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REV. 1

LONG-TERM SURVEILLANCE PLAN FOR THE ESTES GULCH DISPOSAL SITE NEAR RIFLE, COLORADO

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LIST OF ACRONYMS

Acronym	Definition
BLM	Bureau of Land Management
DOE	U.S. Department of Energy
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
HDPE	high density polyethylene
LTSP	long-term surveillance plan
MCL	maximum concentration limit
MK-F	Morrison Knudsen-Ferguson
NGVD	National Geodetic Vertical Datum
NRC	U.S. Nuclear Regulatory Commission
POC	point of compliance
QA	quality assurance
RAP	remedial action plan
TAC	Technical Assistance Contractor
TDS	total dissolved solids
UMTRA	Uranium Mill Tailings Remedial Action
UMTRCA	Uranium Mill Tailings Radiation Control Act

1. 0 PURPOSE AND SCOPE

This long-term surveillance plan (LTSP) describes the U.S. Department of Energy's (DOE) long-term care program for the Uranium Mill Tailings Remedial Action (UMTRA) Project Estes Gulch disposal site located near Rifle, Colorado, in Garfield County.

The U.S. Nuclear Regulatory Commission (NRC) has developed regulations for the issuance of a general license for the custody and long-term care of UMTRA Project disposal sites in 10 CFR Part 40. The purpose of this general license is to ensure that the UMTRA Project disposal sites are cared for in a manner that protects the public health and safety and the environment. For disposal sites to be licensed, the NRC requires the DOE to submit a site-specific LTSP; the DOE prepared this LTSP to meet that requirement for the Estes Gulch disposal site. The general license becomes effective when the NRC concurs with the DOE's determination of completion of remedial action for the Estes Gulch site and the NRC formally accepts this LTSP.

This document describes the long-term surveillance program the DOE will implement to ensure that the Estes Gulch disposal site performs as designed. The program is based on site inspections to identify threats to disposal cell integrity. The LTSP is based on the UMTRA Project long-term surveillance program guidance (DOE, 1996a) and meets the requirements of 10 CFR §40.27(b) and 40 CFR §192.03.

2. 0 FINAL SITE CONDITIONS

Remedial action at the former uranium processing sites in Rifle, Colorado, consisted of excavating and relocating the residual radioactive materials to the Estes Gulch disposal site. The DOE constructed a disposal cell to control the residual radioactive materials in accordance with 40 CFR Part 192. The Estes Gulch disposal site is partially fenced, and its perimeter is marked with warning signs. The site completion report (DOE, 1997) contains a detailed description of the final site conditions.

2.1 SITE HISTORY

The Estes Gulch disposal cell was constructed to stabilize waste from the two former processing sites near Rifle, Colorado. Both processing sites (named Old Rifle and New Rifle) are located on the floodplain of the Colorado River valley and are north of the Colorado River. Old Rifle is just east of the city limits of Rifle, in Garfield County, Colorado. New Rifle is west of the city of Rifle, approximately 2 miles (mi) (3 kilometers [km]) from Old Rifle. The Estes Gulch disposal cell is located approximately 6 mi (9 km) north of Rifle.

Both processing sites were once owned by Union Carbide Corporation, but now are owned by the state of Colorado. The Old Rifle plant was built by the Standard Chemical Company in 1924 and in 1928 was bought by the United States Vanadium Corporation (an eventual subsidiary of the Union Carbide Corporation). The mill operated from 1924 to 1932, and again from 1942 to 1946 for recovery of vanadium. In 1946, uranium processing was added to the vanadium recovery circuit and recovery of both vanadium and uranium continued until 1958. In 1958, operations were transferred to the New Rifle mill and the Old Rifle mill was shut down.

About 761,000 short tons (tons) of ore from the nearby Meeker and Rifle Creek mines, as well as ore from

the Uravan mineral belt, were processed at the Old Rifle mill. Tailings and spent processing solutions were deposited at the site. About 411,000 tons of these tailings were later reprocessed at the New Rifle mill and deposited there. Approximately 350,000 tons of tailings (approximately 259,000 cubic yards [yd^3], or 197,000 cubic meters [m^3]) remained at Old Rifle. In 1967, Union Carbide moved the southern edge of this tailings pile away from the Colorado River and partially stabilized the pile with a 6-inch (15-centimeter [cm]) cover of earth seeded with grasses.

In July 1958, operations began at the New Rifle mill, which produced both uranium and vanadium until December 1972. After 1972, only vanadium was produced and milling operations ceased in 1981. In addition to tailings from the Old Rifle site, uranium ores and upgrader products were processed at the New Rifle mill. A total of 2.7 million tons of tailings, ores, and upgrader products were processed at this mill.

Upgrader products came from other Union Carbide mills at Slick Rock, Colorado, and Green River, Utah. Upgrader products from Slick Rock were dried fines, dried slime concentrates, green sludge, and uranium-bearing chemical precipitates. The Green River upgrader products consisted of dried slimes and asphaltic uranium-bearing concentrates. Uranium bearing lignite ash from Belfield, North Dakota, was supplied to the New Rifle mill. Union Carbide partially stabilized the New Rifle pile with mulch, fertilizer, and native grasses.

At the Old Rifle mill, a salt roasting process initially was used to recover vanadium. Water, sodium chloride, and sulfuric acid were used in this process. When uranium processing was added to the vanadium recovery circuit in 1946, additional reagents were used: hydrochloric acid, sodium hypochlorate, sodium carbonate, ferric iron sulfate, ammonia, and ammonium chloride.

The New Rifle mill used a solvent extraction method to recover uranium. Reagents used in the process included water, sodium chloride, sulfuric and hydrochloric acid, kerosene, di(2-ethylhexyl) phosphoric acid, sodium hypochlorate, sodium carbonate, sodium hydroxide, and ammonia.

The Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 (42 USC §7901 *et seq.)* gave the DOE authority to perform remedial action at both Rifle sites. The DOE evaluated the environmental impacts associated with site remedial action in an environmental impact statement (EIS) (DOE, 1990. The NRC and the state of Colorado concurred with the DOE's remedial action plan (RAP) (DOE, 1992a) to comply with the requirements of 40 CFR Part 192, Subparts A through C.

