DOE–EM/GJRAC2040-F

Office of Environmental Management – Grand Junction

UMTRA Project

Moab UMTRA Project
Crescent Junction Disposal Cell Interim Completion Report Addendum F

Revision 1

December 2017

U.S. Department of Energy

Office of Environmental Management

Prepared by the Remedial Action Contractor under contract number DE-DT0011049
for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

DOE-EM/GJRAC2040-F

Moab UMTRA Project
Crescent Junction Disposal Cell Interim Completion Report
Addendum F

Revision 1

December 2017

Prepared by the Remedial Action Contractor under contract number DE-DT0011049
for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado

Moab UMTRA Project
Crescent Junction Disposal Cell Interim Completion Report
Addendum F

Revision 1

Review and Approval

Kathy Turvy
RAC Quality Assurance Manager

12/7/2017
Date

Greg D. Church
RAC Project Manager

12/7/17
Date

Revision History

Revision	Date	Reason for Revision
0	December 2016	Initial issue.
1	December 2017	Revision includes editorial changes throughout the document, a technical correction to Appendix A3, and removal of two documents from Attachment 2.

Contents

Section Page

Figures

Tables

Appendices

Attachments

Acronyms and Abbreviations

CAES	Computer Aided Earthmoving System
CAT	Caterpillar
DOE	U.S. Department of Energy
DOE O	DOE Order
ft	foot/feet
gpm	gallons per minute
NQA	Nuclear Quality Assurance
NRC	U.S. Nuclear Regulatory Commission
QA	quality assurance
Ra-226	radium-226
RAC	Remedial Action Contract or Contractor
RAIP	Remedial Action Inspection Plan
RAP	Remedial Action Plan
RRM	residual radioactive material
TAC	Technical Assistance Contract or Contractor
UMTRA	Uranium Mill Tailings Remedial Action
yd^3	cubic yards

Executive Summary

This Interim Completion Report Addendum F documents the construction of a portion of the disposal cell near Crescent Junction, Utah. The disposal cell is being constructed under the U.S. Department of Energy (DOE) Moab Uranium Mill Tailings Remedial Action (UMTRA) Project. The purpose of the disposal cell is to isolate and stabilize uranium mill tailings and other contaminated materials, known as residual radioactive material (RRM), removed from the former millsite in Moab, Utah. The disposal cell is designed to be effective for 1,000 years to the extent reasonably achievable, with a minimum performance period of 200 years.

The Crescent Junction disposal cell will require many years to construct. Multiple Interim Completion Reports will be prepared to compile and document data collected during the ongoing construction process. These Interim Completion Reports will be written in the format of sequential addenda referenced in a Final Completion Report that will be prepared to address the entire cell construction.

This Addendum addresses activities performed by Portage, Inc., the DOE Remedial Action Contractor (RAC) for the Moab Project, from October 1, 2015, through September 30, 2016. This report includes excavation of 495,000 cubic yards (yd^3) of Phase 3a of the disposal cell, placement of 320,233 yd^3 of RRM, and 17,361 yd^3 of interim cover.

This Addendum also demonstrates the referenced portion of the disposal cell was constructed in accordance with the Moab UMTRA Project Final Remedial Action Plan and Site Design for Stabilization of Moab Title I Uranium Mill Tailings at the Crescent Junction, Utah, Disposal Site (DOE-EM/GJ1547). The Final Remedial Action Plan (RAP) received conditional concurrence from the U.S. Nuclear Regulatory Commission (NRC). Included in this report are a critical review, design assessment, and remedial action assessment of activities performed during this report period. Associated data tables, photographs, laboratory results, and other supporting documentation are also provided.

The Moab Project follows the Nuclear Quality Assurance-1 (NQA-1) requirements for quality assurance (QA), including conducting audits and surveillances during the design and construction of the cell.

1.0 Introduction

The scope of the Moab Project is to relocate RRM from the former uranium ore-processing facility and from off-site properties known as vicinity properties in Moab, Utah, to an engineered disposal cell constructed near Crescent Junction, Utah. Most of the processing buildings at the Moab site were demolished and placed in the southern corner of the tailings pile. An interim cover was placed over the tailings pile as part of decommissioning activities between 1988 and 1995. The estimated volume of the tailings pile before relocation began was 12 million yd^3 (16 million tons). The RRM is being transported to Crescent Junction primarily by rail.

The Moab site is located about 3 miles northwest of the city of Moab in Grand County. The Crescent Junction site is located northeast of the junction of Interstate 70 and U.S. Highway 191, approximately 30 miles north of the Moab site, also in Grand County (see Figure 1). The completed disposal cell will be generally rectangular and will encompass approximately 230 acres. Figure 2 shows general features of the Crescent Junction site.

