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Office of Environmental Management – Grand Junction

UMTRA Project

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

Revision 0

December 2012

U.S. Department of Energy

Office of Environmental Management

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Prepared by the Remedial Action Contractor under contract numbers DE-AT30-07CC00014 and DE-DT0002936 for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

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Addendum A

Revision 0

Review and Approval

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Revision History

Revision No.	Date	Reason/Basis for Revision
0	December 2012	Initial issue.

Contents

Tables

Tables *(continued)*

Figures

Appendices

Attachments

Attachment 1. Geologic Verifications of Phase 1 and Phase 2 Cell Excavation
Attachment 2. Procedures and Work Instruction
Attachment 3. Design Change Notices
Attachment 4. NRC Correspondence
Attachment 5. Supporting Documents

Acronyms and Abbreviations

ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
CAT	Caterpillar, Inc.
CAES	Computer Aided Earthmoving System
CID	Construction Interface Document
DCN	Design Change Notice
DOE	U.S. Department of Energy
DOE O	DOE Order
EPA	U.S. Environmental Protection Agency
ft	feet
GPS	global positioning system
NQA	Nuclear Quality Assurance
NRC	U.S. Nuclear Regulatory Commission
pCi/g	picocuries per gram
$pCi/m^2/s$	picocuries per square meter per second
QA	Quality Assurance
Ra-226	radium-226
RAC	Remedial Action Contract or Contractor
RAIP	Remedial Action Inspection Plan
RAP	Remedial Action Plan
RAS	Remedial Action Selection Report
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 A documents the construction of a portion of a 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 that are referenced in a Final Completion Report that will be prepared to address the entire cell construction.

This Addendum A addresses activities performed by Energy*Solutions*, the DOE Remedial Action Contractor (RAC) for the Moab Project, and its teaming partner, Jacobs Engineering, Inc., from June 20, 2007, through April 29, 2012. This report includes excavation of the first two phases of the disposal cell totaling 3.5 million cubic yards (yd^3) of soils, placement of 2.4 million yd^3 of RRM, and placement of almost 28 acres of final cover materials.

This Addendum A 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 *Remedial Action Plan* (RAP) received conditional concurrence from the U.S. Nuclear Regulatory Commission (NRC). Included in this report are a critical review, design assessment, and remedial action assessment of activities performed during this report period. Also provided are associated data tables, photographs, laboratory results, and other supporting documentation.

During construction of the cell, conditions were encountered that could affect the cell performance and, therefore, required modifications to the final designs. The design changes are documented on Design Change Notices (DCNs). Some of the conditions were sufficient to require changes to the RAP; therefore, DOE sought and obtained NRC acceptance of these changes.

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

1.0 Introduction

The scope of the Moab UMTRA Project is to relocate RRM from the former uranium-ore processing facility and from offsite 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 southeast 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.

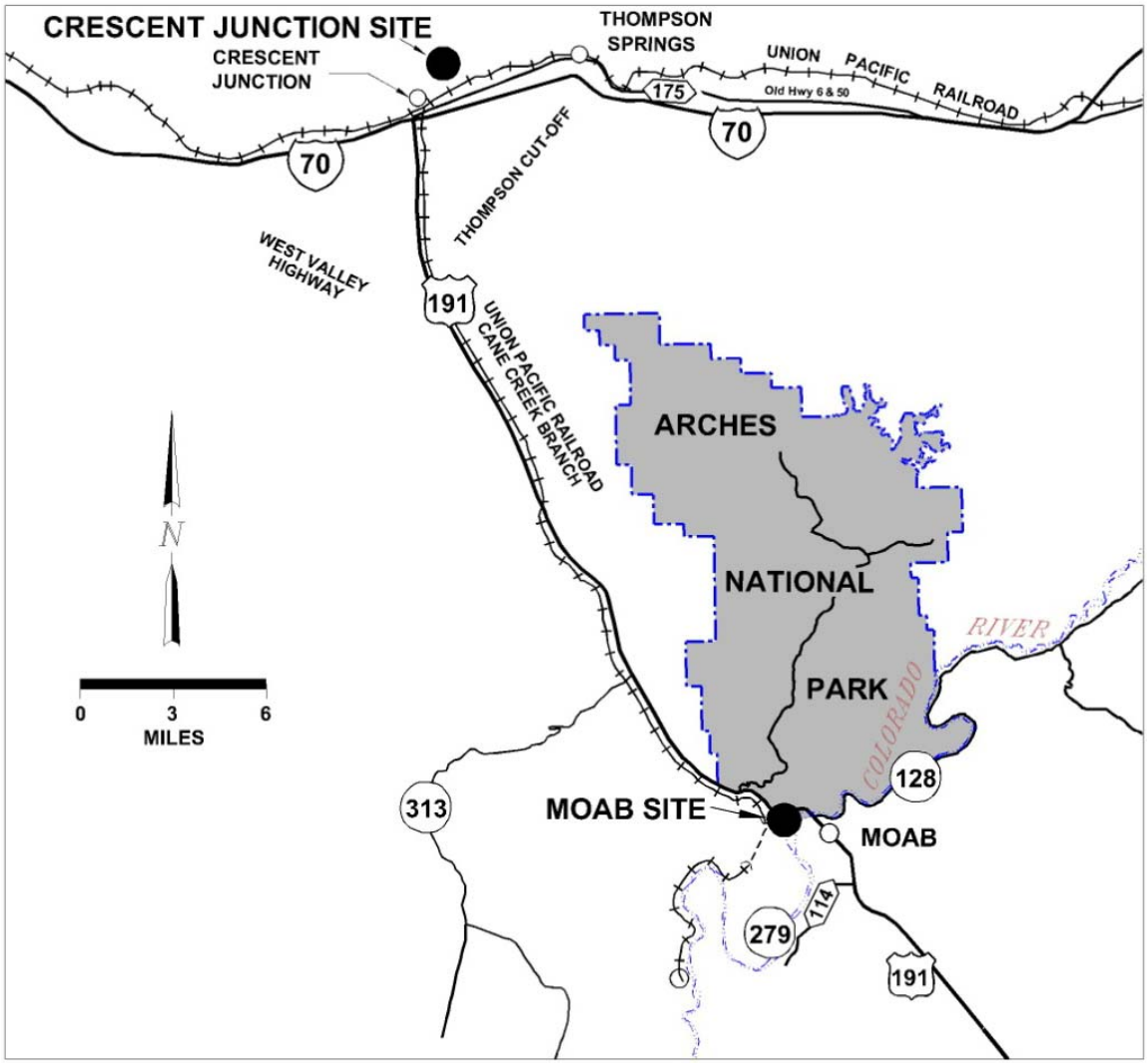

Figure 1. Location of Moab and Crescent Junction Sites

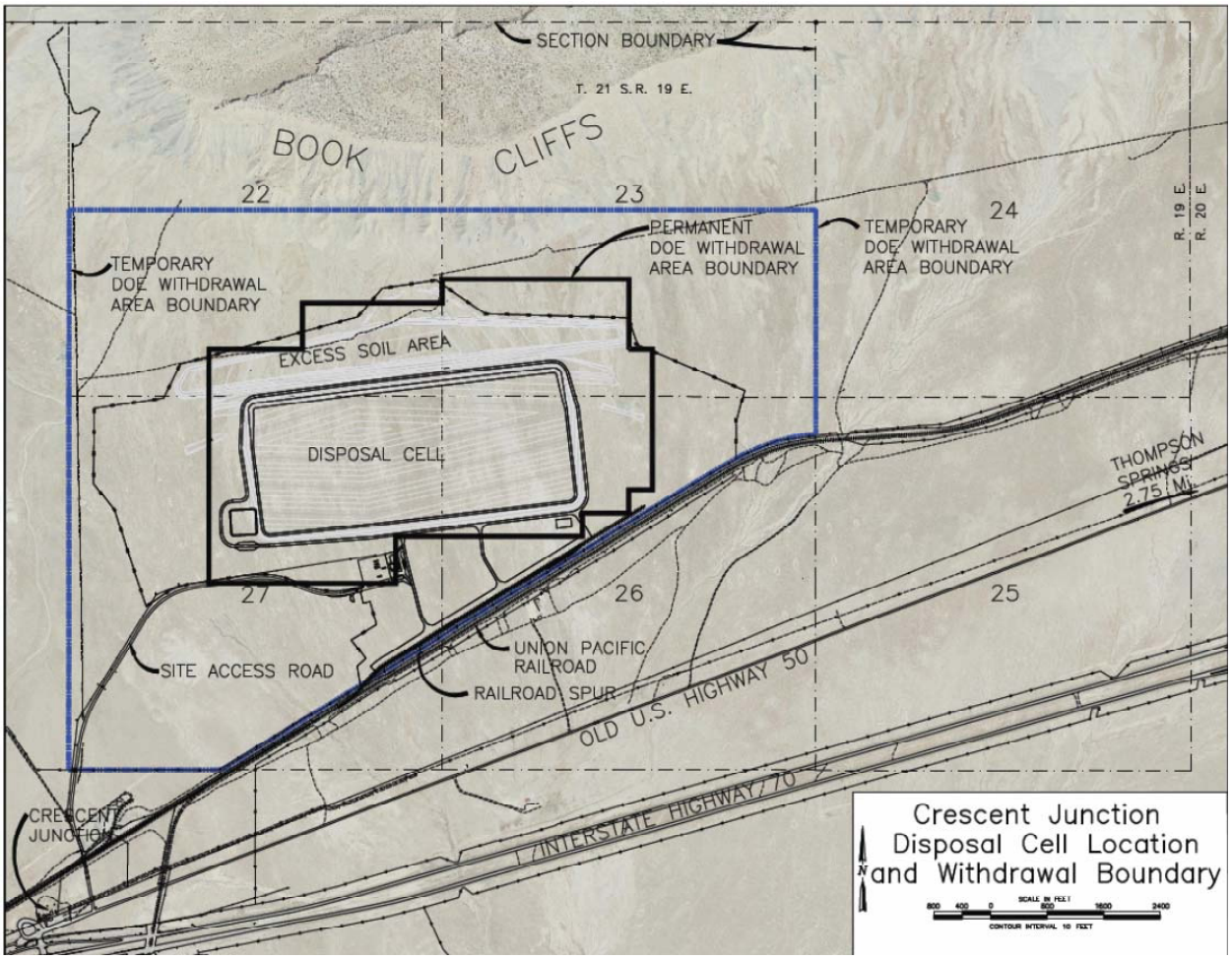

Figure 2. Crescent Junction Site Features

This Interim Completion Report Addendum A documents the excavation of the first two phases of the disposal cell, placement of RRM removed from the Moab site, and placement of final cell cover materials. Removal of the RRM began in April 2009. This report was written to document activities performed by the RAC for the Project from June 20, 2007, through April 29, 2012.

This document is structured as follows:

- 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 to the design requirements in the RAP.
- Section 4.0 provides verification that the excavation of the cell and placement of RRM 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.
- Attachment 1 contains the geologic verifications of Phase 1 and 2 cell excavation.
- Attachment 2 contains copies of the procedures and a work instruction associated with constructing the cell.

- Attachment 3 contains copies of the DCNs that required NRC concurrence.
- Attachment 4 contains correspondence with NRC.
- Attachment 5 contains other supporting information used in preparing this Addendum.

2.0 Critical Review

The critical review provides the reader with key technical information about the disposal cell construction. This section contains tables summarizing inspections or tests for cell excavation, embankment construction, RRM placement, and cover placement. 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 the *Remedial Action Inspection Plan* (RAIP), which is Addendum E to the RAP. The distribution survey associated with each material type is also included in this section.

Information regarding total lifts of compacted material, tests performed, and geotechnical data is outlined in Table 1. Additional geotechnical data are located in Appendix A. 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 the Phase 2 excavation and the south perimeter embankment.

Table 1. Lifts/Testing Totals

	Total Volume Placed (yd^3)	Total # of Lifts Approved	Lifts Approved Using CAES	Lifts Approved Not Using CAES	Total # of Standard Proctor Tests	Total # of In-Place Density/Moisture Tests	Total Average for all In-Place Density Tests Performed (%)	Total Average CAES Passes that Meet Compaction Criteria (%)	Total # of Soil Classifications	Total # of Durability Tests	Total # of Gradation Tests
Cell Perimeter Embankment	182,860	93	N/A	93	57	208	97.5	N/A	N/A	N/A	N/A
RRM	2,382,080	3,155	2,905	250	281	336	92.5	87.3	N/A	N/A	N/A
Interim Cover	71,865	35	19	16	7	41	>90.0	>90.0	N/A	N/A	N/A
Radon Barrier	187,744	72	43	29	47	71	98.3	97.5	47	N/A	N/A
Infiltration and Biointrusion Barrier	25,151	6	N/A	6	N/A	N/A	N/A	N/A	N/A	7	12
Frost Protection Layer	135,731	40	10	30	10	34	96.0	92.8	N/A	N/A	N/A
2-in. Cap Rock	25,502	3	N/A	3	N/A	N/A	N/A	N/A	N/A	10	13

= number; % = percent; CAES = Computer Aided Earthmoving System; in. = inch; N/A = not applicable

Figure 3. General Extent of Cover Layers

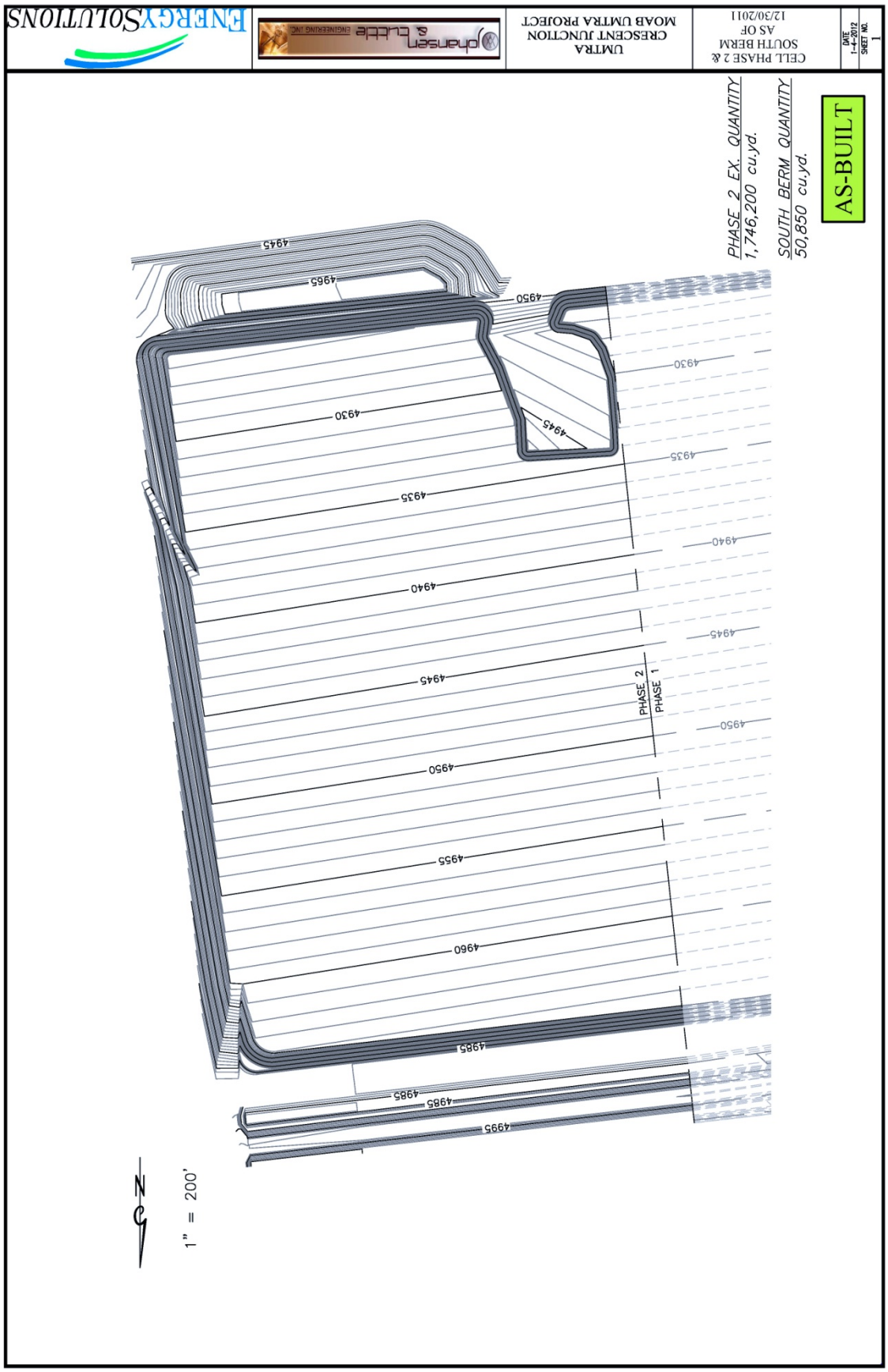

Figure 4. Extent of Phase 2 Excavation and South Perimeter Embankment

2.1 Cell Excavation

The inspection and testing summary for disposal cell excavation can be found in Table 2. The RAC hired S.M. Stoller Corporation to perform independent evaluation of the Phase 1 disposal cell excavation. A geologist with the Technical Assistance Contractor (TAC) performed a review of the Phase 2 cell excavation. The geologic characterization report prepared for Phase 1 and summary of the Phase 2 review can be found in Attachment 1.

