DOE–EM/GJRAC2040-I

Office of Environmental Management – Grand Junction

UMTRA Project

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

Revision 0

December 2019

U.S. Department of Energy

Office of Environmental Management

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

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Crescent Junction Disposal Cell Interim Completion Report
Addendum I

Revision 0

Review and Approval

12/3/2019

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Revision History

Revision	Date	Reason for Revision
0	December 2019	Initial issue.

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Tables

Appendices

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Acronyms and Abbreviations

ASME	American Society of Mechanical Engineers
ASTM	ASTM International
CAES	Computer Aided Earthmoving System
CAT	Caterpillar
CBCS	Computer Based Compaction System
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DOE O	DOE Order
ft	foot/feet
gal	gallon
GPS	Global Positioning System
in.	inch
NQA	Nuclear Quality Assurance
pCi/g	picocuries per gram
QA	quality assurance
Ra-226	radium-226
RAC	Remedial Action Contract or Contractor
RAIP	Remedial Action Inspection Plan
RAP	Remedial Action Plan
RRM	residual radioactive material
TAC	Technical Assistance Contractor
UMTRA	Uranium Mill Tailings Remedial Action
yd^3	cubic yard(s)

Executive Summary

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

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

This Addendum addresses activities performed by North Wind Portage, the DOE Remedial Action Contractor (RAC) for the Moab Project, from October 1, 2018, through September 30, 2019. This Report includes placement of 388,858 cubic yards (yd^3) of RRM and 4,372 yd^3 of final cover materials.

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

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

1.0 Introduction

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

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

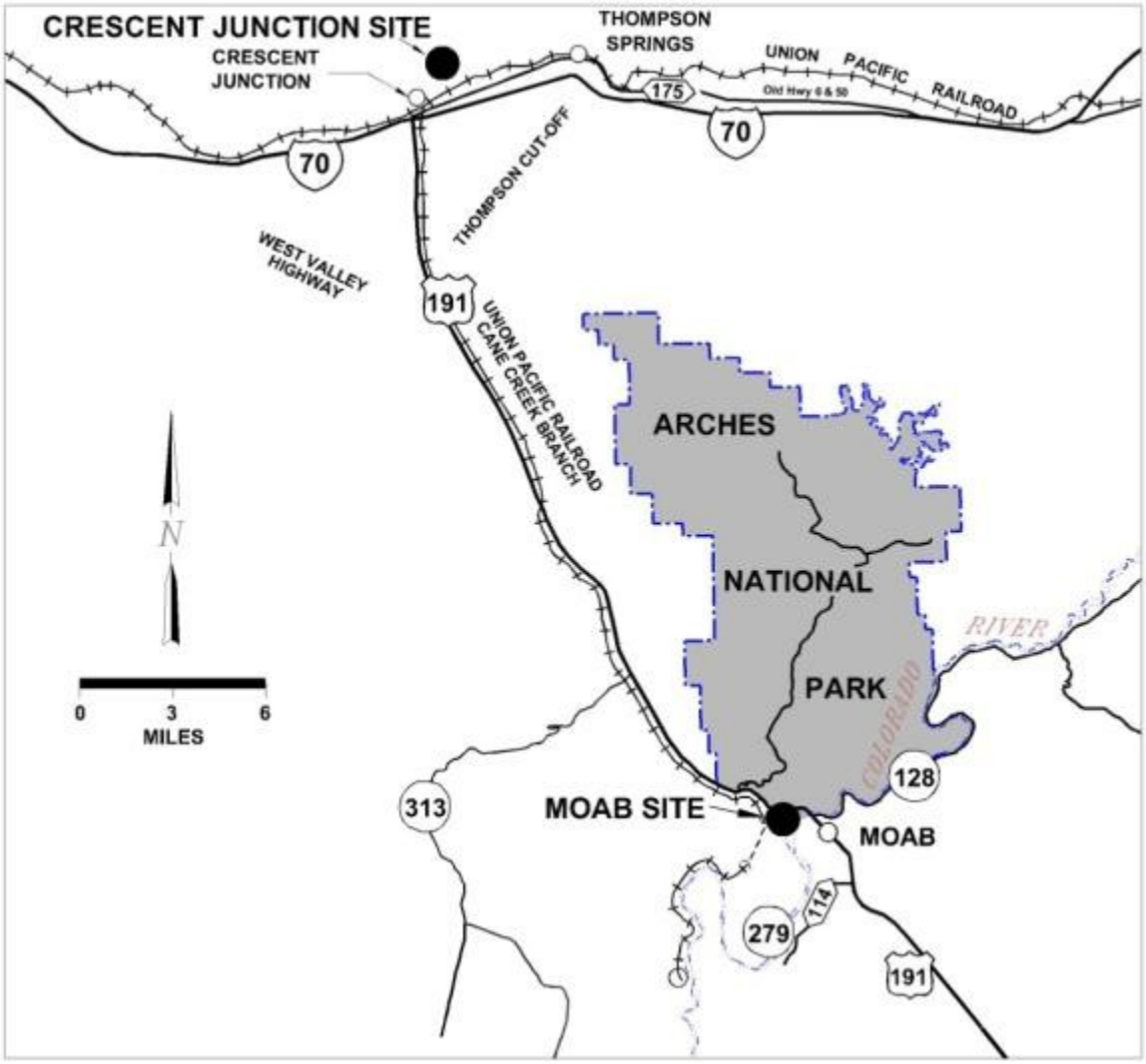


Figure 1. Location of Moab and Crescent Junction Sites

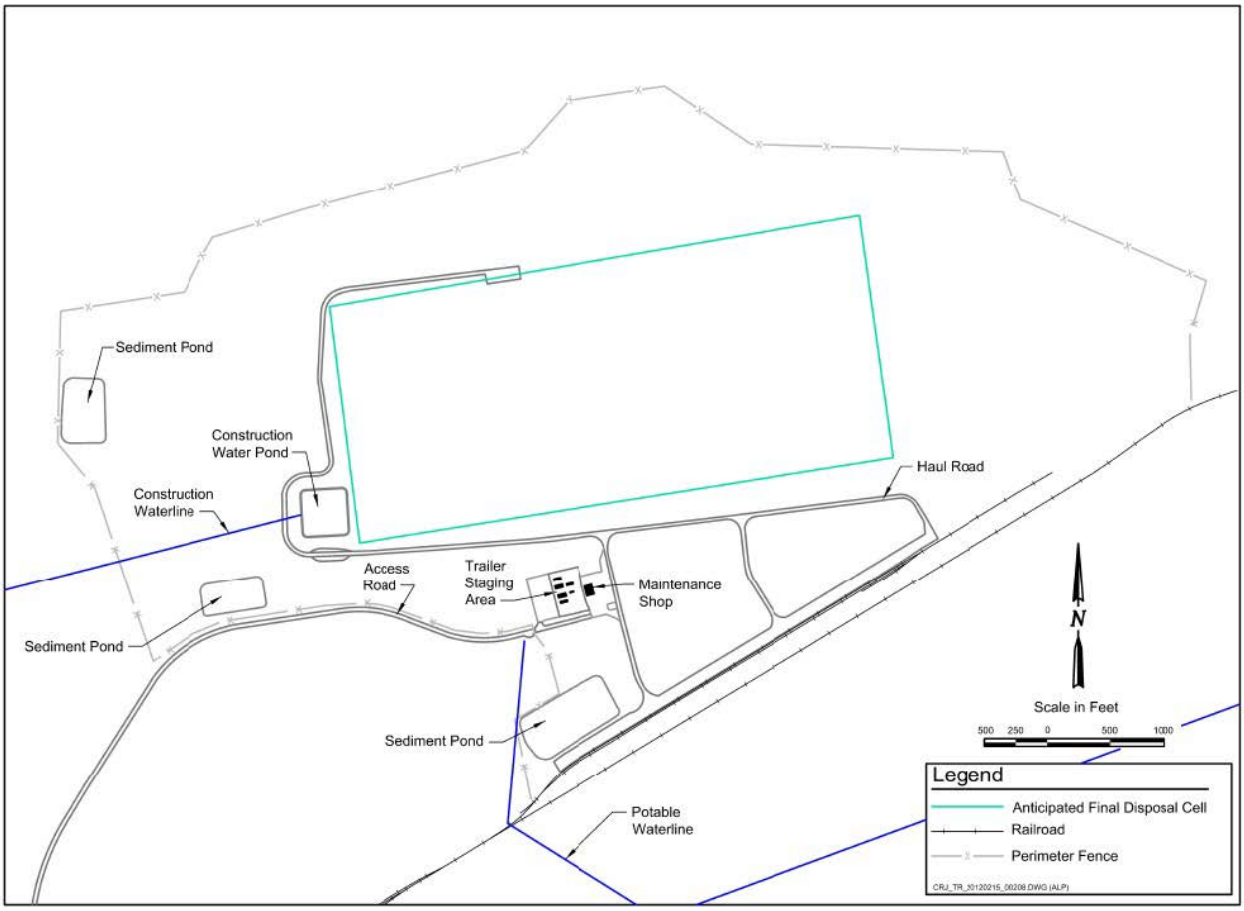


Figure 2. Crescent Junction Site Features

This Addendum documents activities performed by the RAC for the Project from October 1, 2018, through September 30, 2019.

Addendum I sections are outlined below.

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

2.0 Critical Review

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

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

Table 1. Lifts/Testing Totals

Area/ Material	Total Volume Placed (yd^3)	Total Number of Lifts Approved	Lifts Approved Using CAES/CBCS	Lifts Approved Not Using CAES/ CBCS	Total Number of Standard Proctor Tests	Total Number of In-place Density/Moisture Tests	Total Average for All In-place Density Tests Performed (%)	Total Average CAES/CBCS Passes that Meet Compaction Criteria (%)	Total Number of Soil Classifications	Total Number of Durability Tests	Total Number of Gradation Tests
Cell Perimeter Embankment	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
RRM	388,858	295	292	3	2	102	93.8	99.8	N/A	N/A	N/A
Interim Cover	4,372	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Radon Barrier	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Infiltration and Biointrusion Barrier	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Frost Protection Layer	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2-in. Cap Rock	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

CAES = Computer Aided Earthmoving System; CBCS = Computer Based Compaction System; in. = inch

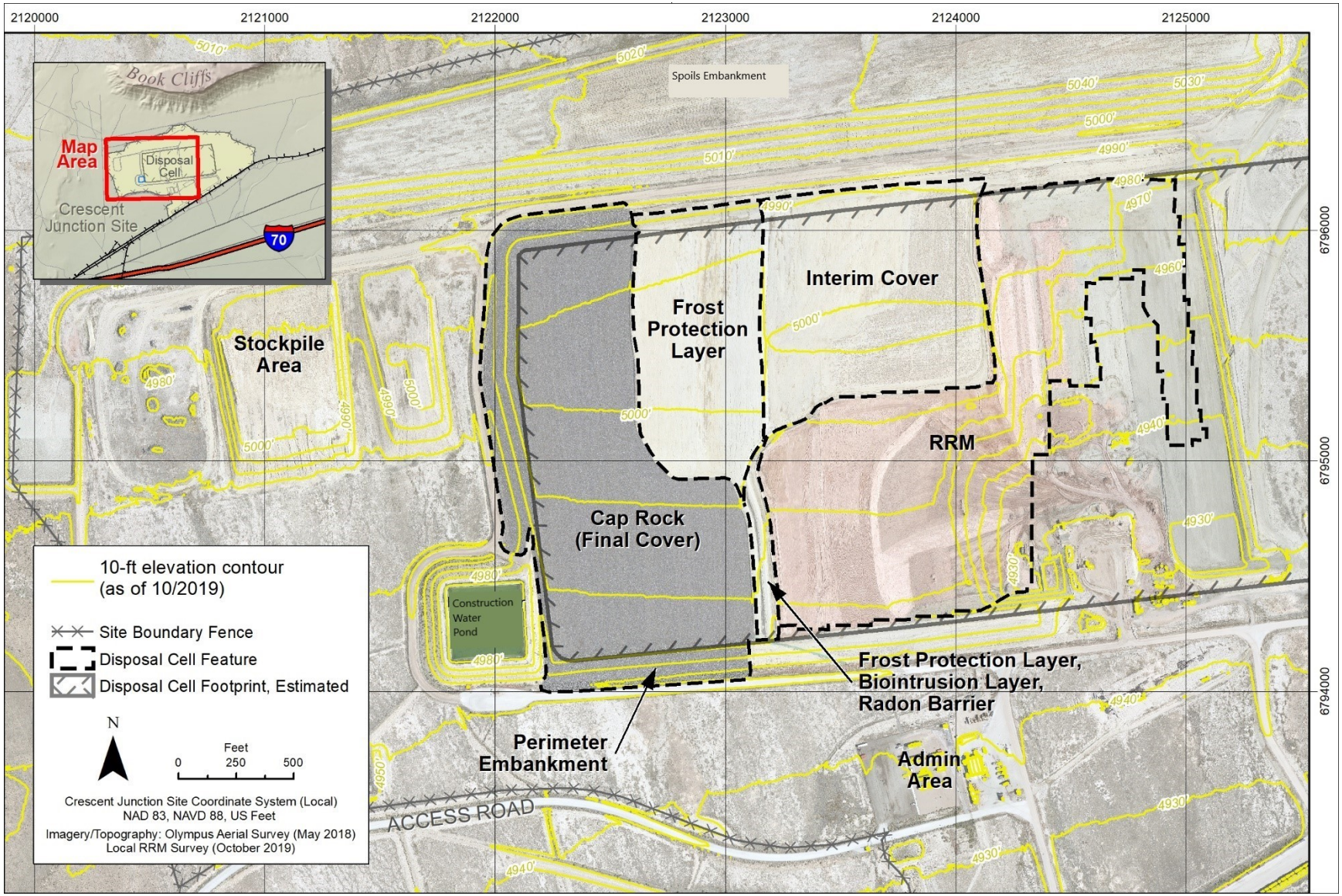


Figure 3. General Extent of Cover Layers

2.1 Cell Excavation

No quantities for cell excavation have been documented during this reporting period. The cell excavation that took place this fiscal year was minuscule and consisted of obtaining material to be utilized for interim cover. Borrow material was removed from the future footprint of the cell; however, no excavation was completed to the designed grades. These diminutive quantities will be incorporated with the upcoming mass excavation effort to construct the next phase of the cell and will be reported accordingly at that time.

2.2 Perimeter Embankment

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

2.3 Residual Radioactive Material

2.3.1 Computer Aided Earthmoving System/Computer Based Compaction System Performance Verification Testing

The Project used machines equipped with a Computer Aided Earthmoving System (CAES) through November to meet RRM compaction requirements as specified in Section 6.4.3 of the RAIP. In December, the Project upgraded from the CAES to another Computer Based Compaction System (CBCS). The CCS900 (compaction control system) platform is the replacement platform for the Caterpillar (CAT) CAES. The on-machine CAES function has migrated to the CCS platform, and the CAES office software functionality has migrated to VisionLink and Landfill Project Monitoring. The new hardware/software monitors compaction and elevation. Additional information about the CBCS verification testing is provided in Section 4.3 of this Addendum.

The RAIP also requires periodic verification of the CAES/CBCS compaction by comparing the results to in-place, nuclear density gauge test results. Table 2 shows the results of the comparison tests performed during this Report period.

Table 2. CAES/CBCS Performance Verification Testing

Lift ID Number	Test Performance Date	Average In-place Density Compaction	Lift Area Meeting CAES/CBCS
UW1R02180907-00	9/11/2018	91.9	96.8
UW1R02180912-00	9/18/2018	92.0	86.6
UW1R02180920-00	10/1/2018	94.9	97.5
UW1M26181114-00	11/15/2018	93.6	100
UW1S06190329-00	4/1/2019	96.6	100
UW1P01190404-00	4/10/2019	94.5	100
UW1R01190425-00	5/7/2019	94.8	99.9
UW1T13190506-00	5/7/2019	96.4	99.4
UW1R01190507-00	5/14/2019	93.5	100
UW1M26190213-00	6/5/2019	92.6	99.7
UW1H33190621-00	6/26/2019	95.2	100
UW1I24190205-00	8/20/2019	92.1	99.9
UW2C01190917-00	9/23/2019	92.9	100
UW1R01190916-00	9/26/2019	95.7	100
UW1W01190917-00	9/26/2019	95.5	100

2.3.2 RRM Placement

RRM inspections and tests are shown in Table 3. The distribution of survey points is shown in Figure 4. The standard proctor test results summary, two foot test pad lift approval packages, lift approval summaries, one lift approval package for RRM, and top-of-waste buyoff survey are provided in Appendix A2.

In September 2018, a test pad of three lifts placed on top of each other was constructed for lift thickness up to an un-compacted average of 24 in. The test pad provided data that a minimum of 90 percent compaction of a standard proctor such as ASTM International (ASTM) D-698 will be achieved with a minimum of eight machine passes for 80 percent of the lift area. Ninety-nine in-place density tests were performed throughout the year to verify eight machine passes achieved the minimum 90 percent compaction requirement for 24-inch (in.) lifts.

In January 2019, revision 6 to Specification 31 00 20 Section 3.2.1 was approved to allow an average uncompacted thickness of 24 in. for 2-ft lifts, and Section 3.2.5 was approved allowing a sacrificial lift that may have debris to be placed at the bottom of the disposal cell in a 2-ft lift. Sacrificial lifts are not subject to moisture and compaction criteria. Beginning in March of this year, small quantities of debris mixed with uranium mill tailings were shipped in most trainloads through the end of this report period. The debris was appropriately sized and incorporated into the 1-ft tailings lifts.

Table 3. RRM Inspection and Testing

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
Visual Observation	Scarify, at a minimum, the top 1 in. of subsoil or preceding RRM lift using a footed roller or a dozer before placing subsequent RRM layers. Fill materials shall be placed in continuous and planar lifts. The method of dumping and spreading RRM shall result in loose lifts of nearly uniform thickness, with average thickness not to exceed 24 in. Compaction equipment shall consist of footed rollers or dozers. Footed rollers shall have a minimum weight of 45,000 lb, and at least one tamping foot shall be provided for each 110 $in.^2$ of drum surface. The length of each tamping foot from the outside surface of the drum shall be at least 6 in. After lift placement, moisture content shall be maintained until the next lift is placed. Erosion that occurs in RRM layers shall be repaired and grades re-established. If freezing or desiccation occurs, the affected soil shall be reconditioned.	Specification 31-00-20 Sections 1.3.2, 3.2.1, 3.2.4, 3.5.1, and 3.5.2	6.4.2, 6.4.3	Visually verified throughout material preparation, ground preparation, and RRM placement. Documented in lift approval packages.
Laboratory Compaction Characteristics	Assessment tests shall be performed on RRM to ensure compliance with specified requirements and to develop compaction requirements for placement. Perform tests (standard proctor) in accordance with the following standards, as applicable: *ASTM D698 and D2216.	Specification 31-00-20 Section 3.1.1	6.4.3	Two tests were performed to determine compaction characteristics.

Table 3. RRM Inspection and Testing (continued)

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
Visual Observation	RRM shall be placed and compacted within the moisture content range needed to achieve 90% of the laboratory-determined maximum dry density of each type of material. The range in moisture content shall be maintained uniform throughout each lift as necessary to achieve 90% compaction and dust control. The moisture content shall be maintained uniform throughout each lift.	Specification 31-00-20 Section 3.2.2	6.4.3	Daily observations were performed during placement.
Moisture Test	Fill material is properly moisture conditioned. Perform in accordance with the following standard: *ASTM D4643.	Specification 31-00-20 Section 3.4.2	6.4.3	Moisture tests were performed and documented in lift approval packages.
In-place Density/ Moisture Test	Density tests must meet at least 90% of the material's maximum dry density in accordance with *ASTM D698. Perform in accordance with the following standards, as applicable: *ASTM D1556, D2216, D4643, and D6938.	Specification 31-00-20 Sections 3.2.2, 3.2.3	6.4.3	One hundred and two tests were performed with average in-place density of 93.8% of the laboratory-determined maximum dry density. Three lifts were approved using in-place density/moisture tests with average in-place density of 93.4%.
Compaction by CAES/CBCS	QC shall monitor CAES/CBCS 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	Forty-five lifts were approved using CAES and 247 lifts were approved using the CBCS.
Visual Observation	Each container of demolition debris shall be in the cell along with RRM. Debris shall not contain free liquids. Debris shall be sized to minimize voids. Pipes and ducts that are 6 in. or greater in diameter shall be crushed, filled, or cut.	Specification 31-00-20 Section 3.2.5	6.4.4	Debris inspections performed during debris placement. Inspections documented in lift approval packages.
Visual Inspection	Debris may be placed as a sacrificial lift at the bottom of the disposal cell in a 2-ft lift. Debris in sacrificial lifts shall contain no free liquids and shall be oriented in a manner that minimizes voids, and contained within the 2-ft lift profile. Sacrificial debris lifts are not subject to moisture and compaction criteria.	Specification 31-00-20 Section 3.2.5	6.4.4	Debris inspections performed during debris placement. Inspections documented in lift approval packages.

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

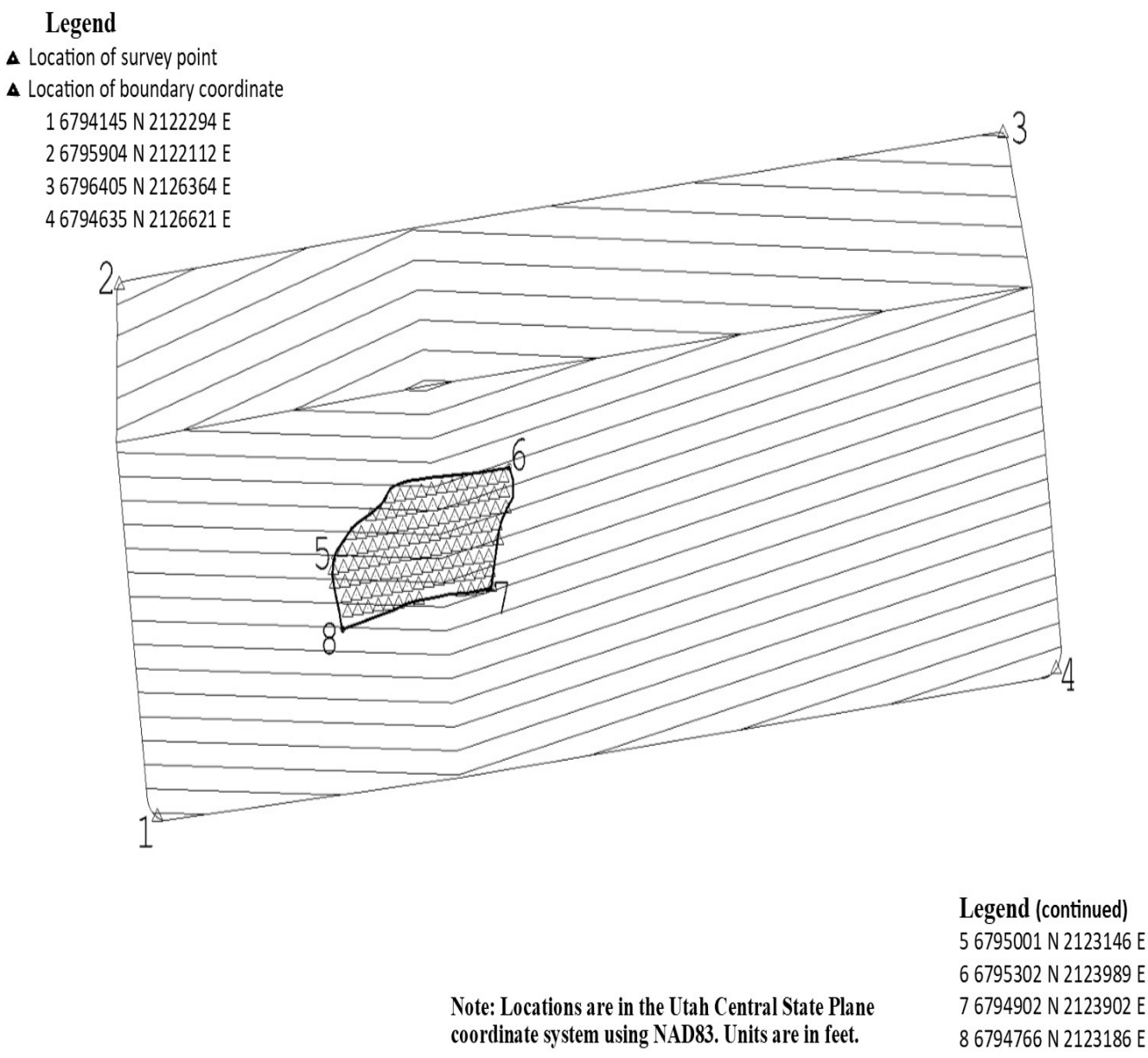


Figure 4. Distribution of Survey Points to Verify Compliance with RRM Specification

2.4 Interim Cover

Material from the cell excavation was placed for interim cover, but no lifts were approved during the reporting period.

2.5 Radon Barrier

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

2.6 Infiltration and Biointrusion Barrier

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

2.7 Frost Protection Layer

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

2.8 Cap Rock and Armoring

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

3.0 Design Assessment

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

This section discusses design criteria changes, changes to the design of the disposal cell and associated erosion control features, fulfillment of QA requirements, and compliance with permit requirements.

3.1 Design Criteria Changes

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

3.2 Design Changes

DCN #26 was implemented to allow loose lifts of up to 14 in. and to allow use of rubber-tired vehicle to achieve compaction for Interim Cover. Design authority did not consider this a change in design.

3.3 QA Requirements

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

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

- ASME NQA-1 2008 and addenda through 2009 consensus standard, "Quality Assurance Requirements for Nuclear Facility Applications."
- DOE Order (O) 226.1B, "Implementation of Department of Energy Oversight Policy."
- Title 10 Code of Federal Regulations Part 830 (10 CFR 830) Subpart A, "Nuclear Safety Management, Quality Assurance Requirements."
- DOE Office of Environmental Management EM-QA-001, "EM Quality Assurance Program."
- DOE O 414.1D, Admin Chg 1, "Quality Assurance."

3.4 Permits and Agreements

The Project is in compliance with permits and agreements applicable to the Crescent Junction site. The permits and agreements are summarized in Table 4.

Table 4. Crescent Junction Site Permits and Agreements

Agreement Number	Document Name or Description	Issuing Agency	Purpose
400-00177	Easement for Green River Pump Station	Utah Division of Forestry, Fire, and State Lands	ROW easement to construct and operate water pipeline in the Green River.
4P-082364-0	UDOT Encroachment Permit	UDOT	To construct waterline within UDOT 60-ft ROW and operate within 20-ft ROW for State Route 19 near City of Green River.
6-UT-06-F-014	Biological Opinion	U.S. Fish and Wildlife Service	U.S. Fish and Wildlife Service issued Biological Opinion for Green River Pump Station.
1-92-677	Green River Water Right	State Water Engineer	Gives DOE right to divert 323 acre-feet or ~200 gallons per minute from Green River for Crescent Junction disposal site.
DE-RO01-06GJ68009	Access Roadway Contract and Grant of Easement	Private Owner	Perpetual easement and ROW for construction of an access roadway and related utilities at the disposal site.
ESMT 463	Waterline Easement	SITLA	Easement across state land for potable waterline.
Folder No. 02392-96	Pipeline Crossing Agreement	Union Pacific Railroad	Agreement grants right to construct, maintain, and operate one underground waterline and access for phone line and 1.5-in. conduit across Union Pacific Railroad's property at mile post 533.2, Green River Subdivision.
Folder No. 02399-44	Pipeline Crossing Agreement	Union Pacific Railroad	Agreement grants right to construct, maintain, and operate one underground waterline and access for phone line and 1.25-in. conduit at mile post 0.25, Cane Creek Subdivision, Thompson Springs, for the disposal site.
Folder No. 2537-02	Industrial Track Contract	Union Pacific Railroad	Covers construction, maintenance, and operation of 5,209-ft Track A, 3,524-ft Track B, and 617-ft Track C at mile post 533.21, Green River Subdivision line.
Property No. 70-4; 189A: AEQ	Easement	UDOT	Easement for waterline across UDOT property near Floy Wash that allows 60-ft construction ROW and 20-ft permanent ROW.
Public Land Order 7697	Permanent Land Transfer	BLM	Order permanently transferred 500 acres of BLM public domain land to DOE for disposal cell.
REEMCBCDOE-3-15-0702	Real Estate License	Rocky Mountain Power	Power line extension to dump ramp.
REEMCBCDOE-6-08-0302	Waterline Easement	Grand County	Easement within County Road 175 or old Highway 6 and 50 and Hastings Lane ROWs to construct waterline within 60-ft ROW and operate within 20-ft ROW.

Table 4. Crescent Junction Site Permits and Agreements (continued)

Agreement Number	Document Name or Description	Issuing Agency	Purpose
REEMCBCDOE-6-08-0304	Waterline Easement	Private Owner	Easement across private land near the Green River to construct waterline within 60-ft ROW and operate within 20-ft ROW and pump station.
REEMCBCDOE-6-08-0308 SITLA No. 1345	Waterline Easement	SITLA	Easement to construct waterline within 60-ft ROW and operate within 20-ft ROW on three parcels of SITLA land near Green River and Crescent Junction.
REEMCBCDOE-6-08-0309	Waterline Easement	City of Green River	Easement to construct waterline within 60 ft of County Road 175 or old Highway 6 and 50 ROWs within Green River city limits and operate within 20-ft ROWs.
REEMCBCDOE-6-12-0302	Waterline Easement	Private Owner	Permanent easement across private land near Crescent Junction to construct waterline within 60-ft ROW and operate within 20-ft ROW.
REEMCBCDOE-7-15-014	Access Agreement	Private Owner	For installation and maintenance of air monitoring equipment and collection of air quality data for monitoring station MPS-0306.
REEMCBCDOE-7-15-0106	Access Agreement	Private Owner	For installation and maintenance of air monitoring equipment and collection of air quality data for monitoring station MPS-0307.
Resolution 2006-2741	Grand County Council Resolution	Grand County	Approves conditional use permit for the Project.
Statewide Utility License Agreement No. 8439	Utility License	UDOT	License with state of Utah to construct waterline across UDOT property.
U.S. DOT No. 050217551021ZB	Hazardous Materials Certificate of Registration	U.S. DOT	For shippers of hazardous materials through 06/2020.
U.S. DOT-SP 14283	Special Permit	U.S. DOT	Permit to transport mill tailings from Moab site to the disposal site.
UTR359187	Storm Water Permit	Utah Division of Water Quality	To limit the discharge of pollutants from disposal cell construction activities.
UT-SES-GR-17001	MOU	Utah Dept. of Natural Resources and BLM	MOU outlines terms and conditions for helicopter use of pond for wildland fire fighting.
UTU-83354	Waterline ROW	BLM Moab Field Office	For construction of 14.5 miles of waterline on BLM land from Green River to disposal site.
UTU-83396	Utility ROW	BLM Moab Field Office	For buried telephone line at the disposal site.
UTU-83450	Utility ROW	BLM Moab Field Office	ROW for power line to the disposal site.

Table 4. Crescent Junction Site Permits and Agreements (continued)

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

BLM = U.S. Bureau of Land Management; ft = feet; MOU = Memorandum of Understanding; ROW = right-of-way; SITLA = School and Institutional Trust Lands Administration; UDOT = Utah Department of Transportation;
U.S. DOT = U.S. Department of Transportation.

4.0 Remedial Action Assessment

This section describes pre-excavation site conditions, construction activities, and verifications performed at the Crescent Junction disposal site.

4.1 Pre-excavation Site Conditions

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

4.2 Cell Construction

The only cell construction activities during this period were:

- Placement of RRM to the design thickness, and ensuring that the radium-226 (Ra-226) activity in the upper 7 feet (ft.) of placed material does not exceed design criteria.
- Material from the cell excavation was placed for interim cover but no final lifts were approved during the reporting period.

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 above cell construction activities are provided in Table 5.

Each activity performed as part of this Addendum is further described in the following subsections. Photographs representative of the cell construction activities are included in Appendix B.

4.2.1 Excavation

No quantities for cell excavation have been documented during this reporting period. The cell excavation that took place this fiscal year was minuscule and consisted of obtaining material to be utilized for interim cover. Borrow material was removed from the future footprint of the cell; however, no excavation was completed to the design grades.

Table 5. Compaction Equipment Used during Cell Construction

Compaction Equipment	Machine Weight (lb)	Equipped with CAES/CBCS	Material Layer						
			RRM	Interim Cover	Radon Barrier	Infiltration and Biointrusion Barrier	Frost Protection	Perimeter Embankment	Spoils Embankment
CAT 825H Soils Compactor	69,000	X	X						
CAT D8 Bulldozer	84,850	X	X						
Komatsu 275AX Bulldozer	112,466	X	X						

CAT = Caterpillar; lb = pounds

4.2.2 Perimeter Embankment Construction

There were no perimeter embankment construction activities during this period.

4.2.3 RRM Placement

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

4.2.4 Cover and Rock Armoring Placement

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

4.2.5 Spoils Embankment Construction

There were no spoils embankment (also called the wedge) construction activities during this period.

4.3 Soil Compaction and Testing

Initial CAES compaction set up and verification is documented in Addendum A of the *Crescent Junction Disposal Cell Interim Completion Report*. In December, the Project upgraded the CAES to the new high-accuracy global positioning system (GPS)-guided CBCS. The CAES and CBCS compaction is periodically verified by performing in-place tests using a nuclear density gauge manufactured by Troxler Electronic Laboratories, Inc., following ASTM methods and in compliance with the RAIP. The individual nuclear density tests verify the compaction achieved with the CAES and CBCS is greater than or equal to the required 90 percent. The CAES and CBCS compaction results are compared to the nuclear density gauge results in Table 2.

4.4 Lift Approval

The *Lift Approval Procedure* and Addenda B and E of the RAP were followed to verify each lift met established criteria. Results of lifts are documented in lift approval packages. A sample lift approval package for RRM placed during this Report period is provided in Appendix A.

4.5 Geotechnical Testing

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

4.5.1 Soils Testing

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

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

Material is compacted to meet 90 percent of the laboratory-determined maximum dry density in accordance with ASTM D698. The thickness of each lift was surveyed and verified using a high-accuracy GPS, when practical; otherwise, manual measurements were taken.

4.5.2 Aggregate Testing

There were no aggregate testing activities during this period.

4.6 Radiological Verification

Section 5 of the Remedial Action Selection Report of the RAP, *Radon Attenuation*, identifies two primary verification criteria associated with construction of the disposal cell: radium-226 (Ra-226) measurements in RRM placed in the upper 7 ft., and radon flux measurements to verify the integrity of the radon barrier. Addendum A of this Report provides an explanation of this verification process.

During this Addendum period, 336 samples of RRM were taken in 12 lifts in the upper 7 ft. of the disposal cell. The Ra-226 activity of the material ranged from 58.8 to 728.0 picocuries per gram (pCi/g). Table 6 shows the average results for material placed in each lift tested.

Table 6. Results of Ra-226 Activity in Upper 7 Feet of Placed RRM

Lift Identification No.	Samples Taken	Lift Average (pCi/g)	Lift Area (m^2)
UW1F24	28	267	2952
UW1A16	28	254	6220
UW1B18	28	242	5260
UW1E30	28	246	3269
UW1A31	28	242	4357
UW1I24	28	548	5047
UW1K21	28	548	7100
UWZ20	28	320	5230
UWY24	28	313	5785
UWY27	28	313	3986
UWY29	28	273	3372
UWY23	28	308	3479

4.7 QA Requirements

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

In addition, the Technical Assistance Contractor (TAC) supports the DOE in the assessment of the RAC.

During the period of this Addendum, three oversight inspections and three management assessments were performed (see Table 7). Corrective actions are developed to address any deficiencies identified during the assessments.

Table 7. Inspections and Assessments Conducted during Construction

Date	Conducted By	Type	Assessment Number	Scope
11/05/2018	TAC	Oversight Inspection	DOE-19-A-005	Independent review of Interim Completion Report.
01/02/2019	RAC	Management Assessment	MA-19-005	Review the process used to sample, identify, and test both soil and air samples of suspect RRM that was reported as odorous.
01/11/2019	RAC	Management Assessment	MA-19-006	Evaluate the Radiological Area Monitoring program as specified in 10 CFR 835, along with its DOE Guidance Document (DOE G 441.1-1 C).
5/29/2019	TAC	Oversight Inspection	DOE-19-MA-009	Review RRM and debris design specifications and RRM placement, compaction, and density testing processes.
6/03/19	TAC	Oversight Inspection	DOE-19-A-013	Evaluate disposal cell Contamination Area boundary control.
8/06/2019	RAC	Management Assessment	MA-19-020	Evaluate the implementation of the corrective action program.

4.8 Monitoring Free Liquid Presence

During this period, the results of monitoring the one existing standpipe (see Figure 5) for the presence of free liquids in the disposal cell are shown in Table 8. It was not possible to access the standpipe in December 2018 and March 2019 due to site conditions. No additional standpipes were installed during this period.

Table 8. Monitoring Results for the Presence of Fluids in Standpipe 01

Date Monitored	Presence or Level of Fluids (ft)
06/25/19	Dry

Dry = no fluids present.

4.9 Monitoring Groundwater Presence

Monitoring results for the presence of groundwater are shown in Table 9. As noted in the table, wells 0203 and 0210 were dry throughout this reporting period. As displayed in Table 9, a significant volume of water was detected in well 0202 starting in June 2019, when there was 8.9 ft (which is equivalent to 3.3 gal) present. Water was first encountered in well 0205 in late June 2015 and has been present since that time.

Table 9. Monitoring Results for Presence of Groundwater

Date Monitored	Monitor Well Number			
	0202	0203	0205	0210
12/19/18	Dry	Dry	DTW = 49.39 ft btoc	Dry
03/19/19	Dry	Dry	DTW = 48.25 ft btoc	Dry
06/25/19	DTW = 53.63 ft btoc	Dry	DTW = 46.95 ft btoc	Dry

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

As part of the quarterly monitoring practice, a sample may be collected of any water present in sufficient quantity and submitted to a laboratory for analysis of various anions, cations, inorganics, and radionuclides.

During this Report period, two groundwater samples (one from well 0202 and the other from well 0205) and two short-term recovery tests (both from well 0205) were completed to determine the water source and recharge rates. All water quality data are presented and discussed in the *Moab UMTRA Project Groundwater and Surface Water Monitoring Report July through December 2018* (DOE-EM/GJTAC3011) and the *Moab UMTRA Project Groundwater and Surface Water Monitoring Report January through June 2019* (DOE-EM/GJTAC3024).

Data from the recovery tests and associated analytical results continue to suggest the water is not from leakage from the disposal cell but is, rather, surface runoff flowing off the cover. Recovery test results from well 0205 indicate that the recharge rates were identical at approximately 0.035 gallons (gal) per minute during this reporting period.

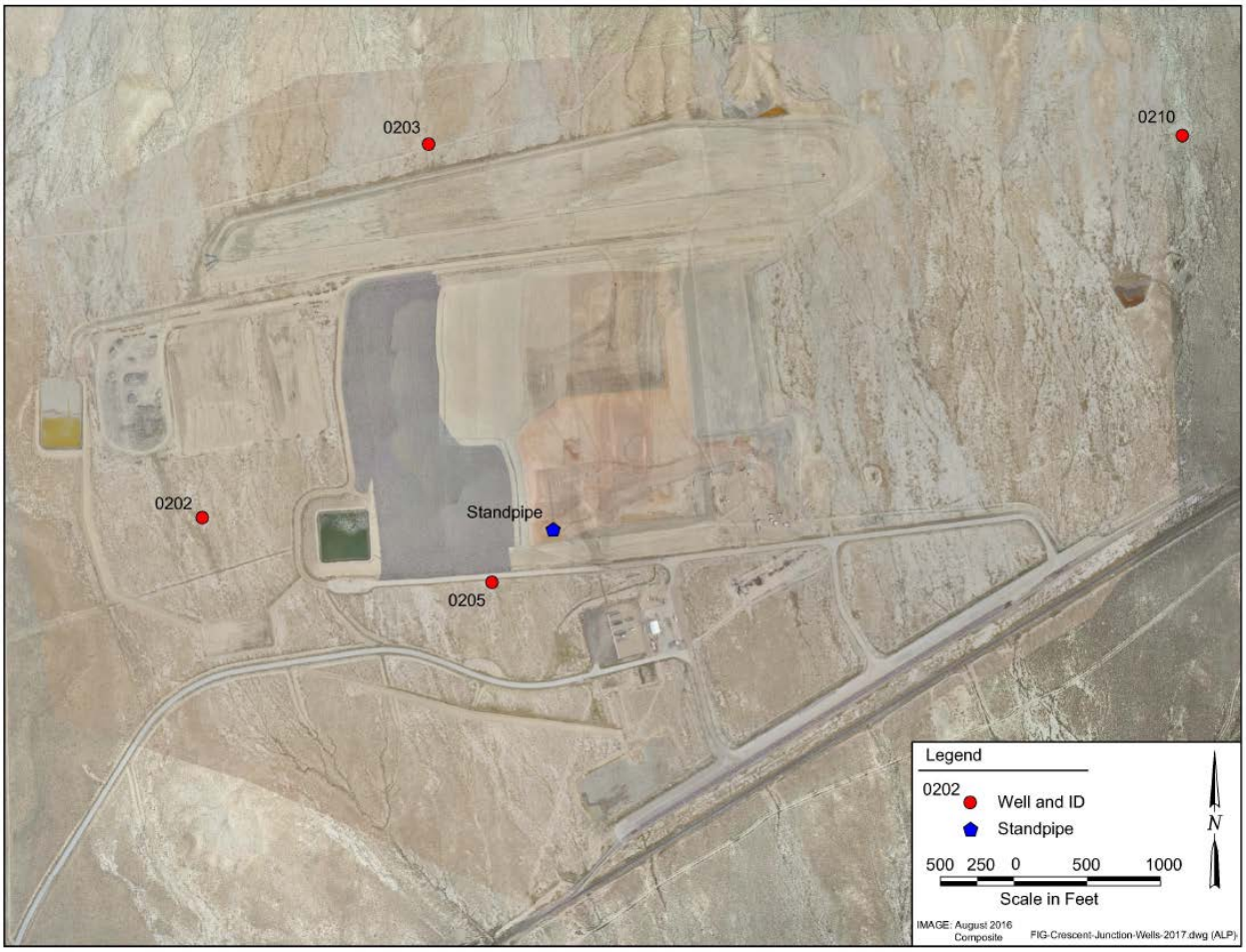


Figure 5. Locations of Monitoring Wells and Standpipe

5.0 References

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

ASME (American Society of Mechanical Engineers), Nuclear Quality Assurance (NQA)-1 2008 and addenda through 2009 consensus standard, "Quality Assurance Requirements for Nuclear Facility Applications (QA)."

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

ASTM Standard D1556, "Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method."

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

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

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

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

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

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

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

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

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

DOE (U.S. Department of Energy), *Moab UMTRA Project Groundwater and Surface Water Monitoring Report July through December 2018* (DOE-EM/GJTAC3011).

DOE (U.S. Department of Energy), *Moab UMTRA Project Groundwater and Surface Water Monitoring Report January through June 2019* (DOE-EM/GJTAC3024).

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

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

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

Appendix A.
Construction Verification Data

Crescent Junction Disposal Cell Completion Report Addendum I
Appendix A. Construction Verification Data

Contents

NOTE: Appendices A1 and A3 through A8 are not included as they are not relevant to the period covered in this Addendum.

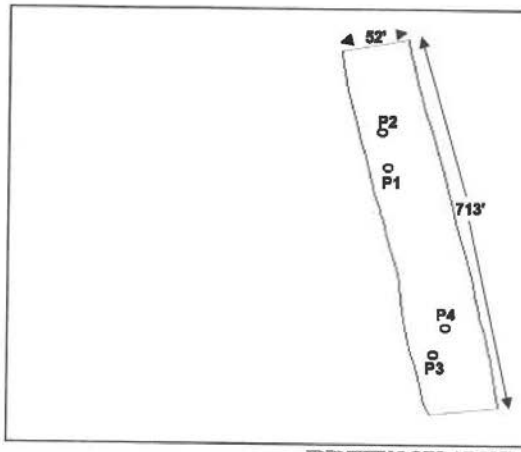
Appendix A2.
RRM

Two Foot Test Pads
Standard Proctor Test Results Summary
Lift Approval Summaries
Lift Approval Package
Top-of-Waste Buyoff Surveys

LIFT APPROVAL FORM

PROJECT: Moab UMTRA OTHER

NW CORNER DATE: 9/7/2018



P 1	6795527 N. 2124253 E.			
EW:	52	X 0.119	=	6
NS:	713	X 0.359	=	256
P 2	6795576 N. 2124257 E.			
EW:	52	X 0.195	=	10
NS:	713	X 0.290	=	207
P 3	6795218 N. 2124261 E.			
EW:	52	X 0.277	=	14
NS:	713	X 0.793	=	565
P 4	6795247 N. 2124271 E.			
EW:	52	X 0.468	=	24
NS:	713	X 0.752	=	536
P 5	N			
EW:		X		
NS:		X A	=	
Page 2 attached:			Y	N

IDENTIFY LOTS ABOVE

LIFT ID: UW1R02180907-00 NW CORNER: 6795783 N. 2124247 E.

Uncompacted Thickness: 1.8 Compacted Thickness: N/A Debris Insp. By: N/A Date: N/A Time: N/A

NW CORNER of debris placement: N/A EW Dimension N/A NS Dimension N/A

Lift Area (ft²): 34,829 Lift Volume (yd³): 2,322

Comments: This lift is the first of three lifts to provide data and a method for compacting two feet of soil. After the lift area was identified for the test pad QC surveyed the area for a boundary and baseline elevations. On 9/7/2018 QC verified that the lift area was scarified prior to placement. Operations began placement from north to south using haul trucks to dump piles and the 275 bulldozer to push material to a thickness of approximately two foot loose material. Thickness was verified using GPS on the CAES equipment. Operations began compaction using the CAT 825. On 9/10/2018 Operations added moisture to the surface and continued compaction. Moisture was added throughout compaction efforts. On 9/11/2018 Operations finished compaction and the CAES showed uniform compaction. CAES was set to 8 machine passes. QC then began testing for in place desity using a nuclear gauge. The top surface was scrapped and then tested at four locations. Then a track hoe was used to pothole down approximately eight inches and QC performed testing at these elevations for all four locations. Last the track hoe potholed down sixteen inches and QC tested at that elevation for all four locations. All tests were satisfactory for moisture and compaction. A trench correction was performed on the nuclear gauge for each level of density testing. A correlation sandcone was performed, this test was satisfactory as well. Attached on page two is a summary table showing all density and moisture results for this lift. The test ID's are labeled by testing location (P1, P2, P3...) and then the test depth (1 surface, 2 eight inches below, 3 16 inches below). The coordinates location on the lift approval form are the random locations, the coordinate location on the density forms are the actual testing locations.

Attached Forms: Grid Slope X Compaction Macro X Print Screen X Moisture/ Density X

KEYING IN NOTES: N E S [W] Satisfactory MOISTURE/ DENSITY TESTS ID # (S): P1-1 through P4-3

LIFT APPROVED BY: Mitch Hogan/ DATE: 9/12/2018 TIME: 1336

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
DOE-EM/GJRAC1783
Rev. 1

QC-F-001
File Index No. 43.8.2
Page ___ of ___

Lift ID: UW1R02180907-00						
Location	In- Place Sandcone DD lbs/ft³	In- Place Gauge DD lbs/ft³	In- Place Moisture %	Proctor max dry density	Proctor optimum moisture %	Compaction % (Sandcone/ Gauge)
P1-1		94.3	19.4	104.3	20	90.4
P1-2		94.4	18.9	104.3	20	90.5
P1-3		95.7	18.1	104.3	20	91.8
P2-1		94.5	18.4	104.3	20	90.6
P2-2		95	17.2	104.3	20	91.1
P2-3		94.9	17.2	104.3	20	91
P3-1		94.3	19.7	104.3	20	90.4
P3-2		96.3	19.6	104.3	20	92.3
P3-3	100.6	100.3	17.1	104.3	20	96.5/ 96.2
P4-1		95.2	17	104.3	20	91.3
P4-2		95.7	19.3	104.3	20	91.8
P4-3		94	17.9	104.3	20	90.2

DD= Dry Density

Pg 2 of 19

Slope Elevation Survey

Average lift thickness=	1.8	Bounding Box	Northing	Easting	
Grid Size=	20'	Lower Left	N		
Lift ID:	UW1R02180907-00	Upper Right		A	

Last Lift Elevations			Lift Approval Elevations			Lift Thickness	
Northing	Easting	Elevation	Northing	Easting	Elevation	Thickness	
6795193	2124298	4953.3	6795193	2124298	4955.5	2.2	OK
6795213	2124298	4953.9	6795213	2124298	4956.0	2.0	OK
6795233	2124298	4954.5	6795233	2124298	4956.4	1.9	OK
6795253	2124298	4955.0	6795253	2124298	4956.7	1.7	OK
6795273	2124298	4955.4	6795273	2124298	4957.1	1.7	OK
6795293	2124298	4955.7	6795293	2124298	4957.5	1.8	OK
6795313	2124298	4956.2	6795313	2124298	4957.9	1.7	OK
6795333	2124298	4956.5	6795333	2124298	4958.3	1.7	OK
6795353	2124298	4956.9	6795353	2124298	4958.8	1.9	OK
6795373	2124298	4957.4	6795373	2124298	4959.3	1.9	OK
6795393	2124298	4958.0	6795393	2124298	4959.8	1.8	OK
6795413	2124298	4958.5	6795413	2124298	4960.2	1.7	OK
6795433	2124298	4958.7	6795433	2124298	4960.7	1.9	OK
6795453	2124298	4959.1	6795453	2124298	4961.2	2.1	OK
6795473	2124298	4959.6	6795473	2124298	4961.5	2.0	OK
6795493	2124298	4960.1	6795493	2124298	4962.0	1.9	OK
6795513	2124298	4960.6	6795513	2124298	4962.3	1.8	OK
6795533	2124298	4961.0	6795533	2124298	4962.8	1.8	OK
6795553	2124298	4961.3	6795553	2124298	4963.3	2.0	OK
6795573	2124298	4961.7	6795573	2124298	4963.6	1.9	OK
6795593	2124298	4962.2	6795593	2124298	4964.1	1.9	OK
6795613	2124298	4962.6	6795613	2124298	4964.5	2.0	OK
6795633	2124298	4962.9	6795633	2124298	4965.0	2.1	OK
6795653	2124298	4963.3	6795653	2124298	4965.0	1.7	OK
6795673	2124298	4963.5	6795673	2124298	4965.2	1.6	OK
6795693	2124298	4963.9	6795693	2124298	4965.3	1.4	OK
6795713	2124298	4964.3	6795713	2124298	4965.6	1.3	OK
6795093	2124318	4949.9	6795093	2124318	4951.7	1.8	OK
6795113	2124318	4950.9	6795113	2124318	4952.9	2.0	OK
6795133	2124318	4951.6	6795133	2124318	4953.6	2.0	OK
6795153	2124318	4952.2	6795153	2124318	4954.1	1.8	OK
6795173	2124318	4952.7	6795173	2124318	4954.6	1.8	OK
6795193	2124318	4953.2	6795193	2124318	4955.2	2.0	OK
6795213	2124318	4953.7	6795213	2124318	4955.7	2.0	OK
6795233	2124318	4954.2	6795233	2124318	4956.0	1.8	OK
6795253	2124318	4954.6	6795253	2124318	4956.3	1.8	OK
6795273	2124318	4954.9	6795273	2124318	4956.7	1.8	OK
6795293	2124318	4955.3	6795293	2124318	4957.2	1.9	OK
6795313	2124318	4955.7	6795313	2124318	4957.5	1.8	OK
6795333	2124318	4956.1	6795333	2124318	4957.9	1.8	OK
6795353	2124318	4956.6	6795353	2124318	4958.6	2.0	OK
6795373	2124318	4957.1	6795373	2124318	4959.1	2.0	OK
6795393	2124318	4957.6	6795393	2124318	4959.5	1.9	OK
6795413	2124318	4957.9	6795413	2124318	4959.9	1.9	OK
6795433	2124318	4958.2	6795433	2124318	4960.0	1.8	OK
6795453	2124318	4958.7	6795453	2124318	4960.4	1.8	OK
6795473	2124318	4959.0	6795473	2124318	4960.7	1.7	OK
6795493	2124318	4959.5	6795493	2124318	4961.0	1.5	OK
6795513	2124318	4959.9	6795513	2124318	4961.0	1.2	OK
6795533	2124318	4960.3	6795533	2124318	4961.0	0.8	OK

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6795093	2124338	4949.3	6795093	2124338	4951.1	1.8	OK
6795113	2124338	4950.4	6795113	2124338	4952.3	1.9	OK
6795133	2124338	4951.3	6795133	2124338	4953.2	2.0	OK
6795153	2124338	4951.9	6795153	2124338	4953.8	1.9	OK
6795173	2124338	4952.5	6795173	2124338	4954.3	1.8	OK
6795193	2124338	4952.9	6795193	2124338	4954.7	1.8	OK
6795213	2124338	4953.4	6795213	2124338	4955.0	1.6	OK
6795233	2124338	4953.8	6795233	2124338	4955.0	1.3	OK
6795253	2124338	4954.2	6795253	2124338	4955.4	1.2	OK
6795273	2124338	4954.5	6795273	2124338	4955.8	1.3	OK
6795293	2124338	4954.9	6795293	2124338	4956.0	1.1	OK
6795511	2124270	4960.6	6795541	2124274	4962.4	1.8	OK
6795556	2124270	4961.7	6795586	2124274	4963.2	1.6	OK
6795601	2124270	4962.7	6795631	2124274	4964.2	1.5	OK
6795646	2124270	4963.7	6795676	2124274	4965.0	1.3	OK
6795691	2124270	4964.5	6795721	2124274	4966.3	1.8	OK
6795736	2124270	4965.5	6795766	2124274	4967.6	2.1	OK
						0.0	OK
						0.0	OK

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% >=16	96.8%
Elevation Avg	4960.2
Total >=16	2912
Total Lines	3007

Pass

Minimum Number of Machine Passes
8

Lift ID: UW1R02180907-00

Northing	Easting	Elevation	# of Passes	Passes =>16	Count
6795746	2124248	4967.7	16	1	1
6795749	2124248	4967.7	15		1
6795753	2124248	4967.8	10		1
6795756	2124248	4968.0	16	1	1
6795759	2124248	4968.0	16	1	1
6795763	2124248	4968.0	7		1
6795766	2124248	4968.3	6		1
6795769	2124248	4968.2	16	1	1
6795697	2124251	4966.5	15		1
6795700	2124251	4966.6	16	1	1
6795704	2124251	4966.6	16	1	1
6795707	2124251	4966.7	16	1	1
6795710	2124251	4966.8	16	1	1
6795713	2124251	4966.8	16	1	1
6795717	2124251	4966.9	16	1	1
6795720	2124251	4967.0	16	1	1
6795723	2124251	4967.1	16	1	1
6795726	2124251	4967.1	16	1	1
6795730	2124251	4967.2	16	1	1
6795733	2124251	4967.3	16	1	1
6795736	2124251	4967.2	16	1	1
6795740	2124251	4967.3	16	1	1
6795743	2124251	4967.6	16	1	1
6795746	2124251	4967.7	15		1
6795749	2124251	4967.9	15		1
6795753	2124251	4968.0	12		1
6795756	2124251	4967.9	16	1	1
6795759	2124251	4967.9	16	1	1
6795763	2124251	4967.9	16	1	1
6795766	2124251	4968.2	16	1	1
6795769	2124251	4968.0	16	1	1
6795644	2124254	4965.8	6		1
6795648	2124254	4965.8	9		1
6795651	2124254	4965.9	11		1
6795654	2124254	4965.9	12		1
6795658	2124254	4965.9	14		1
6795661	2124254	4965.9	16	1	1
6795664	2124254	4965.9	16	1	1
6795667	2124254	4965.9	15		1
6795671	2124254	4966.0	16	1	1
6795674	2124254	4966.0	16	1	1
6795677	2124254	4966.1	16	1	1
6795681	2124254	4966.1	16	1	1
6795684	2124254	4966.0	16	1	1

Lift Height
2" 0"

Thick Lift Threshold
3' 0"

