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Office of Environmental Management – Grand Junction

UMTRA Project

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

Revision 0

January 2018

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.

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Revision 0

Review and Approval

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Date

Greg D. Church — 1/22/18

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Date

Revision History

Revision	Date	Reason for Revision
0	January 2018	Initial issue.

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Acronyms and Abbreviations

CAES	Computer Aided Earthmoving System
CAT	Caterpillar
DOE	U.S. Department of Energy
DOE O	DOE Order
ft	foot/feet
lb	pounds
NQA	Nuclear Quality Assurance
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 *Crescent Junction Disposal Cell Interim Completion Report* Addendum G 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, 2016, through September 30, 2017. This Report includes excavation of 496,600 cubic yards (yd^3) of Phase 3b of the disposal cell and placement of 285,403 yd^3 of RRM.

This Addendum also demonstrates that 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 (RAP) (DOE-EM/GJ1547). The RAP received conditional concurrence from the U.S. Nuclear Regulatory Commission. Included in this Report are a critical review, design assessment, and remedial action assessment of activities performed during this Report period. Also provided are associated data tables, photographs, laboratory results, and other supporting documentation.

The Moab Project follows the American Society of Mechanical Engineers (ASME) 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 generally be rectangular and will encompass approximately 230 acres. Figure 2 shows general features of the Crescent Junction site.

