DOE–EM/GJRAC2040-E

Office of Environmental Management – Grand Junction

UMTRA Project

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

Revision 0

December 2015

U.S. Department of Energy

Office of Environmental Management

Prepared by the Remedial Action Contractor under contract number DE-DT0002936
for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

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Review and Approval

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12-11-15
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Revision History

Revision Number	Date	Reason for Revision
0	December 2015	Initial issue.

Contents

Figures

Tables

Appendices

Acronyms and Abbreviations

CAES	Computer Aided Earthmoving System
CAT	Caterpillar
DOE	U.S. Department of Energy
DOE O	DOE Order
ft	foot/feet
GPS	global positioning system
NQA	Nuclear Quality Assurance
NRC	U.S. Nuclear Regulatory Commission
QA	quality assurance
QAP	Quality Assurance Plan
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 E 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, 2014, through September 30, 2015, and includes placement of 379,490 cubic yards (yd^3) of RRM and 58,992 yd^3 of final cover materials.

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* (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 reporting period. Also provided are associated data tables, photographs, laboratory results, and other supporting documentation.

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 is 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.

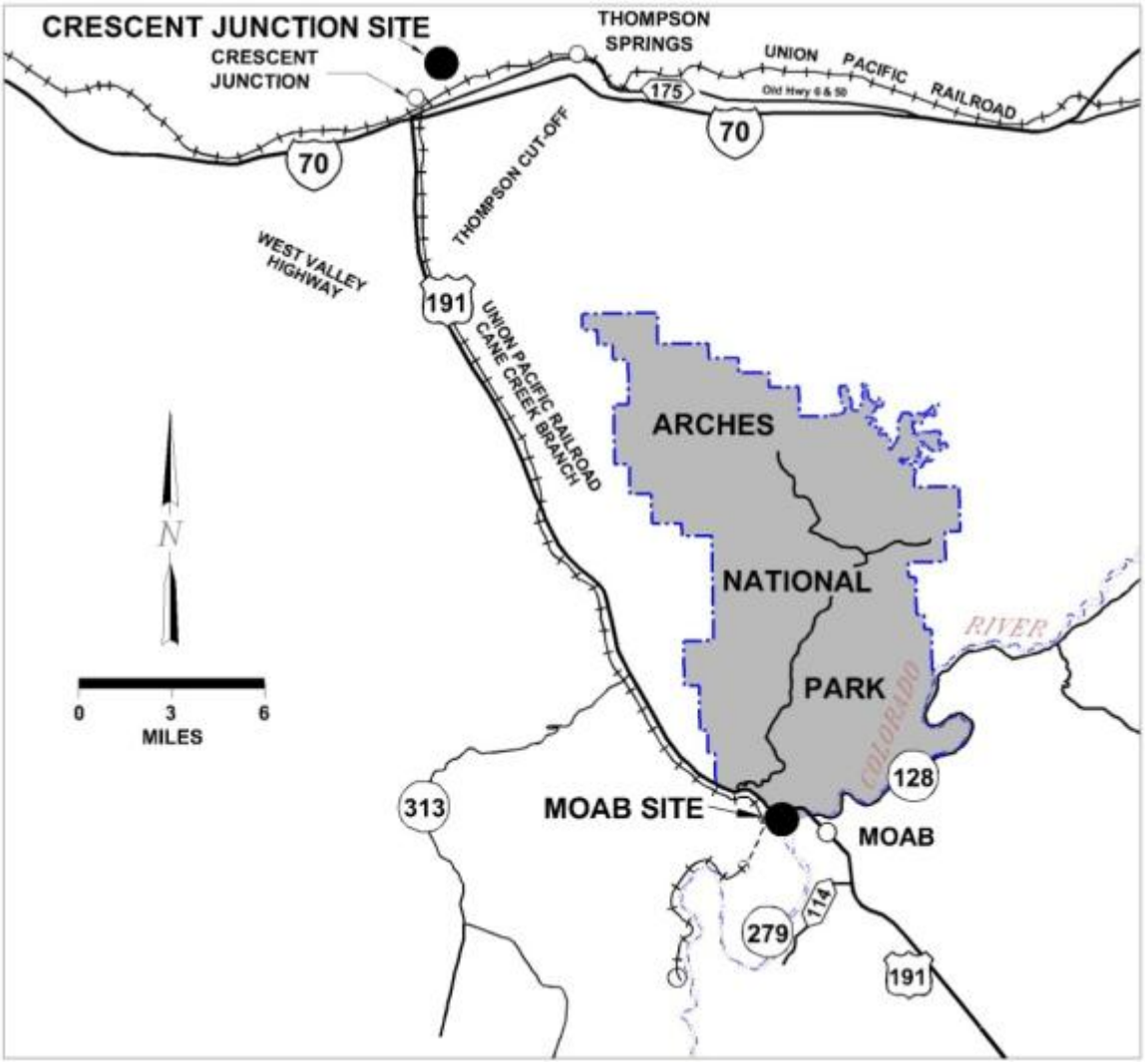

Figure 1. Location of Moab and Crescent Junction Sites

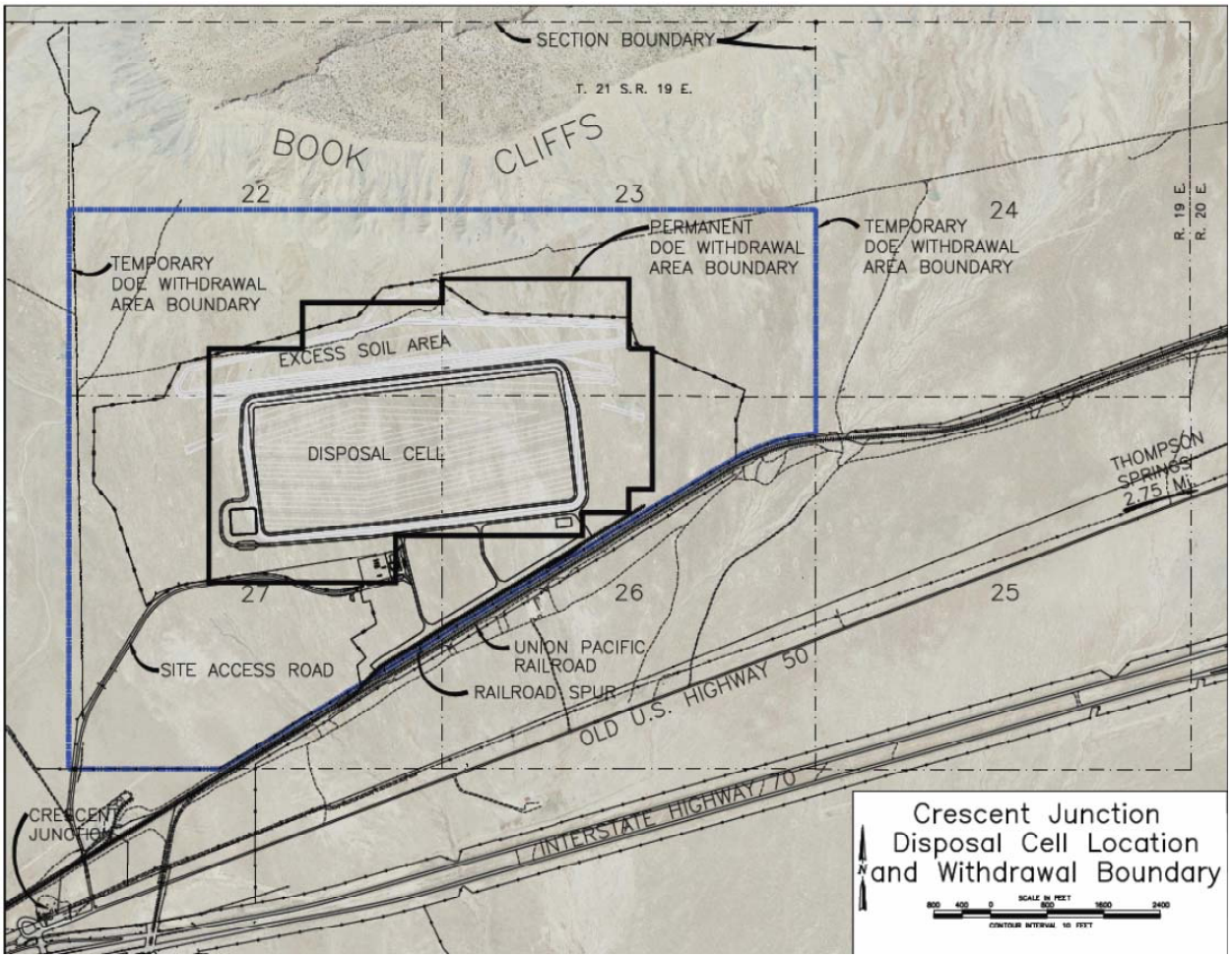

Figure 2. Crescent Junction Site Features