Table 2. Cell Excavation Inspection and Testing

Inspection or Test Type	Criteria and Method #	RAP Specification Section or Drawing #	RAIP Section #	Verification Results
Visual Observation	The disposal cell floor is weathered Mancos Shale bedrock or low spots have been compacted with processed Mancos Shale bedrock.	N/A	6.2.3	All locations observed met criteria. Phase 1: 76 locations observed. Phase 2: 24 locations observed.
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 northeast to southwest. The cut slopes on the north, west, and south sides of the cell slope at 2:1 or 3:1.	Drawing C-02-C-102	6.2.1	The design volume in Phase 1 was compared to the final survey. The discrepancy was 968 yd^3. See the email of approval of Jacobs Engineering Cell Conformance dated 03/19/09 (Attachment 1).

= number; % = percent; GPS = global positioning system; N/A = not applicable

2.2 Perimeter Embankment

The inspection and testing for the perimeter embankment can be found in Table 3. The standard Proctor test results summary, lift approval summary, and one lift approval package for the perimeter embankment are provided in Appendix A1. A lift approval package consists of documentation of the tests conducted to demonstrate that the lift met requirements. A package could include lift approval forms and associated figures, slope elevation surveys, and field density tests.

Table 3. Perimeter Embankment Inspection and Testing

Inspection or Test Type	Criteria and Method #	RAP Specification Section or Drawing #	RAIP Section #	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 Caterpillar 816 sheepsfoot compactor
High-Accuracy GPS Survey	Interior slopes are 3:1. Exterior slopes are 5:1 with a minimum 30-ft wide and level top.	Specification 31-00-00 Section 3.11.1.2	6.3.4	Phase 1: See design Drawing C-02-C-102 and email of approval of Jacobs Engineering Cell Conformance dated 03/19/09 (Attachment 1). Phase 2: See Johansen & Tuttle Engineering, Inc. as-built drawing dated 01/04/12 (Figure 4).
In-Place Density/ Moisture Test	Common fill: compaction 95% of maximum dry density (standard Proctor). Optimum moisture content ± 5%. Perform in accordance with the following as applicable: ASTM D1556, D2216, D4643, or D6938.	Specification 31-00-00 Section 3.14	6.3.4	93 lifts were approved. 208 tests were performed with average density of 97.5% of the laboratory-determined maximum dry density.
Moisture Correlation	Perform one correlation test for moisture in accordance with ASTM D4643 or D2216 for every 10 tests performed per ASTM D6938.	Specification 31-00-00 Section 3.14.2	6.3.4	> 42 moisture correlation tests were performed to correlate with 208 density tests.
Sand Cone Correlation	When ASTM D6938 is used, check in-place densities by ASTM D1556.	Specification 31-00-00 Section 3.14.2	6.3.4	Sand cone correlation performed. 1 sand cone check test for each. 20 nuclear density gauge tests completed. > 21 sand cone tests performed.
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	57 tests were performed to determine compaction characteristics.

= number; % = percent; ASTM = American Society for Testing and Materials; ft = feet; in. = inches; lb = pounds

2.3 RRM

2.3.1 Computer Aided Earthmoving System Performance Verification Testing

The Project utilized machines equipped with a Computer Aided Earthmoving System (CAES) to compact RRM to meet verification requirements of in-place density tests in compliance with Section 6.4.3 of the RAIP. Two test pads were created to develop the criteria for demonstrating that the CAES-equipped dozers met the compaction requirements. Additional information about the CAES verification testing is provided in Section 4.3 of this Addendum. Four lifts of RRM were placed to establish the criteria for demonstrating that the CAES-equipped 825H sheepsfoot compactor met the compaction requirements. The lift approval packages for the test pads and the four lifts of RRM are provided in Appendix A2. The RAIP also requires periodic verification of the CAES compaction by comparing the results to in-place density test results. Table 4 shows the results of the comparison tests.

Table 4. CAES Performance Verification Testing

Lift ID #	Test Performance Date	In-Place Density Compaction (%)	Lift Area Meeting CAES Compaction Criteria (%)
UWA32090423-00	04/23/09	93.1	70.9
UWG32090430-00	04/30/09	91.8	79.6
UWA32090430-00	04/30/09	94.3	80.0
UWA32090430-00	04/30/09	94.3	80.0
UWG32090430-01	04/30/09	90.0	78.3
UWA32090430-01	04/30/09	90.3	85.0
UWG32090430-02	04/30/09	90.5	81.4
UWA32090430-02	04/30/09	93.1	80.4
UWA32090501-00	05/01/09	92.0	83.1
UWG32090501-00	05/01/09	91.4	90.8
UWA32090507-00	05/07/09	92.1	79.7
UWG32090507-00	05/07/09	91.5	89.0
UWG32090513-02	05/13/09	97.5	89.8
UWA32090513-00	05/13/09	98.4	80.3
UWA32090603-02	06/03/09	94.9	96.0
UWA32090603-03	06/03/09	93.4	95.8
UWG32090603-03	06/03/09	91.5	80.9
UWG32090604-00	06/04/09	91.5	73.9
UWD22090604-00	06/04/09	95.2	97.3
UWA32090604-00	06/04/09	90.1	98.2
UWA32090604-01	06/04/09	91.8	89.4
UWD22090616-00	06/16/09	91.3	70.9
UWA32090617-02	06/17/09	95.6	89.3
UWI35090617-02	06/17/09	93.1	89.1
UWI35090626-01	06/26/09	91.1	83.7
UWH33090626-02	06/26/09	91.5	84.6

Table 4. CAES Performance Verification Testing (continued)

Lift ID #	Test Performance Date	In-Place Density Compaction (%)	Lift Area Meeting CAES Compaction Criteria (%)
UWH33090701-01	07/01/09	91.8	76.3
UWI35090701-02	07/01/09	91.1	70.6
UWH33090709-02	07/09/09	92.0	94.8
UWI35090709-01	07/09/09	94.3	90.1
UWF28090827-01	08/27/09	94.9	79.2
UWA32090827-01	08/27/09	90.8	79.3
UWH31090827-01	08/27/09	91.4	76.3
UWH32090827-01	08/27/09	93.7	78.1
UWE27090901-00	09/01/09	94.5	78.1
UWC23090901-00	09/01/09	91.3	91.3
UWF24090910-04	09/10/09	95.6	96.0
UWF24090911-03	09/11/09	90.9	73.5
UWH21091028-02	10/29/09	92.0	71.7
UWD20100111-00	01/11/10	90.4	74.1
UWE19100112-00	01/12/10	91.6	72.9
UWG14100205-00	02/05/10	92.1	75.2
UWE19100205-00	02/05/10	92.6	74.4
UWB03100414-00	04/14/10	92.4	92.3
UWH03100702-00	07/02/10	94.5	90.8
UWM12101117-01	11/17/10	90.9	95.7
UWJ21101211-00	12/11/10	90.6	94.8
UWM12101216-01	12/16/10	91.0	93.4
UWZ07110120-00	01/20/11	95.6	92.7
UWZ07110121-00	01/21/11	90.9	90.9
UWJ21110120-00	01/21/11	91.0	97.3
UWI24110120-00	01/21/11	94.2	94.7
UWN19110209-01	02/09/11	92.3	97.0
UWV21110802-00	08/02/11	92.5	93.9
UWR05110809-00	08/09/11	91.1	90.5
UWR06110812-00	08/12/11	90.9	96.0
UWP01111205-00	12/07/11	92.6	98.6
UWT01120404-00	04/05/12	92.4	98.4
UWZ06120419-00	04/20/12	91.3	98.9

= number; % = percent

2.3.2 RRM Placement

The inspection and testing for RRM can be found in Table 5. The distribution of survey points is shown in Figure 5. The standard Proctor test results summary, lift approval summaries, one lift approval package, and top-of-waste buyoff surveys for the RRM are provided in Appendix A2.

Table 5. RRM Inspection and Testing

Inspection or Test Type	Criteria and Method #	RAP Specification Section or Drawing #	RAIP Section #	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, prior to 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 reestablished. 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	Documented on 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, as applicable: ASTM D698 and D2216.	Specification 31-00-20 Section 3.1.1	6.4.3	281 tests were performed to determine compaction characteristics.
Sand Cone and Moisture Correlation Test	Companion sand cone tests and moisture tests must be performed with nuclear tests until a sufficient number have been performed to demonstrate a clear correlation. Perform in accordance with the following, as applicable: ASTM D1556, D2216, and D4643.	Specification 31-00-20 Section 3.4.1	6.4.3	Sand cone and moisture tests performed for correlation.
Moisture Test	Fill material is properly moisture conditioned. Optimum moisture content is ± 3% of optimum. Perform in accordance with the following, 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 5. RRM Inspection and Testing (continued)

Inspection or Test Type	Criteria and Method #	RAP Specification Section or Drawing #	RAIP Section #	Verification Results
In-place Density/ Moisture Test	Must meet 90% of maximum dry density standard Proctor. Optimum moisture content is ± 3% of optimum. Perform in accordance with the following, as applicable: ASTM D1556, D2216, D4643, and D6938.	Specification 31-00-20 Section 3.2.2	6.4.3	3,155 lifts were approved; 250 lifts were approved using in-place density/ moisture testing; 336 tests were performed with average in-place density of 92.5%, the laboratory-determined maximum dry density.
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	3,155 lifts were approved; 2,905 lifts were approved using CAES.
High-accuracy GPS	The top surface of the RRM shall be no greater than 2 in. above the lines and grades shown on the drawings, and verified by survey or the use of the CAES. No minus tolerance is permitted.	Specification 31-00-20 Section 3.3	6.4.5	Completed using high-accuracy GPS. Top-of-waste surveys (see Appendix A2).
Visual Observation	Each container of demolition debris shall be spread in a single layer (not stacked) and placed in a manner that results in a minimum of voids around the debris. Wood, concrete, and masonry: cut or break up to a maximum size of 3 ft measured in any dimension. Structural steel member, pipes, ducts, and other long items: cut into maximum lengths of 10 ft concrete, clay tile, and other pipes: crush concrete and clay tile pipes. Crush other pipes and ducts that are 6 in. or greater in diameter or, if crushing is impractical, cut pipes and ducts in half longitudinally. Do not crush asbestos-cement pipe. Rubber tires excavated at the site: cut into two halves around the circumference. Geo-membranes and other sheet material: cut into strips with a maximum of 4 ft wide by 4 ft long. Tree limbs with a diameter of 4 in. and larger: cut into lengths of 8 ft or less.	Specification 31-00-20 Section 3.2.5	6.4.4	Debris inspections performed during debris placement. Inspections documented in lift approval packages.

= number; ASTM = American Society for Testing and Materials; ft = feet; GPS = global positioning system; in. = inches; in^2 = square inches; lb = pounds; lb/ft^2 = pounds per square feet; QC = Quality Control

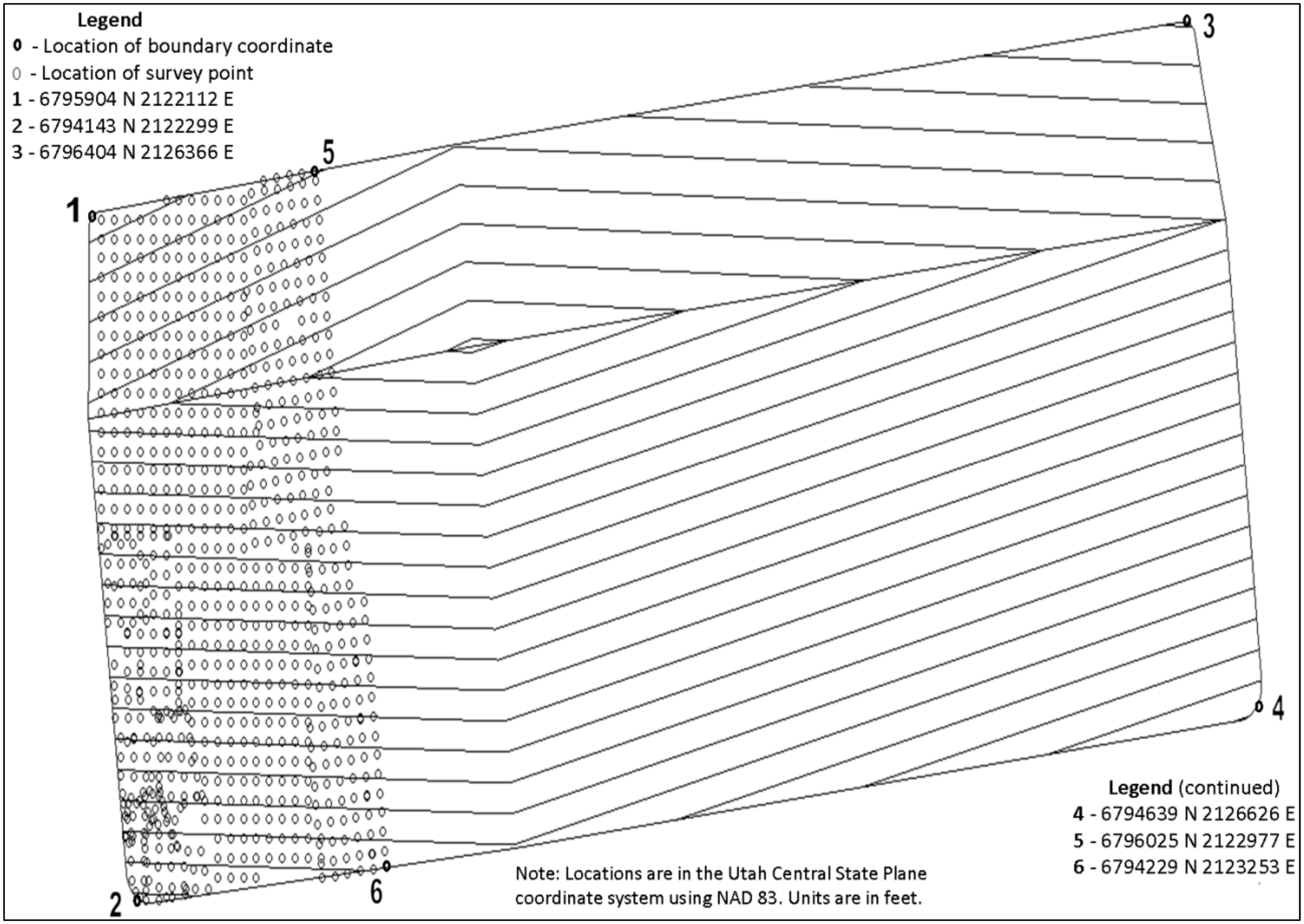

Figure 5. Distribution of Survey Points to Verify Compliance with RRM Specification

2.4 Interim Cover

The inspection and testing for the interim cover can be found in Table 6. 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 interim cover are provided in Appendix A3.

