Department of Energy

Oak Ridge Office of Environmental Management
P.O. Box 2001
Oak Ridge, Tennessee 37831

ROUTE TO: BCY

JAN 16 2019

January 15, 2019

CERTIFIED MAIL

CC/
JBS

Ms. Constance A. Jones
Superfund Division
U.S. Environmental Protection Agency
Region 4
Atlanta Federal Center
61 Forsyth Street, SW
Atlanta, Georgia 30303-8960

Mr. Randy C. Young
State of Tennessee
Department of Environment and Conservation
Division of Remediation – Oak Ridge
761 Emory Valley Road
Oak Ridge, Tennessee 37830-7072

Dear Ms. Jones and Mr. Young:

TRANSMITTAL OF THE *PHASE 3 FIELD SAMPLING PLAN FOR THE PROPOSED ENVIRONMENTAL MANAGEMENT DISPOSAL FACILITY FOR COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OAK RIDGE RESERVATION WASTE DISPOSAL, OAK RIDGE, TENNESSEE* (DOE/OR/01-2808&D1)

Enclosed please find the identified number of copies of the subject document and compact disks for your review. This plan describes the Phase 3 characterization effort that focuses on borrow areas for the proposed Environmental Management Disposal Facility.

If you have any questions or if we can be of further assistance, please contact Brian Henry at (865) 241-8340 or me at (865) 241-6344.

Sincerely,

Brian T. Henry
Portfolio Federal Project Director

John Michael Japp
Federal Facility Agreement Project Manager

See Page 2 for cc list.

CERTIFIED – RETURN RECEIPT REQUESTED
(JONES 7009 2820 0001 9922 5444)
(YOUNG 7009 2820 0001 9922 5451)

TRANSMITTAL OF THE *PHASE 3 FIELD SAMPLING PLAN FOR THE PROPOSED ENVIRONMENTAL MANAGEMENT DISPOSAL FACILITY FOR COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OAK RIDGE RESERVATION WASTE DISPOSAL, OAK RIDGE, TENNESSEE* (DOE/OR/01-2808&D1)

Enclosures:
1. Document
2. CD

EPA: 1 (Enclosure 1), 2 (Enclosure 2)
TDEC: 2 (Enclosure 1), 1 (Enclosure 2)

cc w/enclosure 1:
Rhonda Butler, Value Added Solutions, K-1007, MS-7243, plus 1 copy of Enclosure 2
SSAB

cc w/o enclosures:
Carl Froede, EPA Region 4
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Brad Stephenson, TDEC
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Pat Halsey, EM-942

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Phase 3 (Borrow Areas) Field Sampling Plan for the Proposed Environmental Management Disposal Facility for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal, Oak Ridge, Tennessee

This document is approved for public release per review by:

Tina O. Fancher — 12/20/18

UCOR Classification & Information Control Office — Date

DOE/OR/01-2808&D1

Phase 3 (Borrow Areas) Field Sampling Plan for the Proposed Environmental Management Disposal Facility for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal, Oak Ridge, Tennessee

Date Issued—January 2019

Prepared for the
U.S. Department of Energy
Office of Environmental Management

URS | CH2M Oak Ridge LLC
under contract DE-SC-0004645

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CONTENTS

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FIGURES

TABLES

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ACRONYMS

ASTM	ASTM International
BCV	Bear Creek Valley
CBCV	Central Bear Creek Valley
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DOE	U.S. Department of Energy
DQO	data quality objective
EMDF	Environmental Management Disposal Facility
EPA	U.S. Environmental Protection Agency
FSP	Field Sampling Plan
NT	North Tributary
OREM	Oak Ridge Office of Environmental Management
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
SPT	standard penetration test
UPF	Uranium Processing Facility

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1. INTRODUCTION

The mission of the U.S. Department of Energy (DOE) Oak Ridge Office of Environmental Management (OREM) is to decommission and demolish numerous facilities and conduct remedial actions under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) on the Oak Ridge Reservation (ORR) in Oak Ridge, Tennessee, and associated sites. This effort requires an estimated 2.2 million cy of landfill disposal capacity beyond what is available in the existing Environmental Management Waste Management Facility for the disposal of wastes from CERCLA cleanup actions.