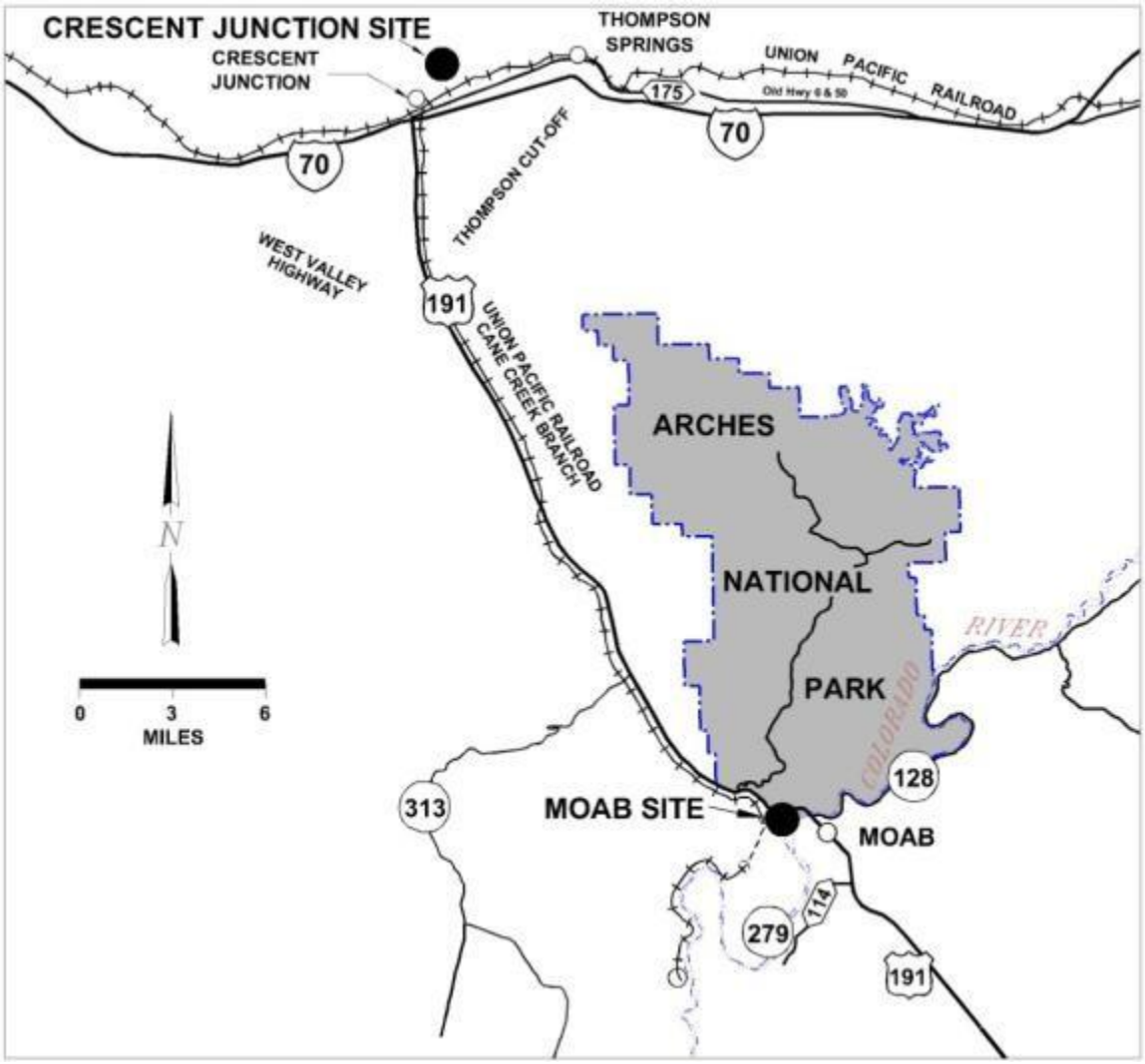

Figure 1. Location of Moab and Crescent Junction Sites

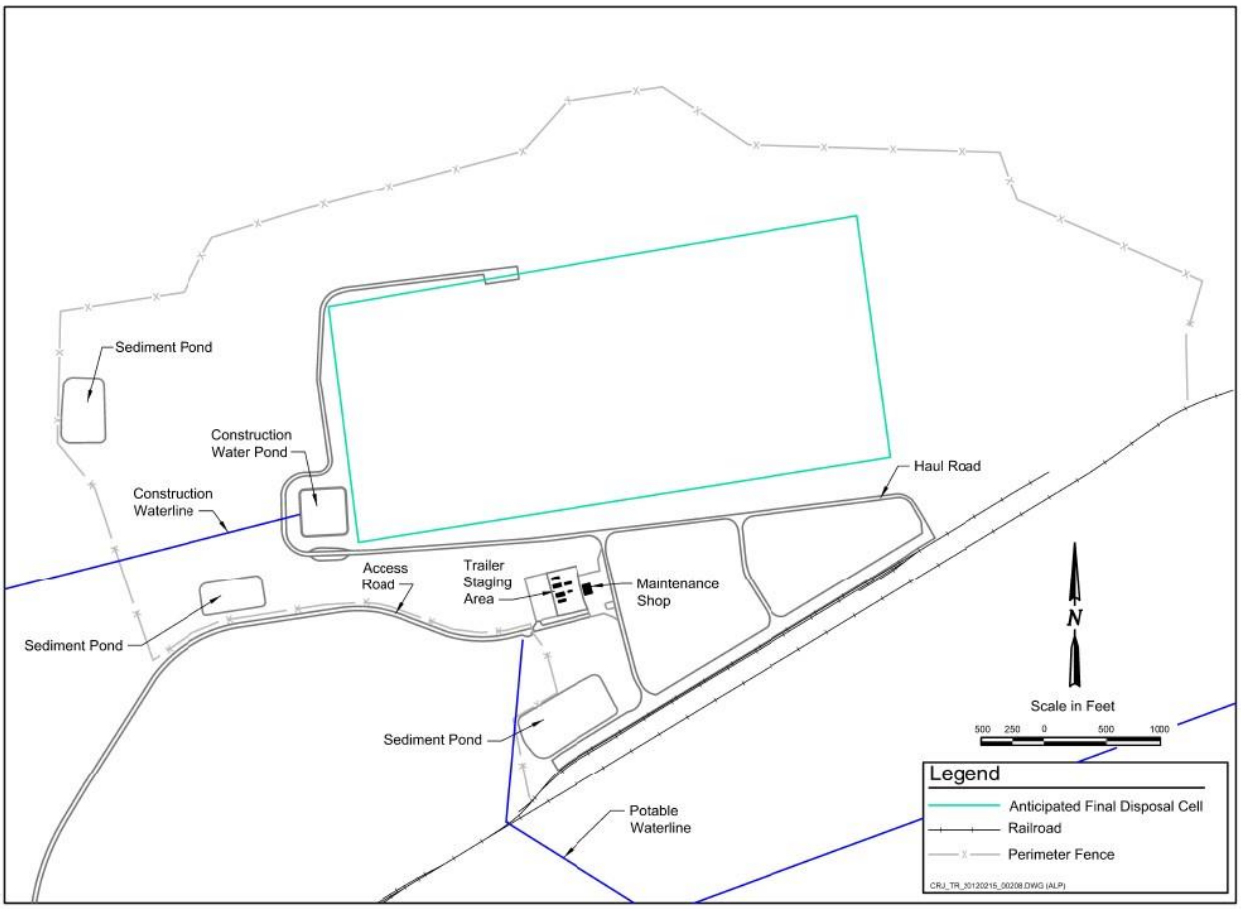

Figure 2. Crescent Junction Site Features

This Addendum documents activities performed by the RAC for the Project from October 1, 2016, through September 30, 2017.

Addendum G 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 buyoff survey verification of cell excavation.
- Attachment 2 contains current revisions of two procedures associated with RRM placement.