Last Lift Elevation
N/A

Min. # of Wheel Passes
16

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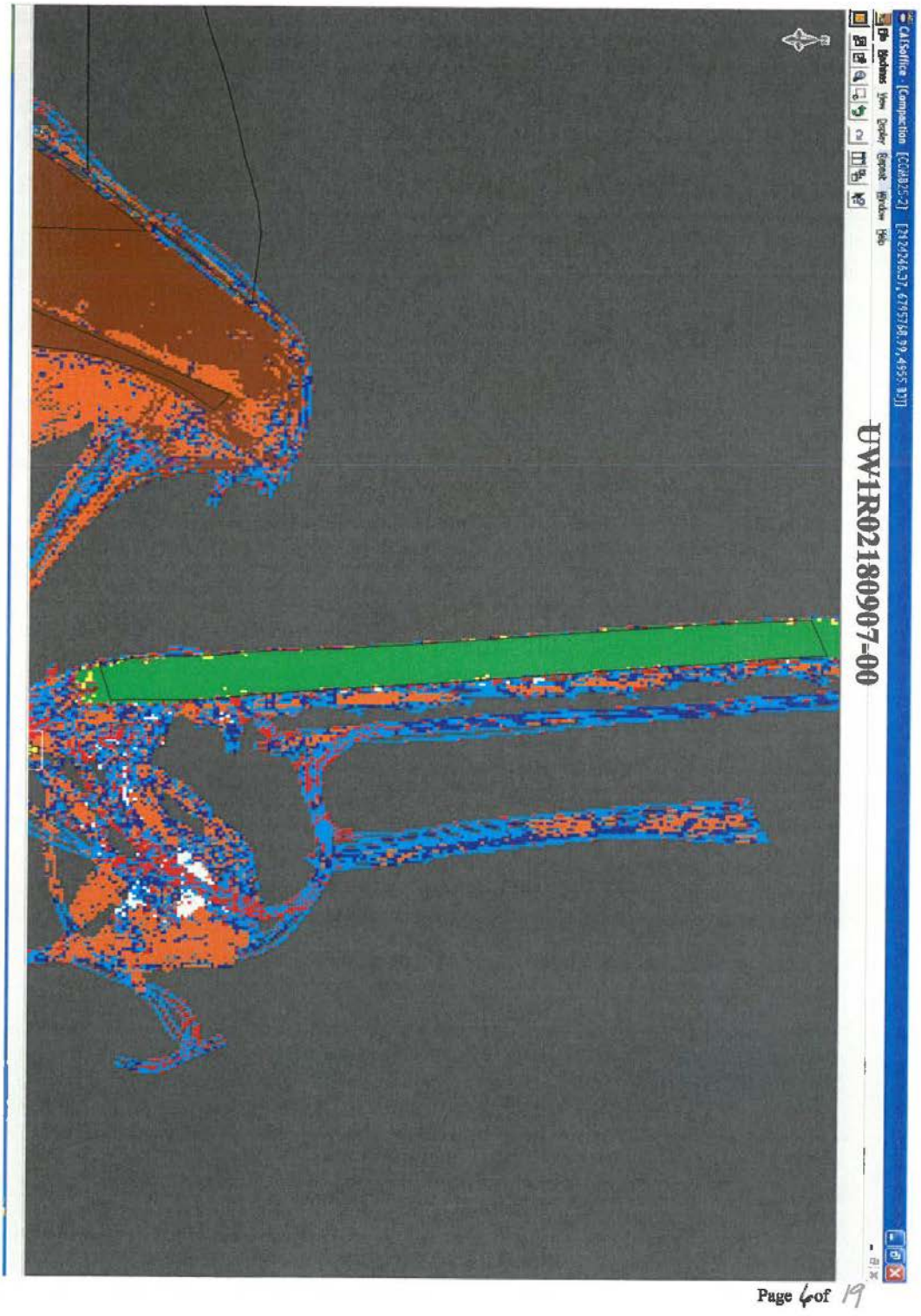
UWHR021809007-00
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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180907-00 DATE: 9/11/2018

TEST ID NUMBER(S): P1-1

TEST LOCATION: P1- 6795528 N. 2124276 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3076 Moisture 500

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 164 Density Count 2047

Wet Density (ρ_m) 112.6 *(lbs/ft³)* Dry Density 94.5 *(lbs/ft³)*

Moisture Density 18.8 *(lbs/ft³)* Moisture Fraction 20.7 *(%)*

MOISTURE DETERMINATION
ASTM D4643

Container ID 102

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	502.5	g
Mass of container & dry specimen (M_{cds})	456.4	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	46.1	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	238.0	g
Moisture content (w) $w = (M_w / M_s) \times 100$	19.4	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 112.6) / (100 + 19.4) = 94.3$ lbs/ft³

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max$ x 100

94.3 / 104.3 x 100 = 90.4 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ g/cm³ ___ lbs/ft³

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone **before** filling cone, plate & hole	g
Mass of bottle & cone **after** filling cone, plate & hole	g
Mass of sand to fill cone, plate, & hole (M_1)	g
Mass of sand to fill hole	g
Mass of wet soil & container	g
Mass of container	g
Mass of wet soil (M_3)	g

Test Hole Volume
$V = (M_1 - M_2) / \rho_1$ ___ cm³

Dry Mass of soil
$M_d = 100\ M_3 / (w + 100)$ ___ g

Wet Density
$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft³

Dry Density
$\rho_d = M_d / V$ ___ g/cm³

Dry Unit Weight
$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft³

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489
Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft³)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:
Test Surface Elevation 4962.6. Off cell standard: DS- 2277 MS- 502. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:
X Pass Date: 9/11/18
___ Failed Moisture
___ Failed Compaction Time: 1430

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180907-00 DATE: 9/11/2018

TEST ID NUMBER(S): P1-2

TEST LOCATION: P1- 6795534 N. 2124272 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3134 Moisture 496

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 115 Density Count 2081

Wet Density (ρ_m) 112.3 *(lbs/ft³)* Dry Density 94.2 *(lbs/ft³)*

Moisture Density 17.8 *(lbs/ft³)* Moisture Fraction 19.3 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID JE

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	518.8	g
Mass of container & dry specimen (M_{cds})	470.9	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	47.9	g
Mass of container (M_c)	218.1	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	252.8	g
Moisture content (w) $w = (M_w / M_s) \times 100$	18.9	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 112.3) / (100 + 18.9) = 94.4$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

94.4 / 104.3 x 100 = 90.5 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ *g/cm³* ___ *lb/ft³*

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone **before** filling cone, plate & hole	g
Mass of bottle & cone **after** filling cone, plate & hole	g
Mass of sand to fill cone, plate, & hole (M_1)	g
Mass of sand to fill hole	g
Mass of wet soil & container	g
Mass of container	g
Mass of wet soil (M_3)	g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm^3

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ ___ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ___ *lbs/ft³*

Dry Density

$\rho_d = M_4 / V$ ___ *g/cm³*

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ *lbs/ft³*

Soil Description: Greyish brown, very fine to medium, subround. well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft³)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4962.0. Off cell standard: DS- 2277 MS- 502. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 9/11/18

___ Failed Moisture

___ Failed Compaction Time: 1509

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project OTHER

LIFT IDENTIFICATION: UW1R02180907-00 DATE: 9/11/2018

TEST ID NUMBER(S): P1-3

TEST LOCATION: P1- 6795522 N. 2124280 E. TEST METHOD: ____ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3345 Moisture 505

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 170 Density Count 2501

Wet Density (ρ_m) 113.1 *(lbs/ft³)* Dry Density 93.9 *(lbs/ft³)*

Moisture Density 19.4 *(lbs/ft³)* Moisture Fraction 22.5 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID JV

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	509.7	g
Mass of container & dry specimen (M_{cds})	465.0	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	44.7	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	246.6	g
Moisture content (w) $w = (M_w / M_s) \times 100$	18.1	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 113.1) / (100 + 18.1) = 95.7$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

95.7 / 104.3 x 100 = 91.8 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ____ Calibrated Vol. *(lbs/ft³)* ____

Bulk Density of sand (ρ_1) ____ *g/cm³* ____ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) ____ g

Mass of bottle & cone before filling cone, plate & hole ____ g

Mass of bottle & cone after filling cone, plate & hole ____ g

Mass of sand to fill cone, plate, & hole (M_1) ____ g

Mass of sand to fill hole ____ g

Mass of wet soil & container ____ g

Mass of container ____ g

Mass of wet soil (M_3) ____ g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ____ cm^3

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ ____ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ____ lbs/ft^3

Dry Density

$\rho_d = M_4 / V$ ____ g/cm^3

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ____ lbs/ft^3

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft^3)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4961.2. Off cell standard: DS- 2277 MS- 502. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 9/11/18

____ Failed Moisture

____ Failed Compaction Time: 1525

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project OTHER

LIFT IDENTIFICATION: UW1R02180907-00 DATE: 9/11/2018

TEST ID NUMBER(S): P2-1

TEST LOCATION: P2- 6795577 N. 2124270 E. TEST METHOD: ____ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3076 Moisture 500

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 146 Density Count 2108

Wet Density (ρ_m) 111.8 *(lbs/ft³)* Dry Density 92.4 *(lbs/ft³)*

Moisture Density 16.5 *(lbs/ft³)* Moisture Fraction 17.9 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID JV

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	545.8	g
Mass of container & dry specimen (M_{cds})	495.0	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	50.8	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	276.6	g
Moisture content (w) $w = (M_w / M_s) \times 100$	18.4	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 111.8) / (100 + 18.4 = 94.5$ lbs/ft³

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

94.5 / 104.3 x 100 = 90.6 %

Comments:

Test Surface Elevation 4963.9. Off cell standard: DS- 2277 MS- 502. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ____ Calibrated Vol. *(lbs/ft³)* ____

Bulk Density of sand (ρ_1) ____ g/cm³ ____ lbs/ft³

Mass of Sand to Fill Conc & Plate (M_2) ____ g

Mass of bottle & cone before filling cone, plate & hole		g
Mass of bottle & cone after filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ____ cm³

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ ____ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ____ lbs/ft³

Dry Density

$\rho_d = M_4 / V$ ____ g/cm³

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ____ lbs/ft³

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft³)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

TEST RESULTS:

X Pass Date: 9/11/18

____ Failed Moisture

____ Failed Compaction Time: 1430

By: Mitch Hogan / *Mitch Hogan*
(print) *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project OTHER

LIFT IDENTIFICATION: UW1R02180907-00 DATE: 9/11/2018

TEST ID NUMBER(S): P2- 2

TEST LOCATION: P2- 6795580 N. 2124268 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3134 Moisture 496

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 131 Density Count 2608

Wet Density (ρ_m) 111.3 *(lbs/ft³)* Dry Density 96.3 *(lbs/ft³)*

Moisture Density 14.7 *(lbs/ft³)* Moisture Fraction 17.0 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID BS

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	526.1	g
Mass of container & dry specimen (M_{cds})	481.0	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	45.1	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	262.6	g
Moisture content (w) $w = (M_w / M_s) \times 100$	17.2	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 111.3) / (100 + 17.2 = 95.0$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

95.0 / 104.3 x 100 = 91.1 %

Comments:

Test Surface Elevation 4963.2. Off cell standard: DS- 2277 MS- 502. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ *g/cm³* ___ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone **before** filling cone, plate & hole	g
Mass of bottle & cone **after** filling cone, plate & hole	g
Mass of sand to fill cone, plate, & hole (M_1)	g
Mass of sand to fill hole	g
Mass of wet soil & container	g
Mass of container	g
Mass of wet soil (M_3)	g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm^3

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ ___ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft^3

Dry Density

$\rho_d = M_4 / V$ ___ g/cm^3

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft^3

Soil Description: **Greyish brown, very fine to medium, subround. well graded clay.**

Proctor ID: **RRM # 489**

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) **104.3** (lbs/ft^3)

Optimum Moisture (w_{opt}) **20.0** (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: **90.0** (%)

TEST RESULTS:

X Pass Date: 9/11/18

___ Failed Moisture

___ Failed Compaction Time: 1509

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180907-00 DATE: 9/11/2018

TEST ID NUMBER(S): P2- 3

TEST LOCATION: P2- 6795576 N. 2124278 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3345 Moisture 505

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 145 Density Count 2242

Wet Density (ρ_m) 111.2 *(lbs/ft³)* Dry Density 96.4 *(lbs/ft³)*

Moisture Density 16.2 *(lbs/ft³)* Moisture Fraction 17.3 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID BS

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	501.7	g
Mass of container & dry specimen (M_{cds})	460.1	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	41.6	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	241.7	g
Moisture content (w) $w = (M_w / M_s) \times 100$	17.2	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 111.2) / (100 + 17.2) = 94.9$ lbs/ft³

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max$ x 100

94.9 / 104.3 x 100 = 91.0 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ g/cm³ ___ lbs/ft³

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone before filling cone, plate & hole	g
Mass of bottle & cone after filling cone, plate & hole	g
Mass of sand to fill cone, plate, & hole (M_4)	g
Mass of sand to fill hole	g
Mass of wet soil & container	g
Mass of container	g
Mass of wet soil (M_3)	g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm³

Dry Mass of soil

$M_d = 100\ M_3 / (w + 100)$ ___ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft³

Dry Density

$\rho_d = M_d / V$ ___ g/cm³

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft³

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft³)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4962.2. Off cell standard: DS- 2277 MS- 502. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 9/11/18

___ Failed Moisture

___ Failed Compaction Time: 1526

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
DOE-EM/GJRAC1783

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project OTHER

LIFT IDENTIFICATION: UW1R02180907-00 DATE: 9/11/2018

TEST ID NUMBER(S): P3- 1

TEST LOCATION: P3- 6795219 N. 2124307 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3076 Moisture 500

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 146 Density Count 1953

Wet Density (ρ_m) 112.9 *(lbs/ft³)* Dry Density 96.2 *(lbs/ft³)*

Moisture Density 16.5 *(lbs/ft³)* Moisture Fraction 17.3 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID BS

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	559.3	g
Mass of container & dry specimen (M_{cds})	503.2	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	56.1	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	284.8	g
Moisture content (w) $w = (M_w / M_s) \times 100$	19.7	%

Dry Density $(\rho_{dj} = (100 \times \rho_m)/(100 + w)$

$pd = (100 \times 112.9) / (100 + 19.7 = 94.3$ lbs/ft³

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

94.3 / 104.3 x 100 = 90.4 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ g/cm³ ___ lbs/ft³

Mass of Sand to Fill Cone & Plate (M_3) ___ g

Mass of bottle & cone before filling cone, plate & hole	g
Mass of bottle & cone after filling cone, plate & hole	g
Mass of sand to fill cone, plate, & hole (M_1)	g
Mass of sand to fill hole	g
Mass of wet soil & container	g
Mass of container	g
Mass of wet soil (M_2)	g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm³

Dry Mass of soil

$M_4 = 100\ M_2 / (w + 100)$ ___ g

Wet Density

$\rho_m = (M_2 / V) \times 62.43$ ___ lbs/ft³

Dry Density

$\rho_d = M_4 / V$ ___ g/cm³

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft³

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft³)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4955.8. Off cell standard: DS- 2277 MS- 502. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 9/11/18

___ Failed Moisture

___ Failed Compaction Time: 1446

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

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DOE-EM/GJRAC1783

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project OTHER

LIFT IDENTIFICATION: UW1R02180907-00 DATE: 9/11/2018

TEST ID NUMBER(S): P3-2

TEST LOCATION: P3- 6795217 N. 2124304 E. TEST METHOD: ____ D1556 __X__ D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3134 Moisture 496

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 118 Density Count 2406

Wet Density (ρ_m) 115.2 *(lbs/ft³)* Dry Density 99.6 *(lbs/ft³)*

Moisture Density 13.0 *(lbs/ft³)* Moisture Fraction 14.2 *(%)*

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ____ Calibrated Vol. *(lbs/ft³)* ____

Bulk Density of sand (ρ_1) ____ g/cm³ ____ lbs/ft³

Mass of Sand to Fill Cone & Plate (M_2) ____ g

Mass of bottle & cone before filling cone, plate & hole ____ g

Mass of bottle & cone after filling cone, plate & hole ____ g

Mass of sand to fill cone, plate, & hole (M_3) ____ g

Mass of sand to fill hole ____ g

Mass of wet soil & container ____ g

Mass of container ____ g

Mass of wet soil (M_3) ____ g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ____ cm³

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ ____ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ____ lbs/ft³

Dry Density

$\rho_d = M_4 / V$ ____ g/cm³

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ____ lbs/ft³

MOISTURE DETERMINATION

ASTM D4643

Container ID BS

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	542.3	g
Mass of container & dry specimen (M_{cds})	489.2	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	53.1	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	270.8	g
Moisture content (w) $w = (M_w / M_s) \times 100$	19.6	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (\ 100 \times 115.2\ ) / (100 + 19.6 = 96.3$ lbs/ft³

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

96.3 / 104.3 x 100 = 92.3 %

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft³)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4954.8. Off cell standard: DS- 2277 MS- 502. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

__X__ Pass Date: 9/11/18

____ Failed Moisture

____ Failed Compaction Time: 1458

By: Mitch Hogan *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
DOE-EM/GJRAC1783

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project OTHER

LIFT IDENTIFICATION: UW1R02180907-00 DATE: 9/11/2018

TEST ID NUMBER(S): P3- 3 nuclear gauge

TEST LOCATION: P3- 6795214 N. 2124312 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3345 Moisture 505

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 130 Density Count 2195

Wet Density (ρ_m) 117.4 *(lbs/ft³)* Dry Density 99.3 *(lbs/ft³)*

Moisture Density 14.3 *(lbs/ft³)* Moisture Fraction 14.8 *(%)*

MOISTURE DETERMINATION
ASTM D4643

Container ID JE

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	556.3	g
Mass of container & dry specimen (M_{cds})	507.0	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	49.3	g
Mass of container (M_c)	218.1	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	288.9	g
Moisture content (w) $w = (M_w / M_s) \times 100$	17.1	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (\ 100 \times 117.4\ ) / (100 + 17.1 = 100.3$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

100.3 / 104.3 x 100 = 96.2 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ *g/cm³* ___ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone **before** filling cone, plate & hole		g
Mass of bottle & cone **after** filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_4)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

N A

Test Hole Volume
$V = (M_1 - M_2) / \rho_1$ ___ cm^3

Dry Mass of soil
$M_d = 100\ M_3 / (w + 100)$ ___ g

Wet Density
$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft^3

Dry Density
$\rho_d = M_d / V$ ___ g/cm^3

Dry Unit Weight
$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft^3

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489
Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft^3)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:
Test Surface Elevation 4954.0. Off cell standard: DS- 2277 MS- 502. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:
X Pass Date: 9/11/18
___ Failed Moisture
___ Failed Compaction Time: 1536

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
DOE-EM/GJRAC1783

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project OTHER

LIFT IDENTIFICATION: UW1R02180907-00 DATE: 9/11/2018

TEST ID NUMBER(S): P3- 3 sandcone

TEST LOCATION: P3- 6795214 N. 2124312 E. TEST METHOD: X D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3345 Moisture 505

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 130 Density Count 2195

Wet Density (ρ_m) 117.4 *(lbs/ft³)* Dry Density 99.3 *(lbs/ft³)*

Moisture Density 14.3 *(lbs/ft³)* Moisture Fraction 14.8 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID JE

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	556.3	g
Mass of container & dry specimen (M_{cds})	507.0	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	49.3	g
Mass of container (M_c)	218.1	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	288.9	g
Moisture content (w) $w = (M_w / M_s) \times 100$	17.1	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 117.8) / (100 + 17.1 = 100.6$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

100.6 / 104.3 x 100 = 96.5 %

Comments:

Test Surface Elevation 4954.0. Off cell standard: DS- 2277 MS- 502. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus _____ Calibrated Vol. *(lbs/ft³)* 0.04733

Bulk Density of sand (ρ_1) 1.48 *g/cm³* 92.1 *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) 1977.4 *g*

Mass of bottle & cone **before** filling cone, plate & hole	7080.3	g
Mass of bottle & cone **after** filling cone, plate & hole	3375.3	g
Mass of sand to fill cone, plate, & hole (M_1)	3705.0	g
Mass of sand to fill hole	1727.6	g
Mass of wet soil & container	2218.4	g
Mass of container	8.9	g
Mass of wet soil (M_3)	2209.5	g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ 1171 cm^3

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ 1887.4 *g*

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ 117.8 *lbs/ft³*

Dry Density

$\rho_d = M_4 / V$ 1.6 *g/cm³*

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ 100.6 *lbs/ft³*

Soil Description: Greyish brown, very fine to medium, subround. well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft³)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

TEST RESULTS:

X Pass Date: 9/11/18

_____ Failed Moisture

_____ Failed Compaction Time: 1536

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
DOE-EM/GJRAC1783

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180907-00 DATE: 9/11/2018

TEST ID NUMBER(S): P4- 1

TEST LOCATION: P4- 6795247 N. 2124314 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3076 Moisture 500

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 160 Density Count 1969

Wet Density (ρ_m) 111.4 *(lbs/ft³)* Dry Density 93.1 *(lbs/ft³)*

Moisture Density 18.3 *(lbs/ft³)* Moisture Fraction 19.7 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID 218

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	553.8	g
Mass of container & dry specimen (M_{cds})	505.1	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	48.7	g
Mass of container (M_c)	218.9	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	286.2	g
Moisture content (w) $w = (M_w / M_s) \times 100$	17.0	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 111.4) / (100 - 17.0 = 95.2$ lbs/ft³

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

95.2 / 104.3 x 100 = 91.3 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ g/cm³ ___ lbs/ft³

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone **before** filling cone, plate & hole		g
Mass of bottle & cone **after** filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_2)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm³

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ ___ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft³

Dry Density

$\rho_d = M_4 / V$ ___ g/cm³

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft³

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft³)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4955.8. Off cell standard: DS- 2277 MS- 502. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 9/11/18

___ Failed Moisture

___ Failed Compaction Time: 1446

By: Mitch Hogan / *(signature)*
(print)

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
DOE-EM/GJRAC1783

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180907-00 DATE: 9/11/2018

TEST ID NUMBER(S): P4-2

TEST LOCATION: P4- 6795244 N. 2124310 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3134 Moisture 496

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 132 Density Count 2436

Wet Density (ρ_m) 114.2 *(lbs/ft³)* Dry Density 99.3 *(lbs/ft³)*

Moisture Density 14.9 *(lbs/ft³)* Moisture Fraction 16.6 *(%)*

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ g/cm³ ___ lbs/ft³

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone before filling cone, plate & hole		g
Mass of bottle & cone after filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm³

MOISTURE DETERMINATION

ASTM D4643

Container ID 218

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	557.1	g
Mass of container & dry specimen (M_{cds})	502.4	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	54.7	g
Mass of container (M_c)	218.9	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	283.5	g
Moisture content (w) $w = (M_w / M_s) \times 100$	19.3	%

Dry Mass of soil

$M_4 = 100\, M_3 / (w + 100)$ ___ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft³

Dry Density

$\rho_d = M_4 / V$ ___ g/cm³

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft³

Dry Density (ρ_d) $= (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 114.2) / (100 + 19.3) = 95.7$ lbs/ft³

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

95.7 / 104.3 x 100 = 91.8 %

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft³)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4955.1. Off cell standard: DS- 2277 MS- 502. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 9/11/18

___ Failed Moisture

___ Failed Compaction Time: 1458

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
DOE-EM/GJRAC1783

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180907-00 DATE: 9/11/2018

TEST ID NUMBER(S): P4-3

TEST LOCATION: P4- 6795250 N. 2124318 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3345 Moisture 505

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 162 Density Count 2215

Wet Density (ρ_{wd}) 110.9 *(lbs/ft³)* Dry Density 92.1 *(lbs/ft³)*

Moisture Density 18.4 *(lbs/ft³)* Moisture Fraction 20.0 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID 102

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	502.4	g
Mass of container & dry specimen (M_{cds})	459.2	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	43.2	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	240.8	g
Moisture content (w) $w = (M_w / M_s) \times 100$	17.9	%

Dry Density (ρ_d) $= (100 \times \rho_m)/(100 + w)$

$\rho_d = (100 \times 110.9) / (100 + 17.9) =$ 94.0 lbs/ft³

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_{wd})

Percent Compaction = ρ_d / $\gamma_d max \times 100$

94.0 / 104.3 x 100 = 90.2 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ g/cm³ ___ lbs/ft³

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone before filling cone, plate & hole		g
Mass of bottle & cone after filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm³

Dry Mass of soil

$M_d = 100\ M_3 / (w + 100)$ ___ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft³

Dry Density

$\rho_d = M_d / V$ ___ g/cm³

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft³

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft³)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4954.4. Off cell standard: DS- 2277 MS- 502. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 9/11/18

___ Failed Moisture

___ Failed Compaction Time: 1536

By: Mitch Hogan / (signature)

(print)

QA/QC APPROVAL 10-22-2019 DATE

Density Testing
DOE-EM/GJRAC1783

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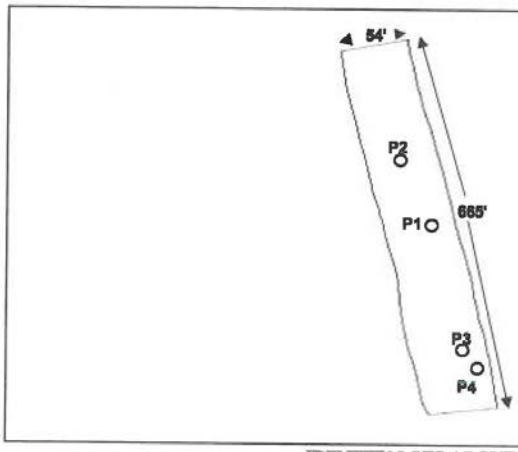
LIFT APPROVAL FORM

PROJECT: Moab UMTRA OTHER

NW CORNER **DATE:** 9/12/2018



P 1	6795361 N. 2124314 E.			
EW:	0.777	X 54	=	42
NS:	0.577	X 665	=	384
P 2	6795515 N. 2124283 E.			
EW:	0.454	X 54	=	25
NS:	0.346	X 665	=	230
P 3	6795192 N. 2124321 E.			
EW:	0.659	X 54	=	36
NS:	0.832	X 665	=	553
P 4	6795164 N. 2124335 E.			
EW:	0.895	X 54	=	48
NS:	0.873	X 665	=	581
P 5				
EW:	N	X	=	
NS:		X	=	

Page 2 attached: A Y N

IDENTIFY LOTS ABOVE

LIFT ID: **UW1R02180912-00** NW CORNER: **6795745 N. 2124242 E.**

Uncompacted Thickness: **1.7** Compacted Thickness: **N/A** Debris Insp. By: **N/A** Date: **N/A** Time: **N/A**

NW CORNER of debris placement: **N/A** EW Dimension **N/A** NS Dimension **N/A**

Lift Area (ft²): **32,880** Lift Volume (yd³): **2,070**

Comments: This is the second of three lifts to provide data and a method for compacting two feet of soil. On 9/12/2018 QC verified that the lift area was scarified prior to placement. Operations began dumping material from the stockpile on the east edge. Operations used the 275 dozer to place the material. On 9/13/2018 Operations continued placement for the rest of the lift. Placement was from north to south. QC performed a moisture test as material was being placed with satisfactory results. Operations finished placement then started compaction with the CAT 825. The CAES was set on 8 machine passes. On 9/17/2018 Operations finished with compaction and CAES showed uniform compaction. Moisture was added throughout the day during compaction. On 9/18/2018 QC performed in-place moisture/ density tests at all four random locations. QC tested the material the same as the previous test pad, at the surface then 8" below and 16" below. One correlation sandcone was performed. All tests had satisfactory results. A track hoe was used to pothole test locations with care not to disturb compaction.

Attached on page two is a summary table showing all density and moisture results for this lift. The test ID's are labeled by testing location (P1, P2, P3...) and then the test depth (1 surface, 2 eight inches below, 3 16 inches below). The coordinates location on the lift approval form are the random locations, the coordinate location on the density forms are the actual testing locations.

Attached Forms: **Grid Slope** X **Compaction Macro** X **Print Screen** X **Moisture/ Density** X

KEYING IN NOTES: N E S [W] **Satisfactory** MOISTURE/ DENSITY TESTS ID # (S): **P1-1 through P4-3**

LIFT APPROVED BY: **Mitch Hogan/** DATE: **9/19/2018** TIME: **1100**

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
DOE-EM/GJRAC1783
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Lift ID: UW1R021809I2-00

Location	In- Place Sandcone DD lbs/ft³	In- Place Gauge DD lbs/ft³	In- Place Moisture %	Proctor max dry density lbs/ft³	Proctor optimum moisture %	Compaction % (Sandcone/ Gauge)
P1-1		94.2	17.1	104.3	20.0	90.3
P1-2		95.4	16.8	105.5	14.2	90.4
P1-3		96.3	16.8	105.5	14.2	91.3
P2-1		96.7	18.1	104.3	20.0	92.7
P2-2		95.4	21.1	104.3	20.0	91.5
P2-3		96.8	18.1	104.3	20.0	92.8
P3-1	101.2	97.9	22.1	104.3	20.0	97.1/ 93.9
P3-2		96.1	14.9	105.5	14.2	91.1
P3-3		96.3	16.1	105.5	14.2	91.3
P4-1		94.4	17.5	104.3	20.0	90.5
P4-2		95.5	18.5	104.3	20.0	91.6
P4-3		95.0	18.0	104.3	20.0	91.1

DD= Dry Density

Pg 2 of 19

Slope Elevation Survey

Average lift thickness=	1.7	Bounding Box	Northing	Easting	
Grid Size=	20'	Lower Left	N		
Lift ID:	UW1R02180912-00	Upper Right		A	

Last Lift Elevations			Lift Approval Elevations			Lift Thickness	
Northing	Easting	Elevation	Northing	Easting	Elevation	Thickness	
6795641	2124256	4965.7	6795641	2124256	4967.5	1.8	OK
6795661	2124256	4965.9	6795661	2124256	4967.9	2.0	OK
6795681	2124256	4966.0	6795681	2124256	4968.1	2.0	OK
6795701	2124256	4966.4	6795701	2124256	4968.3	1.9	OK
6795721	2124256	4966.9	6795721	2124256	4968.7	1.8	OK
6795741	2124256	4967.4	6795741	2124256	4969.1	1.7	OK
6795761	2124256	4967.8	6795761	2124256	4968.9	1.1	OK
6795421	2124276	4960.3	6795421	2124276	4962.4	2.0	OK
6795441	2124276	4960.8	6795441	2124276	4962.7	1.9	OK
6795461	2124276	4961.3	6795461	2124276	4963.2	1.8	OK
6795481	2124276	4961.8	6795481	2124276	4963.7	1.9	OK
6795501	2124276	4962.3	6795501	2124276	4964.1	1.8	OK
6795521	2124276	4962.8	6795521	2124276	4964.6	1.8	OK
6795541	2124276	4963.3	6795541	2124276	4965.0	1.6	OK
6795561	2124276	4963.8	6795561	2124276	4965.3	1.5	OK
6795581	2124276	4964.1	6795581	2124276	4965.8	1.7	OK
6795601	2124276	4964.5	6795601	2124276	4966.3	1.8	OK
6795621	2124276	4965.0	6795621	2124276	4966.8	1.9	OK
6795641	2124276	4965.4	6795641	2124276	4967.3	1.9	OK
6795661	2124276	4965.6	6795661	2124276	4967.6	2.0	OK
6795681	2124276	4965.9	6795681	2124276	4967.9	2.0	OK
6795701	2124276	4966.1	6795701	2124276	4968.3	2.2	OK
6795721	2124276	4966.5	6795721	2124276	4968.6	2.1	OK
6795741	2124276	4967.1	6795741	2124276	4969.1	2.0	OK
6795761	2124276	4967.4	6795761	2124276	4969.2	1.8	OK
6795142	2124296	4953.9	6795142	2124296	4955.9	1.9	OK
6795162	2124296	4954.8	6795162	2124296	4956.3	1.5	OK
6795182	2124296	4955.2	6795182	2124296	4956.7	1.5	OK
6795202	2124296	4955.5	6795202	2124296	4957.3	1.8	OK
6795221	2124296	4956.0	6795221	2124296	4957.7	1.7	OK
6795241	2124296	4956.4	6795241	2124296	4958.2	1.8	OK
6795261	2124296	4956.7	6795261	2124296	4958.6	1.8	OK
6795281	2124296	4957.0	6795281	2124296	4958.8	1.8	OK
6795301	2124296	4957.5	6795301	2124296	4959.3	1.8	OK
6795321	2124296	4957.9	6795321	2124296	4959.8	1.9	OK
6795341	2124296	4958.3	6795341	2124296	4960.2	1.9	OK
6795361	2124296	4958.8	6795361	2124296	4960.4	1.6	OK
6795381	2124296	4959.3	6795381	2124296	4960.8	1.5	OK
6795401	2124296	4959.8	6795401	2124296	4961.2	1.5	OK
6795421	2124296	4960.3	6795421	2124296	4961.8	1.5	OK
6795441	2124296	4960.7	6795441	2124296	4962.3	1.6	OK
6795461	2124296	4961.1	6795461	2124296	4962.8	1.7	OK
6795481	2124296	4961.5	6795481	2124296	4963.4	1.9	OK
6795501	2124296	4961.9	6795501	2124296	4963.9	2.0	OK
6795521	2124296	4962.4	6795521	2124296	4964.3	1.9	OK
6795541	2124296	4962.8	6795541	2124296	4964.7	1.9	OK
6795561	2124296	4963.2	6795561	2124296	4965.0	1.8	OK
6795581	2124296	4963.5	6795581	2124296	4965.4	1.9	OK
6795601	2124296	4963.8	6795601	2124296	4965.8	2.1	OK
6795621	2124296	4964.2	6795621	2124296	4966.0	1.8	OK

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6795641	2124296	4964.7	6795641	2124296	4966.1	1.4	OK
6795661	2124296	4964.7	6795661	2124296	4966.5	1.8	OK
6795681	2124296	4964.9	6795681	2124296	4965.9	1.0	OK
6795102	2124316	4951.9	6795102	2124316	4953.0	1.1	OK
6795122	2124316	4952.9	6795122	2124316	4954.7	1.8	OK
6795142	2124316	4953.5	6795142	2124316	4955.4	1.9	OK
6795162	2124316	4954.0	6795162	2124316	4955.9	1.9	OK
6795182	2124316	4954.6	6795182	2124316	4956.5	1.9	OK
6795202	2124316	4955.2	6795202	2124316	4957.2	2.0	OK
6795221	2124316	4955.6	6795221	2124316	4957.4	1.9	OK
6795241	2124316	4955.9	6795241	2124316	4957.9	2.0	OK
6795261	2124316	4956.3	6795261	2124316	4958.4	2.0	OK
6795281	2124316	4956.7	6795281	2124316	4958.5	1.9	OK
6795301	2124316	4957.0	6795301	2124316	4958.8	1.8	OK
6795321	2124316	4957.4	6795321	2124316	4959.2	1.9	OK
6795341	2124316	4957.9	6795341	2124316	4959.7	1.8	OK
6795361	2124316	4958.5	6795361	2124316	4960.1	1.6	OK
6795381	2124316	4959.1	6795381	2124316	4960.3	1.1	OK
6795401	2124316	4959.2	6795401	2124316	4960.9	1.7	OK
6795421	2124316	4959.6	6795421	2124316	4961.2	1.7	OK
6795441	2124316	4959.9	6795441	2124316	4961.5	1.6	OK
6795461	2124316	4960.2	6795461	2124316	4961.3	1.1	OK
6795481	2124316	4960.5	6795481	2124316	4961.7	1.1	OK
6795102	2124336	4951.2	6795102	2124336	4952.7	1.5	OK
6795122	2124336	4952.3	6795122	2124336	4954.0	1.7	OK
6795142	2124336	4953.1	6795142	2124336	4955.1	1.9	OK
6795162	2124336	4953.7	6795162	2124336	4955.6	2.0	OK
6795182	2124336	4954.2	6795182	2124336	4955.9	1.7	OK
6795202	2124336	4954.6	6795202	2124336	4956.2	1.6	OK
6795221	2124336	4954.9	6795221	2124336	4956.5	1.5	OK
6795241	2124336	4955.1	6795241	2124336	4956.4	1.2	OK
6795261	2124336	4955.4	6795261	2124336	4956.7	1.3	OK
						0.0	OK
						0.0	OK
						0.0	OK

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% =12	86.6%
Elevation Avg	4961.8
Total =12	2644
Total Lines	3054

Pass

Minimum Number of Machine Passes
12

Lift ID: UW1R02180912-00

Northing	Easting	Elevation	# of Passes	Passes =12	Count
6795703	2124244	4968.4	1		1
6795706	2124244	4968.4	4		1
6795709	2124244	4968.5	5		1
6795713	2124244	4968.6	6		1
6795716	2124244	4968.5	6		1
6795719	2124244	4968.6	6		1
6795722	2124244	4968.7	6		1
6795726	2124244	4968.9	7		1
6795729	2124244	4968.8	8		1
6795732	2124244	4969.0	9		1
6795736	2124244	4968.8	10		1
6795739	2124244	4968.9	10		1
6795742	2124244	4968.9	12	1	1
6795745	2124244	4968.9	12	1	1
6795647	2124248	4967.5	2		1
6795650	2124248	4967.5	2		1
6795654	2124248	4967.5	4		1
6795657	2124248	4967.6	4		1
6795660	2124248	4967.8	6		1
6795663	2124248	4967.9	6		1
6795667	2124248	4967.9	6		1
6795670	2124248	4967.8	8		1
6795673	2124248	4967.8	5		1
6795676	2124248	4967.8	8		1
6795680	2124248	4967.9	9		1
6795683	2124248	4967.9	12	1	1
6795686	2124248	4967.9	11		1
6795690	2124248	4968.0	12	1	1
6795693	2124248	4968.1	12	1	1
6795696	2124248	4968.1	12	1	1
6795699	2124248	4968.2	12	1	1
6795703	2124248	4968.2	12	1	1
6795706	2124248	4968.3	12	1	1
6795709	2124248	4968.4	12	1	1
6795713	2124248	4968.4	12	1	1
6795716	2124248	4968.5	12	1	1
6795719	2124248	4968.5	12	1	1
6795722	2124248	4968.6	12	1	1
6795726	2124248	4968.6	12	1	1
6795729	2124248	4968.6	12	1	1
6795732	2124248	4968.8	12	1	1
6795736	2124248	4968.8	12	1	1
6795739	2124248	4968.9	12	1	1
6795742	2124248	4968.9	12	1	1

Lift Height
2' 0"

Thick Lift Threshold
3' 0"

Last Lift Elevation
N/A

Min. # of Wheel Passes
12

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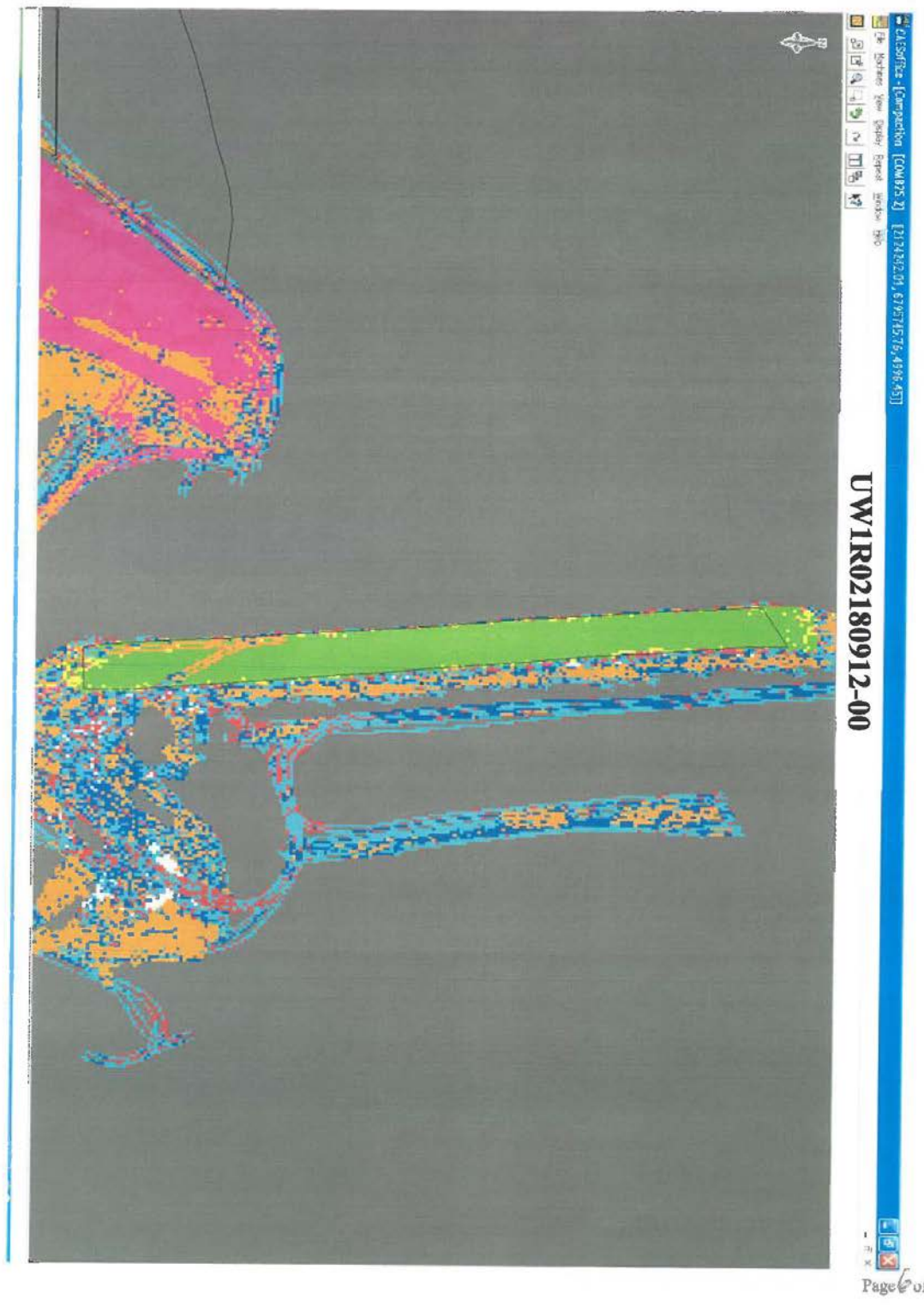
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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180912-00 DATE: 9/18/2018

TEST ID NUMBER(S): P1- 1

TEST LOCATION: 6795422 N. 2124307 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 2957 Moisture 504

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 152 Density Count 1952

Wet Density (ρ_m) 110.3 *(lbs/ft^3)* Dry Density 93.2 *(lbs/ft^3)*

Moisture Density 17.1 *(lbs/ft^3)* Moisture Fraction 18.4 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID BS

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	568.4	g
Mass of container & dry specimen (M_{cds})	517.2	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	51.2	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	298.8	g
Moisture content (w) $w = (M_w / M_s) \times 100$	17.1	%

Dry Density (ρ_d) = $(100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 110.3) / (100 + 17.1 = 94.2$ *lbs/ft^3*

Note: Wet Density from ASTM D 1556 (ρ_w) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

94.2 / 104.3 x 100 = 90.3 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft^3)* ___

Bulk Density of sand (ρ_1) ___ *g/cm^3* ___ *lbs/ft^3*

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone before filling cone, plate & hole		g
Mass of bottle & cone after filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

N A

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ *cm^3*

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ ___ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ___ *lbs/ft^3*

Dry Density

$\rho_d = M_4 / V$ ___ *g/cm^3*

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ *lbs/ft^3*

Soil Description: **Greyish brown, very fine to medium, subround. well graded clay.**

Proctor ID: **RRM # 489**

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) **104.3** (lbs/ft^3)

Optimum Moisture (w_{opt}) **20.0** (%)

Required Moisture: **17.0** % to **23.0** %

Required Percent Compaction: **90.0** (%)

Comments:

Test Surface Elevation 4961.2. Off cell standard: DS- 2291 MS- 504. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 9/18/18

___ Failed Moisture

___ Failed Compaction Time: 1513

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
DOE-EM/GJRAC1783

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180912-00 DATE: 9/18/2018

TEST ID NUMBER(S): P1 - 2

TEST LOCATION: 6795415 N. 2124309 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3265 Moisture 512

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 132 Density Count 2266

Wet Density (ρ_m) 111.4 *(lbs/ft³)* Dry Density 97.9 *(lbs/ft³)*

Moisture Density 14.3 *(lbs/ft³)* Moisture Fraction 15.2 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID BS

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	482.9	g
Mass of container & dry specimen (M_{cds})	444.8	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	38.1	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	226.4	g
Moisture content (w) $w = (M_w / M_s) \times 100$	16.8	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 111.4) / (100 + 16.8 = 95.4$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

95.4 / 105.5 x 100 = 90.4 %

Comments:

Test Surface Elevation 4960.4. Off cell standard: DS- 2291 MS- 504. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ *g/cm³* ___ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) ___ *g*

Mass of bottle & cone before filling cone, plate & hole		g
Mass of bottle & cone after filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm^3

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ ___ *g*

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft^3

Dry Density

$\rho_d = M_4 / V$ ___ g/cm^3

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft^3

Soil Description: Very pale brown, very fine , angular, poorly graded sand.

Proctor ID: RRM # 483

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 105.5 (lbs/ft^3)

Optimum Moisture (w_{opt}) 14.2 (%)

Required Moisture: 11.2 % to 17.2 %

Required Percent Compaction: 90.0 (%)

TEST RESULTS:

X Pass Date: 9/18/18

___ Failed Moisture

___ Failed Compaction Time: 1430

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
DOE-EM GJRAC1783

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project OTHER

LIFT IDENTIFICATION: UW1R02180912-00 DATE: 9/18/2018

TEST ID NUMBER(S): P1- 3

TEST LOCATION: 6795414 N. 2124298 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3265 Moisture 512

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 166 Density Count 2250

Wet Density (ρ_m) 112.5 *(lbs/ft³)* Dry Density 93.5 *(lbs/ft³)*

Moisture Density 18.6 *(lbs/ft³)* Moisture Fraction 20.7 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID JV

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	517.3	g
Mass of container & dry specimen (M_{cds})	474.2	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	43.1	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	255.8	g
Moisture content (w) $w = (M_w / M_s) \times 100$	16.8	%

Dry Density (ρ_d) $= (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 112.5) / (100 + 16.8) = 96.3$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_w) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

96.3 / 105.5 x 100 = 91.3 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ *g/cm³* ___ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_1) ___ g

Mass of bottle & cone **before** filling cone, plate & hole		g
Mass of bottle & cone **after** filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_2)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm^3

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ ___ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft^3

Dry Density

$\rho_d = M_4 / V$ ___ g/cm^3

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft^3

Soil Description: Very pale brown, very fine , angular, poorly graded sand.

Proctor ID: RRM # 483

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 105.5 (lbs/ft^3)

Optimum Moisture (w_{opt}) 14.2 (%)

Required Moisture: 11.2 % to 17.2 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4959.6. Off cell standard: DS- 2291 MS- 504. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 9/18/18

___ Failed Moisture

___ Failed Compaction Time: 1443

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
DOE-EM/GJRAC1783

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180912-00 **DATE:** 9/18/2018

TEST ID NUMBER(S): P2 - 1

TEST LOCATION: 6795559 N. 2124272 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 2957 Moisture 504

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 142 Density Count 2029

Wet Density (ρ_m) 114.2 *(lbs/ft³)* Dry Density 98.9 *(lbs/ft³)*

Moisture Density 15.9 *(lbs/ft³)* Moisture Fraction 17.1 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID JV

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	517.0	g
Mass of container & dry specimen (M_{cds})	471.3	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	45.7	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	252.9	g
Moisture content (w) $w = (M_w / M_s) \times 100$	18.1	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 114.2) / (100 + 18.1) = 96.7$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

96.7 / 104.3 x 100 = 92.7 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ *g/cm³* ___ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone before filling cone, plate & hole ___ g

Mass of bottle & cone after filling cone, plate & hole ___ g

Mass of sand to fill cone, plate, & hole (M_1) ___ g

Mass of sand to fill hole ___ g

Mass of wet soil & container ___ g

Mass of container ___ g

Mass of wet soil (M_3) ___ g

Test Hole Volume $V = (M_1 - M_2) / \rho_1$ ___ cm^3

Dry Mass of soil $M_4 = 100\ M_3 / (w + 100)$ ___ g

Wet Density $\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft^3

Dry Density $\rho_d = M_4 / V$ ___ g/cm^3

Dry Unit Weight $\gamma_d = \rho_d \times 62.43$ ___ lbs/ft^3

Soil Description: Greyish brown, very fine to medium, subround. well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft³)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4964.7. Off cell standard: DS- 2291 MS- 504. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 9/18/18

___ Failed Moisture

___ Failed Compaction Time: 1502

By: Mitch Hogan / *(signature)*
(print)

QA/QC APPROVAL 10-22-2018 DATE

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project OTHER

LIFT IDENTIFICATION: UW1R02180912-00 DATE: 9/18/2018

TEST ID NUMBER(S): P2 - 2

TEST LOCATION: 6795558 N. 2124280 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3265 Moisture 512

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 150 Density Count 2189

Wet Density (ρ_m) 115.6 *(lbs/ft³)* Dry Density 99.1 *(lbs/ft³)*

Moisture Density 16.6 *(lbs/ft³)* Moisture Fraction 17.8 *(%)*

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ *g/cm³* ___ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) ___ *g*

Mass of bottle & cone **before** filling cone, plate & hole		g
Mass of bottle & cone **after** filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm^3

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ ___ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft^3

Dry Density

$\rho_d = M_4 / V$ ___ g/cm^3

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft^3

MOISTURE DETERMINATION

ASTM D4643

Container ID 218

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	514.2	g
Mass of container & dry specimen (M_{cds})	462.7	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	51.5	g
Mass of container (M_c)	218.9	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	243.8	g
Moisture content (w) $w = (M_w / M_s) \times 100$	21.1	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 115.6) / (100 + 21.1 = 95.4$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

95.4 / 104.3 x 100 = 91.5 %

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft³)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4964.0. Off cell standard: DS- 2291 MS- 504. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 9/18/18

___ Failed Moisture

___ Failed Compaction Time: 1512

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project OTHER

LIFT IDENTIFICATION: UW1R02180912-00 DATE: 9/18/2018

TEST ID NUMBER(S): P2 - 3

TEST LOCATION: 6795558 N. 2124268 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3265 Moisture 512

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 142 Density Count 2730

Wet Density (ρ_m) 114.3 *(lbs/ft^3)* Dry Density 97.1 *(lbs/ft^3)*

Moisture Density 15.6 *(lbs/ft^3)* Moisture Fraction 18.2 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID 218

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	499.7	g
Mass of container & dry specimen (M_{cds})	456.7	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	43.0	g
Mass of container (M_c)	218.9	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	237.8	g
Moisture content (w) $w = (M_w / M_s) \times 100$	18.1	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 114.3) / (100 + 18.1) = 96.8$ lbs/ft^3

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max$ x 100

96.8 / 104.3 x 100 = 92.8 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft^3)* ___

Bulk Density of sand (ρ_1) ___ g/cm^3 ___ *(lbs/ft^3)*

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone before filling cone, plate & hole	g
Mass of bottle & cone after filling cone, plate & hole	g
Mass of sand to fill cone, plate, & hole (M_1)	g
Mass of sand to fill hole	g
Mass of wet soil & container	g
Mass of container	g
Mass of wet soil (M_3)	g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm^3

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ ___ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft^3

Dry Density

$\rho_d = M_4 / V$ ___ g/cm^3

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft^3

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft^3)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4963.0. Off cell standard: DS- 2291 MS- 504. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 9/18/18

___ Failed Moisture

___ Failed Compaction Time: 1442

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
DOE-EM/GJRAC1783

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180912-00 DATE: 9/18/2018

TEST ID NUMBER(S): P3 - 1 nuclear gauge

TEST LOCATION: 6795324 N. 2124312 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 2957 Moisture 504

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 183 Density Count 2087

Wet Density (ρ_m) 119.6 *(lbs/ft³)* Dry Density 98.3 *(lbs/ft³)*

Moisture Density 21.1 *(lbs/ft³)* Moisture Fraction 24.4 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID 102

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	552.4	g
Mass of container & dry specimen (M_{cds})	491.9	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	60.5	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	273.5	g
Moisture content (w) $w = (M_w / M_s) \times 100$	22.1	%

Dry Density (ρ_d) $= (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 119.6) / (100 + 22.1) = 97.9$ lbs/ft³

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

97.9 / 104.3 x 100 = 93.9 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ∞ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ g/cm³ ___ lbs/ft³

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone before filling cone, plate & hole	g
Mass of bottle & cone after filling cone, plate & hole	g
Mass of sand to fill cone, plate, & hole (M_1)	g
Mass of sand to fill hole	g
Mass of wet soil & container	g
Mass of container	g
Mass of wet soil (M_3)	g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm³

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ ___ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft³

Dry Density

$\rho_d = M_4 / V$ ___ g/cm³

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft³

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft³)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4958.8. Off cell standard: DS- 2291 MS- 504. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 9/18/18

___ Failed Moisture

___ Failed Compaction Time: 1523

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180912-00 DATE: 9/18/2018

TEST ID NUMBER(S): P3 - 1 sandcone

TEST LOCATION: 6795324 N. 2124312 E. TEST METHOD: x D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 2957 Moisture 504

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 183 Density Count 2087

Wet Density (ρ_m) 119.6 *(lbs/ft^3)* Dry Density 98.3 *(lbs/ft^3)*

Moisture Density 21.1 *(lbs/ft^3)* Moisture Fraction 24.4 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID 102

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	552.4	g
Mass of container & dry specimen (M_{cds})	491.9	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	60.5	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	273.5	g
Moisture content (w) $w = (M_w / M_s) \times 100$	22.1	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 123.6) / (100 + 22.1 = 101.2$ *lbs/ft^3*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

101.2 / 104.3 x 100 = 97.1 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ∞ Calibrated Vol. *(lbs/ft^3)* 0.04157

Bulk Density of sand (ρ_1) 1.54 *g/cm^3* 95.9 *lbs/ft^3*

Mass of Sand to Fill Cone & Plate (M_2) 1808.2 g

Mass of bottle & cone before filling cone, plate & hole	7007.9	g
Mass of bottle & cone after filling cone, plate & hole	3122.6	g
Mass of sand to fill cone, plate, & hole (M_1)	3885.3	g
Mass of sand to fill hole	2077.1	g
Mass of wet soil & container	2686.7	g
Mass of container	9.2	g
Mass of wet soil (M_3)	2677.5	g

Test Hole Volume $V = (M_1 - M_2) / \rho_1$ 1352 *cm^3*

Dry Mass of soil $M_4 = 100 M_3 / (w + 100)$ 2192.5 g

Wet Density $\rho_m = (M_3 / V) \times 62.43$ 123.6 *lbs/ft^3*

Dry Density $\rho_d = M_4 / V$ 1.6 *g/cm^3*

Dry Unit Weight $\gamma_d = \rho_d \times 62.43$ 101.2 *lbs/ft^3*

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft^3)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4958.8. Off cell standard: DS- 2291 MS- 504. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 9/18/18

___ Failed Moisture

___ Failed Compaction Time: 1523

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project — OTHER

LIFT IDENTIFICATION: UW1R02180912-00 — DATE: 9/18/2018

TEST ID NUMBER(S): P3 - 2

TEST LOCATION: 6795322 N. 2124317 E. — TEST METHOD: ____ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 — Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3265 — Moisture 512

Method A (Direct Transmission)

Depth Setting 8 *(inches)* — Count Time 1 *(minutes)*

Moisture Count 126 — Density Count 2442

Wet Density (ρ_m) 110.5 *(lbs/ft³)* — Dry Density 97.3 *(lbs/ft³)*

Moisture Density 13.6 *(lbs/ft³)* — Moisture Fraction 14.7 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID 102

Scale Serial # 14714971 — Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	549.3	g
Mass of container & dry specimen (M_{cds})	506.3	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	43.0	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	287.9	g
Moisture content (w) $w = (M_w / M_s) \times 100$	14.9	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 110.5) / (100 + 14.9 = 96.1$ lbs/ft³

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

96.1 / 105.5 x 100 = 91.1 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ____ Calibrated Vol. *(lbs/ft³)* ____

Bulk Density of sand (ρ_1) ____ g/cm³ ____ lbs/ft³

Mass of Sand to Fill Cone & Plate (M_2) ____ g

Mass of bottle & cone **before** filling cone, plate & hole	g
Mass of bottle & cone **after** filling cone, plate & hole	g
Mass of sand to fill cone, plate, & hole (M_1)	g
Mass of sand to fill hole	g
Mass of wet soil & container	g
Mass of container	g
Mass of wet soil (M_3)	g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ____ cm³

Dry Mass of soil

$M_d = 100\ M_3 / (w + 100)$ ____ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ____ lbs/ft³

Dry Density

$\rho_d = M_d / V$ ____ g/cm³

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ____ lbs/ft³

Soil Description: Very pale brown, very fine, angular, poorly graded sand.

Proctor ID: RRM # 483

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 105.5 (lbs/ft³)

Optimum Moisture (w_{opt}) 14.2 (%)

Required Moisture: 11.2 % to 17.2 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4958.1. Off cell standard: DS- 2291 MS- 504. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass — Date: 9/18/18

____ Failed Moisture

____ Failed Compaction — Time: 1435

By: Mitch Hogan (print) / (signature)

QA/QC APPROVAL — 10-22-2018 DATE

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180912-00 DATE: 9/18/2018

TEST ID NUMBER(S): P3 - 3

TEST LOCATION: 6795318 N. 2124305 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3265 Moisture 512

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 163 Density Count 2211

Wet Density (ρ_m) 111.8 *(lbs/ft³)* Dry Density 93.8 *(lbs/ft³)*

Moisture Density 18.2 *(lbs/ft³)* Moisture Fraction 20.0 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID BS

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	517.4	g
Mass of container & dry specimen (M_{cds})	475.9	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	41.5	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	257.5	g
Moisture content (w) $w = (M_w / M_s) \times 100$	16.1	%

Dry Density (ρ_d) $= (100 \times \rho_m)/(100 + w)$

$pd = (100 \times 111.8) / (100 + 16.1) = 96.3$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

96.3 / 105.5 x 100 = 91.3 %

Comments:

Test Surface Elevation 4957.4. Off cell standard: DS- 2291 MS- 504. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ *g/cm³* ___ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone **before** filling cone, plate & hole		g
Mass of bottle & cone **after** filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_2)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm^3

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ ___ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft^3

Dry Density

$\rho_d = M_4 / V$ ___ g/cm^3

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft^3

Soil Description: Very pale brown, very fine, angular, poorly graded sand.