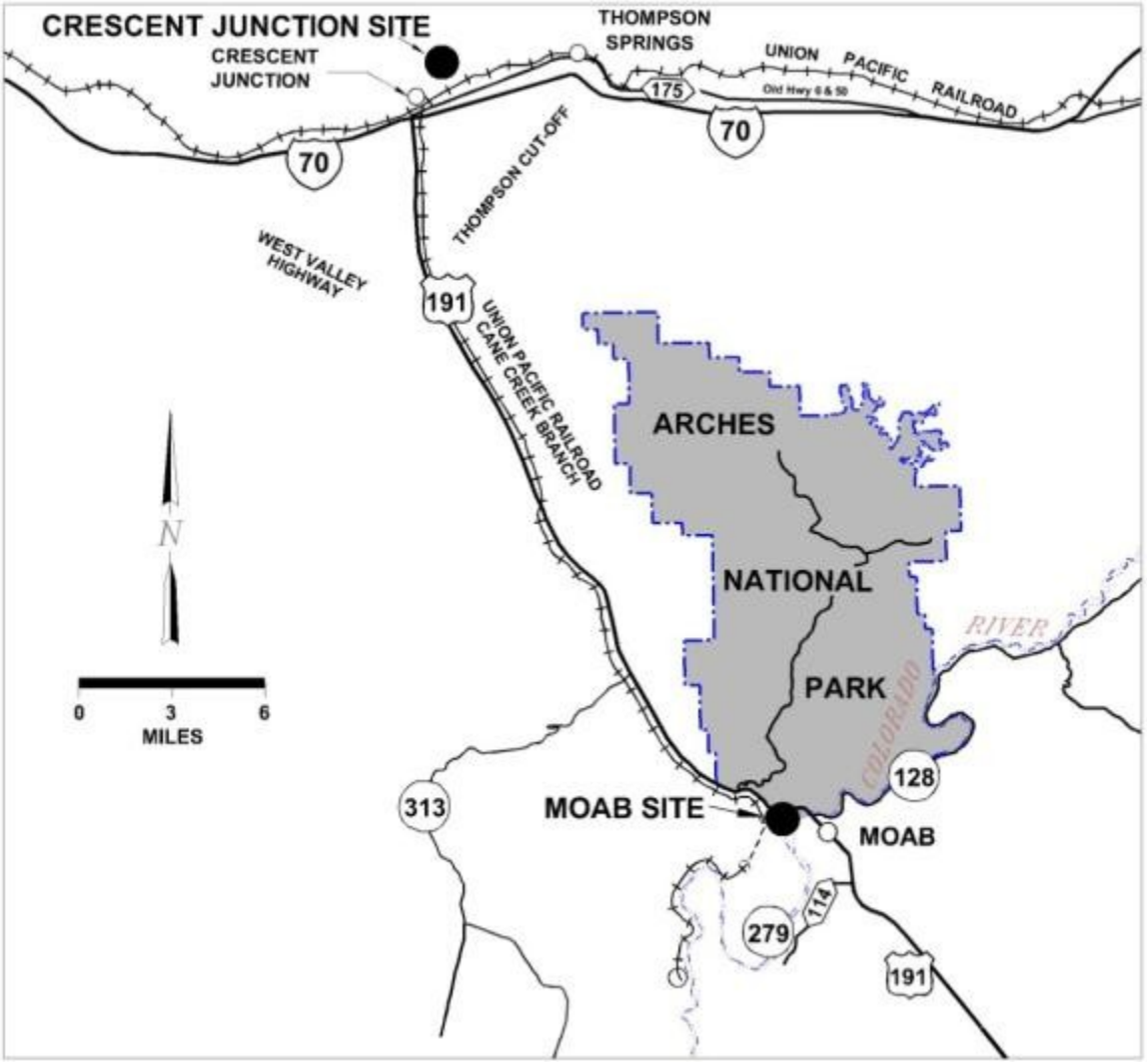

Figure 1. Location of Moab and Crescent Junction Sites

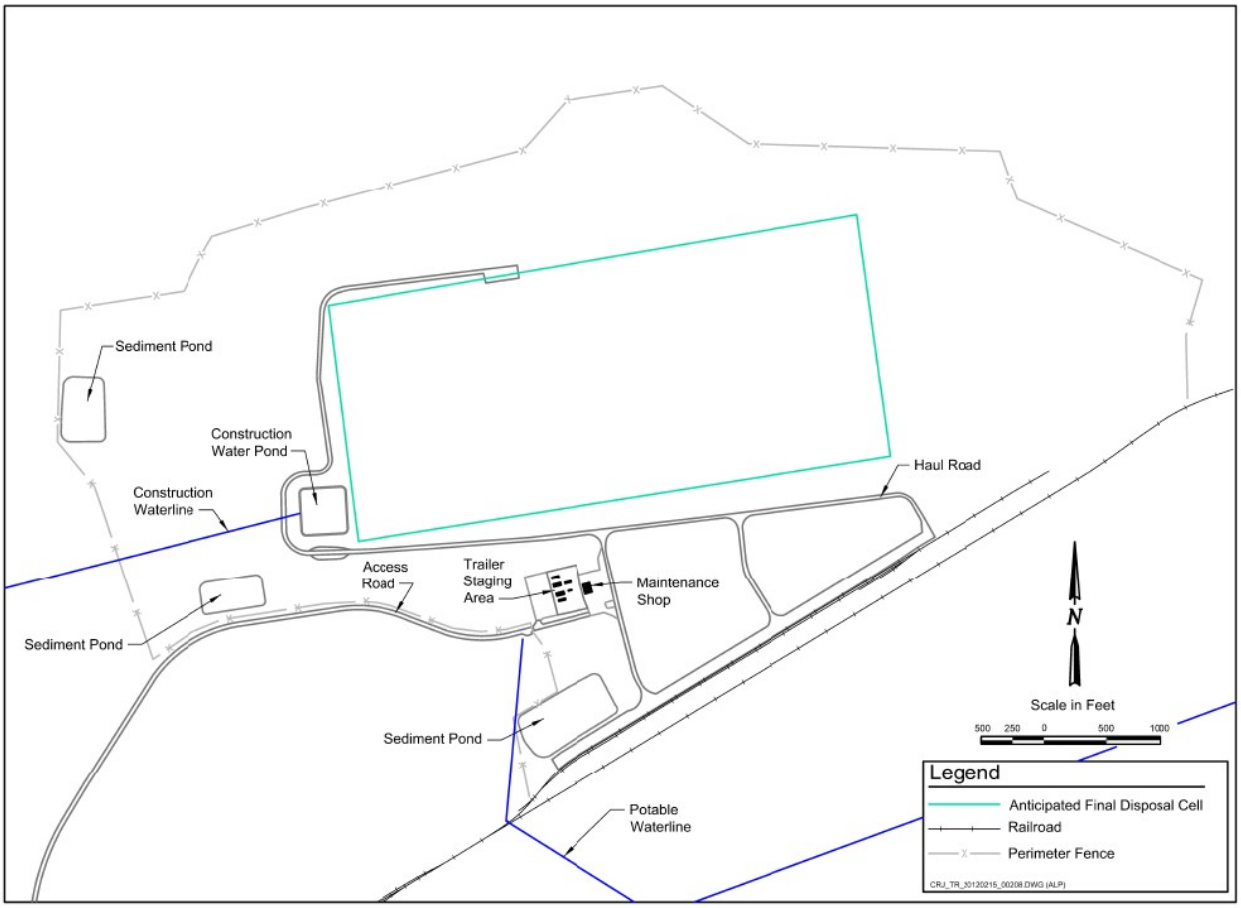

Figure 2. Crescent Junction Site Features

This Addendum documents activities performed by the RAC for the Project from October 1, 2015, through September 30, 2016.

Addendum F sections are outlined below.

- Section 2.0 summarizes the results of critical aspects of the disposal cell construction and provides tables and figures summarizing data found in Appendix A.
- Section 3.0 describes any differences in the completed design from design requirements in the RAP.
- Section 4.0 provides verification that placement of RRM and cell cover materials was conducted according to RAP requirements.
- Section 5.0 is a list of references for this document.
- Appendix A includes test results to demonstrate compliance with compaction requirements.
- Appendix B contains photographs of the various stages of cell construction.
- Attachment 1 contains the geologic verifications of cell excavations.
- Attachment 2 contains a new procedure associated with debris processing and disposal.
- Attachment 3 contains NRC correspondence.

2.0 Critical Review

The Critical Review provides key technical information about the disposal cell construction. This section contains tables summarizing inspections or tests for cell excavation, embankment construction, RRM placement, and cell cover material placement as appropriate for the report period. The tables reference the criteria and material testing procedures used to verify cell excavation and placement of each type of material were performed in accordance with design specifications or drawings and with Addendum E of the RAP, "Remedial Action Inspection Plan" (RAIP). The distribution survey associated with each material type is also included in this section, as appropriate. Figure 3 shows the general extent of cell cover layers as of the end of this Addendum period, and Figure 4 shows the extent of Phase 3a excavation and the southern perimeter embankment.

Information regarding total lifts of compacted material, tests performed, and geotechnical data is summarized in Table 1. Additional geotechnical data, including proctor test result summaries, lift approval summaries, and lift approval packages, as appropriate, are located in Appendix A. A lift approval package consists of documentation of tests conducted to demonstrate the lift met requirements. A package could include lift approval forms and associated figures, slope elevation surveys, and field density tests.

Table 1. Lifts/Testing Totals

Area/Material	Total Volume Placed (yd^3)	Total Number of Lifts Approved	Lifts Approved Using CAES	Lifts Approved Not Using CAES	Total Number of Standard Proctor Tests	Total Number of In-place Density/Moisture Tests	Total Average for All In-place Density Tests Performed (%)	Total Average CAES Passes that Meet Compaction Criteria (%)	Total Number of Soil Classifications	Total Number of Durability Tests	Total Number of Gradation Tests
Cell Perimeter Embankment	1,095	14	N/A	14	0	15	97.9	N/A	N/A	N/A	N/A
RRM	320,233	243	243	0	9	3	95.8	99.2	N/A	N/A	N/A
Interim Cover	17,361	4	0	4	2	9	98.1	N/A	N/A	N/A	N/A
Radon Barrier	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Infiltration and Biointrusion Barrier	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Frost Protection Layer	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2-in. Cap Rock	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

