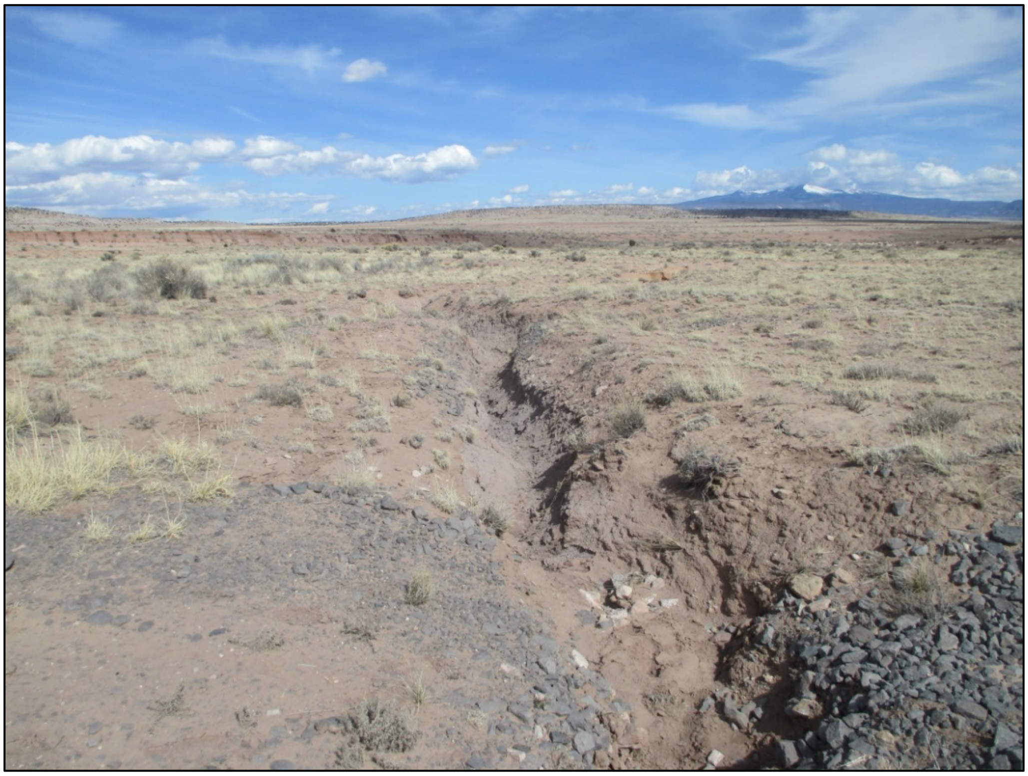
Romero, 2018. John T. Romero, PE, director, Water Rights, State of New Mexico Office of the State Engineer, letter (Request for Well Drilling Prohibition Associated with the Remedial Action at the Former Homestake and Bluewater Mill Sites, Cibola County, New Mexico) to Bruce Yurdin, director, Water Protection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

1.9 Photographs

Photograph Location Number	Azimuth	Photograph Description
PL-1	100	Erosion of the Site Perimeter Road (South Area)
PL-2	70	Erosion Near the Site Perimeter Road (North Area)
PL-3	270	Erosion Along the Perimeter Fence
PL-4	50	Perimeter Sign P52 and Southwest Corner of the Main Tailings Disposal Cell
PL-5	10	Site Marker
PL-6	320	Top Slope of the Main Tailings Disposal Cell
PL-7	180	Ponding on the Top Slope of the Main Tailings Disposal Cell
PL-8	5	Siphon on North Side Slope of the Main Tailings Disposal Cell
PL-9	350	South Side Slope of the Main Tailings Disposal Cell
PL-10	210	Rills at the Base of the Main Tailings Disposal Cell East Side Slope
PL-11	0	Rills at the Base of the South Bench Disposal Area
PL-12	50	Minor Ponding in the Shallow Depression on the Northwest Extension of the Carbonate Tailings Disposal Cell
PL-13	145	Area of Depression Repaired in the Asbestos Disposal Area
PL-14	320	Minor Depression on the Asbestos Disposal Area North Side Slope
PL-15	20	PCB Disposal Area
PL-16	105	East Dump
PL-17	—	Settlement in Fill Covering Basalt at the Interface of the East Dump Cover
PL-18	100	East Side Slope of the Main Tailings Disposal Cell and Ephemeral Ponds (Wet)

Note:
— = Photograph taken from directly above.



PL-1. Erosion of the Site Perimeter Road (South Area)

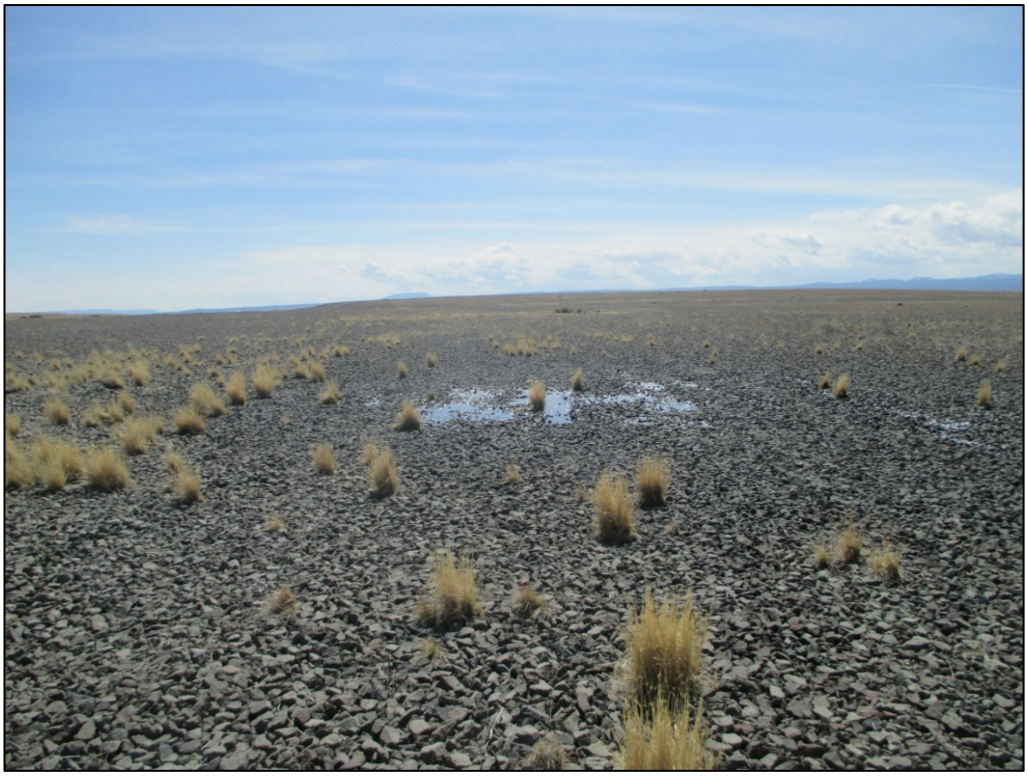
PL-2. Erosion Near the Site Perimeter Road (North Area)

PL-3. Erosion Along the Perimeter Fence

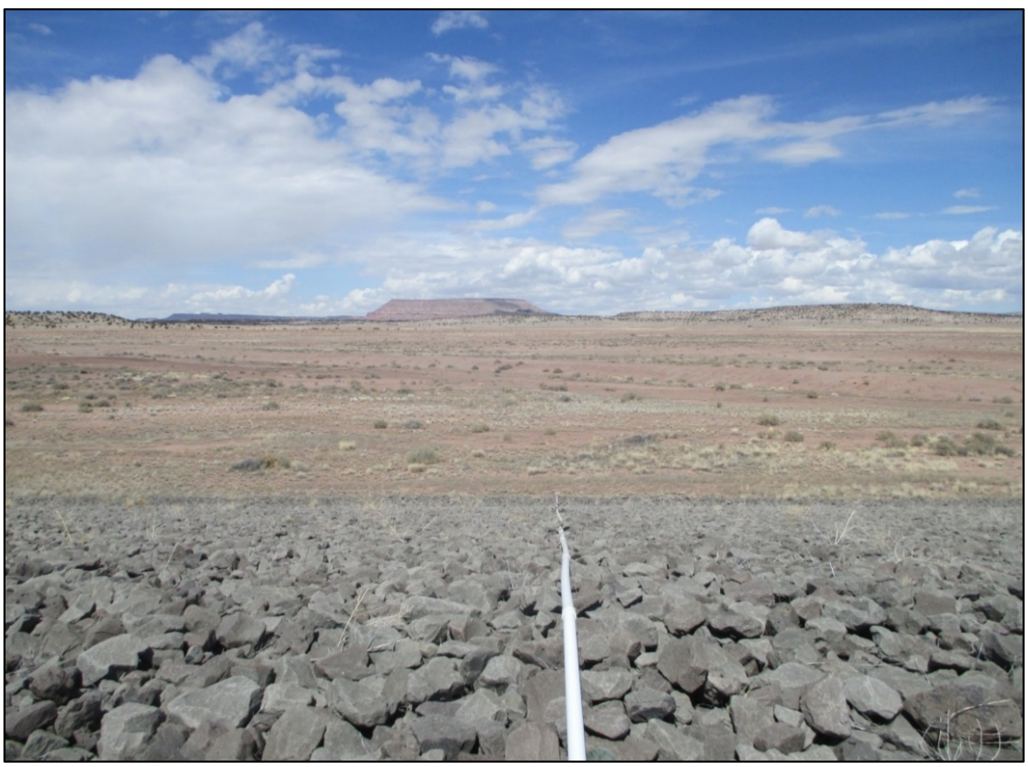
PL-4. Perimeter Sign P52 and Southwest Corner of the Main Tailings Disposal Cell

PL-5. Site Marker

PL-6. Top Slope of the Main Tailings Disposal Cell



PL-7. Ponding on the Top Slope of the Main Tailings Disposal Cell



PL-8. Siphon on North Side Slope of the Main Tailings Disposal Cell

PL-9. South Side Slope of the Main Tailings Disposal Cell

PL-10. Rills at the Base of the Main Tailings Disposal Cell East Side Slope

PL-11. Rills at the Base of the South Bench Disposal Area

PL-12. Minor Ponding in the Shallow Depression on the Northwest Extension of the Carbonate Tailings Disposal Cell

PL-13. Area of Depression Repaired in the Asbestos Disposal Area

PL-14. Minor Depression on the Asbestos Disposal Area North Side Slope

PL-15. PCB Disposal Area

PL-16. East Dump

PL-17. Settlement in Fill Covering Basalt at the Interface of the East Dump Cover

PL-18. East Side Slope of the Main Tailings Disposal Cell and Ephemeral Ponds (Wet)

APPENDIX D

Subsurface Investigation Plan

Accident Prevention Plan

Kansas City District
Geotechnical Branch
Geology Section and Drill Crew

ACCIDENT PREVENTION PLAN

13 October 2022

Table of Contents

1. Background Information

1.1. Introduction:

This site-specific accident prevention plan (APP) is for work at Bluewater Uranium Mill Tailings Disposal Site. The work to be completed includes field activities related to a subsurface geotechnical investigation at the Bluewater Uranium Mill Tailings Disposal Site. This plan is based on existing information regarding the site and describes the specific safety procedures to be utilized for all US Army Corps of Engineers (USACE), other Federal agencies, and subcontractor personnel involved in the geotechnical investigation. This plan presents a general approach to avoid or mitigate anticipated hazards at the site. Site conditions may vary throughout the duration of the project, and as site conditions change, parts of the plan may be upgraded or downgraded as warranted. The information presented in this plan will be reviewed with employees during the site-specific training and a copy of this plan will be maintained at the work site and will always be available. All health and safety measures changes must be approved and conveyed in a timely and clear manner to all affected employees.