The DOE began constructing the Estes Gulch disposal cell in 1993. During 1994 and 1995, the DOE relocated uranium mill tailings and other residual radioactive materials (such as contaminated mill buildings and associated debris, windblown materials, and about 24,000 yd^3 [18,400 m^3] of vicinity property materials) and placed them in the Estes Gulch disposal cell. Disposal cell construction was completed in 1996 with placement of a radon/infiltration barrier and frost- and erosion-protection layers. A completion report documents compliance with the RAP and the site as-built conditions (DOE, 1997). In addition, the DOE prepared a final audit report and certification summary and submitted it along with the completion report to the NRC for concurrence. Concurrence from the NRC on the completion report is included in the permanent site file.

2.2 GENERAL DESCRIPTION OF THE SITE VICINITY

The Estes Gulch disposal site is in Garfield County in west-central Colorado on the western slope of the Rocky Mountains. The site is approximately 6 mi (10 km) north of the town of Rifle, Colorado (Figure 2.1) in Township 5 South, Range 93 west, Section 14. This section briefly describes the site vicinity. Detailed descriptions can be found in the site EIS (DOE, 1990) and the RAP (DOE, 1992a).

Figure 2.1 Location of the Estes Gulch disposal site near Rifle, Colorado

The general climatic regime in the vicinity of the Estes Gulch disposal site is semiarid. North of Estes Gulch at significantly higher elevations, precipitation is much heavier. The area is characterized by low humidity, frequent sunny days, and large diurnal and seasonal temperature ranges. The average annual precipitation in the region is 11 inches (28) centimeters [cm]) and the average temperatures range from 23 to 71

degrees Fahrenheit (° F) (-5 to 22 degrees Celsius [° C]) (Yeend, 1969). Snowfall averages 37 inches (94 cm) a year. The highest monthly rainfall usually occurs during July and August, while the least rainfall occurs from April through June. Summer rainfall occurs as intense, scattered thunderstorms.

Site-specific precipitation, temperature, and wind-related data were collected from October 1993 to September 1996. Average annual precipitation ranged from about 14.3 to 18.5 inches (36 to 47 cm). Annual snowfall ranged from 22.3 to 34 inches (57 to 86 cm). The site-specific average daily temperature ranged from 15 to 86° F (- 9.4 to 30° C).

Site-specific wind data indicate that wind direction was predominately from the west and northwest over 50 percent of the period of record. Winds were from the south 10 percent of the time. Wind intensity data are available from Morrison Knudsen-Ferguson (MK-F) (MK-F, 1996).

The Estes Gulch site ranges from about 5960 to 6200 feet (ft) (1820 to 1890 meters [m]) above mean sea level. The Grand Hogback rises to an elevation of about 7850 ft (2400 m) north of the site. To the south, 3300 ft (1000 m) the dissected pediment surfaces drop down to the alluvial valley of Government Creek at an elevation of about 5750 ft (1750 m).

The Estes Gulch site is at the head of a small drainage basin on a dissected pediment and alluvial fan surface sloping southwest toward Government Creek from the foot of the Grand Hogback monocline.

Off-site runoff water that could have affected the integrity of the cell previously came from a 20-acre (ac) (8-hectare [ha]) watershed north of the cell. Runoff from about 6 ac (2 ha) of the uppermost part of this watershed was diverted from the disposal cell by an interceptor ditch. The other 14 ac (5.6 ha) of the watershed between the interceptor ditch and the cell were graded and covered with erosion-resistant material. The graded area has a slight crown to shed some runoff away from the cell and onto the adjacent ground. Precipitation falling on top of the cell will drain to a toe ditch at the south end and will discharge eastward into Estes Gulch (DOE, 1992a).

There is little potential for future natural resource development in the immediate site vicinity.

2.3 DISPOSAL SITE DESCRIPTION

This section briefly describes the disposal site; detailed descriptions can be found in the site RAP (DOE, 1992a) and completion report (DOE, 1997).

2.3.1 Site ownership and legal description

The government currently owns the Estes Gulch disposal site and most of the surrounding area. The Bureau of Land Management (BLM) permanently transferred administration of public land to the DOE in August 1991 for use as the Estes Gulch disposal site. The BLM administers the adjacent surrounding lands. Attachment 1 provides a legal description of the disposal site. Plate 1 shows the final site boundary and identifies ownership of the site and surrounding areas at the time of licensing.

2.3.2 Directions to the disposal site

The Estes Gulch disposal site can be reached by automobile via paved and gravel roads (Figure 2.2) by following these directions.

1. From Rifle, Colorado, at the intersection of U.S. Highway 6 (also called U.S. Highway 24) and the State Highway 13 by-pass, go north.
2. Take the State Highway 13 bypass to State Highway 13 north; go approximately 5 mi (8 km).
3. Turn right onto a paved road. The paved section of the road extends about 30 ft (9 m) to a gate. After the gate, the road becomes a gravel road. Follow this gravel road about a mile to the disposal site.

4. Entry to the disposal site is restricted by a fence at the site entrance. The south access gate is kept locked and the key needed to enter the site may be obtained from the DOE Grand Junction Office.

2.3.3 Description of surface conditions

The Estes Gulch disposal site is located on approximately 205 ac (83 ha) (Plate 1). The completion report contains a detailed description of the final site conditions, including the results of the final site topographic survey.

During the final site grading, all areas were contoured to promote drainage away from the disposal cell. A mix of grasses and sagebrush was used to revegetate all disturbed areas of the disposal site not covered by riprap (DOE, 1997).

At the completion of remedial action, the DOE documented final disposal site conditions with site maps, as-built drawings, and ground and aerial photographs.

Figure 2.2 Estes Gulch Disposal site near Rifle, Colorado

2.3.4 Permanent site-surveillance features

Survey and boundary monuments, site markers, and warning signs are the permanent long-term surveillance features of the Estes Gulch disposal site. Plate 1 shows the locations of these features and Table 2.1 provides survey coordinates for the monuments and markers. Typical construction and installation specifications for these features are shown in the long-term surveillance guidance (DOE, 1996a) and subcontract documents (DOE, 1996b).