Proctor ID: RRM # 483

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 105.5 (lbs/ft³)

Optimum Moisture (w_{opt}) 14.2 (%)

Required Moisture: 11.2 % to 17.2 %

Required Percent Compaction: 90.0 (%)

TEST RESULTS:

X Pass Date: 9/18/18

___ Failed Moisture

___ Failed Compaction Time: 1450

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
DOE-EM/GJRAC1783

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project OTHER

LIFT IDENTIFICATION: UW1R02180912-00 DATE: 9/18/2018

TEST ID NUMBER(S): P4 - 1

TEST LOCATION: 6795270 N. 2124322 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 2957 Moisture 504

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 136 Density Count 2003

Wet Density (ρ_m) 110.9 *(lbs/ft³)* Dry Density 94.3 *(lbs/ft³)*

Moisture Density 15.1 *(lbs/ft³)* Moisture Fraction 16.0 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID JE

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	521.8	g
Mass of container & dry specimen (M_{cds})	476.7	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	45.1	g
Mass of container (M_c)	218.3	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	258.4	g
Moisture content (w) $w = (M_w / M_s) \times 100$	17.5	%

Dry Density (ρ_d) = $(100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 110.9) / (100 + 17.5 = 94.4$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

94.4 / 104.3 x 100 = 90.5 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ *g/cm³* ___ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone before filling cone, plate & hole		g
Mass of bottle & cone after filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm^3

Dry Mass of soil

$M_d = 100\ M_3 / (w + 100)$ ___ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ___ *lbs/ft³*

Dry Density

$\rho_d = M_d / V$ ___ *g/cm³*

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ *lbs/ft³*

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft³)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4957.8. Off cell standard: DS- 2291 MS- 504. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 9/18/18

___ Failed Moisture

___ Failed Compaction Time: 1521

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
DOE-EM/GJRAC1783

QC-F-002
File Index No. 43.8.2
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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180912-00 DATE: 9/18/2018

TEST ID NUMBER(S): P4-2

TEST LOCATION: 6795263 N. 2124327 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3265 Moisture 512

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 132 Density Count 2372

Wet Density (ρ_m) 113.2 *(lbs/ft³)* Dry Density 96.5 *(lbs/ft³)*

Moisture Density 14.3 *(lbs/ft³)* Moisture Fraction 15.5 *(%)*

MOISTURE DETERMINATION
ASTM D4643

Container ID 102

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	492.1	g
Mass of container & dry specimen (M_{cds})	449.4	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	42.7	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	231.0	g
Moisture content (w) $w = (M_w / M_s) \times 100$	18.5	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$pd = (100 \times 113.2) / (100 + 18.5 = 95.5$ lbs/ft³

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

95.5 / 104.3 x 100 = 91.6 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ g/cm³ ___ lbs/ft³

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone before filling cone, plate & hole		g
Mass of bottle & cone after filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume
$V = (M_1 - M_2) / \rho_1$ ___ cm³

Dry Mass of soil
$M_4 = 100\ M_3 / (w + 100)$ ___ g

Wet Density
$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft³

Dry Density
$\rho_d = M_4 / V$ ___ g/cm³

Dry Unit Weight
$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft³

Soil Description: Greyish brown, very fine to medium, subround. well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft³)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:
Test Surface Elevation 4957.0. Off cell standard: DS-2291 MS-504. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 9/18/18

___ Failed Moisture

___ Failed Compaction Time: 1451

By: Mitch Hogan (print) / (sign)

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
DOE-EM/GJRAC1783

QC-F-002
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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180912-00 DATE: 9/18/2018

TEST ID NUMBER(S): P4 - 3

TEST LOCATION: 6795258 N. 2124322 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *On-Cell Standard*

Density 3265 Moisture 512

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 133 Density Count 2067

Wet Density (ρ_m) 112.1 *(lbs/ft³)* Dry Density 97.6 *(lbs/ft³)*

Moisture Density 14.5 *(lbs/ft³)* Moisture Fraction 14.8 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID JE

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	547.3	g
Mass of container & dry specimen (M_{cds})	497.2	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	50.1	g
Mass of container (M_c)	218.3	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	278.9	g
Moisture content (w) $w = (M_w / M_s) \times 100$	18.0	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 112.1) / (100 + 18.0 = 95.0$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

95.0 / 104.3 x 100 = 91.1 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ *g/cm³* ___ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone before filling cone, plate & hole	g
Mass of bottle & cone after filling cone, plate & hole	g
Mass of sand to fill cone, plate, & hole (M_1)	g
Mass of sand to fill hole	g
Mass of wet soil & container	g
Mass of container	g
Mass of wet soil (M_3)	g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm^3

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ ___ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft^3

Dry Density

$\rho_d = M_4 / V$ ___ g/cm^3

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft^3

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft^3)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4956.2. Off cell standard: DS- 2291 MS- 504. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 9/18/18

___ Failed Moisture

___ Failed Compaction Time: 1500

By: Mitch Hogan / *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
DOE-EM/GJRAC1783

QC-F-002
File Index No. 43.8.2
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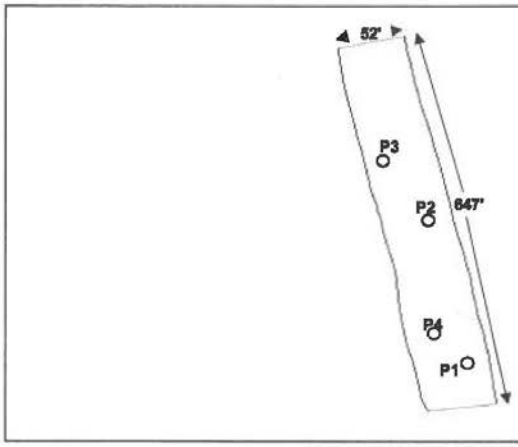
LIFT APPROVAL FORM

PROJECT: Moab UMTRA OTHER

NW CORNER **DATE:** 9/20/2018



P 1	6795192 N. 2124322 E.					
EW:	0.874	X	52	=	45
NS:	0.852	X	647	=	551
P 2	6795370 N. 2124295 E.					
EW:	0.572	X	52	=	30
NS:	0.576	X	647	=	373
P 3	6795506 N. 2124264 E.					
EW:	0.248	X	52	=	13
NS:	0.366	X	647	=	237
P 4	6795233 N. 2124291 E.					
EW:	0.323	X	52	=	17
NS:	0.789	X	647	=	510
P 5	N					
EW:		X		=		
NS:		X	A	=		
Page 2 attached:			Y		N	

IDENTIFY LOTS ABOVE

LIFT ID: UW1R02180920-00 NW CORNER: 6795743 N. 2124238 E.

Uncompacted Thickness: 1.8 Compacted Thickness: N/A Debris Insp. By: N/A Date: N/A Time: N/A

NW CORNER of debris placement: N/A EW Dimension N/A NS Dimension N/A

Lift Area (ft²): 32,971 Lift Volume (yd³): 2,198

Comments: This is the third of three two foot test pads. QC verified that the lift area was scarified prior to placement. On 9/20/2018 Operations began placement from north to south. The 275 was used to push the pile to near two foot thickness using CAES as a guide. QC performed a moisture test while the material was being placed with satisfactory results. Lift placement was not completed today. On 9/25/2018 Operations finished placement and the lift area was approved for thickness. On 9/26/2018 and 9/27/2018 Operations performed compaction using a CAT 825 and using CAES. The CAES was set to 8 machine passes. After the CAES showed uniform compaction QC began in place testing. On 10/1/2018 QC tested four locations. At each location an in place moisture/ density was performed on the surface, approximately eight inches below the surface, and approximately 16 inches below the surface. A companion sandcone was performed at P3 location. All moisture/ density tests were satisfactory. A track hoe was used to pothole test locations with care not to disturb compaction.

Attached on page two is a summary table showing all density and moisture results for this lift. The test ID's are labeled by testing location (P1, P2, P3,..) and then the test depth (1 surface, 2 eight inches below, 3 16 inches below). The coordinates location on the lift approval form are the random locations, the coordinate location on the density forms are the actual testing locations.

Attached Forms: **Grid Slope** X **Compaction Macro** X **Print Screen** X **Moisture/ Density** X

KEYING IN NOTES: N E S [W] Satisfactory MOISTURE/ DENSITY TESTS ID # (S): P1-1 through P4-3

LIFT APPROVED BY: Mitch Hogan/ DATE: 10/2/2018 TIME: 1000

10.22.2018

QA/QC APPROVAL DATE

Density Testing
DOE-EM/GJRAC1783
Rev. 1

QC-F-001
File Index No. 43.8.2
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Lift ID: UW1R021809 20-00

Location	In- Place Sandcone DD lbs/ft³	In- Place Gauge DD lbs/ft³	In- Place Moisture %	Proctor max dry density lbs/ft³	Proctor optimum moisture %	Compaction % (Sandcone/ Gauge)
P1-1		104.9	18.3	112.5	16.9	93.2
P1-2		105.2	16.7	112.5	16.9	93.5
P1-3		111.4	14.5	114.7	14.3	97.1
P2-1		104.9	16.9	112.5	16.9	93.3
P2-2		100.9	20.2	104.3	20	96.7
P2-3		105.9	19.7	112.5	16.9	94.1
P3-1	107.4	109.5	17.2	112.5	16.9	85.5/ 97.4
P3-2		102	16.8	112.5	16.9	90.7
P3-3		100.7	20.1	104.3	20	96.5
P4-1		110.7	16.9	112.5	16.9	98.4
P4-2		102.4	18.5	112.5	16.9	91.1
P4-3		108.4	17.9	112.5	16.9	96.4

DD= Dry Density

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Slope Elevation Survey

	Average lift thickness=	1.8	Bounding Box	Northing	Easting		
	Grid Size=	20'	Lower Left	N			
Lift ID:	UW1R02180920-00		Upper Right		A		
Last Lift Elevations			Lift Approval Elevations			Lift Thickness	
Northing	Easting	Elevation	Northing	Easting	Elevation	Thickness	
6795597	2124253	4966.2	6795597	2124253	4968.2	2.0	OK
6795617	2124253	4966.8	6795617	2124253	4968.5	1.7	OK
6795637	2124253	4967.1	6795637	2124253	4968.8	1.6	OK
6795657	2124253	4967.5	6795657	2124253	4969.1	1.5	OK
6795677	2124253	4967.7	6795677	2124253	4969.3	1.7	OK
6795697	2124253	4967.9	6795697	2124253	4969.8	1.8	OK
6795717	2124253	4968.4	6795717	2124253	4970.1	1.7	OK
6795737	2124253	4968.7	6795737	2124253	4970.3	1.6	OK
6795377	2124273	4960.8	6795377	2124273	4963.0	2.2	OK
6795397	2124273	4961.2	6795397	2124273	4963.5	2.2	OK
6795417	2124273	4961.8	6795417	2124273	4964.0	2.2	OK
6795437	2124273	4962.3	6795437	2124273	4964.4	2.1	OK
6795457	2124273	4962.8	6795457	2124273	4964.9	2.2	OK
6795477	2124273	4963.3	6795477	2124273	4965.3	2.0	OK
6795497	2124273	4963.9	6795497	2124273	4965.7	1.8	OK
6795517	2124273	4964.3	6795517	2124273	4966.1	1.8	OK
6795537	2124273	4964.7	6795537	2124273	4966.4	1.7	OK
6795557	2124273	4965.0	6795557	2124273	4966.7	1.7	OK
6795577	2124273	4965.4	6795577	2124273	4967.3	1.9	OK
6795597	2124273	4966.0	6795597	2124273	4967.7	1.7	OK
6795617	2124273	4966.5	6795617	2124273	4968.2	1.7	OK
6795637	2124273	4966.9	6795637	2124273	4968.7	1.8	OK
6795657	2124273	4967.2	6795657	2124273	4969.0	1.8	OK
6795677	2124273	4967.5	6795677	2124273	4969.2	1.7	OK
6795697	2124273	4967.9	6795697	2124273	4969.8	1.9	OK
6795717	2124273	4968.3	6795717	2124273	4970.1	1.8	OK
6795737	2124273	4968.6	6795737	2124273	4970.2	1.6	OK
6795757	2124273	4968.6	6795757	2124273	4969.9	1.3	OK
6795117	2124293	4955.3	6795117	2124293	4957.0	1.6	OK
6795137	2124293	4955.7	6795137	2124293	4957.8	2.1	OK
6795157	2124293	4956.2	6795157	2124293	4958.1	2.0	OK
6795177	2124293	4956.5	6795177	2124293	4958.5	2.0	OK
6795197	2124293	4957.0	6795197	2124293	4959.1	2.1	OK
6795217	2124293	4957.5	6795217	2124293	4959.5	2.0	OK
6795237	2124293	4957.9	6795237	2124293	4959.9	2.0	OK
6795257	2124293	4958.4	6795257	2124293	4960.4	2.0	OK
6795277	2124293	4958.7	6795277	2124293	4960.8	2.0	OK
6795297	2124293	4959.1	6795297	2124293	4961.1	2.0	OK
6795317	2124293	4959.5	6795317	2124293	4961.7	2.1	OK
6795337	2124293	4960.0	6795337	2124293	4962.0	2.0	OK
6795357	2124293	4960.3	6795357	2124293	4962.2	1.9	OK
6795377	2124293	4960.6	6795377	2124293	4962.6	2.0	OK
6795397	2124293	4961.0	6795397	2124293	4963.1	2.0	OK
6795417	2124293	4961.5	6795417	2124293	4963.7	2.2	OK
6795437	2124293	4962.0	6795437	2124293	4964.2	2.1	OK
6795457	2124293	4962.5	6795457	2124293	4964.7	2.2	OK
6795477	2124293	4963.0	6795477	2124293	4965.0	2.0	OK
6795497	2124293	4963.5	6795497	2124293	4965.5	1.9	OK
6795517	2124293	4964.0	6795517	2124293	4965.9	1.9	OK
6795537	2124293	4964.4	6795537	2124293	4966.2	1.8	OK

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6795557	2124293	4964.7	6795557	2124293	4966.6	1.8	OK
6795577	2124293	4965.2	6795577	2124293	4966.9	1.7	OK
6795597	2124293	4965.6	6795597	2124293	4967.1	1.5	OK
6795617	2124293	4966.0	6795617	2124293	4967.2	1.2	OK
6795637	2124293	4966.3	6795637	2124293	4967.5	1.2	OK
6795657	2124293	4966.5	6795657	2124293	4967.5	1.0	OK
6795677	2124293	4966.6	6795677	2124293	4967.6	1.0	OK
6795117	2124313	4954.3	6795117	2124313	4956.5	2.2	OK
6795137	2124313	4955.0	6795137	2124313	4957.2	2.2	OK
6795157	2124313	4955.6	6795157	2124313	4957.7	2.1	OK
6795177	2124313	4956.2	6795177	2124313	4958.2	2.0	OK
6795197	2124313	4956.8	6795197	2124313	4958.8	2.0	OK
6795217	2124313	4957.2	6795217	2124313	4959.2	2.0	OK
6795237	2124313	4957.6	6795237	2124313	4959.5	1.9	OK
6795257	2124313	4958.0	6795257	2124313	4960.0	2.0	OK
6795277	2124313	4958.4	6795277	2124313	4960.6	2.2	OK
6795297	2124313	4958.7	6795297	2124313	4960.9	2.2	OK
6795317	2124313	4959.1	6795317	2124313	4961.3	2.2	OK
6795337	2124313	4959.5	6795337	2124313	4961.5	2.0	OK

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% >=16	97.5%
Elevation Avg	4963.6
Total >=16	2988
Total Lines	3066

Pass

Minimum Number of Machine Passes
8

Lift ID: UW1R02180920-00

Northing	Easting	Elevation	# of Passes	Passes =>16	Count
6795677	2124240	4969.3	11		1
6795680	2124240	4969.4	16	1	1
6795684	2124240	4969.4	16	1	1
6795687	2124240	4969.5	16	1	1
6795690	2124240	4969.6	16	1	1
6795693	2124240	4969.6	16	1	1
6795697	2124240	4969.7	16	1	1
6795700	2124240	4969.6	16	1	1
6795703	2124240	4969.7	16	1	1
6795707	2124240	4969.8	16	1	1
6795710	2124240	4969.8	16	1	1
6795713	2124240	4969.9	16	1	1
6795716	2124240	4969.9	16	1	1
6795720	2124240	4970.0	16	1	1
6795723	2124240	4970.0	16	1	1
6795726	2124240	4970.1	16	1	1
6795729	2124240	4970.1	16	1	1
6795733	2124240	4970.1	16	1	1
6795736	2124240	4970.2	16	1	1
6795739	2124240	4970.1	16	1	1
6795743	2124240	4970.1	16	1	1
6795621	2124243	4968.8	10		1
6795624	2124243	4968.8	13		1
6795628	2124243	4968.8	16	1	1
6795631	2124243	4968.8	16	1	1
6795634	2124243	4968.8	16	1	1
6795638	2124243	4968.8	16	1	1
6795641	2124243	4968.9	16	1	1
6795644	2124243	4968.9	16	1	1
6795647	2124243	4969.0	16	1	1
6795651	2124243	4969.0	16	1	1
6795654	2124243	4969.1	16	1	1
6795657	2124243	4969.0	16	1	1
6795661	2124243	4969.1	16	1	1
6795664	2124243	4969.1	16	1	1
6795667	2124243	4969.2	16	1	1
6795670	2124243	4969.3	16	1	1
6795674	2124243	4969.3	16	1	1
6795677	2124243	4969.3	16	1	1
6795680	2124243	4969.4	16	1	1
6795684	2124243	4969.5	16	1	1
6795687	2124243	4969.4	16	1	1
6795690	2124243	4969.4	16	1	1
6795693	2124243	4969.5	16	1	1

Lift Height
24"

Thick Lift Threshold
2' 0"

Last Lift Elevation
N/A

Min. # of Wheel Passes
16

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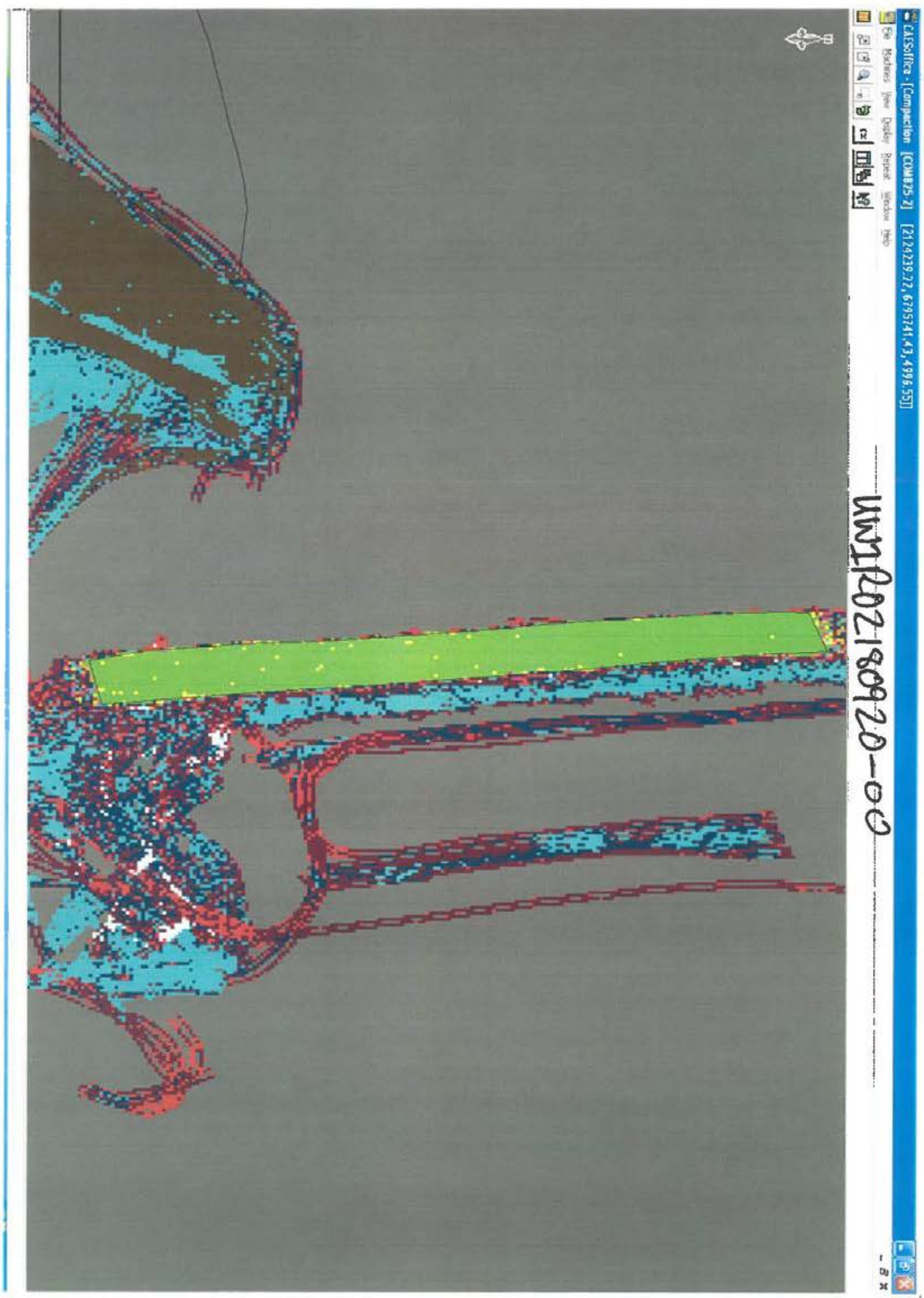
CAESoffice - [Compaction [COMB25 2] [2124239.22,6795741.43,4996.55]]
File Machines View Display Report Window Help
UW1202180920-00

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180920-00 DATE: 10/1/2018

TEST ID NUMBER(S): P1 - 1

TEST LOCATION: P1- 6795186 N. 2124323 E. TEST METHOD: D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *Off-Cell Standard*

Density 2273 Moisture 501

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 169 Density Count 2229

Wet Density (ρ_m) 124.1 *(lbs/ft³)* Dry Density 104.4 *(lbs/ft³)*

Moisture Density 19.7 *(lbs/ft³)* Moisture Fraction 18.8 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID 102

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	503.4	g
Mass of container & dry specimen (M_{cds})	459.3	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	44.1	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	240.9	g
Moisture content (w) $w = (M_w / M_s) \times 100$	18.3	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 124.1) / (100 + 18.3 = 104.9$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

104.9 / 112.5 x 100 = 93.2 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ____ Calibrated Vol. *(lbs/ft³)* ____

Bulk Density of sand (ρ_1) ____ *g/cm³* ____ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) ____ *g*

Mass of bottle & cone before filling cone, plate & hole		g
Mass of bottle & cone after filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_2)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

N A

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ____ cm^3

Dry Mass of soil

$M_4 = 100 M_3 / (w + 100)$ ____ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ____ lbs/ft^3

Dry Density

$\rho_d = M_4 / V$ ____ g/cm^3

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ____ lbs/ft^3

Soil Description: Brown sandy clay.

Proctor ID: RRM # 517

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 112.5 (lbs/ft³)

Optimum Moisture (w_{opt}) 16.9 (%)

Required Moisture: 13.9 % to 19.9 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4957.7. On cell standard: DS- 3224 MS- 496. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 10/1/18

____ Failed Moisture

____ Failed Compaction Time: 1525

By: Cory Vetere *(print)* *(signature)*

QA/QC APPROVAL 10.22.18 DATE

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180920-00 DATE: 10/1/2018

TEST ID NUMBER(S): P1-2

TEST LOCATION: P1- 6795171 N. 2124321 E, TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *Off-Cell Standard*

Density 2273 Moisture 501

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 136 Density Count 2342

Wet Density (ρ_m) 122.8 *(lbs/ft^3)* Dry Density 107.6 *(lbs/ft^3)*

Moisture Density 15.2 *(lbs/ft^3)* Moisture Fraction 14.1 *(%)*

MOISTURE DETERMINATION
ASTM D4643

Container ID JE

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	504.0	g
Mass of container & dry specimen (M_{cds})	463.1	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	40.9	g
Mass of container (M_c)	218.3	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	244.8	g
Moisture content (w) $w = (M_w / M_s) \times 100$	16.7	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 122.8) / (100 + 16.7 = 105.2$ lbs/ft^3

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

105.2 / 112.5 x 100 = 93.5 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft^3)* ___

Bulk Density of sand (ρ_1) ___ g/cm^3 ___ lbs/ft^3

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone before filling cone, plate & hole		g
Mass of bottle & cone after filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

N A

Test Hole Volume
$V = (M_1 - M_2) / \rho_1$ ___ cm^3

Dry Mass of soil
$M_d = 100 M_3 / (w + 100)$ ___ g

Wet Density
$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft^3

Dry Density
$\rho_d = M_d / V$ ___ g/cm^3

Dry Unit Weight
$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft^3

Soil Description: Brown sandy clay.

Proctor ID: RRM # 517

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 112.5 (lbs/ft^3)

Optimum Moisture (w_{opt}) 16.9 (%)

Required Moisture: 13.9 % to 19.9 %

Required Percent Compaction: 90.0 (%)

Comments:
Test Surface Elevation 4957.0. On cell standard: DS- 3276 MS- 501. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:
X Pass Date: 10/1/18
___ Failed Moisture
___ Failed Compaction Time: 1455

By: Cory Vetere *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: **UW1R02180920-00** DATE: **10/1/2018**

TEST ID NUMBER(S): **P1- 3**

TEST LOCATION: **P1- 6795180 N. 2124326 E.** TEST METHOD: ____ D1556 **X** D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model **Troxler 3430** Gauge Serial # **23532**

Last Calibration Date: **3/22/18**

Daily Standard Counts: *Off-Cell Standard*

Density **2273** Moisture **501**

Method A (Direct Transmission)

Depth Setting **8** *(inches)* Count Time **1** *(minutes)*

Moisture Count **112** Density Count **2393**

Wet Density (ρ_{wt}) **127.6** *(lbs/ft³)* Dry Density **115.7** *(lbs/ft³)*

Moisture Density **11.9** *(lbs/ft³)* Moisture Fraction **10.3** *(%)*

MOISTURE DETERMINATION
ASTM D4643

Container ID **218**

Scale Serial # **14714971** Last Calibration Date: **10/6/17**

Mass of container & wet specimen (M_{cms})	577.1	g
Mass of container & dry specimen (M_{cds})	531.7	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	45.4	g
Mass of container (M_c)	218.9	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	312.8	g
Moisture content (w) $w = (M_w / M_s) \times 100$	14.5	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 127.6) / (100 + 14.5 = 111.4$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_{wt})

Percent Compaction = ρ_d / $\gamma_d max \times 100$

111.4 / 114.7 x 100 = **97.1** %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ____ Calibrated Vol. *(lbs/ft³)* ____

Bulk Density of sand (ρ_1) ____ *g/cm³* ____ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) ____ *g*

Mass of bottle & cone before filling cone, plate & hole		g
Mass of bottle & cone after filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

N A

Test Hole Volume
$V = (M_1 - M_2) / \rho_1$ ____ cm^3

Dry Mass of soil
$M_d = 100\ M_3 / (w + 100)$ ____ g

Wet Density
$\rho_m = (M_3 / V) \times 62.43$ ____ lbs/ft^3

Dry Density
$\rho_d = M_d / V$ ____ g/cm^3

Dry Unit Weight
$\gamma_d = \rho_d \times 62.43$ ____ lbs/ft^3

Soil Description: **Greyish brown, fine to medium, subround sand with clay.**

Proctor ID: **RRM # 525**

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) **114.7** (lbs/ft^3)

Optimum Moisture (w_{opt}) **14.3** (%)

Required Moisture: **11.3** % to **17.3** %

Required Percent Compaction: **90.0** (%)

Comments:
Test Surface Elevation 4956.4. On cell standard: DS- 3715 MS- 508. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:
X Pass Date: **10/1/18**
____ Failed Moisture
____ Failed Compaction Time: **1455**

By: **Cory Vetere** *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180920-00 DATE: 10/1/2018

TEST ID NUMBER(S): P2-1

TEST LOCATION: P2- 6795394 N. 2124292 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *Off-Cell Standard*

Density 2273 Moisture 501

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 166 Density Count 2302

Wet Density (ρ_m) 122.7 *(lbs/ft³)* Dry Density 103.4 *(lbs/ft³)*

Moisture Density 19.3 *(lbs/ft³)* Moisture Fraction 18.6 *(%)*

MOISTURE DETERMINATION
ASTM D4643

Container ID JE

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	519.2	g
Mass of container & dry specimen (M_{cds})	475.6	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	43.6	g
Mass of container (M_c)	218.3	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	257.3	g
Moisture content (w) $w = (M_w / M_s) \times 100$	16.9	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 122.7) / (100 + 16.9) = 104.9$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

104.9 / 112.5 x 100 = 93.3 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ *g/cm³* ___ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) ___ *g*

Mass of bottle & cone **before** filling cone, plate & hole		g
Mass of bottle & cone **after** filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

N A

Test Hole Volume
$V = (M_1 - M_2) / \rho_1$ ___ cm^3

Dry Mass of soil
$M_4 = 100\ M_3 / (w + 100)$ ___ g

Wet Density
$\rho_m = (M_3 / V) \times 62.43$ ___ *lbs/ft³*

Dry Density
$\rho_d = M_4 / V$ ___ *g/cm³*

Dry Unit Weight
$\gamma_d = \rho_d \times 62.43$ ___ *lbs/ft³*

Soil Description: Brown sandy clay.

Proctor ID: RRM # 517

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 112.5 (lbs/ft³)

Optimum Moisture (w_{opt}) 16.9 (%)

Required Moisture: 13.9 % to 19.9 %

Required Percent Compaction: 90.0 (%)

Comments:
Test Surface Elevation 4962.4. On cell standard: DS- 3224 MS- 496. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:
X Pass Date: 10/1/18
___ Failed Moisture
___ Failed Compaction Time: 1515
By: Cory Vetere *(print)* *(signature)*

QA/QC APPROVAL 10-22-2019 DATE

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180920-00 DATE: 10/1/2018

TEST ID NUMBER(S): P2-2

TEST LOCATION: P2- 6795400 N. 2124295 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *Off-Cell Standard*

Density 2273 Moisture 501

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 156 Density Count 2425

Wet Density (ρ_w) 121.2 *(lbs/ft³)* Dry Density 103.4 *(lbs/ft³)*

Moisture Density 17.8 *(lbs/ft³)* Moisture Fraction 17.2 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID BS

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	540.1	g
Mass of container & dry specimen (M_{cds})	486.1	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	54.0	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	267.7	g
Moisture content (w) $w = (M_w / M_s) \times 100$	20.2	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 121.2) / (100 + 20.2 = 100.9$ lbs/ft³

Note: Wet Density from ASTM D 1556 (ρ_w) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

100.9 / 104.3 x 100 = 96.7 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ g/cm³ ___ lbs/ft³

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone before filling cone, plate & hole		g
Mass of bottle & cone after filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

N A

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm³

Dry Mass of soil

$M_d = 100 M_3 / (w + 100)$ ___ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft³

Dry Density

$\rho_d = M_d / V$ ___ g/cm³

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft³

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft³)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4961.6. On cell standard: DS- 3276 MS- 501. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 10/1/18

___ Failed Moisture

___ Failed Compaction Time: 1520

By: Cory Vetere *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180920-00 DATE: 10/1/2018

TEST ID NUMBER(S): P2- 3

TEST LOCATION: P2- 6795409 N. 2124291 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *Off-Cell Standard*

Density 2273 Moisture 501

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 186 Density Count 2415

Wet Density (ρ_m) 126.7 *(lbs/ft³)* Dry Density 105.4 *(lbs/ft³)*

Moisture Density 21.3 *(lbs/ft³)* Moisture Fraction 20.2 *(%)*

MOISTURE DETERMINATION
ASTM D4643

Container ID JV

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	503.1	g
Mass of container & dry specimen (M_{cds})	456.3	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	46.8	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	237.9	g
Moisture content (w) $w = (M_w / M_s) \times 100$	19.7	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 126.7) / (100 + 19.7 = 105.9$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

105.9 / 112.5 x 100 = 94.1 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ *g/cm³* ___ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) ___ *g*

Mass of bottle & cone **before** filling cone, plate & hole		g
Mass of bottle & cone **after** filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume
$V = (M_1 - M_2) / \rho_1$ ___ cm^3

Dry Mass of soil
$M_d = 100\ M_3 / (w + 100)$ ___ g

Wet Density
$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft^3

Dry Density
$\rho_d = M_d / V$ ___ g/cm^3

Dry Unit Weight
$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft^3

Soil Description: Brown sandy clay.

Proctor ID: RRM # 517

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 112.5 (lbs/ft^3)

Optimum Moisture (w_{opt}) 16.9 (%)

Required Moisture: 13.9 % to 19.9 %

Required Percent Compaction: 90.0 (%)

Comments:
Test Surface Elevation 4961.0. On cell standard: DS- 3715 MS- 508. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:
X Pass Date: 10/1/18
___ Failed Moisture
___ Failed Compaction Time: 1455
By: Cory Vetere *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project OTHER

LIFT IDENTIFICATION: UW1R02180920-00 DATE: 10/1/2018

TEST ID NUMBER(S): P3- 1 sandcone

TEST LOCATION: P3- 6795559 N. 2124263 E. TEST METHOD: X D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *Off-Cell Standard*

Density 2273 Moisture 501

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 159 Density Count 2025

Wet Density (ρ_m) 128.4 *(lbs/ft³)* Dry Density 110.0 *(lbs/ft³)*

Moisture Density 18.4 *(lbs/ft³)* Moisture Fraction 16.7 *(%)*

MOISTURE DETERMINATION
ASTM D4643

Container ID BS

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	500.4	g
Mass of container & dry specimen (M_{cds})	459.0	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	41.4	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	240.6	g
Moisture content (w) $w = (M_w / M_s) \times 100$	17.2	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 125.9) / (100 + 17.2 = 107.4$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max$ x 100

107.4 / 112.5 x 100 = 95.5 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ∞ Calibrated Vol. *(lbs/ft³)* 0.04157

Bulk Density of sand (ρ_1) 1.54 *g/cm³* 95.9 *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) 1808.2 *g*

Mass of bottle & cone **before** filling cone, plate & hole	7124.7	g
Mass of bottle & cone **after** filling cone, plate & hole	3525.2	g
Mass of sand to fill cone, plate, & hole (M_1)	3599.5	g
Mass of sand to fill hole	1791.3	g
Mass of wet soil & container	2363.2	g
Mass of container	11.7	g
Mass of wet soil (M_3)	2351.5	g

Test Hole Volume
$V = (M_1 - M_2) / \rho_1$ 1166 *cm³*

Dry Mass of soil
$M_4 = 100\ M_3 / (w + 100)$ 2006.3 *g*

Wet Density
$\rho_m = (M_3 / V) \times 62.43$ 125.9 *lbs/ft³*

Dry Density
$\rho_d = M_4 / V$ 1.7 *g/cm³*

Dry Unit Weight
$\gamma_d = \rho_d \times 62.43$ 107.4 *lbs/ft³*

Soil Description: Brown sandy clay.

Proctor ID: RRM # 517

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 112.5 (lbs/ft³)

Optimum Moisture (w_{opt}) 16.9 (%)

Required Moisture: 13.9 % to 19.9 %

Required Percent Compaction: 90.0 (%)

Comments:
Test Surface Elevation 4966.4. On cell standard: DS- 3224 MS- 496. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:
X Pass Date: 10/1/18
___ Failed Moisture
___ Failed Compaction Time: 1505

By: Cory Vetere *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180920-00 DATE: 10/1/2018

TEST ID NUMBER(S): P3- 1 nuclear gauge

TEST LOCATION: P3- 6795559 N. 2124263 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *Off-Cell Standard*

Density 2273 Moisture 501

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 159 Density Count 2025

Wet Density (ρ_m) 128.4 *(lbs/ft³)* Dry Density 110.0 *(lbs/ft³)*

Moisture Density 18.4 *(lbs/ft³)* Moisture Fraction 16.7 *(%)*

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ∞ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ g/cm³ ___ lbs/ft³

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone before filling cone, plate & hole		g
Mass of bottle & cone after filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume
$V = (M_1 - M_2) / \rho_1$ ___ cm³

Dry Mass of soil
$M_4 = 100\ M_3 / (w + 100)$ ___ g

Wet Density
$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft³

Dry Density
$\rho_d = M_4 / V$ ___ g/cm³

Dry Unit Weight
$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft³

MOISTURE DETERMINATION
ASTM D4643

Container ID BS

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	500.4	g
Mass of container & dry specimen (M_{cds})	459.0	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	41.4	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	240.6	g
Moisture content (w) $w = (M_w / M_s) \times 100$	17.2	%

Soil Description: Brown sandy clay.

Proctor ID: RRM # 517

Standard Proctor (ASTM D698)

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 128.4) / (100 + 17.2) = 109.5$ lbs/ft³

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max$ x 100

109.5 / 112.5 x 100 = 97.4 %

Maximum Dry Density ($\gamma_d max$) 112.5 (lbs/ft³)

Optimum Moisture (w_{opt}) 16.9 (%)

Required Moisture: 13.9 % to 19.9 %

Required Percent Compaction: 90.0 (%)

Comments:
Test Surface Elevation 4966.4. On cell standard: DS- 3224 MS- 496. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:
X Pass Date: 10/1/18
___ Failed Moisture
___ Failed Compaction Time: 1505
By: Cory Vetere *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project OTHER

LIFT IDENTIFICATION: UW1R02180920-00 DATE: 10/1/2018

TEST ID NUMBER(S): P3- 2

TEST LOCATION: P3- 6795560 N. 2124258 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *Off-Cell Standard*

Density 2273 Moisture 501

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 133 Density Count 2545

Wet Density (ρ_m) 119.2 *(lbs/ft³)* Dry Density 104.4 *(lbs/ft³)*

Moisture Density 14.8 *(lbs/ft³)* Moisture Fraction 14.2 *(%)*

MOISTURE DETERMINATION
ASTM D4643

Container ID JV

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	524.1	g
Mass of container & dry specimen (M_{cds})	480.1	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	44.0	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	261.7	g
Moisture content (w) $w = (M_w / M_s) \times 100$	16.8	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 119.2) / (100 + 16.8 = 102.0$ lbs/ft³

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

102.0 / 112.5 x 100 = 90.7 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ g/cm³ ___ lbs/ft³

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone **before** filling cone, plate & hole	g
Mass of bottle & cone **after** filling cone, plate & hole	g
Mass of sand to fill cone, plate, & hole (M_1)	g
Mass of sand to fill hole	g
Mass of wet soil & container	g
Mass of container	g
Mass of wet soil (M_3)	g

Test Hole Volume
$V = (M_1 - M_2) / \rho_1$ ___ cm³

Dry Mass of soil
$M_d = 100 M_3 / (w + 100)$ ___ g

Wet Density
$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft³

Dry Density
$\rho_d = M_d / V$ ___ g/cm³

Dry Unit Weight
$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft³

Soil Description: Brown sandy clay.

Proctor ID: RRM # 517

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 112.5 (lbs/ft³)

Optimum Moisture (w_{opt}) 16.9 (%)

Required Moisture: 13.9 % to 19.9 %

Required Percent Compaction: 90.0 (%)

Comments:
Test Surface Elevation 4965.8. On cell standard: DS- 3276 MS- 501. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:
X Pass Date: 10/1/18
___ Failed Moisture
___ Failed Compaction Time: 1515
By: Cory Vetere *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
DOE-EM/GJRAC1783

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180920-00 DATE: 10/1/2018

TEST ID NUMBER(S): P3 -3

TEST LOCATION: P3- 6795558 N. 2124269 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *Off-Cell Standard*

Density 2273 Moisture 501

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 158 Density Count 2300

Wet Density (ρ_m) 120.9 *(lbs/ft^3)* Dry Density 105.3 *(lbs/ft^3)*

Moisture Density 17.7 *(lbs/ft^3)* Moisture Fraction 15.9 *(%)*

MOISTURE DETERMINATION
ASTM D4643

Container ID 102

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	524.7	g
Mass of container & dry specimen (M_{cds})	473.4	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	51.3	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	255.0	g
Moisture content (w) $w = (M_w / M_s) \times 100$	20.1	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 120.9) / (100 + 20.1 = 100.7$ *lbs/ft^3*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max$ x 100

100.7 / 104.3 x 100 = 96.5 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft^3)* ___

Bulk Density of sand (ρ_1) ___ *g/cm^3* ___ *lbs/ft^3*

Mass of Sand to Fill Cone & Plate (M_2) ___ *g*

Mass of bottle & cone before filling cone, plate & hole	g
Mass of bottle & cone after filling cone, plate & hole	g
Mass of sand to fill cone, plate, & hole (M_1)	g
Mass of sand to fill hole	g
Mass of wet soil & container	g
Mass of container	g
Mass of wet soil (M_3)	g

N A

Test Hole Volume
$V = (M_1 - M_2) / \rho_1$ ___ *cm^3*

Dry Mass of soil
$M_d = 100\ M_3 / (w + 100)$ ___ *g*

Wet Density
$\rho_m = (M_3 / V) \times 62.43$ ___ *lbs/ft^3*

Dry Density
$\rho_d = M_d / V$ ___ *g/cm^3*

Dry Unit Weight
$\gamma_d = \rho_d \times 62.43$ ___ *lbs/ft^3*

Soil Description: Greyish brown, very fine to medium, subround, well graded clay.

Proctor ID: RRM # 489

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.3 (lbs/ft^3)

Optimum Moisture (w_{opt}) 20.0 (%)

Required Moisture: 17.0 % to 23.0 %

Required Percent Compaction: 90.0 (%)

Comments:
Test Surface Elevation 4965.1. On cell standard: DS- 3715 MS- 508. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:
X Pass Date: 10/1/18
___ Failed Moisture
___ Failed Compaction Time: 1455
By: Cory Vetere *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180920-00 DATE: 10/1/2018

TEST ID NUMBER(S): P4- 1

TEST LOCATION: P4- 6795252 N. 2124290 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *Off-Cell Standard*

Density 2273 Moisture 501

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 153 Density Count 1985

Wet Density (ρ_w) 129.3 *(lbs/ft³)* Dry Density 111.7 *(lbs/ft³)*

Moisture Density 17.6 *(lbs/ft³)* Moisture Fraction 15.7 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID 218

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	508.7	g
Mass of container & dry specimen (M_{cds})	466.9	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	41.8	g
Mass of container (M_c)	218.9	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	248.0	g
Moisture content (w) $w = (M_w / M_s) \times 100$	16.9	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 129.3) / (100 + 16.9) = 110.7$ lbs/ft³

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_w)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

110.7 / 112.5 x 100 = 98.4 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ g/cm³ ___ lbs/ft³

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone before filling cone, plate & hole	g
Mass of bottle & cone after filling cone, plate & hole	g
Mass of sand to fill cone, plate, & hole (M_1)	g
Mass of sand to fill hole	g
Mass of wet soil & container	g
Mass of container	g
Mass of wet soil (M_3)	g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm³

Dry Mass of soil

$M_4 = 100 M_3 / (w + 100)$ ___ g

Wet Density

$\rho_w = (M_3 / V) \times 62.43$ ___ lbs/ft³

Dry Density

$\rho_d = M_4 / V$ ___ g/cm³

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft³

Soil Description: Brown sandy clay.

Proctor ID: RRM # 517

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 112.5 (lbs/ft³)

Optimum Moisture (w_{opt}) 16.9 (%)

Required Moisture: 13.9 % to 19.9 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4959.7. On cell standard: DS- 3224 MS- 496. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 10/1/18

___ Failed Moisture

___ Failed Compaction Time: 1515

By: Cory Vetere *(print)* *(signature)*

QA/QC APPROVAL 10/22/2018 DATE

Density Testing
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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180920-00 DATE: 10/1/2018

TEST ID NUMBER(S): P4- 2

TEST LOCATION: P4- 6795253 N. 2124294 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *Off-Cell Standard*

Density 2273 Moisture 501

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 152 Density Count 2412

Wet Density (ρ_m) 121.4 *(lbs/ft³)* Dry Density 104.2 *(lbs/ft³)*

Moisture Density 17.3 *(lbs/ft³)* Moisture Fraction 16.6 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID JE

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cms})	537.9	g
Mass of container & dry specimen (M_{cds})	488.0	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	49.9	g
Mass of container (M_c)	218.3	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	269.7	g
Moisture content (w) $w = (M_w / M_s) \times 100$	18.5	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 121.4) / (100 + 18.5 = 102.4$ lbs/ft³

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max$ x 100

102.4 / 112.5 x 100 = 91.1 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ g/cm³ ___ lbs/ft³

Mass of Sand to Fill Cone & Plate (M_2) ___ g

Mass of bottle & cone **before** filling cone, plate & hole	g
Mass of bottle & cone **after** filling cone, plate & hole	g
Mass of sand to fill cone, plate, & hole (M_1)	g
Mass of sand to fill hole	g
Mass of wet soil & container	g
Mass of container	g
Mass of wet soil (M_3)	g

N A

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ ___ cm³

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ ___ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ ___ lbs/ft³

Dry Density

$\rho_d = M_4 / V$ ___ g/cm³

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ ___ lbs/ft³

Soil Description: Brown sandy clay.

Proctor ID: RRM # 517

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 112.5 (lbs/ft³)

Optimum Moisture (w_{opt}) 16.9 (%)

Required Moisture: 13.9 % to 19.9 %

Required Percent Compaction: 90.0 (%)

Comments:

Test Surface Elevation 4958.8. On cell standard: DS- 3276 MS- 501. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 10/1/18

___ Failed Moisture

___ Failed Compaction Time: 1530

By: Cory Vetere *(print)* *(signature)*

QA/QC APPROVAL 10-22-2018 DATE

Density Testing
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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1R02180920-00 DATE: 10/1/2018

TEST ID NUMBER(S): P4- 3

TEST LOCATION: P4- 6795246 N. 2124300 E. TEST METHOD: ___ D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 3/22/18

Daily Standard Counts: *Off-Cell Standard*

Density 2273 Moisture 501

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 150 Density Count 2368

Wet Density (ρ_m) 127.8 *(lbs/ft³)* Dry Density 111.1 *(lbs/ft³)*

Moisture Density 16.7 *(lbs/ft³)* Moisture Fraction 15.1 *(%)*

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ___ Calibrated Vol. *(lbs/ft³)* ___

Bulk Density of sand (ρ_1) ___ *g/cm³* ___ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) ___ *g*

Mass of bottle & cone before filling cone, plate & hole		g
Mass of bottle & cone after filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume
$V = (M_1 - M_2) / \rho_1$ ___ *cm³*

Dry Mass of soil
$M_4 = 100\ M_3 / (w + 100)$ ___ *g*

Wet Density
$\rho_m = (M_3 / V) \times 62.43$ ___ *lbs/ft³*

Dry Density
$\rho_d = M_4 / V$ ___ *g/cm³*

Dry Unit Weight
$\gamma_d = \rho_d \times 62.43$ ___ *lbs/ft³*

MOISTURE DETERMINATION
ASTM D4643

Container ID BS

Scale Serial # 14714971 Last Calibration Date: 10/6/17

Mass of container & wet specimen (M_{cws})	509.3	g
Mass of container & dry specimen (M_{cds})	465.2	g
Mass of water (M_w) $M_w = M_{cws} - M_{cds}$	44.1	g
Mass of container (M_c)	218.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	246.8	g
Moisture content (w) $w = (M_w / M_s) \times 100$	17.9	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (\ 100\ \times\ 127.8\ ) / (100 +\ 17.9\ =\ 108.4$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max$ x 100

108.4 / 112.5 x 100 = 96.4 %

Soil Description: Brown sandy clay.

Proctor ID: RRM # 517

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 112.5 (lbs/ft³)

Optimum Moisture (w_{opt}) 16.9 (%)

Required Moisture: 13.9 % to 19.9 %

Required Percent Compaction: 90.0 (%)

Comments:
Test Surface Elevation 4958.1. On cell standard: DS- 3715 MS- 508. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:
X Pass Date: 10/1/18
___ Failed Moisture
___ Failed Compaction Time: 1455
By: Cory Vetere (print) (signature)

QA/QC APPROVAL 10/22/2018 DATE

Density Testing
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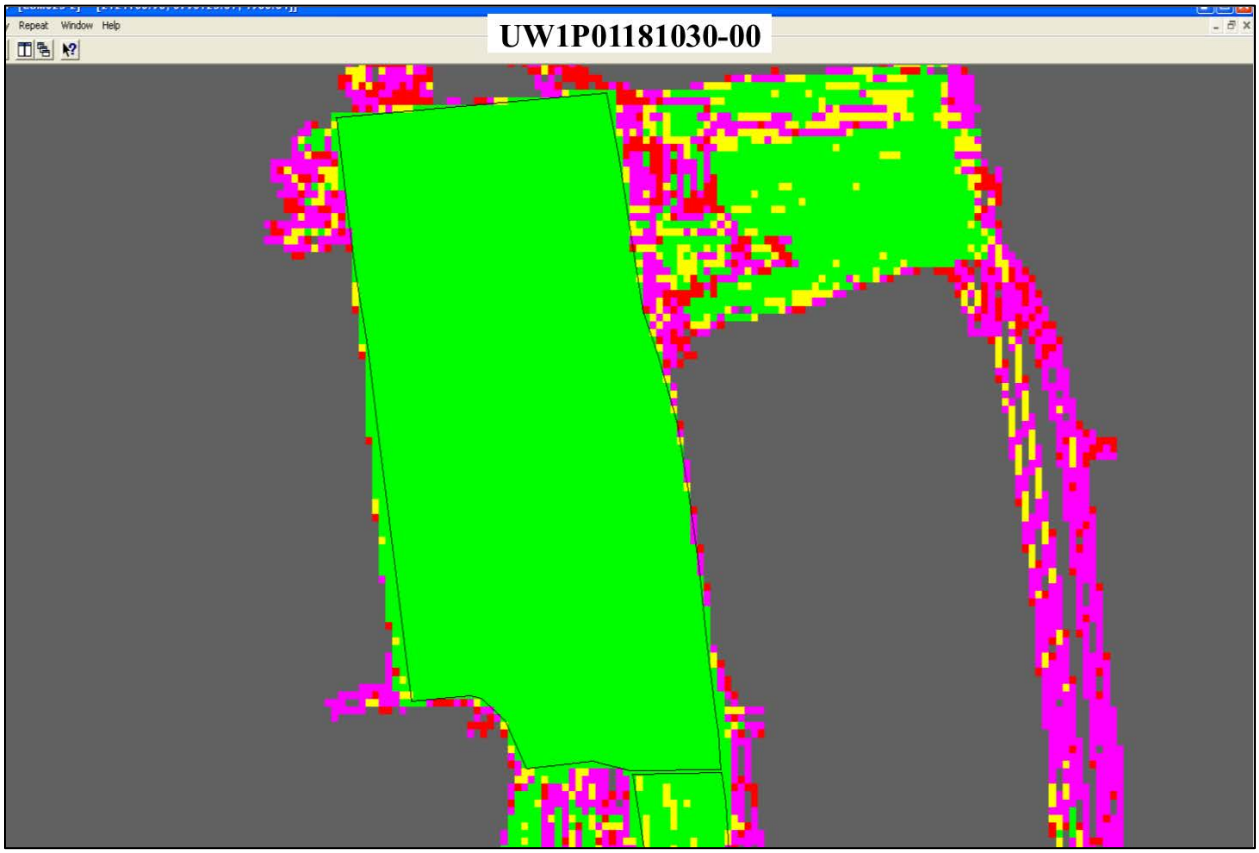
Crescent Junction Disposal Cell Completion Report Addendum I
Appendix A2. RRM Standard Proctor Test Results Summary

Set	Proctor ID #	Date Sampled	Date Approved	Maximum Dry Density (lb/ft^3)	Optimum Moisture Content (%)	Soils Description
Set 174	RRM # 526	10/03/18	10/25/18	104.5	18.2	Brown, fine to coarse, angular, clayey sand. DB-2018-3a
	RRM # 527	10/03/18	10/25/18	94.5	26.0	Brown, fine to coarse, angular, clayey sand. DB-2018-3a
	RRM # 528	10/03/18	10/25/18	110.8	16.6	Brown, fine to coarse, angular, clayey sand. DB-2018-3a
Set 175	RRM # 529	10/08/18	10/29/18	112.3	14.4	Redish brown, very fine to medium, subround, clayey sand. DB-2017-2a
	RRM # 530	10/08/18	10/29/18	103.3	22.3	Redish brown, very fine to medium, subround, clayey sand. DB-2017-2a
	RRM # 531	10/08/18	10/29/18	113.5	15.5	Redish brown, very fine to medium, subround, clayey sand. DB-2017-2a

October 2018										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Cumulative Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Thickness (ft)	Proctor ID #	# of Nuclear Density Gauge Verifications	# of Sandcone Verifications	Verified Compaction (%)
10/01/18	UW1M26180927-00	1	1245	1,245	99.4	1.0	419	0	0	N/A
10/01/18	UW1K27180927-00	1	2044	3,289	100.0	1.0	419	0	0	N/A
10/02/18	UW1M26181001-00	1	996	4,285	100.0	0.8	419	0	0	N/A
10/02/18	UW1K27181002-00	1	2044	6,329	100.0	1.0	489	0	0	N/A
10/22/18	UW1R02180912-00	12	2322	8,651	N/A	1.8	489	12	1	91.8
10/22/18	UW1R02180922-00	12	2070	10,721	N/A	1.7	489	12	1	92
10/22/18	UW1R02180907-00	12	2198	12,919	N/A	1.8	517	12	1	94.9
10/25/18	UW1P01181023-00	1	1087	14,006	99.7	0.9	488	0	0	N/A
10/25/18	UW1S06181023-00	1	510	14,516	100.0	1.0	488	0	0	N/A
10/25/18	UW1P01181025-00	1	1208	15,724	99.9	1.0	488	0	0	N/A
10/25/18	UW1S06181025-00	1	510	16,234	99.8	1.0	488	0	0	N/A
10/29/18	UW1P01181025-01	1	966	17,200	99.9	0.8	488	0	0	N/A
10/30/18	UW1S06181029-00	1	522	17,722	98.6	0.7	488	0	0	N/A
10/31/18	UW1M261801030-00	1	0	17,722	100.0	0.0	488	0	0	N/A
10/31/18	UW1K27181030-00	1	0	17,722	99.0	0.0	488	0	0	N/A

Average CAES Screen Passing Pixels (%) = 99.7
Total Quantity Approved (yd^3) = 17,722
Total # of Nuclear Density Gauge Tests = 36
Total # of Moisture Tests = 48
Quantity per Moisture Test (yd^3) = 369
Total Average Thickness (ft) = 1.2

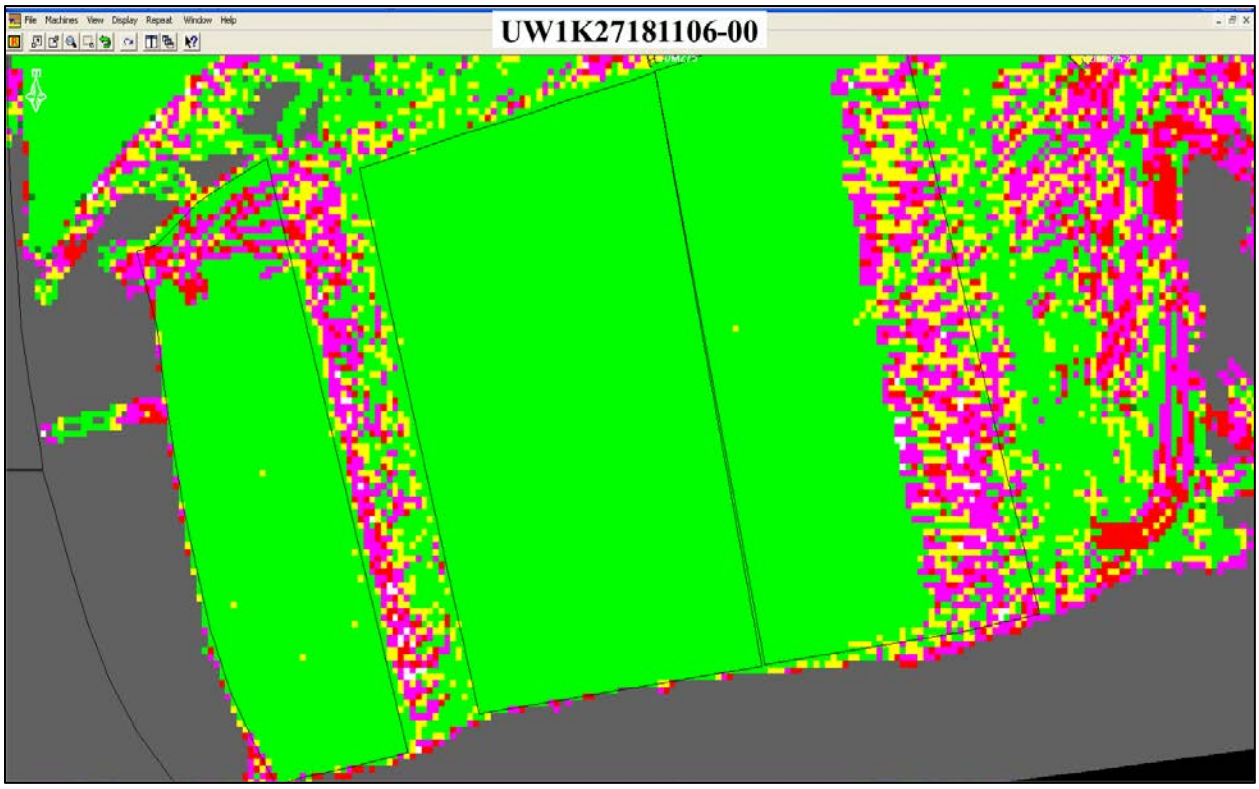
CAES compaction screen example from October 2018. There are compaction screens for each lift approved on record. The number of passing pixels reported refers to the percentage of the lift which has green pixels. A green pixel verifies that the minimum of six wheel passes with the compactor has been recorded.