All workers, visitors and regulatory personnel are expected to be familiar with, and comply with, all aspects of this plan. Any individuals who fail to comply with the protection levels or other provisions of the plan will be excluded from all active work areas (exclusion zones), as deemed appropriate. Any visitors and regulatory personnel wishing to have access to the active work areas must, prior to entry, provide written documentation of compliance with the training and medical monitoring requirements of the plan. This plan also represents the minimum standards for health and safety compliance for project workers but does not substitute for each project subcontractor having his/her own project safety plan. All protective equipment necessary for on-site workers will be provided by their respective companies.

1.2. Project description:

The investigation will include Cone Penetrometer Testing (CPT), decontamination of the equipment, Investigation Derived Waste (IDW) handling and storage, loading and unloading equipment, moving equipment on-site, and excavating test pits to a depth of 2 feet. This site-specific APP is in general compliance with and addresses applicable items specified under EM-385-1-1, Occupational Safety and Health Administration (OSHA) regulations at 29 Code of Federal Regulations (CFR), and Title 8 of this APP will be available to all field personnel participating in the project and all site visitors, including regulatory agency representatives.

FIGURE 1 − BLUEWATER DISPOSAL SITE IS LOCATED APPROXIMATELY 10 MILES NORTHWEST OF GRANTS, NM.

1.3. Field activities anticipated:

Field investigation activities will involve crossing uneven terrain that is partially covered by brushy and grassy vegetation. Potential field hazards include slips, trips and falls, working under hot conditions (heat stress), and biologic (snakes, insect stings/bites). Potential field hazards include those involved with working heavy machinery and rotating equipment associated with the drilling rig and excavator. Movement of heavy equipment will involve a spotter as needed (i.e. reversing, moving around corners, etc.), and other field personnel will take care to stay out of the line of movement. Field personnel will practice safety by using the appropriate personal protective equipment (PPE) for the job (i.e. long pants, long sleeve shirts, hats, safety glasses, at a minimum PPE Level D) and by taking frequent rest breaks and staying hydrated. Field personnel will watch for potential pinch points that pose a hazard, will practice good housekeeping, and ensure that the workspace is kept tidy to reduce the chance of slips, trips, and falls. Daily safety meetings will take place prior to the start of each day's work.

USACE’s Kansas City District drill crew will mobilize a Site Characterization and Analysis Penetrometer System (SCAPS) CPT rig and support equipment to perform the following field activities:

- Push a CPT probe into the main tailings disposal cell to electronically log in-situ characteristics of the tailings cell without creating drill cuttings or requiring physical samples.

- During the advancement of the CPT pushes and or at completion of the drilling, the pushes will be screened for gamma radiation above background levels using field tests and air quality monitoring will be conducted to measure radon levels above background.

- The subsurface investigations will be conducted by Kansas City District’s Drill Crew.

- Test pits will be excavated off the cell at the locations specified in the subsurface investigation plan with hand tools to a depth of 2 feet for the purpose of sampling to determine suitability as a borrow source.

Figure 2 illustrates the general area of the anticipated locations for the field work. The locations shown are subject to change but any changes to the currently specified locations will remain within the areas shown. Detailed Activity Hazard Analyses (AHA)'s have been generated for the field work and data collection effort described above. The AHAs are described in more detail in Section 4.0 and enclosed in Attachment A.

A detailed Site Safety and Health plan for radiological controls has been generated for the anticipated field work and is enclosed in Attachment B.

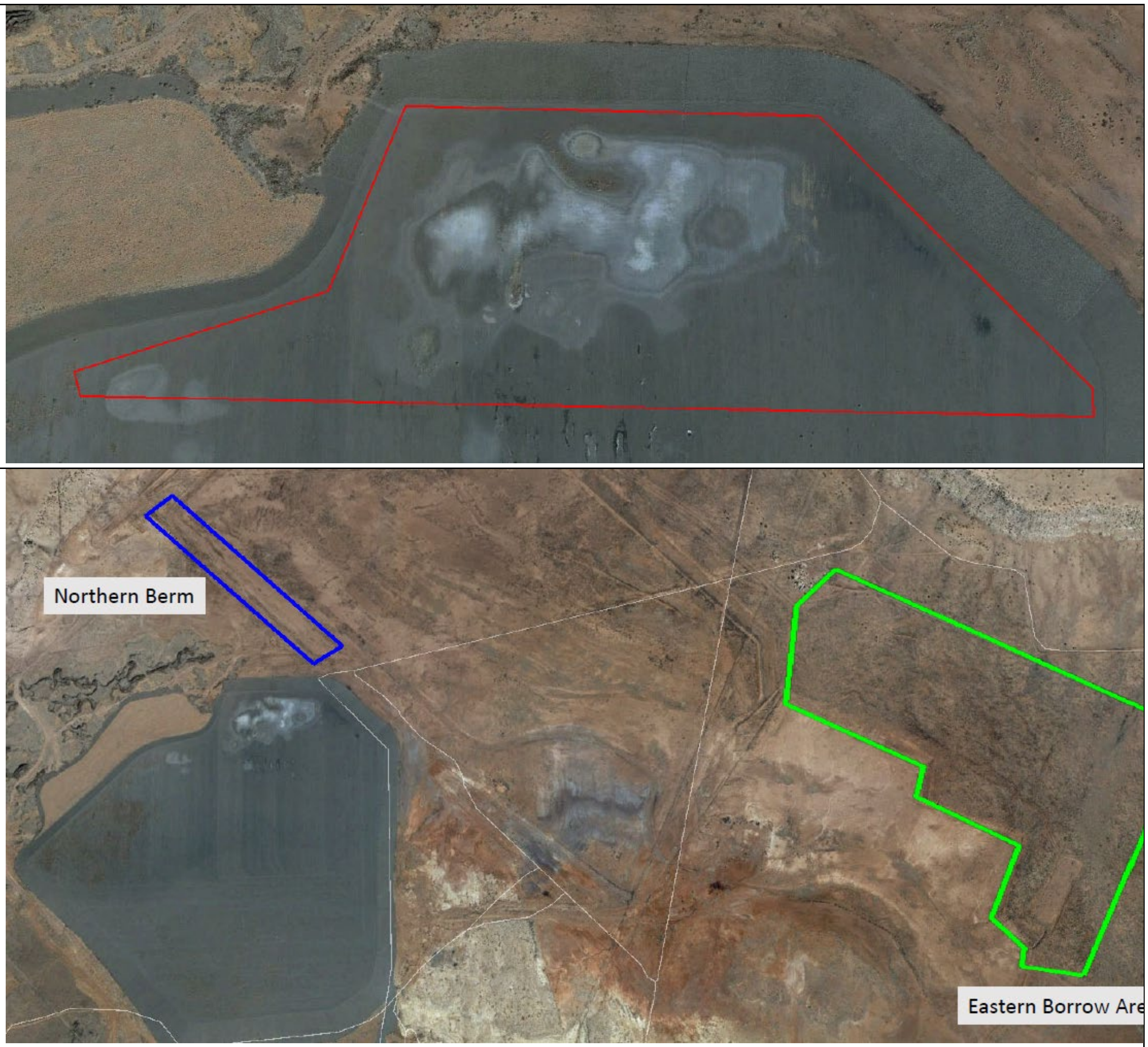


FIGURE 2 THE GENERAL AREA OF THE ANTICIPATED LOCATIONS FOR THE FIELD WORK AT BLUEWATER MAIN TAILINGS DISPOSAL CELL. CPT LOCATIONS WILL BE ON THE CELL WITHIN THE RED POLYGON. TEST PITS WILL BE COLLECTED FROM WITHIN THE BLUE AND GREEN POLYGONS AT LOCATIONS SPECIFIED WITHIN THE INVESTIGATION WORKPLAN.

2. Statement of Safety and Health Policy

Kansas City District, Geotechnical Branch, Geology section is committed to protecting the safety and health of our employees and meeting our obligations with respect to the protection of others affected by our activities. Each field member is our most valuable asset. It is by their hard work that we provide the highest quality of service in a timely and safe manner in all areas of geotechnical and environmental exploration. Accidents and injuries adversely affect the ability to complete our service mission. We strive to ensure that our operations do not pose unreasonable safety or environmental risks. In our activities, we will develop and implement appropriate systems in a manner that reduces risks and designed to comply with applicable laws, legislation, and licensing requirements. Our ultimate goals are to prevent work-related injuries or illnesses; prevent damage to property and/or equipment from our activities and prevent adverse impacts to the environment from the field activities.