Table 2.1 Locations of permanent surveillance features, Rifle, Colorado, disposal site

Feature	Location coordinates[a]	
Survey monuments		
SM-1	N 56,000	E 53,400
SM-2	N 56,500	E 52,100
SM-3	N 59,600	E 52,600
Site markers		
SMK-1	N 56,000	E 53,550
SMK-2	N 57,200	E 52,550

Boundary monuments		
BM-1	N 55,900	E 54,270
BM-2	N 57,205	E 54,280
BM-3	N 57,220	E 53,655
BM-4	N 59,140	E 53,680
BM-5	N 59,170	E 54,000
BM-6	N 60,070	E 53,985
BM-7	N 60,080	E 53,360
BM-8	(No monument.)	
BM-9	(No monument.)	
BM-10	N 59,245	E 52,350
BM-11	N 59,250	E 52,050
BM-12	N 58,945	E 52,045
BM-13	(No monument.)	
BM-14	N 58,250	E 51,690
BM-15	N 58,250	E 51,385
BM-16	N 57,270	E 51,360
BM-17	(No monument.)	
BM-18	N 56,645	E 51,185
BM-19	N 56,620	E 52,010
BM-20	(No monument.)	

aCoordinates in feet based on Project Survey Control Points: CP-13, N 58,634.94, E 54,353.21; CP-15, N 59,208.41, E 52,222.98; CP-19, N 59,856.50, E 53,526.86.

Three survey monuments establish permanent horizontal control based on the Colorado State Plane Coordinate System (Central Zone) and are referenced to the Project Survey Control Points. These control points are shown on Plate 1 and their location coordinates are given in Table 2.1. The three permanent survey monuments (SM-1, SM-2, and SM-3) are Berntsen RT-1 markers set in concrete, with the monument about 4 inches (10 cm) above ground level. Magnets in the markers permit easier detection if the markers become buried over time. The survey monument identification

number is stamped on the top of the metal cap.

The site boundary has 20 corners; 15 are marked by boundary monuments (Plate 1 and Table 2.1). Boundary monuments were not installed at five corners (BM-8, BM-9, BM-13, BM-17, and BM-20) because of steep terrain. Five of the boundary monuments are Berntsen A-1 markers set in reinforced concrete. These markers extend about 1 inch (2.5 cm) above the ground surface. The remaining 10 monuments have been modified for area conditions and are placed to a depth of 3 ft (1 m) or to 6 inches (15 cm) below the top of rock. These modified markers extend a minimum of 1 foot (30 cm) above the ground surface. Magnets in the A-1 markers will allow easier detection if they become buried. The boundary monument identification number is stamped on the top of the metal cap.

Two unpolished granite markers with an incised message identify the Estes Gulch disposal site. The message includes a drawing showing the general location of the stabilized disposal cell within the site boundaries, the date of closure (26 April 1996), the weight of the tailings (4,967,451 dry tons of tailings), and the amount of radioactivity (2738 curies). Site marker SMK-1 near the south access gate to the site is set in reinforced concrete that extends 6 ft (1.8 m) below the ground surface. Site marker SMK-2 at the crest of the disposal cell is set in reinforced concrete that extends down 18 inches (46 cm) to the top of the frost protection barrier.

The site entrance sign is at the south access gate near site marker SMK-1. The entrance sign also displays the DOE 24-hour phone number. In addition, the DOE has posted property use warning signs (18 by 24 inches [610 x 460 mm]) around the disposal site perimeter at approximately 200-ft (60-m) intervals along the south side of the site and approximately 500 ft (150 m) intervals elsewhere. The warning signs are mounted on steel posts set back about 5 ft (1.5 m) inside the site fence, except on the south were they are attached to the fence. Warning signs on posts are mounted with the tops of the signs about 6 ft (1.8 m) above the ground surface. The sign posts are embedded in concrete to a depth of about 3 ft (1 m) below the ground surface.

2.4 DISPOSAL CELL DESIGN

The 71-ac (29-ha) disposal cell is located on a gently sloping pediment betweenthe Grand Hogback and Government Creek. The area of the disposal cell is not subject to any significant hazard from slope failure processes such as landslides, debris flows, mud flows, and rock falls. The geomorphic processes posing a potential hazard to the stabilized disposal cell are ephemeral drainage channel changes, low-gradient slope erosion, and wind erosion; however, these processes are not reasonably expected to affect the disposal cell within the next 1000 years, or in any case for at least 200 years.

The disposal cell is constructed partially below grade. The disposal cell is located on a hillside and generally follows the same slope. The highest elevation of the cell and that of the adjacent ground surface is about 6240 ft (1900 m) above National Geodetic Vertical Datum (NGVD). From this location the cell slopes at 11.9 percent to an elevation of 6160 ft (1880 m) NGVD, where the grade changes to 5.5 percent. At this point, the surface of the cell is about 3 ft (0.9 m) above the adjacent ground surface. After the slope reaches an elevation of 6107 ft (1860 m) NGVD, the slope changes to a grade of 6.5 percent. At this point the cell surface is about 17 ft (6 m) above the adjacent ground surface. There is a major grade break at elevation 6087.2 ft (1855.4 m) NGVD, where the cell surface is about 30 ft (9 m) above the adjacent ground surface. At this point the slope continues at 20 percent to the toe of the cell.

The disposal cell contains approximately 3.7 million yds^3 (2.8 million m^3)of relocated tailings and other residual radioactive materials, primarily contaminated soils and demolition debris. The disposal cell is capped with a multiple-component cover (Figure 2.3).

A 1.5-ft (0.45-m)-thick radon/infiltration barrier is placed over the contaminated materials. The radon barrier is constructed of two layers: a 0.5-ft (0.15-m) compacted clay layer and a 1-ft (0.3-m) layer of bentonite-amended clay. The barrier is designed to reduce the radon-222 flux from the disposal cell to less than 20 picocuries per square meter per second and minimize water infiltration into the tailings. Over much of the radon/infiltration barrier an additional 0.5- to 0.7-ft (0.1- to 0.2-m) layer was placed to prevent drying. A 0.5-ft (0.15-m) -thick coarse-grained filter layer is placed on top of the radon/infiltration barrier to

provide a capillary break and promote drainage of infiltrating water away from the radon barrier. A layer of compacted soil lies on top of the filter layer to insulate the radon/infiltration barrier and keep it from being adversely affected by freeze-thaw cycles. The typical thickness of this layer is 7.5 ft (2.3 m), and it has a maximum thickness of 18 ft (5.5 m) where the cell joins the natural slope. The topslopes and sideslopes of the disposal cell are capped with rock (riprap) to protect against wind and water erosion and prevent damage to the underlying frost protection and radon/infiltration layers.