Table 6. Interim Cover Inspection and Testing

Inspection or Test Type	Criteria and Method #	RAP Specification Section or Drawing #	RAIP Section #	Verification Results
Visual Observation	Common fill (1 ft clean compacted): loose lifts with an average thickness not to exceed 12 in. Interim cover is placed in continuous and approximately horizontal lifts. Soil shall be free of roots, debris, and organic or frozen material. After lift placement, moisture content shall be maintained until the next lift is placed. Erosion that occurs in the RRM layers shall be repaired and grades re-established. Freezing and desiccation of the RRM shall be prevented. If freezing or desiccation occurs, the affected soil shall be reconditioned, as directed.	Specification 31-00-20 Section 3.2.1	6.5.4	Visually verified throughout material preparation, ground preparation, and interim cover placement. Documented on lift approvals.
High-Accuracy GPS Survey	The top surface of the interim cover shall be no greater than 2 in. above the lines and grades shown on the drawings. No minus tolerance is permitted.	Specification 31-00-20 Section 3.3	6.5.5	Completed using high-accuracy GPS.
In-Place Density/ Moisture Test	Common fill: 90% of maximum dry density standard Proctor test. Optimum ±5%. Perform in accordance with the following as applicable: ASTM D1556, D2216, D4643, and D6938.	Specification 31-00-20 Section 3.4.1	6.5.4	35 approved lifts; 16 using in-place density/moisture testing. 41 in-place tests were performed with average density >90% of laboratory-determined maximum dry density.
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	6.5.4	35 approved lifts; 19 lifts approved using CAES.
Sand Cone and Moisture Correlation Test	Common fill. Along with nuclear tests. Perform in accordance with the following as applicable: ASTM D1556, D2216, and D4643.	Specification 31-00-20 Section 3.4.1	6.5.4	Sand cone and moisture-correlation testing performed.
Laboratory Compaction Characteristics	Common fill. Perform in accordance with the following as applicable: ASTM D698 and D2216.	Specification 31-00-20 Section 3.1.1	6.5.4	7 tests performed to determine compaction characteristics.

Table 6. Interim Cover Inspection and Testing (continued)

Inspection or Test Type	Criteria and Method #	RAP Specification Section or Drawing #	RAIP Section #	Verification Results
Visual Observation	A smooth, non-vibratory steel-wheeled roller shall be used to produce a smooth compacted surface on the top of the completed interim cover layer, such that direct rainfall causes minimal erosion. Steel-wheeled rollers shall weigh a minimum of 20,000 lb. The final lift shall be rolled smooth with at least 3 passes of the smooth steel-wheeled roller to provide a smooth surface or proof rolled with rubber-tired construction equipment, such as a loaded dump truck or loaded scraper, with a minimum weight of 45,000 lb to produce a smooth compacted surface on the top of the completed interim cover layers, such that direct rainfall causes minimal erosion.	Specification 31-00-20 Section 1.3.3 and 3.2.4	6.5.5	Visually verified cover compaction using rubber tired construction equipment or a smooth drum roller performed on the final lift of the interim cover.

= number; % = percent; ASTM = American Society for Testing and Materials; ft = feet; GPS = global positioning system; in. = inches; lb = pounds; QC = Quality Control

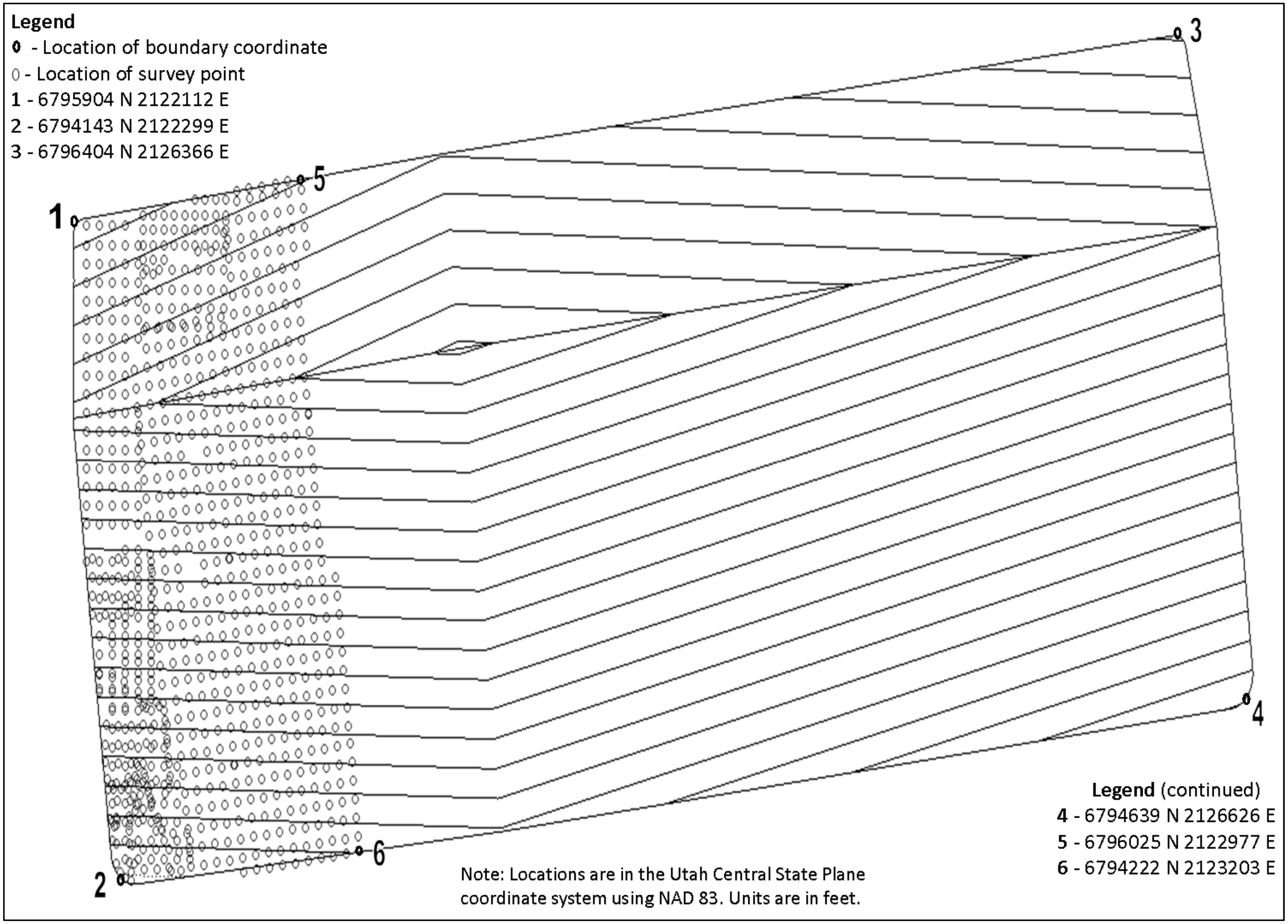

Figure 6. Distribution of Survey Points to Verify Compliance with Interim Cover Specification

2.5 Radon Barrier

2.5.1 Radon Barrier Placement

The inspection and testing for the radon barrier can be found in Table 7. The distribution of survey points is shown in Figure 7. The CAES test pad package, standard Proctor test results summary, lift approval summaries, and one lift approval package for the radon barrier are provided in Appendix A4.

Table 7. Radon Barrier Inspection and Testing

Inspection or Test Type	Criteria and Method #	RAP Specification Section or Drawing #	RAIP Section #	Verification Results
Visual Observation	Processed Mancos Shale bedrock. Loose lifts not to exceed 12 in. Compacted with rubber-tired or footed roller compaction equipment. Maximum particle size in the fill material shall be 4 in. No locations where rock type particles accumulate in a concentrated location. Scarification shall be performed on all areas of the upper surface of each underlying soil layer, prior to placement of the next lift The final lift shall not be scarified. It shall be smooth-rolled with a minimum of 3 passes of an approved steel smooth-drum roller.	Specification 31-00-30 Sections 2.1, 3.2.2, and 3.2.4	6.7.4	Radon barrier processing, ground preparation, and placement were visually verified, surveyed, and documented on lift approval packages.
Visual Observation	Processed Mancos Shale bedrock.	Specification 31-00-30 Section 3.2.1	6.7.4	Lift approval packages document the approval process.
Laboratory Compaction Characteristics	Processed Mancos Shale bedrock. Perform in accordance with the following as applicable: ASTM D698 and D2216.	Specification 31-00-30 Section 3.2.1	6.7.4	47 tests performed to determine compaction characteristics.
In-Place Density/ Moisture Test	Processed Mancos Shale bedrock. 95%. Optimum ± 3%. Perform in accordance with the following as applicable: ASTM D1556, D2216, D4643, and D6938.	Specification 31-00-30 Sections 3.2.1 and 3.2.3	6.7.4	72 approved lifts; 29 lifts approved using in-place density/moisture testing. 71 in-place density/moisture tests performed with average density of 98.3% of the laboratory-determined maximum dry density.
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 31-00-30 Section 3.2.5	6.7.4	72 approved lifts; 43 lifts approved using CAES.
Soil Classification	Processed Mancos Shale bedrock. Perform in accordance with the following as applicable: ASTM D422, D698, D1140, D2216, D4318, or D4643.	Specification 31-00-30 Section 3.2.1, Table 1	6.7.1	47 soil classification tests performed.

Table 7. Radon Barrier Inspection and Testing (continued)

Inspection or Test Type	Criteria and Method #	RAP Specification Section or Drawing #	RAIP Section #	Verification Results
Moisture Test	Processed Mancos Shale bedrock. Optimum ± 3%. Perform in accordance with the following as applicable: ASTM D4643 and D4944 or D4959.	Specification 31-00-30 Section 3.2.3	6.7.4	Tests performed to ensure moisture is within acceptable range.
High-Accuracy GPS Survey	Processed Mancos Shale bedrock. Confirm the total fill thickness of the radon barrier is in accordance with plans and specifications.	Specification 31-00-30 Section 3.5.2	6.7.5	Completed using high-accuracy GPS.
Sand Cone and Moisture Correlation Test	Processed Mancos Shale bedrock. With nuclear tests. Perform in accordance with the following as applicable: ASTM D1556, D2216, and D4643.	Specification 31-00-30 Section 3.6.1	6.7.4	Sand cone and moisture correlation tests performed.

= number; % = percent; ASTM = American Society for Testing and Materials; GPS = global positioning system; in. = inches; QC = Quality Control.

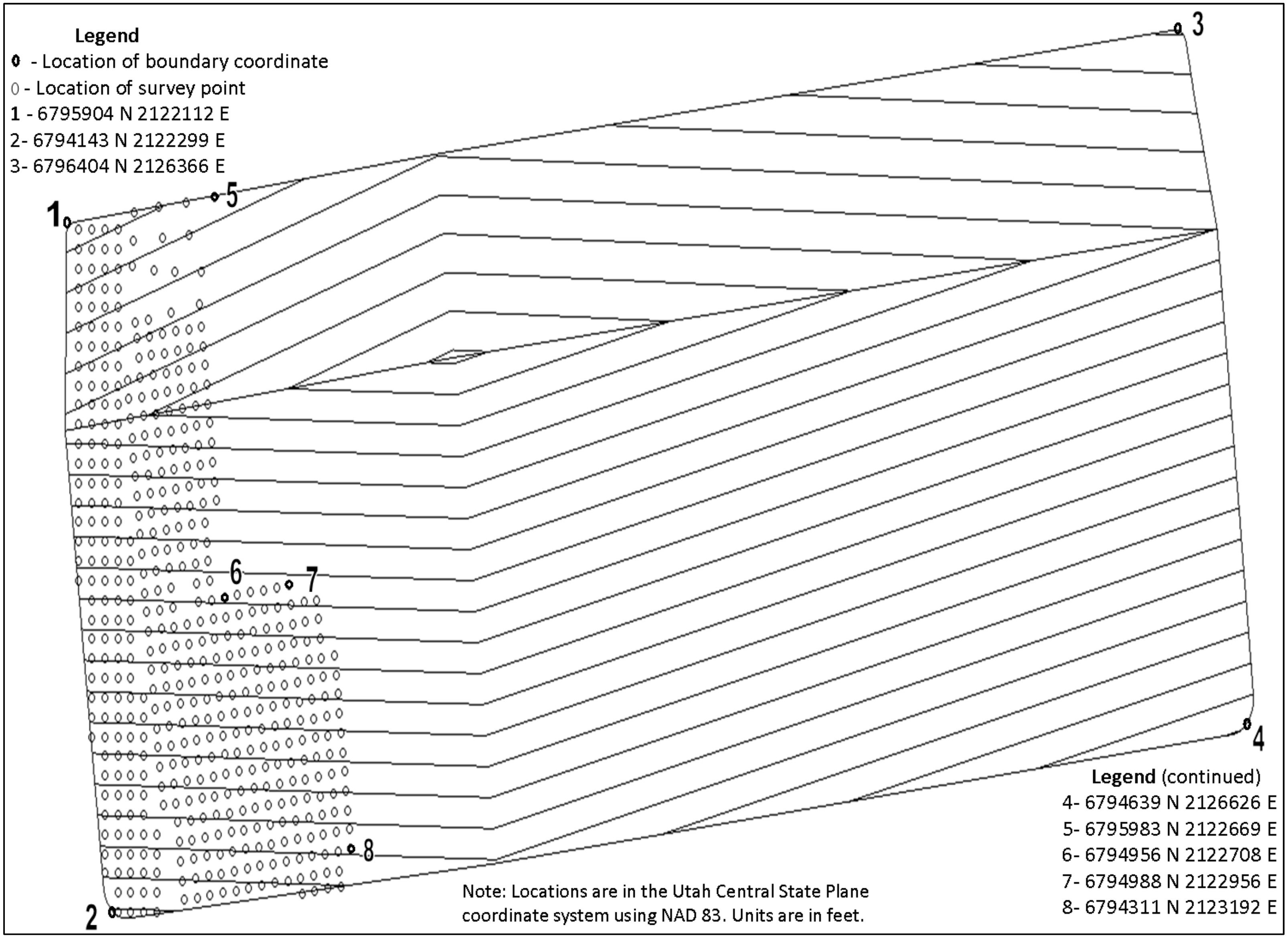

Figure 7. Distribution of Survey Points to Verify Compliance with Radon Barrier Specification

2.5.2 Verification Measurements for Radon Flux

Table 8 shows how the radon flux measurements met the performance criteria. The grid locations referenced in the table are shown on Figure 8, which contains all radon flux grid locations for the entire disposal cell. Further information can be found in Section 4.6.