This Addendum documents activities performed by the RAC for the Project from October 1, 2014, through September 30, 2015.

Addendum E 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 were 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.

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 that the cell excavation and placement of each type of material was 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.

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	34,270	41	N/A	41	4	41	96.9	N/A	N/A	N/A	N/A
RRM	379,490	326	326	0	27	2	92.0	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	4,261	2	N/A	2	N/A	N/A	N/A	N/A	N/A	2	2
Frost Protection Layer	54,491	16	N/A	16	3	32	96.7	N/A	N/A	N/A	N/A
2-in. Cap Rock	240	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

2.1 Cell Excavation

Limited excavation of material east of the Phase 2 cell boundary was conducted to facilitate construction of a new platform used for end-dumping the containers. The excavated material was used as frost protection layer and in the spoils embankment. No inspection or testing of the excavation was needed because the surface did not reach design grade. Excavation also was initiated to remove the former platform (dump ramp) located within the Phase 2 cell boundary. This excavated material was used to complete construction of the southern cell perimeter embankment in this area. Excess material was stockpiled on top of interim cover in a portion of the cell.

2.2 Perimeter Embankment

The inspection and testing for the perimeter embankment can be found in Table 2. The standard proctor test results summary, lift approval summary, and one lift approval package for the perimeter embankment are provided in Appendix A1.