3. Responsibilities and Lines of Authority

3.1. Agency responsibility

Field crew consists of a Drill Crew Coordinator, Drill Crew Foreman, Lead Driller, two Drilling Helpers, and a Field Geologist. For this project, a Project Health Physicist will be on-site with the field crew for the duration of work. Every crewmember has the responsibility of their own safety and the safety of those around them. Safety is everyone's responsibility. Each crewperson should be alert to safety hazards and seek to correct them or notify their supervisor immediately. Onsite, the Lead Driller will evaluate, recommend, and implement necessary corrective action to minimize the associated risk. This may include stopping work until necessary corrective measures are implemented. Adherence with this APP is expected of each employee and subcontractor associated with the professional services being conducted at the site. Safety responsibilities are assigned to all levels of management and are integrated into all phases of project implementation. Additional responsibilities are summarized below:

3.2. Identification and accountability of personnel

3.2.1. Section Chief

The Section Chief, Brandon Harmon, is responsible for the safety and health of all NWK EDG-G personnel. They will verify that this plan is effectively implemented, adequate section resources are made available, and will direct corrective action necessary to provide a safe and healthy workplace.

3.2.2. Safety and Health Manager

The Safety and Health Manager (SHM), Gwyn Martin, Chief of Safety and Occupational Health, is responsible for providing guidance, training, and necessary resources required to evaluate the effectiveness of this program. The SHM is responsible for the following:

- Guidance and support in the identification and appraisal of accident and loss producing conditions and practices;
- Evaluation of the severity of the accident problem; development of accident prevention and loss control methods, procedures, and programs;

- Establishing communication procedures to relay accident and loss control information to District management; and
- Measuring and evaluating procedures to measure the effectiveness of the accident and loss control system and identify whether modifications are needed.

3.3. Names of Competent Person(s) and/or Qualified Person(s)

3.3.1. Drill Crew Coordinator

The Drill Crew Coordinator, **TBD**, will be responsible for tracking all program related health and safety documents, encouraging communication at all levels of the organization concerning health and safety, and performing assurance checks of the program.

3.3.2. Drill Crew Foreman

The Drill Crew Foreman will routinely inspect each crew at their work. The Drill Crew Foreman will use the safety checklist in Attachment B and this Accident Prevention Plan as references.

3.3.3. Field Geologist

The Field Geologist is responsible for documenting toolbox safety meetings and the site-specific hazard analysis. On arrival at each new drilling location, the crew will identify and discuss hazards that are associated specifically with that site. They will discuss site conditions and associated hazards that could negatively affect the work, as well as ways to minimize these risks. Additional equipment needs and corrective action will be discussed with the Drill Crew Coordinator. The Field Geologist and the Driller will periodically field-check the AHA, provided in Attachment A, and review near misses or accidents and modify the analyses as appropriate.

The Field Geologist will serve as the Collateral Duty Safety Officer (CDSO) during the work. The CDSO or the designated person is responsible for ensuring this plan and the site-specific health and safety plan are effectively understood and implemented. The CDSO is responsible for appropriate use of required PPE during all site operations and has authority to upgrade /downgrade PPE. They will be responsible to notify and consult with the SHM as needed. The CDSO, along with the Driller, has authority to stop operations when unacceptable health and safety risks are identified. The CDSO is also responsible for initiating emergency response as indicated later in this plan.

3.3.4. Lead Driller

The Lead Driller as crew chief is responsible for the safety of their crew, individually and collectively. On all sites, except Hazardous, Toxic, and Radioactive Waste (HTRW) sites, the Driller serves as the Site Safety Health Officer (SSHO). The Driller must observe all aspects of the operation including crewmembers, equipment, and site conditions that may contribute to an accident. The Driller will be responsible for all safety and health-related issues associated with operation of the drill rig, well development, and any other work activity performed by a crewmember.

The Driller will assist the Field Geologist in completing the initial site-specific hazard analysis and AHA. If at any time site or drilling conditions are too hazardous to work, the Driller has the responsibility to stop work and notify the Albuquerque District Office.

3.3.5. Drilling Helpers

Drilling helpers must be continually alert to procedures and conditions at the worksite. They are responsible not only for themselves, but also to all other crewmembers. They will be responsible for complying with this program including the proper use of any required protective clothing and safety equipment. They must observe and notify the Driller of any unrecognized unsafe practices or conditions.

3.3.6. Project Health Physicist

Due to the nature of the radioactive tailings within the CPT investigation area, the assigned Project Health Physicist will provide additional guidance and assistance to the field crews and project staff. They will verify that work plans meet regulatory requirements, complete a review of site-related hazards, assist in completing a site-specific hazard analysis, and designate the level or protective equipment that will be required. They will also complete field audits of work to verify compliance with work plan requirements.

3.4. Names of other Key Personnel

The key personnel for the monitoring of the various tasks and monitoring activities will include the following:

NWK Kansas City: Brandon Harmon
Section Chief, RG
816-389-2351 (office); 816-405-1776 (cell)

NWK Kansas City: TBD
Geologist, RG
816-389-3985 (office)

NWK Kansas City: David Whitfill
Health Physicist, P.E., CHP
816-400-3608 (Work cell)

Safety Office: General Safety Office number: (816) 389-3387
Gwyn Martin, Chief, Safety & Occupational Health Office

4. Activity Hazard Analysis (AHA)

Activity Hazard Analysis (AHAs) have been developed for activities associated with project-specific hazards using NWW Form 385-1. The AHAs will be reviewed and updated as appropriate and as necessary to address changing site conditions, and or operations. There are 7 AHAs that have been developed for the project-specific hazards. The detailed AHAs describing site-specific hazards and actions to eliminate or minimize the hazard, for work to be performed, is provided in Attachment A.

4.1. Hazard Assessment

In general, the Hazards that may be encountered during this project primarily include:

General On-site Work:

- Hazards associated with travel to and from the work site
- Vehicular or pedestrian traffic
- Unexpected wildlife encounters or poisonous plants
- Handling/ moving heavy items and equipment hazard
- Environmental/ exposure hazards
- Slip, trip, fall hazards
- Noise
- Dust
- Inclement weather

Subsurface Exploration:

- Overhead and underground utilities
- Air quality monitoring
- Drilling hazards
- Environmental or chemical hazards
- Grout mixing or pumping hazards
- Bentonite and cement dust hazards
- Decontamination procedures, including hot water heater and pressure sprayer
- Investigation Derived Waste handling and storage
- Exposure to gamma radiation
- Exposure to radon
- Lifting 40lb soil sample buckets
- Pressurized equipment hazards
- High-pressure line (air hoses, pipes, valves) hazards
- Biological (insect, spider, snake) hazards
- Electrical shock hazards
- Pinch points
- Fatigue stringing rods and cables
- Crush hazards from excavator boom

• Slip, trip, fall hazards from test pits

4.2. Risk Assessment Code Matrix

The Risk Assessment Code (RAC) matrix is developed based on the degree of the risk associated with the activity considering the hazard severity and mishap probability and as part of this site-specific APP. The RAC matrix has been used to evaluate each activity and the overall RAC was determine using the highest code. The RAC for each activity is shown in each AHA.

5. Emergency Action Plan

An Emergency Action Plan (EAP) has been prepared for emergency situations that may arise on this project. During tailgate safety meetings, the EAP will be briefed to all personnel prior to the start of field activities. The following sections discusses lines of authority, evacuation site routes and procedures, emergency contacts and notifications, emergency equipment and facilities, medical facility route directions, and reporting.

5.1. Lines of Authority

The CDSO has the primary responsibility for responding and correcting emergency situations and for taking appropriate measures to ensure the safety of site personnel. The CDSO is also responsible for ensuring that corrective measures have been implemented, appropriate authorities have been notified, and follow-up reports have been completed.

5.2. Evacuation Site Routes and Procedures

In the event of an emergency that evacuation of a work area or the site is needed, the USACE project leads and or section chiefs in charge of the work being performed will contact all nearby personnel by cellular telephone to advise of the emergency. The site CDSO will also be contacted. All personnel will proceed along access roads to a safe distance upwind from the hazard source. Once personnel are assembled, the CDSO will take a head count and report back to the Albuquerque District to indicate that all personnel have been accounted for and will also report the evacuation location, if necessary. The CDSO person will continually evaluate emergency conditions to determine whether personnel must be relocated to maintain a safe distance from health and safety hazards. All personnel will remain in the safe evacuation area until the project leads or section chiefs and or an authorized entity, such as the fire department or emergency services, provides further instructions.

5.3. Emergency Contacts and Notifications

Table 1 above provides names and telephone numbers of emergency contact personnel.

TABLE 1: Emergency Contact Personnel

Name	District/Division	Role on Project	Key Contact Info
Brandon Harmon	NWK Kansas City	Geology Section Chief	Office: (816) 389 2351 Cell: 816-405-1776
David Whitfill	NWK Kansas City	Safety Officer	Cell (W): 816-400-3608 Cell (P): 785-249-8249
Organization / Agency			
Police Department and Fire Department, Ambulance Service, (local)			911
Medical Facility-Cibola General Hospital; Grants NM, See Figure 3.			(505) 287-4446
Fire Department-Bluewater NM			(505) 876-4942
Local Police-Cibola County NM Sheriff's Department			(505) 876-2040 or (877) 898-0097
Poison Control Center			(800) 222-1222
Chem-Tel			(800) 255-3924
Common Ground Alliance Nationwide Call Before You Dig			811

In the event of a medical emergency, the CDSO will notify the appropriate emergency contact personnel and or organization.

5.4. Emergency Equipment

A First Aid kit and a portable eyewash bottle will be available in a USACE vehicle. Field personnel are expected to provide their own drinking water for the day; the CDSO will also bring additional water if needed. USACE will also provide onsite sanitary facilities and wash station which will be located off the cell cover.