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 this Report period. The tables reference criteria and material testing procedures used to verify cell excavation and placement of each type of material that were performed in accordance with design specifications or drawings and with Addendum E of the RAP, the *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 3b excavation.

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	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
RRM	285,403	177	169	8	5	17	93.1	98.8	N/A	N/A	N/A
Interim Cover	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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

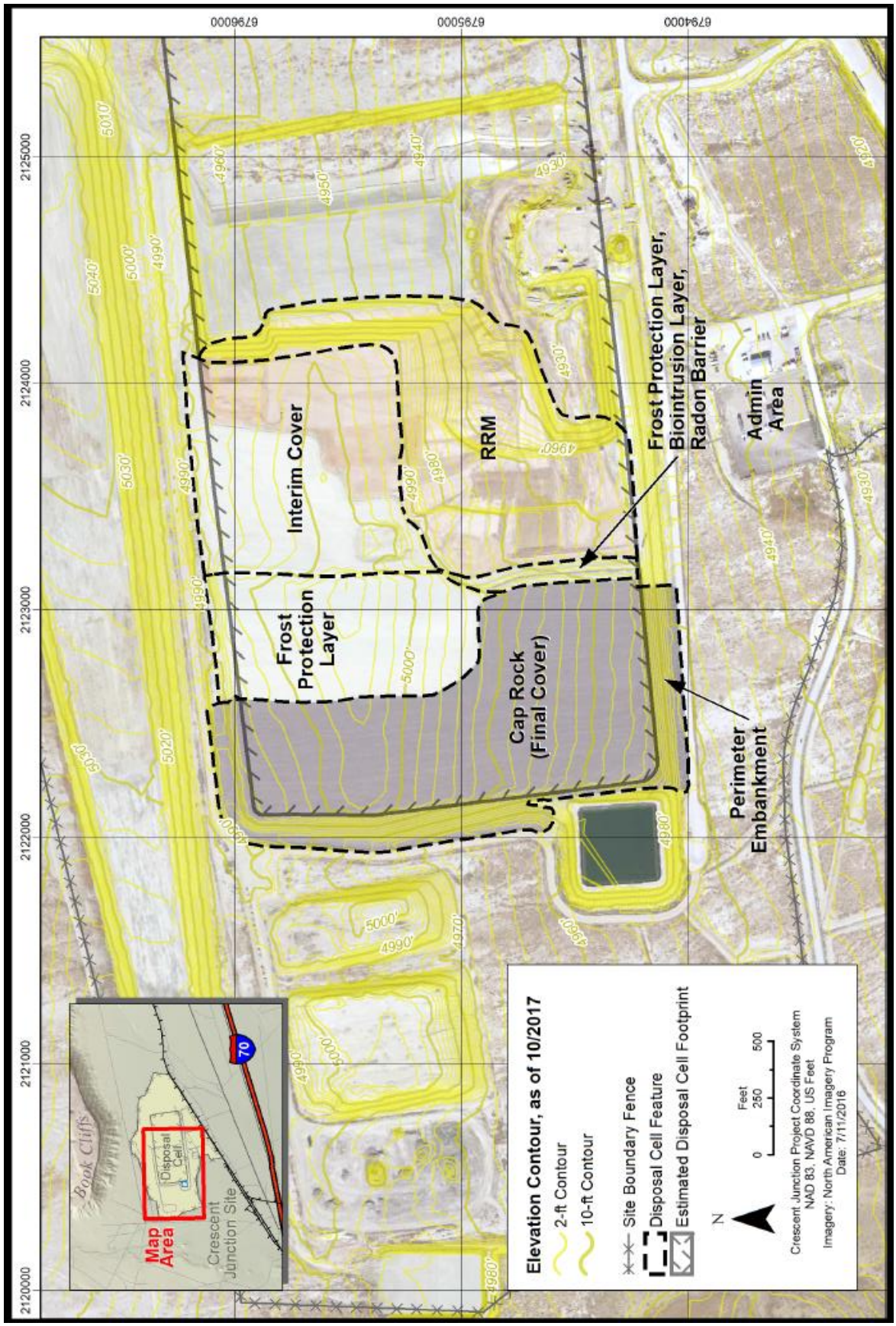

Figure 3. General Extent of Cover Layers

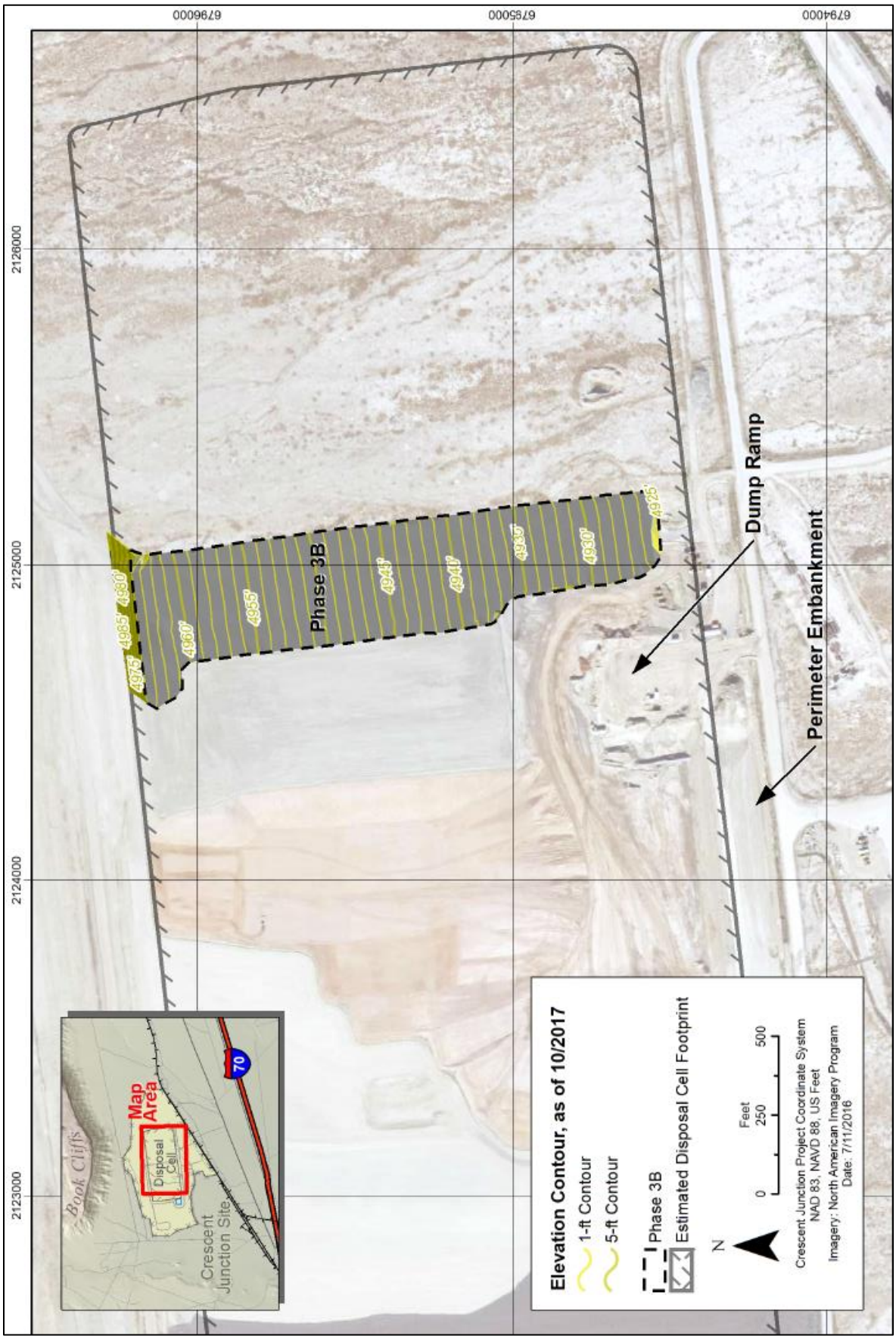

Figure 4. Extent of Phase 3b Excavation

2.1 Cell Excavation

Excavation of Phase 3b, which involved approximately 496,600 yd^3, was performed from March to May 2017. The excavated material was used to extend the spoils embankment to the east. The Phase 3b buyoff survey is included as Attachment 1. The inspection and testing summary for cell excavation can be found in Table 2.

Table 2. Cell Excavation Inspection and Testing

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
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.	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 3b was compared to the final survey. There was no discrepancy.

GPS = global positioning system

2.2 Perimeter Embankment

No activities associated with the perimeter embankment were conducted during this period.

2.3 RRM

2.3.1 Computer Aided Earthmoving System Performance Verification Testing

The Project used machines equipped with a Computer Aided Earthmoving System (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 3 shows the results of the comparison tests performed during this Report period.