November 2018										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Cumulative Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Thickness (ft)	Proctor ID #	# of Nuclear Density Gauge Verifications	# of Sandcone Verifications	Verified Compaction (%)
11/05/18	UW1M26181101-00	1	1561	1,561	99.9	0.9	526	0	0	N/A
11/05/18	UW1K27181101-00	1	1634	3,195	99.8	0.9	526	0	0	N/A
11/05/18	UW1P01181030-00	1	1148	4,343	99.4	0.8	526	0	0	N/A
11/05/18	UW1S06181030-00	1	672	5,015	100.0	0.9	526	0	0	N/A
11/06/18	UW1M26181105-00	1	1561	6,576	99.5	0.9	526	0	0	N/A
11/06/18	UW1K27181106-00	1	1634	8,210	99.9	0.9	526	0	0	N/A
11/07/18	UW1P01181106-00	1	1435	9,645	99.8	1.0	526	0	0	N/A
11/07/18	UW1M26181107-00	1	1388	11,033	99.9	0.8	488	0	0	N/A
11/08/18	UW1K27181107-00	1	1634	12,667	100.0	0.9	488	0	0	N/A
11/08/18	UW1M26181108-00	1	1561	14,228	100.0	0.9	526	0	0	N/A
11/12/18	UW1K27181108-00	1	1834	16,062	99.9	1.0	526	0	0	N/A
11/12/18	UW1M26181112-00	1	1486	17,548	99.5	0.8	488	0	0	N/A
11/13/18	UW1K27181112-00	1	1650	19,198	100.0	0.9	488	0	0	N/A
11/14/18	UW1M26181113-00	1	1857	21,055	100.0	1.0	488	0	0	N/A
11/14/18	UW1K27181114-00	1	1650	22,705	100.0	0.9	525	0	0	N/A
11/15/18	UW1M26181114-00	2	1700	24,405	100.0	0.9	525, 526	1	1	93.6
11/15/18	UW1K27181115-00	1	1884	26,289	99.7	1.0	488	0	0	N/A
11/16/18	UW1I28181116-00	1	0	26,289	100.0	0.0	488	0	0	N/A
11/16/18	UW1M26181116-00	1	1889	28,178	99.8	1.0	531	0	0	N/A
11/20/18	UW1K27181116-00	1	1884	30,062	99.9	1.0	531	0	0	N/A
11/20/18	UW1I28181116-01	1	758	30,820	100.0	0.8	531	0	0	N/A
11/20/18	UW1M26181120-00	1	1511	32,331	100.0	0.8	526	0	0	N/A
11/21/18	UW1K27181120-00	1	1884	34,215	100.0	1.0	526	0	0	N/A
11/26/18	UW1M26181121-00	1	1700	35,915	100.0	0.9	488	0	0	N/A
11/27/18	UW1K27181126-00	1	1884	37,799	100.0	1.0	520	0	0	N/A
11/27/18	UW1I28181126-00	1	852	38,651	100.0	0.9	520	0	0	N/A
11/27/18	UW1M26181126-00	1	1511	40,162	100.0	0.8	520	0	0	N/A
11/28/18	UW1K27181128-00	1	1507	41,669	100.0	0.8	526	0	0	N/A
11/29/18	UW1M26181128-00	1	1363	43,032	100.0	0.8	526	0	0	N/A
11/30/18	UW1K27181130-00	1	1623	44,655	100.0	0.8	488	0	0	N/A

Average CAES Screen Passing Pixels (%) = 99.9
Total Quantity Approved (yd^3) = 44,655
Total # of Nuclear Density Gauge Tests = 1
Total # of Moisture Tests = 31
Quantity per Moisture Test (yd^3) = 1,440
Total Average Thickness (ft) = 0.9

CAES compaction screen example from November 2018. There are compaction screens for each lift approved on record. The number of passing pixels reported refers to the percentage of the lift which has green pixels. A green pixel verifies that the minimum of six wheel passes with the compactor has been recorded.



December 2018										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Cumulative Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Thickness (ft)	Proctor ID #	# of Nuclear Density Gauge Verifications	# of Sandcone Verifications	Verified Compaction (%)
12/04/18	UW1M26181130-00	1	1193	1,193	100.0	0.7	419	0	0	N/A
12/06/18	UW1M26181204-00	1	595	1,788	99.1	0.5	469	0	0	N/A
12/13/18	UW1M261812006-00	1	1491	3,279	99.2	0.5	521	0	0	N/A

Average CAES Screen Passing Pixels (%) = 99.4
Total Quantity Approved (yd^3) = 3,279
Total # of Nuclear Density Gauge Tests = 0
Total # of Moisture Tests = 3
Quantity per Moisture Test (yd^3) = 1,093
Total Average Thickness (ft) = 0.6

CAES compaction screen example from December 2018. There are compaction screens for each lift approved on record. The number of passing pixels reported refers to the percentage of the lift which has green pixels. A green pixel verifies that the minimum of six wheel passes with the compactor has been recorded.

January 2019										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Cumulative Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Thickness (ft)	Proctor ID #	# of Nuclear Density Gauge Verifications	# of Sandcone Verifications	Verified Compaction (%)
01/10/19	UW1F24190110-00	1	0	0	99.4	0.0	520	0	0	N/A
01/14/19	UW1K27181213-00	1	1087	1,087	100.0	0.7	520	0	0	N/A
01/14/19	UW1F24190110-01	1	706	1,793	99.8	0.6	520	0	0	N/A
01/15/19	UW1M26181213-00	1	1353	3,146	99.2	0.8	520	0	0	N/A
01/15/19	UWY24190114-00	1	0	3,146	99.9	0.0	520	0	0	N/A
01/15/19	UW1S01170201-00	0	4397	7,543	N/A	1.8	N/A	0	0	N/A
01/17/19	UW1E30190117-00	1	0	7,543	99.7	0.0	520	0	0	N/A
01/21/19	UW1A31190121-00	1	0	7,543	99.5	0.0	520	0	0	N/A
01/21/19	UW1F24190117-00	3	824	8,367	100.0	0.7	531	0	0	N/A
01/22/19	UWY27190122-00	1	0	8,367	99.8	0.0	520	0	0	N/A
01/22/19	UW1E30190117-01	1	782	9,149	99.7	0.6	531	0	0	N/A
01/23/19	UWY29190123-00	1	0	9,149	99.8	0.0	520	0	0	N/A
01/23/19	UW1A31190121-01	1	637	9,786	100.0	0.4	531	0	0	N/A
01/23/19	UWY23190123-00	1	0	9,786	99.6	0.0	520	0	0	N/A
01/24/19	UWZ20190124-00	1	0	9,786	99.9	0.0	520	0	0	N/A
01/24/19	UW1A16180403-00	2	1233	11,019	99.9	0.5	521	0	0	N/A
01/25/19	UW1K21190125-00	1	0	11,019	99.9	0.0	419	0	0	N/A
01/25/19	UWZ20190124-01	1	626	11,645	99.6	0.3	531	0	0	N/A
01/28/19	UWY23190124-00	1	1248	12,893	100.0	0.9	531	0	0	N/A
01/29/19	UWY24190122-00	2	1153	14,046	99.8	0.5	520, 531	0	0	N/A
01/29/19	UWY27190123-00	1	636	14,682	99.1	0.4	531	0	0	N/A
01/30/19	UWY29190123-01	1	403	15,085	99.8	0.3	531	0	0	N/A
01/31/19	UW1B18190130-00	2	1468	16,553	99.9	0.7	517, 531	0	0	N/A

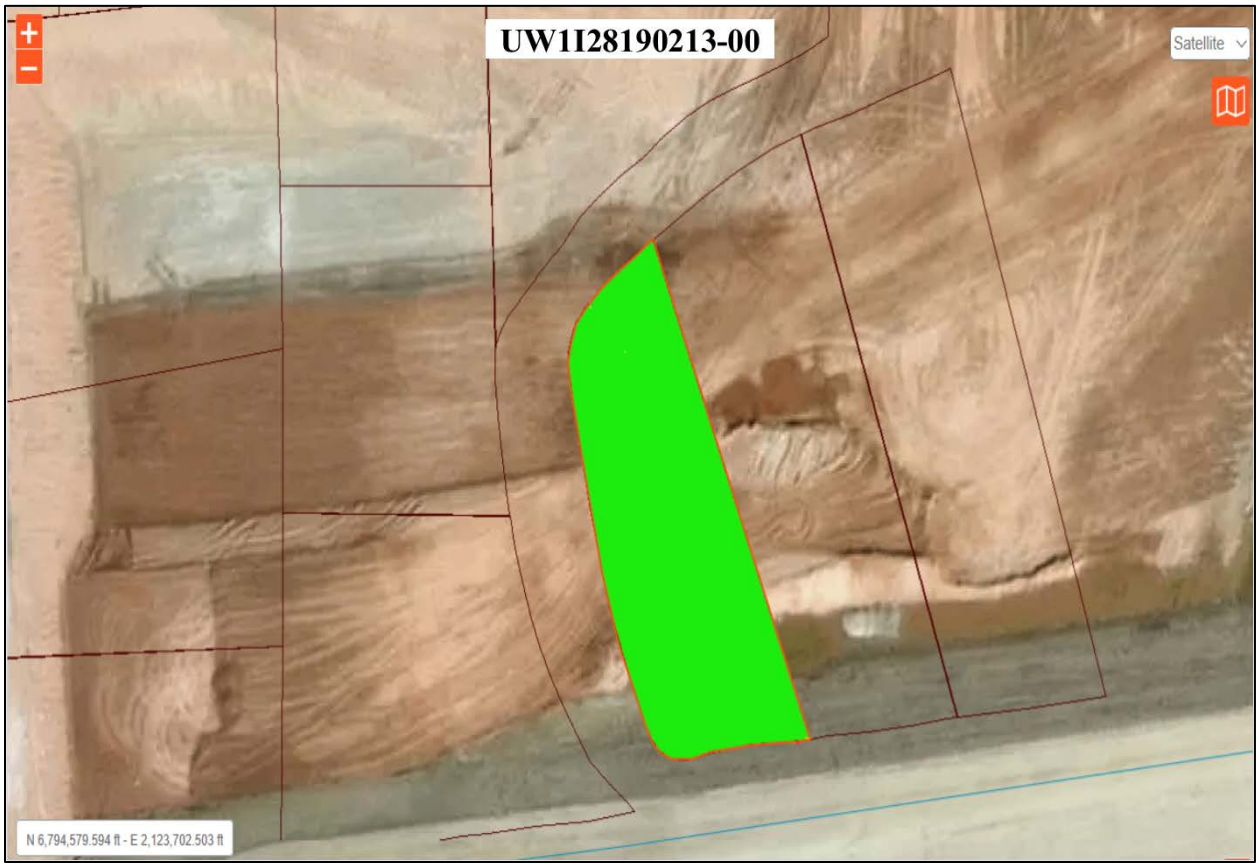
Average CAES Screen Passing Pixels (%) = 99.7
Total Quantity Approved (yd^3) = 16,553
Total # of Nuclear Density Gauge Tests = 0
Total # of Moisture Tests = 27
Quantity per Moisture Test (yd^3) = 613
Total Average Thickness (ft) = 0.4

CAES compaction screen example from January 2019. There are compaction screens for each lift approved on record. The number of passing pixels reported refers to the percentage of the lift which has green pixels. A green pixel verifies that the minimum of six wheel passes with the compactor has been recorded.

February 2019										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Cumulative Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Thickness (ft)	Proctor ID #	# of Nuclear Density Gauge Verifications	# of Sandcone Verifications	Verified Compaction (%)
02/04/19	UWY29190131-00	1	538	538	100.0	0.4	531	0	0	N/A
02/05/19	UW1K27190115-00	1	932	1,470	100.0	0.6	531	0	0	N/A
02/05/19	UW1M26190115-00	0	963	2,433	100.0	0.6	N/A	0	0	N/A
02/07/19	UW1A31190205-00	0	637	3,070	97.9	0.4	N/A	0	0	N/A
02/08/19	UW1M26190207-00	0	1179	4,249	99.5	0.7	N/A	0	0	N/A
02/08/19	UW1K27190207-00	0	1128	5,377	99.9	0.6	N/A	0	0	N/A
02/11/19	UW1M26190208-00	0	1348	6,725	99.9	0.8	N/A	0	0	N/A
02/12/19	UW1K27190211-00	0	1504	8,229	100.0	0.8	N/A	0	0	N/A
02/12/19	UW1M26190212-00	0	1464	9,693	99.9	0.9	N/A	0	0	N/A
02/13/19	UW1I28190208-00	0	379	10,072	99.8	0.4	N/A	0	0	N/A
02/13/19	UW1K27190212-00	0	1395	11,467	100.0	0.8	N/A	0	0	N/A
02/14/19	UW1I28190213-00	0	866	12,333	99.9	0.7	N/A	0	0	N/A
02/28/19	UW1S01190227-00	0	2222	14,555	99.8	0.9	N/A	0	0	N/A

Average CAES Screen Passing Pixels (%) = 99.7
Total Quantity Approved (yd^3) = 14,555
Total # of Nuclear Density Gauge Tests = 0
Total # of Moisture Tests = 2
Quantity per Moisture Test (yd^3) = 7,278
Total Average Thickness (ft) = 0.7

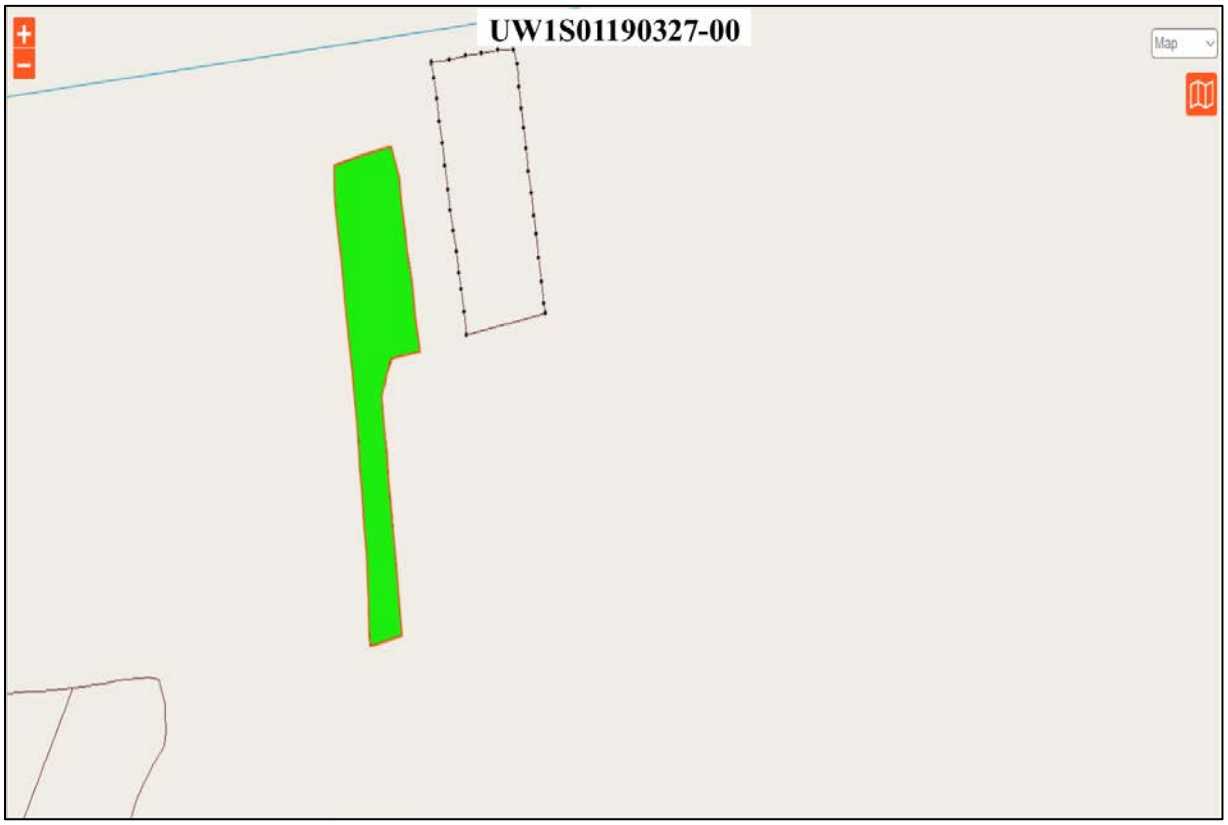
CAES compaction screen example from February 2019. There are compaction screens for each lift approved on record. The number of passing pixels reported refers to the percentage of the lift which has green pixels. A green pixel verifies that the minimum of six wheel passes with the compactor has been recorded.



March 2019										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Cumulative Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Thickness (ft)	Proctor ID #	# of Nuclear Density Gauge Verifications	# of Sandcone Verifications	Verified Compaction (%)
03/18/19	UW1W01190313-00	0	1494	1,494	100.0	0.6	N/A	0	0	N/A
03/19/19	UW1W01190318-00	0	1993	3,487	100.0	0.8	N/A	0	0	N/A
03/20/19	UW1S01190228-00	0	1975	5,462	99.9	0.8	N/A	0	0	N/A
03/26/19	UW1W01190319-00	0	1993	7,455	100.0	0.8	N/A	0	0	N/A
03/27/18	UW1W01190326-00	0	1811	9,266	100.0	0.8	N/A	0	0	N/A
03/27/19	UW1S01190320-00	0	1975	11,241	100.0	0.8	N/A	0	0	N/A
03/28/19	UW1S01190327-00	0	1996	13,237	100.0	0.9	N/A	0	0	N/A
03/28/19	UW1S06190328-00	0	0	13,237	99.7	0.0	N/A	0	0	N/A
03/29/19	UW1W01190328-00	0	1585	14,822	100.0	0.7	N/A	0	0	N/A

Average CAES Screen Passing Pixels (%) = 99.9
Total Quantity Approved (yd^3) = 14,822
Total # of Nuclear Density Gauge Tests = 0
Total # of Moisture Tests = 0
Quantity per Moisture Test (yd^3) = 0
Total Average Thickness (ft) = 0.7

CAES compaction screen example from March 2019. There are compaction screens for each lift approved on record. The number of passing pixels reported refers to the percentage of the lift which has green pixels. A green pixel verifies that the minimum of six wheel passes with the compactor has been recorded.



April 2019										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Cumulative Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Thickness (ft)	Proctor ID #	# of Nuclear Density Gauge Verifications	# of Sandcone Verifications	Verified Compaction (%)
4/1/2019	UW1S06190329-00	3	953	953	100.0	1.7	526	3	0	96.6
4/1/2019	UW1S01190329-00	0	1775	2,728	99.5	0.8	N/A	0	0	N/A
4/3/2019	UW1S06190402-00	0	393	3,121	94.6	0.7	N/A	0	0	N/A
4/3/2019	UW1W01190401-00	0	2038	5,159	99.9	0.9	N/A	0	0	N/A
4/3/2019	UW1P01190402-00	0	0	5,159	99.4	0.0	N/A	0	0	N/A
4/4/2019	UW1S01190402-00	0	957	6,116	99.8	0.7	N/A	0	0	N/A
4/4/2019	UW1P01190403-00	0	1151	7,267	100.0	0.7	N/A	0	0	N/A
4/4/2019	UW1S06190403-00	0	1323	8,590	99.6	0.8	N/A	0	0	N/A
4/10/2019	UW1W01190408-00	0	1599	10,189	100.0	0.8	N/A	0	0	N/A
4/10/2019	UW1S06190409-00	0	1479	11,668	100.0	0.9	N/A	0	0	N/A
4/10/2019	UW1S01190409-00	0	903	12,571	99.8	0.7	N/A	0	0	N/A
4/11/2019	UW1W01190410-00	0	1599	14,170	100.0	0.8	N/A	0	0	N/A
4/11/2019	UW1P01190404-00	9	3576	17,746	100.0	1.8	526, 531	9	0	94.5
4/15/2019	UW1P01190411-00	0	1788	19,534	99.9	0.9	N/A	0	0	N/A
4/15/2019	UW1S06190415-00	0	986	20,520	100.0	0.6	N/A	0	0	N/A
4/16/2019	UW1S01190415-00	0	1161	21,681	100.0	0.9	N/A	0	0	N/A
4/17/2019	UW1P01190416-00	0	1391	23,072	99.9	0.7	N/A	0	0	N/A
4/18/2019	UW1W01190416-00	0	1798	24,870	99.9	0.9	N/A	0	0	N/A
4/22/2019	UW1P01190417-00	1	795	25,665	N/A	0.4	526	1	0	95
4/22/2019	UW1S06190418-00	1	1315	26,980	N/A	0.8	526	1	1	94.8
4/22/2019	UW1S01190422-00	1	903	27,883	N/A	0.7	526	1	0	94.4
4/23/2019	UW1W01190422-00	0	1399	29,282	99.9	0.7	N/A	0	0	N/A
4/24/2019	UW1P01190423-00	0	577	29,859	99.9	0.9	N/A	0	0	N/A
4/24/2019	UW1S01190423-00	0	1286	31,145	99.5	0.5	N/A	0	0	N/A
4/24/2019	UW1R01190402-00	0	2798	33,943	N/A	1.7	N/A	0	0	N/A
4/25/2019	UW1W01190424-00	0	1998	35,941	99.9	1.0	N/A	0	0	N/A

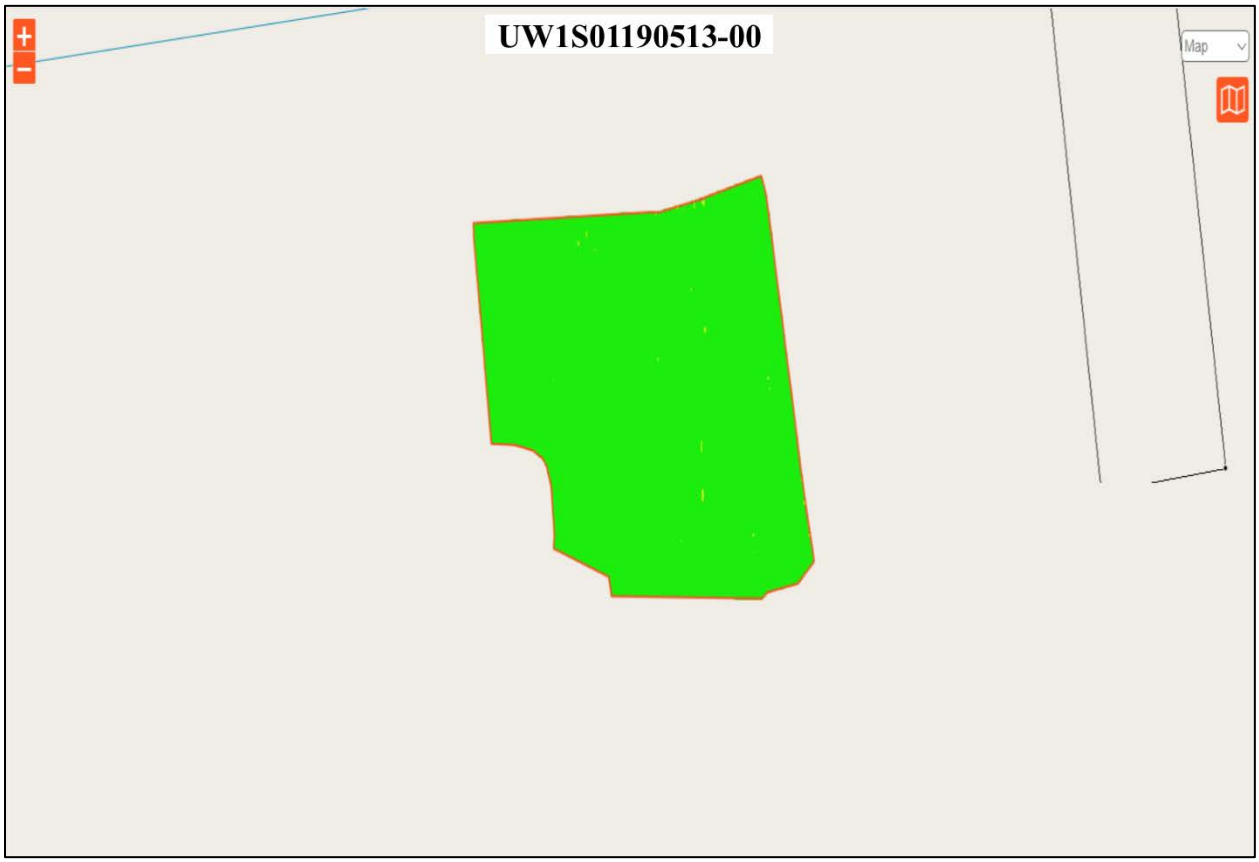
Average CAES Screen Passing Pixels (%) = 99.6
Total Quantity Approved (yd^3) = 35,941
Total # of Nuclear Density Gauge Tests = 15
Total # of Moisture Tests = 15
Quantity per Moisture Test (yd^3) = 2,396
Total Average Thickness (ft) = 0.8

CAES compaction screen example from April 2019. There are compaction screens for each lift approved on record. The number of passing pixels reported refers to the percentage of the lift which has green pixels. A green pixel verifies that the minimum of six wheel passes with the compactor has been recorded.

May 2019										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Cumulative Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Thickness (ft)	Proctor ID #	# of Nuclear Density Gauge Verifications	# of Sandcone Verifications	Verified Compaction (%)
05/07/19	UW1R01190425-00	9	2963	2,963	99.9	1.8	526	9	0	94.2
05/07/19	UW1S06190429-00	0	1518	4,481	100.0	0.9	N/A	0	0	N/A
05/07/19	UW1T13190506-00	3	803	5,284	99.4	2	526	3	0	96.4
05/08/19	UW1K21190129-00	1	1698	6,982	99.9	0.6	531	0	0	N/A
05/09/19	UW1T13190508-00	0	321	7,303	100.0	0.8	N/A	0	0	N/A
05/09/19	UW1S01190506-00	0	1775	9,078	100.0	0.7	N/A	0	0	N/A
05/09/19	UW1P01190506-00	0	483	9,561	99.9	0.7	N/A	0	0	N/A
05/13/19	UW2A01190507-00	0	2317	11,878	N/A	1.5	N/A	0	0	N/A
05/13/19	UW1W01190509-00	0	1006	12,884	99.9	0.6	N/A	0	0	N/A
05/14/19	UW1T13190514-00	0	281	13,165	100.0	0.7	N/A	0	0	N/A
05/14/19	UW1A16190125-00	1	1240	14,405	99.8	0.5	531	0	0	N/A
05/14/19	UW1S06190509-00	0	1169	15,574	99.6	0.7	N/A	0	0	N/A
05/14/19	UW1R01190507-00	9	2751	18,325	100.0	1.7	526, 531	9	1	93.5
05/16/19	UW1P01190513-00	0	483	18,808	99.9	0.7	N/A	0	0	N/A
05/16/19	UW1S01190513-00	0	2029	20,837	99.9	0.8	N/A	0	0	N/A
05/16/19	UW1R01190515-00	0	1133	21,970	100.0	0.7	N/A	0	0	N/A
05/17/19	UWZ20190128-00	1	834	22,804	99.9	0.4	531	0	0	N/A
05/20/19	UW1I28190520-00	0	96	22,900	100.0	0.1	N/A	0	0	N/A
05/20/19	UW1K27190520-00	0	0	22,900	99.8	0.0	N/A	0	0	N/A
05/20/19	UW1T13190516-00	0	316	23,216	100.0	0.8	N/A	0	0	N/A
05/20/19	UW1W01190514-00	0	1287	24,503	99.8	0.8	N/A	0	0	N/A
05/21/19	UW1S06190516-00	0	1325	25,828	100.0	0.8	N/A	0	0	N/A
05/21/19	UW1K27190520-01	0	746	26,574	99.9	0.6	N/A	0	0	N/A
05/21/19	UW1I28190521-00	0	675	27,249	100.0	0.7	N/A	0	0	N/A
05/22/19	UW1R02190522-00	0	232	27,481	99.8	0.2	N/A	0	0	N/A
05/22/19	UW1T13190520-00	0	237	27,718	100.0	0.6	N/A	0	0	N/A
05/22/19	UW1P01190517-00	0	690	28,408	99.9	1	N/A	0	0	N/A
05/22/19	UW1S01190517-00	0	2029	30,437	99.9	0.8	N/A	0	0	N/A
05/22/19	UW1T13190522-00	0	337	30,774	100.0	0.8	N/A	0	0	N/A
05/28/19	UW1R01190521-00	0	1602	32,376	99.7	0.9	N/A	0	0	N/A
05/29/19	UW1I28190522-00	0	880	33,256	99.9	0.9	N/A	0	0	N/A
05/29/19	UW1S061190529-00	1	1118	34,374	99.9	0.7	526	0	0	N/A
05/29/19	UW2A01190528-00	0	1545	35,919	100.0	1.0	N/A	0	0	N/A
05/30/19	UW1K27190529-00	0	878	36,797	100.0	0.7	N/A	0	0	N/A
05/30/19	UW1T13190529-00	0	337	37,134	100.0	0.8	N/A	0	0	N/A

Average CAES Screen Passing Pixels (%) = 99.9
Total Quantity Approved (yd^3) = 37,134
Total # of Nuclear Density Gauge Tests = 21
Total # of Moisture Tests = 25
Quantity per Moisture Test (yd^3) = 1,485
Total Average Thickness (ft) = 0.8

CAES compaction screen example from May 2019. There are compaction screens for each lift approved on record. The number of passing pixels reported refers to the percentage of the lift which has green pixels. A green pixel verifies that the minimum of six wheel passes with the compactor has been recorded.

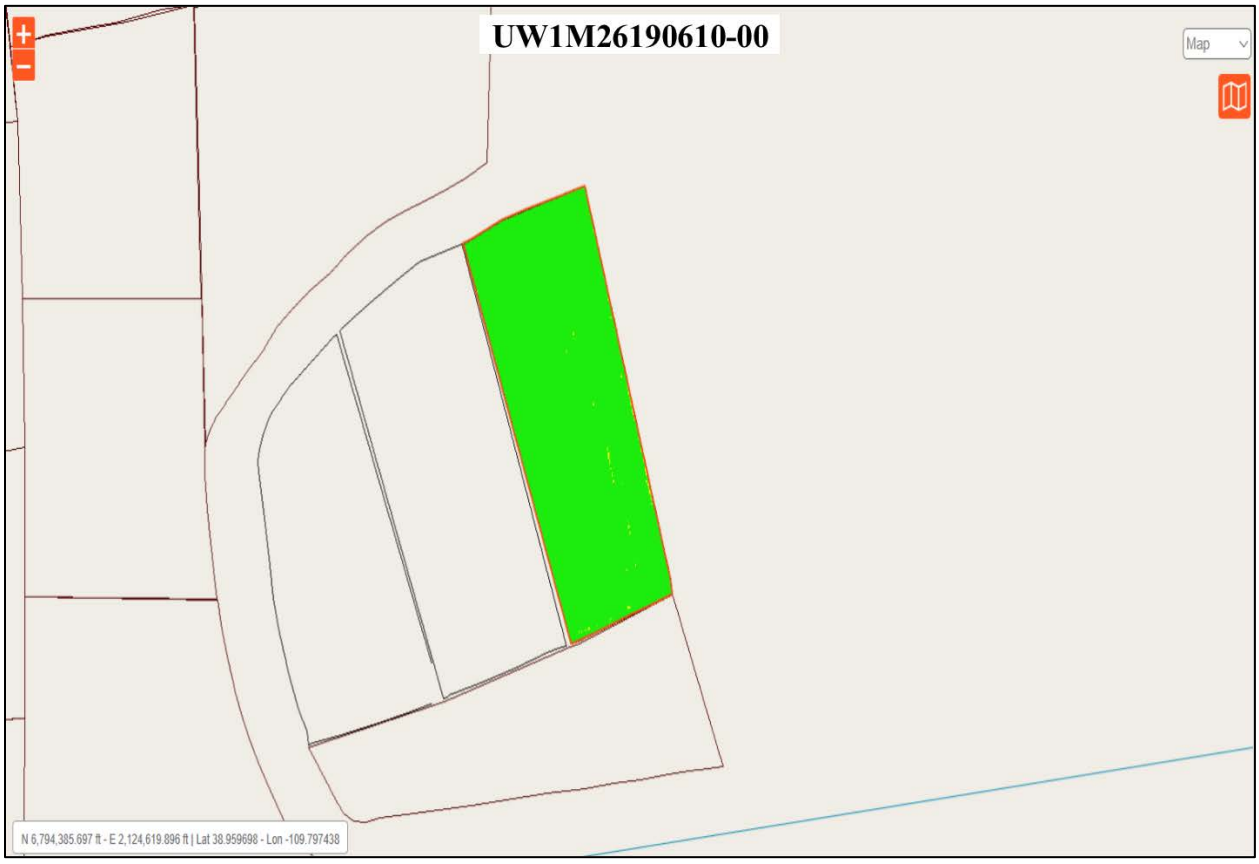


June 2019										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Cumulative Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Thickness (ft)	Proctor ID #	# of Nuclear Density Gauge Verifications	# of Sandcone Verifications	Verified Compaction (%)
06/03/19	UW1I28190530-00	0	782	782	99.9	0.8	N/A	0	0	N/A
06/03/19	UW1R01190530-00	0	1733	2,515	99.9	0.9	N/A	0	0	N/A
06/03/19	UW1W01190522-00	0	1287	3,802	100.0	0.8	N/A	0	0	N/A
06/04/19	UW1K27190603-00	0	1004	4,806	99.9	0.8	N/A	0	0	N/A
06/04/19	UW1T13190603-00	0	337	5,143	100.0	0.8	N/A	0	0	N/A
06/05/19	UW1M26190213-00	6	2383	7,526	99.7	1.8	526	6	0	93.4
06/05/19	UW1I28190603-00	0	782	8,308	99.9	0.8	N/A	0	0	N/A
06/05/19	UW1R01190604-00	0	1615	9,923	100.0	0.8	N/A	0	0	N/A
06/06/19	UW1M26190605-00	0	161	10,084	99.3	0.6	N/A	0	0	N/A
06/06/19	UW1H33190606-00	0	852	10,936	99.6	0.7	N/A	0	0	N/A
06/07/19	UW1K27190606-00	0	1324	12,260	100.0	1.0	N/A	0	0	N/A
06/07/19	UW1M26190606-00	0	973	13,233	100.0	0.8	N/A	0	0	N/A
06/07/19	UW1H33190607-00	0	134	13,367	99.8	0.5	N/A	0	0	N/A
06/10/19	UW1I28190607-00	0	843	14,210	99.9	0.8	N/A	0	0	N/A
06/10/19	UW1K27190607-00	0	1060	15,270	99.9	0.8	N/A	0	0	N/A
06/11/19	UW1M26190610-00	0	1095	16,365	99.8	0.9	N/A	0	0	N/A
06/11/19	UW1H33190610-00	0	918	17,283	100.0	0.8	N/A	0	0	N/A
06/12/19	UW1H33190611-00	0	918	18,201	100.0	0.8	N/A	0	0	N/A
06/12/19	UW1I28190610-00	0	948	19,149	99.6	0.9	N/A	0	0	N/A
06/12/19	UW1K27190612-00	1	893	20,042	99.9	0.7	526	0	0	N/A
06/13/19	UW1M26190612-00	0	730	20,772	100.0	0.6	N/A	0	0	N/A
06/13/19	UW1H33190612-00	0	820	21,592	99.5	0.8	N/A	0	0	N/A
06/17/19	UW1H33190613-00	0	923	22,515	99.9	0.9	N/A	0	0	N/A
06/17/19	UW1I28190613-00	0	763	23,278	99.9	0.7	N/A	0	0	N/A
06/18/19	UW1K27190613-00	0	893	24,171	100.0	0.7	N/A	0	0	N/A
06/18/19	UW1H33190617-00	0	820	24,991	100.0	0.8	N/A	0	0	N/A
06/18/19	UW1M26190618-00	0	572	25,563	100.0	0.6	N/A	0	0	N/A
06/19/19	UW1H33190618-00	0	1025	26,588	99.9	1	N/A	0	0	N/A
06/20/19	UW1K27190619-00	0	1275	27,863	99.1	1	N/A	0	0	N/A
06/20/19	UW1I28190618-00	1	873	28,736	99.7	0.8	526	0	0	N/A
06/21/19	UW1H33190620-00	0	1120	29,856	99.0	1	N/A	0	0	N/A
06/21/19	UW1M26190619-00	0	858	30,714	100.0	0.9	N/A	0	0	N/A
06/24/19	UW1I28190620-00	0	727	31,441	99.6	0.6	N/A	0	0	N/A
06/25/19	UW1K27190621-00	0	939	32,380	99.6	0.7	N/A	0	0	N/A
06/25/19	UW1M26190624-00	0	668	33,048	99.7	0.7	N/A	0	0	N/A
06/26/19	UW1H33190621-00	6	2128	35,176	100.0	1.9	526	6	0	95.2
06/26/19	UW1I28190624-00	0	969	36,145	99.8	0.8	N/A	0	0	N/A
06/26/19	UW1K27190626-00	0	1073	37,218	99.8	0.8	N/A	0	0	N/A
06/26/19	UW1B18190204-00	0	1258	38,476	99.1	0.6	N/A	0	0	N/A

June 2019										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Cumulative Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Thickness (ft)	Proctor ID #	# of Nuclear Density Gauge Verifications	# of Sandcone Verifications	Verified Compaction (%)
06/27/19	UW1P01190605-00	0	516	38,992	100.0	0.8	N/A	0	0	N/A
06/27/19	UW1R01190626-00	0	1817	40,809	99.9	0.9	N/A	0	0	N/A
06/27/19	UW1M26190626-00	0	763	41,572	99.5	0.8	N/A	0	0	N/A

Average CAES Screen Passing Pixels (%) = 99.8
Total Quantity Approved (yd^3) = 41,572
Total # of Nuclear Density Gauge Tests = 12
Total # of Moisture Tests = 14
Quantity per Moisture Test (yd^3) = 2,969
Total Average Thickness (ft) = 0.8

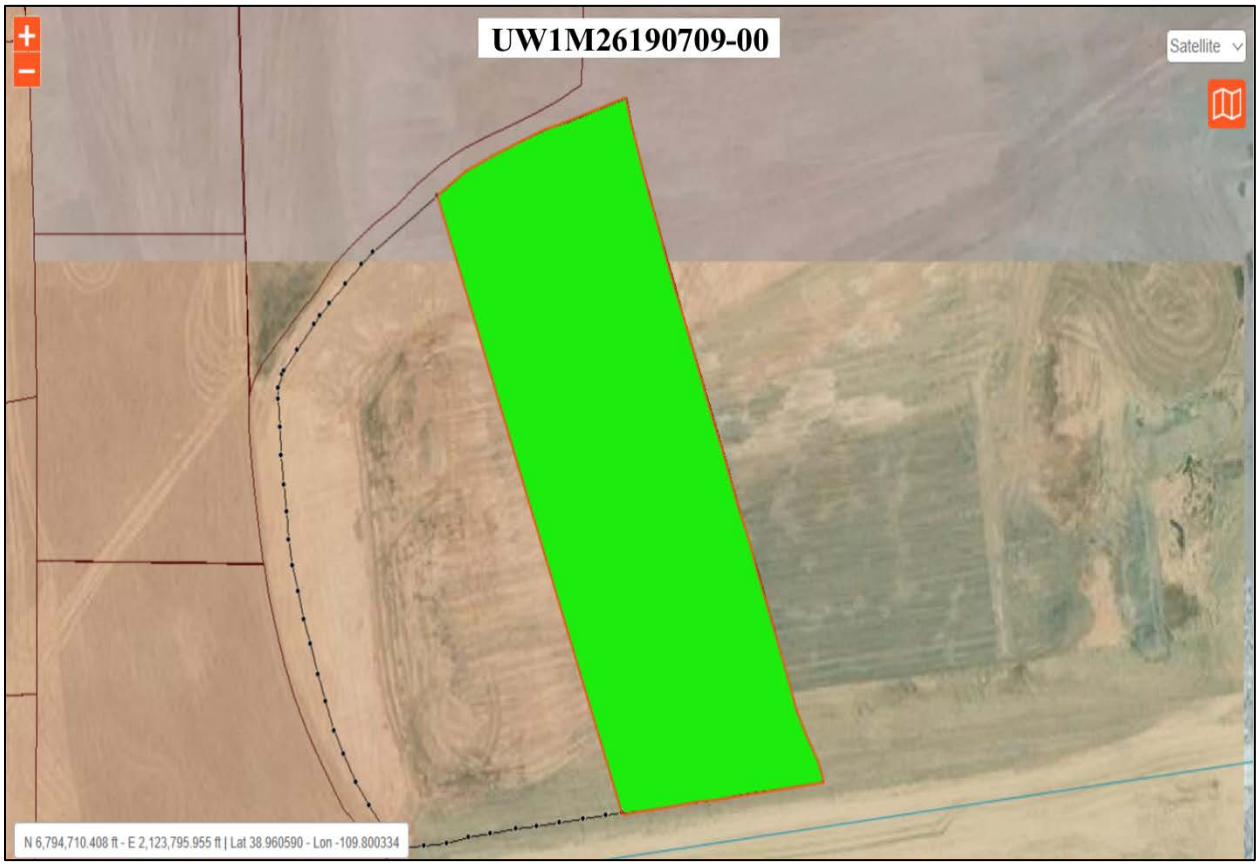
CAES compaction screen example from June 2019. There are compaction screens for each lift approved on record. The number of passing pixels reported refers to the percentage of the lift which has green pixels. A green pixel verifies that the minimum of six wheel passes with the compactor has been recorded.



July 2019										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Cumulative Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Thickness (ft)	Proctor ID #	# of Nuclear Density Gauge Verifications	# of Sandcone Verifications	Verified Compaction (%)
07/01/19	UW1I28190627-00	0	2059	2,059	100.0	0.9	N/A	0	0	N/A
07/02/19	UW1M26190701-00	0	2327	4,386	99.9	0.9	N/A	0	0	N/A
07/02/19	UW1S01190605-00	0	1998	6,384	100.0	0.8	N/A	0	0	N/A
07/02/19	UW1T13190625-00	0	332	6,716	100.0	0.7	N/A	0	0	N/A
07/03/19	UW1I28190701-00	0	2288	9,004	100.0	1.0	N/A	0	0	N/A
07/08/19	UW1M26190703-00	0	2586	11,590	99.8	1.0	N/A	0	0	N/A
07/09/19	UW1I28190708-00	0	1988	13,578	99.1	0.8	N/A	0	0	N/A
07/10/19	UW1M26190709-00	0	2295	15,873	100.0	0.9	N/A	0	0	N/A
07/11/19	UW1I28190710-00	1	1740	17,613	99.9	0.7	531	0	0	N/A
07/15/19	UW1R01190711-00	0	1279	18,892	100.0	0.6	N/A	0	0	N/A
07/16/19	UW1M26190711-00	0	2040	20,932	99.8	0.8	N/A	0	0	N/A
07/16/19	UW1I28190715-00	0	1799	22,731	99.9	0.7	N/A	0	0	N/A
07/17/19	UW1M26190716-00	0	2048	24,779	100.0	0.8	N/A	0	0	N/A
07/18/19	UW1I28190717-00	1	2056	26,835	100.0	0.8	526	0	0	N/A
07/19/19	UW1M26190718-00	0	2048	28,883	99.4	0.8	N/A	0	0	N/A
07/23/19	UW1M26190722-00	1	2048	30,931	100.0	0.8	526	0	0	N/A
07/23/19	UW1I28190718-00	0	1799	32,730	100.0	0.7	N/A	0	0	N/A
07/24/19	UW1I28190723-00	0	2583	35,313	99.9	0.9	N/A	0	0	N/A
07/25/19	UW1M26190724-00	0	2221	37,534	99.9	0.9	N/A	0	0	N/A
07/29/19	UW1R01190722-00	0	1279	38,813	99.9	0.6	N/A	0	0	N/A
07/30/19	UW1M26190729-00	0	1728	40,541	99.6	0.7	N/A	0	0	N/A
07/30/19	UW1I28190725-00	0	2583	43,124	100.0	0.9	N/A	0	0	N/A
07/31/19	UW1S01190730-00	0	2087	45,211	99.9	0.8	N/A	0	0	N/A
07/31/19	UW1S06190730-00	1	1244	46,455	100.0	0.8	526	0	0	N/A

Average CAES Screen Passing Pixels (%) = 99.9
Total Quantity Approved (yd^3) = 46,455
Total # of Nuclear Density Gauge Tests = 0
Total # of Moisture Tests = 4
Quantity per Moisture Test (yd^3) = 11,614
Total Average Thickness (ft) = 0.8

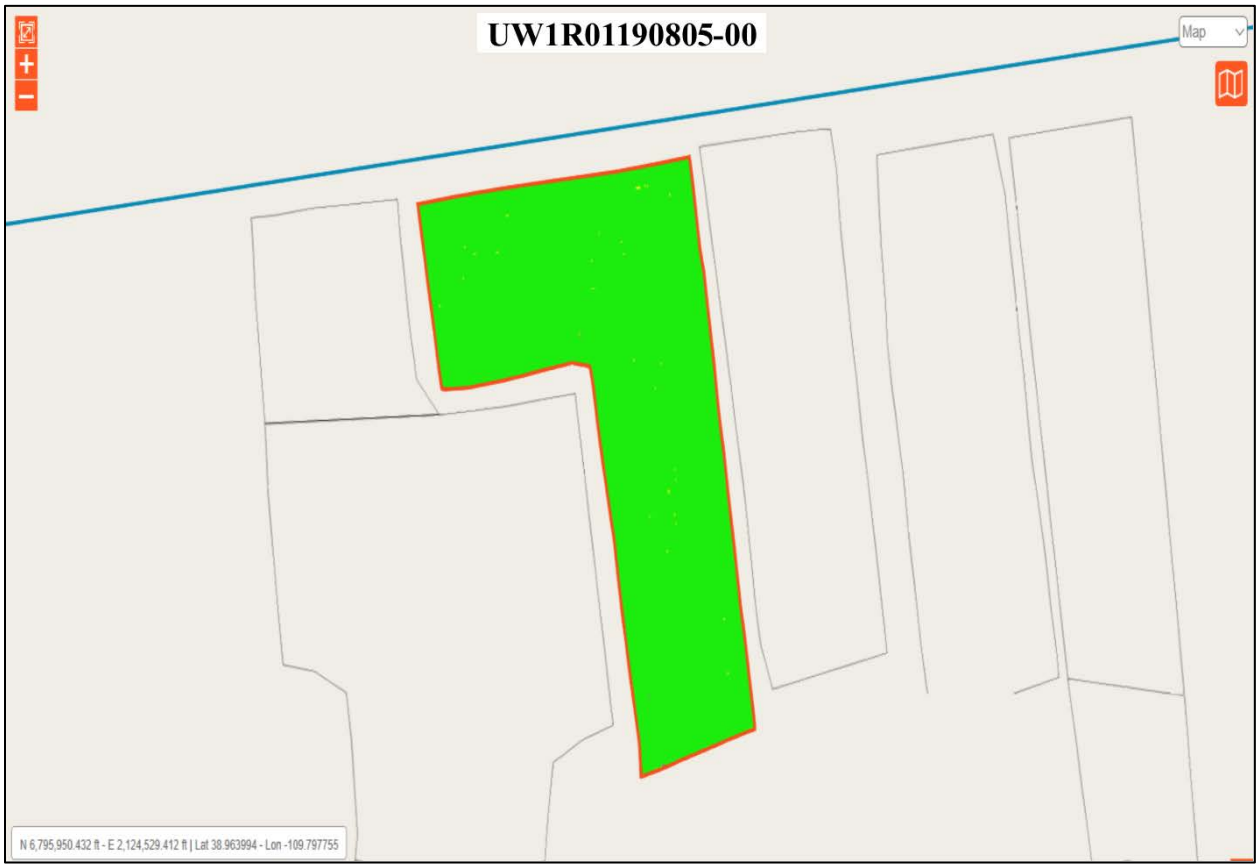
CAES compaction screen example from July 2019. There are compaction screens for each lift approved on record. The number of passing pixels reported refers to the percentage of the lift which has green pixels. A green pixel verifies that the minimum of six wheel passes with the compactor has been recorded.



August 2019										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Cumulative Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Thickness (ft)	Proctor ID #	# of Nuclear Density Gauge Verifications	# of Sandcone Verifications	Verified Compaction (%)
08/01/19	UW1S06190801-00	0	1149	1,149	100.0	0.8	N/A	0	0	N/A
08/01/19	UW1R01190731-00	0	1492	2,641	100.0	0.7	N/A	0	0	N/A
08/05/19	UW1P01190801-00	0	625	3,266	100.0	0.9	N/A	0	0	N/A
08/05/19	UW1S01190801-00	0	2427	5,693	99.9	0.9	N/A	0	0	N/A
08/06/19	UW1P01190805-00	0	555	6,248	100.0	0.8	N/A	0	0	N/A
08/07/19	UW1P01190807-00	0	627	6,875	99.6	0.9	N/A	0	0	N/A
08/07/19	UW1R01190805-00	0	2030	8,905	99.8	0.9	N/A	0	0	N/A
08/07/19	UW1R02190806-00	1	1497	10,402	99.6	0.7	526	0	0	N/A
08/07/19	UW1U05190805-00	0	4068	14,470	N/A	1.7	N/A	0	0	N/A
08/08/19	UW1S01190806-00	0	2427	16,897	99.8	0.9	N/A	0	0	N/A
08/12/19	UW1R01190808-00	0	2298	19,195	99.9	1.0	N/A	0	0	N/A
08/12/19	UW1U05190808-00	0	1436	20,631	99.9	0.6	N/A	0	0	N/A
08/13/19	UWY24190130-00	1	923	21,554	100.0	0.4	497	0	0	N/A
08/13/19	UW1W01190808-00	0	875	22,429	99.6	0.6	N/A	0	0	N/A
08/14/19	UW1S01190812-00	1	2229	24,658	99.5	1.0	N/A	0	0	N/A
08/14/19	UW1R02190812-00	0	2180	26,838	100.0	0.9	N/A	0	0	N/A
08/14/19	UW1P01190813-00	0	697	27,535	99.9	1.0	N/A	0	0	N/A
08/14/19	UW1F24190130-00	1	353	27,888	100.0	0.3	531	0	0	N/A
08/15/19	UW1T13190815-00	0	417	28,305	99.8	0.9	N/A	0	0	N/A
08/15/19	UW1T13190814-00	0	417	28,722	100.0	0.9	N/A	0	0	N/A
08/15/19	UW1R01190814-00	1	2298	31,020	100.0	1.0	526	0	0	N/A
08/19/19	UW1W01190815-00	0	1313	32,333	100.0	0.9	N/A	0	0	N/A
08/20/19	UW1I24190205-00	3	2010	34,343	99.9	1.0	505	3	0	92.1
08/21/19	UW1R02190819-00	0	2350	36,693	99.8	1.0	N/A	0	0	N/A
08/21/19	UW1S01190819-00	1	2209	38,902	99.9	1.0	526	0	0	N/A
08/21/19	UW1P01190820-00	0	547	39,449	100.0	0.8	N/A	0	0	N/A
08/22/19	UW1U05190814-00	0	2388	41,837	99.9	1.0	N/A	0	0	N/A
08/22/19	UW1R01190821-00	0	2387	44,224	99.7	1.0	N/A	0	0	N/A
08/26/19	UW1W01190821-00	0	1557	45,781	99.8	1.0	N/A	0	0	N/A
08/27/19	UW1R02190822-00	0	1956	47,737	100.0	1.0	N/A	0	0	N/A
08/29/19	UW1S01190826-00	0	2125	49,862	99.8	0.9	N/A	0	0	N/A

Average CAES Screen Passing Pixels (%) = 99.9
Total Quantity Approved (yd^3) = 49,862
Total # of Nuclear Density Gauge Tests = 3
Total # of Moisture Tests = 9
Quantity per Moisture Test (yd^3) = 5,540
Total Average Thickness (ft) = 0.9

CAES compaction screen example from August 2019. There are compaction screens for each lift approved on record. The number of passing pixels reported refers to the percentage of the lift which has green pixels. A green pixel verifies that the minimum of six wheel passes with the compactor has been recorded.

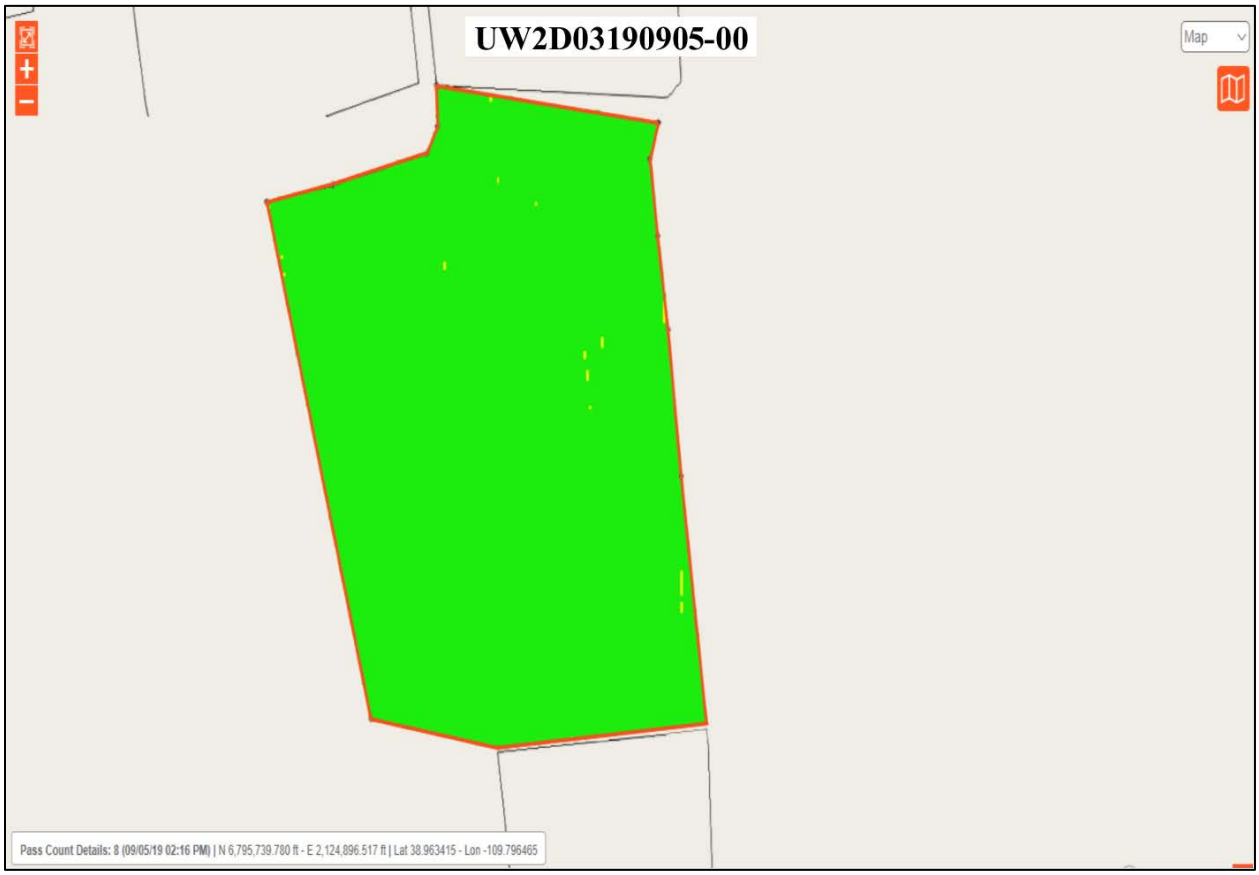


September 2019										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Cumulative Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Thickness (ft)	Proctor ID #	# of Nuclear Density Gauge Verifications	# of Sandcone Verifications	Verified Compaction (%)
09/03/19	UW1R01190827-00	0	2387	2,387	100.0	1.0	N/A	0	0	N/A
09/03/19	UW1W01190827-00	0	1401	3,788	100.0	0.9	N/A	0	0	N/A
09/03/19	UW1P01190822-00	0	535	4,323	100.0	1.0	N/A	0	0	N/A
09/03/19	UW1U05190903-00	0	2123	6,446	100.0	0.9	N/A	0	0	N/A
09/03/19	UW1T13190826-00	0	381	6,827	100.0	0.8	N/A	0	0	N/A
09/03/19	UW1R012190829-00	0	1760	8,587	100.0	0.9	N/A	0	0	N/A
09/03/19	UW1P01190903-00	0	354	8,941	98.2	0.9	N/A	0	0	N/A
09/04/19	UW1R01190904-00	0	2175	11,116	99.9	1.0	N/A	0	0	N/A
09/04/19	UW1T13190904-00	1	450	11,566	100.0	1.0	520	0	0	N/A
09/04/19	UW2A01190903-00	0	1249	12,815	100.0	0.8	N/A	0	0	N/A
09/04/19	UW1S01190829-00	0	2341	15,156	99.8	1.0	N/A	0	0	N/A
09/04/19	UW2C01190820-00	0	1991	17,147	N/A	1.3	N/A	0	0	N/A
09/04/19	UW2D03190820-00	0	1323	18,470	N/A	1.2	N/A	0	0	N/A
09/04/19	UW2E09190821-00	0	1168	19,638	N/A	1.4	N/A	0	0	N/A
09/04/19	UW2F16190821-00	0	806	20,444	N/A	1.3	N/A	0	0	N/A
09/05/19	UW2F16190904-00	0	558	21,002	100.0	0.9	N/A	0	0	N/A
09/05/19	UW1T13190905-00	0	360	21,362	100.0	0.8	N/A	0	0	N/A
09/05/19	UW2E09190904-00	0	834	22,196	100.0	1.0	N/A	0	0	N/A
09/05/19	UW2D03190904-00	0	1103	23,299	99.9	1.0	N/A	0	0	N/A
09/09/19	UW2CO1190905-00	0	1532	24,831	99.9	1.0	N/A	0	0	N/A
09/09/19	UW1U05190904-00	0	2129	26,960	100.0	0.9	N/A	0	0	N/A
09/10/19	UW1W01190905-00	0	1212	28,172	100.0	0.9	N/A	0	0	N/A
09/10/19	UW1R02190909-00	0	1956	30,128	100.0	1.0	N/A	0	0	N/A
09/10/19	UW1T13190910-00	0	360	30,488	100.0	0.8	N/A	0	0	N/A
09/11/19	UW1S01190909-00	1	2306	32,794	99.8	1.0	526	0	0	N/A
09/11/19	UW1P01190909-00	0	394	33,188	100.0	1.0	N/A	0	0	N/A
09/12/19	UW1R01190910-00	0	1766	34,954	99.7	0.9	N/A	0	0	N/A
09/12/19	UW1W01190911-00	0	1087	36,041	100.0	1.0	N/A	0	0	N/A
09/16/19	UW2A01190911-00	0	1449	37,490	99.9	0.9	N/A	0	0	N/A
09/16/19	UW2C01190912-00	0	1663	39,153	99.4	1.0	N/A	0	0	N/A
09/18/19	UW1U05190910-00	0	1967	41,120	99.6	0.8	N/A	0	0	N/A
09/18/19	UW1P01190912-00	0	485	41,605	100.0	0.7	N/A	0	0	N/A
09/18/19	UW1S01190912-00	0	2306	43,911	100.0	1.0	N/A	0	0	N/A
09/19/19	UW2A01190918-00	1	1449	45,360	99.9	0.9	491	0	0	N/A
09/23/19	UW1S01190919-00	0	2488	47,848	99.9	1.0	N/A	0	0	N/A
09/23/19	UW2C01190917-00	3	2162	50,010	100.0	1.3	396	3	1	92.9
09/25/19	UW2A01190924-00	0	1695	51,705	99.5	1.0	N/A	0	0	N/A
09/25/19	UW2C01190924-00	0	1413	53,118	99.9	0.9	N/A	0	0	N/A
09/26/19	UW1R01190916-00	6	3335	56,453	100.0	1.7	396	6	0	95.7
09/26/19	UW1W01190917-00	3	2355	58,808	100.0	1.8	396	3	0	95.5
09/26/19	UW1U05190923-00	0	2109	60,917	100.0	0.9	N/A	0	0	N/A
09/26/19	UW1S01190925-00	0	2204	63,121	100.0	0.9	N/A	0	0	N/A

September 2019										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Cumulative Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Thickness (ft)	Proctor ID #	# of Nuclear Density Gauge Verifications	# of Sandcone Verifications	Verified Compaction (%)
09/30/19	UW1R02190916-00	0	1662	64,783	100.0	0.9	N/A	0	0	N/A
09/30/19	UW2A01190926-00	0	1525	66,308	100.0	0.9	N/A	0	0	N/A

Average CAES Screen Passing Pixels (%) = 99.9
Total Quantity Approved (yd^3) = 66,308
Total # of Nuclear Density Gauge Tests = 12
Total # of Moisture Tests = 15
Quantity per Moisture Test (yd^3) = 4,421
Total Average Thickness (ft) = 1.0

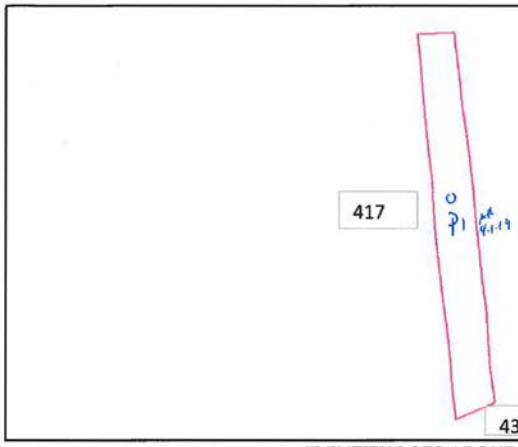
CAES compaction screen example from September 2019. There are compaction screens for each lift approved on record. The number of passing pixels reported refers to the percentage of the lift which has green pixels. A green pixel verifies that the minimum of six wheel passes with the compactor has been recorded.