Table 2. 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 sheepsfoot compactor
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	Forty-one lifts were approved. Forty-one tests were performed with average density of 96.9% of the laboratory-determined maximum dry density.

Table 2. 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
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 41 density tests.
Laboratory Compaction Characteristics	Common fill: perform laboratory density (standard proctor) and moisture content tests for each type of fill material to determine the optimum moisture and laboratory maximum density values. Perform in accordance with the following as applicable: *ASTM D698 and D2216.	Specification 31-00-00 Section 3.14.4	6.3.4	Four tests were performed to determine compaction characteristics.

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

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 (%)
UW1M01141105-00	11/06/14	93.4	98.3
UW1M20150504-01	05/05/15	90.5	99.5

2.3.2 RRM Placement

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 placement of 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 the RRM layers shall be repaired and grades re-established. If freezing or desiccation occurs, the affected soil shall be reconditioned, as directed.	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.
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	Twenty-seven 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 standards, as applicable: *ASTM D4643, D4944, and D4959.	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	Two tests were performed with average in-place density of 92.0% of the laboratory-determined maximum dry density. Both 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	Three hundred twenty-six 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 interim cover were conducted during this period.

2.5 Radon Barrier

2.5.1 Radon Barrier Placement

No lift approval activities associated with the radon barrier were conducted during this period**.** One buyoff survey was completed from work conducted during the previous report period and is provided in Appendix A4. The distribution of survey points is shown in Figure 4.

2.5.2 Verification Measurements for Radon Flux

No radon flux measurements were conducted during this period.

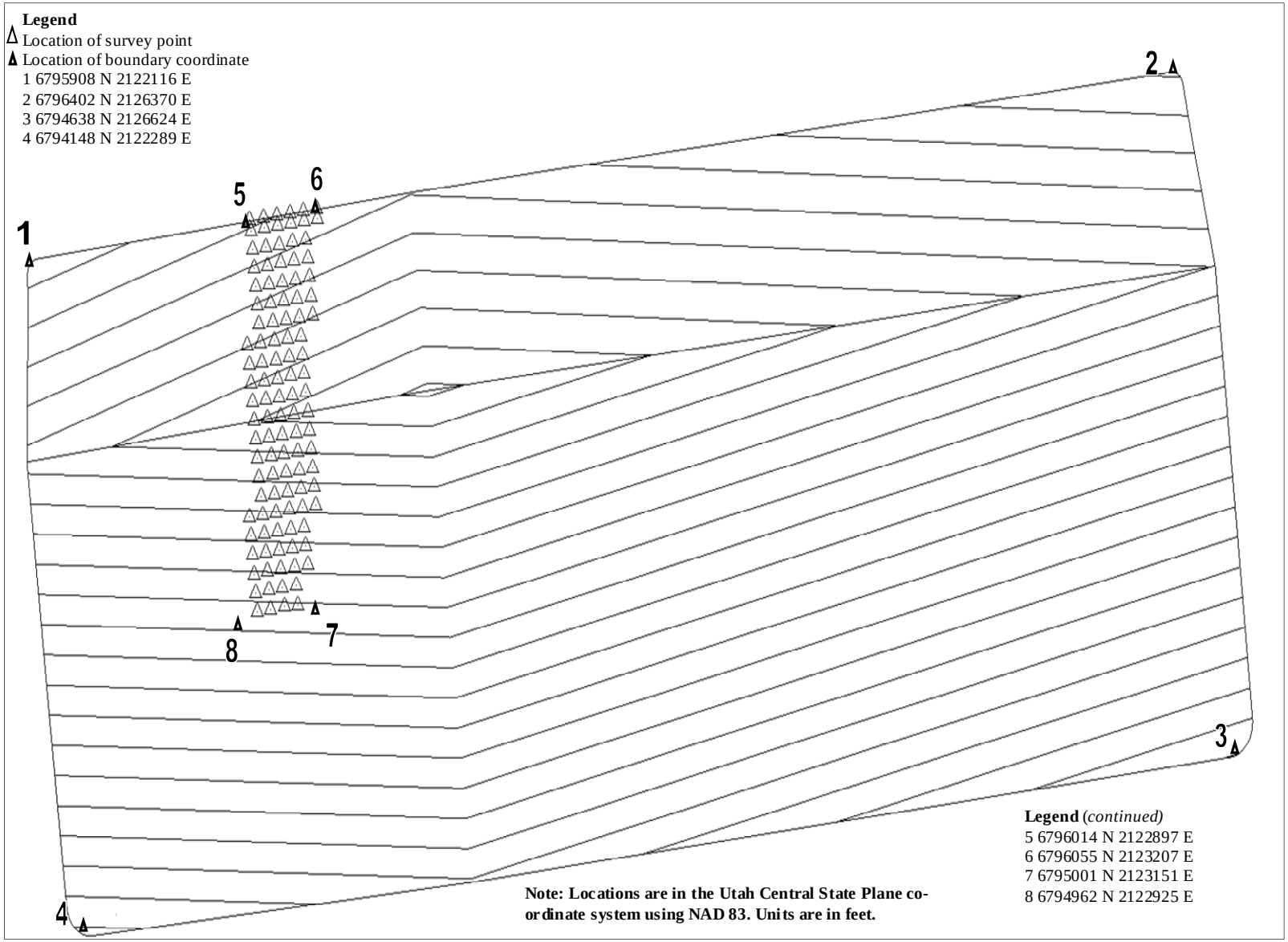

Figure 4. Distribution of Survey Points to Verify Compliance with Radon Barrier Specifications