Table 3. CAES Performance Verification Testing

Lift ID Number	Test Performance Date	In-place Density Compaction (%)	Lift Area Meeting CAES Compaction Criteria (%)
UWY27161129-00	12/1/2016	93.4	99.1
UWY24170425-00	4/26/2017	90.8	99.3
UW1E30170824-00	8/28/2017	90.7	93.6
UW1F24170919-00	9/21/2017	94.5	99.4
UW1F24170926-00	9/27/2017	94.4	99.5

2.3.2 RRM Placement

Through November 2016, small quantities of debris mixed with uranium mill tailings were shipped in most trainloads. The debris was appropriately sized and incorporated into the 1-foot (ft) lifts of tailings. Debris lifts were placed through January 3, 2017. RRM inspections and tests are shown in Table 4.

No lifts were placed to reach the design top of waste; therefore, no buyoff surveys were conducted. The standard proctor test results summary, lift approval summaries, and one lift approval package for RRM are provided in Appendix A2.

Table 4. 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.

Table 4. RRM 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	Each container of demolition debris shall be spread in a single layer 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
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	Five tests were performed to determine compaction characteristics.
Moisture Test	Fill material is properly moisture conditioned. Acceptable moisture content is ±3% of optimum moisture. 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.

Table 4. RRM 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	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	Seventeen tests were performed with average in-place density of 93.1% of the laboratory-determined maximum dry density. Eight lifts were approved using in-place density/moisture tests. All approved 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	One hundred sixty-nine 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

No activities associated with the interim cover were conducted during this period.

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**.**

3.0 Design Assessment

The disposal cell design incorporates established design criteria, drawings and specifications, and calculations, all of which are included in the RAP and in 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 5.

Table 5. Crescent Junction Site Permits and Agreements

Agreement Number	Document Name or Description	Issuing Agency	Purpose
400-00177	Easement for Green River Pump Station	Utah Division of Forestry, Fire, and State Lands	ROW easement to construct and operate water pipeline in the Green River.
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.

Table 5. Crescent Junction Site Permits and Agreements (continued)

Agreement Number	Document Name or Description	Issuing Agency	Purpose
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.
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.

Table 5. Crescent Junction Site Permits and Agreements (continued)

Agreement Number	Document Name or Description	Issuing Agency	Purpose
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.
Statewide Utility License Agreement No. 8439	Utility License	UDOT	License with state of Utah to construct waterline across UDOT property.
U.S. DOT No. 050217551021ZB	Hazardous Materials Certificate of Registration	U.S. DOT	For shippers of hazardous materials through 06/2020.
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	Utah Dept. of Natural Resources and BLM	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.
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.

Table 5. Crescent Junction Site Permits and Agreements (continued)

Agreement Number	Document Name or Description	Issuing Agency	Purpose
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; ft = feet; in. = inches; MOU = Memorandum of Understanding; ROW = right-of-way; SITLA = School and Institutional Trust Lands Administration; 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 verifications 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 Addendum A of the *Moab UMTRA Project Crescent Junction Disposal Cell Interim Completion Report* (DOE-EM/GJRAC2040-A).

4.2 Cell Construction

Cell construction during this period included three major activities:

- Excavation of soils to the design depth to ensure an adequate surface for RRM placement.
- Placement of RRM to the design thickness.
- 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 6.

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 6. 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						
CAT D8 Bulldozer	84,850	X	X						
Komatsu 275AX Bulldozer	112,466	X	X						
CAT 815F Soils Compactor	45,765								X
CAT 631G Scraper	102,459								X

CAT = Caterpillar; lb = pounds

4.2.1 Excavation

The disposal cell is excavated in phases. Excavation of Phase 3b (10 acres) began in March 2017 and was completed in May 2017. Approximately 496,600 yd^3 were excavated to a depth of about 25 ft, including a minimum 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 3b excavation.

4.2.2 Perimeter Embankment Construction

There were no perimeter embankment construction activities during this period.

4.2.3 RRM Placement

Placement of RRM in the disposal cell continued east from where it ended, as shown in Addendum F of the *Moab UMTRA Project Crescent Junction Disposal Cell Interim Completion Report* (DOE-EM/GJ2040-F). 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.

4.2.4 Cover and Rock Armoring Placement

There were no cover or rock armoring activities during this period.

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 storm water drainage around the cell perimeter.

During this Report period, 496,600 yd^3 of material excavated for Phase 3b of the cell was used to extend the spoils embankment to the east. The inspection and testing of the spoils embankment can be found in Table 7. The standard proctor test results summary, lift approval summaries, and one lift approval package for the spoils embankment are provided in Appendix A8. Figure 5 shows the topographic surface of the spoils embankment as of the end of this Addendum period.

Table 7. 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 applicable: *ASTM D698 and D2216.	Specification 31-00-00 Section 3.11.1.3	6.3.5	Twenty-five 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	Three hundred fifty-eight in-place density/moisture tests performed with an average density of >94.2% of the laboratory-determined maximum dry density. All moisture tests were within ±5% of optimum.