LIFT APPROVAL FORM

PROJECT: Moab UMTRA **OTHER**

NW CORNER **DATE:** 3/29/2019



P 1	N 6795549 E 2124353			
EW:	43	X 0.651	=	28
NS:	417	X 0.472	=	197
P 2				
EW:		X	=	
NS:		X	=	
P 3				
EW:		X	=	
NS:		X	=	
P 4				
EW:		X	=	
NS:		X	=	
P 5				
EW:		X	=	
NS:		X	=	
Page 2 attached:		Y	N	

IDENTIFY LOTS ABOVE

LIFT ID: UW1S06190329-00 NW CORNER: 6795746 N. 2124325 E.

Uncompacted Thickness: 1.7 Compacted Thickness: N/A Debris Insp. By: N/A Date: N/A Time: N/A

NW CORNER of debris placement: N/A EW Dimension N/A NS Dimension N/A

Lift Area (ft²): 15,141 Lift Volume (yd³): 953

Comments: QC verified that the lift area was scarified prior to placement. QC observed the material placed to have proper moisture for compaction. QC performed in-place moisture density tests in correlation with the computer compaction system. The first test was performed at the surface, the second at 8 inches below, and the third at 12 inches below. These tests were satisfactory

Attached Forms: **Grid Slope** X **Compaction Macro** X **Print Screen** X **Moisture/ Density** X

KEYING IN NOTES: N [E] S [W] Satisfactory MOISTURE/ DENSITY TESTS ID # (S): 1, 2, 3

Mitch Hogan 04.01.2019 1153

LIFT APPROVED BY: Max von Zastrow DATE: 4/1/2019 TIME: 1153

Kathy Jay 4/8/2019

QA/QC APPROVAL DATE

Density Testing
DOE-EM/GJRAC1783
Rev. 1

QC-F-001
File index No. 43.8.2
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Slope Elevation Survey

	Average lift thickness=		1.7	Bounding Box	Northing	Easting
	Grid Size=	30'		Lower Left	N	
Lift ID:	UW1S06190329-00			Upper Right		A
Last Lift Elevations			Lift Approval Elevations			Lift Thickness
Northing	Easting	Elevation	Northing	Easting	Elevation	Thickness
6,795,404	2,124,364	4,950.9	6,795,404	2,124,364	4,952.4	1.5
6,795,404	2,124,394	4,950.7	6,795,404	2,124,394	4,952.3	1.6
6,795,434	2,124,364	4,951.4	6,795,434	2,124,364	4,953.1	1.7
6,795,434	2,124,394	4,951.3	6,795,434	2,124,394	4,953.0	1.8
6,795,464	2,124,364	4,952.0	6,795,464	2,124,364	4,953.7	1.8
6,795,464	2,124,394	4,952.0	6,795,464	2,124,394	4,953.7	1.7
6,795,494	2,124,364	4,953.0	6,795,494	2,124,364	4,954.4	1.5
6,795,494	2,124,394	4,952.7	6,795,494	2,124,394	4,954.4	1.8
6,795,524	2,124,364	4,953.3	6,795,524	2,124,364	4,955.1	1.8
6,795,554	2,124,364	4,954.2	6,795,554	2,124,364	4,955.8	1.6
6,795,584	2,124,364	4,954.9	6,795,584	2,124,364	4,956.5	1.6
6,795,614	2,124,364	4,955.6	6,795,614	2,124,364	4,957.2	1.6
6,795,644	2,124,364	4,956.2	6,795,644	2,124,364	4,957.9	1.7
6,795,674	2,124,364	4,957.1	6,795,674	2,124,364	4,958.5	1.4
6,795,704	2,124,364	4,957.5	6,795,704	2,124,364	4,959.2	1.7
6,795,734	2,124,334	4,958.3	6,795,734	2,124,334	4,960.1	1.8
6,795,734	2,124,364	4,957.9	6,795,734	2,124,364	4,959.9	2.0
						0.0
						0.0
						0.0
						0.0
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						0.0
						0.0
						0.0
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						0.0

MZ 4-1-19

Page 2 of 7

% =8	100.0%
Elevation Avg	4956.1
Total =8	1475
Total Lines	1475

Pass

Minimum Required Machine Passes
8

Lift ID: UW1S06190329-00

Northing	Easting	Elevation	# of Passes	Passes =8	Count
6795347	2124373	4951.3	8	1	1
6795351	2124373	4951.5	8	1	1
6795351	2124376	4951.4	8	1	1
6795351	2124379	4951.1	8	1	1
6795354	2124369	4951.6	8	1	1
6795354	2124373	4951.7	8	1	1
6795354	2124376	4951.6	8	1	1
6795354	2124379	4951.5	8	1	1
6795354	2124383	4951.6	8	1	1
6795354	2124386	4951.4	8	1	1
6795357	2124369	4951.7	8	1	1
6795357	2124373	4951.6	8	1	1
6795357	2124376	4951.7	8	1	1
6795357	2124379	4951.7	8	1	1
6795357	2124383	4951.7	8	1	1
6795357	2124386	4951.5	8	1	1
6795357	2124389	4951.6	8	1	1
6795357	2124393	4951.6	8	1	1
6795361	2124369	4951.8	8	1	1
6795361	2124373	4951.7	8	1	1
6795361	2124376	4951.7	8	1	1
6795361	2124379	4951.8	8	1	1
6795361	2124383	4951.8	8	1	1
6795361	2124386	4951.6	8	1	1
6795361	2124389	4951.7	8	1	1
6795361	2124393	4951.7	8	1	1
6795361	2124396	4951.6	8	1	1
6795361	2124399	4951.7	8	1	1
6795364	2124369	4951.8	8	1	1
6795364	2124373	4951.8	8	1	1
6795364	2124376	4951.8	8	1	1
6795364	2124379	4951.7	8	1	1
6795364	2124383	4951.8	8	1	1
6795364	2124386	4951.7	8	1	1
6795364	2124389	4951.8	8	1	1
6795364	2124393	4951.7	8	1	1
6795364	2124396	4951.7	8	1	1
6795364	2124399	4951.7	8	1	1
6795364	2124402	4951.7	8	1	1
6795367	2124369	4952.0	8	1	1
6795367	2124373	4951.9	8	1	1
6795367	2124376	4951.9	8	1	1
6795367	2124379	4951.8	8	1	1
6795367	2124383	4951.9	8	1	1

Lift Height
2' 0"
Thick Lift Threshold
3' 0"
Last Lift Elevation
N/A

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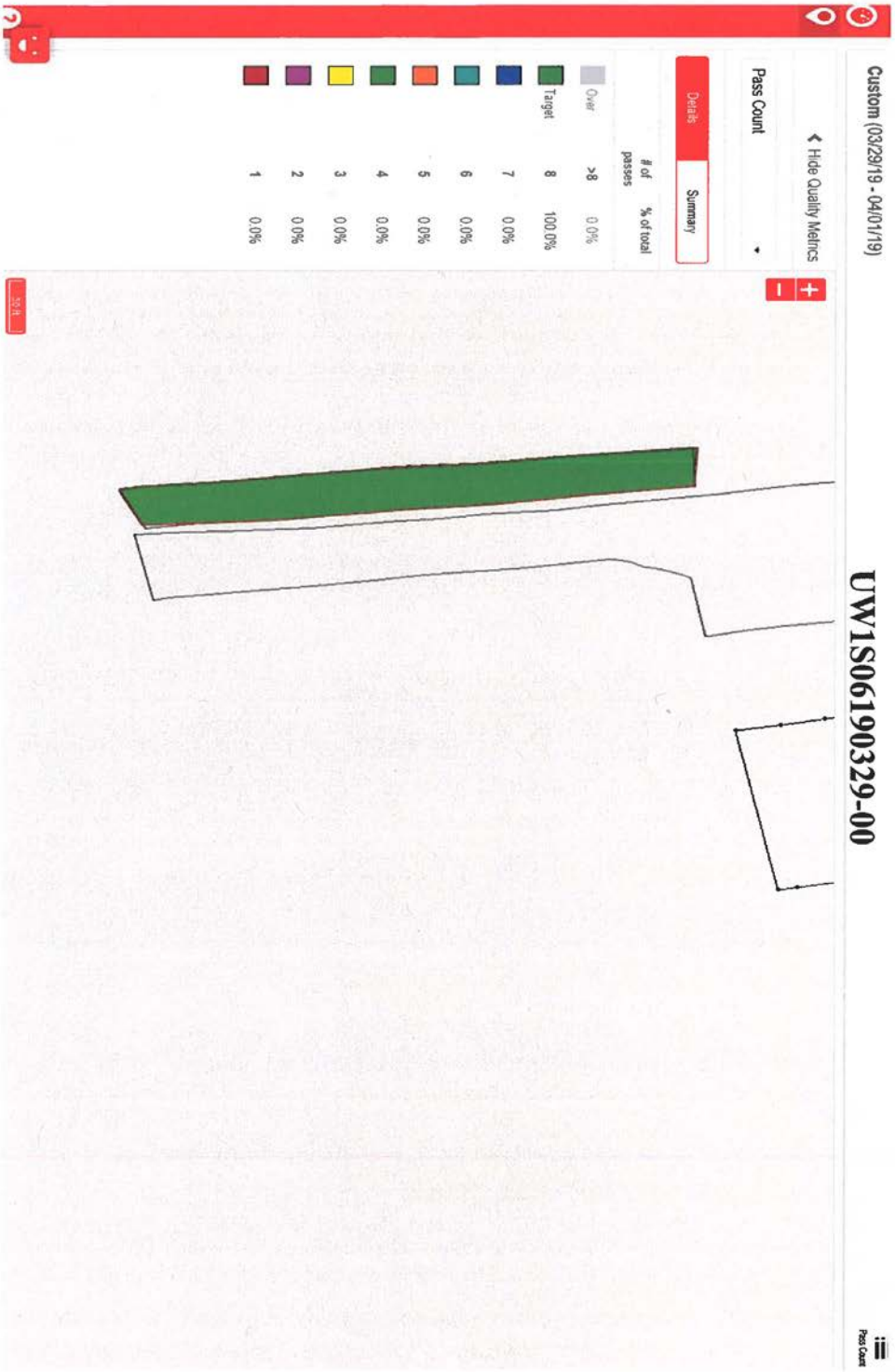
Custom (03/29/19 - 04/01/19)
Hide Quality Metrics
Pass Count
Details
Summary
# of passes
% of total
Target
Over
>8 0.0%
8 100.0%
7 0.0%
6 0.0%
5 0.0%
4 0.0%
3 0.0%
2 0.0%
1 0.0%
UW1S06190329-00
Pass Count

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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER** _____

LIFT IDENTIFICATION: UW1S06190329-00 DATE: 4/1/2019

TEST ID NUMBER(S): 1- suface test

TEST LOCATION: N 6795549 E 2124353 TEST METHOD: N/A D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 1/23/19

Daily Standard Counts: *Off-Cell Standard*

Density 2255 Moisture 499

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 157 Density Count 1818

Wet Density (ρ_m) 129.9 *(lbs/ft³)* Dry Density 112.2 *(lbs/ft³)*

Moisture Density 17.7 *(lbs/ft³)* Moisture Fraction 15.8 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID Sammy

Scale Serial # 14725064 Last Calibration Date: 1/23/10

Mass of container & wet specimen (M_{cms})	527.9	g
Mass of container & dry specimen (M_{cds})	480.3	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	47.6	g
Mass of container (M_c)	219.2	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	261.1	g
Moisture content (w) $w = (M_w / M_s) \times 100$	18.2	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 129.9) / (100 + 18.2) = 109.9$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

109.9 / 104.5 x 100 = 105.1 %

Comments:

On cell standard. DS: 2948, MS: 504. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus _____ Calibrated Vol. *(lbs/ft³)* _____

Bulk Density of sand (ρ_1) _____ *g/cm³* _____ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) _____ *g*

Mass of bottle & cone **before** filling cone, plate & hole		g
Mass of bottle & cone **after** filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ _____ *cm³*

Dry Mass of soil

$M_4 = 100 M_3 / (w + 100)$ _____ *g*

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ _____ *lbs/ft³*

Dry Density

$\rho_d = M_4 / V$ _____ *g/cm³*

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ _____ *lbs/ft³*

Soil Description: **Brown, fine to coarse, angular, clayey sand. DB-2018-3a**

Proctor ID: **RRM #526**

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.5 (lbs/ft³)

Optimum Moisture (w_{opt}) 18.2 (%)

Required Moisture: 15.2 % to 21.2 %

Required Percent Compaction: 90.0 (%)

TEST RESULTS:

X Pass Date: 4/1/19

Failed Moisture

Failed Compaction Time: 10:25

By: Max von Zastrow *(print)* *(signature)*

QA/QC APPROVAL 4/8/2019 DATE

Density Testing
DOE-EM/GJRAC1783

QC-F-002
File Index No. 43.8.2
Page 5 of 7

FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1S06190329-00 DATE: 4/1/2019

TEST ID NUMBER(S): 2- 8" below surface

TEST LOCATION: N 6795549 E 2124353 TEST METHOD: N/A D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 1/23/19

Daily Standard Counts: *Off-Cell Standard*

Density 2255 Moisture 499

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 191 Density Count 2177

Wet Density (ρ_m) 115.7 *(lbs/ft³)* Dry Density 87.5 *(lbs/ft³)*

Moisture Density 21.2 *(lbs/ft³)* Moisture Fraction 24.2 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID 102

Scale Serial # 14725064 Last Calibration Date: 1/23/10

Mass of container & wet specimen (M_{cms})	510.8	g
Mass of container & dry specimen (M_{cds})	467.4	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	43.4	g
Mass of container (M_c)	218.7	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	248.7	g
Moisture content (w) $w = (M_w / M_s) \times 100$	17.5	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times 115.7) / (100 + 17.5) = 98.5$ lbs/ft³

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

98.5 / 104.5 x 100 = 94.3 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus _____ Calibrated Vol. *(lbs/ft³)* _____

Bulk Density of sand (ρ_1) _____ g/cm³ _____ lbs/ft³

Mass of Sand to Fill Cone & Plate (M_2) _____ g

Mass of bottle & cone **before** filling cone, plate & hole		g
Mass of bottle & cone **after** filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole ($M_{\_}$)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume $V = (M_1 - M_2) / \rho_1$ _____ cm³

Dry Mass of soil $M_4 = 100\ M_3 / (w + 100)$ _____ g

Wet Density $\rho_m = (M_3 / V) \times 62.43$ _____ lbs/ft³

Dry Density $\rho_d = M_4 / V$ _____ g/cm³

Dry Unit Weight $\gamma_d = \rho_d \times 62.43$ _____ lbs/ft³

Soil Description: Brown, fine to coarse, angular, clayey sand. DB-2018-3a

Proctor ID: RRM #526

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.5 (lbs/ft³)

Optimum Moisture (w_{opt}) 18.2 (%)

Required Moisture: 15.2 % to 21.2 %

Required Percent Compaction: 90.0 (%)

Comments:

On cell standard. DS: 3261, MS: 521. This test was performed 8 inches below the surface.Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 4/1/19

Failed Moisture

Failed Compaction Time: 9:36

By: Max von Zastrow *(print)* *(signature)*

Kathy Trujillo QA/QC APPROVAL 4/8/19 DATE

Density Testing
DOE-EM/GJRAC1783

QC-F-002
File Index No. 43.8.2
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FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER**

LIFT IDENTIFICATION: UW1S06190329-00 DATE: 4/1/2019

TEST ID NUMBER(S): 3- 12" below surface

TEST LOCATION: N 6795549 E 2124353 TEST METHOD: N/A D1556 X D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model Troxler 3430 Gauge Serial # 23532

Last Calibration Date: 1/23/19

Daily Standard Counts: *Off-Cell Standard*

Density 2255 Moisture 499

Method A (Direct Transmission)

Depth Setting 8 *(inches)* Count Time 1 *(minutes)*

Moisture Count 198 Density Count 2141

Wet Density (ρ_m) 110.6 *(lbs/ft³)* Dry Density 87.5 *(lbs/ft³)*

Moisture Density 23.1 *(lbs/ft³)* Moisture Fraction 26.4 *(%)*

MOISTURE DETERMINATION

ASTM D4643

Container ID JV

Scale Serial # 14725064 Last Calibration Date: 1/23/10

Mass of container & wet specimen (M_{cms})	517.5	g
Mass of container & dry specimen (M_{cds})	473.5	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	44.0	g
Mass of container (M_c)	218.8	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	254.7	g
Moisture content (w) $w = (M_w / M_s) \times 100$	17.3	%

Dry Density $(\rho_d) = (100 \times \rho_m)/(100 + w)$

$\rho_d = (100 \times 110.6) / (100 + 17.3) = 94.3$ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max$ x 100

94.3 / 104.4 x 100 = 90.3 %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus _____ Calibrated Vol. *(lbs/ft³)* _____

Bulk Density of sand (ρ_1) _____ *g/cm³* _____ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) _____ g

Mass of bottle & cone **before** filling cone, plate & hole		g
Mass of bottle & cone **after** filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ _____ cm^3

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ _____ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ _____ *lbs/ft³*

Dry Density

$\rho_d = M_4 / V$ _____ *g/cm³*

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ _____ *lbs/ft³*

Soil Description: Brown, fine to coarse, angular, clayey sand. DB-2018-3a

Proctor ID: RRM #526

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 104.4 (lbs/ft³)

Optimum Moisture (w_{opt}) 18.2 (%)

Required Moisture: 15.2 % to 21.2 %

Required Percent Compaction: 90.0 (%)

Comments:

On cell standard. DS: 3368, MS: 499. This test was performed 12 inches below the surface. Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 4/1/19

Failed Moisture

Failed Compaction Time: 9:36

By: Max von Zastrow (print) (signature)

Kathy Lee 4/8/2019

QA/QC APPROVAL DATE

Density Testing
DOE-EM/GJRAC1783

QC-F-002
File Index No. 43.8.2
Page 1 of 1

Environmental Management - Grand Junction Office
MOAB
UMTRA Project

Top of Waste Buyoff Form

Client: Department of Energy
Project: Moab UMTRA Project
Date: 06/17/2019

In signing this document, the signatory agrees that the lift is complete and meets both the project specifications and RAIP requirements.

Lift Area	Lift Area
UW1K21, UW1A16, UWZ20, UWY23	

Approver Name/Title	Signature	Sign Date
Mike McCullough/ Site Operations Manager		06-18-19
Mitch Hogan/ QA/QC Representative		06.17.2019
Max von Zastrow/ QA/QC Representative		06/17/19
Comments		
131,919 ft²		

OP-F-013
Rev 0, August 2010

File Index No. 43.1.1
Page 1 of 1

Top Of Waste Buyoff Survey

Lift Area Buyoff ID:			UW1K21, UW1A16, UWZ20, UWY23		Date:	6/17/2019
Point #	Northing	Easting	Surveyed Elevation	Design Elevation	Difference in feet	Difference in inches
2217	6795076	2123229	4987.743	4987.660	0.08	1.0
2252	6795082	2123278	4987.846	4987.842	0.00	0.0
2286	6795138	2123322	4989.277	4989.275	0.00	0.0
2287	6795088	2123328	4988.033	4988.024	0.01	0.1
2321	6795144	2123372	4989.562	4989.457	0.10	1.3
2322	6795094	2123378	4988.208	4988.206	0.00	0.0
2355	6795199	2123415	4990.971	4990.890	0.08	1.0
2356	6795150	2123421	4989.724	4989.639	0.09	1.0
2357	6795100	2123427	4988.405	4988.388	0.02	0.2
2390	6795205	2123465	4991.089	4991.072	0.02	0.2
2391	6795156	2123471	4989.838	4989.821	0.02	0.2
2392	6795106	2123477	4988.589	4988.570	0.02	0.2
2425	6795212	2123514	4991.300	4991.254	0.05	0.6
2426	6795162	2123520	4990.092	4990.003	0.09	1.1
2427	6795112	2123526	4988.752	4988.752	0.00	0.0
2460	6795218	2123564	4991.528	4991.436	0.09	1.1
2461	6795168	2123570	4990.271	4990.185	0.09	1.0
2462	6795118	2123576	4989.005	4988.934	0.07	0.9
2495	6795224	2123614	4991.624	4991.618	0.01	0.1
2496	6795174	2123620	4990.451	4990.367	0.08	1.0
2497	6795124	2123626	4989.144	4989.116	0.03	0.3
2498	6795075	2123632	4987.961	4987.866	0.10	1.1
2530	6795230	2123663	4991.708	4991.595	0.11	1.4
2531	6795180	2123669	4990.471	4990.345	0.13	1.5
2532	6795131	2123675	4989.149	4989.095	0.05	0.6
2533	6795081	2123681	4987.854	4987.845	0.01	0.1
2565	6795236	2123713	4991.497	4991.465	0.03	0.4
2566	6795186	2123719	4990.264	4990.214	0.05	0.6
2567	6795137	2123725	4989.071	4988.964	0.11	1.3
2568	6795087	2123731	4987.781	4987.714	0.07	0.8
2600	6795242	2123762	4991.426	4991.334	0.09	1.1
2601	6795192	2123769	4990.097	4990.084	0.01	0.2
2602	6795143	2123775	4988.972	4988.833	0.14	1.7
2603	6795093	2123781	4987.704	4987.583	0.12	1.5
2635	6795248	2123812	4991.246	4991.203	0.04	0.5
2636	6795198	2123818	4990.002	4989.953	0.05	0.6
2637	6795149	2123824	4988.777	4988.703	0.07	0.9
2638	6795099	2123830	4987.463	4987.452	0.01	0.1
2670	6795254	2123862	4991.098	4991.072	0.03	0.3
2671	6795205	2123868	4989.869	4989.822	0.05	0.6
2672	6795155	2123874	4988.648	4988.572	0.08	0.9
2673	6795105	2123880	4987.440	4987.322	0.12	1.4
2705	6795260	2123911	4990.948	4990.941	0.01	0.1
2706	6795211	2123917	4989.765	4989.691	0.07	0.9
2707	6795161	2123923	4988.448	4988.441	0.01	0.1
2708	6795111	2123930	4987.272	4987.191	0.08	1.0
2740	6795266	2123961	4990.918	4990.811	0.11	1.3
2741	6795217	2123967	4989.647	4989.560	0.09	1.0
2742	6795167	2123973	4988.442	4988.310	0.13	1.6
					0.0	0.0
					0.0	0.0

mments: QC performed a visual inspection of the final surface with satisfactory results. Visual inspection notes: The area was free of humping, thickened edges and defects. The layer uniform thickness was satisfactory see above survey results for layer thickness.

Approval Date: 6/17/2019 Total Square Feet: 131,919

North West Corner: 6795101 N. 2123535 E.

QC Signature:Mitch Hoogan/ Reviewed By:Max von Zastrow/

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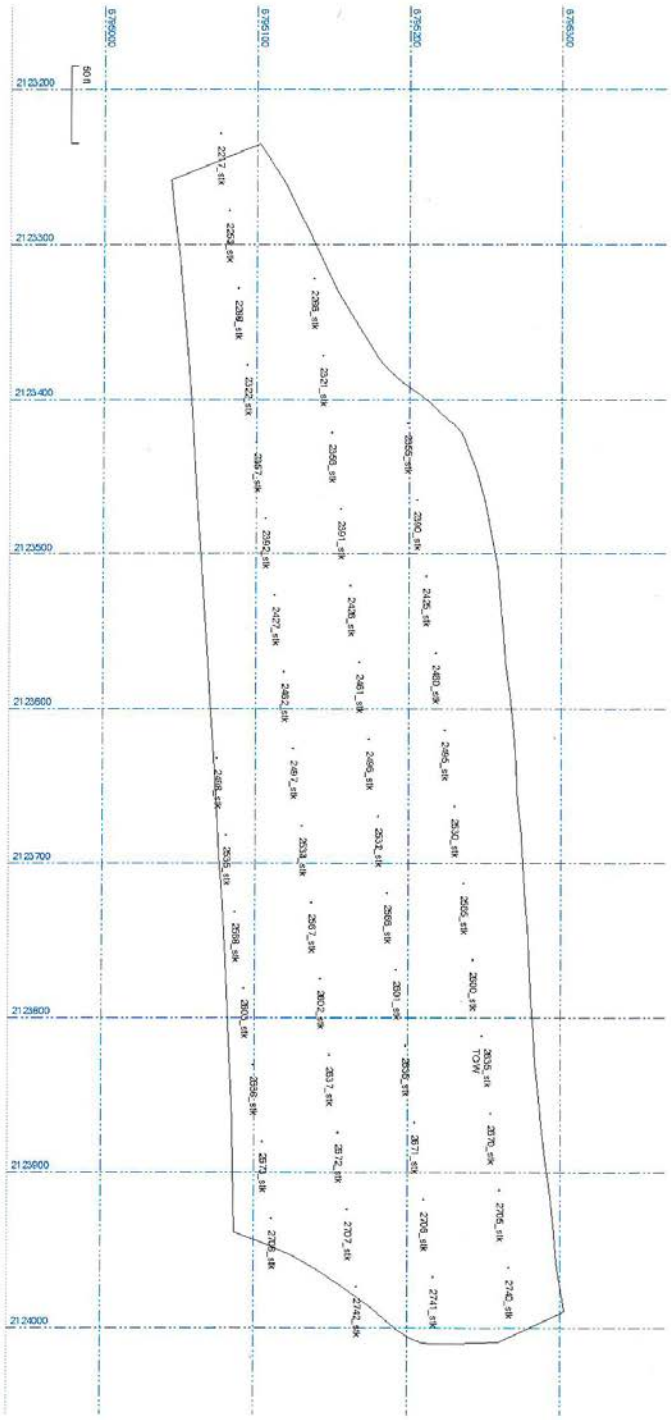

Surveyed points for UW1K21, UW1A16, UWZ20

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Environmental Management - Grand Junction Office
MOAB
UMTRA Project

Top of Waste Buyoff Form

Client: Department of Energy
Project: Moab UMTRA Project
Date: 07/08/2019

In signing this document, the signatory agrees that the lift is complete and meets both the project specifications and RAIP requirements.

Lift Area	Lift Area
UW1B18	

Approver Name/Title	Signature	Sign Date
Mike McCullough/ Site Operations Manager		07.08.19
Kathy Turvy/ QA Manager		7/8/2019
Mitch Hogan/ QA/QC Representative		07.08.2019
Comments		
172,885 ft²		

OP-F-013
Rev 0, August 2010

File Index No. 43.1.1
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Top Of Waste Buyoff Survey

Lift Area Buyoff ID:			UW1B18		Date:	7/8/2019
Point #	Northing	Easting	Surveyed Elevation	Design Elevation	Difference in feet	Difference in inches
2677_stk	6794907	2123904	4982.414	4982.321	0.1	1.1
2676_stk	6794956	2123898	4983.627	4983.571	0.1	0.7
2675_stk	6795006	2123892	4984.837	4984.821	0.0	0.2
2674_stk	6795056	2123886	4986.078	4986.071	0.0	0.1
2709_stk	6795062	2123936	4985.945	4985.941	0.0	0.0
2642_stk	6794901	2123855	4982.529	4982.452	0.1	0.9
2641_stk	6794950	2123849	4983.768	4983.702	0.1	0.8
2640_stk	6795000	2123843	4985.009	4984.952	0.1	0.7
2639_stk	6795050	2123836	4986.203	4986.202	0.0	0.0
2604_stk	6795044	2123787	4986.358	4986.333	0.0	0.3
2605_stk	6794994	2123793	4985.160	4985.083	0.1	0.9
2606_stk	6794944	2123799	4983.869	4983.833	0.0	0.4
2607_stk	6794895	2123805	4982.668	4982.582	0.1	1.0
2572_stk	6794889	2123755	4982.811	4982.713	0.1	1.2
2571_stk	6794938	2123749	4983.993	4983.963	0.0	0.4
2570_stk	6794988	2123743	4985.224	4985.214	0.0	0.1
2569_stk	6795037	2123737	4986.483	4986.464	0.0	0.2
2534_stk	6795031	2123688	4986.596	4986.595	0.0	0.0
2535_stk	6794982	2123694	4985.396	4985.344	0.1	0.6
2536_stk	6794932	2123700	4984.110	4984.094	0.0	0.2
2501_stk	6794926	2123650	4984.160	4984.113	0.0	0.6
2500_stk	6794976	2123644	4985.372	4985.364	0.0	0.1
2499_stk	6795025	2123638	4986.635	4986.615	0.0	0.2
2498_stk	6795075	2123632	4987.867	4987.866	0.0	0.0
2463_stk	6795069	2123582	4987.713	4987.683	0.0	0.4
2464_stk	6795019	2123588	4986.483	4986.433	0.1	0.6
2465_stk	6794970	2123594	4985.258	4985.182	0.1	0.9
2466_stk	6794920	2123601	4984.025	4983.931	0.1	1.1
2431_stk	6794914	2123551	4983.793	4983.749	0.0	0.5
2432_stk	6794864	2123557	4982.575	4982.498	0.1	0.9
2430_stk	6794963	2123545	4985.105	4985.000	0.1	1.3
2429_stk	6795013	2123539	4986.252	4986.250	0.0	0.0
2428_stk	6795063	2123533	4987.559	4987.501	0.1	0.7
2393_stk	6795057	2123483	4987.328	4987.319	0.0	0.1
2394_stk	6795007	2123489	4986.097	4986.068	0.0	0.3
2395_stk	6794957	2123495	4984.841	4984.817	0.0	0.3
2396_stk	6794908	2123501	4983.600	4983.567	0.0	0.4
2397_stk	6794858	2123507	4982.439	4982.316	0.1	1.5
2362_stk	6794852	2123458	4982.233	4982.134	0.1	1.2
2361_stk	6794902	2123452	4983.448	4983.384	0.1	0.8
2360_stk	6794951	2123446	4984.639	4984.635	0.0	0.0
2359_stk	6795001	2123439	4985.890	4985.886	0.0	0.0
2358_stk	6795050	2123433	4987.150	4987.137	0.0	0.2
2323_stk	6795044	2123384	4986.963	4986.955	0.0	0.1
2324_stk	6794995	2123390	4985.783	4985.704	0.1	0.9
2325_stk	6794945	2123396	4984.550	4984.453	0.1	1.2
2326_stk	6794895	2123402	4983.302	4983.202	0.1	1.2
2327_stk	6794846	2123408	4981.959	4981.951	0.0	0.1
2292_stk	6794840	2123358	4981.846	4981.769	0.1	0.9
2291_stk	6794889	2123352	4983.043	4983.020	0.0	0.3
2290_stk	6794939	2123346	4984.346	4984.271	0.1	0.9
2289_stk	6794989	2123340	4985.566	4985.522	0.0	0.5
2288_stk	6795038	2123334	4986.782	4986.773	0.0	0.1
2253_stk	6795032	2123284	4986.604	4986.591	0.0	0.2
2254_stk	6794983	2123290	4985.392	4985.340	0.1	0.6
2255_stk	6794933	2123297	4984.090	4984.089	0.0	0.0
2256_stk	6794883	2123303	4982.914	4982.838	0.1	0.9
2257_stk	6794834	2123309	4981.692	4981.587	0.1	1.3
2222_stk	6794828	2123259	4981.420	4981.405	0.0	0.2
2221_stk	6794877	2123253	4982.704	4982.656	0.0	0.6
2220_stk	6794927	2123247	4983.926	4983.907	0.0	0.2
2219_stk	6794976	2123241	4985.195	4985.158	0.0	0.4
2218_stk	6795026	2123235	4986.434	4986.409	0.0	0.3
2217_stk	6795076	2123229	4987.706	4987.660	0.0	0.6

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2183_stk	6795020	2123185	4986.237	4986.227	0.0	0.1
2184_stk	6794970	2123191	4985.006	4984.976	0.0	0.4
2185_stk	6794921	2123197	4983.793	4983.725	0.1	0.8
2186_stk	6794871	2123203	4982.491	4982.474	0.0	0.2
2187_stk	6794821	2123210	4981.262	4981.223	0.0	0.5
2150_stk	6794915	2123148	4983.574	4983.543	0.0	0.4
2149_stk	6794964	2123142	4984.874	4984.794	0.1	1.0
					0.0	0.0
					0.0	0.0
					0.0	0.0
					0.0	0.0
					0.0	0.0

Comments: QC performed a visual inspection of the final surface with satisfactory results. Visual inspection notes: The area was free of humping, thickened edges and defects. The layer uniform thickness was satisfactory see above survey results for layer thickness.

Approval Date: 7/8/2019 **Total Square Feet:** 172,885

North West Corner: 6794948 N. 2123139 E.

QC Signature: Mitch Hogan/ 7/9/19 **Reviewed By: Kathy Turvy**

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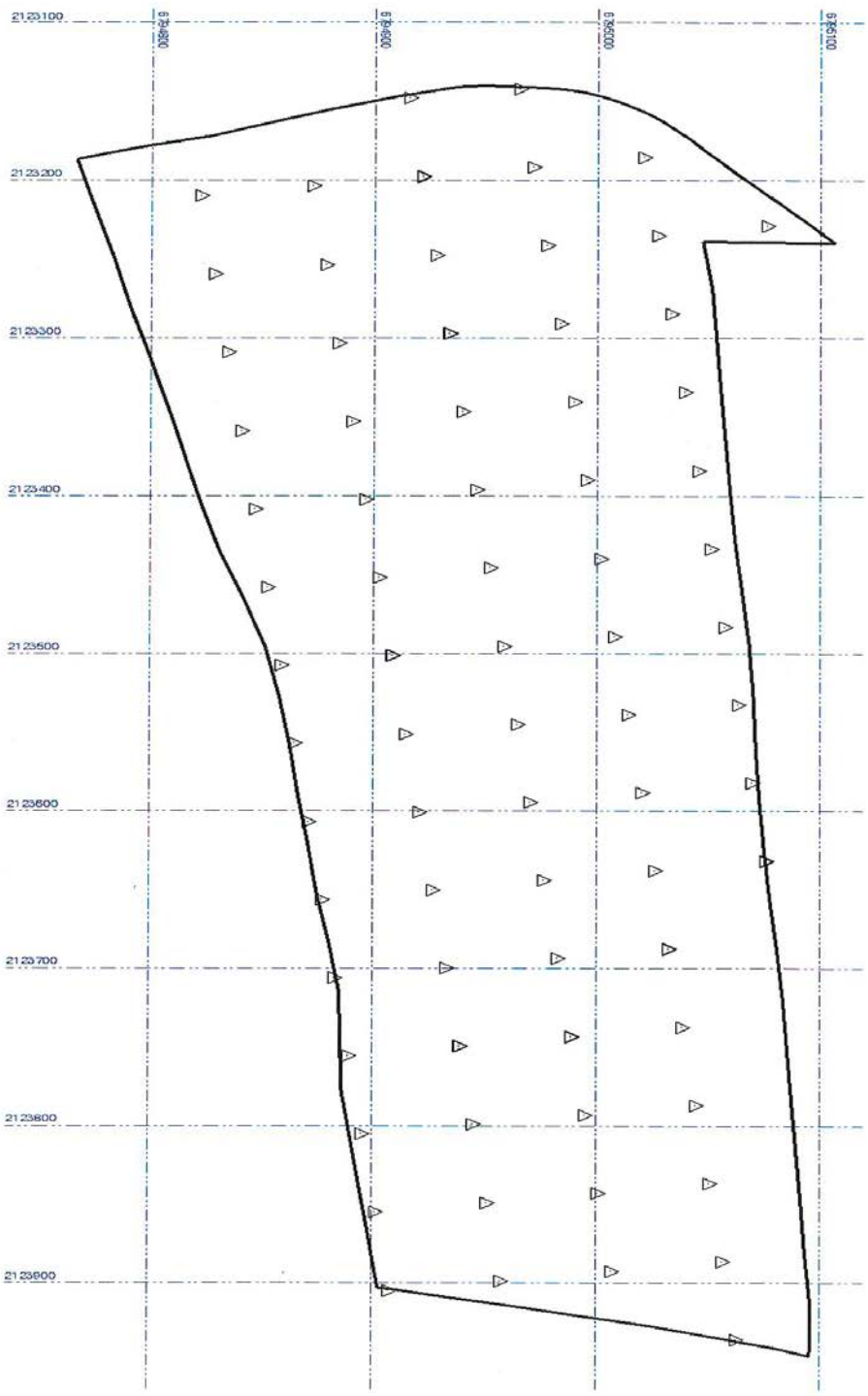

Buyoff points for UW1B18 7/8/2019

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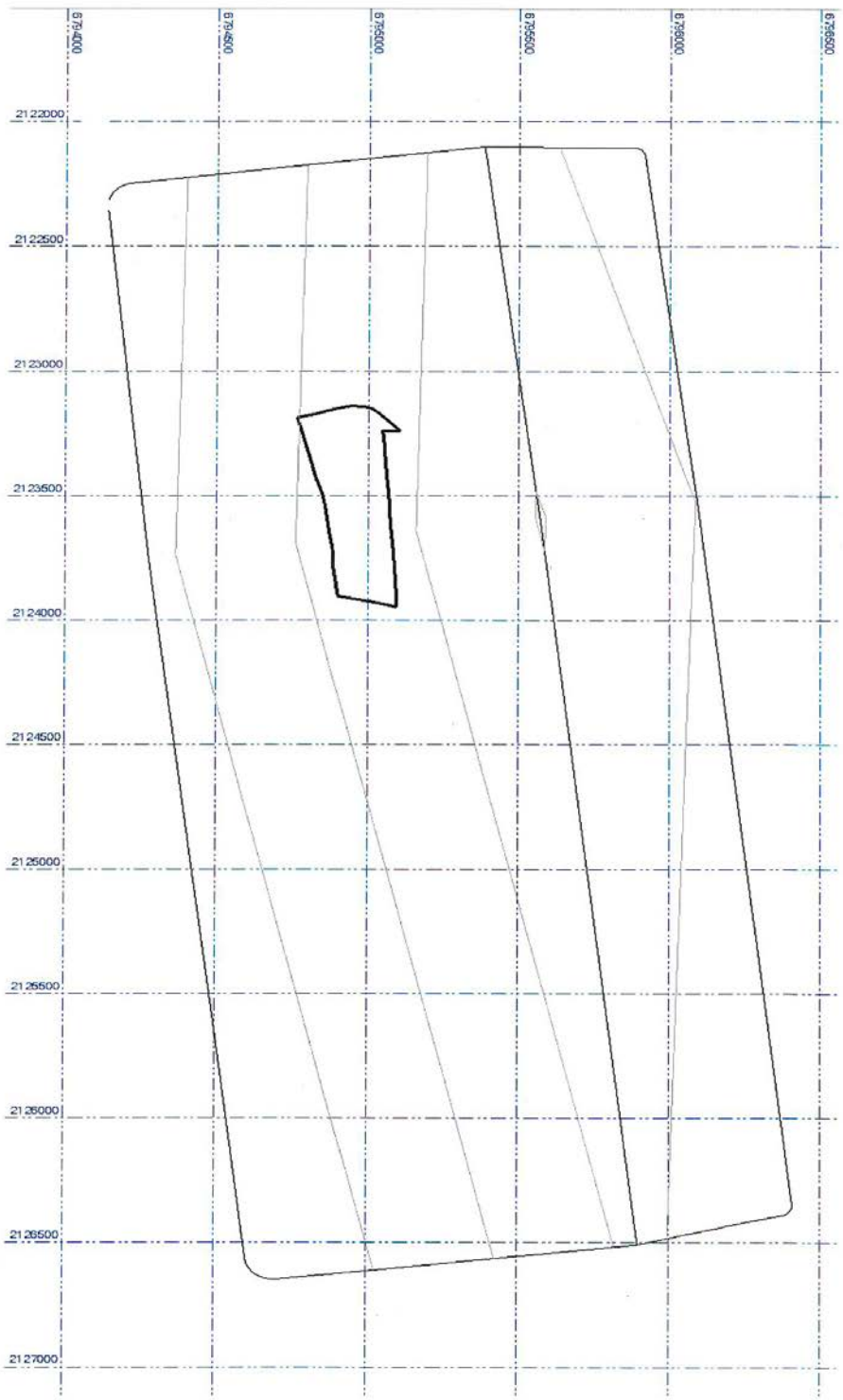

Map of boundary line for RRM buyoff 7/8/2019

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Appendix B.
Photographs

Appendix B. Photographs

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Photo 4. Quality Control Performing In-place Density Test October 2018

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Photo 5. Bulldozer Pushing Material Out November 2018

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Appendix B. Photographs – RRM *(continued)*

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Photo 18. Material Disked for Air Drying March 2019

Appendix B. Photographs – RRM *(continued)*

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Appendix B. Photographs – RRM *(continued)*

Photo 21. Compacting Lift with Sheepsfoot March 2019

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Appendix B. Photographs – RRM *(continued)*

Photo 23. Placing Material with Bulldozer April 2019

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Photo 25. Pushing Debris with Bulldozer May 2019

Photo 26. Bulldozer Pushing Debris in a Two-foot Lift May 2019

Appendix B. Photographs – RRM *(continued)*

Photo 27. Placement of Last Seven Feet of Design Grade June 2019

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Photo 29. Debris Ready for Placement in Sacrificial Lift June 2019

Appendix B. Photographs – RRM *(continued)*

Photo 30. Bulldozer Pushing Material Over Debris July 2019

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Photo 34. Sheepsfoot Compacting Lift Area September 2019

Photo 35. Bulldozer Cleaning Up Slopes September 2019

Appendix B. Photographs – RRM *(continued)*

Photo 36. Bulldozer Placing Material September 2019

Attachment 1.

Procedures and Work Instruction

Moab UMTRA Project Remedial Action Inspection Plan Addendum E, (DOE-EM/GJ1547)

Moab UMTRA Project Moisture/Density Testing Procedure (DOE-EM/GJRAC1783)

Moab UMTRA Project Lift Approval Procedure (DOE-EM/GJRAC1803)

ADDENDUM B, Final Remedial Action Plan (DOE-EM/GJ157)

DOE–EM/GJ1547

Office of Environmental Management – Grand Junction

UMTRA Project

Remedial Action Plan and Site Design for Stabilization of Moab Title I Uranium Mill Residual Radioactive Material at the Crescent Junction, Utah, Disposal Site

Addendum E.
Remedial Action Inspection Plan

Revision 5

March 2019

U.S. Department of Energy

Office of Environmental Management

Prepared by the Technical Assistance Contract under contract number DE-EM0005014 and the Remedial Action Contractor under contract number DE-EM0011049 for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

Moab UMTRA Project
Remedial Action Inspection Plan
Addendum E

Revision 5

Review and Approval

3/20/2019

X 

Mitch Hogan
RAC Quality Assurance and Quality Control ...
Signed by: Mitch Hogan

3/20/2019

X Kathy Turvy

Kathy Turvy
RAC Quality Assurance Manager
Signed by: KATHRYN TURVY (Affiliate)

3/19/2019

X Michael McCullough

Michael McCullough
RAC Crescent Junction Operations/Site Man...
Signed by: MICHAEL MCCULLOUGH (Affiliate)

3/20/2019

X Greg D. Church

Greg D. Church
RAC Project Manager
Signed by: GREGORY CHURCH (Affiliate)

Statement of Policy

This Remedial Action Inspection Plan identifies the means by which the remedial action activities associated with the U.S. Department of Energy (DOE) Uranium Mill Tailings Remedial Action (UMTRA) Project disposal cell at Crescent Junction, Utah, are controlled, verified, and documented.

This Plan has been developed within the scope of the *Moab UMTRA Project Quality Assurance Plan for the Remedial Action Contractor* (QAP) (DOE-EM/GJ1766) and complies with the applicable parts of American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance (NQA)-1-2008, and addenda through 2009, "Quality Assurance Program for Nuclear Facilities," Title 10 Code of Federal Regulations Part 830 Subpart A (10 CFR 830A), "Quality Assurance," and DOE Order 414.1D, "Quality Assurance."

The testing and inspection activities discussed in this Plan are performed in accordance with the following applicable sections of the QAP: Section 1.0, Organization; Section 2.0, Quality Assurance Program; Section 12.0, Control of Measuring and Testing Equipment; Section 15.0, Nonconforming Materials, Parts, or Components; Section 16.0, Corrective Action; and Section 17.0, Quality Assurance Records.

Testing and Inspection

1.0 Purpose

The purpose of this Plan is to describe the methods by which the construction activities will be tested and inspected to verify compliance with the design specification requirements.

2.0 Scope

This Plan defines the testing and inspection of remedial action construction activities at the Crescent Junction site. Types of tests, test frequencies and acceptability, and documentation and reporting requirements are contained in this Plan. Procedures for performing the individual tests shall be in accordance with the applicable ASTM International (ASTM) standards, the referenced or other approved methods, and the design specifications.

3.0 Acronyms

ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials International
CFR	Code of Federal Regulations
D50	median stone diameter
DOE	U.S. Department of Energy
GPS	global positioning system
ISRM	International Society for Rock Mechanics
NQA	Nuclear Quality Assurance

QA	Quality Assurance
QAP	Quality Assurance Plan
QC	Quality Control
RAC	Remedial Action Contractor
RRM	residual radioactive material
UMTRA	Uranium Mill Tailings Remedial Action

4.0 Attachment

None.

5.0 References

10 CFR 830 (Code of Federal Regulations), "Nuclear Safety Management," Subpart A, "Quality Assurance."

ASME (American Society of Mechanical Engineers), Nuclear Quality Assurance (NQA)-1 2008 and addenda through 2009 consensus standard, "Quality Assurance Requirements for Nuclear Facility Applications (QA)."

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

ASTM (ASTM International) C117 – Standard Test Method for Materials Finer than 75 µm (No. 200) Sieve in Mineral Aggregates by Washing.

ASTM (ASTM International) C127 – Standard Test Method for Density, Relative Density, Specific Gravity, and Absorption of Coarse Aggregates.

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

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

ASTM (ASTM International) D422 – Standard Test Method for Particle-Size Analysis of Soils.

ASTM (ASTM International) D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.

ASTM (ASTM International) D1140 – Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve.

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

ASTM (ASTM International) D2216 – Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

ASTM (ASTM International) D2922 – Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

ASTM (ASTM International) D4318 – Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

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

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

ASTM (ASTM International) D4959 – Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating Method.

ASTM (ASTM International) D6938 – Standard Test Method for In-Place Density and Water content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

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

DOE (U.S. Department of Energy), *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545).

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

ISRM (International Society for Rock Mechanics) Method, Schmidt Rebound Hardness.

ISRM (International Society for Rock Mechanics) Method, Splitting Tensile Strength.

6.0 General Requirements

6.1 General Approach to Soil Compaction and Compaction Testing

Typically, soil is tested in a laboratory to determine the maximum density that the particular soil can achieve. The maximum density will be achieved at the optimum moisture content for that soil. The laboratory maximum density and optimum moisture content for the soil becomes the basis of comparison for the compaction of the soil in the field.

In the field, the soil is placed in layers, compacted with specialized compaction equipment, and tested to confirm the soil density is close to the previously determined laboratory maximum density. A variety of field tests have been used to determine soil density, including sand cone, rubber balloon, drive cylinder, and nuclear gauge methods. Moisture content tests are also needed to determine the in-place soil density.

All of these test methods determine the density of a small quantity of soil at a single point in a large quantity of placed and compacted soil. A number of tests are required to infer that an entire layer of soil is adequately compacted. The documentation of soil compaction has typically consisted of a visual inspection report combined with a map of the compacted layer and the field test results.

6.1.1 Computer-based Compaction System

Global positioning system (GPS) and computer terrain modeling technology have been combined to provide a new method of performing soil compaction. The system works as follows:

- A digital terrain model of the site to receive fill material is fed into an on-site computer, linked to a computer in the cab of the compaction equipment. A GPS receiver is also linked to the compaction machine's on-board computer. When the machine moves across the site, the GPS equipment provides the exact position and elevation of the equipment at all times.
- Soil is dumped and spread into a layer of fill. As the compaction machine spreads and compacts the layer of soil, the position of the machine is compared to the original terrain model to determine the location and thickness of the fill layer being installed. The on-board computer helps the equipment operator place the material in a layer with uniform thickness by informing the operator of thick or thin areas of the fill.
- After a layer has been placed with uniform thickness, the compaction equipment makes multiple passes over the fill to compact the fill. A compaction machine, compacting material within an acceptable moisture content range, will eventually compact the fill to near its maximum density such that additional compaction passes produce negligible change. The computer recording the GPS location data interprets the passes that produce no vertical change to indicate that the soil is at its maximum density.
- A record of each soil layer's location, thickness, and compaction is generated by the Quality Assurance (QA)/Quality Control (QC) organization using the computer-based compaction system.

Visual inspection, correct placement and compaction techniques, and good moisture control are still required to ensure fill is properly placed, but the computer-based compaction system method has distinct advantages over traditional field density testing. Lift thicknesses are computer controlled and are more uniform than when layers are installed based on visual estimates by the equipment operators.

The computer checks compaction over the entire surface of every layer, whereas the in-place test methods only check a few points on each layer. Soil density verification tests and independent land surveys will be performed to demonstrate the effectiveness of the computer-based compaction system. In the following sections of this Plan, the verification testing and surveying will be described in detail for each element of the cell in which fill is placed.

6.2 Cell Excavation

Part of the proposed disposal cell will be below the ground surface in an excavation. The excavation will be constructed in phases. The overall cell floor and side slopes are described below.

6.2.1 Floor and Side Slopes

The cell floor slopes 2.3 percent from northwest to southeast. The cut slopes on the north, west, and south sides of the cell slope at 2:1 or 3:1.

6.2.2 Final Floor and Embankment Elevations

The cell floor coordinates and elevations are shown on the design plans. When each section of the cell is excavated to the elevations indicated on the plans, a verification survey shall be performed to confirm the excavation MEETS proposed lines and grades. The verification survey shall be signed and submitted to the Remedial Action Contractor (RAC) Crescent Junction Operation/Site Manager.

6.2.3 Cell Floor in Weathered Mancos Shale

The cell floor elevation has been set based on test pit and soil boring data and is at least 2 feet below the top of the Mancos Shale at each data point. The cell floor shall be visually inspected to confirm that it is in the Mancos Shale formation. If an area is observed where the overburden soil extends below the cell floor, the area will be undercut, backfilled with prepared Mancos Shale, and compacted.

6.2.4 Inspection and Testing

QC shall visually inspect the material and ground preparation and verify the cell floor is constructed in accordance with plans and specifications by checking and confirming:

- Floor and side slopes follow the design plans.
- Final floor and side slopes survey match the coordinates and elevations in the plans.
- The floor is weathered Mancos Shale, or low spots have been compacted with Mancos Shale.

6.3 Embankment Construction

Part of the proposed disposal cell will be below the existing ground surface in an excavation, and part will be above the existing ground surface within a constructed embankment. The proposed embankment will have 3:1 or 2:1 interior slopes, 5:1 exterior slopes, and a minimum 30-foot-wide level top. Excavated material from the cell excavation will be used to construct the cell perimeter embankment.

6.3.1 Material

Excavated material from the cell excavation shall be segregated into four types of soil: topsoil, weathered Mancos Shale, common fill, and unsuitable material. Materials shall be stockpiled separately. The perimeter and spoils embankments will be constructed of common fill. The fill shall be tested to determine its maximum dry density in accordance with ASTM D698, and the moisture content shall be modified to bring the fill to its optimum moisture for compaction.

6.3.2 Ground Preparation

The ground beneath the proposed perimeter and spoils embankments shall be prepared by stripping vegetation and loose soil from the site, scarifying and compacting the top 6 inches of soil.

6.3.3 Lift Placement and Thickness

The embankment shall be constructed of fill materials placed in continuous and approximately horizontal lifts. The method of dumping and spreading fill shall result in loose lifts of nearly uniform thickness, not to exceed 12 inches.

At the RAC's option, the compactor may be equipped with a computer-based compaction system and soil placement, and compaction shall be controlled by the computer-based compaction system. The contractor may use the computer-based compaction system to determine and document compaction or perform soil density tests IS in accordance with the Inspection and Testing section below.

6.3.4 Inspection and Testing of Cell Perimeter Embankment

QC shall visually inspect the material preparation, ground preparation, and fill placement operations. QC shall perform in-place density tests with companion moisture tests to verify at least 95 percent of the laboratory maximum dry density in accordance with ASTM D698.

QC shall verify that the perimeter embankment is constructed in accordance with plans and specifications by checking and confirming:

- Interior slopes are 3:1 or 2:1, and exterior slopes are 5:1 with a minimum 30-foot-wide level top verified one time at the end of excavation.
- Fill material is properly moisture conditioned near optimum moisture.
- 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 inches.
- Embankment construction soil is common fill and/or Mancos shale.
- Compaction is properly performed.
- Compaction – Embankment fill shall be compacted with a minimum 45,000-pound static weight compactor. The compactor shall be a footed roller capable of kneading compaction, with feet a minimum of 6 inches in length.
- Compaction Verification Tests – Perform in-place density and moisture content tests on compacted fill material in accordance with the In-Place Density Testing sections below.
- Verification tests of in-place density shall be performed on initial layers of soil placed and on any specific type of material for which the computer-based compaction system is used.

Testing and verification frequencies for lifts constructed without the computer-based compaction system shall be in accordance with the following.

Testing of Cell Perimeter Embankment

- For material compacted by other than hand-operated machines: One test per 50,000 square feet or 1,850 cubic yards of material placed (or fraction thereof), a minimum of one test for each lift of fill or backfill, and a minimum of two tests per day that fill is compacted in accordance with ASTM D6938.
- One test per 500 square feet (or fraction thereof) of each lift of fill or backfill areas for material compacted by hand-operated machines.

In place density and moisture content tests shall be performed in accordance with the following methods.