2.6 Infiltration and Biointrusion Barrier

The inspection and testing for the infiltration and biointrusion barrier can be found in Table 5. The distribution of survey points is shown in Figure 5. The lift approval summary, one lift approval package, buyoff surveys, and durability and gradation test results for the infiltration and biointrusion barrier are provided in Appendix A5.

Table 5. Infiltration and Biointrusion Barrier Inspection and Testing

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
Visual Observation	Gravel material is placed and compacted to produce a continuous, uniform thickness of at least 6 in. Compaction is performed by a vibratory steel-drum roller, and the roller makes a minimum of two passes over the placed gravel fill.	Specification 31-00-30 Section 3.4.1	6.8.2	Material placement was visually observed and surveyed throughout placement and documented in lift approval packages. Compaction was performed by a vibratory steel-drum roller, and the roller made a minimum of two passes over the placed gravel fill.
Durability	Perform in accordance with the following as applicable: *ASTM C88, C127, and C131; Schmidt rebound hardness ISRM Method and Splitting Tensile Strength ISRM Method.	Specification 32-11-23 Table 2	6.8.1	Two durability tests performed.
Gradation	Perform in accordance with the following as applicable: *ASTM C117 and C136.	Specification 32-11-23 Table 3	6.8.2	Two gradation tests performed.

ASTM = ASTM International; in. = inches; ISRM = International Society for Rock Mechanics
*ASTM Standard titles are included in the References Section 5.0.

2.7 Frost Protection Layer

The inspection and testing for the frost protection layer can be found in Table 6. The CAES was not used for compaction of frost protection lifts, so inspections and associated criteria for the CAES are not included in the table. The distribution of survey points is shown in Figure 6. The standard proctor test results summary, lift approval summaries, one lift approval package, and buyoff surveys for the frost protection layer are provided in Appendix A6.