The erosion-protection layer is 1-ft (0.3-m) thick. A 0.5-ft (0.15-m)-thick bedding layer is beneath the erosion-protection layer to prevent damage to the underlying frost protection layer from rocks and soil loss from runoff water. These grades, in conjunction with the bedding layer, will allow excess surface water to run off the disposal cell and be conveyed to adjacent site grades, thereby minimizing the risk of significant erosion. The components of both the

Figure 2.3 Cover cross section typical thickness, Estes Gulch disposal site near Rifle, Colorado

topslope and sideslope covers are intended to minimize the potential for deep percolation of precipitation into the residual radioactive material. A riprap apron and toe ditch at the toe of the disposal cell carry water away from the cell and provide erosion protection from gullying. An unlined interceptor ditch abuts the upslope portion of the disposal cell to divert surface flow away from the cell.

Detailed engineering drawings of the disposal cell are in the site completion report (DOE, 1997).

During design and analysis of the Rifle disposal cell in 1990 and 1991, the UMTRA Project team and the NRC were concerned that transient drainage and surface infiltration might collect near the toe of the cell and build up excessively. If tailings drainage water built up above the rim of the excavation, a surface expression (i.e., seep) along the south slope of the disposal cell could inadvertently allow radionuclides to escape. It was concluded in the RAP that to prevent a surface expression (i.e., seep) a temporary high density polyethylene (HDPE) liner would be constructed inside the toe of the disposal cell, and that a temporary leachate collection system would be constructed. The HDPE liner and a leachate collection system (standpipes), consisting of three 18-inch (46 cm)-diameter monitor wells and a granular under-drain layer beneath the tailings (see MK-F Rifle site construction drawings RFL-DS-10-0724, RFL-DS-10-0731, and RFL-DS-10-0732).

Monitoring and analysis of the standpipes will be required under the Long-Term Surveillance Program until it is determined that after review by the State and approval by NRC the standpipes can be decommissioned. The operation and contingency plan for monitoring well closure (see appendix) contains detailed requirements for monitoring the water level in the standpipes and analyzing the data to determine when the standpipes can be decommissioned.

Several phases of permeability testing of the Wasatch Formation bedrock at the Estes Gulch disposal site have been conducted. These include field studies by the Technical Assistance Contractor (TAC), Morrison Knudsen-Ferguson Environmental Services with support by Morrison Knudson-Ferguson, and Daniel B. Stephens & Associates. Laboratory permeability testing was conducted by the University of Arizona, Lambert and Associates, and Herzog Associates. A summary of testing results is presented below.

The TAC estimated a mean hydraulic conductivity of 7×10^{-10} cm per second for the saturated deep Wasatch Formation using water level recovery data (Calculation RFL09-89-14-02-9). However, hydrostatic equilibrium in these wells, which varied in depth from 300 to 440 ft (91 to 134 m), was never achieved.

To improve sandstone and siltstone permeability estimates in the extreme upper Wasatch Formation at the bottom of the disposal cell excavation, a number of short-, intermediate-, and long-term infiltrometer tests were conducted in 1992 and 1993. This testing defined the saturated vertical permeability of sandstones at the low portion of the disposal cell and the saturated vertical permeability of siltstone in the cell foundation. The sandstone's geometric mean permeability was found to be 4×10^{-7} cm per second. The geometric mean permeability of the siltstone was determined to be 7×10^{-8} cm per second.

2.5 GROUND WATER CHARACTERIZATION

This section briefly describes the hydrogeologic units and background ground water quality at the Estes Gulch disposal site and identifies the constituents of concern at the site. More detail on ground water characterization of the site is found in the Rifle RAP (DOE, 1992a). The justification for no ground water monitoring is provided in Section 2.6.

2.5.1 Hydrogeology

The hydrogeology of the Estes Gulch disposal site was characterized during preparation of the RAP (DOE, 1992a). The Estes Gulch disposal site is underlain by the Wasatch Formation, which consists of approximately 5000 ft (1525 m) of siltstones, shales, and fine-grained sandstones Figure 2.4. The Mesaverde Group (Ohio Creek and Williams Fork Formations) underlies the Wasatch Formation, and is the uppermost useable aquifer beneath the disposal cell. The Williams Fork Formation of the Mesaverde Group is approximately 4500 ft (1370 m) thick, and consists of light-brown to white sandstones, gray to black shale, and coal beds (Tweto et al., 1978). The resistant beds of the formation comprise the Grand Hogback north of the disposal site. The thin Ohio Creek Formation is considered by some to be the uppermost member of the Mesaverde Group (and Williams Fork Formation). However, the kaolinitic sandstone Ohio Creek unit is less than 100 ft (30 m) thick near Estes Gulch and is not known to be a regional aquifer. Near the Estes Gulch disposal site, the Ohio Creek unit contains a high percentage of clay and appears to be quite impermeable.

Exploratory drilling conducted during characterization of the Estes Gulch disposal site encountered several faults paralleling the bedding planes and occurring randomly in the steeply-dipping strata beneath the site. Exploratory drilling shows that these faults are filled with clay gouge having a hydraulic conductivity of approximately 1×10^{-9} cm per second. Therefore the faults do not appear to be a significant ground water transport pathway. Closely spaced fractures sometimes occur near these minor faults, becoming widely spaced within a few feet of the faults.

The Wasatch Formation is generally an aquitard, and does not contain significant quantities of ground water (Wright Water Engineers, 1979; Giles, 1980; Coffin et al., 1968, 1971). The limited ground water in the Wasatch Formation beneath the site flows primarily through fractures and joints in the siltstone and sandstone beds. Localized recharge to the bedrock occurs through weathered zones and fractures, and in areas where more permeable beds crop out at the surface. Recharge percolates down to limited zones of saturation,

Figure 2.4 Geologic cross sections, Estes Gulch disposal site near Rifle, Colorado

then ground water generally flows slowly along the strike and down dip of the nearly vertical beds. Because ground water saturation is localized and because ground water levels appearapproaching hydrostatic equilibrium within completed wells, the potentiometric surface and potentiometric gradient cannot be accurately defined in the disposal cell vicinity.