Table 7. 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
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	Thirty-seven moisture correlation tests performed, meeting the requirement of one every 10 tests.
Laboratory Compaction Characteristics	Perform laboratory density and moisture content tests for each type of fill material to determine the optimum moisture 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-five 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.

4.3 Soil Compaction and Testing

Initial CAES compaction setup and verification is documented in the *Crescent Junction 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 the compaction achieved with the CAES is greater than or equal to the required 90 percent. The CAES compaction results compared to the nuclear density gauge are provided in Table 3 of Section 2.3.1.

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. The Procedure was modified during this Addendum period, and the revised Procedure is provided in Attachment 2. Results of lifts are documented in lift approval packages. A sample lift approval package for the spoils embankment and RRM placed during this Report period is provided in Appendix A. In anticipation of accommodating changes in lift specifications, the *Moab UMTRA Project Debris Processing and Disposal Procedure* (DOE-EM/GJRAC2178) was modified during this Addendum period, and the revised Procedure is provided in Attachment 2.

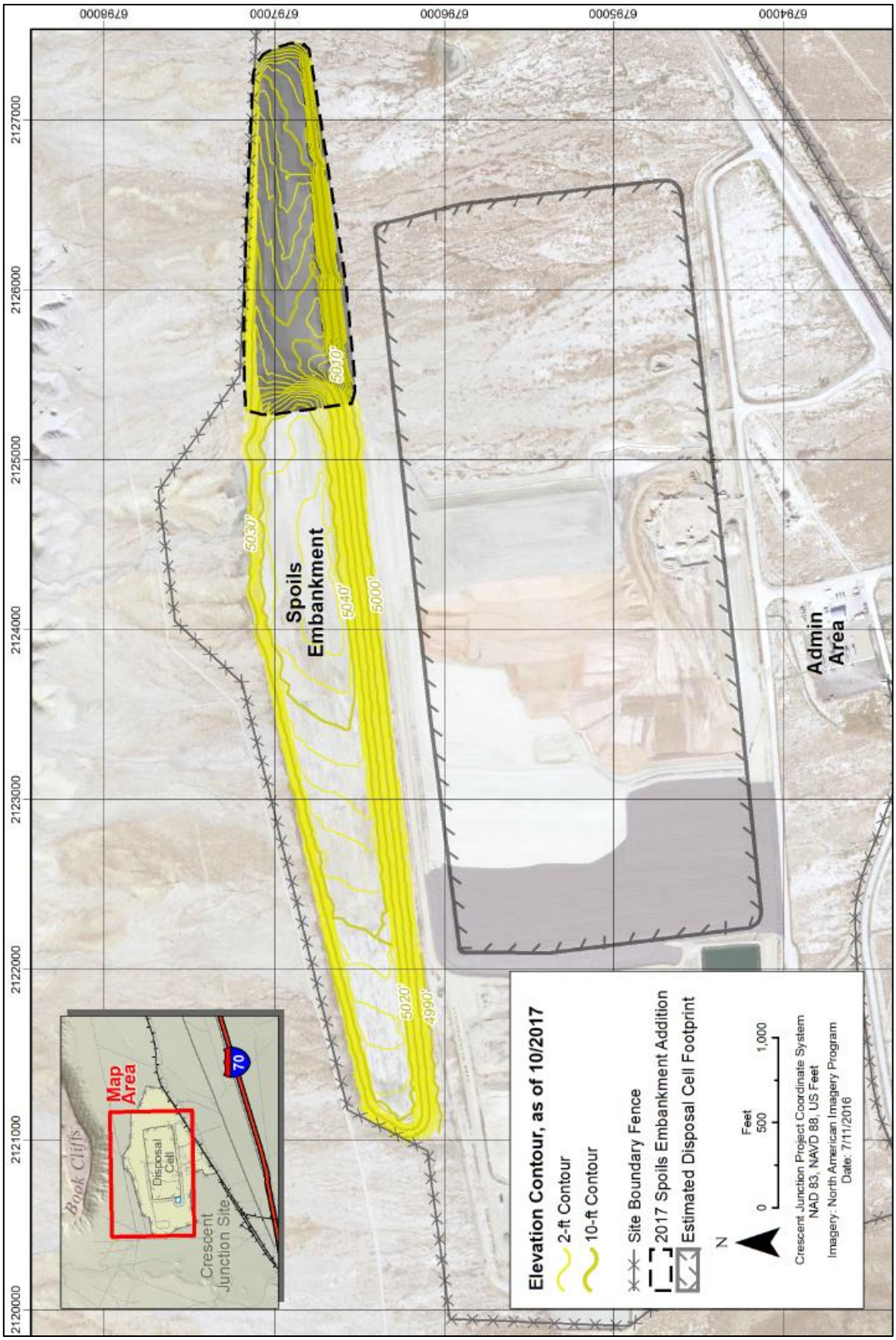

Figure 5. Topographic Surface of Spoils Embankment

4.5 Geotechnical Testing

The RAIP describes methods and frequencies for performing tests to verify 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.