5.5. Medical Facility Route Directions

Emergency medical facilities are available in the vicinity of the project site if medical emergencies occur during the project. However, for immediate response, emergency organizations will be contacted by calling 911. Figure 3 is a map and written directions for the closest medical facility. The medical facility is listed below:

- Emergency Medical Facility:
  Cibola General Hospital
  1016 Roosevelt Ave, Grants, NM 87020
  Tel: 505-287-4446
  See Figure 3 for Route to Emergency Medical Facility

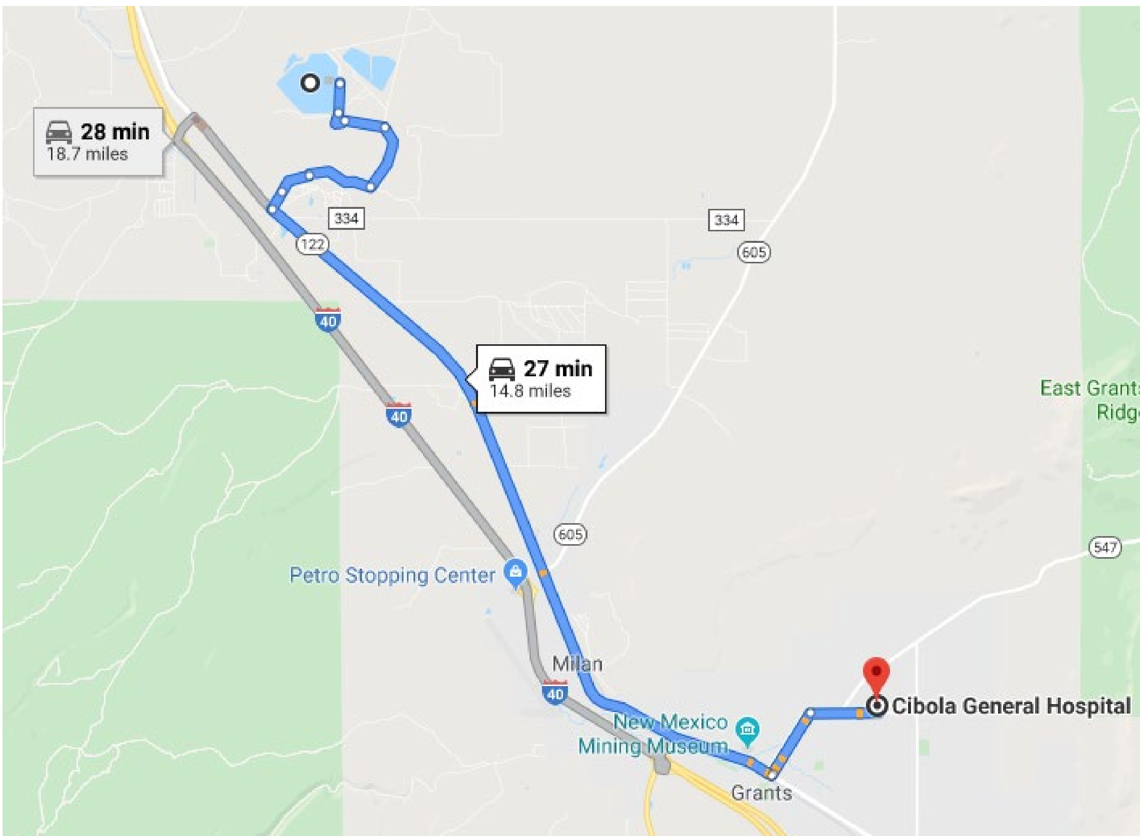


Figure 3. Route to Cibola General Hospital

1. Continue to NM-122 E/Rte 66; 8 min (3.4 mi)
2. Continue on Rte 66 to Grants; 18 min (11.3 mi)
3. Continue on Cordova Ct Ave to your destination; 38 s (482 ft)

Cibola General Hospital
1016 Roosevelt Ave, Grants, NM 87020

5.6. Reporting

All emergency situations require follow-up and reporting. An employee involved in an incident will immediately or as soon as possible report the incident to the CDSO by telephone. Mishap Notification and Investigation Form (see Attachment B) must be completed by the CDSO and submitted to the PM within 24 hours of an emergency. The report must include proposed actions to prevent similar incidents from occurring. The CDSO must implement immediate corrective actions to prevent similar incidents from occurring, also.

6. Closure

The USACE cannot guarantee the health or safety of any person entering this site. Due to the potentially hazardous nature of this site, and the activities occurring thereon, it is not possible to discover, evaluate, and provide protection for all possible hazards which may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury at this site. The health and safety guidelines in this plan were prepared specifically for this site and project and should not be used on any other site without prior research and evaluation by trained health and safety specialists.

7. Approvals

The undersigned personnel certify that this APP will be utilized for the protection of the health and safety of workers during all field activities.

Approved By:

Brandon Harmon, R.G.,
[Signature]

____
Chief of the Geology Section
U.S. Army Corps of Engineers, Kansas City District
Geology Section

The undersigned field personnel have been briefed about the contents of this site-specific APP and intend to comply with its provisions:

Signature	Name	Date

ATTACHMENT A – Accident Prevention Plan Addendum

Accident Prevention Plan Addendum

Kansas City District Geotechnical Branch Geology Section and Drill Crew Accident Prevention Plan Addendum for Radiological controls during Site Characterization and Analysis Penetrometer System (SCAPS) truck operation and Shelby Tube Sampling at the Bluewater Disposal Site, New Mexico

US Army Corps of Engineers ®

Prepared By:

U. S. Army Corps of Engineers, Kansas City District

601 East 12th Street

Kansas City, Missouri

May 2022

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TABLES

ACRONYMS AND ABBREVIATIONS

APP	Accident Prevention Plan
AHA	Activity hazard analysis
ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
CFR	Code of Federal Regulations
cpm	counts per minute
CPT	Cone Penetration Test
DOE	U.S. Department of Energy
LD	detection limit
EPA	U. S. Environmental Protection Agency
GM	Geiger-Muller
HAZWOPER	hazardous waste operations and emergency response
HTRW	hazardous, toxic, and radioactive waste
IDW	Investigation-derived waste
LC	critical level
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
mrem	millirem
mSv	millisievert
NaI	sodium iodide
NRC	U.S. Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
pCi/g	picocurie per gram
pCi/L	picocurie per liter
PPE	Personal protective equipment
RSO	Radiation Safety Officer
RCAs	radiologically controlled areas
SCAPS	Site Characterization and Analysis Penetrometer System
SSHO	Site Safety and Health Officer
Sv	sievert
TEDE	Total Effective Dose Equivalent
USACE	U. S. Army Corps of Engineers
ZnS	Zinc Sulfide

Radiological controls during Site Characterization and Analysis Penetrometer System (SCAPS) truck operation and Shelby Tube sampling at the Bluewater Disposal Site

1.0 INTRODUCTION

Radiological controls will be implemented during SCAPS truck operations and Shelby tube radon barrier sample collection on the main tailings disposal cell at the Bluewater Disposal Site to ensure that the presence of radioactivity above background levels will be identified and properly controlled. Precautions necessary to ensure worker safety and protection of the general public will be taken. Radiological controls will focus on identifying radioactive contamination as close to the source as possible and preventing the spread of contamination to personnel or any uncontrolled area.

The SCAPS vehicle and process is designed to minimize worker exposure to contaminants. Workers handle equipment after it has passed through the decontamination process and workers do not contact contaminated soils, except during sample retrieval. Shelby tube sampling is not expected to penetrate the radon barrier. No samples of uranium mill tailings will be taken during operations on the main tailings disposal cell.

The truck is divided into two compartments, separated by a wall with a viewing window. All walls are stainless steel for ease of decontamination, if necessary. Push rods can be automatically decontaminated below the truck as they are withdrawn from the push hole, by a high pressure, high temperature cleaner. This arrangement minimizes crew exposure to potential contamination and crew down-time for equipment decontamination. This also minimizes the quantity of decontamination wash water that must be managed as investigative derived waste (IDW).

Most systems are typically deployed with a three-person crew and a geologist. Two people are needed to handle the push rods and operate the hydraulic press, and a third person operates the sensor systems. A health physicist will accompany the SCAPS truck/Geotechnical crew while operating on the main tailings disposal cell. There will also be a Health Physicist present during Shelby Tube sampling. Shelby tube samples will be surveyed for radioactivity to ensure there are no mill tailings present.

An Activity Hazards Analysis (AHA) for radiological hazards associated with SCAPS truck operations and Shelby Tube Sample Collection on the Bluewater Uranium Mill Tailings Disposal Cell is found in section 19.0. The overall risk assessment code assigned is marginal.

2.0 CONTAMINANTS OF CONCERN

Contaminants of concern in the disposal cell are uranium bearing mill tailings consisting primarily of the uranium decay series Uranium-238, and to a lesser degree the Uranium-235 decay series. The most likely exposure during SCAP operation is external gamma exposure (predominately from Radium-226 and its associated decay series) and internal exposure from radon gas (Radon-222, a decay product of Radium-226 which is part of the Uranium-238 decay chain). Radiation exposures are expected to be low.

3.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Personal protective equipment (PPE) will be a modified Level D with Tyvek coveralls, gloves, and boot covers worn in the hydraulic push room during penetrometer operations on the cap. Respirators will not be required. The SCAPS truck team will be issued personal radiation dosimetry for operations on the site.

3.1 Medical surveillance program

It is anticipated that personnel engaging in SCAPS truck operations on the cap of the Bluewater Main Tailings Disposal Cell will not require participation in a medical surveillance program. The medical surveillance program is required to be instituted for: 1) all employees who are or may be exposed to hazardous substances or health hazards at or above the permissible exposure limits or, if there is no permissible exposure limit, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year; (2) All employees who wear a respirator for 30 days or more a year or as required by § 1910.134; (3) All employees who are injured, become ill or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operation; and (4) members of HAZMAT teams.

If any of the above conditions are met, affected personnel working on a site or at a facility that contains hazardous, toxic, and radioactive waste (HTRW) shall submit current physician's certificate stating that employee is participating in an appropriate medical surveillance program meeting 29 Code of Federal Regulation (CFR) 1910.120.

4.0 SCAPS TRUCK OPERATIONS AND SHELBY TUBE SAMPLE COLLECTION

Minimal disturbance of the underlying uranium mill tailings during core penetrometer operation on the cap at Bluewater is expected. No direct sampling of the material will occur. Direct gamma radiation and radon exposure is possible during the brief period (approximately 20 minutes) that that the core penetration is open prior to backfill as the probe is withdrawn. It is expected that 86 CPT sample locations will be evaluated with each penetration advancing to approximately 40 feet depth below the top of the radon barrier. Up to 22 Shelby Tube Samples of the radon barrier will be sampled adjacent to CPT sounding locations. The radon barrier is not expected to be breached during sampling.

The SCAPS truck has an automatic decontamination system that cleans the probe as it is being withdrawn. The amount of water generated is approximately 10 gallons per penetration and is collected in a 55-gallon drum. The water will be mixed with grout and pumped downhole per applicable requirements. Any excess water not pumped downhole will be allowed to evaporate onsite.

During retraction of the probe, the SCAPS decontamination and grouting systems are activated. The decontamination system ensures all hardware retrieved is cleaned prior to worker contact. Fresh water is stored onboard and spent decontamination water is captured by a drum on the rear deck. Since the Cone Penetration Test (CPT) is a displacement technique, no soil is removed from the site. Ideally, the only IDW is the decontamination waste water. The grouting system injects a cement grout into the cavity formed by the retracting probe. This ensures a bottom-up style grouting seal of the investigation hole.