The DOE installed a total of 13 monitor wells at the Estes Gulch disposal site prior to disposal cell construction (Table 2.2). In 1986, the DOE installed 10 monitor wells at the Estes Gulch site. The wells ranged from 60 to 301 ft (18 to 92 m) deep. Nine of the wells are dry and one found ground water. Water was encountered in the deepest well (well 963) at a depth of 270 ft (82 m) below ground surface. The water level then slowly rose to a depth of 150 ft (46 m) below ground surface when last measured. In 1988, the DOE installed three additional wells (wells 701, 702, and 703) completed to depths of 500 to 545 ft (150 to 165 m). These three wells showed little or no water at completion; however, water levels rose in these wells following completion until 1990. When last measured in March 1992, ground water levels ranged from 274 to 434 ft (84 to 132 m) below ground surface in the three wells (Figure 2.5).

Ground water levels in two of the four wells that produced water appeared to reach hydrostatic equilibrium during the 6-year sampling period, reflecting the very low permeability of the bedrock beneath the disposal site. After periods of more than 4 years, water level elevations differed by 130 ft (40 m) or more between completed wells and showed no defined piezometric surface. All wells at the Estes Gulch site will be abandoned in accordance with state ground water protection laws at the earliest practicable date after the site is licensed for long-term custody.

These 13 wells are no longer sampled and are not point of compliance (POC) wells. All monitor wells will be abandoned and ground water monitoring will not occur. Nine of the monitor wells were either dry or produced too little water (less than 1 gallon [gal] or 3.8 liter [L]) to sample properly. Four of the deep wells (963, 701, 702, and 703) produced sufficient water for sampling. Ground water quality sampling of these wells was conducted at the Estes Gulch disposal site from 1986 through 1992.

2.5.2 Background ground water quality

The pH values in ground water sampled from monitor wells completed in the Wasatch Formation beneath the site range from 7.3 to 12.8. Although it is known that well 964 is grout-contaminated, samples from three of the four wells also may be cement-grout contaminated, with pH values ranging from 10.9 to 12.8. However, it is also possible that this pH is natural (DOE, 1992a).

Water levels did not reach hydrostatic equilbrium during the 4-year sampling period, reflecting the very low permeability of the bedrock beneath the disposal

Table 2.2 Completion intervals and ground water levels in monitor wells, Estes Gulch site near Rifle, Colorado

Monitor well number[a]	Ground level elevation	Completion interval (depth in ft)[b]	Date	Ground water level (ft above mean sea level)
952	6257.6	245.75 to 250.75	01/14/86	Dry
955	6013.8	55.00 to 60.00	01/14/86	Dry
			10/20/87	Dry
956	5995.2	58.00 to 73.00	01/14/86	Dry
			10/20/87	Dry
958[c]	6024.7	106.40 to 116.40	01/14/86	Dry
			10/20/87	Dry
959	6016.3	97.35 to 102.25	01/14/86	Dry

			10/20/87	Dry
962[c]	6061.1	67.25 to 72.25	01/14/86	Dry
			10/20/87	Dry
963[c]	6043.8	296.0 to 301.0	01/14/86	5773.55[d]
			10/20/87	5860.75[d]
964[c]	6046.4	212.50 to 217.50	01/14/86	Dry
			10/20/87	Dry
965	5987.0	97.25 to 102.75	01/14/86	Dry
			10/20/87	Dry
969	6003.8	97.50 to 102.50	01/14/86	Dry
			10/20/87	Dry
701	5979.0	180 to 545	07/28/88	5455
			12/10/88	5581.81
			03/24/89	5640.50
			3/8/90	5710.10
			3/19/92	5705.48
702	6008.0	355 to 543	07/28/88	5521
			12/10/88	5519.91
			03/24/89	5529.55
			3/8/90	5542.38
			3/19/92	5573.60

703	6006.0	420 to 502	07/28/88	5516
			12/10/88	5553.52
			03/24/89	5580.80
			3/8/90	5634.57
			3/19/92	5630.64

aMonitor well locations are shown on Figure 2.5. All are RFL-08-0XXX.

bAll monitor wells are completed in the Wasatch Formation and have casing diameters of 4 inches.

cDecommissioned May 1997

dThe depth from the land surface to ground water in monitor well 963 was 270.2 ft on 01/14/86 and 183 ft on 10/20/87.

Figure 2.5 Monitor well locations, Estes Gulch disposal site near Rifle, Colorado

site. In wells 963, 701, 702, and 703 water levels slowly increased over periods of more than 2 years, reflecting slow recharge to the wells from ground water. However, even after periods of more than two years, water level elevations differed by 75 ft (23 m) or more between completed wells and showed no clear piezometric surface (Table 2.3).

Thus background water quality is difficult to characterize for the Wasatch Formation because the wells recharged slowly, grout could possibly contaminate three wells, and the chemistry of water sampled from all wells varied with changes in water levels. This variance is especially true of trace metals such as selenium, cadmium, and radium, which were at high levels (greater than maximum concentration limits [MCL]) during the first sampling rounds, but which decreased to levels below detection or MCLs as water levels in the wells increased.

Well 963, which has a 5-ft (1.5-m) screened interval, produced very little water and water quality varied from one sampling round to the next. This, in conjunction with evidence for grout contamination, indicates that samples from this well may not reflect ground water quality in the Wasatch. By contrast, major element concentrations were relatively constant during the entire 4-year sampling period for wells 701, 702, and 703. These three wells screen large intervals of the Wasatch Formation. Thus the chemistry of ground water from these three wells likely is typical of Wasatch Formation ground water beneath the site.

In wells 701, 702, and 703, the average total dissolved solids (TDS) concentrations were 20,300; 20,400; and 10,900 milligrams (mg) per liter respectively. In these three wells, the high TDS is due primarily to high levels of sodium chloride in the ground water.

Median levels of barium exceeded the U.S. Environmental Protection Agency (EPA) MCL in wells 701, 702, and 703 and tended to increase as water levels in the wells increased. Median levels of selenium exceeded the EPA MCL in the same three wells, though over the sampling period, concentrations decreased to levels less than the MCL. Cadmium and lead slightly exceeded the EPA MCLs in a few samples from the three wells, though median concentrations were below the MCL. Median levels of chromium and molybdenum exceeded the EPA MCL (0.1 mg per liter) in wells 702 and 703. The average combined radium-226 and -228 for samples from well 701 slightly exceeded the UMTRA MCL (5 picocuries [pCi] per liter). Based on these data, ground water in the Wasatch Formation beneath the disposal cell is of limited use and is not a potential source of drinking water because it contains more than 10,000 mg per liter TDS and because ambient levels of barium, cadmium, chromium, lead, molybdenum, selenium, and combined radium-226 and -228 have exceeded EPA MCLs (40 CFR Part 192).