CAES = Computer Aided Earthmoving System; in. = inch

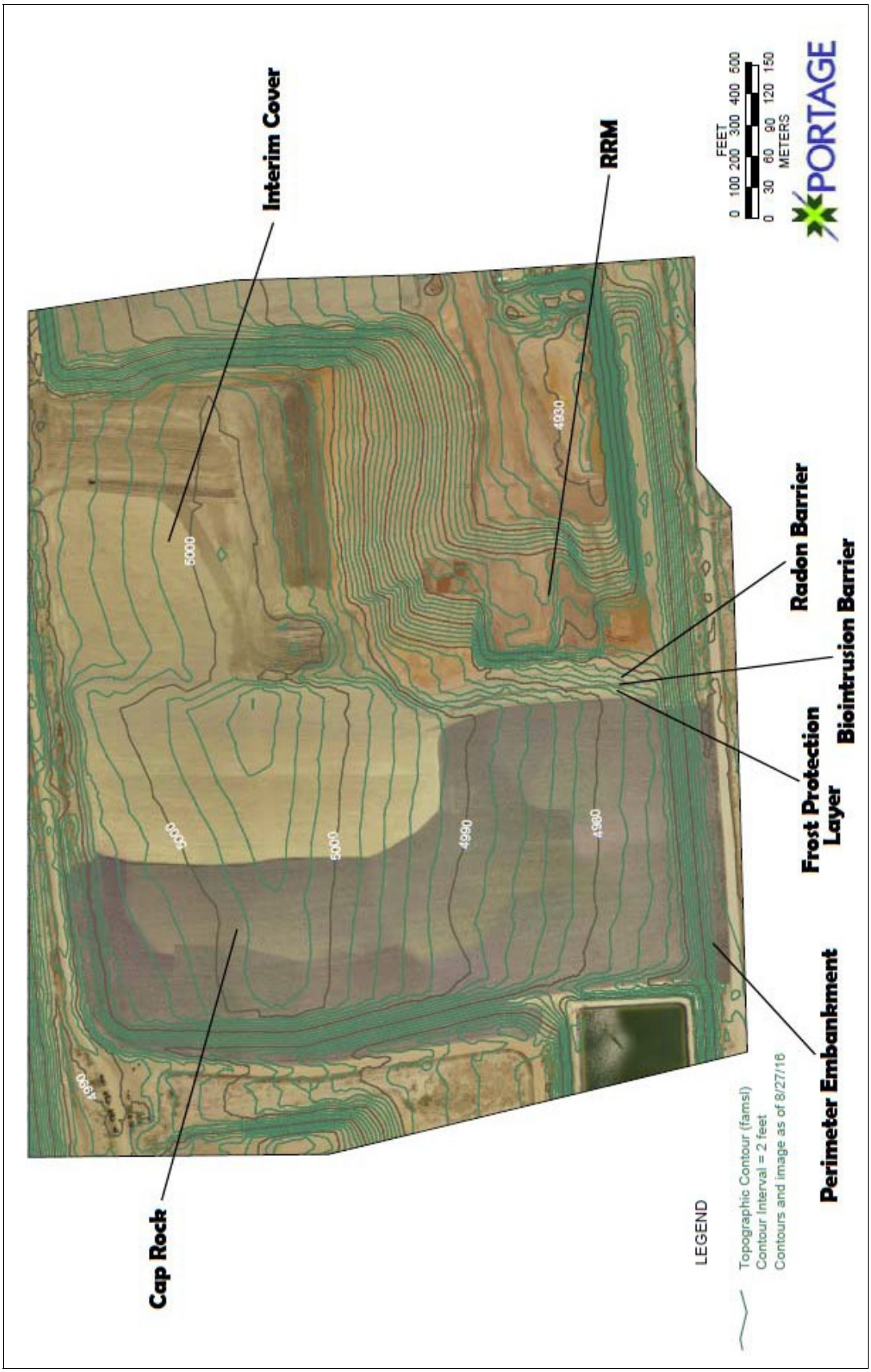

Figure 3. General Extent of Cover Layers

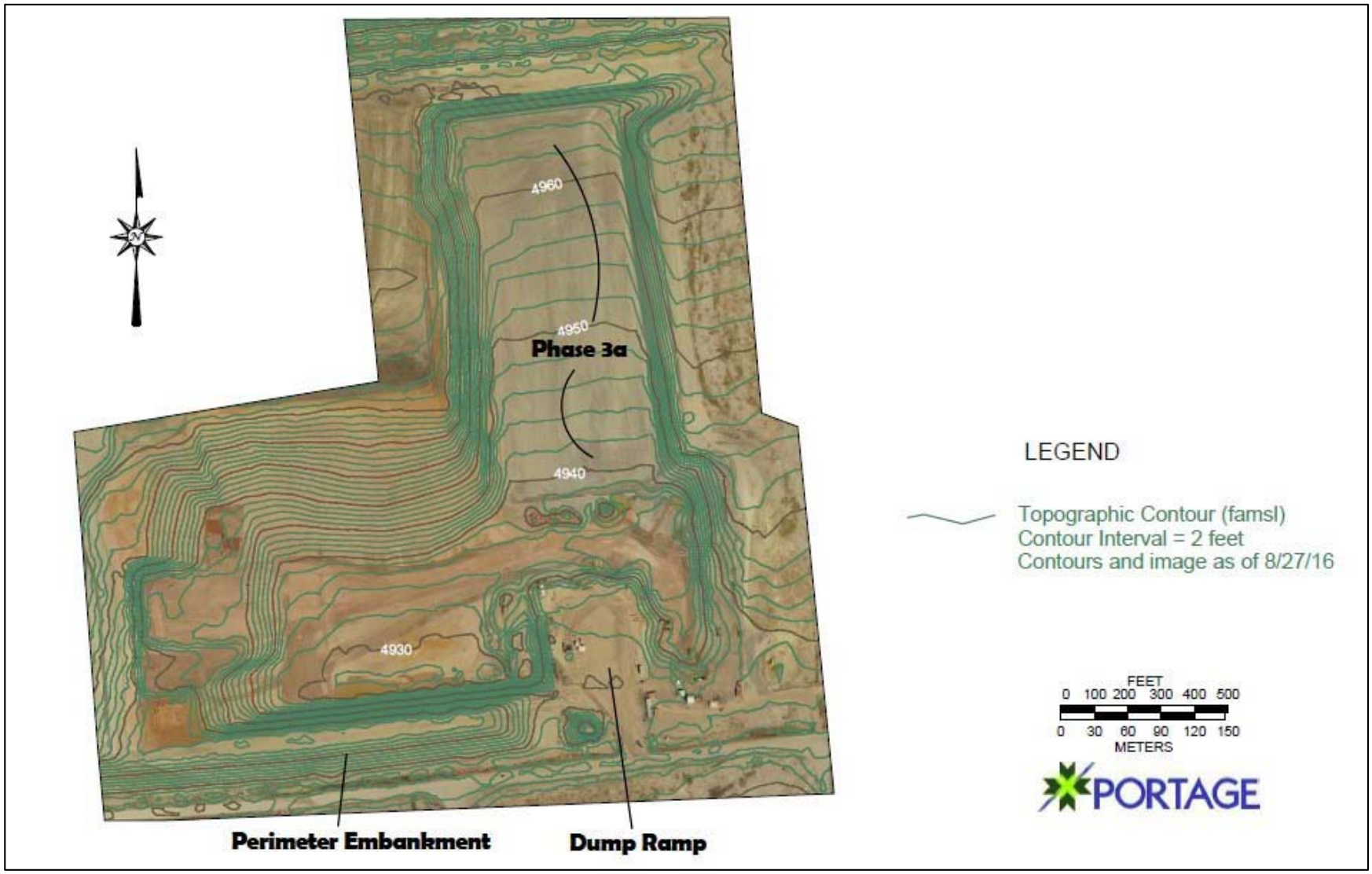

Figure 4. Extent of Phase 3a Excavation and Southern Perimeter Embankment

2.1 Cell Excavation

Two separate areas of cell excavation were completed during this report period. The first area completed removal in October 2015 of the former platform (dump ramp) located within the Phase 2 cell boundary. The excavated material was used to complete construction of the southern cell perimeter embankment in this area. Excess material was temporarily stockpiled on top of interim cover in a portion of the cell until it was placed in August 2016 as interim cover.

Some areas around the dump ramp had been excavated below design grade to facilitate load out of dumped material. Mancos Shale was used to bring the cell floor to design grade. Nine lifts were tested and approved. Table 2 shows the lifts, quantities placed, percent compaction using the Computer Aided Earthmoving System (CAES), and average lift thickness.

Table 2. Cell Floor Lifts

Date	Lift ID Number	Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Thickness (ft)
10/28/15	UCF1D25151028-00	9	96.9	0.7
10/28/15	UCF1D27151028-00	20	86.7	0.6
10/28/15	UCFZ28151028-00	12	100.0	1.0
10/28/15	UCF1D25151028-01	10	100.0	0.8
10/28/15	UCF1D27151028-01	26	100.0	0.8
10/28/15	UCFZ28151028-01	11	100.0	0.9
10/28/15	UCF1D27151028-02	20	97.6	0.6
10/29/15	UCF1D27151029-00	20	100.0	0.6
10/29/15	UCF1D25151028-02	9	100.0	0.7

ft = feet

The second area of cell excavation was Phase 3a, which involved approximately 495,000 yd^3, performed from March to May 2016. The Technical Assistance Contractor (TAC) performed an assessment of the Phase 3a cell floor. The excavated material was used to extend the spoils embankment to the east.

The geologic verifications for the Phase 2 former dump ramp area and Phase 3a, including buyoff surveys and inspection reports, are included as Attachment 1. The inspection and testing summary for both areas of cell excavation can be found in Table 3.

2.2 Perimeter Embankment

The inspection and testing for the perimeter embankment can be found in Table 4. The standard proctor test results summary, lift approval summary, and one lift approval package for the perimeter embankment are provided in Appendix A1.

Table 3. Cell Excavation Inspection and Testing

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
Visual Observation	The disposal cell floor is weathered Mancos Shale or low spots that have been compacted with processed Mancos Shale.	N/A	6.2.3	Entire cell floor excavated during this report period was observed and met inspection criteria.
High-accuracy GPS Survey	Floor and side slopes are per design plans. Final floor and side slopes survey match the coordinates and elevations in the plans. The cell floor slopes 2.3% from northwest to southeast. The cut slopes on the northern, western, and southern sides of the cell slope at 2:1 or 3:1.	Drawing E-02-C-102	6.2.1	Buyoff survey verified cell floor was constructed to design grade (Attachment 1). Because only a portion of Phase 3 was constructed, there is no southern slope. The design volume in Phase 3a was compared to the final survey. There was no discrepancy.

GPS = global positioning system

Table 4. Perimeter Embankment Inspection and Testing

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
Visual Observation	Common fill: fill material is placed in continuous and approximately horizontal lifts. The method of dumping and spreading material shall result in loose lifts of nearly uniform thickness, not to exceed 12 in. Compaction: embankment fill shall be compacted with a minimum 45,000-lb static weight compactor. The compactor shall be a footed roller capable of kneading compaction, with feet having a minimum length of 6 in.	Specification 31-00-00 Section 3.11.1.2	6.3.4	Methodology verified with photographs, lift reports, and visual observations. Compaction performed using a CAT 825 Soil Compactor equipped with wheels and tips. Compactor.
High-accuracy GPS Survey	Interior slopes are 2:1 or 3:1. Exterior slopes are 5:1 with a minimum 30-ft wide and level top.	Specification 31-00-00 Section 3.11.1.2	6.3.4	See Figure 4 for extent of southern perimeter embankment.