The *Remedial Investigation/Feasibility Study for the Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal, Oak Ridge, Tennessee* (DOE 2017) evaluated several alternatives and waste disposal locations. The Central Bear Creek Valley (CBCV) Site, also known as Site 7c, was chosen as the preferred location for the proposed Environmental Management Disposal Facility (EMDF) (Fig. 1).

1.1 OBJECTIVE

This Field Sampling Plan (FSP) describes the objectives, requirements, and approach to conducting geotechnical testing and exploration to characterize three potential borrow sites, referred to as the Uranium Processing Facility (UPF) Borrow Area, Site 7b Borrow Area, and Central Borrow Area (Fig. 1). This FSP describes the geotechnical characterization activities to be conducted to determine if materials in these areas are of sufficient quality and quantity to support construction of the EMDF and support borrow area design.

Only the borrow areas will be investigated. Additional investigations will be conducted in the future for the CBCV site to obtain analytical data to determine baseline groundwater and surface water quality.

This plan uses the results of the data quality objective (DQO) process, as specified in *Guidance on Systematic Planning Using the Data Quality Objectives Process - EPA QA/G-4* (U.S. Environmental Protection Agency [EPA] 2006), which focuses on the use of data for engineering design of the borrow areas.

The project-specific Quality Assurance Project Plan (QAPP) for this investigation (Appendix A) identifies the procedures that will be followed in the collection, custody, sample handling, data management, and quality control (QC) activities for all anticipated EMDF investigation activities, including future investigation activities not described in this document.

Safety controls for this sampling will be addressed in task-specific work control documents that will be approved by the appropriate disciplines. These work control documents will contain the detailed work scope for implementing this work.

The overall objective of this plan is to provide usable, representative geotechnical data to evaluate quantities and quality of soil borrow material available and be able to identify potential uses for the borrow material. Slope stability also will be evaluated to develop the design of the borrow areas.

1.2 PROJECT ORGANIZATION

The organizational structure for this project is presented in Fig. 2.