Table 8. Radon Flux Measurements

Grid #	Location	Date Counted	Flux* ($pCi/m^2/s$)
1	6795750 N 2122250 E	10/09/2011	7.8804
2	6795500 N 2122250 E	10/09/2011	3.3663
3	South Position 1 6795202 N 2122305 E	09/15/2011	11.8050
4	South Position 2 6794997 N 2122235 E	09/15/2011	2.1364
5	North Position 1 6794837 N 2122242 E	09/15/2011	5.4166
6	South Position 3 6794376 N 2122349 E	09/15/2011	0.5048
7	North Position 2 6794291 N 2122347 E	09/15/2011	4.2170
8	6795750 N 2122500 E	06/10/2011	0.2177
9	6795499 N 2122500 E	06/10/2011	0.2393
10	6795250 N 2122500 E	06/10/2011	0.2601
11	6795000 N 2122500 E	06/10/2011	0.3338
12	6794750 N 2122500 E	06/10/2011	0.2326
13	6794500 N 2122500 E	06/10/2011	0.2374
14	6794250 N 2122500 E	06/10/2011	0.3133
19	6794749.993 N 2122749.997 E	10/18/2011	5.4953
20	674499.999 N 2122749.987 E	Re-validated per procedure	30.5212
20	674499.999 N 2122749.987 E	Re-validated per procedure	30.6035
20	674499.999 N 2122749.987 E	10/21/2011	20.6410

Table 8. Radon Flux Measurements (continued)

Grid #	Location	Date Counted	Flux* ($pCi/m^2/s$)
21	6794250.020 N 2122749.978 E	10/18/2011	2.0430
27	6794750.264 N 2122999.663 E	10/18/2011	0.5453
28	6794500.325 N 2122999.313 E	10/18/2011	0.2426
29	6794249.995 N 2122999.996 E	10/18/2011	0.8099

E = Easting; N = Northing; $pCi/m^2/s$ = picocuries per square meter per second
*Average activity measurement is 3.3469 $pCi/m^2/s$

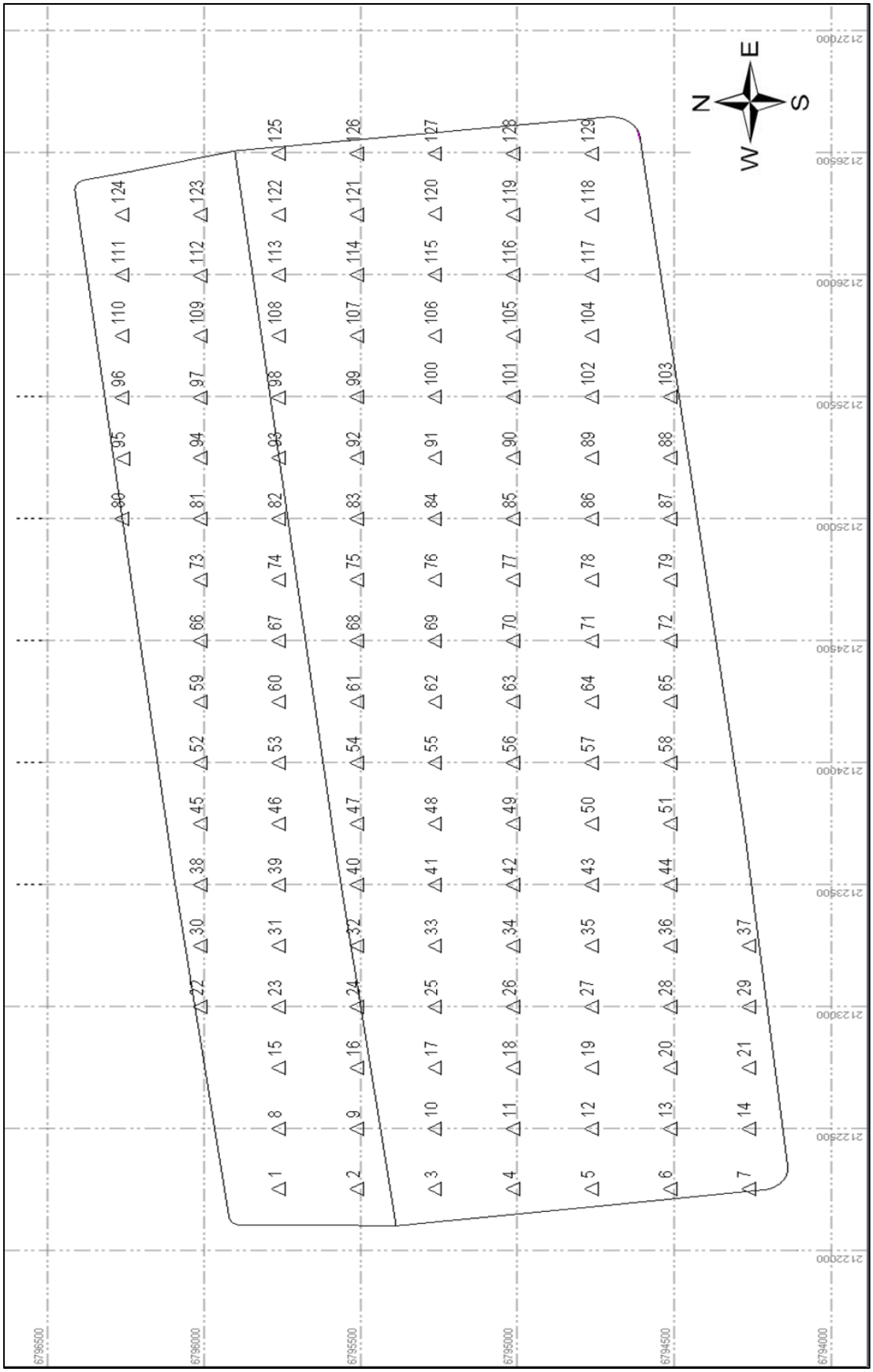

Figure 8. Radon Flux Measurement Grid Numbers and Locations

2.6 Infiltration and Biointrusion Barrier

The inspection and testing for the infiltration and biointrusion barrier can be found in Table 9. The distribution of survey points is shown in Figure 9. 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 9. Infiltration and Biointrusion Barrier Inspection and Testing

Inspection or Test Type	Criteria and Method #	RAP Specification Section or Drawing #	RAIP Section #	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 as the roller makes a minimum of 2 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.
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	7 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	12 gradation tests performed.
High-Accuracy GPS Survey	Confirm total thickness is in accordance with plans and specifications.	Specification 31-00-30 Section 3.5.1	6.8.2	Completed using high-accuracy GPS.

= number; ASTM = American Society for Testing and Materials; in. = inches; ISRM = International Society for Rock Mechanics.

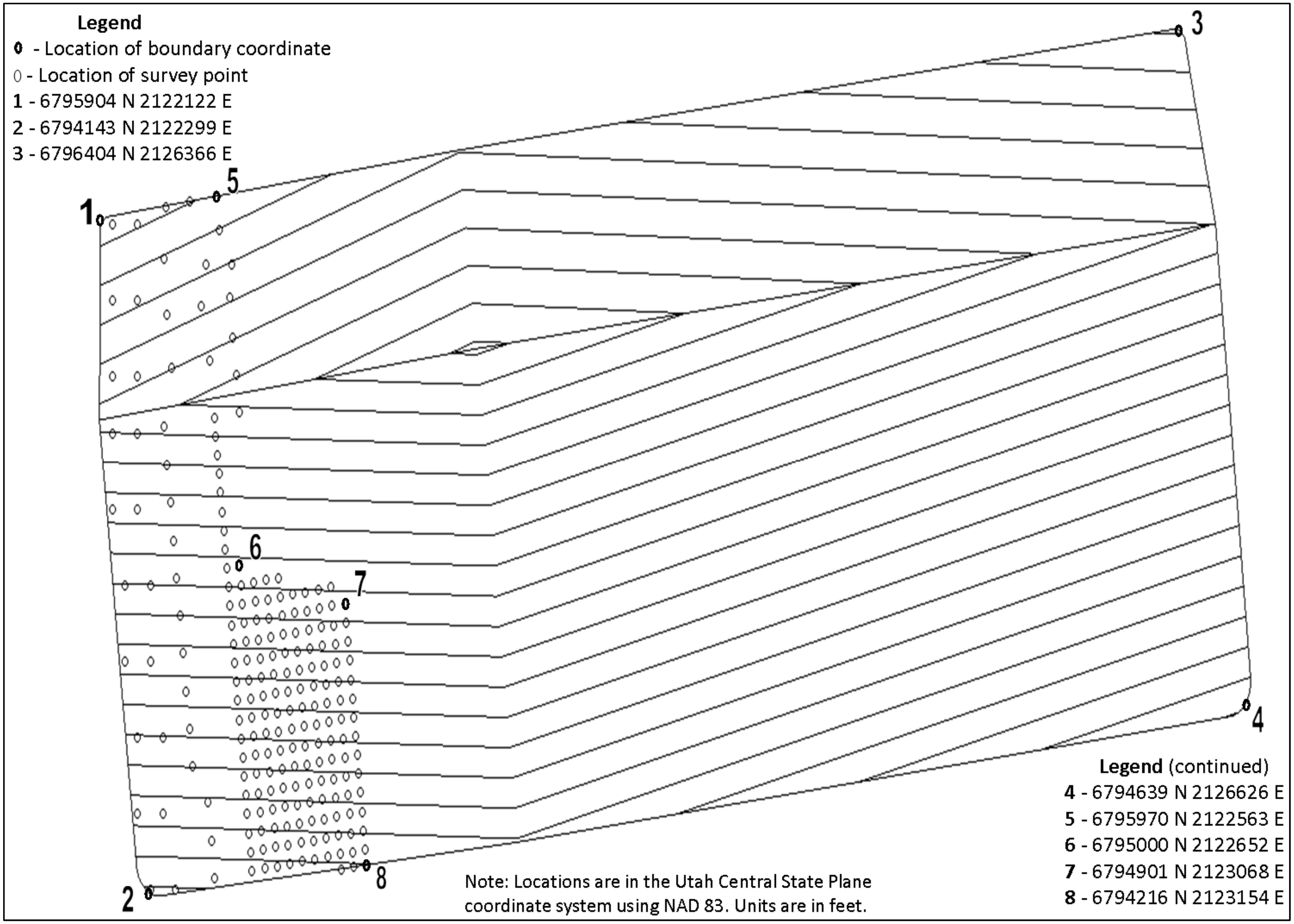

Figure 9. Distribution of Survey Points to Verify Compliance with Infiltration and Biointrusion Barrier Specification

2.7 Frost Protection Layer

The inspection and testing for the frost protection layer can be found in Table 10. The distribution of survey points is shown in Figure 10. The standard Proctor test results summary, lift approval summary, one lift approval package, and buyoff surveys for the frost protection layer are provided in Appendix A6.

Table 10. Frost Protection Layer Inspection and Testing

Inspection or Test Type	Criteria and Method #	RAP Specification Section or Drawing #	RAIP Section #	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 prior to placement of the next lift Final lift of soil shall not be scarified. Final lift shall be smooth rolled with at least 3 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 layer. Documentation is provided in lift approval packages.
High-Accuracy GPS Survey	Document the pre-cap and post-cap geometry of the site.	Specification 31-00-30 Section 3.3.2	6.9.5	Pre-installation and post-cap 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: 90% standard Proctor. Optimum ±5%. 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	40 lifts approved; 30 lifts approved using in place density/moisture testing. 34 in-place density/moisture tests performed with an average density of 96% of the laboratory determined maximum dry density.
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 31-00-30 Section 3.3.5	6.9.4	40 lift approved; 10 lifts approved using CAES.
Sand Cone and Moisture Correlation Test	Common fill, along with nuclear tests. Perform in accordance with the following as applicable: ASTM D1556, D2216, and D4643.	Specification 31-00-30 Section 3.6.1	6.9.4	Sand cone and moisture correlation tests performed.
Laboratory Compaction Characteristics	Tests have been performed on the common fill to determine its maximum dry density and optimum moisture content per ASTM D 698. Perform in accordance with the following as applicable: ASTM D698 and D2216.	Specification 31-00-30 Section 3.3.5	6.9.4	10 tests performed to determine compaction characteristics.