Table 4. Perimeter Embankment Inspection and Testing (continued)

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
In-place Density/ Moisture Test	Common fill: Density tests must meet at least 95% of the material's maximum dry density in accordance with ASTM D698. Acceptable moisture content is ±5% of optimum moisture. Perform in accordance with the following as applicable: *ASTM D1556, D2216, D4643, or D6938.	Specification 31-00-00 Section 3.14	6.3.4	Fourteen lifts were approved. Fifteen tests were performed with average density of 97.9% of the laboratory-determined maximum dry density.
Moisture Correlation	Perform one correlation test for moisture in accordance with *ASTM D2216 or D4643 for every 10 tests performed per *ASTM D6938.	Specification 31-00-00 Section 3.14.2	6.3.4	Eight moisture correlation tests were performed to correlate with 15 density tests.

ASTM = ASTM International; CAT = Caterpillar; ft = feet; in. = inches; GPS = global positioning system; lb = pound
*ASTM Standard titles are included in the References Section 5.0.

2.3 RRM

2.3.1 CAES Performance Verification Testing

The Project used machines equipped with a CAES to meet RRM compaction requirements as specified in Section 6.4.3 of the RAIP. Additional information about the CAES verification testing is provided in Section 4.3 of this Addendum. The RAIP also requires periodic verification of the CAES compaction by comparing the results to in-place, nuclear density gauge test results. Table 5 shows the results of the comparison tests performed during this report period.

Table 5. CAES Performance Verification Testing

Lift ID Number	Test Performance Date	In-place Density Compaction (%)	Lift Area Meeting CAES Compaction Criteria (%)
UW1O07151015-00	10/27/15	95.0	99.4
UWY29160229-00	03/01/16	99.5	99.5
UWY24160825-00	08/31/16	92.9	99.9

2.3.2 RRM Placement

Beginning in March 2016, small quantities of debris mixed with uranium mill tailings were shipped in most trainloads through the end of this report period. The debris was appropriately sized and incorporated into the 1-foot (ft) lifts of tailings. The inspection and testing for RRM are shown in Table 6. The distribution of survey points is shown in Figure 5. The standard proctor test results summary, lift approval summaries, one lift approval package, and a buyoff survey for RRM are provided in Appendix A2.

Table 6. RRM Inspection and Testing

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
Visual Observation	At a minimum, scarify the top 1 in. of subsoil or preceding RRM lift, using a footed roller or a dozer, before placing subsequent RRM layers. Fill material is placed in continuous and planar lifts. The method of dumping and spreading RRM shall result in loose lifts. Average thickness of fill area is not to exceed 12 in. Dozers shall have a minimum ground pressure of 1,650 lb/ft^2. Compaction equipment shall be footed rollers or dozers. Footed rollers shall have a minimum weight of 45,000 lb and at least one tamping foot provided for each 110 in^2 of drum surface. The length of each tamping foot from the outside surface of the drum shall be at least 6 in. After lift placement, moisture content shall be maintained until the next lift is placed. Erosion that occurs in RRM layers shall be repaired and grades re-established. If freezing or desiccation occurs, the affected soil shall be reconditioned,	Specification 31-00-20 Sections 1.3.2, 3.2.1, and 3.2.4	6.4.2	Visually verified throughout material preparation, ground preparation, and RRM placement. Documented in lift approval packages.
Visual Observation	Each container of demolition debris shall be spread in a single layer (not stacked) and placed in a manner that results in a minimum of voids around the debris. Wood, concrete, and masonry: cut or break up to a maximum size of 3 ft. measured in any dimension. Structural steel member, pipes, ducts, and other long items: cut into maximum lengths of 10 ft Concrete, clay tile, and other pipes: crush concrete and clay tile pipes. Crush other pipes and ducts that are 6 in. or greater in diameter or, if crushing is impractical, cut pipes and ducts in half longitudinally. Do not crush asbestos-cement pipe. Rubber tires excavated at the site: cut into two halves around the circumference. Geo-membranes and other sheet material: cut into strips with a maximum of 4 ft wide by 4 ft long. Tree limbs with a diameter of 4 in. and larger: cut into lengths of 8 ft or less.	Specification 31-00-20 Section 3.2.5	6.4.4	Debris inspections performed during debris placement. Inspections documented in lift approval packages.

Table 6. RRM Inspection and Testing (continued)

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
Laboratory Compaction Characteristics	Assessment tests shall be performed on RRM to ensure compliance with specified requirements and to develop compaction requirements for placement. Perform tests (standard proctor) in accordance with the following standards, as applicable: *ASTM D698 and D2216.	Specification 31-00-20 Section 3.1.1	6.4.3	Nine tests were performed to determine compaction characteristics.
Moisture Test	Fill material is properly moisture conditioned. Optimum moisture content is ±3%. Perform in accordance with the following standard: *ASTM D4643.	Specification 31-00-20 Section 3.4.2	6.4.3	Moisture tests performed daily and documented in lift approval packages.
In-place Density/Moisture Test	Density tests must meet at least 90% of the material's maximum dry density in accordance with *ASTM D698. Acceptable moisture content is ±3% of optimum moisture. Perform in accordance with the following standards, as applicable: *ASTM D1556, D2216, D4643, and D6938.	Specification 31-00-20 Section 3.2.2	6.4.3	Three tests were performed with average in-place density of 95.8% of the laboratory-determined maximum dry density. All moisture tests were within ±3% of optimum.
Compaction by CAES	QC shall monitor CAES compaction by visually inspecting the process and reviewing the computer records for each layer of soil placed.	Specification 31-00-20 Section 3.4.1	6.4.3	Two hundred forty-three lifts were approved using CAES.

ASTM = ASTM International; in. = inches; in^2 = square inches; lb = pounds; lb/ft^2 = pounds per square foot; QC = quality control
*ASTM Standard titles are included in the References Section 5.0.

2.4 Interim Cover

The inspection and testing for the interim cover is shown in Table 7. The distribution of survey points is shown in Figure 6. The standard proctor test results summary, lift approval summary, one lift approval package, and buyoff surveys for the interim cover are provided in Appendix A3.