Results of tests conducted are shown in the standard proctor test results summary tables included in Appendix A. When multiple standard proctor tests, or "sets," were performed on RRM, 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 of the *Remedial Action Selection Report* 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. *Crescent Junction Interim Completion Report Addendum A* provides an explanation of this verification process.

There were no final radiological verification activities during this period for Ra-226 measurements in the upper 7 ft of RRM or for radon flux measurements 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 Technical Assistance Contractor (TAC) supports the DOE in the assessment of the RAC.

During the period of this Addendum, seven assessments and one management assessment were performed (see Table 8). Corrective actions are developed to address any deficiencies identified during the assessments.

Table 8. Surveillances and Assessments Conducted during Construction

Date	Conducted By	Type	Assessment Number	Scope
10/31/16-11/10/16	DOE	Assessment	2016-11-IA-MOAB-QA	Evaluate the adequacy and effectiveness of the Project QA Program's compliance with implementation of EM-QA-001, Rev. 1.
11/23/16	DOE/TAC	Assessment	DOE-17-A-015	Review of *Interim Completion Report Addendum A*.
2/20/17-5/5/17	RAC	Assessment	MB-17-A-008	Evaluate the control of radioactive contamination within the enclosed structures in the Contamination Area at the Crescent Junction disposal site.
3/3-17/17	DOE/TAC	Assessment	DOE-17-A-023	Review of placement of material in the disposal cell to ensure compliance with Specifications and RAIP.
3/27-30/17	DOE/TAC	Assessment	Field Oversight	Observation of Phase 3b excavation.
June 2017	DOE	Assessment	Moab Project ISMS 2017 Annual Assessment	Verify compliance with requirements for Radiological Buffer Area contamination control.
6/19/17-7/11/17	RAC	Assessment	MB-17-A-010	Verify the implementation of QA requirements for measuring and test equipment.
8/22/17	RAC	Management Assessment	MA-17-020	Evaluate the implementation of and compliance with the RAC's QA Program.

ISMS = Integrated Safety Management System

4.8 Monitoring Free Liquid Presence

During this period, results of monitoring the one existing standpipe (see Figure 6) for the presence of free liquids in the disposal cell are shown in Table 9. It was not possible to access the standpipe in December 2016 and March 2017 due to site conditions. No additional standpipes were installed during this period.

4.9 Monitoring Ground Water Presence

Table 9 shows results of monitoring the one existing standpipe (see Figure 6) for the presence of free liquids in the disposal cell during this period. Monitoring results are shown in Table 10, with wells 0203 and 0210 dry throughout this Report period. Water was first encountered in well 0202 during monitoring in early February 2016.

Only a very limited volume of 0.4 ft of water (equivalent to less than 0.15 gallons) has been present in well 0202 since that time, which is an insufficient volume to collect a sample for analysis. This water likely represents condensation that accumulates inside the well.