Table 2.3 Summary of background water quality at the Estes Gulch disposal site near Rifle, Colorado

Parameter	MCL	No. of samples	No. of nondetects	Median	Maximum
Barium	1	5	0	1.05	2
Cadmium	0.01	5	2	0.005	0.011
Chromium	0.05	5	0	0.07	0.99
Lead	0.05	5	2	0.015	0.04
Molybdenum	0.1	5	0	0.24	1.26
Total Radium	5	5	0	3	3.9
Selenium	0.01	5	2	0.029	0.212
Total dissolved solids	NA	5	0	11900	12900

MCL - maximum concentration limit.

NA - not applicable.

Notes: 1. Based on data collected from wells 701, 702, and 703 during the time period 1988 to 1992.

2. All values reported in units of milligrams per liter, except for radium -226 + radium -228, which is reported in picocuries per liter.

2.5.3 Hazardous constituents

Analyses of tailings and tailings solutions, tailings leachates (Markos and Bush, 1983), and ground water samples from both the Old and New Rifle sites (DOE, 1990; TAC, 1996) were evaluated for hazardous constituents generally expected to be in or derived from the residual radioactive materials related to the uranium processing activities. After evaluating these existing data, the DOE identified the following hazardous constituents as associated with the tailings source term:

- alpha-BHC
- antimony
- arsenic
- barium
- benzo[a]anthracene
- benzo[a]pyrene
- beryllium
- cadmium
- chromium
- chrysene
- cobalt
- copper
- diethyl phthalate
- di-n-octylphthalate
- fluoranthene
- fluoride
- indeno(1,2,3-cd)pyrene
- methyl ethyl ketone
- lead
- molybdenum
- net gross alpha
- nickel
- nitrate
- pyrene
- radium-226 and -228
- selenium
- silver
- strontium
- tin
- toluene
- vanadium
- uranium
- zinc
- 2,4-D
- 2,4,5-T
- 2,4,5-TP (Silvex)

2.6 GROUND WATER PROTECTION

The ability of the disposal cell to meet ground water protection requirements depends on the following:

1. The multicomponent disposal cell cover will limit the amount of precipitation that infiltrates the cell, thereby minimizing long-term leaching of hazardous components from the tailings.
2. Wasatch Formation ground water quality beneath the Estes Gulch disposal site has been determined to have the characteristics of limited use (40 CFR §192.11(e)(1)).
3. The Estes Gulch disposal site is geologically isolated from the uppermost useable aquifer by 3800 ft (1160 m) or more of low-permeability siltstones, shales, and sandstones of the Wasatch Formation, which dips toward and beneath the Colorado River.

The DOE evaluated the need for ground water monitoring at the Estes Gulch disposal site in accordance with the licensing regulations in 10 CFR §40.27(b)(2); the ground water protection standards in 40 CFR Part 192, Subparts A and C; and the DOE's long-term surveillance program guidance (DOE, 1996a). POC monitoring is not required for the long-term surveillance program of the Estes Gulch disposal site.

Ground water monitoring of the uppermost aquifer at the Estes Gulch disposal cell is not required. Postclosure ground water monitoring will not be conducted in the Wasatch siltstone and sandstone aquifer beneath the site due to the limited use designation of ground water in the Wasatch Formation and due to the Wasatch Formation's considerable thickness (projected to be 3800 ft (1160 m) (40 CFR

§192.11(e)(1)). Limited use ground water is ground water that is neither a current nor a potential source of drinking water because 1) the TDS concentration exceeds 10,000 mg per liter; 2) the existing widespread ambient contamination is unrelated to processing activities, and the contamination cannot be cleaned up using treatment methods reasonably employed in public water supply systems; or 3) the quantity of water available is less than 150 gal (570 L) per day.

3. 0 SITE INSPECTIONS

The DOE will inspect of the Estes Gulch disposal site to detect progressive changes caused by slow-acting natural processes and to identify potential problems before there is a need for extensive maintenance, repairs, or corrective action. Inspections may also be conducted to follow up on events or conditions that have affected or potentially could affect the disposal site. The DOE will compare the findings from these inspections to initial baseline conditions to identify changes over time and to provide a basis for future inspections, repairs, and corrective actions. This process is shown in Figure 3.1.

Custodial maintenance or repair is discussed in Section 4.0. The corrective action process is outlined in Section 5.0.

3.1 INSPECTION FREQUENCY

The DOE will inspect the Estes Gulch disposal site annually. The DOE may schedule more frequent inspections if necessary. The DOE will notify the NRC of the inspection schedule.

3.2 INSPECTION TEAM

The inspection team will consist of a minimum of two inspectors qualified to inspect disposal cell integrity and make preliminary assessments of modifying processes that could adversely affect the disposal cell.

If problems are observed that require more investigation, follow-up inspections will be performed and teams will include one or more technical specialists in appropriate disciplines to assess the problems under investigation. For example, a follow-up inspection by a plant specialist may be required to evaluate reports of significant plant growth on the rock cover, or a soils scientist or geomorphologist may be needed to evaluate erosion processes.

The inspection team will consist of a chief inspector and one or more assistants. The chief inspector will be a geotechnical engineer, a civil engineer, or an engineering geologist knowledgeable in the process that could adversely affect the site (e.g., geomorphic agents of change).

3.3 ANNUAL INSPECTION

Before inspections, inspectors will perform a preinspection briefing. The long-term surveillance program guidance (DOE, 1996a) contains information useful in preparing for inspections.

Site inspections will cover the disposal cell, the surrounding disposal site area, and the immediate off-site areas. Site inspections must be thorough enough to identify significant changes or active modifying processes that potentially could adversely affect the disposal cell: gully formation, slope erosion, changes to the rock cover, ephemeral drainage channel changes, and significant modifications by humans, animals, or plants.

Inspectors will measure and evaluate the leachate level in the monitor well leachate collection system (stand pipes) located on the 5 to 1 slope of the disposal cell.