= number; % = percent; ASTM = American Society for Testing and Materials; ft = feet; GPS = global positioning system; in. = inches; lb = pounds; QC = Quality Control

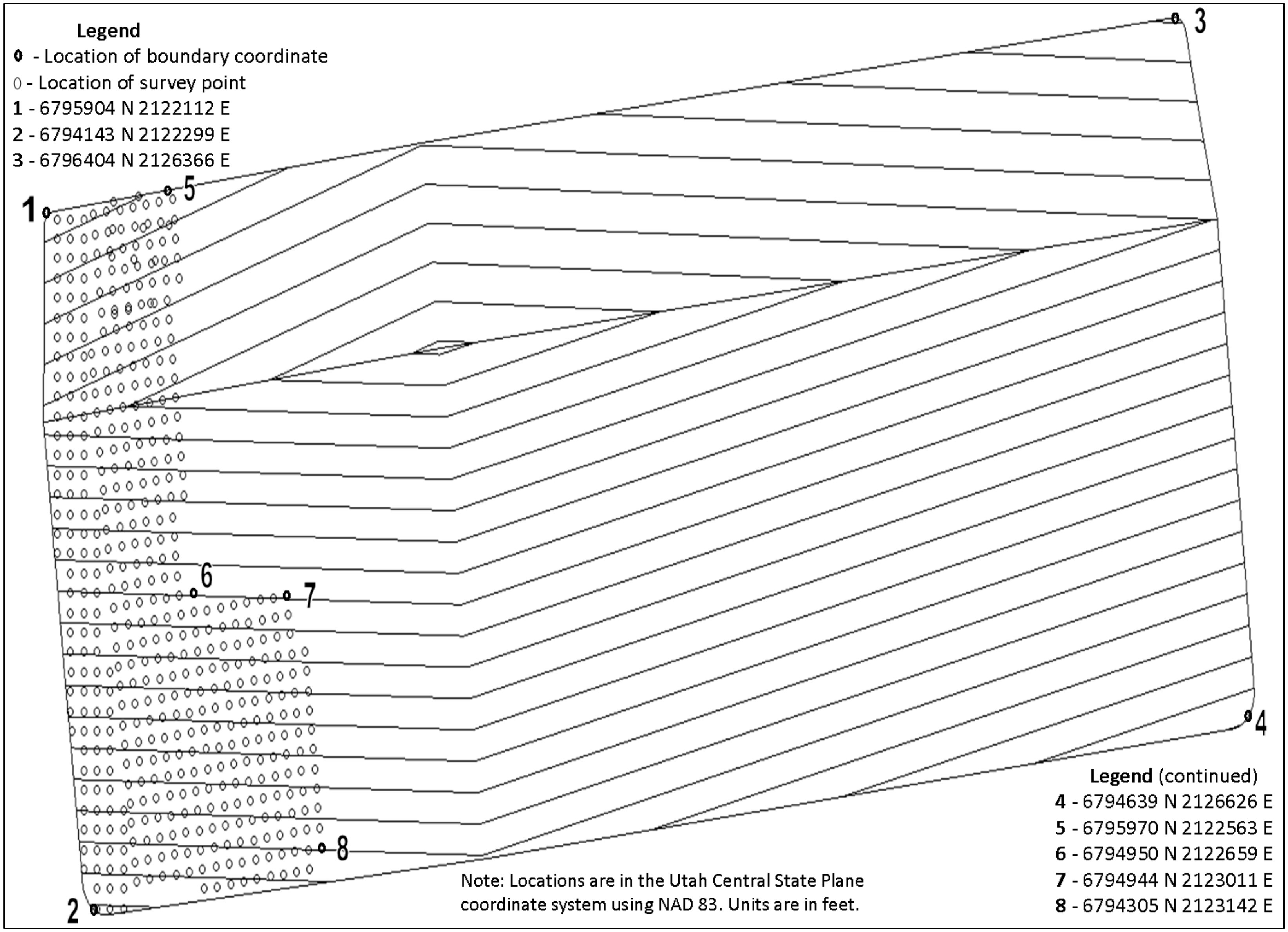

Figure 10. Distribution of Survey Points to Verify Compliance with Frost Protection Layer Specification

2.8 Cap Rock and Armoring

The inspection and testing for the cap rock and armoring can be found in Table 11. Rock armoring includes the side slopes and apron of the disposal cell. The distribution of survey points to verify compliance for the cap rock is shown in Figure 11. The distribution surveys for the rock armoring are shown in Appendix A7. The lift approval summaries, one lift approval package for the cap rock, buyoff surveys, and durability and gradation test results are also provided in AppendixA7.

Table 11. Cap Rock and Armoring Inspection and Testing

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing #	RAIP Section #	Verification Results
Visual Observation	Periodically, at the quarry operations, a geologist will inspect the stockpiles to ensure the percent of other-than-gray basalt does not exceed 10% for rock for the final cover layers.	N/A	6.10.1	Inspection performed.
Visual Observation and High-Accuracy GPS Survey	Thickness required by plans for each area.	Specification 32-11-23 Table 3	6.10.2	Cap thickness verified visually and verified by high-accuracy surveys.
Durability	Perform in accordance with the following as applicable: Specific gravity saturated surface dry absorption sodium sulfate soundness (5 cycles); L.A. abrasion (100 cycles); Schmidt rebound hardness ISRM Method; ASTM C88, C127, and C131.	Specification 32-11-23 Section 2.1.5	6.10.1	9 durability tests performed.
Gradation	Perform in accordance with the following as applicable: ASTM C117 and C136.	Specification 32-11-23 Table 3.	6.10.2	13 gradation tests performed.

= number; % = percent; ASTM = American Society for Testing and Materials; GPS = global positioning system; ISRM = International Society for Rock Mechanics; L.A. = Los Angeles

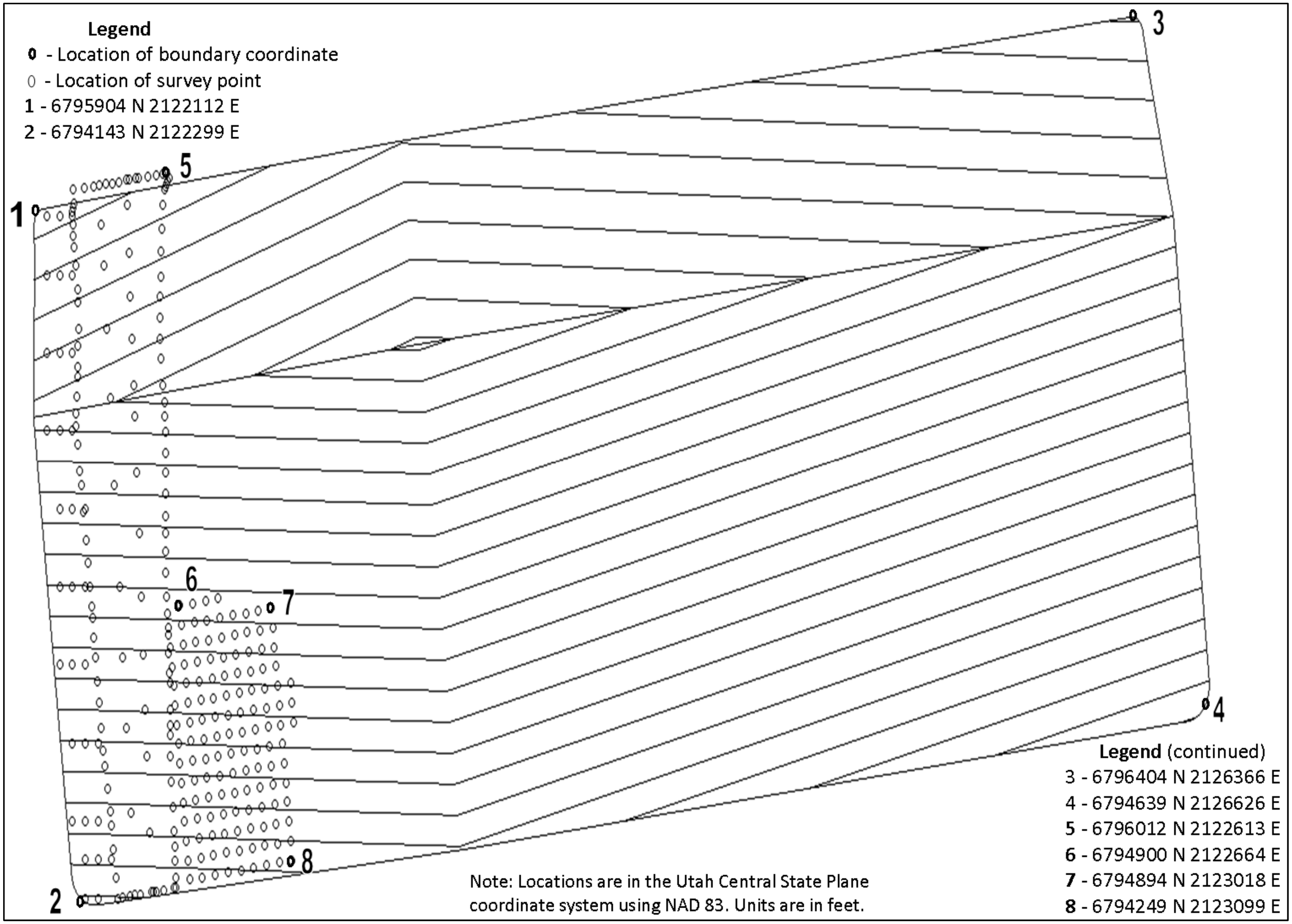

Figure 11. Distribution of Survey Points to Verify Compliance with Cap Rock Specification

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 Quality Assurance (QA) requirements, and compliance with permit requirements.

3.1 Design Criteria Changes

Design criteria were identified in the RAP as a reference to the "Technical Approach Document" (UMTRA-DOE/AL 050425.0002). The Technical Approach Document was prepared during the UMTRA surface remediation program in the 1980s to describe the general technical approaches and design criteria adopted by DOE to implement RAPs and final designs that comply with U.S. Environmental Protection Agency (EPA) standards. No changes to the design criteria were made during the period represented by this Addendum.

3.2 Design Changes

Design changes may take the form of a new or revised specification or drawing. Design changes are made to correct or improve a project construction or operational activity, or to take advantage of a superior or more cost-efficient design solution. Design control is implemented following project work instruction, "Design Change Control with NQA-1 QA Requirements" **(**FONQAWI 105) (see Attachment 2), to identify, register, and communicate design changes. The Construction Interface Document (CID) is used to resolve a construction issue or to propose a design change, and to document its resolution. If a design change is required, a DCN is prepared. The DOE requested concurrence of NRC for DCNs that could affect the cell performance.

Table 12 summarizes DCNs that were submitted to NRC for concurrence, and the DCNs are included in Attachment 3. Specifications referenced in Table 12 are from Addendum B of the RAP. Correspondence between DOE and NRC is presented in Attachment 4. DCNs 1-16 were issued for design changes outside the Crescent Junction disposal cell.

Table 12. DCNs Submitted to NRC

DCN #	Date of Issue	DCN Description	Status
17	02/15/10	Revise the top-of-waste plane drawings, C-02-C-124 and C-02-C125, to show adjusted contours along edge of top-of-waste. (CID 053)	As-built drawing of top of waste to be submitted at cell completion.
18	08/02/10	Revise Specification 31-00-30 to redefine the 1-in. requirements for radon barrier material to allow for presence of occasional shale fragments with a maximum particle size 3-4 in. (CID 055)	Approved in Revision 4 of Specification 31-00-30 on 08/03/10.

Table 12. DCNs Submitted to the NRC (continued)

DCN #	Date of Issue	DCN Description	Status
19	09/02/10	Revise Specification 31-00-30 to state placement of Mancos Shale bedrock will be visually inspected to ensure there are no locations where rock-type particles accumulate in a concentrated location. Particles found in a concentrated location will be removed or reworked per QC direction. (CID 056)	Approved in Revision 5 of Specification 31-00-30 on 09/02/10.
20	09/09/10	Revise Specification 32-11-23 to change the infiltration and biointrusion barrier stone gradation for 1.5-in. rock from 40-50 to 40-60. Revise Specification 31-00-30 and add a subsection that describes aggregate gradation testing and provides guidance for evaluating the gradation tests for acceptability. Revise Table 1 of Specification 31-00-30 to change the minimum liquid limit from 35 to 30 and add a maximum liquid limit of 50. (CID 057 and CID 058)	Approved in Revision 6 of Specification 31-00-30 on 09/09/10 and Revision 6 of Specification 32-11-23 on 09/08/10.
21	05/21/11	Revise Specification 32-11-23 and Drawing E-02-C-501 to change selected riprap D50 size and gradation. (CID 062 and CID 063)	Approved in Revision 7 of Specification 32-11-23 on 05/20/11.
22	08/18/11	Revise Table 3 of Specification 32-11-23 to change selected gradations of fines. (CID 065 and CID 067)	Approved in Revision 8 of Specification 32-11-23 on 08/18/11.

= number; D50 = median particle size; in. = inches; QC = Quality Control

3.3 QA Requirements

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 the following:

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

During design activities, quality audits and surveillances were performed by the RAC, including one conducted by the Energy*Solutions*' corporate office, to verify and provide assurance that these activities were performed in accordance with established plans, drawings, instructions, procedures, specifications, and other applicable documents. For definitions of audit activities, see the Introduction in Part 1 of ASME NQA-1-2004.

During the disposal cell design phase, five audits and four surveillances were performed. A summary is contained in Table 13. Any issues identified during these audits and surveillances have been addressed.

Table 13. Audits and Surveillances Conducted during Design

Date	Conducted By	Type	Assessment #	Scope
08/13/07	RAC	Audit	X-07-22	Approve Jacobs Engineering QA Program
11/30/07	RAC	Audit	X-07-22a	Approve Jacobs Engineering QA Program
02/04/08 – 02/07/08	Energy*Solutions*' Corporate	Audit	AS-08-01	QA Program Readiness Assessment
06/09/08 – 06/17/08	RAC	Surveillance	MB-08-S-005	Evaluate the RAC's preparation and issuance of project procedures
06/18/08 – 06/30/08	RAC	Surveillance	MB-08-S-008	Evaluate RAC employee knowledge of the project's organizational structure, responsibilities, authority of individuals, and lines of communication
07/14/08 – 07/16/08	RAC	Audit	MB-08-A-002	Evaluate Jacobs Engineering's NQA-1 Program
10/30/08 – 10/31/08	RAC	Audit	MB-09-A-001	Approve corrective actions completed by Jacobs Engineering and verify the QA Program meets NQA-1 requirements
02/26/09 – 02/27/09	RAC	Surveillance	MB-09-S-007	Verify completion of corrective actions under Jacobs Engineering Corrective Action Program
08/12/09	RAC	Surveillance	MB-09-S-011	Verify that contract-required environmental records have been submitted and continue to be submitted to DOE

= number.

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 14.

Table 14. Crescent Junction Site Permits and Agreements

Agreement #	Document Name or Description	Issuing Agency	Purpose
Resolution 2006-2741	Grand County Council Resolution	Grand County	Approves Conditional Use Permit for the Project.
DE-RO01-05GJ68003	Access Agreement	DOE EMCBC	For installation and maintenance of air monitoring equipment and collection of air quality data for monitoring station MPS-0306.
DE-RO01-05GJ68004	Access Agreement	DOE EMCBC	For installation and maintenance of air monitoring equipment and collection of air quality data for monitoring station MPS-0307.
Public Land Order 7697	Permanent Land Transfer	BLM	Order permanently transferred 500 acres of BLM public domain land to DOE for disposal cell.
Public Land Order 7734	Public Land Withdrawal	BLM	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.

Table 14. Crescent Junction Site Permits and Agreements (continued)

Agreement #	Document Name or Description	Issuing Agency	Purpose
Not assigned	Water Use Agreement	Thompson Special Service District	Water use agreement between 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.
UTU-83353	ROW	BLM, Moab Field Office	ROW for 3-in. service culinary waterline and a 2-in. delivery culinary waterline to the disposal site.
UTU-83450	ROW	BLM, Moab Field Office	ROW for power line to the disposal site.
Case # 11-0028	Memorandum of Agreement	BLM, Utah State Preservation Office	Between DOE, BLM, and Utah State Historic Preservation Office regarding cultural resource issues related to development of disposal site.
Not assigned	Memorandum of Agreement	BLM, Moab Field Office	Between BLM and DOE for management of existing uses on lands withdrawn in conjunction with the Project.
UTR359187	Storm Water Permit	Utah Division of Water Quality	For the disposal site.
UTU-83396	ROW	BLM, Moab Field Office	For buried telephone line at the disposal site.
Folder # 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 1-1/4 in. conduit at mile post 0.25, Cane Creek Subdivision, Thompson Springs, for the disposal site.
Folder # 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 1-1/2 in. conduit across Union Pacific Railroad's property at mile post 533.2, Green River Subdivision.
U.S. DOT-SP 14283	Special Permit Authorization	U.S. DOT	Permit to transport mill tailings from Moab site to the disposal site.
U.S. DOT # 011309550013QR	U.S. DOT Hazardous Materials Certificate of Registration	U.S. DOT	For shippers of hazardous materials for 2008 – 2010.
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.
REECBCDOE-6-08-0302	Waterline Easement	Grand County	Easement within CR-175 or old Highway 6 & 50 and Hastings Lane ROWs to construct waterline within 60-ft ROW and operate within 20-ft ROW.
REECBCDOE-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.
REECBCDOE-6-08-0301-1	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.
REECBCDOE-6-08-0309	Waterline Easement	City of Green River	Easement to construct waterline within 60 ft of CR-175 or old Highway 6 & 50 ROWs within Green River city limits and operate within 20-ft ROWs.