- ASTM D1556
- ASTM D2216
- ASTM D4643
- ASTM D6938

Check Tests on In-Place Densities
If ASTM D6938 is used, check in-place densities by ASTM D1556 as follows:
- One check test for each 20 tests of fill or backfill compacted by other than hand-operated machines (per ASTM D698).
- One check test for each 10 tests of fill or backfill compacted by hand-operated machines (per ASTM D6938).

Optimum Moisture and Laboratory Maximum Density
Perform laboratory density and moisture content tests (ASTM D698 and ASTM D2216) for each type of fill material to determine the optimum moisture and laboratory maximum density values. One representative density test per material type and every 20,000 cubic yards thereafter or when any change in material occurs that may affect the optimum moisture content or laboratory maximum dry density.

One correlation test for moistures every 10 tests per ASTM 6938 will be performed in accordance with ASTM D4643 or D2216. In the stockpile, excavations, or borrow areas, perform moisture tests to control the moisture content of material being placed as fill.

Control of moisture content of fill shall be performed by conducting routine testing of moisture content by one of the following tests.
- ASTM D2216
- ASTM D4643
- ASTM D4944
- ASTM D4959

During unstable weather, perform tests as dictated by local conditions and approved by the Crescent Junction Operations/Site Manager.

6.3.5 Disposal Cell Spoils Embankment (Wedge)
The spoils embankment is a fill embankment to be constructed north of the cell. The embankment will divert storm water from the Book Cliffs around the cell and shall be constructed of surplus excavated material (spoils material) from the cell excavation.

Before placement, spoils material shall be tested to determine its maximum dry density in accordance with ASTM D698, and the moisture content shall be modified to bring the fill to near optimum for compaction.

Constructing the Spoils Embankment
1. Prepare the ground beneath the proposed perimeter embankment by stripping vegetation and loose soil from the site.
2. Dump and spread fill in loose lifts of nearly uniform thickness, not to exceed 12 inches.
3. Compact material with rollers, equipment tracks, or successive passes of scrapers. Fill shall be compacted to a density of 90 percent of the laboratory-determined maximum density in accordance with ASTM D698.

QC shall verify the spoils embankment is constructed in accordance with plans and specifications by checking and confirming:

- Exterior slopes are 3:1.
- Fill material is properly moisture conditioned near optimum moisture.
- 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 exceed 12 inches.
- Embankment construction soil is surplus excavated material.
- Compaction is properly performed.
- Compaction – Embankment fill shall be compacted with rollers, equipment tracks, or successive passes of scrapers at a minimum 45,000-pound static weight.
- Compaction Verification Tests – Perform in-place density and moisture content tests on compacted fill material in accordance with the In-Place Density Testing sections below.
- Verification tests of in-place density shall be performed on initial layers of soil placed and on any specific type of material for which the computer-based compaction system is used.

Testing and verification frequencies for lifts constructed without the computer-based compaction system shall be in accordance with the following tests.

Testing Spoils Embankment

- One test per 100,000 square feet or 3,700 cubic yards of material placed for material compacted by other than hand-operated machines.
- One test per 500 square feet (or fraction thereof) of each lift of fill or backfill areas for material compacted by hand-operated machines.

In place density and moisture content tests shall be performed in accordance with the following methods.

- ASTM D1556
- ASTM D2216
- ASTM D6938
- ASTM D4643

Check Tests on In-Place Densities

If ASTM D6938 is used, check in-place densities with ASTM D1556 as follows.

- One check test for each 20 tests of fill or backfill compacted by other than hand-operated machines (per ASTM D6938).
- One check test for each 10 tests of fill or backfill compacted by hand-operated machines (per ASTM D6938).

Optimum Moisture and Laboratory Maximum Density

Perform laboratory density and moisture content tests (ASTM D698 and D2216) for each type of fill material to determine the optimum moisture (optimum moisture content plus or minus five percent) and laboratory maximum density values.

Perform one representative density test per material type and every 20,000 cubic yards thereafter or when any change in material occurs that may affect the optimum moisture content or laboratory maximum dry density. One correlation test for moistures every 10 tests per ASTM D6938 will be performed in accordance with ASTM D4643 or D2216.

In the stockpile, excavations, or borrow areas, perform moisture tests to control the moisture content of material being placed as fill. Control of moisture content of fill shall be performed by conducting routine testing of moisture content by one of the following tests:

- ASTM D2216
- ASTM D4643
- ASTM D4944
- ASTM D4959

During unstable weather, perform tests as dictated by local conditions and approved by the Crescent Junction Operations/Site Manager.

6.4 Residual Radioactive Material

The objective is to place and compact the residual radioactive material (RRM) in the waste cell to create a stable waste mass. QC shall visually inspect the material preparation, ground preparation, RRM placement operations, and shall perform in-place density tests with companion moisture tests for the computer-based compaction system to verify RRM compaction meets the compaction requirements.

QC shall verify RRM placement is performed in accordance with plans and specifications and that the top of the placed waste matches the final grades identified in Section 6.4.5. RRM shall not be placed when frozen or over frozen subgrade. If rainwater ponding has occurred, placement of RRM shall only be performed after the area is dewatered, and approval of the Crescent Junction Operations/Site Manager and QC to place has been obtained.

6.4.1 Moisture Modification

RRM material should be shipped from the Moab site at or near optimum moisture for compaction. Some RRM may require minor moisture modification when received at Crescent Junction site.

6.4.2 Residual Radioactive Material Placement

Scarify at a minimum the top 1 inch of subsoil or preceding RRM lift using a footed roller or a dozer before placing subsequent RRM layers. Fill materials shall be placed in continuous and planar lifts. The method of dumping and spreading RRM shall result in loose lifts of nearly uniform thickness, with average thickness not to exceed 24. Compaction equipment shall consist of footed rollers or dozers. Footed rollers shall have a minimum weight of 45,000 pounds and at least one tamping foot shall be provided for each 110 square inches of drum surface.

The length of each tamping foot from the outside surface of the drum shall be at least 6 inches. During compaction operations, the spaces between the tamping feet shall be maintained clear of materials that would impair the effectiveness of the tamping foot rollers. Dozers shall have a minimum ground pressure of 1,650 pounds per feet. The computer-based compaction system may be used to direct fill placement, monitor compaction, and record the location and thickness of each soil layer being placed.

6.4.3 Inspection and Testing

QC shall visually inspect the ground preparation and fill placement operations. RRM shall be compacted to meet 90 percent of the laboratory-determined maximum dry density in accordance with ASTM D698. QC shall verify the RRM placement is constructed in accordance with design plans and specifications by checking and confirming:

- Assessment tests shall be performed on RRM to ensure compliance with specified requirements and to develop compaction requirements for placement. A minimum of three tests for maximum dry density (ASTM D698) and optimum moisture content (ASTM D2216) shall be performed for each type of RRM soil observed.
- Fill material is properly moisture conditioned; one moisture content quick test will be performed each day material is placed in accordance with ASTM D4643, D4944, or D4959 until a sufficient number have been performed to demonstrate a clear correlation allowing a reduction in testing.
- Fill material is placed in continuous and planar lifts. The method of dumping and spreading RRM shall result in loose lifts of nearly uniform thickness, with average thickness of fill area not to exceed 24 inches.
- Compaction meets specifications.
- Compaction by the computer-based compaction system – QC shall monitor the computer-based compaction system compaction by visually inspecting the process and reviewing the computer records for each layer of soil placed.
- Verification tests of in-place density shall be performed on the initial layer of RRM and on any layers in which the computer-based compaction system indicates problems occurred obtaining compaction. In-place density will be taken every 6 months to verify the performance of the computer-based compaction system.

NOTE: Companion sand cone and moisture tests must be performed along with nuclear tests until a sufficient number have been performed to demonstrate a clear correlation.

If the computer-based compaction system is not used, the following testing requirements shall be followed.

- Compaction Verification Tests – Perform in-place density and moisture content tests on compacted fill material in accordance with the following requirements.
  - A verification representative sample from each principal type or combination of blended RRM materials shall be tested to establish compaction curves using ASTM D698.
  - A minimum of one set of compaction curves shall be developed per 10,000 cubic yards of RRM material.
  - In-place density and moisture content tests are performed on a soil layer; a minimum of two tests shall be performed per 5,000 cubic yards or 135,000 square feet of fill material placed.
- Compaction and moisture content tests shall be performed in accordance with the following methods:
  - ASTM D1556
  - ASTM D2216
  - ASTM D6938
  - ASTM D4643
- Erosion that occurs in the RRM layers shall be repaired and grades re-established before proceeding.

- Freezing and desiccation of the RRM soil shall be prevented. If freezing or desiccation occurs, the affected soil shall be reconditioned.
- Areas that have been repaired shall be retested. Repairs to the RRM layers shall be documented, including location and volume of soil affected, corrective action taken, and results of retests.

6.4.4 Demolition Debris

Demolition debris will be placed in the cell along with RRM.

Debris shall not contain free liquids. Debris shall be sized to minimize voids. Pipes and ducts 6 inches or greater in diameter shall be crushed or, if crushing is impractical, shall be longitudinally cut in half or filled. Rubber tires shall be cut and placed to minimize void space. Debris shall be spread and/or oriented in a manner that results in a minimum of voids.

Debris may be placed as a sacrificial lift at the bottom of the disposal cell in a 2-foot lift. Debris in sacrificial lifts shall contain no free liquids and shall be oriented in a manner that minimizes voids, and contained within the 2-foot lift profile. Sacrificial debris lifts are not subject to moisture and compaction criteria.

6.4.5 Final RRM Geometry

The top surface of the RRM shall be no greater than 2 inches above the lines and grades shown on the drawings and verified by survey or the use of the computer-based compaction system. No minus tolerance will be permitted.

6.5 Interim Cover

After a section the RRM has been placed in the waste cell to final grade and verified by survey, an interim cover consisting of 1 foot of clean, compacted soil shall be placed over the RRM. Interim cover material will be placed and compacted directly on top of RRM to provide a buffer of uncontaminated soil before placement of the final multi-layer cap. A protective layer may be placed as mentioned in section 6.5.5.

6.5.1 Material

Interim cover soil will be from the excavation of the Crescent Junction waste cell. It will be material that has been produced on site by modifying the existing overburden soil and weathered Mancos Shale excavated on site. Overburden and weathered Mancos Shale shall be excavated, pulverized, wetted, and mixed to produce a uniform, fine-grained soil near optimum moisture content for compaction. Soil shall be free of roots, debris, and organic or frozen material.

6.5.2 Ground Preparation

The RRM beneath the proposed interim cover shall be prepared by scarifying to a minimum depth of 1 inch before placing the initial lift of interim cover soil.

6.5.3 Lift Placement and Thickness

The interim cover shall be constructed of fill materials placed in continuous lifts of uniform thickness. The method of dumping and spreading interim cover soil over the RRM shall result in loose lifts with average thickness not to exceed 12 inches.

6.5.4 Inspection and Testing

QC shall visually inspect the ground preparation and fill placement operations. The interim cover layer shall be compacted to meet 90 percent of the laboratory-determined maximum dry density in accordance with ASTM D698.

QC shall verify the interim cover is constructed in accordance with plans and specifications by checking and confirming:

- A representative sample from each type or combination of stockpiled excavated soil for use as interim cover soil shall be tested to establish a compaction curve using ASTM D698.
- Interim cover is properly moisture conditioned tested in accordance with ASTM D4643, D4944, or D4959, and moisture content shall be within the range needed to achieve a minimum of 90 percent of the laboratory-determined maximum dry density of each material type.
- Interim cover is placed in continuous and approximately horizontal lifts. The method of dumping and spreading interim cover shall result in loose lifts of nearly uniform thickness, with average thickness not to exceed 12 inches.
- Compaction is properly performed.
- Compaction by computer-based compaction system – QC shall monitor the computer-based compaction system compaction by visually inspecting the process and reviewing the computer records for each layer of soil placed.
- Verification tests of in-place density shall be performed on the first 5,000 cubic yards of interim cover and on any layers in which the computer-based compaction system indicates that problems occurred obtaining compaction.

NOTE: Companion sand cone tests and moisture tests must be performed along with nuclear tests until a sufficient number have been performed to demonstrate a clear correlation.

If the computer-based compaction system is not used, the following testing requirements shall be followed.

- Compaction Verification Tests – Perform in-place density and moisture content tests on compacted fill material in accordance with the following requirements.
  - When verification, in-place density, and moisture content tests are performed on a soil layer, a minimum of two tests shall be performed per 5,000 cubic yards or 135,000 square feet of fill material placed.
  - A representative sample from each type or combination of stockpiled excavated soil for use as interim cover soil shall be tested to establish a compaction curve using ASTM D698.
  - Interim cover is properly moisture conditioned and tested in accordance with ASTM D4643, D4944, or D4959. The moisture content range needed to achieve a minimum of 90 percent of the laboratory-determined maximum dry density of each material type.
  - Interim cover is placed in continuous and approximately horizontal lifts. The method of dumping and spreading interim cover shall result in loose lifts of nearly uniform thickness, with average thickness not to exceed 12 inches.
  - Compaction is properly performed.
  - Compaction and moisture content tests shall be performed in accordance with the following methods.
    - ASTM D1556
    - ASTM D2216
    - ASTM D6938

- ASTM D4643
- ASTM D698

NOTE: Companion sand cone tests and moisture tests must be performed along with nuclear tests until a sufficient number have been performed to demonstrate a clear correlation.

- After lift placement, moisture content shall be maintained until the next lift is placed.
- Erosion that occurs in the interim cover layer shall be repaired and grades re-established.
- Freezing and desiccation of the interim cover soil shall be prevented. If freezing or desiccation occurs, the affected soil shall be reconditioned.
- Areas that have been repaired shall be re-tested. Repairs to the interim cover layer shall be documented, including location and volume of soil affected, corrective action taken, and results of retests.

6.5.5 Final Interim Cover Geometry

The top surface of the interim cover shall be no greater than 2 inches above the lines and grades shown on the drawings. No minus tolerance will be permitted. If the radon barrier is not placed immediately after completion of the interim cover, it is acceptable to use a best management practice of placing a protective layer of 0.8 foot (minimum) on the interim cover, which will protect the interim cover from damaged caused by erosion and roots and self-sown vegetation. The vegetation does not have to be removed until the radon barrier placement. The protective layer can be cleared of vegetation and re-used as a part of the radon barrier.

6.6 Cap Construction

An UMTRA cover (a multi-layer cap) will be constructed over the RRM and interim cover. The cap materials and configuration are intended to protect the RRM from exposure due to water erosion, wind erosion, and burrowing animals for a design life of 1,000 years. The proposed cap layers are shown in the UMTRA cover design figure in Section 6.7.1.

6.7 Radon Barrier Layer

The initial cap layer is a 4-foot-thick radon barrier layer constructed of compacted clay soil. The radon barrier will be a low-permeability clay layer that limits radon emissions from the RRM and limits the infiltration of water from above.

6.7.1 Material

The radon barrier layer will be constructed of processed Mancos Shale. The clay soil will be produced on site by processing excavated Mancos Shale into a fine-grained soil and adding water to bring the Mancos Shale to near optimum moisture content for compaction.

Assessment tests shall be performed on radon barrier material to ensure compliance with specified requirements and to develop compaction requirements for placement. A minimum of three tests for maximum dry density (ASTM D698); optimum moisture content tests (ASTM D2216) shall be performed for each type of soil observed to establish the optimum moisture for radon barrier material placement.

At a minimum, perform the following soil tests on each 10,000 cubic yards of soil.

- ASTM D4318
- ASTM D1140
- ASTM D422
- ASTM D698
- ASTM D2216 or D4643

6.7.2 Ground Preparation

The interim cover layer beneath the proposed radon barrier layer shall be prepared by scarifying to a minimum depth of 1 inch before placing the initial lift of radon barrier soil. Scarification shall be performed on the upper surface of each underlying soil layer before placement of the next lift.

The final lift of radon barrier shall not be scarified; it shall be smooth-rolled with a minimum of three passes with a smooth, steel-wheeled roller with a minimum weight of 20,000 pounds to provide a smooth surface.

6.7.3 Lift Placement and Thickness

The radon barrier layer shall be constructed of fill materials placed in continuous lifts of uniform thickness. The method of dumping and spreading radon barrier shall result in loose lifts not to exceed 12 inches. Compaction equipment shall consist of rubber-tired or footed-roller compaction equipment with a minimum weight of 45,000 pounds. The in-place material may contain particles up to 4 inches.

Placement of Mancos Shale will be visually inspected to make sure 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.

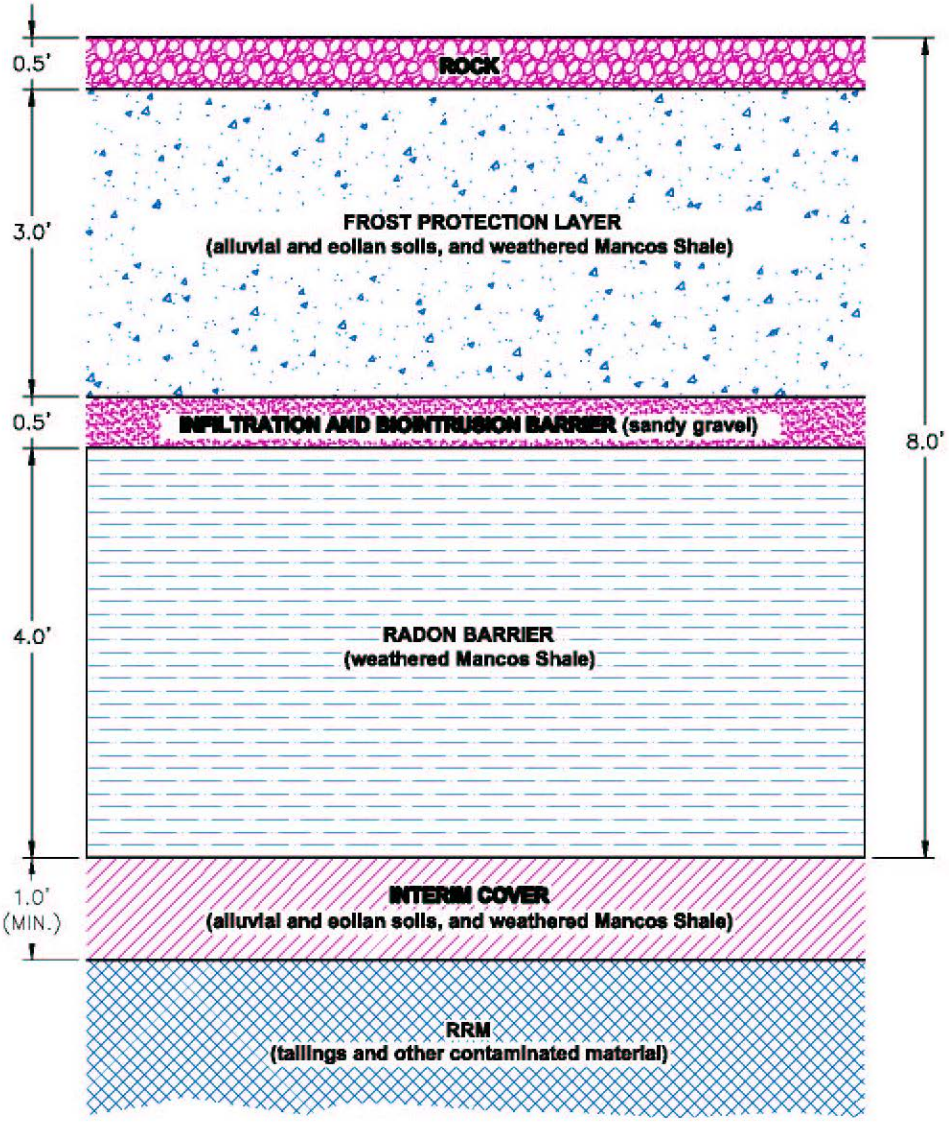
6.7.4 Inspection and Testing

QC shall visually inspect the processing of Mancos Shale into clay soil, ground preparation, and fill-placement operations. QC shall perform in-place density tests with companion moisture tests to verify optimum moisture plus or minus 3 percent and at least 95 percent of the material's maximum dry density according to ASTM D698.

QC shall verify the radon barrier is constructed in accordance with plans and specifications by checking and confirming:

- Fill material is properly moisture conditioned; one moisture content test will be performed each day material is placed in accordance with ASTM D4643, D4944, or D4959, with moisture content plus or minus 3 percent.
- Material is placed in continuous uniform thickness lifts. The method of dumping and spreading the radon barrier shall result in loose lifts not to exceed 12 inches.
- Radon barrier soil is processed Mancos Shale.
- Tests have been performed on the processed shale soil to determine its maximum dry density and optimum moisture content.
- Compaction – Radon barrier fill is compacted with rubber-tired or footed-roller compaction equipment.

- Compaction by the computer-based compaction system – QC shall monitor the computer-based compaction system compaction by visually inspecting the process and reviewing the computer records for each layer of soil placed.
- Verification tests of in-place density shall be performed on the initial layer of radon barrier placed and on any layers in which the computer-based compaction system indicates problems occurred obtaining compaction.
- Maximum particle size in the fill material shall be 4 inches.
- Placement of Mancos shale will be visually inspected to make sure there are no locations where rock-type particles accumulate in a concentrated location.



UMTRA COVER DESIGN

NOTE: Companion sand cone tests and moisture tests must be performed along with nuclear tests until a sufficient number have been performed to demonstrate a clear correlation.

If the computer-based compaction system is not used, the following testing requirements shall be followed.

- Compaction Verification Tests – Perform in-place density and moisture content tests on compacted fill material in accordance with the following requirements.
  - A verification representative sample from each principal type or combination of blended radon barrier materials shall be tested to establish compaction curves using ASTM D698. A minimum of one set of compaction curves shall be developed per 10,000 cubic yards of radon barrier material.
  - In-place density and moisture content tests are performed on a soil layer; a minimum of two tests shall be performed per 5,000 cubic yards or 135, 000 square feet of fill material placed.
  - Fill material is properly moisture conditioned in accordance with ASTM D4643, D4944, or D4959, with moisture content plus or minus 3 percent.
  - Material is placed in continuous uniform thickness lifts. The method of dumping and spreading radon barrier shall result in loose lifts not to exceed 12 inches.
  - Radon barrier soil is processed Mancos Shale.
  - Tests have been performed on the processed shale soil to determine its maximum dry density and optimum moisture content.
  - Compaction – Radon barrier fill is compacted with rubber-tired or footed-roller compaction equipment.
  - Maximum particle size in the fill material shall be 4 inches.
  - Placement of Mancos Shale will be visually inspected to make sure there are no locations where rock-type particles accumulate in a concentrated location
  - Compaction and moisture content tests shall be performed in accordance with the following methods.
    - ASTM D1556
    - ASTM D2216
    - ASTM D6938
    - ASTM D4643
    - ASTM D698

NOTE: Companion sand cone tests and moisture tests must be performed along with nuclear tests until a sufficient number have been performed to demonstrate a clear correlation.

- After placement, moisture content shall be maintained or adjusted to meet criteria.
- Erosion that occurs in the fill layers shall be repaired and grades re-established.
- Freezing and desiccation of the radon barrier layer shall be prevented. If freezing or desiccation occurs, the affected soil shall be removed or reconditioned.
- Areas that have been repaired shall be retested. Repairs to the radon barrier layer shall be documented, including location and volume of soil affected, corrective action taken, and results of retests.

6.7.5 Initial and Confirmatory Surveys

Verification of the thickness of the radon barrier layer will be performed by comparing before and after surveys of the layer by surveying or using the computer-based compaction system. Before placing the radon barrier layer, an initial survey shall be performed of the section to be capped.

The initial survey will document the pre-cap geometry of the site. After the radon barrier layer has been installed, a post-installation survey will be performed on the top of the radon barrier fill to confirm that the total fill thickness is in accordance with the plans and specifications.

6.8 Infiltration and Biointrusion Barrier (Gravel)

Above the radon barrier layer, a 6-inch-thick infiltration and biointrusion layer of gravel will be placed to provide a barrier to burrowing animals and a pathway for drainage of water that has infiltrated through upper layers of the cap. The gravel will be a sandy gravel with a gradation in accordance with Project plans and specifications. Rock shall be spread to the thickness indicated on the drawings or in accordance with oversizing due to scoring criteria. Rock placement shall be guided by GPS grade control to ensure the appropriate thickness has been placed at all locations. The biointrustion layer shall be compacted with a smooth steel drum.

6.8.1 Erosion Protection Materials Testing

Rock for the infiltration and biointrusion barrier layer shall be tested by a commercial testing laboratory during production in accordance with the following:

Test Method	Reference
SSD Specific Gravity	ASTM C127
Sodium Sulfate Soundness (5 cycles)	ASTM C88
L.A. Abrasion (100 cycles)	ASTM C131
Schmidt Rebound Hardness	International Society of Rock Engineers (ISRM) Method

Test results shall be submitted to a commercial testing lab for analysis and subsequent acceptance or rejection or the material represented by the test results, based on engineering calculations.

Rock for the infiltration and biointrusion barrier layer shall be tested for gradation in accordance with ASTM C-117 and C-136 and other approved testing methods. Test results shall be in accordance with the design specifications.

Rock for the final cover layers shall be tested a minimum of three times. The materials shall be tested initially before the delivery of any of the materials to the site for gradation and durability, then from the on-site stockpile at the beginning of placement for gradation. Lastly, testing shall be performed for every 5,000 square yards of material delivered. All placed material shall be visually inspected during and after placement. The visual inspections shall verify (1) no nesting of fines, (2) no nesting of small-large aggregates in a concentrated area, and (3) all aggregate material is interlocking.

Rock for the infiltration and biointrusion barrier layer shall be material that has long-term chemical and physical durability. The material shall achieve an acceptable score for its intended use in accordance with the rock scoring and acceptance criteria.

6.8.2 Rock Acceptance Criteria

An acceptable rock score depends on the intended use of the rock. The rock's score must meet the following criteria:

- For occasionally saturated areas, which include the top and sides of the final cover, the rock must score at least 50 percent, or the rock is rejected. If the rock scores between 50 percent and 80 percent, the rock may be used, but a larger median stone diameter (D50) must be provided (oversizing). If the rock score is 80 percent or greater, no oversizing is required.
- For frequently saturated areas, which include all channels and buried slope toes, the rock must score 65 percent, or the rock is rejected. If the rock scores between 65 and 80 percent, the rock may be used, but must be oversized. If the rock score is 80 percent or greater, no oversizing is required.

Oversizing Rock

- Subtract the rock score from 80 percent to determine the amount of oversizing required. For example, a rock with a rating of 70 percent will require oversizing of 10 percent (80 percent – 70 percent = 10 percent).
- The D50 of the stone shall be increased by the oversizing percent. For example, a stone with a 10 percent oversizing factor and a D50 of 12 inches will increase to a D50 of 13.2 inches.
- The final thickness of the stone layer shall increase proportionately to the increased D50 rock size. For example, a layer thickness equals twice the D50, such as when the plans call for 24 inches of stone with a D50 of 12 inches; if the stone D50 increases to 13.2, the thickness of the layer of stone with a D50 of 13.2 should be increased to 26.4 inches.

QC shall verify the infiltration and biointrusion layer is installed in accordance with plans and specifications by checking and confirming:

- Gravel material gradation matches the gradation required in the specifications.
- Gravel material is placed and compacted to produce a continuous uniform thickness of at least 6 inches.
- Compaction is performed by a smooth steel-drum roller with a minimum of two passes over the placed gravel fill.

6.9 Frost Protection Layer

Above the infiltration and biointrusion layer a 3-foot-thick frost protection layer will be installed. This soil layer will provide protection for the low-permeability radon barrier layer beneath. The frost protection layer will consist of 3 feet of clean, compacted soil that shall be placed directly on the gravel infiltration and biointrusion layer.

6.9.1 Material

The frost protection layer will be constructed of common fill. The fill shall come from the cell excavation, tested to determine its maximum dry density, and the moisture content modified to bring the fill to optimum for compaction in accordance with ASTM D698.

6.9.2 Ground Preparation

The frost protection layer will be placed directly on the gravel infiltration and biointrusion layer.

6.9.3 Lift Placement and Thickness

The frost protection layer shall be constructed of fill materials placed in continuous lifts of uniform thickness. The method of dumping and spreading the frost protection layer shall result in loose lifts, with average thickness not to exceed 12 inches. Scarification shall be performed on all areas of the upper surface of each underlying soil layer before placing the next lift. The final lift of soil shall not be scarified. The final lift shall be smooth-rolled with at least three passes of the approved smooth, steel-wheeled roller weighing a minimum of 20,000 pounds.

6.9.4 Inspection and Testing

QC shall visually inspect the material preparation, ground preparation, and fill placement operations. QC shall perform in-place density tests with companion moisture tests. Frost protection soil shall be placed and compacted within a moisture content range that will achieve at least 90 percent of the material's maximum dry density on the initial layer according to ASTM D698.

QC shall verify the frost protection layer is constructed in accordance with plans and specifications by checking and confirming:

- Frost protection layer soil is common fill.
- Tests have been performed on the common fill to determine its maximum dry density and optimum moisture content per ASTM D698.
- Fill material is properly moisture conditioned to near optimum moisture.
- Fill material is placed in continuous and approximately horizontal lifts. The method of dumping and spreading the frost protection layer shall result in loose lifts of nearly uniform thickness, with average thickness not to exceed 12 inches.
- Compaction is properly performed.
- Compaction – Frost protection fill will be compacted with rubber-tired or footed-roller compaction equipment.
- Compaction by the computer-based compaction system – QC shall monitor the computer-based compaction system compaction by visually inspecting the process and reviewing the computer records for each layer of soil placed.
- Verification tests of in-place density shall be performed on initial layers of soil placed and on any layers in which the computer-based compaction system indicates problems occurred obtaining compaction.

NOTE: Companion sand cone and moisture tests must be performed along with nuclear tests until a sufficient number have been performed to demonstrate a clear correlation.

If the computer-based compaction system is not used, testing requirements below shall be followed.

- Compaction Verification Tests – Perform in-place density and moisture content tests on compacted fill material in accordance with the following requirements:
  - When verification, in-place density, and moisture content tests are performed on a soil layer, a minimum of two tests per 5,000 cubic yards or 135,000 square feet of fill material placed.
  - Frost protection layer soil is common fill.
  - Tests have been performed on the common fill to determine its maximum dry density and optimum moisture content per ASTM D698.
  - Fill material is properly moisture conditioned.
  - Fill material is placed in continuous and approximately horizontal lifts. The method of dumping and spreading the frost protection layer shall result in loose lifts of nearly uniform thickness, with average thickness not to exceed 12 inches.

- Compaction is properly performed.
- Compaction – Frost protection fill will be compacted with rubber-tired or footed-roller compaction equipment.
- Compaction and moisture content tests shall be performed in accordance with the following methods:
  - ASTM D1556
  - ASTM D698
  - ASTM D2216
  - ASTM D2922
  - ASTM D6938
  - ASTM D4643

NOTE: Companion sand cone tests and moisture tests must be performed along with nuclear tests until a sufficient number have been performed to demonstrate a clear correlation.

6.9.5 Initial and Confirmatory Surveys

Verification of the thickness of the frost protection layer will be performed by comparing before and after surveys of the layer. Before placing the frost protection layer, an initial survey of the section to be capped shall be performed. The initial survey will document the geometry of the top of the infiltration and biointrusion layer. After the frost protection layer has been installed, a post-installation survey will be performed on the top of the frost protection layer to confirm the total fill thickness is in accordance with the plans and specifications.

6.10 Rock Armoring

The final cap layer is rock armoring placed over the frost protection layer. The rock armoring will vary in size and thickness at different locations on the cap and shall be installed in accordance with Project plans and specifications. Rock shall be spread to the thickness indicated on the drawings or in accordance with oversizing due to scoring criteria. Rock placement shall be guided by a GPS system to ensure the appropriate thickness has been placed at all locations. Stone shall be compacted with a smooth steel drum.

6.10.1 Erosion Protection Materials Testing

Rock for the final cover layers shall be tested by a commercial testing laboratory during production in accordance with the following:

Rock Armoring	**Reference**
Specific Gravity (SSD)	ASTM C127 (Absorption)
Sodium Sulfate Soundness (5 cycles)	ASTM C88 (Coarse Aggregate)
L.A. Abrasion (100 cycles)	ASTM C131 (Abrasion)
Schmidt Rebound Hardness	ISRM Method

Test samples shall be submitted to a commercial testing lab for analysis and subsequent acceptance or rejection of the material represented by the test results, based on engineering calculations.

Rock for the final cover layers shall be tested for gradation in accordance with ASTM C-117 and C-136 and other approved testing methods. Test results shall be in accordance with the design specifications.

Rock for the final cover layers shall be tested a minimum of three times. The materials shall be tested initially before the delivery of any of the materials to the site for gradation and durability, then from the on-site stockpile at the beginning of placement for gradation. Lastly, testing shall be performed for every 5,000 yd^3 of material delivered. All placed material shall be visually inspected during and after placement. The visual inspections shall verify: (1) no nesting of fines, (2) no nesting of small-large aggregates in a concentrated area, and (3) all aggregate material interlocks

Rock for the final cover layers shall be rock material that has long-term chemical and physical durability. Rock for final cover layers shall achieve an acceptable score for its intended use, in accordance with the rock scoring and acceptance criteria.

A geologist will periodically inspect the stockpiles at the quarry operations to ensure the percentage of other than gray basalt does not exceed 10 percent for rock for the final cover layers.

6.10.2 Rock Acceptance Criteria

An acceptable rock score depends on the intended use of the rock. The rock's score must meet the following criteria:

- For occasionally saturated areas, which include the top and sides of the final cover, the rock must score at least 50 percent, or the rock is rejected. If the rock scores between 50 and 80 percent, the rock may be used, but a larger D50 must be provided (oversizing). If the rock score is 80 percent or greater, no oversizing is required.
- For frequently saturated areas, which include all channels and buried slope toes, the rock must score 65 percent, or the rock is rejected. If the rock scores between 65 and 80 percent, the rock may be used, but must be oversized. If the rock score is 80 percent or greater, no oversizing is required.

Oversizing Rock

- Subtract the rock score from 80 percent to determine the amount of oversizing required. For example, a rock with a rating of 70 percent will require oversizing of 10 percent (80 percent – 70 percent = 10 percent).
- The D50 of the stone shall be increased by the oversizing percentage. For example, a stone with a 10 percent oversizing factor and a D50 of 12 inches will increase to a D50 of 13.2 inches.
- The final thickness of the stone layer shall increase proportionately to the increased D50 rock size. For example, a layer thickness equals twice the D50, such as when the plans call for 24 inches of stone with a D50 of 12 inches; if the stone D50 increases to 13.2, the thickness of the layer of stone with a D50 of 13.2 should be increased to 26.4 inches.

QC shall verify the rock armoring is installed in accordance with plans and specifications by checking and confirming stone material is placed to produce the thickness required by the plans for each area. At a minimum, depth verification will be performed every 10,000 cubic yards.

6.11 Settlement Monitoring

A grid system shall be established for periodic surveys to monitor cell settlement. This system will be transferred to DOE Legacy Management for continued cell settlement monitoring.

Cell Construction Material Installation Summary Table

Cell Component	Material of Construction	Compaction Requirements	Lift Thickness max/approx loose/compact	Frequency of Verification Tests
Cell Excavation	NA	NA	NA	NA
Perimeter Embankment	Common Fill	95 percent	12 inches/10 inches	Initial layer/Section 6.3.4
RRM Placement	RRM	90 percent	Average thickness 24 inches/ 20 inches	Initial layer/Section 6.4.3
Interim Cover	Common Fill	90 percent	Average 12 inches/10 inches	Initial layer/Section 6.5.4
Radon Barrier	Weathered Mancos Shale	95 percent	12 inches/10 inches	Initial layer/Section 6.7.4
Infiltration and Biointrusion Barrier	Stone	NA	NA	NA
Frost Protection	Common Fill	90 percent	Average thickness 12 inches/10 inches	Initial layer/Section 6.9.4
Cap Armoring	Stone	NA	NA	NA

7.0 Records

All documentation created as a result of compliance with this Plan is considered a Project record and will be managed in accordance with the *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545), which follows DOE orders, policies, and regulations for retention and maintenance of records.

Test and inspection records shall be reported and filed in a timely manner, consistent with the status of work performed. Inspection and test status shall be available at all times to prevent inadvertent by-passing of an inspection or test.

Test and inspection records shall contain the following, at a minimum.

- Items tested or inspected
- Date of test or inspection
- Tester/inspector
- Type of test or inspection
- Results and acceptability, including the test or inspection acceptance criteria
- Identification number of instrument used in performing the test or inspection
- Action taken in connection with any deviations noted
- Person evaluating test results, if different from person named in paragraph

Test and inspection records shall be filed and maintained in accordance with the *Records Management Manual*. Surveillances shall be performed by QA of measure and test equipment used by QC. Daily Inspection Reports shall be generated, describing the adequacy, discrepancies, progress, dispositions, and details of each day's construction activities. Permanent QA/QC records shall be periodically evaluated through internal and external surveillances and audits.

QC reports shall be generated daily, summarizing the volume of placed materials and the number of lifts approved. A summary of this information shall be included in the RAC's weekly Project status report submitted to DOE.

DOE–EM/GJRAC1783

Office of Environmental Management – Grand Junction

MOAB UTAH
UMTRA Project

Moab UMTRA Project Moisture/Density Testing Procedure

Revision 4

April 2019

U.S. Department of Energy

Office of Environmental Management

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

DOE-EM/GJRAC1783

Moab UMTRA Project
Moisture/Density Testing Procedure

Revision 4

Review and Approval

4/18/2019

X 

Mitch Hogan
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Signed by: Mitch Hogan

4/16/2019

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4/17/2019

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4/30/2019

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Steven D. Rima
RAC Environmental, Safety, Health, and Qua...
Signed by: Shawn Bradfield

Revision History

Revision	Date	Reason for Revision
0	February 2009	Initial issue.
1	April 2011	Added revised Lift Approval Form and added Emergency Procedure for Troxler gauge damage.
2	January 2013	Revision includes updated text and forms.
3	June 2014	Revision includes content revisions throughout for clarification.
4	April 2019	Revision includes changing Troxler to nuclear gauge or adding nuclear gauge throughout. In Section 2.3, changed DOE-EM/GJRAC1885 to DOE-EM/GJ610. In Section 3.1, removed moisture requirements for RRM, interim cover, and frost protection layers. Changed standard count performed from start of each day to prior to tests for day. Added "density standard count must be within ranges established." Added 5 percent and 10 percent deviation to sand cone for correlation. Added "or" for compaction and moisture requirements.

Contents

Attachments

1.0 Purpose and Scope

1.1 Purpose

This procedure provides requirements and methods for the proper moisture/density testing of soils placed at the U.S. Department of Energy (DOE) Moab Uranium Mill Tailings Remedial Action (UMTRA) Project.

1.2 Scope

This procedure applies to the moisture/density testing of all soil materials placed at the Moab UMTRA Project.

2.0 General

2.1 Definitions

Authorized user **–** One who has met the training requirements in Section 2.3 of this procedure, has the proper thermoluminescent dosimeter (TLD) (or equivalent) with neutron dosimetry, and is authorized to use the nuclear gauge by the Radiological Control Manager.

Compactable soils – Having a bulk density greater than 70 pounds per cubic foot dry weight in accordance with ASTM International (ASTM) D698, "Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))." Compactable soils are also graded material that will pass through a 4-inch grizzly and have soil-like properties.

Frozen material – Material that contains frost or ice or cannot meet the compaction requirements because of frozen water inside the material.

Lift area **–** An area of the embankment identified for placement.

Lift identification **–** A discrete number that consists of:

- Moab UMTRA Project (e.g., U for UMTRA Project cell)
- Work Element: W for residual radioactive material (RRM) placement, I for interim cover placement, R for radon barrier placement, B for biointrusion placement, F for frost protection placement, C for cap rock placement, E for embankment placement, CF for cell floor).
- Lift Area –A1, B1, C1, year, month, and day (e.g., UWA1090117, UIA1090117, URA1090117, UBA1090117, UFA1090117, UCA1090117).
- Number of lifts tested and approved for a specific lift area on the same day (e.g., first lift -00, second lift -01)

Example:
U for Moab UMTRA Project, W for RRM lift, A1 for lift area, 121206 date for day the lift was first tested, -00 for first lift tested that day (e.g., UWA1121206-00).

NOTE: The day the lift area is first tested will be the date used for lift identification.

Lot – A portion of a lift area that shall be tested individually to ensure it meets compaction requirements.

Old/new lift interface **–** The intersection of the old lift and the new lift.

Random number – A number between 0.001 and 0.999 generated from a calculator or computer with a random generator.

Standard count – A measurement of a known reference to ensure accurate gauge readings.

Standard proctor **–** ASTM D698.

Nuclear Gauge – A moisture/density gauge that uses radioactive materials to determine in-place moisture and density. Special requirements are employed for use and security maintenance of the nuclear gauge.

2.2 Responsibilities

2.2.1 Quality Assurance Manager

The Quality Assurance (QA) Manager is responsible for:

- Implementing and directing quality control (QC) activities contained within this procedure.
- Identifying QC problems.
- Initiating, recommending, or providing QC solutions.

2.2.2 Quality Assurance/Quality Control Representative

The QA/QC Representative is responsible for proper implementation of this procedure.

2.2.3 Quality Technician or Qualified Personnel

The QC Technician or qualified personnel is responsible for following the testing and disposal process of this procedure.

2.2.4 Radiation Control Technician

The Radiation Control Technician is responsible for:

- Performing necessary surveys to minimize workers' exposure in accordance with the *Moab UMTRA Project ALARA Program* (DOE-EM/GJRAC1922).
- Posting radiation hazards in accordance with the *Moab UMTRA Project Radiological Posting and Access Control Procedure* (DOE-EM/GJRAC1748).
- Posting requirements for radiation hazards.
- Briefing radiation workers that enter a controlled area under a radiological work permit (RWP).

2.2.5 Equipment Operator

The equipment operator is responsible for handling and placing the waste.

2.2.6 Authorized User

The authorized user is responsible for:

- Maintaining nuclear gauge security.
- Maintaining compliance with the requirements of this procedure
- Minimizing any radiation exposures from the nuclear gauge.

2.2.7 Radiological Control Manager

The Radiological Control Manager is responsible for:

- Overseeing the Radiation Protection Program at the UMTRA Moab Project.
- Designating, in writing, personnel authorized to use the nuclear density gauge.

2.3 Precautions and Limitations

- Work shall be immediately terminated by any personnel who feel the activity in progress is unsafe and/or may cause an unsafe condition. Work will be resumed when the condition is corrected.
- All workers are responsible to ensure they have met the requirement of the appropriate Integrated Work Plan/Job Safety Analysis and RWP.
- All personnel shall remain clear of any operating equipment.
- All personnel using the nuclear gauge shall attend the 8-hour Nuclear Moisture/Density Gauge training before use.
- New users shall be required to contact the Radiological Control Manager to add their names to the authorized user list.
- Before removing the nuclear gauge from its designated storage location, the responsible authorized user shall ensure the gauge source rod is in the shielded, locked position and that the transport case is locked.
- The nuclear gauge shall be kept under constant surveillance by the authorized user for as low as reasonably achievable (ALARA) and security purposes.
- The nuclear gauge shall not be chained to a post, chained in the back of an open bed truck, or secured in a similar manner when not in constant surveillance, transport, or in storage.
- Nuclear gauge users are required to use a minimum of two independent physical controls that form tangible barriers to secure portable gauges from unauthorized removal whenever the portable gauges are not under the control and constant surveillance of the licensee; that is, the nuclear gauge shall be locked in the cab of a vehicle and chained to the steering wheel, locked in a secured box and chained in the back of a truck, or locked in the cab of the vehicle inside the restricted area.
- The source rod on the nuclear gauge shall not be touched with fingers, hands, or any part of the body unless needed maintenance is performed by a trained service technician.
- All personnel shall minimize their exposure from the unshielded source rod. Authorized users shall embrace the ALARA principles of time, distance, and shielding to accomplish this and shall limit the access of unnecessary personnel to the nuclear gauge. Never look directly under the gauge when lowering the rod into the ground.
- Authorized users shall comply with the *Moab UMTRA Project Radiation Protection Program* (DOE-EM/GJ610).
- Authorized users shall always wear their assigned TLD (or equivalent) when using the nuclear gauge.
- Authorized users shall always return the source to the locked and shielded position after each measurement is taken.
- Nuclear gauges shall only be stored in approved storage. Gauges are kept in an approved storage location when not under constant surveillance by an authorized user.

- The *Moab UMTRA Project Emergency/Incident Response Plan* (DOE-EM/GJ1520) shall be initiated if the source rod fails to return to the locked position or if the nuclear gauge is damaged in any way that endangers others; a 25-foot area shall be cordoned off around any damaged nuclear gauge.

2.4 Records

All documentation created as a result of compliance with this procedure is considered a Project record and will be managed in accordance with the *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545). Moab UMTRA Records are retained and maintained in accordance with federal orders, policies, and regulations.

All Field Density Test Forms QC-F-002 shall be attached to the appropriate Lift Approval Form QC-F-001. All forms are available on the Project's SharePoint website.

Records shall be reviewed and approved before being sent to Records Management.

The Nuclear Gauge Sign-Out Log Form QC-F-003 shall be completed when the nuclear gauge is used.

3.0 Requirements and Guidance

3.1 Compliance

- Each lift shall be given a discrete designation (lift identification number) for testing and surveying purposes.
- Each lift shall be tested to meet the specifications.
- Radon barriers shall be compacted to at least 95 percent of a standard proctor (ASTM D698) and have a moisture content of ±3 percent of the optimum moisture.
- RRM and interim cover shall be compacted to at least 90 percent of a standard proctor (ASTM D698). Moisture/density testing shall be performed for each waste or fill material in the lift.
- Perimeter embankments shall be compacted to at least 95 percent of a standard proctor (ASTM D698) and have a moisture content of ±5 percent of the optimum moisture.
- Spoils embankments shall be compacted to at least 90 percent of a standard proctor (ASTM D698) and have a moisture content of ±5 percent of the optimum moisture.
- Construction projects shall be in accordance with specifications in each Project construction plan associated documentation.
- Frost protection shall be compacted to at least 90 percent of a standard proctor (ASTM D698).
- All soil density and moisture tests shall be performed with a calibrated nuclear moisture/density gauge in accordance with ASTM D6938, "Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth") or by the sand-cone method in accordance with ASTM D1556, "Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-cone Method."
-

Proficiency testing of the nuclear moisture/density gauge shall be completed by performing a sand-cone density test and an oven or microwave drying test.

- A sand-cone density test (ASTM D1556) shall be performed jointly with 5 percent of all nuclear density tests. The range of deviation for clean fill is 5 percent and 10 percent for waste soils of the dry density.
- An oven or microwave drying test in accordance with ASTM D2216, "Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass," or ASTM D4643, "Standard Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Heating," shall be jointly performed with 10 percent of all nuclear moisture tests.
- A standard count shall be performed prior to testing for the day.
- Density standard counts must be within the ranges established.

NOTE: If the moisture standard count is not within the indicated range, a moisture dry-back shall be performed to determine the moisture of any material tested (ASTM D2216 or ASTM D4643).

- Soils shall only be placed in cold weather (<32°F) when the required moisture and/or compaction requirements can be met.
- Nuclear gauge security and accountability is kept through use of the Troxler Sign-Out Log Form.
- Lost, damaged, or unaccounted sources require immediate (within 2 hours) notification to the Radiological Control Manager. If the nuclear gauge is damaged, follow the emergency procedure in Attachment 1 for damaged nuclear gauges.
- All applicable U.S. Department of Transportation requirements shall be followed when transporting the nuclear gauge in accordance with Title 49 Code of Federal Regulations Part 173.24 (49 CFR 173.24), "Shippers—General Requirements For Shipments And Packagings, General requirements for packagings and packages" and 49 CFR 173.465, "Shippers—General Requirements for Shipments and Packagings, Type A packaging tests."
- Authorized users shall take precautions to protect gauges from damage.

3.2 Procedure

1. Calculate the approximate area of the lift, then sketch the lift area on the Lift Approval Form.
2. Divide the lift into lots as described in Addendum E, Remedial Action Inspection Plan, of the *Moab UMTRA Project Remedial Action Plan* (DOE-EM/GJ1547) for testing frequencies.
3. Generate random numbers for the in-place moisture/density test coordinates as follows.
   - Generate two random numbers for each lot using a calculator or computer with a random number generator.
   - Multiply one random number by the approximate north/south dimension of the lot and the other random number by the approximate east/west dimension of the lot as measured in feet.
   - Locate the test locations specified by the random numbers.
   - If the sample location is outside the lot, generate two new random numbers.
   - Record this on the Lift Approval Form.
4. Prepare the testing site for the nuclear gauge and/or sand-cone test by leveling the area and removing any loose material from the surface.

5. When testing density and moisture with a nuclear gauge, follow the density gauge manual for operation and ASTM D6938 for the proper testing methods. When testing density by the sand-cone method, follow ASTM D1556.
6. When the lift does not meet compaction or moisture requirements, record the results on the Field Density Test Form and notify the equipment operator to re-work the material.
7. After the equipment operator has reworked the material, retest the material and document the rework performed.
8. The QC representative or qualified personnel shall approve lots that meet compaction and moisture requirements. Document results on the Field Density Form.

NOTE: Conditional approval can be given in the field from gauge readings if the QC Representative is confident that moisture dry-back results will not produce a failing moisture or density.

NOTE: If the QC representative gives conditional approval, and the moisture results produce failing moisture or density, a condition report shall be written unless the lift had no additional material disposed on that particular lift area.

4.0 References

10 CFR 20 (Code of Federal Regulations), "Standards for Protection Against Radiation."

10 CFR 30 (Code of Federal Regulations), "Rules of General Applicability to Domestic Licensing of Byproduct Material.

49 CFR 173 (Code of Federal Regulations), "Shippers—General Requirements for Shipments and Packagings."

ASTM (ASTM International) D698, "Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))."

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

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

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

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

DOE (U.S. Department of Energy), *Moab UMTRA Project ALARA Program* (DOE-EM/GJRAC1922).

DOE (U.S. Department of Energy), *Moab UMTRA Project Emergency/Incident Response Plan* (DOE-EM/GJ1520).

DOE (U.S. Department of Energy), *Moab UMTRA Project Radiation Protection Program* (DOE-EM/GJ610).

DOE (U.S. Department of Energy), *Moab UMTRA Project Radiological Posting and Access Control* (DOE-EM/GJRAC1748).

DOE (U.S. Department of Energy), *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545).

DOE (U.S. Department of Energy), *Moab UMTRA Project Remedial Action Plan* (DOE-EM/GJ1547).

Attachment 1.
Emergency Procedure for Nuclear Gauge Damage

Attachment 4. Emergency Procedure for Nuclear Gauge Damage

Emergency Procedure for Nuclear Gauge Damage
The following procedures apply when the source fails to return to a shielded position (e.g., as a result of being damaged, source becomes struck below the surface) or if any other emergency or unusual situation arises (e.g., the gauge is struck by a moving vehicle or is in an accident involving a vehicle).

1. Immediately secure the area and keep people at least 25 feet from the gauge in all directions until the situation is assessed and radiation levels are known and notify Radiological Control of situation; however, if any personnel are injured, contact site Health and Safety and immediate supervisors.
2. If any heavy equipment is involved, detain the equipment and operator until it is determined there is no contamination present and is approved by the Operations/Site Manager or designee.
3. Gauge users and other potentially contaminated individuals should not leave the scene until emergency assistance arrives.
4. Visually inspect the gauge to determine the position of the source rod practice ALARA and ensure your safety before performing inspection (exposed or shielded) and the position of the source shutters (open or closed), and the extent of damage, if any, to the source housing and/or shielding.
5. Notify the following persons listed below, but do not leave the scene to make notifications if needed; get someone to assist.
   - Radiological Controls Manager
   - Operations/Site Manager
   - QA Manager
   - Radiological Controls Supervisor
6. Follow the directions provided by the Radiological Control Manager.
7. The Radiological Control Manager must:
   - Arrange for a radiation survey to be conducted as soon as possible by a knowledgeable person using the appropriate radiation detection instrumentation (i.e., the person performing the survey must be competent in the use of the survey instrument).
   - Make necessary notifications.

Reports to the U.S. Nuclear Regulatory Commission and/or the DOE must be made within the reporting time frames specified in regulations. Reporting requirements are found in 10 CFR 20, “Standards for Protection Against Radiation,” and 10 CFR 30, “Rules of General Applicability to Domestic Licensing of Byproduct Material.

NOTE: Before shipping a damaged gauge:
- Send close-up photographs of the damaged gauge to Troxler.
- Send a leak test sample to Troxler for analysis or send leak test results.
- Obtain a returned goods authorization number from Troxler.

Office of Environmental Management – Grand Junction

MOAB UTAH
UMTRA Project

Moab UMTRA Project
Lift Approval Procedure

Revision 9

April 2019

U.S. Department of Energy

Office of Environmental Management

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

Moab UMTRA Project
Lift Approval Procedure

Revision 9

Review and Approval

3/27/2019

X 

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RAC Quality Assurance Representative
Signed by: Mitch Hogan

3/28/2019

X Kathy Turvy

Kathy Turvy
RAC Quality Assurance Manager
Signed by: KATHRYN TURVY (Affiliate)

3/27/2019

X 

Steven D. Rima
RAC Environmental, Safety, Health, and Qua...
Signed by: Shawn Bradfield

Revision History

Revision	Date	Reason for Revision
0	April 16, 2009	Initial issue.
1	April 23, 2009	Revision update includes correction of lift approval percentage.
2	December 2009	Revision updates include machine parameter changes, compactor information, cold weather placement, and surveying methods.
3	November 2010	Revision updates include updated forms, reference to testing in accordance with DOE-EM/GJRAC1783, horizontal lift compaction requirements, and survey documentation requirements.
4	July 2011	Revision updates include new verbiage to section 3.2.4 Lift Survey.
5	August 2012	Revision updates include adding the correct machine weights and updated forms.
6	January 2013	Revision updates includes new verbiage and deletion of Source Documentation section.
7	June 2014	Revision update includes new content for clarification.
8	August 2016	Updated lift Approval to allow 24” loose lifts and increased the number of passes required.
9	March 2019	Revision update to incorporate changes to specifications includes changing the table of contents and attachments. Changing 2.1 “wheel passes” to left and right from rear and front. Changing 2.2.4 and 2.2.5 to include “placing”. Changing 3.1.3 lift thickness to “less than or equal to 24 inches”. Changing 3.1.4 debris size and placement to reflect changes to the RAP. Changed 3.1.5 removing attachments 4 and 5, changed machine properties for 12 inches and less thickness and greater than 12 inch thickness. Changed 3.2.1 removed daily moisture testing. Changed 3.2.2 removing debris/ RRM ratio. Changed 3.2.4 single point thickness to no greater than 2.3’ and average thickness to 2.0’ loose lift thickness. Changed 3.2.5 removing machine weight and type of machine for required passes. Changed 3.2.6 updated machine passes for sloped and near horizontal lifts. Changed 3.2.7 removed “adding”. Changed attachments 1and 2. Removing attachments 3, 4, 5 and 6.

Contents

Attachments

1.0 Purpose and Scope

1.1 Purpose

The purpose of this procedure is to provide a consistent and practical method of compacting residual radioactive material (RRM) on the Moab Uranium Mill Tailings Remedial Action (UMTRA) Project using a machine equipped with a computer-based compaction system and to provide methods for approving RRM lifts.

1.2 Scope

This procedure applies to RRM lifts using a machine equipped with a computer system and the approval of RRM lifts.

2.0 General

2.1 Definitions

Compute-based compaction system – Machine guidance system that delivers real-time productivity information to machine operators on an in-cab display using satellite navigation technology, machine-mounted components, a radio network, and office-management software.

Layer of snow – Blanket of snow that covers working lift areas without any voids in the snow.

Lift Area – Area of the embankment identified for material placement.

Lift Identification – Discrete number that consists of:

- Moab UMTRA Project (e.g., U for UMTRA Project cell).
- Work Element (e.g., W for RRM placement, I for interim cover placement, R for radon barrier placement, B for biointrusion placement, F for frost protection placement, C for cap rock placement, E for embankment placement, CF for cell floor).
- Lift Area – (e.g., A1, B1, C1) year, month, and day (e.g., UWA1090117, UIA1090117, URA1090117, UBA1090117, UFA1090117, UCA1090117).
- Number of lifts tested and approved for a specific lift area on the same day (e.g., 1st lift -00, 2nd lift -01).

Example: U for Moab UMTRA Project, W for RRM lift, A1 for lift area, 121206 date or day lift was first tested, and -00 for first lift tested that day (e.g., UWA1121206-00).

NOTE: The day the lift area is first tested will be the date used for lift identification.

Machine – Heavy equipment that is greater than or equal to 56,669 pounds (lb) in weight.

Machine pass – Movement of a machine across an area of the lift in any direction that meets compaction criteria calculated by an algorithm in the computer system.

Movement of the machine from one side of the lift to the opposite side of the lift, which meets compaction criteria calculated by an algorithm in the computer system, constitutes one pass; the return trip from the opposite side of the lift, which also meets compaction criteria calculated by an algorithm in the compactor's system, constitutes a second pass.

Wheel pass – Movement of the machine left or right axle/wheels across an area of the lift that meets compaction criteria calculated by an algorithm in the compactor's system. The computer system reports one wheel pass for each end of the machine (i.e., two wheel passes equals one machine pass).

2.2 Responsibilities

2.2.1 Quality Assurance Manager

The Quality Assurance (QA) Manager is responsible for:

- Implementing and directing Quality Control (QC) activities contained within this procedure.
- Identifying QC problems.
- Initiating, recommending, and/or providing QC solutions.