Figure 3.1 Steps for follow-up inspections, custodial maintenance, and corrective action, at the Estes Gulch disposal site near Rifle, Colorado

Monitoring, corrective action, and closure of these wells will be performed in compliance with the plan as provided in the operation and contingency plan (see appendix).

Inspectors will evaluate the integrity of the disposal cell by walking a series of transects around the perimeter and over the rock cover. Sufficient transects, at approximately 150-ft (46-m) intervals, must be walked so that the disposal cell is thoroughly covered and inspected. Diagonal transects of the topslopes will be made and the crest line will be walked. Additional transects will be walked along the sideslopes and rock apron. Transects along the entire length of the diversion ditch will be made to determine whether it is functioning as designed and can be expected to continue to function properly. Inspectors will make efforts to vary the path of transects from one inspection to the next to ensure small anomalies are not overlooked. The sample inspection checklist in the LTSP guidance document lists items that should be examined during inspections (DOE, 1996a).

The disposal cell has a rock cover and there is no planned vegetation on the disposal cell. However, remedial action of the areas surrounding the disposal cell included revegetation with grasses and sage brush. The area surrounding the disposal cell will be monitored to determine the success of the revegetation efforts. Inspectors also will inspect this area for evidence of erosion caused by wind, sheet wash, or changes in drainage patterns.

Site inspectors also will monitor damage to or disturbance of permanent site-surveillance features, ground water monitor wells (until they are decommissioned), fencing, locks, and the gate.

From inside the disposal site, inspectors will visually survey the area approximately 0.25 mi (0.40 km) outside the disposal site boundary for evidence of land-use changes that indicate increased human activity, such as land development or new roads and paths. Inspectors will note the condition of and changes to site access roads, surrounding vegetation, and relevant geomorphic features like gullies or ephemeral drainage channels; potential impacts to the site will be noted. Off-site DOE monitor wells will be inspected until they are properly decommissioned.

3.4 FOLLOW-UP INSPECTIONS

In addition to annual inspections, DOE may conduct follow-up inspections due to unusual or annual inspection findings or observations. DOE also may conduct follow-up inspections to investigate and quantify specific problems found during a previous inspection, other DOE-initiated activity, or confirmed reports of vandalism, intrusion, damage, unusual occurrences, or other significant threats to the disposal site. The DOE will monitor the disposal cell area for the occurrence of extreme natural events (e.g., earthquakes, tornadoes, floods) and vandalism to ensure such events are investigated in a timely manner to assess their effects on the disposal cell. To facilitate this, the DOE has requested notification from federal, state, and local agencies of discoveries or reports of any purposeful intrusion or damage at the disposal site as well as in the disposal site area.

Notification agreements with the Garfield County Sheriff's Office and the U.S. Geological Survey's National Earthquake Information Center are included in Attachment 2. The DOE will also monitor the weather for the occurrence of severe storms in the disposal cell vicinity. In addition, the DOE 24-hour telephone number is posted on the site entrance sign so the public can notify the DOE if problems are discovered. If an extreme natural event or vandalism has occurred, the DOE will inspect the cell to assess the damage. The notification, response, and follow-up activities will be documented. This documentation will be included in the annual site report to the NRC and become part of the permanent site file.

The nature of the occurrence and the amount of firsthand knowledge available will determine the DOE's response. If a situation is a threat to the public, the DOE will notify individuals who may be affected and appropriate federal, state, and local agencies, including the NRC. If necessary, the DOE will schedule a follow-up inspection to assess potential effects from the unusual occurrence, and will take necessary response action. Follow-up inspections will be conducted to determine whether processes currently active at or near the site threaten site security or stability and to evaluate the need for custodial maintenance, repair, or other corrective action. The scope of these follow-up inspections may be broad and similar in

nature to routine site inspections or focused on specific areas of concern.

During the follow-up inspection, inspectors and technical specialists will investigate reported problems to determine whether the disposal cell has been damaged or threatened. The DOE will conduct additional site visits, if necessary to acquire data or plan maintenance and repairs.

3.5 QUALITY ASSURANCE

The DOE has developed and implemented a quality assurance plan (QA) (DOE, 1996d) for the site inspection program that meets the requirements of DOE Order 5700.6C. Site inspections will be conducted in accordance with this QA plan.

4. 0 CUSTODIAL MAINTENANCE AND REPAIR

The DOE does not plan to conduct routine maintenance at the Estes Gulch disposal site. However, the DOE will perform needed custodial maintenance or repair as determined from site inspections.

Unscheduled custodial maintenance or repair required at the Estes Gulch disposal site may include the following:

- Repairing or replacing deteriorated or vandalized warning signs, fencing, gate, and locks.
- Removal of deep-rooted plants determined to be a threat to the integrity of the cover.
- Reseeding areas surrounding the disposal cell.

After the work is completed, and before the contractors are released, DOE will verify that work was performed according to specification. The annual report to the NRC will document repairs that are performed. Copies of records, reports, and certifications will be included in the permanent site file.

5. 0 CORRECTIVE ACTION

Corrective action is repairs that are needed to address problems that affect the integrity of the disposal cell or compliance with 40 CFR Part 192. The NRC must approve the recommended action in advance.

Site inspections are designed to identify problems at the developmental stage. The following theoretical conditions are examples that might trigger corrective action:

- Surface rupture or subsidence of the disposal cell.
- Development of rills, gullies, or slope instability on the disposal cell.
- Deterioration of the erosion-protection rock on the disposal cell.
- Tailings fluid originating from the disposal cell.
- Gully development on or immediately adjacent to disposal site property that could affect the integrity of the disposal cell.
- Damage to the cell cover or disposal site property from natural catastrophic events or vandalism.
- Damage to the disposal cell cover from deep-rooted plant growth.

The DOE will evaluate the factors that caused the problem and identify actions to mitigate the impact and prevent recurrence. An on-site inspection or preliminary assessment will include, but is not limited to, the following:

- Identifying the nature and extent of the problem.
- Reevaluating germane engineering design parameters.

When a potential problem is identified, the DOE will submit a preliminary assessment report to the NRC for review no more than 60 days after the problem is identified. The preliminary assessment report will evaluate the problem and recommend the next step (e.g., immediate action or continued evaluation). If the problem requires immediate repair, the DOE will develop a corrective action plan for NRC approval. Once the NRC approves the corrective action, the DOE will implement the plan. In some cases, corrective action could include temporary emergency measures instituted prior to the completion of the normal approval process. If the problem does not require immediate repair, the problem will be documented in the annual report and assessed at the next annual inspection.