Table 14. Crescent Junction Site Permits and Agreements (continued)

Agreement #	Document Name or Description	Issuing Agency	Purpose
REECBCDOE-6-08-0308, SITLA # 1345	Waterline Easement	SITLA	Easement to construct waterline within 60-ft ROW and operate within 20-ft ROW on three parcels on SITLA land near Green River and Crescent Junction.
ESMT 463	Waterline Easement	SITLA	Easement across state land for potable waterline.
400 00177	Waterline Easement	Utah Division of Forestry, Fire, and State Lands	ROW easement to construct and operate waterline in the Green River.
Statewide Utility License Agreement # 8439	UDOT Utility License	Permits Officer	License with State of Utah to construct waterline across UDOT property.
Property # 70-4;189A: AEQ	UDOT Easement	Permits Officer	Easement for waterline across UDOT property near Floy Wash that allows 60-ft construction ROW and 20-ft permanent ROW.
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.
SPK-2007-632	Corps of Engineers 404 Permit	Corps of Engineers	To construct pump station on the Green River.
08-92-01SA	Stream Channel Alteration Permit	Utah Division of Water Rights	To construct pump station on the Green River.
Folder # 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.
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.
DAQC-1110-2006	Fugitive Dust Control Plan (08/07/06) UAC R307-309-6 "Fugitive Emissions and Fugitive Dust-Fugitive Dust Control Plan-Uranium Mill Tailings Repository (UMTRA) Project near Crescent Junction-Grand Co"	Utah Division of Air Quality	Approval letter from the State of Utah for the Fugitive Dust Control Plan for the Crescent Junction disposal cell.

= number; BLM = Bureau of Land Management; CR = County Road; EMCBC = Environmental Management Consolidated Business Center; ft = feet; in. = inches; 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

The U.S. Department of Interior permanently transferred 500 acres at the Crescent Junction site to DOE for the disposal cell. An additional 936 acres is in temporary withdrawal to support cell construction and RRM placement activities. Ten boreholes and five test pits were located to characterize subsurface conditions as reported in Attachment 5, "Field and Laboratory Results," in Volume 1 of the RAP.

Construction of infrastructure, including access and haul roads, a rail load-out area, retention ponds, waterlines, initial site drainage control, and administrative areas necessary for support of the disposal operations was performed largely prior to excavation of the cell.

4.2 Cell Construction

Cell construction includes five major activities:

- Excavation of the soils to the design depth to ensure a competent surface for placement of RRM.
- Construction of the perimeter embankment, which will extend along the western, southern, and eastern cell boundaries.
- Placement of RRM to the design thickness, and assuring that the radium-226 (Ra-226) activity in the upper 7 feet (ft) of placed material does not exceed design criteria.
- Placement of cover material and rock armoring.
- Construction of a spoils embankment.

The *Moab UMTRA Project Lift Approval Procedure* (DOE-EM/GJRAC1803) was used to ensure that the material placed met the compaction criteria. Descriptions of compaction equipment used during the construction of the cell are provided in Table 15. 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 15. 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	Rock Armor	Spoils Embankment	Perimeter Embankment
CAT 825H Soils Compactor	69,000	X	X	X	X		X		X	X
CAT D-8 Bulldozer	84,850	X	X							
CAT D-7 Bulldozer	56,669	X	X							
Komatsu 275X Bulldozer	112,466	X	X							
CAT 637G Scraper	118,084			X	X		X		X	X
CAT 815 Soils Compactor	45,765			X	X		X		X	X
CAT CS563 Vibratory Roller	24,537				X	X	X	X		

CAT = Caterpillar, Inc., lb = pounds.

4.2.1 Excavation

The disposal cell is being excavated in phases. Excavation of Phase 1 began in June 2008 and was completed in December 2008. This phase encompassed approximately 44 acres and consisted of the following.

- Excavation of approximately 1.7 million yd^3 of soil to a depth of about 25 ft, including 2 ft into the weathered Mancos Shale bedrock. This phase of the cell was constructed to store roughly 2.4 million yd^3 of RRM.
- Stockpiling excavated materials as Mancos Shale bedrock or common fill for later use in cell cover layers.
- Creation of the spoils embankment and the embankment for the construction water storage pond using excavated materials.

Excavation of Phase 2, encompassing about 49 acres, began in January 2010, and was completed in December 2011. Approximately 1.8 million yd^3 of soil was excavated to a depth of about 25 ft, including 2 ft into the weathered Mancos Shale bedrock. This phase of the cell was constructed to store roughly 3.5 million yd^3 of RRM. About a 2-acre area of the cell was not

excavated to the design grade so as to create a platform to facilitate emptying and decontaminating RRM containers. Figure 4 shows the extent of the Phase 2 excavation and south perimeter embankment.

4.2.2 Perimeter Embankment Construction

Soils from the Phase 1 excavation that met the specification for common fill were used to construct the perimeter embankment along the western and southern boundaries. Soils from the Phase 2 excavation were used to continue the perimeter embankment along the southern boundary, except where the platform lies.

4.2.3 RRM Placement

Placement of RRM began in April 2009 in the southwestern corner of the cell and progressed to the north and east. Initially the material was end-dumped from the containers onto the cell floor and spread directly in loose lifts not exceeding 1 ft following the *Lift Approval Procedure*. Over time, the dumping location shifted from the cell floor to the top of the interim cover. In March 2010, containers began being emptied from the platform discussed in Section 4.2.1. The dumped material was loaded into dump trucks, and driven to the disposal area where it was spread for compaction using a bulldozer. A sheepsfoot roller was then used to compact the RRM in place. In a letter dated October 26, 2009, DOE notified NRC that polypropylene liners were being used in the RRM containers to facilitate complete dumping of the material. Use of the liners did not result in voids in the waste mass. NRC accepted the liner use in its response letter dated November 23, 2009. Oversized material from an off-pile area at the Moab site was shipped by truck to the disposal cell in 2010. On March 18, 2010, DOE requested a variance to allow for disposal of debris that was too large to be sized to meet RAIP Section 6.4.4 for demolition debris. NRC accepted the size variance in its response letter dated November 15, 2010. Copies of this correspondence between DOE and NRC regarding liners and the size variance are included in Attachment 4.

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" (RAS) of the RAP. Once the RRM placed in the cell has reached the design thickness, a minimum of 1 ft of interim cover is placed over the RRM. The interim cover material comes from soils excavated to create the cell that have been stockpiled on-site. Three additional cover layers are placed over the interim cover before the final rock cover. Material for the radon barrier and frost protection layer also come from materials excavated on-site (processed Mancos Shale bedrock). 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 period, almost 28 acres of final cover was placed.

4.2.5 Spoils Embankment Construction

Material excavated to construct the disposal cell was used to create a spoils embankment, or wedge, between the north 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 16. The topographic surface of the spoils embankment is shown on Figure 12. The standard Proctor test results summary, lift approval summary, and one lift approval package for the spoils embankment are provided in Appendix A8.

Table 16. Spoils Embankment Inspection and Testing

Inspection or Test Type	Criteria and Method #	RAP Specification Section or Drawing #	RAIP Section #	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 816 compactor. Thickness was visually verified. Each lift is documented.
High-Accuracy GPS Survey	Exterior slopes are 3:1.	Drawing C-02-C-501	6.3.5	Survey performed. See drawings C-02-C-102 and C-02-C-501.
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 D 698.	Specification 31-00-00 Section 3.11.1.3	6.3.5	57 tests performed to determine compaction characteristics.
In-place Density/ Moisture Test	Initial layers of soil placed, and on any specific type of material in which the CAES is used. (Follow non-CAES frequency.) 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. 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	803 in-place density/moisture tests performed with an average density of >90% of the laboratory-determined maximum dry density.
Sand Cone Correlation	One check test for every 20 tests per ASTM D6938, of fill or backfill compacted by other than hand-operated machines. One check test for every 20 tests per ASTM D6938, of fill or backfill compacted by hand-operated machines. Perform in accordance with the following as applicable: ASTM D1556.	Specification 31-00-00 Section 3.14.2	6.3.5	Sand cone correlation performed.

Table 16. Spoils Embankment Inspection and Testing (continued)

Inspection or Test Type	Criteria and Method #	RAP Specification Section or Drawing #	RAIP Section #	Verification Results
Moisture Correlation Test	One correlation test for moistures every 10 tests per ASTM D6938 will be performed in accordance to ASTM D4643 or D2216.	Specification 31-00-00 Section 3.14.2	6.3.5	Moisture correlation tests performed.
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, which 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	57 tests performed to determine compaction characteristics.

= number; % = percent; ft^2 = square feet, ASTM = American Society for Testing and Materials; CAT = Caterpillar, Inc., GPS = global positioning system; in. = inches; lb = pounds, yd^3 = cubic yards

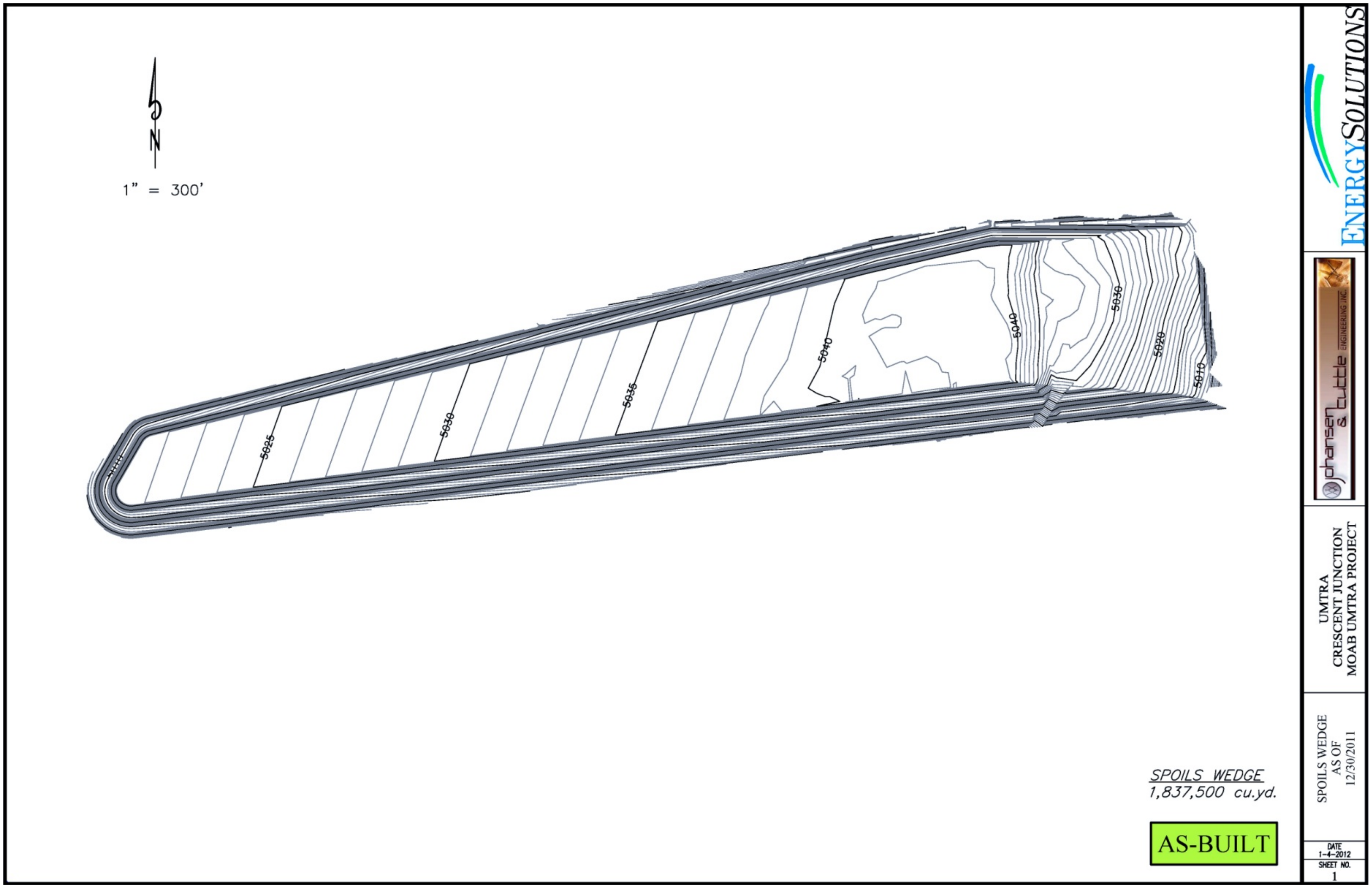

Figure 12. Spoils Embankment Topographic Surface

4.3 Soil Compaction and Testing

The RAC followed Addendum B, "Final Design Specifications," of the RAP and the *Lift Approval Procedure* to verify proper compaction of each lift. The RAC performed soil compaction using the CAES, which was developed by Caterpillar, Inc. (CAT). The system includes a global positioning system (GPS) receiver, multi-radio wireless transmitter receivers, and a display mounted in the cab of each piece of outfitted equipment, such as a bulldozer or compactor, and a desktop computer equipped with terrain modeling software that is located at the Crescent Junction site.

The CAES was utilized on the CAT D-7, CAT D-8, and Komatsu 275X bulldozers that spread lifts and compact RRM, and on the 825H sheepsfoot compactor. Three test pads for verifying the CAES operations were constructed of the processed Mancos Shale bedrock stockpile material. The test pad results for the CAT D-8 bulldozer were used for the Komatsu 275X bulldozer based on allowances in the *Lift Approval Procedure.*

The CAT D-8 bulldozer constructed a test area on a 5:1 slope. The soils were amended to +/- 5 percent of optimum moisture content for the standard Proctor, as specified in the RAIP. Stakes were used to designate a 1-ft loose lift and the CAT D-8 bulldozer placed the lift in the test area. The CAT D-8 bulldozer passed over the material until uniform compaction was observed. The compaction was also tracked using the desktop computer with the CAES software.

The following items were noted during the compaction test with the CAT D-8 bulldozer:

- Each pass of the bulldozer met the terrain model calculation performed by the CAES desktop computer.
- Three passes with the CAT D-8 bulldozer achieved a compaction rate greater than or equal to the required 90 percent of the laboratory-determined maximum dry density.
- The color code of the CAES computer display ranged from red (representing an uncompacted lift), to purple (representing one machine pass), to yellow (representing two bulldozer passes), and to green (representing three bulldozer passes), which completed the area.
- The test area for material placed met the RAIP compaction specification when three machine passes were performed over the entire lift area and 80 percent of the area met CAES compaction criteria (80% was required to demonstrate that the lift area was uniformly compacted). Later in-place density testing showed that, for the slopes, when 70 percent of the test area met CAES compaction criteria, the area would still achieve greater than or equal to the required 90 percent of the laboratory-determined maximum dry density.