2.2.2 Quality Assurance/Quality Control Representative

The QA/QC Representative or designee is responsible for the proper implementation of this procedure and for approving lifts in accordance with this procedure.

2.2.3 Operations/Site Manager

The Operations/Site Manager or designee is responsible for issuing directives to equipment operators.

2.2.4 Equipment Operators

Equipment operators are responsible for placing and compacting lifts with the equipment in accordance with this procedure.

2.2.5 All Personnel

When involved in placing and compacting RRM lifts using the equipment, all employees are responsible for identifying any safety hazards and complying with the applicable Radiological Work Permits and Integrated Work Plans.

2.3 Precautions and Limitations

2.3.1 Pause Work

Work shall be immediately terminated by any personnel who feel the activity in progress is unsafe and/or may create an unsafe condition. Work will be resumed when the condition is corrected.

2.3.2 Safety Protocols

All personnel shall remain clear of any operating equipment and maintain good communication with the equipment operator.

Personnel observing compaction shall always be in visual view of the operator and shall be in front of the machine and never behind the machine working area while machine is in operation.

2.3.3 Training and Procedures

All personnel using the Troxler Nuclear Density Gauge shall attend 8 hours of Nuclear Moisture/Density Gauge training or working in direct supervision of a trained operator and shall perform all testing in accordance with Project procedures.

2.4 Records

All documentation created as a result of compliance with this procedure is considered a Project record and will be managed in accordance with *the Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545). Moab UMTRA Records are retained and maintained in accordance with federal orders, policies, and regulations.

The compactor screen printout and the calculations of the exported terrain data shall be attached to the Lift Approval Form (QC-F-001).

Following QA/QC approval of the QC documents, the original documentation shall be transmitted to Records.

3.0 Requirements and Guidance

3.1 Compliance

3.1.1 Lift Identification

Each lift shall be given a discrete lift identification number. The lift identification number shall be used to identify all documentation for that lift.

3.1.2 RRM Disposal

No RRM shall be disposed of on a lift until the previous lift is approved, with the exception of management of stockpile material

3.1.3 Lift Thickness

Lift thickness shall not exceed an average uncompacted thickness of 24 inches.

3.1.4 Debris

Demolition debris will be placed in the waste cell along with RRM. Debris shall not contain free liquids. Debris shall be sized to minimize voids. Pipes and ducts that are 6 inches or greater in diameter shall be crushed or, if crushing is impractical, shall be cut in half longitudinally or filled. Rubber tires shall be cut and placed in order to minimize void space. Debris shall be spread and/or oriented in a manner that results in a minimum of voids.

Debris may be placed as a sacrificial lift at the bottom of the disposal cell in a 2-foot lift. Debris in sacrificial lifts shall contain no free liquids, and oriented in a manner that minimizes voids and contained within the 2-foot lift profile. Sacrificial debris lifts are not subject to moisture and compaction criteria.

3.1.5 Machine Properties

The machine properties (see Attachments 1and 2) under the machine parameters tab for the machines shall be:

- Number of levels (the number of machine passes) shall be set at:
  - Up to 12 inch loose average thickness lifts, no survey points greater than 1.3' thick and less than half the lift points are equal to or less than 1.3' - Four machine passes are required for machines weighing more than 56,669.
  - Lifts that do not meet 12 inch loose average criteria - Eight machine passes are required for the 825H sheepsfoot compactor.

3.2 Procedure

3.2.1 Moisture Testing

When performing moisture testing, a representative sample shall be obtained from the desired material. The QC Representative (or qualified personnel) shall perform a moisture test in accordance with applicable ASTM International (ASTM) standards. Test results shall be documented on the Field Density Test Form (QC-F-002).

3.2.2 Debris Inspection

The QC Representative (or qualified personnel) shall inspect the debris once it is spread out across the lift. The debris shall be spread out uniformly across the lift in a manner that minimizes void spaces and shall not exceed debris size requirements. The debris inspection shall be documented on the Lift Approval Form.

3.2.3 Visual Inspection

The QC Representative (or qualified personnel) shall visually inspect the lift areas for frozen material, frost, and snow before placement of RRM. No soil that is frozen, has frost, or is under a layer of snow shall be approved for placement. The inspection shall be documented on the Lift Approval Form under the comment section.

3.2.4 Lift Surveys

Each lift shall be surveyed using a high-accuracy, hand-held global positioning system (GPS) or computer system. When determining the lift thickness of a lift area less than 3,000 square feet, one survey point should be performed for every 15 feet. When determining the lift thickness of a lift area greater than or equal to 3,000 square feet, the survey for each lift shall have a minimum of 10 points.

The lift thickness will be determined by comparing the current lift elevations to the previous lift elevations located on the same northing and easting locations. When calculating the uncompacted lift thickness, no survey point shall be greater than 2.3 feet, as long as the average uncompacted thickness is less than or equal to 2 foot.. The lift shall be placed in a manner that will result in a relative uniform thickness. Surveys shall be documented on the appropriate form and attached to the Lift Approval Form.

3.2.5 Computer-based Compaction System

Each lift shall be compacted by the minimum number of required machine passes depending on lift thickness. To ensure the lift area meets the minimum required machine pass, print the compaction screen, identify the lift and export the terrain data for the lift using the computer system.

3.2.6 Requirements for Lift Approval

Lifts that meet the following requirements shall be approved.

- Seventy percent of the pixels have greater than or equal to four machine passes (green pixels) for lift 12 inches or less or eight machine passes (green pixels) for lifts greater than 12 inches thick when placing material on slopes.
- Eighty percent of the pixels (green pixels) have greater than or equal to four machine passes for lifts 12 inches or less or eight machine passes for lifts greater than 12 inches when placing material on approximately horizontal lifts.
- The average lift thickness is less than or equal to 24 inches with no white pixels on the compactor screen printout.
- The compactor screen print out shows uniform compaction over the entire lift area.

3.2.7 Reworking of Lifts

Lifts that do not meet the Moab UMTRA Project requirements shall be reworked (e.g., additional compaction, cutting the lift, adding moisture); rework performed shall be documented.

3.2.8 Nuclear Gauge Testing

The QC Representative (or qualified personnel) shall perform in-place density tests every 6 months in accordance with ASTM Standard D6938, "Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth),"and ASTM D1556, "Standard Test Method for Density and Unit Wight of Soil in Place by the Sand-Cone Method," to verify the computer system is working correctly.

If the computer system is not used to verify compaction and the lift thickness, then the lift shall be tested in accordance with *Moab UMTRA Project Moisture/Density Testing Procedure* (DOE-EM/GJRAC1783). The testing frequency, inspections, and required reporting shall comply with the RAIP. Surveying shall be performed using a hand-held GPS or a level survey.

4.0 References

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

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

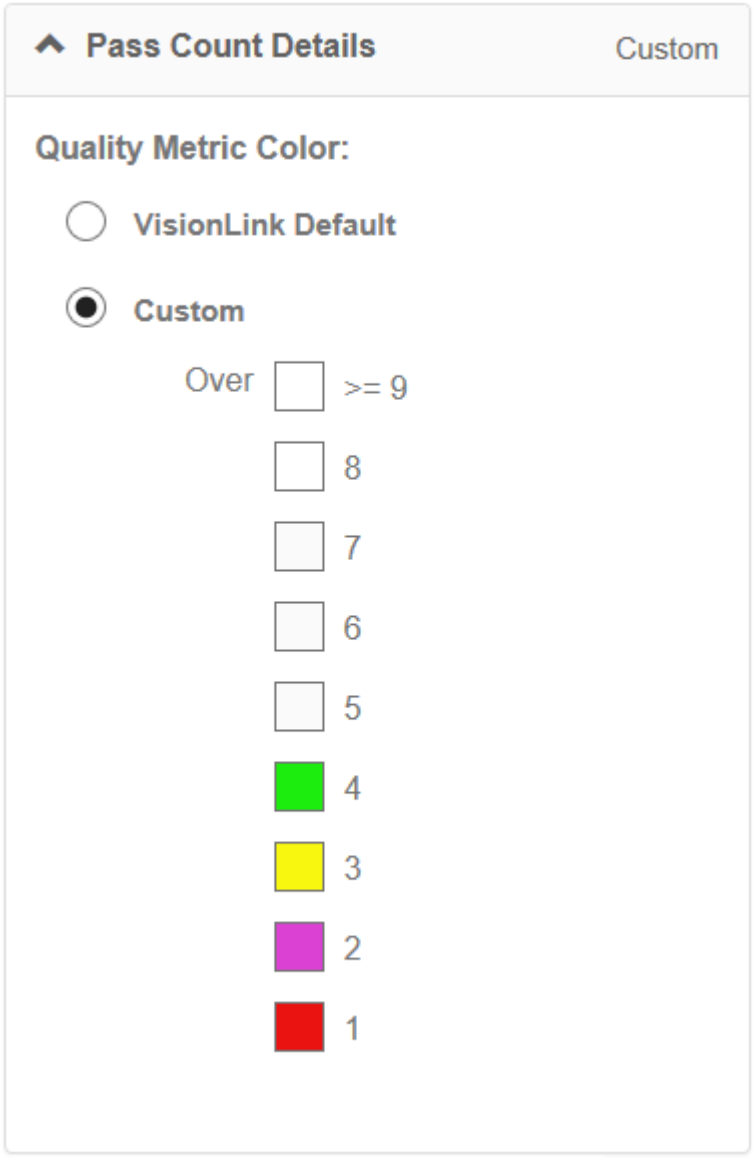
DOE (U.S. Department of Energy) *Moab UMTRA Project Moisture/Density Testing Procedure* (DOE-EM/GJRAC1783).

DOE (U.S. Department of Energy) *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545).

DOE (U.S. Department of Energy) *Moab UMTRA Project Remedial Action Plan* (DOE-EM/GJ1547).

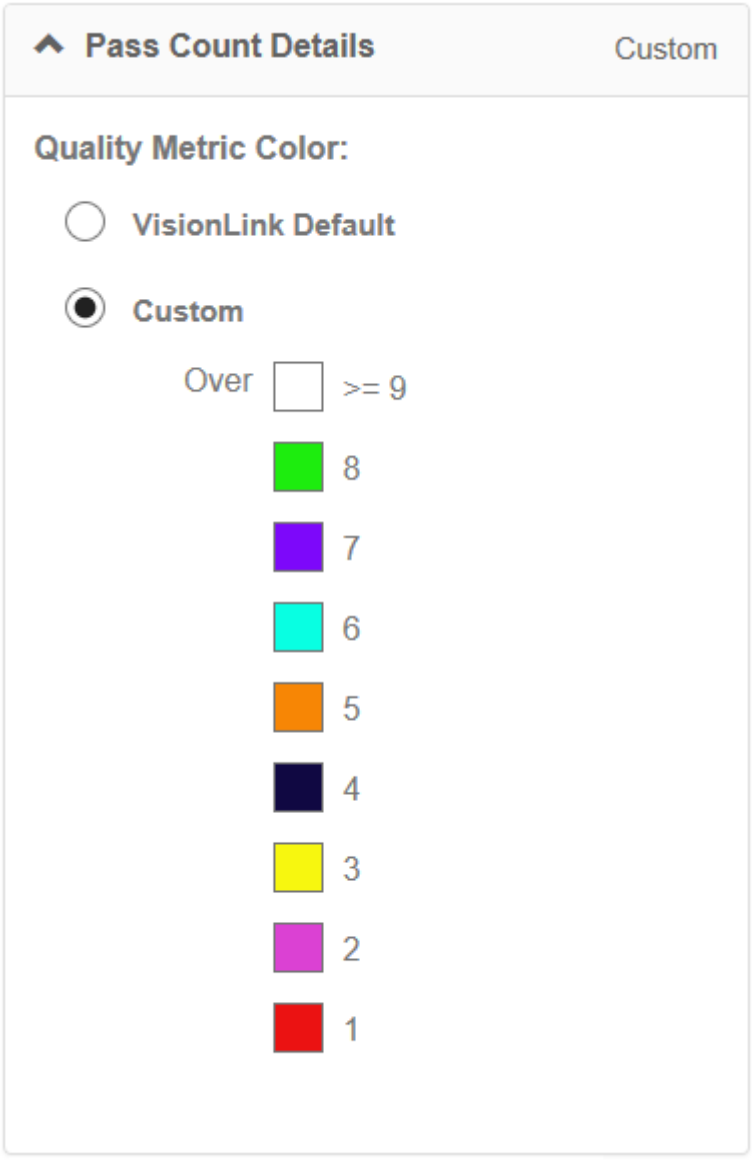
Attachment 1.
12-inch or Less Average Machine Parameters for Machines Weighing at Least 56,669 lb.

Attachment 1. 12-inch or Less Average Machine Parameters for Machines Weighing at Least 56,669 lb.



Attachment 2.
Greater than 12-inch Lift Machine Parameters for 825 Sheepsfoot

Attachment 2. Greater than 12-inch Lift Machine Parameters for 825 Sheepsfoot



ADDENDUM B

Final Remedial Action Plan
DOE-EM/GJ1547

October 2019

Final Design Specifications

Number	Title
31-00-00 R5	Earthwork
31-00-20 R6	Placement and Compaction of Tailings and Interim Cover
31-00-30 R8	Placement and Compaction of Final Cap Layers
31-32-11 R2	Surface Water Management and Erosion Control
32-11-23 R9	Aggregate and Riprap

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MOAB UMTRA PROJECT **MOAB, UTAH** **PROJECT NO: 35DJ2600**	DOCUMENT NO.: 35DJ2600-056-SPEC-31-00-00
	SECTION NO.: 31-00-00
	EARTHWORK

This title sheet is the first page of the specification and a record of each issue or revision. The pages revised and the description of the revision should be noted under remarks.

REV.	DATE	BY	CKD	APPROVED	PAGES	REMARKS
0	12/17/07	WDB	FMP	W. Barton	ALL	ISSUED FOR CONSTRUCTION
1	1/30/08	WDB	FMP	W. Barton	ALL	Page 16: Added Section 3.11.1.2 Pages 18-19, revised soil testing frequencies
2	2/27/08	WDB	FMP	W. Barton	ALL	Revised per DOE & Golder Comments Page 6 Section 1.2.7: revised to reference Section 32 11 23, AGGREGATE AND RIPRAP Page 7, Section 1.5: revised to include topsoil. Page 10, Section 3.1.5: revised to include additional requirements for safe trench excavation. Page 12, Section 3.4: revised to add sediment/erosion control to stockpile areas. Page 13, Section 3.6.2: revised to delete word muddy. Page 14, Section 3.9.1.3: revised to include sand (SW). Page 19, Section 3.14.2: revised frequency of check tests.
3	4/14/08	WDB	FMP	W. Barton	ALL	Page 8, Section 1.7: Added section about NQA-1 and Quality Levels. Page 16, Section 3.11.1: Revised from 10" loose lift thickness to 12" loose lift thickness. Page 16, Section 3.11.1.1, Item 2): Revised wording to clarify, fill placed in lifts not to exceed 12" loose. Page 16, Section 3.11.1.2, Item 2): Revised wording to clarify, fill placed in lifts not to exceed 12" loose.
4	06/01/08	WDB	FMP	W. Barton	ALL	Revised per NRC Comments Page 5, Section 1.2 Revised Definitions. Page 17, Section 3.11: Revised Embankments Section, corrected misspelled words, and

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STATE OF UTAH

7/1/19

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MOAB UMTRA PROJECT MOAB, UTAH PROJECT NO: 35DJ2600	DOCUMENT NO.: 35DJ2600-056-SPEC-31-00-00
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This title sheet is the first page of the specification and a record of each issue or revision. The pages revised and the description of the revision should be noted under remarks.

REV.	DATE	BY	CKD	APPROVED	PAGES	REMARKS
						deleted sentence describing compaction of cohesionless material. Pages 17 - 20, Sections 3.11-3.14: Revised testing requirements to describe testing by others and the Contractor's role in compaction of material. Page 14, Section 3.7.1: Added moisture range of "optimum moisture content plus or minus 5%" Page 21, Section 3.14.4: Added moisture range of "optimum moisture content plus or minus 5%"
5	1/23/19	FMP	WDB	W. Barton	ALL	Section 1.2.2: Revised Construction Manager to Crescent Junction Operations/Site Manager Section 1.3: Revised Construction Manager to Crescent Junction Operations/Site Manager Section 1.5.3: Revised Construction Manager to Crescent Junction Operations/Site Manager Section 1.5.4: Revised Construction Manager to Crescent Junction Operations/Site Manager Section 3.1.5.5: Revised Construction Manager to Crescent Junction Operations/Site Manager Section 3.1.6: Revised Construction Manager to Crescent Junction Operations/Site Manager Section 3.1.7: Revised Construction Manager to Crescent Junction Operations/Site Manager Section 3.3.2: Revised Construction Manager to Crescent Junction Operations/Site Manager Section 3.6.1: Revised Construction Manager to Crescent Junction Operations/Site Manager Section 3.11.1.2: Revised Computer Aided Earthmoving

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This title sheet is the first page of the specification and a record of each issue or revision. The pages revised and the description of the revision should be noted under remarks.

REV.	DATE	BY	CKD	APPROVED	PAGES	REMARKS
						System to Computer Based Compaction System, Revised CAES to Computer Based Compaction System Section 3.11.3: Deleted "contracted by Energy Solutions" Section 3.12.1: Revised Construction Manager to Crescent Junction Operations/Site Manager Section 3.14.4: revised Energy Solutions to RAC Section 3.14.4: Revised Construction Manager to Crescent Junction Operations/Site Manager Section 3.15: Revised Construction Manager to Crescent Junction Operations/Site Manager

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DIVISION 31 - EARTHWORK

SECTION 31 00 00

EARTHWORK

End of Section Table of Contents --

SECTION 31 00 00

EARTHWORK

PART 1 GENERAL

This Earthwork Specification covers most of the earthwork in support of the Moab UMTRA Project, including work at the Moab site, at Crescent Junction, and for the Green River to Crescent Junction Water Line. Earthwork not covered by this specification (covered under separate specifications) includes the Haul Road work at Moab, Placement and Compaction of Tailings and Interim Cover, and Placement and Compaction of Final Cap Layers.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 99 (2001; R 2004) Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in) Drop

AASHTO T 180 (2001; R 2004) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in) Drop

AASHTO T 224 (2001; R 2004) Correction for Coarse Particles in the Soil Compaction Test

ASTM INTERNATIONAL (ASTM)

ASTM A 139 (2004) Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)

ASTM C 136 (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM C 33 (2003) Standard Specification for Concrete Aggregates

ASTM D 698 (2000ael) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu ft)

ASTM D 1140 (2000) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve

ASTM D 1556 (2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D 1557 (2002el) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (56,000 ft-lbf/cu ft)

ASTM D 1883 (2005) CBR (California Bearing Ratio) of Laboratory-Compacted Soils

ASTM D 2487 (2006) Soils for Engineering Purposes Unified Soil Classification System)

ASTM D 422 (1963; R 2002el) Particle-Size Analysis of Soils

ASTM D 4318 (2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D 6938 (2007b) In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

ASTM D 2216 (2005) Laboratory Determination of Water Moisture) Content of Soil and Rock by Mass (Oven Moisture)

ASTM D 4643 (2000) Determination of Water (Moisture) Content of Soil by the Microwave Oven Heating

ASTM D 4944 (2004) Field Determination of Water Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester

ASTM D 4643 (2000) Determination of Water (Moisture) Content of Soil by Direct Heating

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1 (2004) Structural Welding Code - Steel

1.2 DEFINITIONS

1.2.1 Satisfactory Materials

Satisfactory materials comprise any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM, SW-SM, SC, SW-SC,CL, ML, and CL-ML. Satisfactory materials for grading comprise stones less than 4 inches, except for fill material for pavements and railroads which comprise stones less than 3 inches in any dimension.

1.2.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. Notify the Crescent Junction Operations / Site Manager when encountering any contaminated materials.

1.2.3 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 698 or ASTM D 1557 abbreviated as a percent of laboratory maximum density. Since ASTM D 698 and ASTM D 1557 apply only to soils that have 30 percent or less by weight of their

particles retained on the 3/4 inch sieve, degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve shall be as a percentage of the maximum density in accordance with AASHTO T 99 or AASHTO T 180 and corrected with AASHTO T 224.

1.2.4 Rock

Solid homogeneous material with firmly cemented, laminated, or foliated masses or conglomerate deposits, none of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding 1/2 cubic yard in volume.

1.2.5 Unstable Material

Unstable materials are materials that are too soft or unstable to properly support the utility pipe, conduit, or structure.

1.2.6 Select Granular Material

Select granular materials are materials classified as GW, GP, SW, or SP, or by ASTM D 2487 where indicated. Not more than 30 percent by weight may be finer than No. 200 sieve when tested in accordance with ASTM D 1140.

1.2.7 California Bearing Ratio

California Bearing Ratio (CBR) tests are tests to evaluate the strength of pavement subgrade. If required, perform CBR tests on select granular material in accordance with ASTM D 1883

1.2.8 Pipe Bedding Material

Pipe bedding material shall consist of select granular material in accordance with Section 32 11 23, AGGREGATE AND RIPRAP.

1.2.9 Expansive Soils

Expansive soils are defined as soils that have a soil Activity number greater than 1.25, where Activity (Ac) = Plasticity Index/ percent finer than 0.02 mm.

1.2.10 Non Frost-Susceptible (NFS) Material

Non Frost-Susceptible material is a uniformly graded gravel or washed sand with no more than 3 percent smaller than 0.02mm.

1.3 SUBMITTALS

Approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. All submittals shall be provided to the Crescent Junction Operations / Site Manager in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Shoring; G;

Blasting; G;

Submit 15 days prior to starting work.

SD-03 Product Data

Utilization of Excavated Materials;

Rock Excavation

of any Excavation or Borrow Pit

Procedure and location for disposal of unused satisfactory material. Proposed source of borrow material. Notification of encountering unrippable rock in the project. Advance notice on the opening of excavation or borrow areas.

SD-06 Test Reports

Borrow/Fill Material Testing

Compaction Testing

Within 24 hours of conclusion of physical tests, 3 copies of test results, including calibration curves and results of calibration tests.

SD-07 Certificates Testing

Qualifications of the testing laboratory

1.4 SUBSURFACE DATA

Subsurface soil boring logs are available for elements of this project. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

1.5 CLASSIFICATION OF EXCAVATION

Excavation will be designated as topsoil, common excavation, Mancos Shale, or rock excavation.

1.5.1 Topsoil

Topsoil is defined as the top one ft of natural soil at Crescent Junction.

1.5.2 Common Excavation

Common excavation includes all materials not classified as topsoil, Mancos shale or rock excavation.

1.5.3 Rock Excavation

Include rock excavation with blasting, excavating, grading, disposing of material classified as rock, and the satisfactory removal and disposal of boulders 1/2 cubic yard or more in volume; solid rock; rock material that is in ledges, bedded deposits, and unstratified masses, which cannot be removed without systematic drilling and blasting; firmly cemented conglomerate deposits possessing the characteristics of solid rock impossible to remove without systematic drilling and blasting; and hard materials (see Definitions). Include the removal of any concrete or masonry structures, except pavements, exceeding 1/2 cubic yard in volume that may be encountered in the work in this classification. If at any time during excavation, including excavation from borrow areas, the Contractor encounters material that may be classified as rock excavation, uncover such material and notify the Crescent Junction Operations / Site Manager. The Contractor shall not proceed with the excavation of this material until the Crescent Junction Operations / Site Manager has classified the materials as common excavation or rock excavation and has taken cross sections as required. Failure on the part of the Contractor to uncover such material, notify the Crescent Junction Operations / Site Manager, and allow ample time for classification and cross sectioning of the undisturbed surface of such material will cause the forfeiture of the Contractor's right of claim to any classification or volume of material to be paid for other than that allowed by the Crescent Junction Operations / Site Manager for the areas of work in which such deposits occur.

1.5.4 Blasting

Blasting shall be limited to that required for a quarrying operation to provide rock for the Waste Cell construction at Crescent Junction. At other project locations, blasting to break rock for excavating shall be performed only if no other method of rock removal will work, and only with prior written approval of a blasting plan. The Contractor shall submit a Blasting Plan in conformance with Federal, State, and local safety regulations, prepared and sealed by a registered professional engineer that includes calculations for overpressure and debris hazard. Provide blasting mats and use the non-electric blasting caps. Obtain written approval prior to performing any blasting and notify the Crescent Junction Operations / Site Manager 24 hours prior to blasting. Include provisions for storing, handling and transporting explosives as well as for the blasting operations in the plan. The Contractor is responsible for damage caused by blasting operations.

1.6 DEWATERING

Perform dewatering of work areas in accordance with the project plans and Section 31 32 11, SURFACE-WATER MANAGEMENT AND EROSION CONTROL.

1.7 NQA-1 QUALITY LEVEL

All Earthwork activities for the Disposal Cell at Crescent Junction, including: the cell excavation, construction of the perimeter embankments, Waste Cell Spoil Material Embankment, and perimeter

ditches are designated as Quality Level 2. All other work (not on the Disposal Cell) is non-Quality related (Quality Level 3).

PART 2 PRODUCTS

2.1 BURIED WARNING AND IDENTIFICATION TAPE

Provide polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3-inch minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Provide permanent color and printing, unaffected by moisture or soil.

Warning Tape Color Codes

Red:	Electric
Orange:	Telephone and Other Communications
Blue:	Water Systems
Green:	Sewer Systems

2.2 MATERIAL FOR RIP-RAP

Provide filter fabric between soil and riprap in accordance with 31 05 19 GEOTEXTILE and rock conforming to RIPRAP in accordance with 32 11 23 AGGREGATE AND RIPRAP.

2.3 PIPE BEDDING MATERIAL

Provide bedding material consisting of sand, gravel, or crushed rock, open graded with a maximum particle size of 3/8 inch. Compose material of tough, durable particles. Bedding material shall be free of fines passing the No. 200 standard sieve.

2.4 CAPILLARY WATER BARRIER

Provide capillary water barrier of clean, open graded crushed rock, crushed gravel or uncrushed gravel placed beneath a slab with or without a vapor barrier below. Conform to ASTM C 33 for fine aggregate grading with a maximum of 3 percent by weight passing ASTM D 1140, No. 200 sieve.

2.5 PIPE CASING

2.5.1 Casing Pipe

Pipe for casing utility lines shall be ASTM A 139, Grade B or approved substitute. Match casing size to the outside diameter and wall thickness as indicated on the drawings. Protective coating is not required on casing pipe.

PART 3 EXECUTION

3.1 GENERAL EXCAVATION

Perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated on the drawings. Excavate unsatisfactory materials encountered within the limits of the work below grade and replace with satisfactory materials as directed. Dispose of unsatisfactory excavated material in designated waste or spoil areas. During construction, perform excavation and fill in a manner and sequence that will provide proper drainage at all times.

Excavate material required for fill or embankment in excess of that produced by excavation within the grading limits from the borrow areas indicated or from other approved areas selected by the Contractor.

3.1.1 Ditches, Gutters, and Channel Changes

Finish excavation of ditches, gutters, and channel changes by cutting accurately to the cross sections, grades, and elevations shown on the drawings. Do not excavate ditches and gutters below grades shown.

Backfill the excessive open ditch or gutter excavation with satisfactory, thoroughly compacted, material or with suitable stone or riprap to grades shown. Dispose of excavated material as shown or as directed, except in no case allow material to be deposited a maximum 4 feet from edge of a ditch.

Maintain excavations free from detrimental quantities of brush, sticks, trash, and other debris until final acceptance of the work.

3.1.2 Drainage Structures

Make excavations to the lines, grades, and elevations shown, or as directed. Provide trenches and foundation pits of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or other hard foundation material of loose debris and cut to a firm, level, stepped, or serrated surface. Remove loose disintegrated rock and thin strata. Do not disturb the bottom of the excavation when concrete or masonry is to be placed in an excavated area. Do not excavate to the final grade level until just before the concrete or masonry is to be placed. Where pile foundations are to be used, stop the excavation of each pit at an elevation 1 foot above the base of the footing, as specified, before piles are driven. After the pile driving has been completed, remove loose and displaced material and complete excavation, leaving a smooth, solid, undisturbed surface to receive the concrete or masonry.

3.1.3 Drainage

Provide for the collection and disposal of surface and subsurface water encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. Construct storm drainage features (ponds/basins) at the earliest stages

of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

3.1.4 Dewatering

While the excavation is open, dewater the construction area to limit accumulation of water in the work area and to prevent damage to finished work. Operate dewatering system continuously until construction work below existing water levels is complete.

3.1.5 Trench Excavation Requirements

Excavate trenches as recommended by the manufacturer of the pipe to be installed. Provide vertical trench walls where no manufacturer's printed installation manual is available. Shore trench walls more than 4.5 feet high, cut back to a stable slope (as defined by OSHA 29 CFR 1926), or provide with equivalent means of protection for employees who may be exposed to moving ground or cave in. Excavate trench walls which are cut back to at least the angle of repose of the soil as determined by a professional geotechnical engineer. "Safe trench excavation is at all times the responsibility of the Contractor."

3.1.5.1 Bottom Preparation

Grade the bottoms of trenches accurately to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Excavate bell holes to the necessary size at each joint or coupling to eliminate point bearing. Remove stones of 1 inch or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, to avoid point bearing.

3.1.5.2 Removal of Unyielding Material

Where unyielding material is encountered in the bottom of the trench, remove such material 6 inches below the required grade and replace with suitable materials as provided in paragraph BACKFILLING AND COMPACTION.

3.1.5.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, remove such material to the depth directed and replace it to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION.

3.1.5.4 Excavation for Appurtenances

Provide excavation for manholes, catch-basins, inlets, or similar structures sufficient to leave at least 12 inches clear between the outer structure surfaces and the face of the excavation. When concrete or masonry is to be placed in an excavated area, take special care not

to disturb the bottom of the excavation. Do not excavate to the final grade level until just before the concrete or masonry is to be placed.

3.1.5.5 Jacking, Boring, and Tunneling

Unless otherwise indicated, provide excavation by open cut except that sections of a trench may be jacked, bored, or tunneled if, in the opinion of the Crescent Junction Operations / Site Manager, the pipe, cable, or duct can be safely and properly installed and backfill can be properly compacted in such sections.

3.1.6 Underground Utilities

For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines until approval for backfill is granted by the Crescent Junction Operations / Site Manager. Report damage to utility lines or subsurface construction immediately to the Crescent Junction Operations / Site Manager.

3.1.7 Structural Excavation

Ensure that footing subgrades have been inspected and approved by the Crescent Junction Operations / Site Manager prior to concrete placement.

3.2 SELECTION OF BORROW MATERIAL

Select borrow material to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Obtain borrow material from the borrow areas within the limits of the project site, selected by the Contractor or from approved private sources. The Contractor is responsible for obtaining and delivering borrow material to the project site.

3.3 SHORING

3.3.1 General Requirements

Submit a Shoring and Sheeting plan for approval 15 days prior to starting work. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations. Finish shoring, including sheet piling, and install as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Remove shoring, bracing, and sheeting as excavations are backfilled, in a manner to prevent caving.

3.3.2 Geotechnical Engineer

The Contractor is required to hire a Professional Geotechnical Engineer to design shoring, and provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer is responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The

Geotechnical Engineer is responsible for updating the excavation, sheeting and dewatering plans as construction progresses to reflect changing conditions and submit an updated plan if necessary. The Crescent Junction Operations / Site Manager is responsible for arranging meetings with the Geotechnical Engineer at any time throughout the contract duration.

3.4 STOCKPILE AREAS

Keep stockpiles in a neat and well drained condition, giving due consideration to drainage and erosion control at all times. Separately stockpile excavated satisfactory and unsatisfactory materials. Protect stockpiles of satisfactory materials from contamination which may destroy the quality and fitness of the stockpiled material.

3.5 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Do not excavate to final grade until just before concrete is to be placed. Only use excavation methods that will leave the foundation rock in a solid and unshattered condition. Roughen the level surfaces, and cut the sloped surfaces, as indicated, into rough steps or benches to provide a satisfactory bond. Protect shales from slaking and all surfaces from erosion resulting from ponding or water flow.

3.6 GROUND SURFACE PREPARATION

3.6.1 General Requirements

Remove and replace unsatisfactory material with satisfactory materials, as directed by the Crescent Junction Operations / Site Manager, in surfaces to receive fill or in excavated areas. Scarify the surface to a depth of 2 inches before the fill is started. Plow, step, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that the fill material will bond with the existing material. When subgrades are less than the specified density, break up the ground surface to a minimum depth of 6 inches, pulverizing, and compacting to the specified density. When the subgrade is part fill and part excavation or natural ground, scarify the excavated or natural ground portion to a depth of 12 inches and compact it as specified for the adjacent fill.

3.6.2 Frozen Material

Do not place material on surfaces that are frozen or contain frost.

3.7 UTILIZATION OF EXCAVATED MATERIALS

Dispose of unsatisfactory excavated materials in designated waste disposal or spoil areas. Use satisfactory material from excavations, insofar as practicable, in the construction of fills, embankments, subgrades, and for similar purposes. Do not waste any satisfactory excavated material without specific written authorization. Dispose of satisfactory material, authorized to be wasted, in designated areas approved for surplus material storage or designated waste areas as directed.

3.7.1 Use of Excavated Material as Fill

Excavated material to be used as fill shall be stockpiled or hauled directly to the fill site. Prior to installation as fill, the material shall be tested to determine the maximum dry density (ASTM D 698) or (ASTM D 1557) and optimum moisture content (ASTM D 2216) of the material. The moisture content of the soil shall be adjusted to near optimum moisture content (optimum moisture content plus or minus 5%) for compaction.

Moisture shall be added to the material in a manner that results in a consistent moisture content throughout the fill. Quick tests of moisture content (ASTM D 4643, ASTM D 4944, or ASTM D 4959) shall be performed as required to maintain moisture control during fill placement.

3.8 BURIED TAPE AND DETECTION WIRE

3.8.1 Buried Warning and Identification Tape

Provide buried utility lines with utility identification tape. Bury tape 12 inches below finished grade; under pavements and slabs, bury tape 6 inches below top of subgrade.

3.9 BACKFILLING AND COMPACTION

Place backfill adjacent to any and all types of structures, and compact to at least 95 percent laboratory maximum density (ASTM D 698) for cohesive materials or 98 percent laboratory maximum density for cohesionless materials (ASTM D 698), to prevent wedging action or eccentric loading upon or against the structure. Prepare ground surface on which backfill is to be placed as specified in paragraph GROUND SURFACE PREPARATION. Compact backfill materials in conformance with the applicable portions of paragraphs GROUND SURFACE PREPARATION. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.9.1 Trench Backfill

Backfill trenches to the grade shown. Do not backfill trenches until all specified tests are performed.

3.9.1.1 Replacement of Unyielding Material

Replace unyielding material removed from the bottom of the trench with select granular material or bedding material.

3.9.1.2 Replacement of Unstable Material

Replace unstable material removed from the bottom of the trench or excavation with select granular material placed in layers not exceeding 6-inch loose thickness.

3.9.1.3 Bedding and Initial Backfill

Provide bedding of the type and thickness shown. Place initial bedding material and compact it with approved tampers to a height of at least one foot above the utility pipe or conduit. Bring up the bedding backfill evenly on both sides of the pipe for the full length of the pipe. Take care to ensure thorough compaction of the fill under the haunches of the pipe. Compact backfill to top of pipe to 95 percent of ASTM D 698 maximum density. Provide plastic piping with bedding to spring line of pipe.

Provide bedding materials as follows:

a. Clean, coarsely graded natural gravel, crushed stone or a combination thereof, having a classification of SW, GW, or GP in accordance with ASTM D 2487 for bedding. Do not exceed maximum particle size of 3/8 inch.

3.9.1.4 Final Backfill

Fill the remainder of the trench, except for special materials for roadways, and railroads with satisfactory material. Place backfill material and compact as follows:

a. Roadways and Railroads: Place backfill up to the required elevation as specified. Do not permit water flooding or jetting methods of compaction.

3.9.2 Backfill for Appurtenances

After the manhole, catch basin, inlet, or similar structure has been constructed and the concrete has been allowed to cure, place backfill in such a manner that the structure will not be damaged by the shock of falling earth. Deposit the backfill material, compact it as specified for final backfill, and bring up the backfill evenly on all sides of the structure to prevent eccentric loading and excessive stress.

3.10 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

3.10.1 Water Lines

Excavate trenches to a depth that provides a minimum cover of 3 feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe.

3.10.2 Electrical Distribution System

Provide a minimum cover of 24 inches from the finished grade to direct burial cable and conduit or duct line, unless otherwise indicated.

3.10.3 Pipeline Casing

Provide new smooth wall steel pipeline casing under existing railroad by the boring and jacking method of installation. Provide each new pipeline casing, where indicated and to the lengths and dimensions shown, complete and suitable for use with the new piped utility as indicated. Install pipeline casing by dry boring and jacking method as follows:

3.10.3.1 Bore Holes

Mechanically bore holes and case through the soil with a cutting head on a continuous auger mounted inside the casing pipe. Weld lengths of pipe together in accordance with AWS D1.1. Do not use water or other fluids in connection with the boring operation.

3.10.3.2 Cleaning

Clean inside of the pipeline casing of dirt, weld splatters, and other foreign matter which would interfere with insertion of the piped utilities by attaching a pipe cleaning plug to the boring rig and passing it through the pipe.

3.10.3.3 End Seals

After installation of piped utilities in pipeline casing, provide watertight end seals at each end of pipeline casing between pipeline casing and piping utilities. Provide watertight segmented elastomeric end seals.

3.10.4 Rip-Rap Construction

Place rip-rap on filter fabric in the areas indicated. Install riprap to conform to cross sections, lines and grades shown within a tolerance of 0.1 foot.

3.10.4.1 Stone Placement

Place rock for rip-rap on prepared bedding material to produce a well graded mass with the minimum practicable percentage of voids in conformance with lines and grades indicated. Distribute larger rock fragments, with dimensions extending the full depth of the rip-rap throughout the entire mass and eliminate "pockets" of small rock fragments. Rearrange individual pieces by mechanical equipment or by hand as necessary to obtain the distribution of fragment sizes specified above.

3.11 EMBANKMENTS

3.11.1 Earth Embankments

Construct earth embankments in accordance with the following subsections. Section 3.11.1.1 shall apply to all earth embankments at Moab and Crescent Junction except the Waste Cell Perimeter Embankments and the Waste Cell Spoil Material Embankment. Section 3.11.1.2 shall

apply to the Waste Cell Perimeter Embankments and Section 3.11.1.3 shall apply to the Waste Cell Spoil Material Embankment.

3.11.1.1 Earth Embankments

Construct earth embankments from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 3 inches. Place the material in successive horizontal layers of loose material not more than 12 inches in depth. Spread each layer uniformly on a soil surface that has been moistened or aerated as necessary, and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed. After spreading, plow, disk, or otherwise break up each layer; moisten or aerate as necessary; thoroughly mix; and compact material to at least 95 percent laboratory maximum density in accordance with ASTM D 698. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.11.1.1 Waste Cell Perimeter Embankment at Crescent Junction

The Waste Cell Perimeter Embankment forms the outside of the waste cell, and will have 2:1 interior slopes, 5:1 exterior slopes, and a 30 ft wide level top. Material from the cell excavation will be used to construct the Waste Cell Perimeter Embankment. The fill shall be tested (by others) to determine its maximum dry density in accordance with ASTM D 698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort, and the moisture content shall be modified to bring the fill to optimum moisture plus or minus 5%.

Construct the Waste Cell Perimeter Embankment as follows:

1) Prepare the ground beneath the proposed perimeter embankment by stripping vegetation and loose soil from the site, scarifying and compacting the top six inches of soil.
2) Dump and spread fill in lifts of nearly uniform thickness, not to exceed 12" loose. Fill shall be compacted with a minimum 45,000 lb static weight footed roller capable of kneading compaction, with feet a minimum of 6 inches in length.
3) At the Contractor's option, the compactor may be equipped with a computer based compaction system, and soil placement and compaction shall be controlled by the computer based compaction system.
4) If the computer based compaction system is used, the Contractor shall assist on-site soil testing personnel by using the computer based compaction system to determine and document compaction. If the computer based compaction system is not used, soil density tests will be performed by testing personnel in accordance with Section 3.14, below.

3.11.1.2 Waste Cell Spoil Material Embankment at Crescent Junction

The Waste Cell Spoil Material Embankment is a fill embankment to be constructed north of the waste cell. The embankment will divert storm water from the Book Cliffs around the waste cell, and shall be constructed of surplus excavated material (spoil material) from the waste cell excavation. Prior to placement, spoil material shall be

tested to determine its maximum dry density in accordance with ASTM D 698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort, and the moisture content shall be modified to bring the fill to optimum moisture plus or minus 5%.

Construct the Waste Cell Spoil Material Embankment as follows:

1) Prepare the ground beneath the proposed perimeter embankment by stripping vegetation and loose soil from the site.
2) Dump and spread fill in lifts of nearly uniform thickness, not to exceed 12" loose. Compact material with rollers, equipment tracks, or successive passes of scrapers. Fill shall be compacted to a density of 90% of the laboratory determined maximum density in accordance with ASTM D 698.
3) Soil density tests will be performed by testing personnel in accordance with Section 3.14, below.

3.12 SUBGRADE PREPARATION

3.12.1 Proof Rolling

Prior to the placement of fill or stone base material perform proof rolling to identify soft soil areas. Proof roll the existing subgrade with rubber-tired construction equipment, such as a loaded dump truck or loaded scraper, with a minimum weight of 45,000 lbs. Notify the Crescent Junction Operations / Site Manager a minimum of 3 days prior to proof rolling. Perform proof rolling in the presence of the Crescent Junction Operations / Site Manager. Undercut rutting or pumping of material as directed by the Crescent Junction Operations / Site Manager to a depth of 12 inches and replace with select material.

3.12.2 Construction

Shape subgrade to line, grade, and cross section, and compact as specified.

Include plowing, disking, and any moistening or aerating required to obtain specified compaction for this operation. Remove soft or otherwise unsatisfactory material and replace with satisfactory excavated material or other approved material as directed. Excavate rock encountered in the cut section to a depth of 6 inches below finished grade for the subgrade.

Bring up low areas resulting from removal of unsatisfactory material or excavation of rock to required grade with satisfactory materials, and shape the entire subgrade to line and grade, in accordance with project plans.

3.12.3 Compaction

Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Except for paved areas and railroads, compact each layer of the embankment to at least 95 percent of laboratory maximum density (ASTM D 1557).

3.12.3.1 Subgrade for Railroads

Compact subgrade for railroads to at least 95 percent laboratory maximum density for cohesive materials or 98 percent laboratory maximum density for cohesionless materials (ASTM D 1557).

3.12.3.2 Subgrade for Pavements

Compact subgrade for pavements to at least 95 percent laboratory maximum density (ASTM D 1557) for the depth below the surface of the pavement shown. When more than one soil classification is present in the subgrade, thoroughly blend, reshape, and compact the top 6 inches of subgrade.

3.13 FINISHING

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. Provide the degree of finish for graded areas within 0.1 foot of the grades and elevations indicated except that the degree of finish for subgrades specified in paragraph SUBGRADE PREPARATION. Finish gutters and ditches in a manner that will result in effective drainage. Finish the surface of areas to be turfed from settlement or washing to a smoothness suitable for the application of turfing materials. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

3.13.1 Subgrade and Embankments

During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do not disturb the finished subgrade by traffic or other operation.

The Contractor is responsible for protecting and maintaining the finished subgrade in a satisfactory condition until ballast, subbase, base, or pavement is placed. Do not permit the storage or stockpiling of materials on the finished subgrade. Do not lay subbase, base course, ballast, or pavement until the subgrade has been checked and approved, and in no case place subbase, base, surfacing, pavement, or ballast on a muddy, spongy, or frozen subgrade.

3.13.2 Capillary Water Barrier

Place a capillary water barrier under concrete floors and slabs directly on the subgrade and compact with a minimum of two passes of a vibratory compactor.

3.13.3 Grading Around Structures

Construct areas within 5 feet outside of each building and structure line true-to-grade, shape to drain, and maintain free of trash and debris until final inspection has been completed and the work has been accepted.

3.14 TESTING

In-place density testing of fill material will be performed by testing personnel contracted by RAC. The following sections and the Remedial Action Inspection Plan (RAIP) describe the testing that will be performed by others, so that the Contractor will be familiar with the type and frequency of tests being performed. When test results indicate that compaction is not as specified, the Contractor will be required to rework the material, replace and recompact to meet specification requirements.

The following type and number of tests are the minimum for each type operation.

3.14.1 In-Place Densities

In-place density testing will be performed using nuclear gage ASTM D 6928 and/or Sand Cone ASTM D 1556 methods. Moisture content of soil will be determined using oven ASTM D 216 or microwave ASTM D 4643 methods. For small work areas (less than 1/2 acre), in-place density tests will be performed at the following frequency:

a. One test per 5,000 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.

b. One test per 500 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.

For large fill areas (greater than½ acre), in-place density tests will be performed at the following frequency:

a. For material compacted by other than hand-operated machines: One test per 50,000 square feet or 1,850 cubic yards of material placed, or fraction thereof, a minimum of one test for each lift of fill or backfill, and a minimum of two tests per day.

b. For material compacted by hand-operated machines: One test per 500 square feet, or fraction thereof, of each lift of fill or backfill areas.

3.14.1.1 In-Place Density Testing of Waste Cell Perimeter Embankment

a. For material compacted by other than hand-operated machines: One test per 50,000 square feet or 1,850 cubic yards of material placed, or fraction thereof, a minimum of one test for each lift of fill or backfill, and a minimum of two tests per day.

b. For material compacted by hand-operated machines: One test per 500 square feet, or fraction thereof, of each lift of fill or backfill areas.

3.14.1.2 In-Place Density Testing of Waste Cell Spoil Material Embankment

a. For material compacted by other than hand-operated machines: One test per 100,000 square feet or 3,700 cubic yards of material placed.

b. For material compacted by hand-operated machines: One test per 500 square feet, or fraction thereof, of each lift of fill or backfill areas.

3.14.2 Check Tests on In-Place Densities

If ASTM D 6938 is used, check in-place densities by ASTM D 1556 as follows:

a. One check test for each 20 tests per ASTM D 6938, of fill or backfill compacted by other than hand-operated machines.

b. One check test for each 10 tests per ASTM D 6938, of fill or backfill compacted by hand-operated machines.

3.14.3 Optimum Moisture and Laboratory Maximum Density

Laboratory Density and Moisture Content tests (ASTM D 698, ASTM D 1557, and ASTM D 2216) will be performed (by others) for each type of fill material to determine the optimum moisture and laboratory maximum density values. For small fill areas of 50,000 cubic yards of fill or less, one representative test per 5,000 cubic yards of fill and backfill will be performed, or when any change in material occurs that may affect the optimum moisture content or laboratory maximum density. For fill areas requiring more than 50,000 cubic yards of fill, one representative test per 20,000 cubic yards of fill and backfill will be performed, or when any change in material occurs that may affect the optimum moisture content or laboratory maximum density.

3.14.4 Moisture Control

In the stockpile, excavations, or borrow areas, moisture tests will be performed (by others) to determine in situ moisture content. The Contractor shall add moisture to fill materials as needed to bring moisture content to near optimum (optimum moisture content plus or minus 5%) for compaction. The Contractor shall control the moisture content of material being placed as fill, and may perform additional tests of moisture content or make use of tests performed by others to control moisture. Testing of moisture content may be performed by any of the following tests:

1) ASTM D 2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass (Oven Moisture)
2) ASTM D 4643 - Determination of Water (Moisture) Content of Soil by the Microwave Oven Heating
3) ASTM D 4944 - Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester
4) ASTM D 4959 - Determination of Water (Moisture) Content of Soil by Direct Heating

5) During unstable weather, perform tests as dictated by local conditions and approved by the Crescent Junction Operations / Site Manager

3.15 DISPOSITION OF SURPLUS MATERIAL

Surplus material or other soil material not required or suitable for filling or backfilling, and brush and refuse, shall be removed from Government property or disposed of on site as directed by the Crescent Junction Operations / Site Manager.

-- End of Section --

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MOAB UMTRA PROJECT **MOAB, UTAH** **PROJECT NO: 35DJ2600**	DOCUMENT NO.: 35DJ2600-056-SPEC-31-00-20
	SECTION NO.: 31-00-20
	PLACEMENT AND COMPACTION OF RRM AND INTERIM COVER

This title sheet is the first page of the specification and a record of each issue or revision. The pages revised and the description of the revision should be noted under remarks.

REV.	DATE	BY	CKD	APPROVED	PAGES	REMARKS
0	12/17/07	WDB	FMP	W. Barton	ALL	ISSUED FOR CONSTRUCTION
1	01/30/08	WDB	FMP	W. Barton	ALL	Page 5, Section 1.3.2: Added Dozers Page 6, Section 3.2.1: Revised Lift Thickness Page 7, Section 3.4.1: Revised Test Frequencies
2	02/27/08	WDB	FMP	W. Barton	ALL	Page 6, Section 2.2: Removed requirement to screen material.
3	04/14/08	WDB	FMP	W. Barton	ALL	Page 5, Section 1.4: Add section 1.4 NQA-1 Quality Level Page 6, Table 1, Revised gradation to limit fines. Page 6, Section 3.2.1: Revised from 10” loose lift thickness to 12” loose lift thickness.
4	06/02/08	WDB	FMP	W. Barton	ALL	General, revised “Tailings” to “RRM” Page 6, Section 2.2: Revised section on material requirements for Interim Cover. Page 6, Section 3.1.1: Revised section to clarify test requirements for Interim Cover. Page 7, Section 3.2.2: Revised moisture requirement to add “optimum plus or minus 5%. Page 7, Section 3.2.5: Added demolition debris sizing. Page 8, Section 3.4.2: Revised moisture requirement to add: for RRM - “optimum plus or minus 3%”, and for Interim Cover - “optimum plus or minus 5%”.
5	1/23/19	FMP	WDB	W. Barton	ALL	Section 1.2: Revised Construction Manager to Crescent Junction Operations/Site Manager Section 1.3.2: Revised compaction equipment requirements Section 2.1: Revised moisture requirements Section 3.1.1: Revised Energy Solutions to Crescent Junction Operations/Site Manager, revised proctor from 5 points to 4 points, added ASTM reference

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MOAB UMTRA PROJECT **MOAB, UTAH** **PROJECT NO: 35DJ2600**	DOCUMENT NO.: 35DJ2600-056-SPEC-31-00-20
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REV.	DATE	BY	CKD	APPROVED	PAGES	REMARKS
						Section 3.2.1: Revised Computer Aided Earthmoving System and CAES to Computer Based Compaction System, revised lift thickness Section 3.2.2: Revised moisture content requirement Section 3.2.4: Deleted requirement for final lift Section 3.2.5: Revised debris minimization requirements Section 3.4.1: Revised CAES to Computer Based Compaction System Section 3.4.2: Deleted section Section 3.4.3: Revised section number to 3.4.3, revised CAES to Computer Based Compaction System Section 3.5.1: added “for dust suppression” Section 3.5.2: added option to add a protective top layer over Interim Cover for erosion and root protection. Section 3.5.3: Removed “as directed from last sentence
6	10/17/19	FMP	WDB	W. Barton	ALL	Revised to incorporate Design Change Notice 026. Section 1.3.1: Revised minimum lift thickness, Section 3.2.1: Revised minimum lift thickness, Section 3.4.1, 2: Added requirement to alternate compaction testing between the top half and the bottom half of each lift.

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REV.	DATE	BY	CKD	APPROVED	PAGES	REMARKS

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DIVISION 31 – Earthwork

SECTION 31 00 20

PLACEMENT AND COMPACTION OF RRM AND INTERIM COVER

-- End of Section Table of Contents --

SECTION 31 00 20

PLACEMENT AND COMPACTION OF RRM AND INTERIM COVER

PART 1 GENERAL

This specification covers placement, compaction and testing requirements for RRM material and interim clean cover layers at Crescent Junction.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 698 (2000ael) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu ft)

ASTM D 1140 (2000) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve

ASTM D 1556 2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D 1557 (2002el) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu ft)

ASTM D 1587 (2000) Thin-Walled Tube Sampling of Soils for Geotechnical Purposes

ASTM D 2167 (1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method

ASTM D 2216 (2005) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

ASTM D 2488 (2006) Description and Identification of Soils (Visual-Manual Procedure)

ASTM D 2922 (2005) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

ASTM D 3017 (2005) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

ASTM D 3740 (2004a) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

ASTM D 422 (1963; R 2002el) Particle-Size Analysis of Soils

ASTM D 4318 (2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D 4643 (2000) Determination of Water (Moisture) Content of Soil by the Microwave Oven Heating

ASTM D 4944 (2004) Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester

ASTM D 4643 (2000) Determination of Water (Moisture) Content of Soil by Direct Heating

ASTM D 6938 (2007b) In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.2 SUBMITTALS

Approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. All submittals shall be provided to the Crescent Junction Operations / Site Manager in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Protection

Equipment

Materials Handling Plan describing the following: processing and placement of the soil; type, model number, weight and critical dimensions of equipment to be used for soil processing, compaction, scarification, and smooth rolling; method of protecting fill materials from changes in moisture content and freezing after placement.

Testing Laboratory

Name and qualifications of the proposed testing laboratory.

SD-06 Test Reports

RRM/Fill Material Testing Compaction Testing

Within 24 hours of conclusion of physical tests, 3 copies of test results, including calibration curves and results of calibration tests.

1.3 EQUIPMENT

RRM and interim cover material shall be installed with equipment capable of scarifying and preparing the ground surface to receive fill, spreading fill material in uniform lifts, and compacting it to the density required by this specification.

1.3.1 Scarification Equipment

Disks, tillers, or other approved means shall be provided to scarify the ground surface or the surface of each previous lift of fill prior to placement of the next lift. The scarification equipment shall be capable of uniformly disturbing the upper 1 inch of the underlying soil surface to provide good bonding between lifts.

1.3.2 Compaction Equipment

For 24” lifts the compaction equipment shall consist of footed rollers. Footed rollers shall have a minimum weight of 45,000 pounds and at least one tamping foot shall be provided for each 110 square inches of drum surface. The length of each tamping foot from the outside surface of the drum, shall be at least 6 inches. During compaction operations, the spaces between the tamping feet shall be maintained clear of materials which would impair the effectiveness of the tamping foot rollers. For 14” and 8” lifts a dozer with a minimum ground pressure of 1650 pounds per square foot or a rubber-tired piece of equipment with similar ground pressure may be used.

1.3.3 Steel Wheeled Rollers

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 pounds.

1.3.4 Hand Operated Tampers

Hand operated tampers shall consist of rammers or other impact type equipment. Vibratory type equipment will not be allowed.

1.4 NQA-1 QUALITY LEVEL

All construction and testing activities included in this specification: PLACEMENT AND COMPACTION OF RRM AND INTERIM COVER for the Disposal Cell at Crescent Junction, are designated as Quality Level 2.

PART 2 PRODUCTS

2.1 RRM MATERIAL

RRM material will consist of uranium mill tailings from the Moab Pile, off-pile contaminated soils, and demolition debris and other waste materials stored in the Pile at Moab. Most of the material will be uranium mill tailings, consisting of contaminated sands, slimes, intermediate material, and cover soil. The RRM material will be excavated, mixed and blended, dried to moisture necessary to meet required compaction specifications, loaded in containers, and shipped to Crescent Junction for disposal. Off-pile contaminated soil material will be excavated and hauled to the tailings pile and eventually mixed with the tailings. Debris and other waste materials will be excavated, placed in containers, and shipped like the RRM material. In the waste

cell, non-soil materials will be placed in the contaminated RRM fill in a manner that will not result in voids in the waste mass.

2.2 INTERIM COVER SOIL

Interim Cover Soil will be soil from the excavation of the Crescent Junction waste cell. It will be material that has been produced on site by modifying the existing overburden soil and weathered Mancos Shale excavated on site. Overburden and weathered Mancos Shale shall be excavated, pulverized, wetted, and mixed to produce a uniform fine-grained soil near optimum moisture content for compaction. Soil shall be free of roots, debris, organic or frozen material, and shall have a maximum clod size of 2 inch at the time of compaction, based on a visual inspection.

PART 3 EXECUTION

3.1 RRM AND FILL SOIL ASSESSMENT TESTS

Assessment tests shall be performed on RRM and on Stockpiled soil for the Interim Cover Layer to assure compliance with specified requirements and to develop compaction requirements for placement. A minimum of three tests for maximum dry density (ASTM D 698) and moisture content (ASTM D 2216) shall be performed for each type of RRM soil observed. A minimum of three assessment tests shall be performed on stockpiled excavated material for use as Interim Cover Soil for each type of soil observed. During placement of RRM and Interim Cover soil, quick moisture content tests (ASTM D 4643, ASTM D 4944, or ASTM D 4959) shall be performed as required to maintain moisture control.

3.1.1 Compaction Testing

In-place density testing of RRM and Interim Cover material will be performed by the Remedial Action Contractor. The following sections describe the type and frequency of tests being performed. When test results indicate that compaction is not as specified, the material will be reworked, replaced and/or recompacted to meet specification requirements.

The following type and number of tests are the minimum for each type operation:

1) RRM Testing: A representative sample from each principal type or combination of blended RRM materials shall be tested to establish compaction curves using ASTM D 698. A minimum of one set of compaction curves shall be developed per 10,000 cubic yards of RRM material. A minimum of 4 points shall be used to develop each compaction curve as per ASTM D 698.
2) Interim Cover Testing: A representative sample from each type or combination of stockpiled excavated soil for use as Interim Cover soil shall be tested to establish compaction curves using ASTM D 698.
3) In-place density testing of RRM and Interim Cover material shall be performed in accordance with Section 3.4 of this specification.