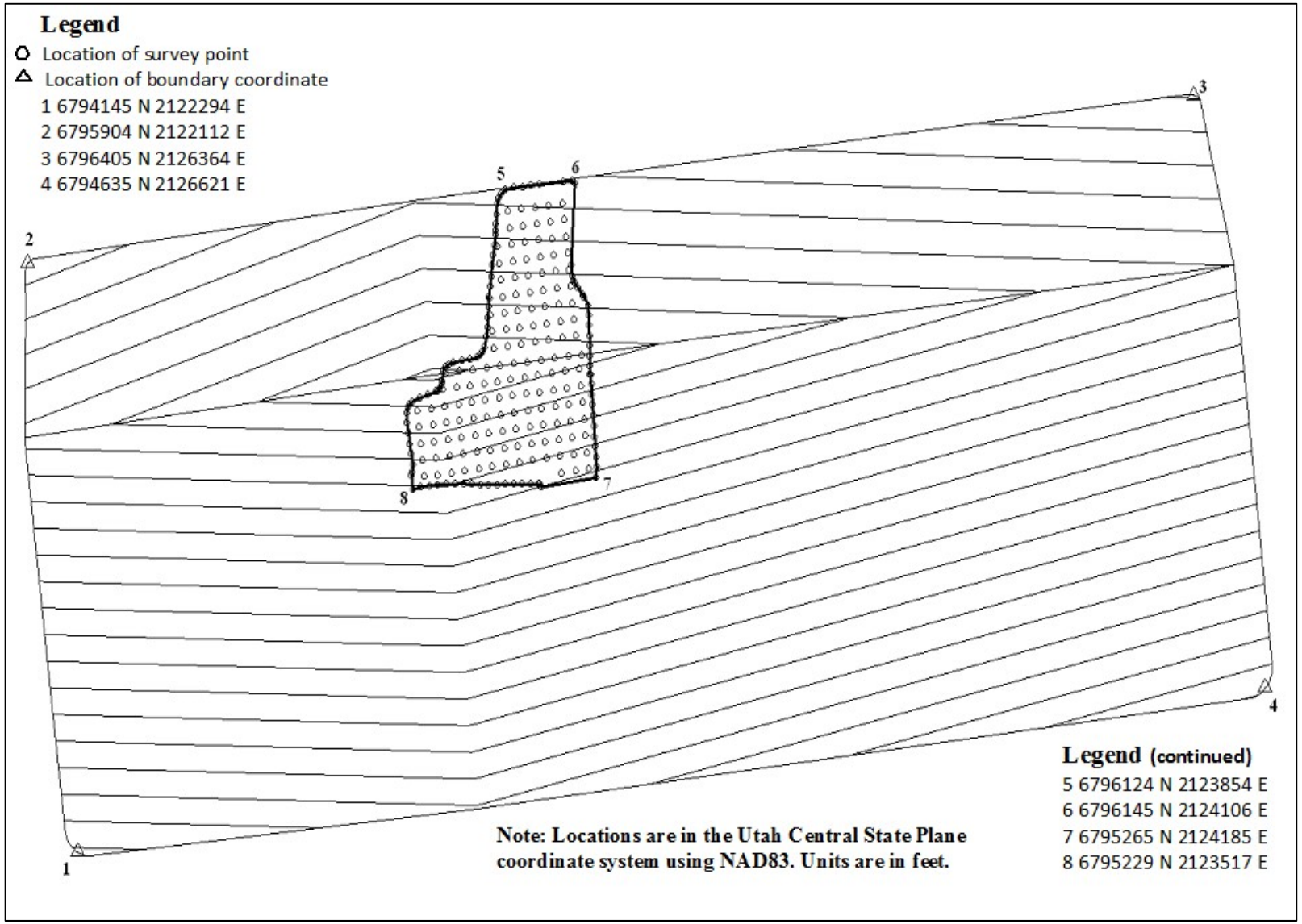

Figure 5. Distribution of Survey Points to Verify Compliance with RRM Specifications

Table 7. Interim Cover Inspection and Testing

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
Visual Observation	Common fill (1 ft clean compacted): loose lifts with an average thickness not to exceed 12 in. Interim cover is placed in continuous and approximately horizontal lifts. Soil shall be free of roots, debris, and organic or frozen material. After lift placement, moisture content shall be maintained until the next lift is placed. Erosion that occurs in the RRM layers shall be repaired and grades re-established. Freezing and desiccation of the RRM shall be prevented. If freezing or desiccation occurs, the affected soil shall be reconditioned, as directed.	Specification 31-00-20 Section 3.2.1	6.5.4	Visually verified throughout material preparation, ground preparation, and interim cover placement. Documented on lift approvals.
Visual Observation	Visual inspection of the process and review of computer records.	Specification 31-00-20 Section 3.4.1	6.5.4	Lift approvals document the approval process.
High-accuracy GPS Survey	The top surface of the interim cover shall be no greater than 2 in. above the lines and grades shown on the drawings. No minus tolerance is permitted.	Specification 31-00-20 Section 3.3	6.5.5	Completed using high-accuracy GPS.
In-place Density/ Moisture Test	Common fill: 90% of maximum dry density standard proctor test. Optimum ±5%. Perform in accordance with the following as applicable: *ASTM D1556, D2216, D4643, and D6938.	Specification 31-00-20 Section 3.4.1	6.5.4	Four approved lifts; four using in-place density/moisture testing. Nine in-place tests were performed with average density 98.1% of laboratory-determined maximum dry density. All moisture tests were within ±5% of optimum.
Laboratory Compaction Characteristics	Common fill. Perform in accordance with the following as applicable: *ASTM D698 and D2216.	Specification 31-00-20 Section 3.1.1	6.5.4	Two tests performed to determine compaction characteristics.

Table 7. Interim Cover Inspection and Testing (continued)

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
Visual Observation	A smooth, non-vibratory, steel-wheeled roller shall be used to produce a smooth compacted surface on the top of the completed interim cover layer, such that direct rainfall causes minimal erosion. Steel-wheeled rollers shall weigh a minimum of 20,000 lb. The final lift shall be rolled smooth with at least three passes of the smooth steel-wheeled roller to provide a smooth surface or proof rolled with rubber-tired construction equipment, such as a loaded dump truck or loaded scraper, with a minimum weight of 45,000 lb.	Specification 31-00-20 Sections 1.3.3 and 3.2.4	6.5.5	Visually verified cover compaction using rubber-tired construction equipment performed on the final lift of the interim cover.

ASTM = ASTM International; in. = inches; GPS = global positioning system; lb = pounds
*ASTM Standard titles are included in the References Section 5.0.

2.5 Radon Barrier

No activities associated with this material layer were conducted during this period.

2.6 Infiltration and Biointrusion Barrier

No activities associated with this material layer were conducted during this period.

2.7 Frost Protection Layer

No activities associated with this material layer were conducted during this period.

2.8 Cap Rock and Armoring

No activities associated with this material layer were conducted during this period**.**

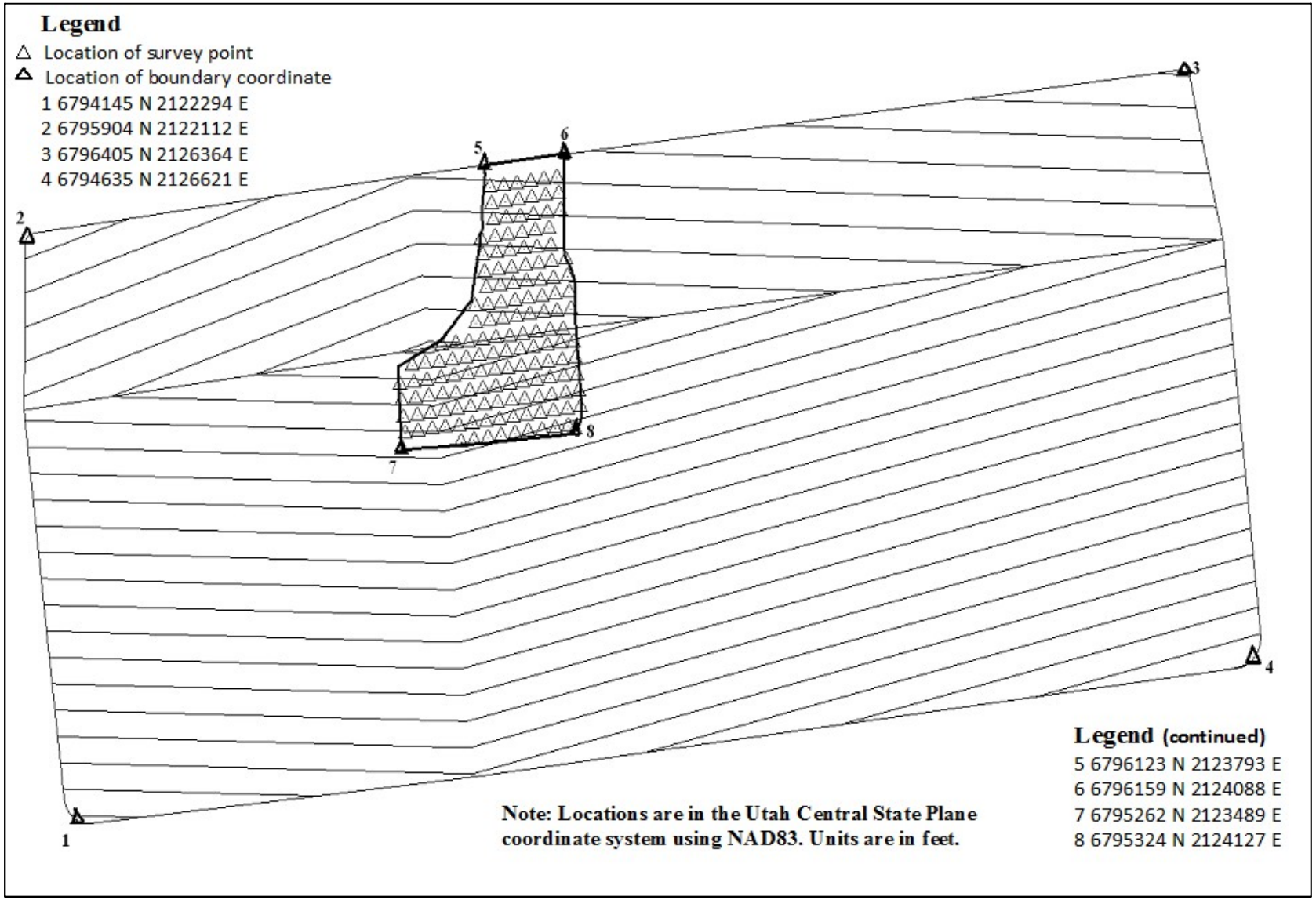

Figure 6. Distribution of Survey Points to Verify Compliance with Interim Cover Specifications

3.0 Design Assessment

The disposal cell design incorporates established design criteria, drawings and specifications, and calculations, and all of which are included in the RAP and the interim completion report addenda. This section discusses design criteria changes, changes to the design of the disposal cell and associated erosion control features, fulfillment of QA requirements, and compliance with permit requirements.