The CAT D-7 bulldozer went through the same tests as stated above on a separate test pad. The difference between the CAT D-8 and the CAT D-7 bulldozer is the number of passes required to achieve the same desired degree of compaction.

The following items were noted during the compaction test with the CAT D-7 bulldozer:

- Each pass of the bulldozer met the terrain model calculation performed by the CAES desktop computer.
- Four passes with the CAT D-7 bulldozer achieved a compaction rate greater than or equal to the required 90 percent of the laboratory-determined maximum dry density.

- The color code of the CAES computer display ranged from red, to purple, to yellow, to dark green (representing three bulldozer passes), and to green (representing four bulldozer passes), which completed the area.
- The test area for material placed met the RAIP compaction specification when four machine passes were performed over the entire lift area and 80 percent of the area met CAES compaction criteria (80 percent was required to demonstrate that the lift area was uniformly compacted). Later in-place density testing showed that, for the slopes, when 70 percent of the test area met CAES compaction criteria, the area would still achieve greater than or equal to the required 90 percent of the laboratory-determined maximum dry density.

The CAES compaction was periodically verified by performing in-place tests using a nuclear density gauge manufactured by Troxler Electronic Laboratories, Inc., following American Society for Testing and Materials (ASTM) methods. The individual nuclear density tests verified that the compaction achieved with the CAES was greater than the required 90 percent. The CAES test pad results compared to the nuclear density gauge are provided in Section 2.3.1.

The CAES-equipped 825H sheepsfoot compactor was verified on a test pad that was constructed of radon barrier material (processed Mancos Shale bedrock). The test area met the 95-percent RAIP compaction specification for radon barrier when 80 percent of the test area met CAES compaction criteria. The lift approval package for the test pad is included in Appendix A4.

4.4 Lift Approval

The *Lift Approval Procedure* and Addendums B and E of the RAP were followed to verify that each lift met established criteria. The procedure was modified several times during this Addendum period. The revision current during an activity was used. Results of lifts are documented in lift approval packages. An example lift approval package for each material type is provided in Appendix A.

4.5 Geotechnical Testing

The following procedures, which are provided in Attachment 2, 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 that the material placed in the cell meet 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 demonstration that specified compaction requirements were met. Test requirements varied depending on whether or not the CAES was used for demonstrating compaction. Because the soils in the RRM, radon barrier, and frost protection layer can vary in composition, multiple compaction curves were prepared to determine the optimum moisture content and maximum dry density. 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 radon barrier and frost protection layer were found to have a consistent soil type, so fewer sets of standard Proctor tests were performed as placement progressed. The tables in Appendix A also summarize the tests performed to determine soil type and geotechnical properties.

Liquid limit and plastic limit tests were performed and the plasticity index was calculated to further differentiate each soil type used for the radon barrier. Moisture content testing was performed daily for all soil layers, to verify that the moisture content met the requirements prior to the approval of soil placed that day. The thickness of each lift was surveyed and verified using high-accuracy 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 was visually observed for the infiltration and biointrusion barrier and the cap rock. The embankment slope armoring and apron aggregates were visually observed to be compacted and interlocking. The thickness of each aggregate layer placed was surveyed and verified using high-accuracy GPS, when practical; otherwise, manual measurements were taken. These measurements are depicted on the relevant distribution of survey point figures (see Figures 8 and 10).

A review of the material used in the infiltration and biointrusion barrier was completed by RB&G Engineering, Inc., on October 12, 2010. The results are documented in a letter sent to Nielson Construction of the RAC (see Attachment 5).

Testing of samples per the RAIP for rock durability was performed and the results are summarized in Table 17, including the calculated NRC rock quality score. All of the samples met the durability requirements and scored above the acceptable NRC criteria of 80 percent.

Table 17. Rock Durability Test Results and NRC Rock Quality Scores

Laboratory Sample* ID #	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								
233040	2.685	0.6	0.0	6.6	56	228.7	260	88.0
258885	2.721	0.7	0.0	7.4	60	239.6	260	92.1
258889	2.709	0.5	0.0	6.7	63	241.0	260	92.7
287641	2.62	0.6	0.0	7.1	51	216.2	260	83.2
287644	2.64	1.0	0.0	6.6	65	222.6	260	85.6
287647	2.62	0.6	0.8	6.7	49	216.7	260	83.3
287662	2.63	0.6	0.0	7.6	48	217.2	260	83.5
Cap Rock								
179332	2.670	0.8	0.0	6.5	52	222.7	260	85.7
211600	2.677	0.5	0.1	6.3	37	219.3	260	84.3
211607	2.675	0.8	0.1	6.7	39	217.0	260	83.5
233040	2.685	0.6	0.0	6.6	56	228.7	260	88.0
258881	2.706	0.5	0.0	7.1	64	241.5	260	92.9
258885	2.721	0.7	0.0	7.4	60	239.6	260	92.1
287650	2.62	0.9	0.0	6.8	45	211.0	260	81.2
287653	2.63	0.6	0.0	6.6	52	219.8	260	84.5
287656	2.62	0.6	0.0	6.3	57	220.2	260	84.7
287659	2.63	0.7	0.0	6.7	42	214.0	260	82.3
Side Slopes								
211613	2.716	0.6	0.1	7.3	43	228.0	260	87.9
241264	2.674	0.79	0.0	6.6	54	224.0	260	86.2
241267	2.706	0.67	0.0	6.0	57	234.8	260	90.3
Apron								
241270	2.681	0.52	0.4	6.2	57	228.4	260	87.8
241273	2.659	1.35	0.0	7.1	54	218.7	260	84.1
295294	2.64	1.0	0.0	7.3	42	213.7	260	82.2

% = percent; ID = identification; L.A. = Los Angeles
* All samples are of gray basalt.

4.6 Radiological Verification

Section 5 of the RAS identifies two primary verification criteria associated with construction of the disposal cell: Ra-226 measurements in RRM placed in the upper 7 ft, and radon flux measurements to verify the integrity of the radon barrier.

The RAC must ensure that the radon flux does not exceed the EPA standard of an average of 20 picocuries per square meter per second ($pCi/m^2/s$) once the radon barrier is placed. Based on modeling presented in Addendum D, "Final Design Calculations," of the RAP, the Project

controls the Ra-226 activity in the upper 7 ft of RRM placed in the disposal cell to meet this standard. The Ra-226 activity is controlled by monitoring the RRM just prior to shipment from the Moab site. The RAC uses 707 picocuries per gram (pCi/g) as the limit of the activity in samples collected in the material shipped to provide reasonable assurance that the radon flux limit will not be exceeded.

A minimum of 26 samples is collected in the upper 7 ft of each 10,000-square meter area of placed RRM to verify that the average sample concentration is below the 707 pCi/g limit. For clarification, DOE requested in a letter to NRC dated June 20, 2011 (see Attachment 4), to add the word "average" before "radium activity in the upper seven feet" in Section 5.2.6 of the RAS. On August 1, 2011, the Project received verbal acceptance of this change (see Attachment 4). The basis for collecting at least 26 samples was determined using DOE Pacific Northwest National Laboratory-developed software, called Visual Sample Plan, which conforms to the DOE-approved sampling methodology defined in NRC Guide 1575, "Multi-Agency Radiation Survey and Site Investigation Manual." An explanation of the Ra-226 sample verification process for the 7-ft criterion is provided in Attachment 5.

Radon flux measurements were taken using *Moab UMTRA Project Radon Flux Measurements Procedure* (DOE-EM/GJRAC1939) and are used to validate that the cell design criteria have been met. Radon flux measurement results are presented in the Critical Review section and ranged from 0.2177 to 20.6410 pCi/m^2/s, with an average flux of 3.3469 pCi/m^2/s, which is well below the 20 pCi/m^2/s limit.

During this Addendum period, 615 samples of RRM were taken in the upper 7 ft of 16 lifts, and the Ra-226 activity of the lifts ranged from 298.34 to 627.96 pCi/g, with an average of 442.22 pCi/g. Table 18 shows the average result for each lift tested.

Table 18. Results of Ra-226 Activity in Upper 7 Ft of Placed RRM

Lift ID #	# of Samples Taken	Average Ra-226 Activity (pCi/g)
UWH06	28	468.90
UWM12	31	365.40
UWI12	32	405.77
UWN23	38	347.58
UWN19	40	386.86
UWJ21	41	306.33
UWI24	36	474.14
UWK28	31	298.34
UWS31	30	624.47
UWR12	29	505.71
UWQ21	27	544.51
UWW27	26	627.96

Table 18. Results of Ra-226 Activity in Upper 7 Ft of Placed RRM (continued)

Lift ID #	# of Samples Taken	Average Ra-226 Activity (pCi/g)
UWS16	27	480.40
UWV21	26	530.54
UWR08	28	477.61
UWR06	28	468.90
UWP01	28	372.96
UWO04	28	374.32
UWQ01	33	381.82
UWQ04	28	401.86
Totals:	**615**	**Average: 442.22**

= number.

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 *Quality Assurance Plan for the Remedial Action Contractor*.

During construction activities, audits and surveillances were performed by the RAC, including some conducted by the Energy*Solutions*' corporate office, to verify and provide assurance that these activities were performed in accordance with established plans, drawings, instructions, procedures, specifications, and other applicable documents. In addition, DOE and the TAC performed audits and surveillances of these activities.

During this Addendum period, nine audits and 46 surveillances were performed of disposal cell construction practices (see Table 19). Any issues identified during these audits and surveillances have been addressed.

Table 19. Audits and Surveillances Conducted during Construction

Date	Conducted By	Type	Assessment #	Scope
03/25/08 – 03/28/08	DOE EMCBC	Audit	EM-PE-08-002	Evaluate QA Phase I Program to verify NQA-1 requirements are met.
03/25/08 – 03/26/08	RAC	Surveillance	MB-08-S-003	Evaluate airborne radioactivity monitoring (particulate and radon) being conducted by RAC radiation protection staff, including sample collection, equipment use, counting (analysis) methods, and documentation.
06/19/08	RAC	Surveillance	MB-08-S-006	Evaluate IWP implementation by reviewing documentation.
07/02/08	RAC	Surveillance	MB-08-S-010	Evaluate and verify the implementation of the Crescent Junction IWP scope, hazard identification, and controls along with responsibilities of individuals, and the lines of communication.

Table 19. Audits and Surveillances Conducted during Construction (continued)

07/10/08	RAC	Surveillance	MB-08-S-011	Evaluate and verify subcontractor Johansen and Tuttle Engineering laboratory for calibrated equipment and process of proctor testing and concrete strength testing.
07/13/08	RAC	Surveillance	MB-08-S-004	Verify that contract-required environmental records have been submitted and continue to be submitted to DOE per RAC contract.
08/04/08 - 08/08/08	DOE EMCBC	Audit	Phase I ISMS	Evaluate Project ISMS Phase I Program.
08/05/08 – 08/07/08	RAC	Surveillance	MB-08-S-012	To verify field inspection and oversight activities.
08/07/08 – 08/11/08	RAC	Surveillance	MB-08-S-013	Evaluate and verify the Equipment Inspection and Preventive Maintenance Program for Energy*Solutions* was implemented and followed accordingly.
09/05/08 – 09/11/08	RAC	Surveillance	MB-08-S-009	Evaluate and verify the implementation of the Emergency Response Program on the Project in accordance with *Moab UMTRA Project Emergency Response Plan*, Rev.0 (DOE-EM/GJ1520). Also, review training, qualifications, and records management requirements.
11/13/08 – 11/19/08	DOE EMCBC	Audit	Phase II ISMS	Evaluate implementation of Project ISMS Phase II Program
11/24/08 – 12/01/08	RAC	Surveillance	MB-09-S-003	Evaluate RAC implementation of the requirements for control of M&TE.
02/02/09 – 02/04/09	RAC	Surveillance	MB-09-S-005	Evaluate RAC implementation of Airborne Radioactivity Monitoring Program. Key elements assessed: personnel training and qualifications, documents and records, M&TE, and sample collection and analysis.
02/18/09 – 02/24/09	RAC	Surveillance	MB-09-S-006	Evaluate RAC implementation of Procurement Document Control Program. Key elements assessed: personnel training and qualifications, and documents and records.
05/04/09 – 05/26/09	RAC	Surveillance	MB-09-S-010	Evaluate and verify Equipment Inspection and Preventive Maintenance Program for RAC was implemented and followed accordingly. Key elements assessed: daily checklist, equipment repair tracking, and training.
06/29/09 – 07/01/09	Energy*Solutions* Corporate	Audit	IA-09-03	Evaluate Project programs.
07/30/09	DOE/TAC	Surveillance	DOE-09-SUR-007	QC field operations compliance with test control.
09/22/09	DOE/TAC	Surveillance	DOE-09-SUR-014	QA/QC field operations, management, and performance compliance with the *Quality Assurance Plan for the Remedial Action Contractor.*
12/08/09 – 12/14/09	RAC	Surveillance	MB-10-S-003	Evaluate implementation of the Project Confined Space Program.
12/09/09 – 12/14/09	RAC	Surveillance	MB-10-S-002	Evaluate and verify implementation of RAC-IWP-024, Rev. 2, for the Crescent Junction Radioactive Material Handling. Evaluate hazard identification and controls, along with responsibilities of individuals and the lines of communication.
12/10/09 – 12/18/09	RAC	Surveillance	MB-10-S-001	Evaluate RAC implementation of requirements for control of M&TE.
01/11/10 – 01/15/10	RAC	Surveillance	MB-10-S-005	Evaluate and verify implementation of MB-IWP-022, Rev.2, *Moab RRM Handling and Transportation Activities at the Moab Project.*

Table 19. Audits and Surveillances Conducted during Construction (continued)

Date	Conducted By	Type	Assessment #	Scope
02/03/10 – 02/05/10	RAC	Surveillance	MB-10-S-011	Evaluate and verify MB-IWP-004, Rev.2, *General Equipment Maintenance for the Moab UMTRA Project,* is implemented with work steps.
02/10/10 – 02/12/10	RAC	Surveillance	MB-10-S-010	Evaluate and verify MB-IWP-023, Rev. 0, *Train Arrival, Container Handling*, *and Train Departure* is implemented.
02/22/10 – 02/24/10	RAC	Surveillance	MB-10-S-007	Evaluate RAC implementation of Airborne Radioactivity Monitoring Program. Key elements assessed: personnel training and qualifications, documents and records, M&TE, sample collection and analysis.
03/24/10	DOE/TAC	Surveillance	DOE-10-SUR-002	Surveillance of TAC subcontractor Geotechnical Engineering Group's laboratory and processes to ensure compliance to testing specified within the RAP Addendum D, "Final Design Specifications," and Addendum E, the RAIP.
04/01/10 – 04/09/10	RAC	Surveillance	MB-10-S-014	Evaluate and verify the Equipment Inspection and Preventive Maintenance Program for the RAC was implemented and followed accordingly. Key elements assessed: daily checklist, equipment repair tracking, and training.
06/21/10 – 06/25/10	DOE EMCBC	Audit	Phase III ISMS	Evaluate implementation of Project ISMS Phase III Program.
07/01/10 – 08/30/10	RAC	Surveillance	MB-10-S-015	Evaluate RAC suppliers to determine if suppliers' capabilities meet the quality and technical criteria for procurement of items and services of *Moab UMTRA Project Supplier Evaluation*, Rev.3 (DOE-EM/GJRAC1703)
07/19/10	RAC	Surveillance	MB-10-S-008	Evaluate RAC implementation of Procurement Document Control Program. Key elements assessed: personnel training and qualifications and documents and records.
07/19/10 – 07/23/10	RAC	Surveillance	MB-10-S-020	Evaluate RAC implementation of the *Statistical Survey and Release Procedure for RRM Transport Containers*, Rev. 1 (DOE-EM/GJRAC1874)
07/19/10 – 07/23/10	RAC	Surveillance	MB-10-S-021	Evaluate RAC implementation of the requirements of *Radiological Posting and Access Control*, Rev.2 (DOE-EM/GJRAC1748). Key elements assessed: field reviews and observations, documents and records, and implementation of the radiological posting and access control.
08/23/10 – 08/27/10	Energy*Solutions* Corporate	Audit	IA-10-03	Evaluate Project programs.
09/20/10 – 09/23/10	RAC	Surveillance	MB-10-S-017	Evaluate RAC implementation of *Suspect and Counterfeit Items*, Rev. 2 (DOE-EM/GJRAC1704), including the process to identify S/CI, prevent delivery of S/CI to DOE facilities, and notify DOE's Office of Inspector General when S/CI are found.