3.2 INSTALLATION

3.2.1 RRM and Interim Cover Soil Placement

RRM and Interim Cover soil shall be placed to the lines and grades shown on the drawings. A GPS guided Computer Based Compaction System can be used to direct fill placement such that RRM and Interim Cover Soil are placed in lifts of nearly uniform thickness which will not exceed an average uncompacted thickness of 14 inches for Interim Cover and 24 inches for RRM. In areas where hand operated tampers must be used, the loose lift thickness should not exceed 4 inches.

3.2.2 Moisture Control

RRM and Interim Cover shall be placed and compacted within the moisture content range needed to achieve 90% of the laboratory determined maximum dry density of each type of material. The range in moisture content shall be maintained uniform throughout each lift as necessary to achieve 90% compaction and dust control. The moisture content shall be maintained uniform throughout each lift.

3.2.3 Compaction

RRM and Interim Cover soil shall be compacted to meet the following density requirements:

1) RRM – 90 percent of the laboratory determined maximum dry density as determined by ASTM D 698.
2) Interim Cover Layer – 90 percent of the laboratory determined maximum dry density as determined by ASTM D 698.

3.2.4 Scarification

Scarification shall be performed on all areas of the upper surface of each lift prior to placement of the next lift. Scarification shall be accomplished with approved equipment. The final lift of Interim Cover soil shall not be scarified.

3.2.5 Placement of Demolition Debris

Demolition debris will be placed in the waste cell along with RRM material.

Debris shall not contain free liquids. Debris shall be sized to minimize voids. Pipes and ducts that are 6 inches or greater in diameter shall be crushed or, if crushing is impractical, shall be cut in half longitudinally or filled. Rubber tires shall be cut and placed in order to minimize void space. Debris shall be spread and/or oriented in a manner that results in a minimum of voids.

Debris may be placed as a sacrificial lift at the bottom of the disposal cell in a 2-foot lift. Debris in sacrificial lifts shall contain no free liquids, and oriented in a manner that minimizes voids and contained within the 2-foot lift profile. Sacrificial debris lifts are not subject to moisture and compaction criteria.

3.3 CONSTRUCTION TOLERANCES

The top surface of the RRM and Interim Cover Layer shall be no greater than 2 inches above the lines and grades shown on the drawings. No minus tolerance will be permitted.

3.4 CONSTRUCTION TESTS

3.4.1 RRM and Interim Cover Layer Tests

Compaction can be verified by the computer based compaction system. When compaction of a lift of RRM or Interim Cover soil is achieved, the computer based compaction system will produce a map of the location and thickness of the completed lift. Computer records for each layer of soil placed will constitute documentation of completed lifts and be compiled as construction records.

Perform compaction Verification Tests, in-place density and moisture content tests on compacted fill material, in accordance with the following requirements:

1) Verification tests of in-place density shall be performed on the initial layer of RRM, on the first 5,000 cubic yards of Interim Cover, and on any layers in which the Computer Based Compaction System indicates that problems occurred obtaining compaction.

2) When verification in-place density and moisture content tests are performed on a soil layer, a minimum of two tests shall be performed per 5,000 cubic yards of fill material placed. Compaction testing should alternate between checking compaction in the top half of each lift and the bottom half of each lift.

3) Compaction and moisture content tests shall be performed in accordance with the following methods:

   - ASTM D 1556 - Density and Unit Weight of Soil in Place by the Sand-Cone Method
   - ASTM D 2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass (Oven Moisture)
   - ASTM D 6938 - In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

Note: Companion sand cone tests and oven moisture tests must be performed along with nuclear tests until a sufficient number have been performed to demonstrate a clear correlation.

3.4.2 Test Results

Where the computer based compaction system indicates acceptable compaction, the computer output for that lift (lift thickness, location, and compaction), shall be considered proof of satisfactory lift placement. If the computer based compaction system indicates that adequate compaction is not achieved, the lift shall be reworked until an acceptable result is achieved. Verification test results of ASTM D

6938, In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth), shall be used to confirm the acceptability of the computer based compaction system results.

3.5 PROTECTION

3.5.1 Moisture Content

After lift placement, moisture content shall be maintained for dust suppression until the next lift is placed.

3.5.2 Erosion

Erosion that occurs in the RRM or Interim Cover layers shall be repaired and grades re-established. If the Radon Barrier is not placed immediately after completion of the Interim Cover it is acceptable to use a Best Management Practice of placing a protective layer of 0.8’ (minimum) on the Interim Cover. The BMP will protect the Interim Cover from damaged caused by erosion and roots and self-sown vegetation. The vegetation does not have to be removed until the Radon Barrier placement. The protective layer can be cleared of vegetation and re-used as a part of the Radon Barrier.

3.5.3 Freezing and Desiccation

Freezing and desiccation of the RRM and Interim Cover soil shall be prevented. If freezing or desiccation occurs, the affected soil shall be reconditioned.

3.5.4 Retests

Areas that have been repaired shall be retested as directed. Repairs to the RRM or Interim Cover layers shall be documented including location and volume of soil affected, corrective action taken, and results of retests.

-- End of Section --

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MOAB UMTRA PROJECT **MOAB, UTAH** **PROJECT NO: 35DJ2600**	DOCUMENT NO.: 35DJ2600-056-SPEC-31-00-30
	SECTION NO.: 31-00-30
	PLACEMENT AND COMPACTION OF FINAL CAP LAYERS

This title sheet is the first page of the specification and a record of each issue or revision. The pages revised and the description of the revision should be noted under remarks.

REV.	DATE	BY	CKD	APPROVED	PAGES	REMARKS
0	12/17/07	WDB	FMP	W. Barton	ALL	ISSUED FOR CONSTRUCTION
1	1/30/08	WDB	FMP	W. Barton	ALL	Page 7, Section 3.2.2: Revised lift thickness Page 8, Section 3.2.6: Added bentonite Page 8, Section 3.3.2: Revised lift thickness Page 9, Section 3.3.6: Added bentonite Page 9, Section 3.4.1: Revised final sentence.
2	4/14/08	WDB	FMP	W. Barton	ALL	Page 6, Section 1.5: Add section 1.5, NQA-1 Quality Level. Page 8, Section 3.2.2: Revised from 10" loose lift thickness to 12" loose lift thickness. Page 9, Section 3.3.2: Revised from 10" loose lift thickness to 12" loose lift thickness.
3	06/02/08	WDB	FMP	W. Barton	ALL	Page 5, Section 1.3: Deleted "Relative" Page 7, Section 2.2: Added reference to Aggregate Spec. Page 8, Section 3.2.1: Added grain size distribution to list of tests on Radon Barrier Material. Page 9, Section 3.2.5: Added reference to ASTM D698. Page 9, Section 3.2.3: Revised moisture requirement to add "optimum plus or minus 3%. Page 9, Section 3.3.3: Revised moisture requirement to add "optimum plus or minus 5%.
4	08/03/10	WDB	FMP	W. Barton	ALL	Page 6, Section 2.1: Change maximum clod size from 1 inch to 3 – 4 inches. Page 7, Table 1: Change maximum particle size from 1 inch to 3 – 4 inches.
5	09/02/10	WDB	FMP	W. Barton	ALL	Page 6, Section 2.1: Change word "clod" to "particle". Page 6, Section 2.1: Add new 3rd paragraph about placement and inspection of Mancos shale.

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REV.	DATE	BY	CKD	APPROVED	PAGES	REMARKS
6	09/08/10	WDB	FMP	W. Barton	ALL	Page 8, Section 2.1, Table 1: Revised the minimum Liquid Limit from 35 to 30 and added a maximum Liquid Limit of 50. Page 12, Section 3.6.1: Added a paragraph describing sampling and testing of in-place aggregate. The paragraph includes criteria for evaluating results of testing and any deviation from the specified range of aggregate.
7	08/18/11	WDB	FMP	W. Barton	ALL	Page 12, Section 3.5: Added Section 3.5.1 Tolerance of RRM and Interim Layers Added Section 3.5.2 Tolerances of Cover Layers New sections revise the tolerances of each layer of material placed.
8	1/23/19	FMP	WDB	W. Barton	ALL	Section 1.3: Revised Construction Manager to Crescent Junction Operations/Site Manager, revised CAES to Computer Based Compaction System, revised Energy Solution Construction Quality Control Manager to Quality Assurance Manager Section 1.4.1: Added rubber-wheeled equipment Section 3.1: Revised Construction Manager to Crescent Junction Operations/Site Manager Section 3.2.5: Revised Computer Aided Earthmoving System to Computer Based Compaction System Section 3.3.3: Revised moisture content Section 3.3.5: Revised Computer Aided Earthmoving System to Computer Based Compaction System Section 3.4.1: Revised Computer Aided Earthmoving System to GPS, revised vibratory steel

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MOAB UMTRA PROJECT **MOAB, UTAH** **PROJECT NO: 35DJ2600**	DOCUMENT NO.: 35DJ2600-056-SPEC-31-00-30
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This title sheet is the first page of the specification and a record of each issue or revision. The pages revised and the description of the revision should be noted under remarks.

REV.	DATE	BY	CKD	APPROVED	PAGES	REMARKS
						drum to smooth drum Section 3.6.1: Revised "shall" to "should", Revised Computer Aided Earthmoving System to Computer Based Compaction System, revised CAES to Computer Based Compaction System Section 3.6.1: Revised CAES to Computer Based Compaction System

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DIVISION 31 - EARTHWORK

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PLACEMENT AND COMPACTION OF FINAL CAP LAYERS

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SECTION 31 00 30

PLACEMENT AND COMPACTION OF FINAL CAP LAYERS

PART 1 GENERAL

1.1 SCOPE

This specification covers material characteristics, placement, compaction, and testing of final cap layers, including:

a. Radon barrier layer;

b. Stone infiltration and bio-barrier;

c. Frost protection layer; and

d. Rock armoring.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 1140 (2000) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve

ASTM D 1556 (2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D 698 (2002e1) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu ft)

ASTM D 2167 (1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method

ASTM D 2216 (2005) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

ASTM D 2488 (2006) Description and Identification of Soils (Visual-Manual Procedure)

ASTM D 6938 (2007b) In-place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

ASTM D 3740 (2004a) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

ASTM D 422 (1963; R 2002e1) Particle-Size Analysis of Soils

ASTM D 4220 (1995; R 2000) Preserving and Transporting Soil Samples

ASTM D 4318 (2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D 4643 (2000) Determination of Water (Moisture) Content of Soil by the Microwave Oven Heating

ASTM D 4944 (2004) Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester

ASTM D 4643 (2000) Determination of Water (Moisture) Content of Soil by Direct Heating

1.3 SUBMITTALS

Approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. All submittals shall be provided to the Crescent Junction Operations / Site Manager in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment

Submit specifications for equipment for the processing, scarification, placement, compaction, and smooth rolling of fill, including type, model number, weight and critical dimensions of equipment.

SD-06 Test Reports

Moisture Content and Density Tests of Fill Materials, G;

Moisture Content Tests of Soil Fill, G;

Moisture Content and In-Place Density Tests of Soil Fill (Verification Testing), G;

COMPUTER BASED COMPACTION SYSTEM Soil Placement and Compaction Records, G;

Test reports shall be submitted to the Quality Assurance Manager within 48 hours of the completion of soil placement and field testing.

1.4 EQUIPMENT

Equipment used to place and compact the Radon Barrier material and Frost Protection common fill shall not brake suddenly, turn sharply, or be operated at excessive speeds.

1.4.1 Compaction Equipment

Compaction equipment shall consist of rubber-wheeled equipment or footed rollers which have a minimum weight of 45,000 pounds and at least one foot for each 110 square inches of drum surface. The length of each tamping foot shall be at least 6 inches from the outside

surface of the drum. During compaction operations, the spaces between the tamping feet shall be maintained clear of materials which would impair the effectiveness of the tamping foot rollers.

1.4.2 Scarification Equipment

Disks, rotor tillers, or other approved means shall be provided to scarify the surface of each lift of soil prior to placement of the next lift. The scarification equipment shall be capable of uniformly disturbing the upper 1 to 2 inches of the soil surface to provide good bonding between lifts.

1.4.3 Steel Wheeled Rollers

A smooth, non-vibratory steel wheeled roller shall be used to produce a smooth compacted surface on finished compacted soil layers. Steel wheeled rollers shall weigh a minimum of 20,000 pounds.

1.4.4 Hand Operated Tampers

Hand operated tampers shall consist of rammers or other impact type equipment. Vibratory type equipment will not be allowed.

1.5 NQA-1 QUALITY LEVEL

All construction and testing activities included in this specification: PLACEMENT AND COMPACTION OF FINAL CAP LAYERS for the Disposal Cell at Crescent Junction, are designated as Quality Level 2.

PART 2 PRODUCTS

2.1 RADON BARRIER LAYER

Radon Barrier is the layer constructed on top of the interim cover layer and the contaminated tailings material in the waste cell and underlying the protection layers in the final cap. The purpose of this layer is to retard the emanation of radon gas from the tailings into the atmosphere and to minimize infiltration of incident precipitation into the tailings material.

Radon Barrier Layer soil shall be produced by modifying the weathered Mancos Shale excavated on site. Weathered Mancos Shale shall be excavated, separated from other excavated materials, pulverized, wetted, and mixed to produce a uniform fine-grained fill soil at or above optimum moisture content for compaction. It shall be free of roots, debris, organic or frozen material, and shall have a maximum particle size of 3 to 4 inches at the time of compaction. Fill material shall comply with the criteria listed in Table 1. Testing of Radon Barrier soil to verify conformance with the following table is described in Section 3.2.1 Radon Barrier Material.

Placement of Mancos shale will be visually inspected to make sure 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.

TABLE 1
REQUIRED PHYSICAL PROPERTIES OF RADON BARRIER FILL SOIL

Test Property	Test Value	Method
Max. particle size (inches)	3 to 4	ASTM D 422
Min. percent passing No. 4 sieve	80	ASTM D 422
Min. percent passing No. 200 sieve	50	ASTM D 1140
Min. liquid limit	30	ASTM D 4318
Max. liquid limit	50	ASTM D 4318
Min. plasticity index	10	ASTM D 4318
Max. plasticity index	40	ASTM D 4318

2.2 STONE FOR FINAL COVER LAYERS

Stone for the final cover layers, infiltration and bio-barrier layer and rock armoring, shall be rock material that has long-term chemical and physical durability. Rock for final cover layers shall be in accordance with Section 32 11 23 Aggregate and Riprap. Rock for final cover layers shall achieve an acceptable score for its intended use, in accordance with the following rock scoring and acceptance criteria:

TABLE 2
NRC TABLE OF SCORING CRITERIA FOR ROCK QUALITY

Laboratory Test	Weighing Factor			10	9	8	7	6	5	4	3	2	1	0
	L*	S*	I*	Good				Fair				Poor		
Specific Gravity	12	6	9	2.75	2.70	2.65	2.60	2.55	2.50	2.45	2.40	2.35	2.3	2.25
Absorption, percent	13	5	2	0.10	0.30	0.50	0.67	0.83	1.0	1.5	2.0	2.5	3.0	3.5
Sodium Sulfate, percent	4	3	11	1.0	3.0	5.0	6.7	8.3	10.0	12.5	15.0	20.0	25.0	30.0
LA Abrasion, percent	1	8	1	1.0	3.0	5.0	6.7	8.3	10.0	12.5	15.0	20.0	25.0	30.0
Schmdt Hammer	11	13	3	70	65	60	54	47	40	32	24	16	8	0

Notes:

1) Scores were derived from Tables 6.2, 6.5, and 6.7 of NUREG/CR-2642, Long-Term Survivability of Riprap for Armoring Uranium Mill Tailings and Covers: A Literature Review, 1982.
2) Weighing Factors are derived from Table 7 of "Petrographic Investigations of Rock Durability and Comparisons of Various Test Procedures," by G.W. Dupuy, Engineering Geology, July 1965. Weighing factors are based on inverse of ranking of test methods for each rock type. Other tests may be used; weighing factors for these tests may be derived using Table 7, by counting upward from the bottom of the table.
3) Test methods should be standardized, if a standard test is available and should be those used in NUREG/CR2642, so that proper correlations can be made.

Rock Acceptance Criteria

An acceptable rock score depends on the intended use of the rock. The rock's score must meet the following criteria:

- For occasionally saturated areas, which include the top and sides of the final cover, the rock must score at least 50 percent or the rock is rejected. If the rock scores between 50 percent and 80 percent the rock may be used, but a larger D50 must be provided (oversizing). If the rock score is 80 percent or greater, no oversizing is required.
- For frequently saturated areas, which include all channels and buried slope toes, the rock must score 65 percent or the rock is rejected. If the rock scores between 65 percent and 80 percent, the rock may be used, but must be oversized. If the rock score is 80 percent or greater, no oversizing is required.

Oversize rock as follows;

- Subtract the rock score from 80 percent to determine the amount of oversizing required. For example, a rock with a rating of 70 percent will require oversizing of 10 percent (80 - 70 = 10 percent).
- The D50 of the stone shall be increased by the oversizing percent. For example, a stone with a 10 percent oversizing factor and a D50 of 12 inches will increase to a D50 of 13.2 inches.
- The final thickness of the stone layer shall increase proportionately to the increased D50 rock size. For example, a layer thickness equals twice the D50, such as when the plans call for 24 inches of stone with a D50 of 12 inches, if the stone D50 increases to 13.2, the thickness of the layer of stone with a D50 of 13.2 should be increased to 26.4 inches.

2.3 FROST PROTECTION LAYER

The Frost Protection Layer is the top soil layer constructed of the waste cell cover. The purpose of this layer is to protect underlying cover layers from degradation due to environmental factors such as freeze-thaw cycles. The Frost Protection Layer shall be constructed of common fill material, which can be any soil material from the waste cell excavation.

PART 3 EXECUTION

3.1 EXCAVATION, SEGREGATION, AND STOCKPILING OF CAP MATERIALS

Cap materials shall be soil material from the waste cell excavation. Materials shall be excavated, segregated into common fill and weathered Mancos Shale, and stockpiled for use as cap materials. Stockpiles shall be at locations shown in the project plans or as directed by the Crescent Junction Operations / Site Manager.

3.2 INSTALLATION OF RADON BARRIER MATERIAL

3.2.1 Radon Barrier Material

The Radon Barrier Layer will be constructed of processed Mancos Shale soil. The soil will be produced on site by processing excavated Mancos Shale into a fine-grained soil and adding water to bring the Mancos Shale soil to near optimum moisture content for compaction. Mancos Shale soil produced for Radon Barrier fill shall be tested to determine its material properties and its maximum dry density and moisture

content. As a minimum, perform the following soil tests on each 10,000 cubic yards of soil:

ASTM D 4318, Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D 422, Particle-Size Analysis of Soils

ASTM D 1140, Amount of Material in Soils Finer than the No. 200 Sieve

ASTM D 698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort

ASTM D 2216, Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass and/or ASTM D 4643, Determination of Water (Moisture) Content of Soil by the Microwave Oven Heating

3.2.2 Radon Barrier Material Placement

Radon Barrier shall be placed to the lines and grades shown on the drawings. The soil shall be placed in loose lifts not to exceed 12 inches in thickness after compaction. In areas where hand operated tampers must be used, the loose lift thickness shall not exceed 4 inches.

3.2.3 Moisture Control

Radon Barrier soil shall be placed and compacted within a moisture content range that will achieve the specified compaction (optimum plus or minus 3 percent). The moisture content shall be maintained uniform throughout each lift. Water added shall be thoroughly incorporated into the soil to ensure uniformity of moisture content prior to compaction.

3.2.4 Scarification and Dressing of Final Lift Surface

Scarification shall be performed on all areas of the upper surface of each underlying soil layer prior to placement of the next lift. Scarification shall be accomplished with approved equipment. The final lift of Radon Barrier soil shall not be scarified. The final lift shall be smooth rolled with at least 3 passes of the approved smooth steel wheeled roller to provide a smooth surface.

3.2.5 Compaction

Radon Barrier soil shall be compacted to at least 95 percent of its laboratory maximum dry density determined in accordance with ASTM D 698. The Computer Based Compaction System may be used to direct fill placement, monitor compaction, and record the location and thickness of the each soil layer being placed. If the COMPUTER BASED COMPACTION SYSTEM is not used for compaction, fill shall be compacted with a minimum 45,000 pound static weight footed roller capable of kneading compaction, with feet a minimum of 6 inches in length.

3.2.6 Repair of Voids

Voids created in the Radon Barrier layer during construction (including, but not limited to, penetrations for test samples, grade

stakes, and other penetrations necessary for construction) shall be repaired by removing any unsuitable material, backfilling with soil and compacting by tamping each lift with a steel rod, or by backfilling with bentonite.

3.3 INSTALLATION OF FROST PROTECTION LAYER SOIL

3.3.1 Frost Protection Material

The Frost Protection layer will be constructed of common fill soil. The soil will be produced on site by adding water to bring the excavated and stockpiled soil to near optimum moisture content for compaction. Test soil in accordance with ASTM D 698, Laboratory Compaction Characteristics of Soil Using Standard Effort. Perform at least 3 tests on each type of material stockpiled for use as fill. Perform additional lab density tests on stockpiled material if changes in material characteristics are observed.

3.3.2 Frost Protection Layer Placement

Frost Protection soil shall be placed to the lines and grades shown on the drawings. The soil shall be placed in loose lifts not to exceed 12 inches in thickness after compaction. In areas where hand operated tampers must be used, the loose lift thickness shall not exceed 4 inches.

3.3.3 Moisture Control

Frost Protection soil shall be placed and compacted within a moisture content range that will achieve the specified compaction. The moisture content shall be maintained uniform throughout each lift. Water added shall be thoroughly incorporated into the soil to ensure uniformity of moisture content prior to compaction.

3.3.4 Scarification and Dressing of Final Lift Surface

Scarification shall be performed on all areas of the upper surface of each underlying soil layer prior to placement of the next lift. Scarification shall be accomplished with approved equipment. The final lift of soil shall not be scarified. The final lift shall be smooth rolled with at least 3 passes of the approved smooth steel wheeled roller to provide a smooth surface.

3.3.5 Compaction

Soil shall be compacted to 90 percent of the laboratory determined maximum dry density in accordance with ASTM D 698. The Computer Based Compaction System may be used to direct fill placement, monitor compaction, and record the location and thickness of each soil layer being placed.

3.3.6 Repair of Voids

Voids created in the Radon Barrier layer during construction (including, but not limited to, penetrations for test samples, grade stakes, and other penetrations necessary for construction) shall be

repaired by removing any unsuitable material, backfilling with soil and compacting by tamping each lift with a steel rod, or by backfilling with bentonite.

3.4 INSTALLATION OF ROCK LAYERS

This section describes the material and installation of rock layers for the Infiltration and Biobarrier and Rock Armoring of the final cover.

3.4.1 Rock Placement and Compaction

Rock shall be spread to the thickness indicated on the drawings or in accordance with oversizing due to scoring criteria (see Section 2.2 of this specification). Rock placement shall be guided by GPS to ensure that the appropriate thickness has been placed at all locations. Stone with a D50 of 2 inches or less shall be shall be compacted with a smooth drum.

3.5 CONSTRUCTION TOLERANCES

3.5.1 Tolerance of RRM and Interim Layers

- RRM Layer - The top surface of the RRM layer shall be no greater than 2 inches above the lines and grades shown on the drawings. No minus tolerance will be permitted.
- Interim Layer – The top surface of the Interim Layer shall be no greater than 2" above the lines and grades shown on the drawings. No minus tolerance will be permitted.

3.5.2 Tolerances of Cap Layers

The following layers shall be installed to the thicknesses indicated for each layer, no minus tolerance will be permitted. Excess soil or rock is permitted to assure that the minimum thickness is achieved, but shall be as little as practically achievable. Final layer thickness shall be uniform, smooth and continuous, without humps or thickened edges or other defects.

- Radon Barrier – Layer minimum thickness is 4 feet, no minus tolerance permitted. Confirm 4 feet minimum thickness by performing a pre and post survey.
- Infiltration and Biointrusion – Layer minimum thickness is 6 inches, no minus tolerance permitted.
- Frost Protection - Layer minimum thickness is 3 feet, no minus tolerance permitted. Confirm 3 feet minimum thickness by performing a pre and post survey.
- Cap Rock - The final thickness of the Cap Rock depend on the location in which the rock is placed and shall be in accordance with the drawings and the Aggregate and Riprap Specification 32-11-23, Table 3. No minus tolerance permitted.

3.6 CONSTRUCTION TESTS

3.6.1 Material Tests

For placement and compaction of soils, moisture content tests should be performed daily prior to placement to maintain moisture control and uniformity of soil to be used for fill. Computer Based Compaction System can be used to place, compact and document compaction of all soil layers. Computer Based Compaction System acceptance of an installed layer of soil will constitute proof of satisfactory compaction. Computer output of the Computer Based Compaction System will be acceptable documentation for location, thickness and compaction of installed layers.

Aggregate Particle Size Tests on In-Place Stone - When particle size tests are performed on in-place stone, obtain bulk samples of aggregate and perform sieve analyses in accordance with ASTM D 422 - Particle Size Analysis of Soils. Aggregate shall be considered acceptable if the result of particle size testing:

- For any sieve size >#4 sieve, is within 5 percent of the specified gradation range (Specification 32 11 23, Table 3); or
- For any sieve size <#4 sieve, is within 3 percent of the specified gradation range (Specification 32 11 23, Table 3).

Compaction Verification Tests - Perform in-place density and moisture content tests on compacted fill material in accordance with the following requirements:

- Verification tests of in-place density shall be performed on initial layer of soil placed, and on any layers in which the Computer Based Compaction System indicates that problems occurred obtaining compaction.
- When verification in-place density and moisture content tests are performed on a soil layer, a minimum of two tests shall be performed per 5,000 cubic yards of fill material placed.
- Compaction and moisture content tests shall be performed in accordance with the following methods:
    - ASTM D 1556 - Density and Unit Weight of Soil in Place by the Sand-Cone Method
    - ASTM D 2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
    - ASTM D 6938(2007b) - In-place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

Note: Companion sand cone tests and oven moisture tests must be performed along with nuclear tests until a sufficient number have been performed to demonstrate a clear correlation.

3.6.2 Initial and Confirmatory Surveys

Verification of the thickness of the Radon Barrier Layer will be performed by comparing before and after surveys of the Layer. Prior to placement of the Radon Barrier Layer, a survey shall be performed of the top of the Interim Cover layer. The initial survey will document

the pre-cap geometry of the site. After the Radon Barrier Layer has been installed, a post-installation survey will be performed on the top of the Radon Barrier fill to confirm that the total fill thickness is in accordance with the plans and specifications.

3.7 PROTECTION

3.7.1 Moisture Content

After placement, moisture content shall be maintained or adjusted to meet criteria.

3.7.2 Erosion

Erosion that occurs in the fill layers shall be repaired and grades re-established.

3.7.3 Freezing and Desiccation

Freezing and desiccation of the Radon Barrier layer shall be prevented. If freezing or desiccation occurs, the affected soil shall be removed or reconditioned as directed.

3.7.4 Retests

Areas that have been repaired shall be retested as directed. Repairs to the Radon Barrier layer shall be documented including location and volume of soil affected, corrective action taken, and results of retests.

-- End of Section --

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MOAB UMTRA PROJECT **MOAB, UTAH** **PROJECT NO: 35DJ2600**	DOCUMENT NO.: 35DJ2600-056-SPEC-31-32-11
	SECTION NO.: 31-32-11
	SURFACE WATER MANAGEMENT AND EROSION CONTROL

This title sheet is the first page of the specification and a record of each issue or revision. The pages revised and the description of the revision should be noted under remarks.

REV.	DATE	BY	CKD	APPROVED	PAGES	REMARKS
0	12/17/07	WDB	FMP	W. Barton	ALL	ISSUED FOR CONSTRUCTION
1	1/30/08	WDB	FMP	W.Barton	ALL	Page 4, Sections 2.3 and 3.1: Added a tackifier or crusting agent for erosion control.
2	1/23/19	FMP	WDB	W.Barton	ALL	Section 1.2: Revised Construction Manager to Crescent Junction Operations/Site Manager, Section 2.3: Revised Construction Manager to Crescent Junction Operations/Site Manager, Section 3.2: Revised Construction Manager to Crescent Junction Operations/Site Manager, Section 3.4: Revised Construction Manager to Crescent Junction Operations/Site Manager

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DIVISION 31 - EARTHWORK

SECTION 31 32 11

SURFACE-WATER MANAGEMENT AND EROSION CONTROL

-- End of Section Table of Contents --

SECTION 31 32 11

SURFACE-WATER MANAGEMENT AND EROSION CONTROL

PART 1 GENERAL

1.1 SCOPE

This section includes materials and placement of silt fence, erosion mat, check dams, construction entrances, diversions, ditches, channels, berms, and stabilization; and maintenance of sedimentation basins and surface-water management and erosion control measures.

1.2 SUBMITTALS

Approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. All submittals shall be provided to the Crescent Junction Operations / Site Manager in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Manufacturer's data on silt fence;

Manufacturer's data on erosion control matting;

SD-08 Manufacturer's Instructions

Manufacturer's installation and maintenance instructions;

PART 2 PRODUCTS

2.1 SILT FENCE

Furnish silt fence with either woven or nonwoven geotextile. Silt fence shall be:

a. Woven geotextile consisting of slit films of polypropylene treated with ultraviolet light stabilizers, or nonwoven geotextile consisting of long chain polymeric filaments or polyester yarns, inert to chemicals commonly found in soils and to hydrocarbons, and resistant to mildew, rot, insects, and rodent attack.

b. Reinforcement Backing: Shall be minimum 14-gauge steel wire and maximum mesh spacing of 6 inches or synthetic netting of equal strength. Use reinforcement backing can be eliminated if post spacing is a maximum of 6 feet and the geotextile tensile strength is at least 200 pounds.

c. Posts: Shall be either wood or steel with minimum length of 4 feet. Wood posts shall be at least 2 inches by 2 inches of oak or similar hardwood. Steel posts shall be round or shaped as a "U", "T", or "C". Steel posts shall have a minimum weight of 1.33 pounds per linear foot and shall have projections for fastening reinforcement to silt fence.

d. Wire Staples: Shall be at least 9-gauge thickness with a minimum length of 1 inch.

e. A preassembled silt fence meeting the material requirements may be used instead of a field constructed silt fence.

2.2 EROSION MAT

Furnish erosion mat that shall be a woven blanket-like fabric made of biodegradable yarn with the following material properties:

a. Material Content: Coir Yarn: 100 percent; containing 45 percent Lignin, 55 percent Cellulose (approximately)

b. Weight: Minimum 22.7 ounces per square yard;

c. Open Area: 38 percent (approximately); and

d. Average Mesh Opening: 0.4" X 0.5"

Furnish erosion mat that will resist degradation for a minimum 6-month period after installation.

Furnish erosion mat having a permissible velocity of 7 feet per second.

2.3 OTHER MATERIALS

a. Culverts shall be in accordance with Section 33 40 01 STORM DRAINAGE.

b. Construction entrances shall be in accordance with design plans and details.

c. Tackifiers or crusting agents shall be used to reduce soil erosion as directed by the Crescent Junction Operations / Site Manager.

d. Materials for other surface-water management and erosion controls shall be in accordance with design plans and details.

2.4 EQUIPMENT

Furnish equipment to perform work specified in this section.

PART 3 EXECUTION

3.1 INSTALLATION

a. Install silt fence in accordance with Manufacturer's Instructions.

b. Install check dams in ditches and channels in accordance with project plans and details.

c. Tackifiers or crusting agents shall be applied in accordance with manufacturer's application instructions.

d. Construct channels, ditches, and other earthwork as shown on the construction drawings and in accordance with the Contractor's Surface-Water Management and Erosion Control Work Plan. Earthwork for channels, ditches, and berms shall be in accordance with Section 31 00 00, EARTHWORK.

3.2 ADDITIONAL REQUIREMENTS

Prevent the runoff of polluting substances such as silt, clay, fuels, oils, and contaminated soils from migrating into water supplies and surface waters.

Remove accumulated silt and debris from behind the face of the silt fence when the silt deposits reach approximately one half the height of the fence. Replace silt fence geotextile damaged during maintenance operations. Removed silt and debris shall be placed in locations approved by the Crescent Junction Operations / Site Manager.

3.3 MAINTENANCE

Clean, maintain, repair, and replace surface-water management and erosion controls for the duration of the contract in accordance with the Contractor's Surface-Water Management and Erosion Control Work Plan.

3.4 INSPECTIONS

Inspect surface-water management and erosion control measures and sedimentation basins to evaluate their effectiveness and need for maintenance. Any required repairs to the surface-water management and erosion control measures and sedimentation basins shall be initiated upon discovery, but no later than 24 hours after discovery. Inspections shall occur, at a minimum, at the following frequencies:

a. Weekly.

b. Daily after each rain event exceeding 0.5 inch.

c. Daily during prolonged rainfall events.

Records of inspections shall be kept on file on site by Contractor and shall be submitted monthly to the Crescent Junction Operations / Site Manager. The records of inspection shall include the following:

a. Summary of the scope of the inspection.

b. Name of inspector.

c. Inspection date.

d. Inspection location.

e. Purpose of the inspection (e.g., regular weekly, following a storm, etc.).

f. Observations relative to performance of the surface-water management and erosion control measures.

g. Any necessary corrective actions.

h. Corrective actions completed and their performance since the previous inspection.

-- End of Section --

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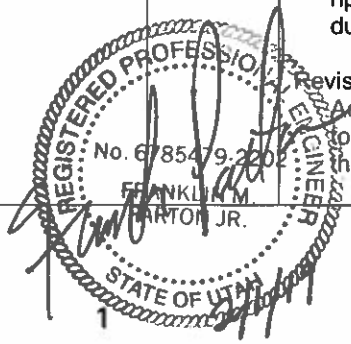
MOAB UMTRA PROJECT **MOAB, UTAH** **PROJECT NO: 35DJ2600**	DOCUMENT NO.: 35DJ2600-056-SPEC-32-11-23
	SECTION NO.: 32-11-23
	AGGREGATE AND RIPRAP

This title sheet is the first page of the specification and a record of each issue or revision. The pages revised and the description of the revision should be noted under remarks.

REV.	DATE	BY	CKD	APPROVED	PAGES	REMARKS
0	12/17/07	WDB	FMP	W. Barton	ALL	ISSUED FOR CONSTRUCTION
1	1/30/08	WDB	FMP	W. Barton	ALL	Page 11, Table 3, Revised Gradations to allow small amount of fines.
2	2/27/08	WDB	FMP	W. Barton	ALL	Page 8, Section 1.5, Revised weather limitations. Page 11, Section 2.1.6.2, revised riprap thicknesses.
3	4/15/08	WDB	FMP	W. Barton	ALL	Page 8, Section 1.7: Added Section 1.7, NQA-1 Quality Levels.
4	06/03/08	WDB	FMP	W. Barton	ALL	Revised Section 1.4.2.2, deleted requirements to check Liquid Limit and Plasticity Index. Revised Section 1.4.3.1, deleted requirements to check Liquid Limit and Plasticity Index.
5	07/03/08	WDB	FMP	W. Barton	ALL	Revised Section 2.1.4, Riprap: Added sentence clarifying: TABLE 1 for non-disposal cell aggregate TABLE 3 for disposal cell aggregate/riprap Revised Section 2.1.6.1 Biobarrier: Added sentence describing the filter requirements of biobarrier material. Revised TABLE 3: Adjusted gradations to increase sizes of materials as follows: Cover Top - D50 = 2 in Cover N, E & W edge - D50 = 4 in Cover South Edge/Slope - D50 = 6 in CJ East and West Apron - D50 = 6 in CJ North Apron - D50 = 8 in CJ South Apron - D50 = 12 in Added note to TABLE 3: Contractor to limit the amount of fines associated with riprap to minimize segregation of riprap during installation. Revised Section 3.6 Installation of Riprap: Added paragraph requiring Contractor to minimize fines and install riprap such that it does not segregate.



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REV.	DATE	BY	CKD	APPROVED	PAGES	REMARKS
6	09/09/10	WDB	FMP	W. Barton	ALL	Revise Table 3, Cover Biobarrier gradation: change range for 1 ½ inch sieve from 40-50 to 40-60.
7	05/20/11	WDB	FMP	W. Barton	ALL	Revise Spec Section 2.1.6, Stone Layers for the Waste Cell Final Cover, to change riprap D50 sizes, and gradations. Table 3 was extensively revised.
8	08/18/11	WDB	FMP	W. Barton	ALL	Revise Table 3, Gradation of fines in accordance with CID 065 and CID 067.
9	1/23/19	FMP	WDB	W. Barton	ALL	Section 1.3: Revised Construction Manager to Crescent Junction Operations/Site Manager Section 1.4: Revised Contracting Officer to Crescent Junction Operations/Site Manager Section 1.4.1: Revised Contracting Officer to Crescent Junction Operations/Site Manager Section 3.3: Revised Contracting Officer to Crescent Junction Operations/Site Manager

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DIVISION 32 - EXTERIOR IMPROVEMENTS

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AGGREGATE AND RIPRAP

-- End of Section Table of Contents --

SECTION 32 11 23

AGGREGATE AND RIPRAP

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 11	(2005) Standard Method of Test for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
AASHTO T 19	(2004) Standard Method of Test for Bulk Density ("Unit Weight") and Voids in Aggregate
AASHTO T 27	(2006) Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates
AASHTO T 99	(2001; R 2004) Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in) Drop
AASHTO T 180	(2004) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in) Drop
AASHTO T 193	(2003) Standard Method of Test for The California Bearing Ratio
AASHTO T 224	(2001; R 2004) Correction for Coarse Particles in the Soil Compaction Test

ASTM INTERNATIONAL (ASTM)

ASTM C 1260	(2005a) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C 127	(2004) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C 128	(2004a) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C 131	(2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM C 29/C 29M (1997; R 2003) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate

ASTM C 88 (2005) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

ASTM D 698 (2000ae1) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu ft)

ASTM D 1556 (2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D 1557 (2002e1) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)

ASTM D 2167 (1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method

ASTM D 2487 (2006) Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D 6938 (2007b) In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

ASTM D 75 (2003) Standard Practice for Sampling Aggregates

ASTM E 11 (2004) Wire Cloth and Sieves for Testing Purposes

1.2 DEFINITIONS

For the purposes of this specification, the following definitions apply.

1.2.1 Untreated Base Course

Untreated Base Course (UBC) is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

1.2.2 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in AASHTO T 99 or AASHTO T 180 abbreviated as a percent of laboratory maximum dry density. The degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve shall be expressed as a percentage of the laboratory maximum dry density in accordance with AASHTO T 99 or AASHTO T 180 Method D and corrected with AASHTO T 224.

1.3 SUBMITTALS

Approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. All submittals shall be provided to the Crescent Junction Operations / Site Manager in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Sampling and Testing, G;

Field Density Tests, G;

Certified copies of test results for approval not less than 10 days before material is required for the work.

Calibration curves and related test results prior to using the device or equipment being calibrated.

Copies of field test results within 24 hours after the tests are performed.

1.4 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. The materials shall be tested to establish compliance with the specified requirements; testing shall be performed at the specified frequency. The Crescent Junction Operations / Site Manager may specify the time and location of the tests. Copies of test results shall be furnished to the Crescent Junction Operations / Site Manager within 24 hours of completion of the tests.

1.4.1 Sampling

Samples for laboratory testing shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Crescent Junction Operations / Site Manager.

1.4.2 Tests

The following tests shall be performed in conformance with the applicable standards listed.

1.4.2.1 Sieve Analysis

Sieve analysis shall be made in conformance with AASHTO T 27 and AASHTO T 11. Sieves shall conform to ASTM E 11.

1.4.2.2 Moisture-Density Determinations

The laboratory maximum dry density and optimum moisture content shall be determined in accordance with AASHTO T 99 or AASHTO T 180, Method D and corrected with AASHTO T 224.

1.4.2.3 Field Density Tests

Density shall be field measured in accordance with ASTM D 1556, ASTM D 2167 or ASTM D 6938. For the method presented in ASTM D 6938 the calibration curves shall be checked and adjusted if necessary using only the sand cone method as described in paragraph Calibration, of the ASTM publication. Tests performed in accordance with ASTM D 6938 result in a wet unit weight of soil and when using this method, ASTM D 938 shall be used to determine the moisture content of the soil. The

calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 6938. The calibration checks of both the density and moisture gauges shall be made by the prepared containers of material method, as described in paragraph Calibration of ASTM D 6938, on each different type of material being tested at the beginning of a job.

1.4.2.4 Wear Test

Wear tests shall be made on aggregate material in conformance with ASTM C 131.

1.4.2.5 Soundness

Soundness tests shall be made on aggregate in accordance with ASTM C 88.

1.4.3 Testing Frequency

1.4.3.1 Tests on Proposed Material

To demonstrate that the proposed material meets all specified requirements, one of each of the following tests shall be performed on the proposed material prior to commencing construction, and subsequently for every 5,000 cubic yards of material. If materials from more than one source are going to be utilized, this testing shall be completed for each source.

a. Sieve Analysis.

b. Moisture-density relationship.

c. Wear.

d. Soundness.

1.4.4 Approval of Material

The source of the material shall be selected prior to the time the material will be required in the work. Approval of material will be based on test results.

1.5 WEATHER EFFECTS

Completed areas damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements.

1.6 PLANT, EQUIPMENT, AND TOOLS

All plant, equipment, and tools used in the performance of the work shall be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

1.7 NQA-1 QUALITY LEVEL

All rock armoring activities for the Disposal Cell at Crescent Junction, including: The Cover Biobarrier, Top, Apron Riprap, Slope Riprap, and Channel Armor are designated as Quality Level 2. All other work (not on the Disposal Cell) is non-Quality related (Quality Level 3).

PART 2 PRODUCTS

2.1 AGGREGATES

Aggregate shall consist of clean, sound, durable particles of crushed stone, crushed gravel, angular sand, or other approved material. Untreated Base Course shall be free of lumps of clay, organic matter, and other objectionable materials or coatings. Gravel shall be free of silt and clay as defined by ASTM D 2487, organic matter, and other objectionable materials or coatings. Aggregates will be used for the following applications, and the material properties for each of these applications will be provided in the following section:

Application	**Name of Material**	**Gradation**
Road Base	Untreated Base Course	UDOT UBC
Pipe Bedding	Coarse sand/gravel	ASTM D 448 #9
Drainage Stone	Open graded gravel	ASTM D 448 #57
Riprap slope armor	Riprap	D50 per plans
Riprap channel armor	Riprap	D50 per plans
Cover Biobarrier	Sandy gravel	D50 2 in
Cover Top	Sandy gravel	D50 2 in
Cover Apron Riprap	Riprap, 1,000 yr	D50 per plans
Cover Slope Riprap	Riprap, 1,000 yr	D50 per plans
CJ Channel Armor	Riprap, 1,000 yr	D50 per plans

2.1.1 Road Base

Aggregate for road base beneath asphalt pavement and for unpaved gravel roads and pads shall be UDOT Untreated Base Course. The UBC coarse aggregate shall not show more than 50 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C 131. The amount of flat and elongated particles shall not exceed 30 percent. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. In the portion retained on each sieve specified, the crushed aggregates shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the piece. When two fractures are contiguous, the angle between planes of the fractures must be at least 30 degrees in order to count as two fractured faces. Crushed gravel for road base shall be provided in the gradation listed in Table 1. When the coarse aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements and shall be stockpiled separately.

2.1.2 Pipe Bedding

Pipe bedding shall be coarse sand, or fine gravel, free from deleterious materials and rocks larger than 3/8 inch. Sandy soil or excavated shaly soil may be used for pipe bedding if it is excavated or processed such that the material size is similar to the gradation listed in Table 1.

2.1.3 Drainage Stone

Drainage stone is an open graded stone material intended as a capillary break beneath concrete slabs. Drainage stone will also be used for French Drains and seepage collection drains for retaining structures and mechanically stabilized earth structures. Drainage stone shall be provided in the gradation listed in Table 1.

2.1.4 Riprap

Riprap for slope and channel protection shall be provided at locations indicated on the drawings. Riprap shall be sized in accordance with plans and as listed in Table 1. Materials listed in Table 1 are not intended for use on the Disposal Cell at Crescent Junction. Disposal Cell materials are included in Table 3, below.

TABLE 1
GRADATION OF AGGREGATES

Percentage by Weight Passing Square-Mesh Sieve

Sieve Designation	Road Base	Pipe Bedding	Drainage Stone	Riprap Slope Armor	Riprap Channel Armor
12 inch	--	--	--	--	100
10 inch	--	--	--	100	80-100
8 inch	--	--	--	80-100	20-80
6 inch	--	--	--	20-60	0-20
4 inch	--	--	--	0-20	0
2 inch	--	--	--	0	--
1-1/2 inch	100	--	100	--	--
1 inch	90-100	--	95-100	--	--
3/4 inch	70-85	--	--	--	--
1/2 inch	65-80	--	25-60	--	--
3/8 inch	55-75	100	--	--	--
No. 4	40-65	85-100	10-20	--	--
No. 8	--	20-40	5-10	--	--
No. 16	25-40	10-20	0	--	--
No. 50	--	5-10	--	--	--
No. 200	7-11	0-5	--	--	--

2.1.5 Stone for Final Cover Layers

Stone for the final cover layers, infiltration and bio-barrier layer and rock armoring, shall be rock material that has long-term chemical and physical durability. Rock for final cover layers shall achieve an

acceptable score for its intended use, in accordance with the following rock scoring and acceptance criteria:

TABLE 2
NRC TABLE OF SCORING CRITERIA FOR ROCK QUALITY

Laboratory Test	Weighing Factor			10	9	8	7	6	5	4	3	2	1	0
	L*	S*	I*	Good				Fair				Poor		
Specific Gravity	12	6	9	2.75	2.70	2.65	2.60	2.55	2.50	2.45	2.40	2.35	2.3	2.25
Absorption, percent	13	5	2	0.10	0.30	0.50	0.67	0.83	1.0	1.5	2.0	2.5	3.0	3.5
Sodium Sulfate, percent	4	3	11	1.0	3.0	5.0	6.7	8.3	10.0	12.5	15.0	20.0	25.0	30.0
LA Abrasion, percent	1	8	1	1.0	3.0	5.0	6.7	8.3	10.0	12.5	15.0	20.0	25.0	30.0
Schmdt Hammer	11	13	3	70	65	60	54	47	40	32	24	16	8	0

* L = Limestone, S = Sandstone, I = Igneous

Notes:
1) Scores were derived from Tables 6.2, 6.5, and 6.7 of NUREG/CR-2642, Long-Term Survivability of Riprap for Armoring Uranium Mill Tailings and Covers: A Literature Review, 1982.
2) Weighing Factors are derived from Table 7 of "Petrographic Investigations of Rock Durability and Comparisons of Various Test Procedures," by G.W. Dupuy, Engineering Geology, July 1965. Weighing factors are based on inverse of ranking of test methods for each rock type. Other tests may be used; weighing factors for these tests may be derived using Table 7, by counting upward from the bottom of the table.
3) Test methods should be standardized, if a standard test is available and should be those used in NUREG/CR2642, so that proper correlations can be made.

2.1.5.1 Rock Acceptance Criteria

An acceptable rock score depends on the intended use of the rock. The rock's score must meet the following criteria:

- For occasionally saturated areas, which include the top and sides of the final cover, the rock must score at least 50 percent or the rock is rejected. If the rock scores between 50 percent and 80 percent the rock may be used, but a larger D50 must be provided (oversizing). If the rock score is 80 percent or greater, no oversizing is required.

- For frequently saturated areas, which include all channels and buried slope toes, the rock must score 65 percent or the rock is rejected. If the rock scores between 65 and 80 percent, the rock may be used, but must oversized. If the rock score is 80 percent or greater, no oversizing is required.

Oversize rock as follows:

- Subtract the rock score from 80 percent to determine the amount of oversizing required. For example, a rock with a rating of 70 percent

will require oversizing of 10 percent (80 - 70 percent = 10 percent).

- The D50 of the stone shall be increased by the oversizing percent. For example, a stone with a 10 percent oversizing factor and a D50 of 12 inches will increase to a D50 of 13.2 inches.

- The final thickness of the stone layer shall increase proportionately to the increased D50 rock size. For example, a layer thickness equals twice the D50, such as when the plans call for 24 inches of stone with a D50 of 12 inches, if the stone D50 increases to 13.2, the thickness of the layer of stone with a D50 of 13.2 should be increased to 26.4 inches.

2.1.6 Stone Layers for the Waste Cell Final Cover

Stone shall be provided and installed for the following Final Cover Layers:

Application	Type of Material	Material Size
Cover Biobarrier	Sandy gravel, 1,000 yr	D50 2 in
Cover Top	Sandy gravel, 1,000 yr	D50 2 in
Cover E & W Edge/Slope	Riprap, 1,000 yr	D50 2.3 in
Cover N Edge/Slope	Riprap, 1,000 yr	D50 4 in
Cover South Edge/Slope	Riprap, 1,000 yr	D50 5.8 in
CJ Apron Armoring (East & West Apron)	Riprap, 1,000 yr	D50 4.7 in
CJ Apron Armoring (North Apron)	Riprap, 1,000 yr	D50 8 in
CJ Apron Armoring (South Apron)	Riprap, 1,000 yr	D50 11.8 in

2.1.6.1 Biobarrier and Cover Top

The Biobarrier and Top of Cover Stone shall meet the 1,000-year lifespan rock scoring criteria and shall be a mix of 2 inch stone and finer materials. The Cover Biobarrier material is overlain by the Frost Protection soil layer and includes fines to act as an aggregate filter and retain the overlying soil. The gradation shall be as listed in Table 3, below.

TABLE 3
GRADATION OF FINAL COVER AGGREGATES

Percentage by Weight Passing Square-Mesh Sieve

Seive Designation	Cover Biobarrier	Cover Top	Cover E & W Edge Riprap	Cover N Edge Riprap	Cover S Edge Riprap	E & W Apron Armor & Bedding	N Apron & Bedding	S Apron Armor & Bedding
D50:	2"	2	2.3	4.0"	5.8"	4.7"	8.0	11.8
Min. Thickness	6"	6"	6"	8"	12"	16"	24"	36"
Bedding Thickness	--	--	--	--	--	--	4"	4"
30 inch	--	--	--	--	--	--	--	80-100

Seive Designation	Cover Biobarrier	Cover Top	Cover E & W Edge Riprap	Cover N Edge Riprap	Cover S Edge Riprap	E & W Apron Armor & Bedding	N Apron & Bedding	S Apron Armor & Bedding
25 inch	--	--	--	--	--	--	--	55-90
22 inch	--	--	--	--	--	--	--	25-60
18 inch	--	--	--	--	--	--	--	10-40
16 inch	--	--	--	--	--	--	--	5-25
12 inch	--	--	--	--	--	--	90-100	0-15
10 inch	--	--	--	--	--	--	45-90	0-10
8 inch	--	--	--	--	90-100	90-100	35-50	--
7 inch	--	--	--	--	45-90	--	--	--
6 inch	--	--	90-100	90-100	35-55	35-90	0-30	--
5 inch	--	--	--	--	--	35-55	--	--
4 inch	100	--	35-90	35-50	10-40	--	--	--
3 inch	--	--	20-60	--	--	--	--	--
2 inch	50-100	40-50	8-45	10-36	--	--	--	--
1-1/2 inch	40-60	20-30	--	0-30	5-30	0-30	100	100
1 inch	20-40	10-20	0-30	5-30	--	--	60-100	60-100
1/2 inch	15-25	5-15	0-30	0-30	0-30	0-30	50-90	50-90
No. 4	10-20	0-5	0-5	0-5	0-5	0-5	20-70	20-70
No. 8	5-15	--	--	--	--	--	10-40	10-40
No. 16	5-10	--	--	--	--	--	0-30	0-30
No. 200	0-5	--	--	--	--	--	0-15	0-15

Note: The Contractor is not required to provide washed riprap, and the gradations shown in Table 3 allow a small percentage of fines. The Contractor shall, however, minimize the amount of fine material to prevent segregation of fines from riprap and the concentration of fine materials in any location. See Section 3.6 Installation of Riprap for more direction on placement of riprap to limit concentration of undersized material.

2.1.6.2 Final Cover Edge Riprap

The Cover Edge consists of the Waste Cell slope and a 10-foot transition zone along the top of the slope. Cover Edge stone sizes, thicknesses, and gradations shall be as listed in Table 3, above. Riprap shall be placed on the Final Cover Edges in accordance with the locations shown on the Final Cover Plans. The riprap must meet the 1,000-year lifespan rock scoring criteria. The Cover edge riprap shall contain up to 15 percent material less than 1/2 inch in size to fill in around the riprap to prevent erosion beneath the riprap.

2.1.6.3 Apron Armor Riprap

Apron armor riprap for the Waste Cell shall have stone sizes, thicknesses, and gradations as listed in Table 3, above; and riprap armoring shall be placed in accordance with locations shown in the Final Cover plans and gradations listed. The riprap must meet the 1,000-year lifespan rock scoring criteria. The apron armor riprap with D50 8 inches or larger shall be installed with a 4-inch bedding layer.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Adequate drainage shall be provided during the entire period of construction to prevent water from collecting or standing on the

working area. Line and grade stakes shall be provided as necessary for control.

3.2 OPERATION OF AGGREGATE SOURCES

Clearing, stripping, and excavating shall be the responsibility of the Contractor. The aggregate sources shall be operated to produce the quantity and quality of materials meeting these specifications requirements in the specified time limit.

3.3 STOCKPILING MATERIAL

Prior to stockpiling of material, storage sites shall be cleared and leveled by the Contractor. All materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Aggregates shall be stockpiled on the cleared and leveled areas designated by the Crescent Junction Operations / Site Manager to prevent segregation. Materials obtained from different sources shall be stockpiled separately.

3.4 PREPARATION OF UNDERLYING COURSE

Prior to constructing the base course(s), the underlying course or subgrade shall be cleaned of all foreign substances. At the time of construction of the base course(s), the underlying course shall contain no frozen material. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. The underlying course shall conform to Section 31 00 00 EARTHWORK. Ruts or soft yielding spots in the underlying courses, areas having inadequate compaction, and deviations of the surface from the requirements set forth herein shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to specified density requirements. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the base course is placed.

3.5 INSTALLATION OF UNTREATED BASE COURSE

3.5.1 Placing

The material shall be placed on the prepared subgrade or subbase in layers of uniform thickness. When a compacted aggregate layer 6 inches or less in thickness is required, the material shall be placed in a single layer. When a compacted aggregate layer in excess of 6 inches is required, the material shall be placed in layers of equal thickness. No layer shall be thicker than 6 inches or thinner than 3 inches when compacted. The layers shall be so placed that when compacted they will be true to the grades shown in the plans.

3.5.2 Grade Control

The finished and completed base course shall conform to the lines, grades, and cross sections shown. Underlying material(s) shall be excavated and prepared at sufficient depth for the required base course

thickness so that the finished base course and the subsequent surface course will meet the designated grades.

3.5.3 Compaction of Untreated Base Course

Each layer of the Untreated Base Course (UBC) shall be compacted as specified with approved compaction equipment. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers. Compaction of UBC shall continue until each layer has a degree of compaction that is at least 95 percent of laboratory maximum density through the full depth of the layer. The Contractor shall make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory base course. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

3.5.4 Thickness

Compacted thickness of the base course shall be as indicated. No individual layer shall be thicker than 6 inches nor be thinner than 3 inches in compacted thickness.

3.5.5 Finishing

The surface of the top layer of base course shall be finished after final compaction by cutting any overbuild to grade and rolling with a steel-wheeled roller. Thin layers of material shall not be added to the top layer of base course to meet grade. If the elevation of the top layer of base course is 1/2 inch or more below grade, then the top layer should be scarified to a depth of at least 3 inches and new material shall be blended in and compacted to bring to grade.

3.5.6 Smoothness of Base Stone for Pavement

The surface of the top layer shall show no deviations in excess of 1/2 inch when tested with a 12 foot straightedge. Measurements shall be taken in successive positions parallel to the centerline of the area to be paved. Measurements shall also be taken perpendicular to the centerline at 50 foot intervals. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

3.6 INSTALLATION OF RIPRAP

Riprap shall be placed at locations, thicknesses, and sizes indicated on the drawings. At all locations except the Waste Cell at Crescent Junction, riprap shall be placed over a geotextile in accordance with Section 31 05 19 GEOTEXTILE. For the Waste Cell cover slopes, bedding aggregate shall be placed and the riprap installed over the bedding aggregate.

For the Crescent Junction Disposal Cell, the Contractor must supply and install riprap such that the riprap material does not segregate. The objective is a uniform distribution of the specified riprap gradation. If excessive fine material is present in the riprap, it may settle to the bottom of a truck during transport and segregate from the riprap when dumped. The Contractor shall minimize the fines in the riprap, and spread the stone in a manner that prevents concentration of fine materials. Visual inspection of the riprap placement will be performed by the inspection personnel and any pockets of fines observed will be required to be replaced with material containing a uniform distribution of the specified material gradation. The Contractor shall minimize segregation of materials when bedding material is placed in conjunction with the installation of riprap and when no bedding material is required.

3.7 TRAFFIC

Completed portions of the base course for pavement may be opened to limited traffic, provided there is no marring or distorting of the surface by the traffic. Heavy equipment shall not be permitted except when necessary to construction, and then the area shall be protected against marring or damage to the completed work.

3.8 MAINTENANCE

The base course shall be maintained in a satisfactory condition until the full pavement section is completed and accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Any base course that is not paved over prior to the onset of winter, shall be retested to verify that it still complies with the requirements of this specification. Any area of base course that is damaged shall be reworked or replaced as necessary to comply with this specification.

3.9 DISPOSAL OF UNSATISFACTORY MATERIALS

Any unsuitable materials that must be removed shall be disposed of as directed.

-- End of Section --