3.1 Design Criteria Changes

No changes to the design criteria were made during the period.

3.2 Design Changes

No changes to the design were made during the period.

3.3 QA Requirements

There were no QA requirements for design changes during this period.

QA activities were conducted in accordance with the *Moab UMTRA Project Quality Assurance Plan for the Remedial Action Contractor* (DOE-EM/GJRAC1766), which complies with:

- American Society of Mechanical Engineers NQA-1 2004 and addenda through 2007 consensus standard, "Quality Assurance Requirements for Nuclear Facility Applications."
- DOE Order (O) 226.1B, "Implementation of Department of Energy Oversight Policy."
- Title 10 Code of Federal Regulations Part 830 Subpart A, "Nuclear Safety Management, Quality Assurance Requirements."
- DOE Office of Environmental Management EM-QA-001, "EM Quality Assurance Program."
- DOE O 414.1D, Admin Chg 1, "Quality Assurance."

3.4 Permits and Agreements

The Project is in compliance with permits and agreements applicable to the Crescent Junction site. These are summarized in Table 8.

Table 8. Crescent Junction Site Permits and Agreements

Agreement Number	Document Name or Description	Issuing Agency	Purpose
08-92-01SA	Stream Channel Alteration Permit	Utah Division of Water Rights	To construct pump station on the Green River.
400-00177	Easement for Green River Pump Station	Utah Division of Forestry, Fire, & State Lands	ROW easement to construct and operate water pipeline.
400-00177	Waterline Easement	Utah Division of Forestry, Fire, & State Lands	ROW easement to construct and operate waterline in the Green River.

Table 8. Crescent Junction Site Permits and Agreements (continued)

Agreement Number	Document Name or Description	Issuing Agency	Purpose
4P-082364-0	UDOT Encroachment Permit	UDOT	To construct waterline within UDOT 60-ft ROW and operate within 20-ft ROW for State Route 19 near City of Green River.
6-UT-06-F-014	Biological Opinion	U.S. Fish & Wildlife Service	U.S. Fish & Wildlife Service issued Biological Opinion for Green River Pump Station.
Case No. 11-0028	Memorandum of Agreement	BLM, Utah State Preservation Office	Among DOE, BLM, and Utah State Historic Preservation Office regarding cultural resource issues related to development of disposal site.
DAQC-1110-2006	Fugitive Dust Control Permit	Utah Division of Air Quality	To address control of fugitive dust generated from disposal cell construction activities.
1-92-677	Green River Water Right	State Water Engineer	Gives DOE right to divert 323 acre-feet or ~200 gallons per minute from Green River for Crescent Junction disposal site.
DE-RO01-06GJ68009	Access Roadway Contract and Grant of Easement	Private Owner	Perpetual easement and ROW for construction of an access roadway and related utilities at the disposal site.
ESMT 463	Waterline Easement	SITLA	Easement across state land for potable waterline.
Folder No. 02392-96	Pipeline Crossing Agreement	Union Pacific Railroad	Agreement grants right to construct, maintain, and operate one underground waterline and access for phone line and 1.5-in. conduit across Union Pacific Railroad's property at mile post 533.2, Green River Subdivision.
Folder No. 02399-44	Pipeline Crossing Agreement	Union Pacific Railroad	Agreement grants right to construct, maintain, and operate one underground waterline and access for phone line and 1.25-in. conduit at mile post 0.25, Cane Creek Subdivision, Thompson Springs, for the disposal site.
Folder No. 2537-02	Industrial Track Contract	Union Pacific Railroad	Covers construction, maintenance, and operation of 5,209-ft Track A, 3,524-ft Track B, and 617-ft Track C at mile post 533.21, Green River Subdivision line.
Property No. 70-4; 189A: AEQ	Easement	UDOT	Easement for waterline across UDOT property near Floy Wash that allows 60-ft construction ROW and 20-ft permanent ROW.
Public Land Order 7697	Permanent Land Transfer	BLM	Order permanently transferred 500 acres of BLM public domain land to DOE for disposal cell.
REEMCBCDOE-3-15-0702	Real Estate License	Rocky Mountain Power	Power line extension to dump ramp.

Table 8. Crescent Junction Site Permits and Agreements (continued)

Agreement Number	Document Name or Description	Issuing Agency	Purpose
REEMCBCDOE-6-08-0302	Waterline Easement	Grand County	Easement within County Road 175 or old Highway 6 and 50 and Hastings Lane ROWs to construct waterline within 60-ft ROW and operate within 20-ft ROW.
REEMCBCDOE-6-08-0304	Waterline Easement	Private Owner	Easement across private land near the Green River to construct waterline within 60-ft ROW and operate within 20-ft ROW and pump station.
REEMCBCDOE-6-08-0308 SITLA No. 1345	Waterline Easement	SITLA	Easement to construct waterline within 60-ft ROW and operate within 20-ft ROW on three parcels of SITLA land near Green River and Crescent Junction.
REEMCBCDOE-6-08-0309	Waterline Easement	City of Green River	Easement to construct waterline within 60 ft of County Road 175 or old Highway 6 and 50 ROWs within Green River city limits and operate within 20-ft ROWs.
REEMCBCDOE-6-12-0302	Waterline Easement	Private Owner	Permanent easement across private land near Crescent Junction to construct waterline within 60-ft ROW and operate within 20-ft ROW.
REEMCBCDOE-7-15-014	Access Agreement	Private Owner	For installation and maintenance of air monitoring equipment and collection of air quality data for monitoring station MPS-0306.
REEMCBCDOE-7-15-016	Access Agreement	Private Owner	For installation and maintenance of air monitoring equipment and collection of air quality data for monitoring station MPS-0307.
Resolution 2006-2741	Grand County Council Resolution	Grand County	Approves conditional use permit for the Project.
SPK-2007-632	404 Permit	U.S. Army Corps of Engineers	To construct pump station on the Green River.
Statewide Utility License Agreement No. 8439	Utility License	UDOT	License with state of Utah to construct waterline across UDOT property.
U.S. DOT No. 041012550006TV	Hazardous Materials Certificate of Registration	U.S. DOT	For shippers of hazardous materials through 06/2017.
U.S. DOT-SP 14283	Special Permit	U.S. DOT	Permit to transport mill tailings from Moab site to the disposal site.
UTR359187	Storm Water Permit	Utah Division of Water Quality	To limit the discharge of pollutants from disposal cell construction activities.
UT-SES-GR-14001	MOU for use of Freshwater Pond	Utah Dept. of Natural Resources	MOU outlines terms and conditions for helicopter use of pond for wildland fire fighting.
UTU-83354	Waterline ROW	BLM Moab Field Office	For construction of 14.5 miles of waterline on BLM land from Green River to disposal site.

Table 8. Crescent Junction Site Permits and Agreements (continued)

Agreement Number	Document Name or Description	Issuing Agency	Purpose
UTU-83396	Utility ROW	BLM Moab Field Office	For buried telephone line at the disposal site.
UTU-83450	Utility ROW	BLM Moab Field Office	ROW for power line to the disposal site.
Not assigned	Memorandum of Agreement	BLM Moab Field Office	Between DOE and BLM for management of existing uses on lands withdrawn in conjunction with the Project.
Not assigned	Water Use Agreement	Thompson Special Service District	Water use agreement among Thompson Special Service District in Grand County, Crescent Junction Properties, Inc., and DOE to install potable waterline from Thompson Springs, Utah, to the disposal site.

BLM = U.S. Bureau of Land Management; EMCBC = Office of Environmental Management Consolidated Business Center; ft = feet; in. = inches; MOU = Memorandum of Understanding; ROW = right-of-way; SITLA = School and Institutional Trust Lands Administration; UAC = Utah Administrative Code; UDOT = Utah Department of Transportation; U.S. DOT = U.S. Department of Transportation

4.0 Remedial Action Assessment

A description of the pre-excavation site conditions, construction activities, and verification performed at the Crescent Junction disposal site is provided in this section.

4.1 Pre-excavation Site Conditions

Pre-excavation site conditions were discussed in the *Moab UMTRA Project Crescent Junction Disposal Cell Interim Completion Report Addendum A* (DOE-EM/GJRAC2040-A).

4.2 Cell Construction

Cell construction during this period included five major activities:

- Excavation of soils to the design depth to ensure a competent surface for placement of RRM.
- Construction of the perimeter embankment.
- Placement of RRM to the design thickness, and ensuring radium-226 (Ra-226) activity in the upper 7 feet (ft) of placed material does not exceed design criteria.
- Placement of cover materials.
- Construction of the spoils embankment.