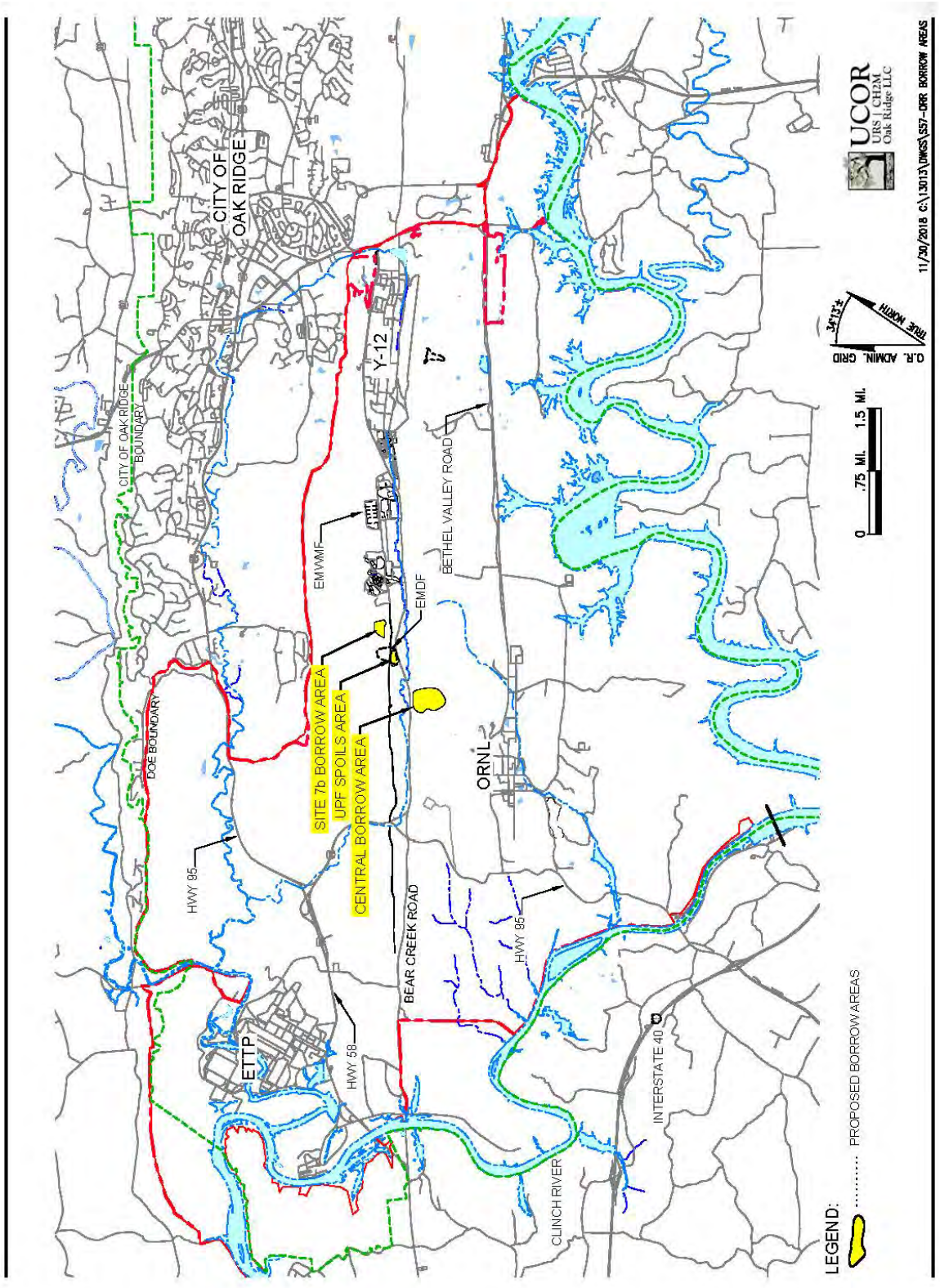

Fig. 1. Proposed EMDF borrow area locations on the ORR.