NRC regulations do not stipulate a time frame for implementing corrective action (except the finding of an exceedance in established ground water concentration limits, which does not apply to this site). The DOE does not consider assessing the extent of a problem and developing a corrective action plan to be initiation of the corrective action program.

In addition to the preliminary assessment report, the DOE may (as appropriate) prepare a progress report on corrective actions while they are under way or under evaluation.

After corrective action is complete, the DOE will certify work and submit a certification statement and supporting documentation to the NRC for review and concurrence. A copy of the certification statement will become part of the permanent site file, as will reports, data, and documentation generated during the corrective action.

6. 0 RECORD KEEPING AND REPORTING

6.1 PERMANENT SITE FILE

The DOE will maintain a permanent site file containing site inspection reports and other supporting documentation of long-term surveillance program activities. The information placed in the site file will include:

- Documentation of disposal site performance.
- Demonstration that licensing provisions were met.
- Information needed to forecast future site-surveillance and monitoring needs.
- Reports to stakeholders regarding disposal cell integrity.

After the site is brought under the general license, the DOE will compile copies of site documentation required by the long-term surveillance program guidance for the disposal site permanent site file (DOE, 1996a). Copies of all deeds, custody agreements, and other property documents will be kept in this file.

The DOE will maintain the surveillance and maintenance documentation identified in other sections of this LTSP; it will become part of the permanent site file. The DOE will update the site file as necessary after disposal site inspections, maintenance activities, or corrective actions are complete. These records will be handled in accordance with DOE directives to ensure their proper handling, maintenance, and disposition. The archival procedures set forth in 41 CFR Part 101 and 36 CFR Parts 1220-1238, Subchapter B, will be followed. The permanent site file information will be available for NRC and public review.

6.2 INSPECTION REPORTS/ANNUAL REPORTS

During site inspections, activities and observations will be recorded and described using site inspection checklists, maps, photographs and photo logs, and field notes. Documentary evidence of anomalous, new, or unexpected conditions or situations must describe developing trends and enable the DOE to make

decisions concerning follow-up inspections, custodial maintenance, and corrective action. This information will be contained in the permanent site file at the DOE office. The DOE will prepare a site inspection report documenting the findings and recommendations from field inspections.

Site inspection reports will be submitted to the NRC within 90 days of the annual site inspection. Inspection reports will summarize the results of follow-up inspections and maintenance completed since the previous annual site inspection.

If unusual damage or disruption is discovered at the disposal site during an inspection, a preliminary report assessing the impact must be submitted to the NRC within 60 days. If maintenance, repair, or corrective action is warranted, the DOE will notify the NRC. The NRC will receive a copy of corrective action plans and corrective action progress reports, or the reports will be attached to the annual report.

The DOE also will provide copies of inspection reports and other generated under the long-term surveillance program to the state of Colorado as required in their cooperative agreement.

7. 0 REFERENCES

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CODE OF FEDERAL REGULATIONS

10 CFR Part 40, *Domestic Licensing of Source Material*, U.S. Nuclear Regulatory Commission.

36 CFR Parts 1220-1238, *National Archives and Records, Subchapter B - Records Management*, National Archives and Records Administration.

40 CFR Part 192, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*, U.S. Environmental Protection Agency.

41 CFR Part 101, *Federal Property Management Regulations*, General Services Administration.

DOE ORDERS

Order 5700.6C, *Quality Assurance*, 21 August 1991, U.S. Department of Energy, Washington, D.C.

UNITED STATES CODE

42 USC §7901 *et seq.*, *Uranium Mill Tailings Radiation Control Act,* 8 November 1978.

SITE REAL ESTATE INFORMATION

GENERAL

The Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, as amended, required the Secretary of Energy to permanently acquire lands needed to carry out the purposes of the UMTRCA (42 USC §7901 *et seq.*). The U.S. Department of Energy (DOE) located the Rifle, Colorado, disposal site on public land administered by the U.S. Department of the Interior's BLM.

JURISDICTIONAL TRANSFER OF THE DISPOSAL SITE

Under the authority vested in the Secretary of the Interior by the UMTRCA, the BLM transferred administration of approximately 205 acres (83 hectares) of public land in Garfield County, Colorado, to the DOE. Publication in the *Federal Register* (Vol. 56, No. 167, p. 42450, FR Doc. 91-20555) of Public Land Order (PLO) 6873 established the effective date of the transfer as 28 August 1991. As a result of this permanent transfer, the land is no longer subject to the operation of the general land laws, including mining and mineral leasing. The transfer vested in the DOE the full management, jurisdiction, and liability for the land and all activities conducted thereon.

LEGAL DESCRIPTION

The legal description contained in the PLO describes the disposal site area as follows:

> Township 5 South, Range 93 West, Sixth Principal Meridian.
>
> Section 11: S1/2 S1/2 SW1/4 SW1/4 SE1/4; Section 14: NW1/4 NW1/4 NE1/4, W1/2 SW1/4 NW1/4 NE1/4, W1/2 W1/2 SW1/4 NE1/4, E1/2 NE1/4 NW1/4, E1/2 NW1/4 NE1/4 NW1/4, SW1/4 NE1/4 NW1/4, SE1/4 SE1/4 NW1/4 NW1/4, NE1/4 NE1/4 SW1/4 NW1/4, S1/2 NE1/4 SW1/4 NW1/4, SE1/4 SW1/4 NW1/4, SE1/4 NW1/4, NE1/4 SW1/4, NE1/4 NW1/4 SW1/4, E1/2 E1/2 NW1/4 NW1/4 SW1/4, W1/2 NW1/4 SE1/4, and W1/2 W1/2 NW1/4 SE1/4, containing approximately 205 acres (83 hectares).

References

42 USC §7901 *et seq.*, *Uranium Mill Tailings Radiation Control Act,* 8 November 1978.

ATTACHMENT 1

SITE REAL ESTATE INFORMATION

Available Upon Request - Click here to email a request

ATTACHMENT 2

AGENCY NOTIFICATION AGREEMENTS

Available Upon Request - Click here to email a request

APPENDIX

OPERATION AND CONTINGENCY PLAN

FOR MONITORING WELL CLOSURE, ESTES GULCH DISPOSAL CELL

Available Upon Request - Click here to email a request