The *Moab UMTRA Project Lift Approval Procedure* (DOE-EM/GJRAC1803) was used to ensure the material placed met the compaction criteria. Descriptions of compaction equipment used during the above cell construction activities are provided in Table 9. Each activity performed as part of this Addendum is further described in the following subsections. Photographs representative of the cell construction activities are included in Appendix B.

Table 9. Descriptions of Compaction Equipment Used during Cell Construction

Compaction Equipment	Machine Weight (lb)	Equipped with CAES	Material Layer						
			RRM	Interim Cover	Radon Barrier	Infiltration and Biointrusion Barrier	Frost Protection	Perimeter Embankment	Spoils Embankment
CAT 825H Soils Compactor	69,000	X	X					X	
CAT D8 Bulldozer	84,850	X	X						
Komatsu 275AX Bulldozer	112,466	X	X						
CAT 637G Scraper	118,084			X					
CAT 815F Soils Compactor	45,765			X					X
CAT 631G Scraper	102,459								X

CAT = Caterpillar; lb = pounds

4.2.1 Excavation

In October 2015, excavation to remove the former platform (dump ramp) located within the Phase 2 cell boundary was completed. The excavated material was used to complete construction of the southern perimeter embankment in that area.

The disposal cell is being excavated in phases. Excavation of Phase 3a (10 acres) began in March 2016 and was completed in May 2016. Approximately 495,000 yd^3 were excavated to a depth of about 25 ft, including 2 ft into the weathered Mancos Shale bedrock. This portion of Phase 3 was constructed to store roughly 865,810 yd^3 of RRM. Excavated material was used to extend the spoils embankment. Figure 4 shows the extent of the Phase 3a excavation and southern perimeter embankment.

4.2.2 Perimeter Embankment Construction

Soils from excavation of the former platform that met the specification for common fill were used to complete construction of the southern perimeter embankment in that area.

4.2.3 RRM Placement

Placement of RRM in the disposal cell continued east from where it ended, as shown in *Moab UMTRA Project Crescent Junction Disposal Cell Interim Completion Report Addendum E* (DOE-EM/GJ2040-E). The RRM was loaded into dump trucks and driven to the disposal area, where it was spread for compaction using a bulldozer. A Caterpillar (CAT) 825H soils compactor, CAT D8 bulldozer, and Komatsu 275AX bulldozer were used to compact the RRM in place.

The *Moab UMTRA Project Debris Processing and Disposal Procedure* (DOE-EM/GJRAC2178) was issued in November 2015 to describe debris inspection, handling, shipment, and placement processes. This Procedure is included in Attachment 2. On July 25, 2016, DOE submitted a letter to NRC requesting concurrence to change relevant sections of the RAP Addendum B Specification 31-00-20, "Placement and Compaction of Tailings and Interim Cover" and the RAIP to allow an increase from 12 to 24 inches of loose RRM in each lift. These changes were to facilitate more efficient handling and compaction of RRM and debris in the disposal cell. On August 11, 2016, NRC concurred with these changes. The Specification and RAIP will be revised to address these changes.

4.2.4 Cover and Rock Armoring Placement

The cover on the disposal cell consists of multiple layers of soil and rock as illustrated in Figure 5-1 of the Remedial Action Selection Report in the RAP. Once the RRM placed in the cell has reached the design thickness, a minimum of 1 ft of interim cover is placed over the RRM.

The interim cover material comes from soils excavated on site (processed Mancos Shale bedrock). Three additional cover layers are placed over the interim cover before the final rock cover. Material for the radon barrier and frost protection layers also come from materials excavated on site. Rock for the infiltration and biointrusion barrier and the uppermost cover layer is transported from a quarry at Fremont Junction, Utah, and stockpiled at the Crescent Junction site. During this Addendum report period, there were 17,361 yd^3 of interim cover placed.

4.2.5 Spoils Embankment Construction

Material excavated on site is used to create a spoils embankment, or wedge, between the northern side of the cell and the Book Cliffs mountain range. The spoils embankment helps control drainage of storm water around the cell perimeter.

During this report period, 495,000 yd^3 of material excavated for Phase 3a of the cell was used to extend the spoils embankment to the east. The inspection and testing for the spoils embankment can be found in Table 10. The standard proctor test results summary, lift approval summary, and one lift approval package for the spoils embankment are provided in Appendix A8. Figure 7 shows the topographic surface of the spoils embankment as of the end of this Addendum period.

4.3 Soil Compaction and Testing

Initial CAES compaction setup and verification is documented in *Interim Completion Report Addendum A.* The CAES compaction is periodically verified by performing in-place tests using a nuclear density gauge manufactured by Troxler Electronic Laboratories, Inc., following ASTM International methods and in compliance with the RAIP. The individual nuclear density tests verify compaction achieved with the CAES is greater than the required 90 percent. The CAES compaction results compared to the nuclear density gauge are provided in Table 5 of Section 2.3.1.

Table 10. Spoils Embankment Inspection and Testing

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
Visual Observation	Common fill: fill material is placed in continuous and approximately horizontal lifts. The method of dumping and spreading material shall result in loose lifts of nearly uniform thickness, not to exceed 12 in. Compaction: embankment fill shall be compacted with rollers, equipment tracks, or successive passes of scrapers with a minimum 45,000-lb static weight. Fill material shall be properly conditioned to near optimum moisture content.	Specification 31-00-00 Section 3.11.1.3	6.3.5	Visual inspection performed throughout placement to verify compaction and lift thickness. Compaction performed using CAT 815F compactor and CAT 631G scraper. Thickness was visually verified. Each lift was documented in a lift approval package.
Laboratory Compaction Characteristics	Common fill: spoil material shall be tested to determine maximum dry density, and the moisture content shall be modified to bring fill to near optimum for compaction. Perform in accordance with the following as applicable: *ASTM D698, D2216.	Specification 31-00-00 Section 3.11.1.3	6.3.5	Twenty-seven tests performed to determine compaction characteristics.
In-place Density/ Moisture Test	One test per 100,000 ft^2 or 3,700 yd^3 of material placed for material compacted by other than hand-operated machines. One test per 500 ft^2, or fraction thereof, of each lift of fill or backfill areas for material compacted by hand-operated machines. Common fill: Density tests must meet at least 90% of the material's maximum dry density in accordance with *ASTM D698.Acceptable moisture content is ±5% of optimum moisture. Perform in accordance with the following as applicable: *ASTM D1556, D2216, D4643, and D6938.	Specification 31-00-00 Section 3.14.1.2	6.3.5	One hundred fifty-four in-place density/moisture tests performed with an average density of >95.7% of the laboratory-determined maximum dry density. All moisture tests were within ±5% of optimum.
Moisture Correlation Test	One correlation test for moisture every 10 tests per *ASTM D6938 will be performed in accordance with *ASTM D2216 or D4643.	Specification 31-00-00 Section 3.14.2	6.3.5	Nineteen moisture correlation tests performed, meeting requirements.

Table 10. Spoils Embankment Inspection and Testing (continued)

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
Laboratory Compaction Characteristics	Perform laboratory density and moisture content tests for each type of fill material to determine the optimum moisture (optimum moisture content ±5%) and laboratory maximum density values. One representative density test per material type and every 20,000 yd^3 thereafter, or when any change in material occurs that may affect the optimum moisture content or laboratory maximum dry density. Perform in accordance with the following as applicable: *ASTM D698 and D2216.	Specification 31-00-00 Section 3.14.3	6.3.5	Twenty-seven tests performed to determine compaction characteristics.

ASTM = ASTM International; ft^2 = square feet; in. = inches; lb = pounds
*ASTM Standard titles are included in the References Section 5.0.

4.4 Lift Approval

The *Lift Approval Procedure* and Addenda B and E of the RAP were followed to verify each lift met established criteria. Results of lifts are documented in lift approval packages. A sample lift approval package for the perimeter embankment, spoils, cell floor backfill, RRM, and interim cover placed during this report period is provided in Appendix A.

4.5 Geotechnical Testing

The RAIP describes the methods and frequencies for performing tests to verify the material placed in the cell meets the requirements. Geotechnical tests fall within two general categories: soils testing and aggregate testing. The *Moab UMTRA Project Moisture/Density Testing Procedure* (DOE-EM/GJRAC1783) provides requirements and methods for the proper moisture/density testing of soils placed in the cell. Only soils testing was used during this Addendum period as described below.

4.5.1 Soils Testing

Laboratory and/or field soils geotechnical tests were conducted on every lift of each material layer placed to support verification that specified compaction requirements were met. Test requirements varied depending on whether the CAES was used for demonstrating compaction. Because the soils in the RRM can vary in composition, multiple compaction curves were developed to determine the maximum dry density and optimum moisture content for that material to achieve compaction.