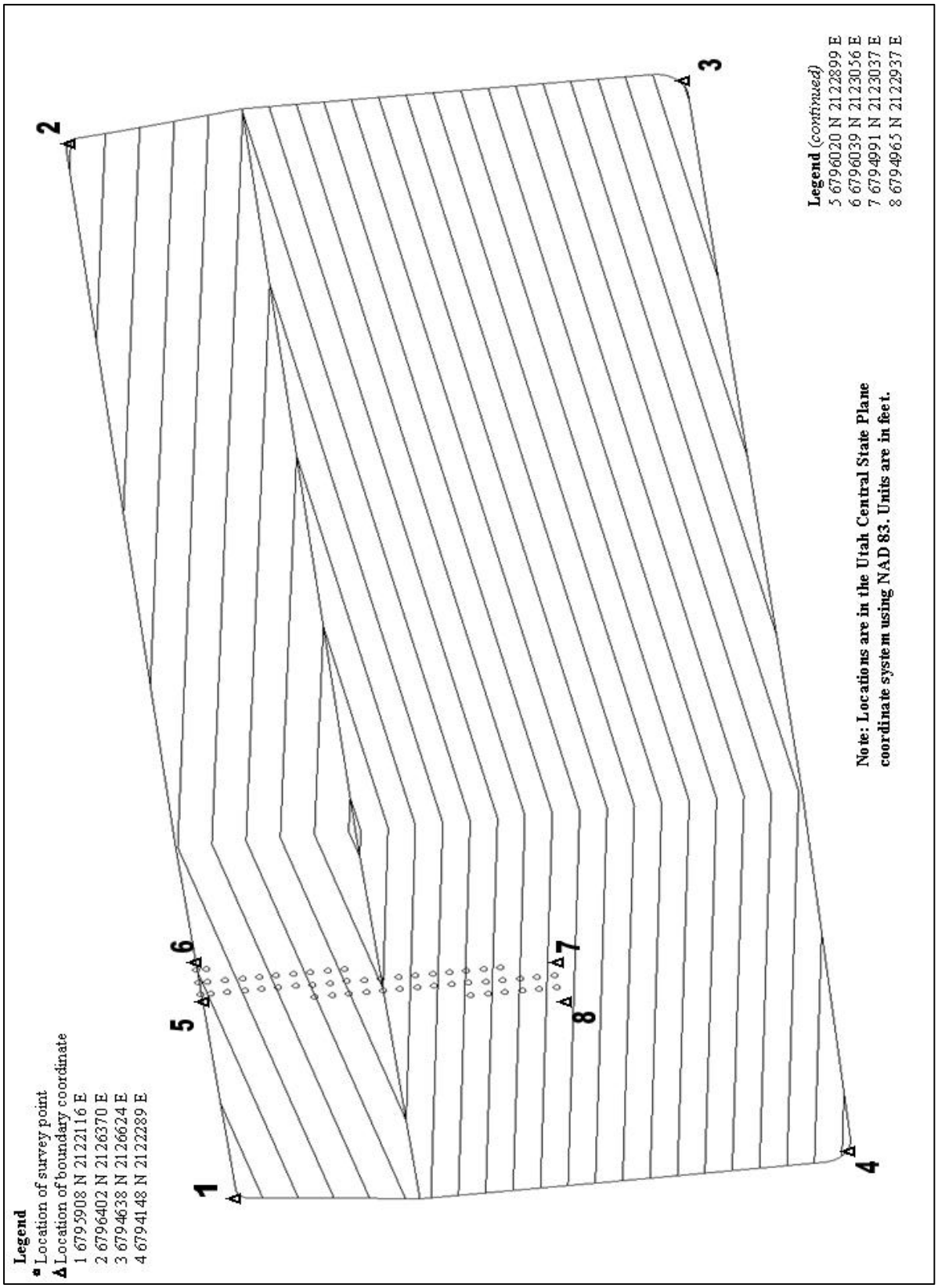

Figure 5. Distribution of Survey Points to Verify Compliance with Infiltration and Biointrusion Barrier Specifications

Table 6. Frost Protection Layer 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: 3 ft of clean, compacted soil. Loose lifts average thickness not to exceed 12 in. compacted with rubber-tired or -footed roller compaction equipment. Scarification of the upper surface of each underlying soil layer before placement of the next lift. Final lift of soil shall not be scarified. Final lift shall be smooth-rolled with at least three passes of the approved, smooth steel-wheeled roller weighing a minimum of 20,000 lb.	Specification 31-00-30 Sections 3.3.2 and 3.3.4	6.9.3	Material preparation, ground preparation, and fill placement operations were visually verified throughout placement. Smooth-drum rolling was also observed on final grade of frost protection. Documentation is provided in lift approval packages.
High Accuracy GPS Survey	Document the pre-cap geometry of the site.	Specification 31-00-30 Section 3.3.2	6.9.5	Pre-installation survey performed using high accuracy GPS.
High Accuracy GPS Survey	Confirm that the total fill thickness is in accordance with plans and specifications.	Specification 31-00-30 Section 3.2.2	6.9.5	Completed using high accuracy GPS.
In-place Density/ Moisture Test	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 31-00-30 Section 3.3.3	6.9.4	Sixteen lifts approved; 32 in-place density/moisture tests performed with an average density of 96.7% of the laboratory-determined maximum dry density. All moisture tests were within ±5% of optimum.
Laboratory Compaction Characteristics	Tests have been performed on the common fill to determine its maximum dry density and optimum moisture content per *ASTM D698. Perform in accordance with the following as applicable: *ASTM D698 and D2216.	Specification 31-00-30 Section 3.3.5	6.9.4	Three tests performed to determine compaction characteristics.