5.0 EXPOSURE AND CONTAMINATION CONTROL

It is not expected that workers will receive any measurable external gamma radiation exposure, however, there is a possibility of internal exposure from the disposal cell's underlying uranium mill tailings during SCAPS truck operations due to potential contamination of the probe if the decontamination system fails and to radon gas emanating from the borehole prior to backfilling.

6.0 DIRECT GAMMA RADIATION MONITORING

6.1 Surface

A surface gamma survey taken 3.28 foot (1-meter) above the surface will be done prior to probe penetration and after the penetration is backfilled. Direct gamma exposure will be monitored continuously during penetrometer operations on the cap.

6.2 Subsurface

Gamma radiation logging will be performed simultaneously with each CPT sounding and correlated with depth to locate the interface between the radon barrier and tailings. This logging will be performed using a sodium iodide (NaI) gamma scintillator located within the tool string and behind the CPT head. A comparative analysis of the radiation log will be performed to determine the radon barrier thickness profile throughout the investigation area and to determine radioactive profile of the tailings relative to depth within the disposal cell.

7.0 RADON MONITORING

Radon monitoring of the Hydraulic Push Room using alpha track detectors and real time radon monitoring will be done during penetrometer operations on the cap.

8.0 CONTAMINATION MONITORING

The penetrometer extensions and probe will be wiped down and surveyed for contamination as it is withdrawn from the borehole. Contamination monitoring will consist of direct monitoring of surfaces for alpha and beta contamination and the counting of wipes or smears using portable hand survey instruments designed to detect alpha and beta contamination. Personnel will be monitored periodically during operations. Both the SCAPS truck Hydraulic Push Room (tires will also be checked) and personnel will be directly surveyed using handheld contamination monitors upon the conclusion of daily operations on the cap. Radon barrier Shelby Tubes Samples will be surveyed to confirm no radioactive material is present.

9.0 RADON FLUX MONITORING

It is anticipated that verification of radon barrier integrity will be required after penetrometer operations. A representative radon flux survey can be done as part of the SCAPS truck operations or the monitoring can be done at a later date after the radon barrier is repaired. It would require placing radon monitors over selected backfilled boreholes and retrieving the next day (24 hours). Preliminary measurements could also be obtained prior to SCAPS truck operations to compare with post measurements.

10.0 CONTAMINATION CONTROL METHODS

There is only one ramp for accessing the top slope of the main tailings disposal cell at the Bluewater site. All equipment and personnel prior to exiting the cap after SCAP truck operations and Shelby Tube Sampling will be surveyed for alpha and beta contamination using portable survey instruments.

Personnel, equipment, or tools, with readings greater than the critical level/detection limit as determined below indicate suspected contamination and will be decontaminated prior to reuse or transport from the site. It is anticipated that all supplies, materials, and waste, including PPE, will be non-hazardous and non-radiologically contaminated and readily available for reuse or disposal as a waste at a municipal landfill. As a contingency, items that cannot be decontaminated and that thus require special management will be reduced in size to the extent possible and packaged for continued storage on site in a new, secure RMA until a disposal avenue is pursued. Alternatively, the material may be sent to another existing DOE LM secure RMA (such as the Grand Junction, Colorado Field Office) for storage until a disposal avenue is pursue. Subsequent disposal, depending on the material, could consist of the use of a commercial waste broker for off-site disposal or could be the placement of the material back into the Bluewater disposal cell when it is open for cell cover repairs. If personnel are contaminated, simple decontamination will be performed by Health Physics personnel using hand wipes or soap and water.

Workers involved in SCAPS truck operations and Shelby Tube Sampling will be monitored should and as a minimum have their hands (gloves) and boots surveyed by the Health Physicist periodically during work on the cap and prior to exiting the cap. Tires, floorboard, Hydraulic Push Room of the SCAP truck will be routinely scanned during the project. Upon completion of SCAPS truck operations on the cap, the decontamination system will need to be surveyed and decontaminated if necessary.

11.0 CRITICAL LEVEL AND DETECTION LIMIT

The following information can be found on the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575, Rev. 1 August 2000, pages 6-31 to 6-49.

The critical level (LC) is the level, in counts, at which there is a statistical probability (with a predetermined confidence) of incorrectly identifying a measurement system background value as “greater than background.” Any response above this level is considered to be greater than background.

The detection limit (LD) is an a priori estimate of the detection capability of a measurement system, and is also reported in units of counts. The minimum detectable concentration (MDC) is the detection limit (counts) multiplied by an appropriate conversion factor to give units consistent with a site guideline.

LC=k*sqrt(2B)

LD = k^2 + 2k*sqrt(2B)

Where:

LC = critical level (counts)

LD = detection limit (counts)
k = Poisson probability sum for alpha and Beta (assuming alpha and Beta are equal)
B = number of background counts that are expected to occur while performing
an actual measurement

For this project, 0.05 is selected for both alpha and Beta, and k = 1.645, the equations above become

LC=2.33*sqrt(B)

LD=3+4.65*sqrt (B) = 3 + 2LC

An example where the background is 100 counts in one minute (100 counts per minute [cpm]):

LC=23.30 cpm

LD=49.6 cpm

For a background of 100 cpm, any gross reading (background included) >123.3 cpm would be above the LC and any gross reading (background included) > 149.6 cpm would be above the LD. In this case, a gross reading (background included) of > 150 cpm measure on any surface would be considered contaminated. The surface would be wiped down and re-surveyed. For project purposes, the background is determined in a non-impacted similar area, such as at the site gate. The apha+beta+gamma background of a Ludlum Model 26-1 with a pancake Geiger-Muller (GM) probe was 74 +/- 9 cpm at the gate to the Bluewater disposal cell during a walk-over survey done on 19 November 2019. Using an upper 95% confidence interval estimate, this would correspond to a background level of 91 cpm (LD = 47 cpm).

12.0 INSTRUMENTATION AND SURVEY METHODS

Portable radiation survey instruments that will or may be used during the investigation:

- A pancake Geiger–Müller (GM)probe will be the primary contamination monitor to detect alpha+beta contamination (a Ludlum Model 26-1 or Model 44-9 pancake GM detector coupled to a Ludlum Model 3 general survey meter or equivalent).

- A contamination monitor using a zinc sulfide (ZnS) + plastic scintillator probe will be used to discriminate between alpha and beta contamination (a Ludlum Model 43-93 ZnS + plastic scintillator coupled to a Ludlum Model 2360 alpha-beta scaler or equivalent). It is expected that primary portion of the Uranium-238 decay chain encountered will be Radium-26 and associated decay chain, which consists of alpha, beta, and gamma emitters so the pancake GM probe should be sufficient for contamination monitoring, but the dual count alpha/beta scintillator will be used as a spot check and back-up instrument for direct scans and counting of wipes and smears.

- An additional smear counter may be required (Ludlum Model 3030 Alpha-Beta sample counter or equivalent).

- External gamma radiation levels will be measured using a sodium iodide (NaI) scintillator (a Ludlum Model 19 micro-R survey meter with an internal 1-inch x 1-inch NaI scintillation detector or equivalent for surface measurements and a Ludlum Model 2221 general purpose scaler-ratemeter or equivalent with an external Ludlum Model 44-62 0.5-inch x 1-inch NaI scintillation detector for subsurface counting measurements). Radon barrier Shelby Tube soil samples will be screened using a 2-inch x 2-inch NaI scintillation detector (Ludlum Model 44-10 or equivalent).

- Air monitoring for radon gas will be done using a real time monitor such as the Corentium Pro or equivalent. An alpha-track detector with an associated control will be used to monitor the hydraulic push room during deployment.

- Radon flux monitoring, if required, will be done using a handheld RAD7 meter in sniff mode. This entails passing the probe over the surface to collect readings which will then be downloaded to a field laptop and processed. Surface flux readings will be available within 24 hours of the survey.

The instruments used identify the presence of low-level alpha, beta, or gamma radioactivity, but they do not identify the specific radionuclides present.

12.1 Daily instrument checks

All instruments should be checked for proper operation (physical condition, battery check, background check, and source check) and valid calibration at least daily or prior to each use. Radioactive check sources are used for response checks of contamination and gamma survey instruments. Response checks should be within ±20% of the reference source check count-rate. Instruments should be taken out of service if readings are outside the ±20% control limits. Daily background checks and source checks should be recorded and maintained with field log records. It is normal to observe statistical fluctuations in background and source checks.

12.2 Surface scanning

The surface scan rate should be 1-inch/second to 2-inch/second. Hold the probe within approximately 0.25-inch to 0.50 inch of the surface and use the audible output of the instrument. As the count rate increases, pause to determine if the increased count rate is greater than background. Perform a one-minute timed count at locations where the count rate is greater than background. Take necessary actions when counts are greater than the LD.

12.3 One-minute timed counts

One-minute timed counts are used as a direct measurement to confirm an area of contamination. Personnel and equipment with discrete areas where the measurements are greater than the LD indicate the need for decontamination. To perform a one-minute count the probe is placed within 0.25-inch to 0.50-inch of the surface, wipe, or smear. For standard ratemeters, collect three count-rate readings over 1-minute and use the average of the readings. For scaler/ratemeter where the count-time can be preset, adjust setting for a 1-minute count and start counting. The accumulated counts (or count-rate) are compared with the background established for that instrument. Multiple counts may be necessary to help verify whether counts (or count-rate) are significantly different from background.

12.4 Instrument sensitivities

Survey instrument sensitivities are found in Table 1. [1]

Table 1. Survey instrument sensitivities

Instrument/Detector	Detector type	Radiation detected	Detection sensitivity	Use
Ludlum Model 2360 with 43-93 detector	ZnS (Ag) adhered to plastic scintillation material	alpha and beta	100 dpm/100 cm^2 alpha 1,000 dpm/100 cm^2 beta	Direct surface measurements Wipe, smear, and filter counting
Ludlum Model 3 with 44-9 detector	Pancake GM	alpha, beta, and gamma	3,400 dpm/100 cm^2 beta	Direct surface measurements Personnel contamination monitoring Wipe, smear, and filter counting
Ludlum Model 26-1 DOSE Integrated frisker with dose equivalent filter	Pancake GM	Without filter: alpha, beta, and gamma With filter: gamma	Without filter: 3,400 dpm/100 cm^2 beta With filter: 0.02 milli-roentgen/h (20 micro- roentgen/h) * * Based on field measurement comparisons with a Ludlum Model 19	Without filter: Direct surface measurements Personnel contamination monitoring Wipe, smear, and filter counting With filter: Gamma exposure rate
Ludlum Model 19	Internal 1-inch x 1-inch NaI scintillation detector	gamma	2 micro-roentgen/h	Gamma exposure rate
Ludlum Model 2221 with 44-62 detector	0.5-inch x 1-inch NaI scintillation detector	gamma	49 cpm per micro-roentgen/h	Subsurface gamma surveys (waterproof probe is attached to a 100 ft cable)

[1] Instruments with equivalent performance characteristics may be used.
[2] Detection sensitivities are apriori approximations or based upon manufacturers specifications unless otherwise denoted.