Table 9. Monitoring Results for the Presence of Fluids in Standpipe 01

Date Monitored	Presence or Level of Fluids (ft)
06/20/17	Dry
09/26/17	Dry

Dry = no fluids present

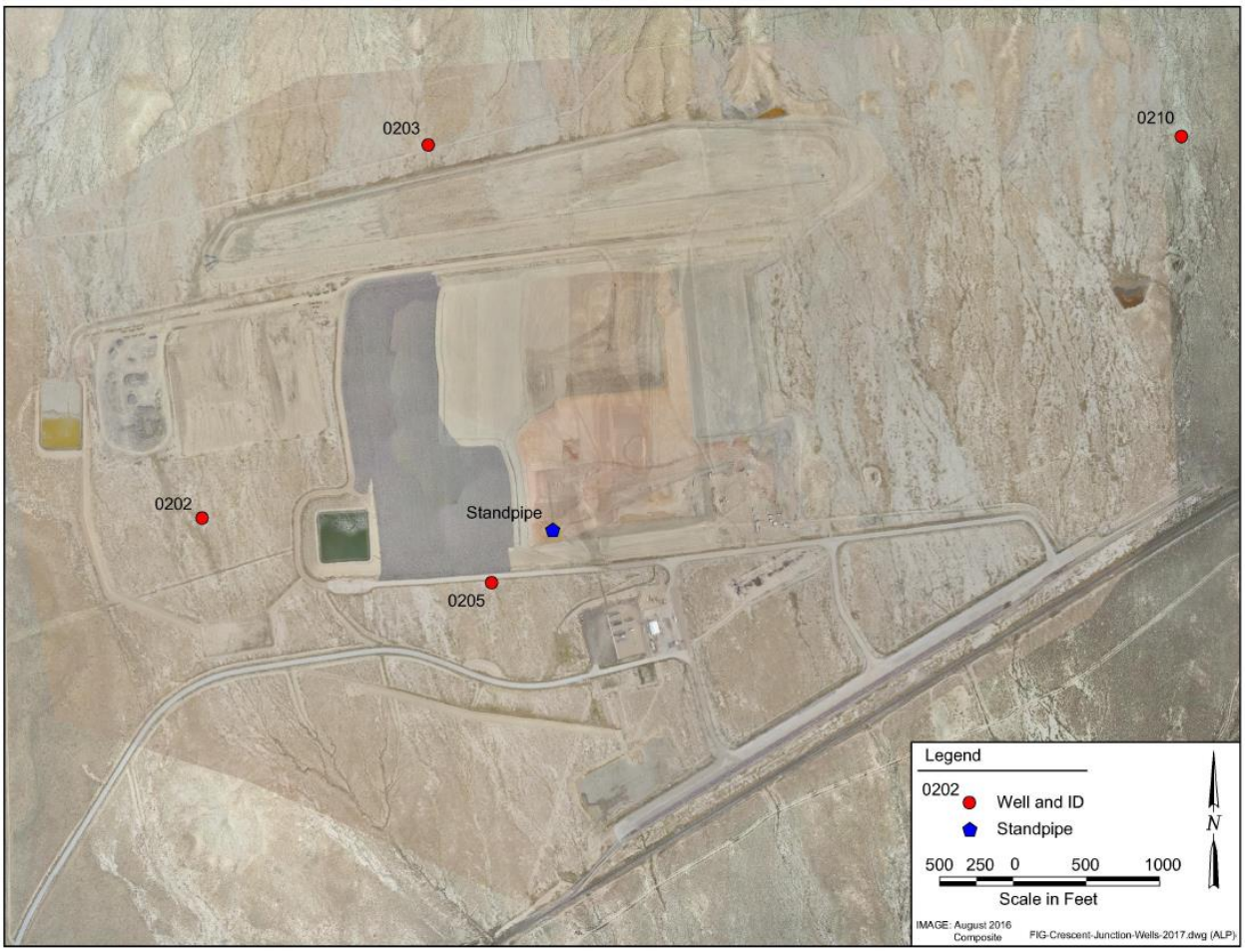

Figure 6. Locations of Monitoring Wells and Standpipe

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 may be collected of any water present in sufficient quantity and submitted to an laboratory for analysis of various anions, cations, inorganics, and radionuclides.

Table 10. Monitoring Results for Presence of Ground Water

Date Monitored	Monitor Well Number			
	0202	0203	0205	0210
12/05/16	DTW = 61.15 ft btoc	Dry	DTW = 52.49 ft btoc	Dry
03/20/17	DTW = 61.16 ft btoc	Dry	DTW = 49.38 ft btoc	Dry
06/20/17	DTW = 61.19 ft btoc	Dry	DTW = 50.23 ft btoc	Dry
09/26/17	DTW = 61.50 ft btoc	Dry	DTW = 50.76 ft btoc	Dry

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

During this Report period, three short-term recovery tests were completed to determine the recharge rate of the water entering well 0205. All water quality data associated with samples collected from well 0205 during this period are presented and discussed in the *Moab UMTRA Project Ground Water and Surface Water Monitoring Report July through December 2016* (DOE-EM/GJTAC2231) and the *Moab UMTRA Project Ground Water and Surface Water Monitoring Report January through June 2017* (DOE-EM/GJTAC2240).

Data from these recovery tests and associated analytical results continue to suggest that the water does not appear to be from leakage from the disposal cell, but rather it is surface runoff of the cover. Test results indicate the recharge rate ranged from 0.042 to 0.066 gallons per minute, which is within the historical range.

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 F* (DOE-EM/GJRAC2040-F).

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 Ground Water and Surface Water Monitoring Report July through December 2016* (DOE-EM/GJTAC2231).

DOE (U.S. Department of Energy), *Moab UMTRA Project Ground Water and Surface Water Monitoring Report January through June 2017* (DOE-EM/GJTAC2240).

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."