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

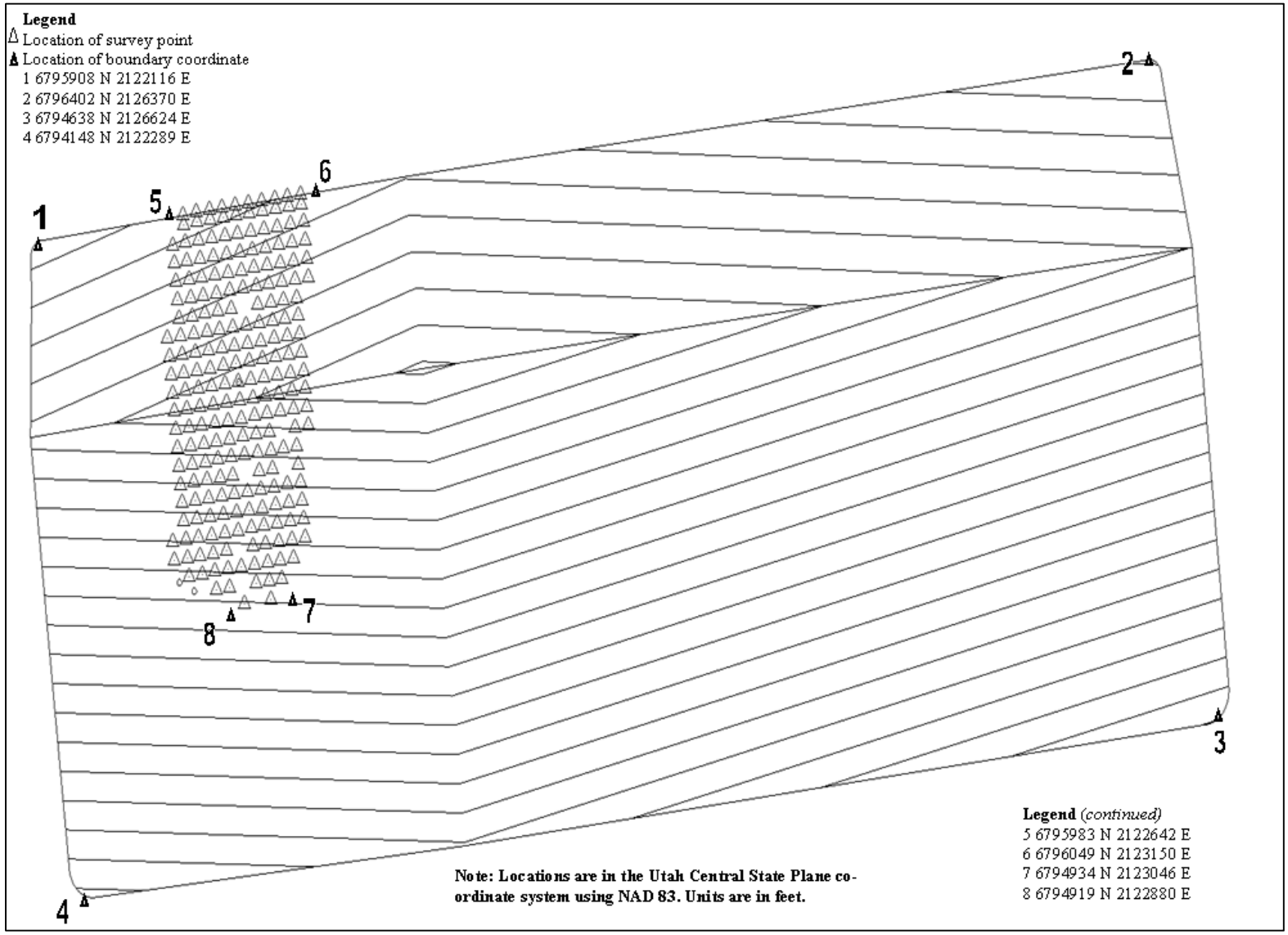

Figure 6. Distribution of Survey Points to Verify Compliance with Frost Protection Layer Specifications

2.8 Cap Rock and Armoring

Approximately 240 yd^3 of cap rock was placed as the top cover layer. Durability testing was previously completed on this rock, and the results are included in Appendix A. Due to the limited quantity placed, no lifts were approved during this reporting 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. 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) (QAP), 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 7.

Table 7. 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.
1-92-677	Green River Water Right	State Water Engineer	DOE has right to divert 323 acre-feet or ~200 gallons per minute from Green River for Crescent Junction disposal site.
400-00177	Easement for Green River Pump Station	Utah Division of Forestry, Fire, and State Lands	ROW easement to construct and operate water pipeline.
400-00177	Waterline Easement	Utah Division of Forestry, Fire, and State Lands	ROW easement to construct and operate waterline in the Green River.
4P-082341-1	UDOT Encroachment Permit	UDOT	To construct waterline within UDOT 60-ft ROW and operate within 20-ft ROW near Floy Wash.
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 and Wildlife Service	US Fish and Wildlife Service issued biological opinion for Green River pump station.
Case No. 11-0028	Memorandum of Agreement	U.S. 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 Plan (08/07/06) UAC R307-309-6, "Fugitive Dust Control Plan"	Utah Division of Air Quality	Approval letter from the state of Utah for the *Crescent Junction Site Fugitive Dust Control Plan.*
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.

Table 7. Crescent Junction Site Permits and Agreements (continued)

Agreement Number	Document Name or Description	Issuing Agency	Purpose
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	UDOT 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	U.S. Bureau of Land Management	Order permanently transferred 500 acres of BLM public domain land to DOE for disposal cell.
Public Land Order 7734	Public Land Withdrawal	U.S. Bureau of Land Management	Order withdrew 936 acres of public land for activities to support disposal of mill tailings at the Crescent Junction disposal site. The withdrawal is for 20 years to support Public Land Order 7697.
REEMCBCDOE-3-15-0702	Real Estate License	Rocky Mountain Power	Powerline 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.
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.

Table 7. Crescent Junction Site Permits and Agreements (continued)

Agreement Number	Document Name or Description	Issuing Agency	Purpose
SPK-2007-632	U.S. Army Corps of Engineers 404 Permit	U.S. Army Corps of Engineers	To construct pump station on the Green River.
Statewide Utility License Agreement No. 8439	UDOT Utility License	UDOT	License with state of Utah to construct waterline across UDOT property.
U.S. DOT No. 041012550006TV	U.S. DOT Hazardous Materials Certificate of Registration	U.S. DOT	For shippers of hazardous materials through 06/2017.
U.S. DOT-SP 14283	Special Permit Authorization	U.S. DOT	Permit to transport mill tailings from Moab site to the disposal site.
UTR359187	Storm Water Permit	Utah Division of Water Quality	For the disposal site.
UT-SES-GR-14001	MOU for use of Fresh Water Pond	Utah Dept. of Natural Resources & BLM	MOU outlines terms and conditions for helicopter use of pond for wildland fire fighting
UTU-83353	ROW	U.S. BLM, Moab Field Office	ROW for 3-in. service culinary waterline and a 2-in. delivery culinary waterline to the disposal site.
UTU-83354	Waterline ROW	U.S. BLM, Moab Field Office	For construction of 14.5 miles of waterline on BLM land from Green River to disposal site.
UTU-83396	ROW	U.S. BLM, Moab Field Office	For buried telephone line at the disposal site.
UTU-83450	ROW	U.S. BLM, Moab Field Office	ROW for power line to the disposal site.
Not assigned	Memorandum of Agreement	U.S. 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 four major activities:

- Excavation of soils within the cell design boundary to facilitate construction of a new tailings dump ramp
- Placement of RRM to the design thickness
- 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 8.