13.0 RADIATION PROTECTION REQUIREMENTS

Radiation protection requirements are discussed in the following sections.

13.1 Training requirements

All USACE personnel working on the site shall be subject to the training requirements of the Hazardous, Toxic and Radioactive Waste (HTRW) program and shall submit hazardous waste operations and emergency response (HAZWOPER) training certificates (40-hour, 8-hour [if applicable], supervisor [if applicable]) to the Site Safety and Health Officer (SSHO). All personnel shall attend a site safety orientation.

Workers who receive or are likely to receive an occupational effective dose equivalent in excess of 0.1 rem in one year will receive Radiation Worker Training. The topics covered are:

- Radiation and its effects on the body
- Federal dose limits and administrative controls
- As low as reasonably achievable (ALARA) and personnel monitoring programs
- Radiological postings
- Contamination controls
- Federal and state regulations

A worker who is not likely to receive an occupational effective dose equivalent in excess of 0.1 rem in one year will receive Radiation Awareness Training. This training familiarizes workers with site hazards and provides instructions for avoiding contact with radioactive material and for keeping individual doses less than 0.1 rem.

For SCAPS truck operations and Shelby Tube Sample collection on the Bluewater main tailings disposal cell, it is not anticipated that exposures more than 0.1 rem in one year will be encountered. The U.S. Army Corps of Engineers (USACE) ALARA goal is 0.1 rem/y. It is unlikely exposures above this will be received. A gamma walkover survey of the cap done on 19 November 2019 showed that external gamma radiation levels were less than the background levels measured at the site entrance.

13.2 Radiation standards

Radiation standards used for worker protection are summarized in Table 2 and Table 3 below. A crosswalk between applicable 10 CFR 20 standards and DOE requirements is given in Table 4.

Table 2. Regulations for Worker Protection: U.S. Government Agencies [a]

Agency	Statutory Requirement	Title
Occupational Safety and Health Administration (OSHA) [b]	29 CFR Part 1926.53 29 CFR Part 1910.120 29 CFR Part 1910.1096	Safety and Health Regulations for Construction, Subpart D—Occupational Health and Environmental Controls, Ionizing radiation Occupational Safety and Health Standards, Subpart H — Hazardous Materials, Hazardous Waste Operations and Emergency Response Occupational Safety and Health standards, Subpart Z—Toxic and Hazardous Substances, Ionizing radiation
U.S. Environmental Protection Agency (EPA) [c]	40 CFR Part 311	Worker Protection
U.S. Nuclear Regulatory Commission (NRC) [d]	10 CFR Part 20	Standards for Protection Against Radiation
U.S. Department of Energy (DOE) [e]	10 CFR Part 835 10 CFR Part 851	Occupational Radiation Protection Worker Safety and Health Program

[a] From Table 3-3, PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents, EPA-400/R-17/001, January 2017.

[b] Worker safety and health is regulated in all states by federal OSHA or by respective state regulations under an OSHA-approved state plan.

[c] 40 CFR Part 311 applies the OSHA HAZWOPER standard (29 CFR 1910.120) to public-sector workers in states that do not operate their own occupational safety and health programs.

[d] It is the NRC's position (56 FR 23365) that dose limits for normal operations should remain the primary guideline in emergencies to the extent practicable. However, in accordance with 10 CFR 20.1001(b), conformance with such dose limits should not hinder an NRC licensee from taking actions that may be necessary to protect public health and safety in an emergency.

[e] These requirements apply to all DOE employees and contractors (except for Naval Nuclear Propulsion Program (NNPP)) who may be exposed to ionizing radiation as a result of their work for DOE, including work relating to emergency response activities. The NNPP has established requirements consistent with those contained in 10 CFR Part 835.

Table 3. USACE Major Radiation Standards Summary (from Table 9-1, EM 1110-35-1, 1 July 2005).

Regulation	Agency	Standard/Numerical Limit
General Public, 10 CFR 20.1301	NRC	Total Effective Dose Equivalent (TEDE): 100 millirem (mrem)/year
Uranium mill tailings, 40 CFR 192 & 10 CFR 40 App. A	EPA & NRC	Radium-226/228: 5 picocurie per gram (pCi/g) (surface) 15 pCi/g (subsurface) Radon-222 20 pCi/meter^2-second NRC standard includes benchmark dose for other radionuclides
High-level waste operations, 10 CFR 60	NRC	100 mrem/year
Low-level waste disposal, 10 CFR 61	NRC	25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ
Effluent emissions, 10 CFR 20	NRC	Radionuclide specific activities, in Appendix B => 50 mrem/year
Drinking water, 40 CFR 141	EPA	Radium: 5 picocurie per liter (pCi/L) Gross Alpha 15 pCi/L (excludes Radon & Uranium) Beta/photon: 4 mrem/year Uranium: 30 microgram/liter
Uranium fuel cycle, 40 CFR 190	EPA	25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ
Air emissions (National Emission Standards for Hazardous Air Pollutants), 40 CFR 61, Subpart H	EPA	10 mrem/year to nearest off-site receptor
Superfund (CERCLA) cleanup, 40 CFR 300	EPA	Protective of human health & environment, Complies with Applicable, or Relevant and Appropriate Requirements
Decommissioning, 10 CFR 20, Subpart E	NRC	Unrestricted Use: 25 mrem/year TEDE plus ALARA Restricted Use: Up to 100 mrem/year or 500 mrem/year if institutional controls fail.
Occupational standards, OSHA 29 CFR 1910.1096; NRC 10 CFR 20; DOE 10 CFR 835	OSHA, NRC, & DOE	5,000 mrem/year & ALARA

Table 4. Crosswalk between applicable 10 CFR 20 standards and DOE requirements. [1]		
Description	**10 CFR 20**	**DOE**
Annual air emissions limit for individual member of the public -Limits are equivalent	10 CFR 20.1101 (d) 10 mrem (0.1 millisievert [mSv])	DOE Order 458.1 [2] 10 mrem (National Emission Standards for Hazardous Air Pollutants, 40 CFR Part 61)
Annual dose limits for adult workers/DOE general employees -Limits are equivalent	10 CFR 20.1201(a)(1)(i) 5 rems (0.05 sievert [Sv])	10 CFR 835.202 (a)(1) 5 rems (0.05 Sv)
Any individual organ or tissue annual dose limits for adult workers/DOE general employees -Limits are equivalent	10 CFR 20.1201(a)(1)(ii) 50 rems (0.5 Sv)	10 CFR 835.202 (a)(2) 50 rems (0.5 Sv)
Annual dose limit to the lens of the eye for adult workers/DOE general employees -Limits are equivalent	10 CFR 20.1201(a)(2)(i) 15 rems (0.15 Sv)	10 CFR 835.202 (a)(3) 15 rems (0.15 Sv)
Annual dose limit to the skin of the whole body and to the skin of the extremities for adult workers/DOE general employees -Limits are equivalent	10 CFR 20.1201(a)(2)(ii) 50 rems (0.5 Sv)	10 CFR 835.202 (a)(4) 50 rems (0.5 Sv)
Limit on soluble uranium intake [3] -Internal dose assessment for uranium can be complex -OSHA (DOE) requirements are more stringent than 10CFR20	10 CFR 20.1201(e) Appendix B Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure 10 milligram/week Footnote 3 Appendix B: 40 h workweek 0.2 milligram/cubic meter (<5% U-235 enrichment)	Derived air concentration limits for soluble uranium are found in Appendix A of 10 CFR 835; Limits for uranium are found in 10 CFR 851.23 (a) (3) and (9); DOE adopts the OSHA generated requirements for uranium [4]. OSHA's uranium limits (29 CFR 1910.1000 Table Z-1): Permissible Exposure Limit (8 h Time Weighted Average) = 0.05 milligram/cubic meter
Dose limit to an embryo/fetus as a result of occupational exposure of a declared pregnant worker -Limits are equivalent	10 CFR 20.1208(a) 0.5 rem (5 mSv)	10 CFR 835.206(a) 0.5 rem (0.005 Sv)
Annual dose limit for individual members of the public from licensed operation in unrestricted areas/DOE controlled areas -Limits are equivalent	10 CFR 20 1301(a)(1) 0.1 rem (1 mSv)	10 CFR 835.208 0.1 rem (0.001 Sv)
[1] Not an exhaustive comparison of all applicable requirements. [2] Radiation Protection of the Public and the Environment, approved date 02-11-2011. [3] Uranium intake limits based on chemical toxicity.		

[4] See also DOE Standard “Good Practices for Occupational Radiological Protection in Uranium Facilities,” DOE-STD-1136-2017.

13.3 Occupational exposure limits

Occupational Exposure limits for the USACE are summarized in Table 5.

Table 5. USACE Occupational Exposure Limits

Total Effective Dose Equivalent (TEDE)	5 rem/y
Sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye	50 rem/y
Skin (shallow-dose equivalent)	50 rem/y
Lens of the eye (shallow-dose equivalent)	15 rem/y
Dose equivalent to the embryo/fetus	0.5 rem for entire pregnancy

An ALARA goal of 0.1 rem/y TEDE is established for the SCAPS truck operations on the cap of the Bluewater Disposal Cell. No person is allowed to exceed this goal without the consent of Health Physics personnel.

13.4 Airborne exposure limits

Radon levels will be monitored in hydraulic push room of SCAPS truck. Contamination levels will also be monitored. The use of respiratory protection equipment is not anticipated for this project and radon levels are expected to below the 4 pCi/L EPA recommended residential level.

14.0 SITE MONITORING

Site monitoring requirements are discussed below.