Figure 7. Topographic Surface of Spoils Embankment

Results of the tests conducted are shown in the standard proctor test results summary tables included in Appendix A. When multiple RRM standard proctor tests, or "sets," were performed, the test selected to represent that soil type appears in red in the table. The tables also summarize the tests performed to determine soil type and geotechnical properties.

Moisture content testing was performed daily for each soil layer placed to verify the moisture content met the requirements before the lifts were approved. The thickness of each lift was surveyed and verified using a high-accuracy global positioning system, when practical; otherwise, manual measurements were taken.

4.5.2 Aggregate Testing

There were no aggregate testing activities during this period.

4.6 Radiological Verification

Section 5.0, Radon Attenuation, of the Remedial Action Selection Report of the RAP identifies two primary verification criteria associated with construction of the disposal cell: radium-226 (Ra-226) measurements in RRM placed in the upper 7 ft and radon flux measurements to verify the integrity of the radon barrier. The *Interim Completion Report Addendum A* provides an explanation of this verification process.

During this Addendum period, 280 samples of RRM were taken in 10 lifts in the upper 7 ft of the disposal cell. The Ra-226 activity of the material ranged from 49.4 to 812.6 picocuries per gram (pCi/g). Table 11 shows the average result for material placed in each lift tested. There were no radon flux measurements taken during this period to verify the integrity of the radon barrier.

4.7 QA Requirements

QA activities were conducted in accordance with documents identified in Section 3.3. During construction activities, surveillances and assessments were performed by the RAC to verify and ensure these activities were performed in accordance with established plans, drawings, instructions, procedures, specifications, and other applicable documents. In addition, the TAC and DOE performed assessments of these activities.

Table 11. Results of Average Ra-226 Activity in Upper 7 Feet of Placed RRM

Lift ID Number	Number of Samples Taken	Average Ra-226 Activity (pCi/g)	Lift Area (m^2)
UW1O07	28	267	8,462
UW1O14	28	227	14,208
UW1N14	28	338	10,390
UW1I16	28	150	16,666
UW1M01	28	399	13,884
UW1L15	28	388	13,200
UW1L08	28	397	7,845
UW1M20	28	424	9,047
UW1O01	28	270	15,067
UW1F16	28	630	9,718

m^2 = square meters

During the period of this Addendum, two surveillances, six assessments, and two management assessments were performed (see Table 12). Corrective actions are developed for any deficiencies identified during the assessments.

Table 12. Surveillances and Assessments Conducted during Construction

Date	Conducted By	Type	Assessment Number	Scope
12/15/15	TAC	Assessment	DOE-16-A-007	Review of Specifications 31-00-00 and 31-00-20.
12/15/15	TAC	Assessment	DOE December Letter	Review of cell design Specifications and RAIP.
1/8/16	DOE	Assessment	Technical Memorandum No. 3	Review *Debris Processing and Disposal Procedure* to identify potential efficiencies during debris placement.
2/02/16	RAC	Surveillance	MB-16-A-007	Verify compliance with requirements for Radiological Buffer Area contamination control.
2/15/16	TAC	Assessment	DOE-16-A-024	Evaluate current RRM transport and placement, previous placement of RRM around standpipe, and QA/QC operational processes performed during periods of freezing temperatures and frozen subgrade.
6/20-24/16	RAC	Surveillance	MB-16-A-013	Evaluate implementation of MB-IWP/JSA-011, *Disposal Cell Operations*.
6/30/16	RAC	Management Assessment	MA-16-014	Evaluate the efficiency and safety of the excavation of Phase 3a of the disposal cell.
7/13/16	TAC	Assessment	DOE-16-A-029	Visual inspection to verify compliance with RAP requirement that cell floor elevation is excavated a minimum of 2 ft into weathered and fractured Mancos Shale.
8/26/16-9/30/16	TAC	Assessment	DOE-16-A-037	Assessment of storm water and sediment management.
9/23/16	RAC	Management Assessment	MA-16-019	Review and verify compliance with the RAC QA Program.

IWP/JSA = Integrated Work Plan/Job Safety Analysis; QC = quality control

4.8 Monitoring Free Liquid Presence

The results of monitoring of the one existing standpipe (see Figure 8) during this period for the presence of free liquids in the disposal cell, are shown in Table 13. It was not possible to access the standpipe in July 2016 due to site conditions. No additional standpipes were installed during this period.

Table 13. Monitoring Results for the Presence of Fluids in Standpipe 01

Date Monitored	Presence or Level of Fluids (ft)
10/28/15	Dry
01/21/16	Dry
04/26/16	Dry

Dry = no fluids present

4.9 Monitoring Ground Water Presence

Four wells were monitored for the presence of ground water outside disposal cell footprint (see Figure 8). Results of the monitoring are shown in Table 14, with wells 0203 and 0210 dry throughout this report period. Water was first encountered in well 0202 during monitoring in early February 2016, with only 0.2 ft present.

Despite the height of water increased to 0.4 ft by late July 2016, there was still insufficient water present to collect a sample for analysis. This water likely represents condensation that has accumulated inside the well.

Figure 8. Locations of Monitoring Wells and Standpipe

Table 14. Monitoring Results for Presence of Ground Water

Date Monitored	Monitor Well Number			
	0202	0203	0205	0210
10/28/15	Dry	Dry	DTW = 58.70 ft btoc	Dry
02/03/16	DTW = 61.51 ft btoc	Dry	DTW = 54.44 ft btoc	Dry
04/19/16	DTW = 61.25 ft btoc	Dry	DTW = 53.14 ft btoc	Dry
07/26/16	DTW = 61.12 ft btoc	Dry	DTW = 53.10 ft btoc	Dry

Dry = no fluids present; DTW = depth to water; ft btoc = feet below top of casing

Water was first encountered in well 0205 in late June 2015, and has been present since then. As part of the quarterly monitoring practice, a sample is collected of any water present in sufficient quantity and submitted to an analytical laboratory to be analyzed for various anions, cations, inorganics, and radionuclides.

In addition, a sample of nearby ponded surface water was collected and submitted for analysis in late October 2015, and soil samples were collected in February 2016 as part of a leachate batch test. These samples were collected in an attempt to determine the source of water present in well 0205.

During this report period, 16 short-term recovery tests were completed to determine the recharge rate of the water entering well 0205. Test results indicate the recharge rate dramatically increased from 0.02 to 0.08 gallons per minute (gpm) between October 2015 and December 2015, apparently in response to significant precipitation events in October and November 2015. After December 2015, the recharge rate gradually decreased to 0.03 gpm through September 2016 in response to below-average precipitation at the site.

Data from the recovery test results, leachate batch test results, the overall analytical data, and uranium isotope ratio differences suggest infiltration of surface runoff is the source of the water present in well 0205.

5.0 References

10 CFR 830A (Code of Federal Regulations), “Nuclear Safety Management, Quality Assurance Requirements.”

ASME (American Society of Mechanical Engineers), Nuclear Quality Assurance (NQA)-1 2004 and addenda through 2007 consensus standard, “Quality Assurance Requirements for Nuclear Facility Applications (QA).”

ASTM (ASTM International) Standard D698, “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.”

ASTM (ASTM International) Standard D1556, “Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.”

ASTM (ASTM International) Standard D2216, “Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.”

ASTM (ASTM International) Standard D4643, “Standard Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Heating.”

ASTM (ASTM International) Standard D6938, “Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).”

DOE (U.S. Department of Energy), *Moab UMTRA Project Crescent Junction Disposal Cell Interim Completion Report Addendum A* (DOE-EM/GJRAC2040-A).

DOE (U.S. Department of Energy), *Moab UMTRA Project Crescent Junction Disposal Cell Interim Completion Report Addendum E* (DOE-EM/GJRAC2040-E).

DOE (U.S. Department of Energy), *Moab UMTRA Project Debris Processing and Disposal Procedure* (DOE-EM/GJRAC2178).

DOE (U.S. Department of Energy), *Moab UMTRA Project Final Remedial Action Plan and Site Design for Stabilization of Moab Title I Uranium Mill Tailings at the Crescent Junction, Utah, Disposal Site, Addendum E, Remedial Action Inspection Plan* (DOE-EM/GJ1547).

DOE (U.S. Department of Energy), *Moab UMTRA Project Lift Approval Procedure* (DOE-EM/GJRAC1803).

DOE (U.S. Department of Energy), *Moab UMTRA Project Moisture/Density Testing Procedure* (DOE-EM/GJRAC1783).

DOE (U.S. Department of Energy), *Moab UMTRA Project Quality Assurance Plan for the Remedial Action Contractor* (DOE-EM/GJRAC1766).

DOE (U.S. Department of Energy) Office of Environmental Management, "EM Quality Assurance Program" (EM-QA-001).

DOE (U.S. Department of Energy), Order 226.1B, "Implementation of Department of Energy Oversight Policy."

DOE (U.S. Department of Energy), Order 414.1D, Admin Chg 1, "Quality Assurance."