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.

4.2.1 Excavation

Limited excavation of material east of the Phase 2 cell boundary was conducted to enable construction of a new platform (dump ramp) to facilitate emptying and decontaminating RRM containers. Excavation also was initiated to remove the former platform located within the Phase 2 cell boundary.

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 D* (DOE-EM/GJ2040-D). 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 275X Bulldozer were used to compact the RRM in place.

Table 8. Descriptions of Compaction Equipment Used during Cell Construction

Compaction Equipment	Machine Weight (lb)	Equipped with CAES	Material Layer Equipment Used On						
			RRM	Interim Cover	Radon Barrier	Infiltration and Biointrusion Barrier	Frost Protection	Perimeter Embankment	Spoils Embankment
CAT 825H Soils Compactor	69,000	X	X				X	X	X
CAT D8 Bulldozer	84,850	X	X						
Komatsu 275X Bulldozer	112,466	X	X						
CAT 637G Scraper	118,084						X		X
CAT CS563 Vibratory Roller	24,537					X	X		

lb = pounds

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 foot (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 reporting period, there were 58,752 yd^3 of final cover placed.

4.2.5 Spoils Embankment Construction

Material excavated on site was 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. The inspection and testing for the spoils embankment can be found in Table 9. The standard proctor test results summary, lift approval summary, and one lift approval package for the spoils embankment are provided in Appendix A8.

Table 9. 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 moisture conditioned near optimum moisture content levels.	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 825H compactor and CAT 637G scraper. Thickness was visually verified. Each lift is documented.
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.	Specification 31-00-00 Section 3.11.1.3	6.3.5	Two 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	Six in-place density/moisture tests performed with an average density of >97.1% of the laboratory-determined maximum dry density. All moisture tests were within ±5% of optimum.

Table 9. 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 to ASTM D2216 or D4643.	Specification 31-00-00 Section 3.14.2	6.3.5	One moisture correlation test performed, meeting requirements.
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	Two tests performed to determine compaction characteristics.

ASTM = ASTM International; ft^2 = square feet, GPS = global positioning system; in. = inches; lb = pounds

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 that the 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 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 that each lift met established criteria. Results of lifts are documented in lift approval packages. A sample lift approval package for the perimeter embankment, RRM, and each cell cover layer placed during this report period is provided in Appendix A.

4.5 Geotechnical Testing

The following procedures were used to ensure cell construction was performed in compliance with the RAP.

- 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.
- The *Moab UMTRA Project Standard Practice for Sampling Aggregates Procedure* (DOE-EM/GJRAC1933) provides a consistent method for sampling aggregates for the cell cover.

The RAIP describes the methods and frequencies for performing tests to verify the material placed in the cell meets the requirements. Geotechnical tests performed fell within two general categories: soils testing and aggregate testing. The following subsections contain descriptions of these categories.

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 the 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, the test selected to represent that soil type appears in red in the table. Over time, the interim cover, radon barrier, and frost protection layers were found to have a consistent soil type, so the need for sets of standard proctor tests was eliminated, and standard proctors were completed in the frequency required by the RAIP. 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 that 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 (GPS), when practical; otherwise, manual measurements were taken.

4.5.2 Aggregate Testing

The following tests were performed on each aggregate layer placed.

- Gradation tests to verify that the rock was appropriately sized
- Durability tests to verify the hardness and mineral composition
- Visual inspections to verify there was no nesting of fines and that the aggregate was uniformly placed

Compaction processes were visually observed for the infiltration and biointrusion barrier. Testing of two samples for rock durability was performed per the RAIP and the results are summarized in Table 10, including the calculated NRC rock quality score. The samples met the durability requirements and scored above the acceptable NRC criteria of 80 percent.

Table 10. Rock Durability Test Results and NRC Rock Quality Scores

Laboratory Sample* ID Number	Rock Durability Test Results					NRC Rock Quality Score		
	Specific Gravity	Absorption (%)	Sodium Sulfate (%)	L.A. Abrasion	Schmidt Hammer	Total	Maximum	Final (%)
Infiltration and Biointrusion Barrier								
UB01	2.675	0.65	0.59	6.7	48	228.0	260	87.7
UB02	2.610	0.93	0.68	6.2	54	213.9	260	82.3

L.A. = Los Angeles
* All samples were of gray basalt.

4.6 Radiological Verification

Section 5, 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.

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. All personnel who performed work addressed in this Addendum were qualified in accordance with the requirements of the QAP.

During construction activities, surveillances, and management 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) performed operational oversight, surveillances, and assessments of these activities. During the period of this Addendum, four surveillances, one oversight assessment, and seven management assessments were performed (see Table 11). Corrective actions were developed and implemented for all issues identified during these assessments.