14.1 General area surveys

The purpose of a general area survey is to characterize the ambient radiation environment. An external gamma will be done before the cone penetration test (CPT) tool use and after the penetration is backfilled 1 m above the ground surface. Radon flux monitoring at selected sampling locations to verify integrity of radon barrier may also be conducted. Radiation and contamination surveys will be conducted during SCAPS truck operations and Shelby Tube sampling as described previously.

14.2 Individual exposure monitoring

In accordance with 10 CFR 20.1502(a), *Conditions requiring individual monitoring of external and internal occupational dose*, external exposure dosimetry shall be worn by:

1. Adults likely to receive, in 1 year from sources external to the body, a dose in excess of 0.5 rem per year;

2. Declared pregnant women likely to receive during the entire pregnancy, from radiation sources external to the body, a deep dose equivalent in excess of 0.1 rem; and
3. Individuals entering a high or very high radiation area as defined by 10 CFR § 20.1003, *Definitions*.

Minors are also required to wear external exposure dosimetry if they are likely to receive, in one year from radiation sources external to the body, a deep dose equivalent in excess of 0.1 rem, a lens dose equivalent in excess of 0.15 rem, or a shallow dose equivalent to the skin or to the extremities in excess of 0.5 rem. The USACE does not allow minors on jobsites to receive any radiation exposure.

SCAPS truck and Shelby Tube sampling operations personnel will be issued personal dosimeter monitors for the duration of the project.

14.3 Portable air sampling

Airborne particulate exposure is not anticipated. Radon will be monitored during SCAPS truck operations (alpha track monitoring during entire period of cap operations and real time air monitoring during probe penetration/retraction).

15.0 HEALTH PHYSICS CONTROLS

Exposures will be maintained ALARA. The USACE TEDE ALARA limit for this project is USACE 100 mrem/y.

15.1 Exposure and contamination control

Work in areas where radioactive material is handled, used, or stored shall be performed in accordance with approved procedures and work instructions. Engineering controls will be used. Exposure to contaminants is minimized by design during SCAPS truck operations via the automatic decontamination system.

The following lists administrative controls that will be implemented to ensure worker doses are ALARA:

- All nonessential personnel will be restricted from radiologically controlled areas (RCAs) such as the hydraulic push room during CPT operations on the cap.

- No eating, drinking or smoking will be allowed in RCAs.

- Individuals will, to the extent practical, remain up-wind of surface preparation, sampling and material handling operations.

15.2 Postings and labels

Area radiological postings during SCAP truck operations on the cap are not necessary as there will be 100% Health Physics coverage. IDW will need to be labeled accordingly. Hazardous substances and contaminated soils, liquids, and other residues shall be handled, transported, labeled, and disposed of in accordance with the following: drums and containers used during SCAP truck operations shall meet the appropriate DOT, OSHA, and EPA regulations for the wastes that they contain, when practical, drums and containers shall be inspected and their integrity shall be assured prior to being moved.

15.3 Surveys, monitoring, action levels, and decontamination

Radiation area and contamination surveys are performed by Health Physics personnel. Area radiation surveys are performed as follows:

- Daily during SCAPS truck and Shelby Tube sampling operations on the cap.
- Weekly, in occupied RCAs, areas where radioactive material and IDW is stored, and at boundaries of the work site where the public could be exposed.
- Whenever operations are performed that might be expected to change existing radiation or contamination levels.
- When equipment or materials contaminated with radioactive material are moved.
- When performing any operations that could result in personnel being exposed to direct radiation or radioactively contaminated material.

Surface contamination surveys are performed as follows:

- Prior to initial entry to an area where contamination is possible.
- Verify appropriateness of contamination controls, control processes, direct remedial efforts, and free release items or areas.
- Daily, in active work areas where contamination is possible and at access control points.
- Weekly, in areas where handling of radioactive material occurs and areas where radioactive material is stored.
- Decontamination and release of equipment and IDW.
- In areas where airborne radioactivity has exceeded the concentrations specified per regulation or procedure.
- When determining the need for PPE and to determine the extent of contamination in an area.

Removable contamination will be evaluated by direct scanning and obtaining representative wipes or smears and counting using instrumentation previously described. All vehicles and equipment exiting the cap of the Bluewater Disposal cell will be surveyed for contamination by Health Physics personnel. Radiological surveys of equipment and IDW will be performed in the immediate vicinity of the work activity location.

15.4 Surface contamination limits

The LD, discussed previously, will be used to initially determine whether a surface is contaminated. Equipment or materials that exceed the LD will be evaluated for uncontrolled release using the Army Radiation Safety Program Pamphlet 385–24, 30 November 2015.

From Section 5–3, Radioactive contamination: “ANSI N13.12 is to be used except for compliance with NRC contamination limits. In the absence of other regulatory or advisory guidance, a surface is contaminated if either the removable or total radioactivity is above the levels in table 5–3 (herein designated as Table 6). [Note: ANSI is the acronym for American National Standards Institute]

Specific instructions:

- If a surface cannot be decontaminated promptly to levels below those in table 6, control, mark, designate, or post it per applicable regulations. Report the contaminated surface to the appropriate Radiation Safety Officer (RSO).

- Always reduce radioactive contamination to levels ALARA (see glossary).

- Local commanders and directors may use contamination standards more restrictive than those in table 6, but will not use standards less restrictive without applying risk management principles.

- Guidance on radioactive contamination release criteria for decommissioned facilities is available in NUREG 1757.

- As a general practice, “Army organizations will not release volumetric-radioactively contaminated materials or items for unrestricted use. Screening levels for volumetric-radioactively contaminated materials are specified by, or negotiated with, the regulator. For volumetric-radioactively contaminated materials not otherwise subject to regulatory control, screening levels for unrestricted release of items or materials potentially radioactively in volume require approval of the Army RSO.”

In Table 6, Bq = becquerel and dpm = disintegrations per minute.

Table 6. Screening Levels for Clearance

Radionuclide Groups [1]	Screening levels (S.I. Units) [2] (Bq/cm^2 or Bq/g) [3]	Surface Screening (Conventional Units) [2] (dpm/100 cm^2)	Volume Screening (Conventional Units) [2] (pCi/g)
Group 1 Radium, Thorium, and Transuranics: ^{210}Po, ^{210}Pb, ^{226}Ra, ^{228}Ra, ^{228}Th, ^{230}Th, ^{232}Th, ^{237}Np, ^{239}Pu, ^{240}Pu, ^{241}Am, ^{244}Cm, and associated decay chains [4], and others [1]	0.1	600	3
Group 2 Uranium and Selected High Dose Beta-Gamma Emitters: ^{22}Na, ^{54}Mn, ^{58}Co, ^{60}Co, ^{65}Zn, ^{90}Sr, ^{94}Nb, ^{106}Ru, ^{110m}Ag, ^{124}Sb, ^{134}Cs, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{192}Ir, ^{234}U, ^{235}U, ^{238}U, Natural Uranium [5], and others [1]	1	6,000	30
Group 3 General Beta-Gamma Emitters: ^{24}Na, ^{36}Cl, ^{59}Fe, ^{109}Cd, ^{131}I, ^{129}I, ^{144}Ce, ^{198}Au, ^{241}Pu, and others [1]	10	60,000	300
Group 4 [6] Other Beta-Gamma Emitters: ^{3}H, ^{14}C, ^{32}P, ^{35}S, ^{45}Ca, ^{51}Cr, ^{5}Fe, ^{63}Ni, ^{89}Sr, ^{99}Tc, ^{111}In, ^{125}I, ^{147}Pm, and others [1]	100	600,000	3,000

Legend:

(1). To determine the specific group for radionuclides not shown, a comparison of the effective dose factors, by exposure pathway, listed in Table A.1 of National Council on Radiation Protection and Measurements (NCRP) Report No. 123 (NCRP 1996) for the radionuclides in question and the radionuclides in the general groups above shall be performed and a determination of the proper group made, based on similarity of the factors.

(2). Rounded to one significant figure.

(3). The screening levels shown are used for either surface activity concentration (in units of Bq/cm2), or volume activity concentration (in units of Bq/g). These groupings were determined based on similarity of the scenario modeling results, as described in Annex B of ANSI N13.12.

(4). For decay chains, the screening levels represent the total activity (that is, the activity of the parent plus the activity of all progeny) present.

(5). Where the Natural Uranium activity equals 48.9% from 238U, plus 48.9% from 234U, plus 2.25% from 235U.

(6). Radionuclides were assigned to groups that were protective of 10 µSv/y (1.0 mrem/y) and were limited to four groups for ease of application, as discussed in Annex B of ANSI N13.12.

Note that this table is identical to that found in ANSI/HPS N13.12-1999 with the exception that Group 5 is missing and the footnotes are different.

16.0 RADIATION PROTECTION

Surveys of personnel will be performed by Health Physics staff when exiting an RCA. The action level for contamination of skin or clothing is any detectable contamination. Health Physics personnel will perform decontamination of personnel as necessary.

16.1 Survey instrumentation

Survey instruments will be calibrated annually and source checked daily or prior to use. If an instrument fails a source check or is damaged, it will be taken out of service and returned to the manufacturer or designated vendor for repair and re-calibration.

16.2 Access control points

An access control point is a location on the perimeter of an RCA through which all entries and exits are made and where precautions are taken to prevent unnecessary exposure or the spread of radioactive contamination to adjacent uncontaminated areas. For this project, the controlled area is the SCAPS truck hydraulic push room. There is only one access ramp to the cap of the Bluewater Main Tailings Disposal cell.

16.3 Visitors

No visitors allowed in hydraulic push room during SCAPS truck operations on the cap of the Bluewater Main Tailings Disposal cell.

16.4 Records

Records of personnel monitoring, radiological surveys, and field notes will be maintained in accordance with applicable regulatory requirements.

16.5 Emergency response

The Emergency response plan is found in Section 5 of the main body of the Accident Prevention Plan.

17.0 REFERENCES

ANSI/HPS N13.12-2013, Surface and Volume Radioactivity Standards for Clearance

Department of the Army Pamphlet 385–24, The Army Radiation Safety Program, 30 November 2015

Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575, Revision 1, August 2000.