Table 19. Audits and Surveillances Conducted during Construction (continued)

Date	Conducted By	Type	Assessment #	Scope
10/18/10 – 10/22/10	RAC	Surveillance	MB-11-S-001	Evaluate and verify implementation of MB-IWP-004, Rev 2, *General Equipment Maintenance for the Moab UMTRA Project*, and MB-IWP-026, Rev. 0, *Container Maintenance*. The assessment includes interviews, and review of procedures, processes, and guidelines. Key elements assessed: documents and records, implementation of IWPs, maintenance program, and training and qualifications.
11/14/10 – 11/23/10	RAC	Surveillance	MB-11-S-002	Evaluate and verify implementation of MB-IWP-039, Rev. 0, *The Dumping and Decontamination of the Intermodal Containers and Haul Trucks at the Crescent Junction Site*; MB-IWP-049, Rev. 0, *The Handling and Disposal of RRM at the Crescent Junction Site*; and MB-IWP-050, Rev. 0, *The Use of a Temper Attachment to Dislodge Built-Up RRM in the Intermodal Containers*. The assessment included interviews and review of procedures, processes, and guidelines. Key elements assessed: documents and records, implementation of the IWPs, and training and qualifications.
12/02/10 – 12/09/10	RAC	Surveillance	MB-11-S-005	Evaluate RAC implementation of Airborne Radioactivity Monitoring Program. Key elements assessed: training and qualifications, documents and records, M&TE, and sample collection and analysis.
12/13/10 – 12/16/10	DOE EMCBC	Audit	EM-PA-10-08	Evaluate implementation of QA Program.
01/10/11 – 01/24/11	RAC	Surveillance	MB-11-S-010	Evaluate and verify implementation of MB-IWP-013, Rev. 1, *Excavation & Conditioning*.
02/01/11 – 02/11/11	RAC	Surveillance	MB-11-S-012	Evaluate and verify implementation of MB-IWP-023, Rev.1, *Train Arrival, Container Handling and Train Departure*, and MB-IWP-038, Rev. 0, *Railway Operations.*
02/17/11 – 02/23/11	RAC	Surveillance	MB-11-S-013	Verify implementation of *Moab UMTRA Project Standard Practice for Sampling Aggregates,* Rev. 0 *(*DOE-EM/ GJRAC1933). The assessment included interviews and review of procedures, processes, and guidelines.
02/28/11 – 03/22/11	RAC	Surveillance	MB-11-S-014	Evaluate and verify implementation of *Moab UMTRA Project Lockout/Tagout Hazardous Energy Control,* Rev. 0 (DOE-EM/GJ1552).
03/14/11 – 03/24/11	RAC	Surveillance	MB-11-S-016	Evaluate and verify implementation of MB-IWP-072, Rev. 0, *Dumping and Placement of Potentially Hazardous Off-Pile Materials.*
03/29/11 – 04/18/11	RAC	Surveillance	MB-11-S-017	Evaluate and verify implementation of RAC-MB-IWP-052, Rev. 0, *The Processing and Placement of the Interim Cover Layer*, and RAC-MB-IWP-053, Rev. 0, *The Processing and Placement of the Radon Barrier Layer.*

Table 19. Audits and Surveillances Conducted during Construction (continued)

Date	Conducted By	Type	Assessment #	Scope
04/06/11	DOE/TAC	Surveillance	DOE-11-SUR-018	Observe placement of RRM and construction of cover components (radon barrier and interim cover layer) and discuss QC operations and processes with RAC QC staff to verify compliance to the RAP, Addendum B, Specifications, and Addendum E, *Remedial Action Inspection Plan.*
04/21/11 – 05/23/11	RAC	Surveillance	MB-11-S-026	Radon barrier soil properties testing.
05/23/11 – 06/10/11	RAC	Surveillance	MB-11-S-024	Evaluate and verify implementation of RAP*,* Addendum E, *Remedial Action Inspection Plan*. The assessment included interviews, review of programs and procedures, and verification of the placement process.
06/06/11 – 06/09/11	Energy*Solutions* Corporate	Audit	IA-11-13	Evaluate Project programs.
06/20/11 – 06/28/11	RAC	Surveillance	MB-11-S-027	Evaluate and verify implementation of *Suspect and Counterfeit Items* (DOE-EM/GJRAC1704). The assessment included interviews, review of procedures, and verification of the process by which to identify S/CI, prevent delivery of S/CI to DOE facilities, and notify DOE's Office of Inspector General when S/CI are found.
07/19/11 – 07/26/11	RAC	Surveillance	MB-11-S-028	Evaluate and verify the implementation of *Moab UMTRA Project Particulate Air Monitoring* (DOE-EM/GJRAC1744), Rev. 5. The assessment includes interviews, review of program, procedures, and lines of communication.
08/01/11 – 12/31/11	DOE/TAC	Surveillance	DOE-12-SUR-002	TAC subcontractor Geotechnical Engineering Group verification of RAC field operations and compliance with the RAP
08/25/11	DOE/TAC	Surveillance	TAC-12-SUR-011	Crescent Junction disposal cell.
10/24/11 – 10/27/11	DOE EMCBC	Audit	Phase IV ISMS	Evaluate implementation of Project ISMS Phase IV Program.
10/26/11 – 11/11/11	RAC	Surveillance	MB-12-S-002	Evaluate and verify implementation of MB-IWP-026, Rev. 0, *Container Maintenance,* and MB-IWP-068, Rev. 0, *Water Testing Intermodal Containers*. The assessment included interviews and review of procedures, processes, and guidelines.
11/15/11 – 11/30/11	RAC	Surveillance	MB-12-S-003	Evaluate and verify implementation of MB-IWP-039, Rev. 1, *The Dumping and Decontamination of Intermodal Containers and Haul Trucks at the Crescent Junction Site,* and MB-IWP-049, Rev. 0, *The Handling and Disposal of RRM at the Crescent Junction Site*. The assessment included interviews and review of procedures, processes, and guidelines.
04/26/12	RAC	Surveillance	MB-12-S-007	Evaluate the implementation of the Confined Space Program.

EMCBC = Environmental Management Consolidated Business Center; ISMS = Integrated Safety Management System; IWP = Integrated Work Plan; M&TE = measuring and test equipment; QC = Quality Control; S/CI = suspect and counterfeit items

4.8 Monitoring for Presence of Free Liquids

To monitor for the presence of free liquids in the disposal cell, four standpipes are specified in Section 7.2.4 of the RAS to be completed so that the screens are at the base of the placed RRM. In August 2011, the RAC placed one standpipe in a southeastern location in the cell (see Figure 13). During the period covered in this Addendum, RRM lifts surrounding the standpipe were placed to a total thickness of about 7 ft Results of periodic monitoring for the presence of fluids are shown in Table 20.

Table 20. Results of Monitoring for the Presence of Fluids in Standpipe

Date Monitored	Presence or Level of Fluids (ft)
10/28/11	Dry
02/22/12	Dry
04/27/12	Dry

Dry = no fluids present.

4.9 Monitoring for Presence of Ground Water

To monitor for the presence of ground water outside of the disposal cell footprint, Section 7.2.4 of the RAS specified that four of the characterization boreholes would be recompleted from a depth of about 300 ft below ground surface to near the contact between the weathered and unweathered Mancos Shale bedrock. The RAS indicated that the recompletion was to be performed prior to initiating RRM placement in the disposal cell. DOE notified NRC in a letter dated November 29, 2010, that the boreholes had not been recompleted prior to initiation of RRM placement. In a second letter to NRC on the subject, dated May 9, 2011, DOE indicated its intent to recomplete the wells, which occurred in September 2011. Copies of this correspondence with NRC are included in Attachment 4.

Three borehole locations were abandoned in 2008, because they were within the Phase 1 excavation area. Three additional borehole locations were abandoned in 2011 because they were either unnecessary or located inside of future excavation phases. The recompletion of the four wells and the well abandonments are detailed in the *Moab UMTRA Project Crescent Junction Disposal Site Borehole Abandonment and Monitoring Well Completion Report* (DOE-EM/GJTAC2018). The well and borehole locations are shown on Figure 13.

Results of monitoring for the presence of ground water in the wells are shown in Table 21.

Table 21. Results of Monitoring for Presence of Ground Water

	Monitor Well Number			
Date Monitored	202	203	205	210
10/28/2011	Dry	Dry	Dry	NM
11/03/2011	NM	NM	NM	Dry
02/22/2012	Dry	Dry	Dry	Dry

NM = not measured; Dry = no fluids present

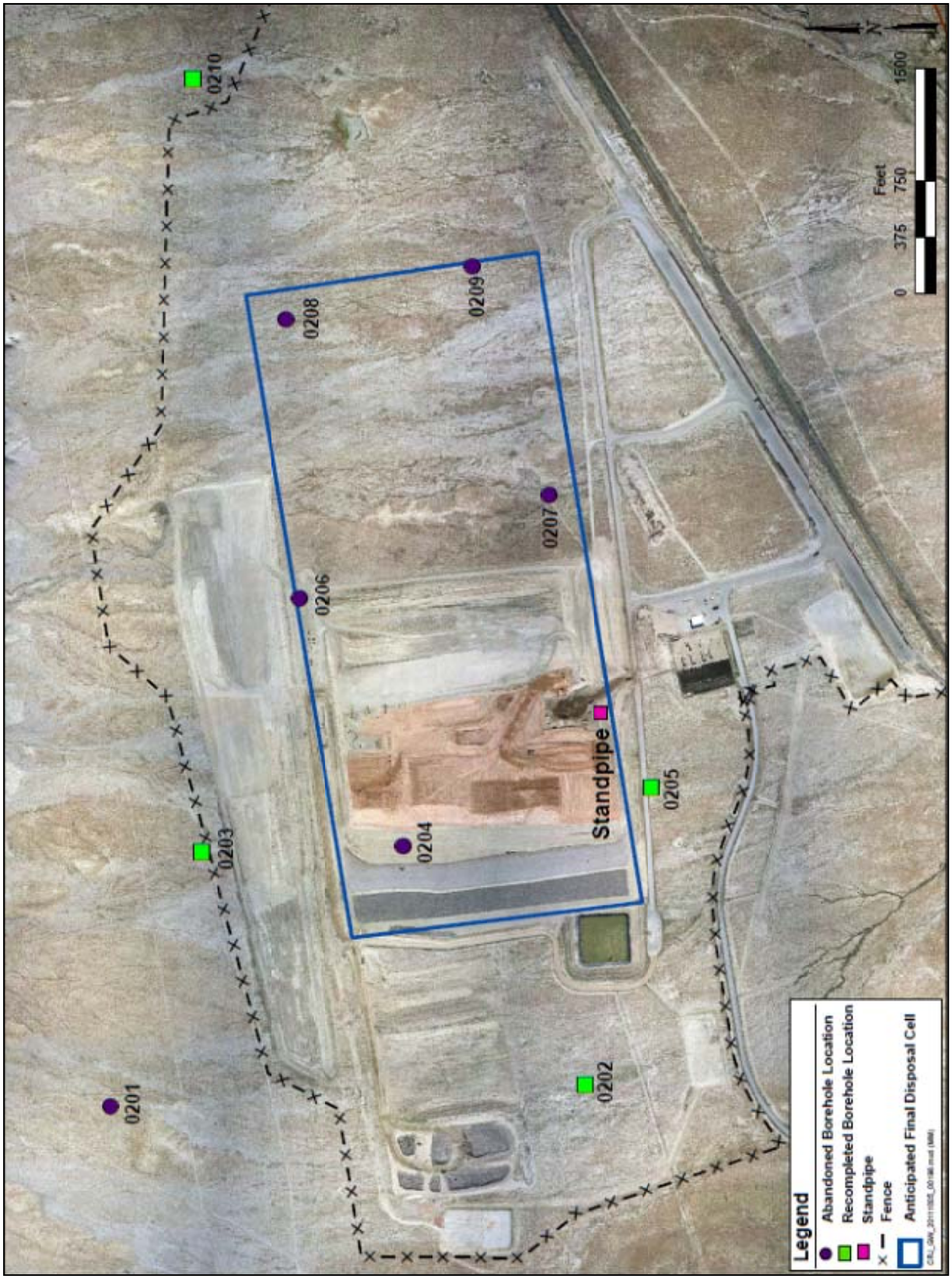

Figure 13. Locations of Abandoned and Recompleted Boreholes and Standpipe

5.0 References

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American Society for Testing and Materials (ASTM) Standard C117, "Standard Test Method for Materials Finer than 75-micrometer (No. 200) Sieve in Mineral Aggregates by Washing."

American Society for Testing and Materials (ASTM) Standard C127, "Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregates."

American Society for Testing and Materials (ASTM) Standard C131, "Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Absorption and Impact in the Los Angeles Machine."

American Society for Testing and Materials (ASTM) Standard C136, "Standard Test Method for Sieve Analysis of Fine and Course Aggregates."

American Society for Testing and Materials (ASTM) Standard D422, "Standard Test Method for Particle-Size Analysis of Soils."

American Society for Testing and Materials (ASTM) Standard D698, "Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort."

American Society for Testing and Materials (ASTM) Standard D1140, "Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve."

American Society for Testing and Materials (ASTM) Standard D1556, "Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method."

American Society for Testing and Materials (ASTM) Standard D2216, "Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass."

American Society for Testing and Materials (ASTM) Standard D4318, "Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils."

American Society for Testing and Materials (ASTM) Standard D4643, "Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Heating."

American Society for Testing and Materials (ASTM) Standard D4944, "Standard Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester."

American Society for Testing and Materials (ASTM) Standard D4959, "Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating Method."

American Society for Testing and Materials (ASTM) Standard D6938, "Standard Test Method for In-Place Density and Water content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)"

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DOE (U.S. Department of Energy), *Moab UMTRA Project Crescent Junction Disposal Site Borehole Abandonment and Monitoring Well Completion Report* (DOE-EM/GJTAC2018), November 2011.

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DOE (U.S. Department of Energy), *Moab UMTRA Project Moisture/Density Testing Procedure* (DOE-EM/GJRAC1783), April 2011.

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

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