Table 11. Surveillances and Assessments Conducted during Construction

Date	Conducted By	Type	Assessment Number	Scope
10/09/14	TAC	Surveillance	DOE-15-SUR-001	Evaluated radon barrier placement activities and sampling of the infiltration and biointrusion barriers to verify compliance to the RAP Addendum B, Final Design Specifications and the RAIP.
10/20/14	TAC	Management Assessment	DOE-15-MA-003	Examine the conditions at the Fremont Junction Quarry Site.
10/22/14	TAC	Surveillance	DOE-15-SUR-002	Evaluate a completed lift of the frost protection layer utilizing both visual inspection and nuclear moisture/density testing to verify compliance with the final RAP Addendum B, Final Design Specifications and the RAIP.
12/08/14 – 12/09/14	TAC	Surveillance	DOE-15-SUR-004	Technical review of the draft Interim Completion Report Addendum D.
01/14/15	RAC	Management Assessment	MA-15-005	Evaluate the efficiency and safety of processes used for placement of interim and final cover on the disposal cell.
02/11/15	TAC	Operational Oversight	NA	Evaluate tailings placement and compaction at the Crescent Junction disposal site.
02/11/15 – 02/13/15	RAC	Surveillance	MA-15-S-004	Evaluate the implementation of MB-IWP/JSA-011, *Disposal Cell Operations*.
06/01/15	RAC	Management Assessment	MA-15-025	Review the Security Operations practices for site access at Moab and Crescent Junction.
06/24/15	RAC	Management Assessment	MA-15-014	Evaluate the efficiency and safety of the new dump ramp area/RBA since its installation in March 2015.
07/27/15	RAC	Management Assessment	MA-15-019	Review the Permits and Agreements Report to determine whether RAC permits and agreements are being maintained and updated in a timely fashion and in compliance with their terms and conditions.
08/16/15 – 09/01/15	RAC	Management Assessment	MA-15-026	Review and verify compliance of the QA Program for the Moab Project.
08/17/15 – 09/25/15	RAC	Management Assessment	MA-15-020	Assess the adequacy and effectiveness of the RAC's QC Program to control, verify and document the remedial action activities associated with the disposal cell.

IWP/JSA = Integrated Work Plan/Job Safety Analysis; QC = quality control; RBA = radiological buffer area

4.8 Monitoring Free Liquid Presence

The results of monitoring, during this period, of the one existing standpipe (see Figure 7) for the presence of free liquids in the disposal cell, are shown in Table 12. No additional standpipes were installed during this period.

Table 12. Monitoring Results for the Presence of Fluids in Standpipe 01

Date Monitored	Presence or Level of Fluids (ft)
09/30/14	Dry
12/10/14	Dry
03/25/15	Dry
06/29/15	Dry

[1]Dry = no fluids present

Figure 7. Locations of Monitoring Wells and Standpipe

4.9 Monitoring Ground Water Presence

Four wells were monitored for the presence of ground water outside of the disposal cell footprint (see Figure 7). Results of the monitoring are shown in Table 13. Water was encountered in one of the wells for the first time since monitoring was initiated in late 2011. On June 29, 2015, it was noted that the bottom of well 0205 had dropped 6 ft in elevation and approximately 11 ft of water was present. This well was sampled in July for anions, cations, inorganics (ammonia, nitrate/nitrite, and total dissolved solids), and select radiological constituents (gross alpha, gross beta, Ra-228, and Ra-226). Based on the radionuclide concentrations, the water recharging well 0205 does not appear to be associated with the disposal cell.

Table 13. Monitoring Results for Presence of Ground Water

Date Monitored	Monitor Well Number			
	0202	0203	0205	0210
9/30/14	Dry		Dry	
10/02/14		Dry		Dry
12/10/14	Dry	Dry	Dry	Dry
03/25/15	Dry	Dry	Dry	Dry
06/29/15	Dry		DTW = 59.57 ft btoc	
07/07/15		Dry		Dry
08/03/15	Dry	Dry	DTW = 58.88 ft btoc	Dry

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

Between July 21 and September 30, the recharge rate for well 0205 gradually decreased from 0.20 to 0.04 gallons per minute. During an investigation to determine if the well was recharging from one discrete zone or throughout the borehole, a fracture at 60.2 ft below top of casing was noted. This fracture appears to be a significant contributor to the recharge. A report will be prepared describing actions taken since the water was discovered and short-term recovery test data and analytical data associated with samples collected from this well.

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.”

ASTM (ASTM International) Standard C88, “Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.”

ASTM (ASTM International) Standard C117, “Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Minerals Aggregates by Washing.”

ASTM (ASTM International) Standard C127, “Standard Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate.”

ASTM (ASTM International) Standard C131, “Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.”

ASTM (ASTM International) Standard C136, “Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.”

ASTM (ASTM International) Standard D698, “Standard Test Method 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 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 D4944, “Standard Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester.”

ASTM (ASTM International) Standard D4959, “Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct 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 D* (DOE-EM/GJRAC2040-D).

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* (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), *Moab UMTRA Project Standard Practice for Sampling Aggregates Procedure* (DOE-EM/GJRAC1933).

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.”