OSHA, 29 CFR 1910 Health and Safety Regulations for General Industry

OSHA 29 CFR 1926 Health and Safety Regulations for Construction

Title 10 Code of Federal Regulation (CFR), Chapter I – Part 20, Nuclear Regulatory Commission

Title 10 Code of Federal Regulation (CFR), Chapter III - Parts 835 and 851, Department of Energy

Title 29 CFR 1910.1096 and 1926.53, Occupational Health and Safety Administration

U.S. Army Corps of Engineers (USACE) Management Guidelines for Working with Radioactive and Mixed Waste, EM 1110-35-1, 01 July 2005

U.S. Army Corps of Engineers (USACE) Manual for Radiation Protection, EM 385-1-80, dated 30 September 2013

U.S. Army Corps of Engineers (USACE), 2014. EM 385-1-1, "Safety and Health Requirements Manual." November 30.

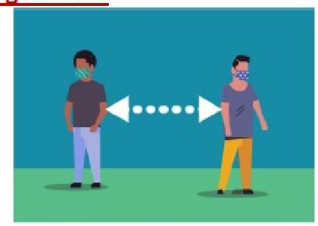
U.S. Army Corps of Engineers (USACE), 2018. ER 395-1-92, Safety and Occupational Health Requirements for Hazardous, Toxic, and Radiological Waste Cleanup Projects"

18.0 Albuquerque District Guidelines for COVID-19

Albuquerque District Guidelines for COVID-19

All individuals in Albuquerque District will wear cloth face coverings when:

- **ANYTIME you are unable to maintain 6 feet from others**
- Entering and Exiting the building to include the parking lot
- Riding in vehicles with other individuals
- Interacting with partners or members of the public



Cloth face coverings should—

- **Reach above the nose, below the chin and completely cover the mouth and nostrils**
- **Fit snugly but comfortably** against the side of the face
- **Be secured** with ties or ear loops
- **Allow for breathing without restriction**

Face coverings are not a substitute for social distancing.

Clean Government vehicles with disinfecting wipes that can be provided by ULA.

- Make sure to wipe door handles, steering wheel, mirror, climate control buttons, radio buttons, arm rests, window controls, and any other frequently touched surfaces.

Wash your hands often

- **Wash your hands often with soap and water for at least 20 seconds** especially after you have been in a public place, or after blowing your nose, coughing, or sneezing.
- No soap and water? **Use a hand sanitizer that contains at least 60% alcohol**.
- **Avoid touching your eyes, nose, and mouth** with unwashed hands.

Cover coughs and sneezes

- **Remember to always cover your mouth and nose with a tissue** when you cough or sneeze or use the inside of your elbow.
- **Throw used tissues** in the trash.
- **Immediately wash your hands** with soap and water for at least 20 seconds.

Clean and disinfect

- **Clean AND disinfect frequently touched surfaces daily**. This includes tables, doorknobs, light switches, countertops, handles, desks, phones, keyboards, faucets, and sinks.
- **If surfaces are dirty, clean them.** Use detergent or soap and water prior to disinfection.
- **Then, use a household disinfectant.** Most common household disinfectants will work.

Contact the safety office at 505-342-3175 or DLL-SPA-SO@usace.army.mil if you have any questions or need assistance.

19.0 Activity Hazard Analysis

Activity Hazards Analysis for Radiological Hazards Associated with SCAPS truck and Shelby Tube sampling operations on the Bluewater Uranium Mill Tailings Disposal Cell

Activity Hazard Analysis (AHA) 1.0

<table>
<tr><td>Activity/Work Task: Radiological hazards associated with SCAPS truck and Shelby Tube sampling operations on the Bluewater Uranium Mill Tailings Disposal Cell</td><td colspan="5">Overall Risk Assessment Code (RAC) (Use Highest Code)</td><td>M</td></tr>
<tr><td>Project Location: Cibola County, New Mexico</td><td colspan="6">Risk Assessment Code (RAC) Matrix</td></tr>
<tr><td>Contract Number:</td><td rowspan="2">Severity</td><td colspan="5">Probability</td></tr>
<tr><td>Date Prepared: 29 March 2021</td><td>Frequent</td><td>Likely</td><td>Occasional</td><td>Seldom</td><td>Unlikely</td></tr>
<tr><td rowspan="2">Prepared by (Name/Title):
David J. Whitfill P.E., CHP
Health Physicist</td><td>Catastrophic</td><td>E</td><td>E</td><td>H</td><td>H</td><td>M</td></tr>
<tr><td>Critical</td><td>E</td><td>H</td><td>H</td><td>M</td><td>L</td></tr>
<tr><td rowspan="2">Reviewed by (Name/Title):</td><td>Marginal</td><td>H</td><td>M</td><td>M</td><td>L</td><td>L</td></tr>
<tr><td>Negligible</td><td>M</td><td>L</td><td>L</td><td>L</td><td>L</td></tr>
<tr><td rowspan="4">Notes: (Field Notes, Review Comments, etc.)
This AHA serves as certification of hazard assessment.</td><td colspan="6">Step 1: Review each “Hazard” with identified safety “Controls” and determine RAC (see above)</td></tr>
<tr><td colspan="4">“Probability” is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.</td><td colspan="2">RAC Chart</td></tr>
<tr><td colspan="4" rowspan="2">“Severity” is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible</td><td colspan="2">E = Extremely High Risk</td></tr>
<tr><td colspan="2">H = High Risk</td></tr>
</table>

	Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.	**M = Moderate Risk**
		L = Low Risk

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
Gamma survey prior to Insertion of the Cone Penetration Test (CPT) tool and Shelby Tube sampling	Slips, trips, or falls due to uneven and rocky ground surface	Ensure stable surface while walking. Utilize a second person to help record survey readings.	**L**
Insertion of the Cone Penetration Test (CPT) tool	-Mechanical pinching hazards due to CPT tool movement and installing push rods. -Potential radon exposure as radon barrier is breached. Potential increase in gamma radiation levels as tool is inserted.	Maintain a safe distance from CPT tool when inserting. Ensure tool secure prior to installing push rods. -Monitor radon levels during CPT tool insertion. -Monitor gamma radiation levels during insertion.	**L**
Retraction of CPT tool -wipe down and contamination survey of tool and push rods as tool is retracted - grouting systems are activated backfilling penetration as CPT tool is retracted. -Periodically survey hydraulic push room between CPT survey locations. Survey Shelby Tube samples for radioactivity	-Mechanical pinching hazards due to CPT tool movement and uninstalling push rods. -Potential radon exposure while radon barrier is breached. Potential increase in gamma radiation levels until tool is fully retracted and penetration is grouted. -Potential internal radiation exposure due to contaminated of push rods and CPT tool.	Maintain a safe distance from CPT tool when inserting. Ensure tool secure prior to uninstalling push rods. -Monitor radon levels during CPT tool retraction. -Monitor gamma radiation levels during CPT tool retraction. -Wipe down push rods and CPT tool and check wipes and surfaces for contamination. Wipe down and resurvey areas that exceed the detection limit (LD). -Periodically check personnel for contamination by surveying hands and work area. Change gloves as necessary to minimize spread of contamination.	**M**
Gamma survey post retraction of the CPT tool and Shelby Tube sampling -Place radon flux monitor over selected grouted penetration if flux monitoring is done. Retrieve after 24 h.	Slips, trips, or falls due to uneven and rocky ground surface.	Ensure stable surface while walking. Utilize a second person to help record survey readings.	**L**

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
Managing liquid waste from decontamination operations -Initial surveys/labeling of 55-gallon drum.	Potential exposure due to spills or contaminated surfaces.	-Ensure drums properly sealed. Hazardous substances and contaminated soils, liquids, and other residues shall be handled, transported, labeled, and disposed of in accordance with the following: drums and containers used during the clean-up shall meet the appropriate DOT, OSHA, and EPA regulations for the wastes that they contain, when practical, drums and containers shall be inspected and their integrity shall be assured prior to being moved. -Monitor gamma radiation levels and perform contamination surveys on drum surfaces. -Wipe down and resurvey any areas above the LD. -Promptly contain any spills-utilize available spill kits as necessary.	**M**
At end of work day, survey equipment, hydraulic push room, SCAPS truck, equipment used for Shelby Tube sample collection, and personnel prior to exiting disposal cell cap. -Decontaminate/wipe down any areas or equipment that exceeds the LD -All personnel will be surveyed prior to exiting area -Dispose of PPE and gloves as IDW if above LD -Package/Survey/Ship investigative derived waste (IDW) as necessary	Potential exposure due to spills, contaminated surfaces, or improperly packaged IDW.	-Ensure IDW properly packaged, surveyed, and shipped according to procedures and regulatory requirements. -Be diligent while performing radiological surveys and monitoring of personnel.	**M**
-Final survey of automatic decontamination system. If residual radioactivity/contamination found above LD, decontaminate system per procedures and re-survey.	Potential exposure due surfaces contaminated with residual radioactive material.	-Be diligent while performing radiological surveys.	**M**

Equipment to be Used	Training Requirements/Competent or Qualified Personnel Name(s)	Inspection Requirements
Personal Protective Equipment Level D: • Hard Hat when in construction areas or when overhead hazards are present • Safety Glasses • Safety-Toed Boots • Work Gloves/ Chemical resistant gloves • ANSI Class 2 high visibility vests Modified Level D: Hydraulic Room during CPT operation on cap of uranium mill tailings disposal cell. • Safety Glasses • Safety-Toed Boots, boot covers • Work Gloves/ Chemical resistant gloves • ANSI Class 2 high visibility vests • Tyvek coveralls • Radiation Dosimeter Equipment: • Fire Extinguishers • Emergency Eyewash • First Aid Kit • Insect repellant with DEET • Permethrin • Hand tools • Drinking water • Weather radio / weather app • Heat stress monitoring • Wind sock • Water level meters • Radiation survey meters-source check daily • Radon monitor	Site Safety and Health Officer (SSHO): _______________ Qualified Person #1 First Aid and CPR: _______________ Qualified Person #2 First Aid and CPR: _______________ Training Requirements (as determined by the SSHO): • HAZWOPER 40-Hour • Site safety orientation • Tailgate Safety Meetings • Emergency procedures • Hazard communication • Applicable AHAs • Fall protection • Fire extinguisher use • Biological hazard identification and control • Tornado shelter location • Lightning safety procedures • Heat stress prevention and treatment • Cold stress prevention and treatment • Radiation hazards	Daily Site Safety Inspection • Housekeeping (daily) • Eye wash equipment (weekly) • Fire extinguisher (monthly) • Vehicle inspection daily • Equipment and tools inspection daily and before use • Survey areas for poisonous plants, insects, and animals (each work area) • Check body for ticks Identify closest usable tornado shelter that is available (each work area).

ATTACHMENT B – Mishap Notification and Investigation Form