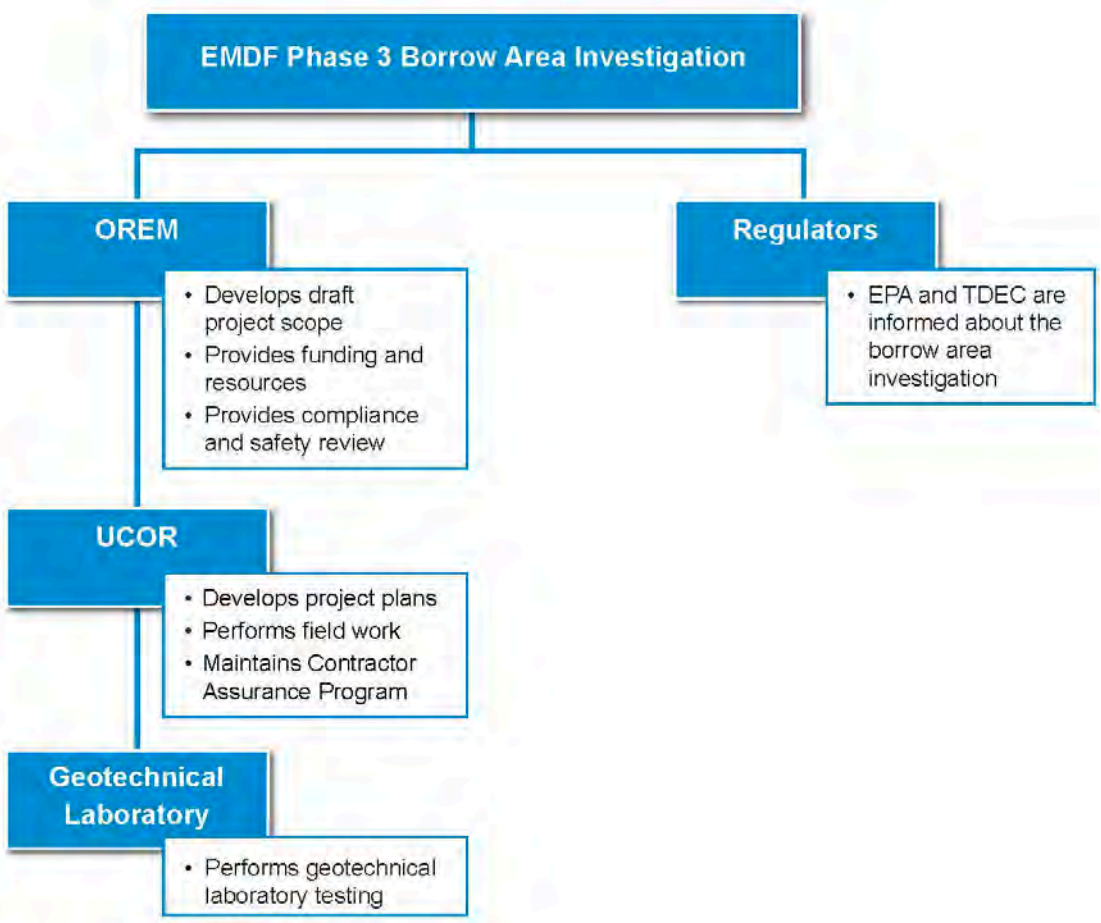

Fig. 2. Phase 3 design investigation project organization.

OREM and their designees provide the overall project direction. UCOR, an AECOM-led partnership with Jacobs, will perform field activities as described in this plan with support from specialty subcontractors. Additional information on the project organization is provided in the QAPP (Appendix A, Sect. A.2).

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2. GENERAL SITE CONDITIONS

The potential borrow area locations are within the outcrop area for the Knox and Conasauga Groups (Lemiszki 2000) (Fig. 3). The general subsurface hydrogeological conditions for these areas are known from previous characterization investigations performed in the Bear Creek Valley (BCV) watershed (DOE 2014), including the recent Phase 1 and 2 EMDF investigations (in progress). Information about hydrogeological conditions on Chestnut Ridge are known from previous investigations (Bechtel Jacobs Company LLC 2006) and construction of borrow areas (Daniel 1989).

Groundwater elevations are typically near the saprolite/bedrock interface in BCV and on Chestnut Ridge and, therefore, are generally expected to be below the depths of expected borrow excavation (DOE 2016 and Oak Ridge National Laboratory [ORNL] 1992).

2.1 UPF SPOILS AREA

The UPF Spoils Area is located within the southern portion of the CBCV site between the existing Haul Road and Bear Creek Road (Fig. 4). Underlying the area is bedrock of the Nolichucky Shale. The site was previously cleared of trees and is currently used for stockpiling uncontaminated spoils from the UPF construction, with spoil piles up to 30 ft high. The spoils are fill materials, alluvial/colluvial soils, and shaley residuum. These materials are expected to have a high moisture content, high organic content, and/or high plasticity index.

2.2 SITE 7B BORROW AREA

The Site 7b Borrow Area is located immediately east of the CBCV site on a knoll north of the Haul Road between North Tributary (NT)-09 and NT-10 (Fig. 5). The site and surrounding area is forested. Underlying the area is bedrock of the Rogersville Shale and Maryville Formations. The typical BCV weathering profile of topsoil, silty/clayey soil residuum, saprolite, and fractured bedrock are expected across the undisturbed site areas of Site 7b.

2.3 CENTRAL BORROW AREA

The Central Borrow Area is located west of the CBCV site on the crest of Chestnut Ridge south of Bear Creek (Fig. 6). The site and surrounding area is forested. Underlying the area is bedrock of the Knox Group. The adjacent, previously constructed West Borrow Area is a source of low permeability clay materials for ORR construction projects (Daniel 1989). The soil/saprolite zone is expected to range from 10-60 ft thick (ORNL 1989).

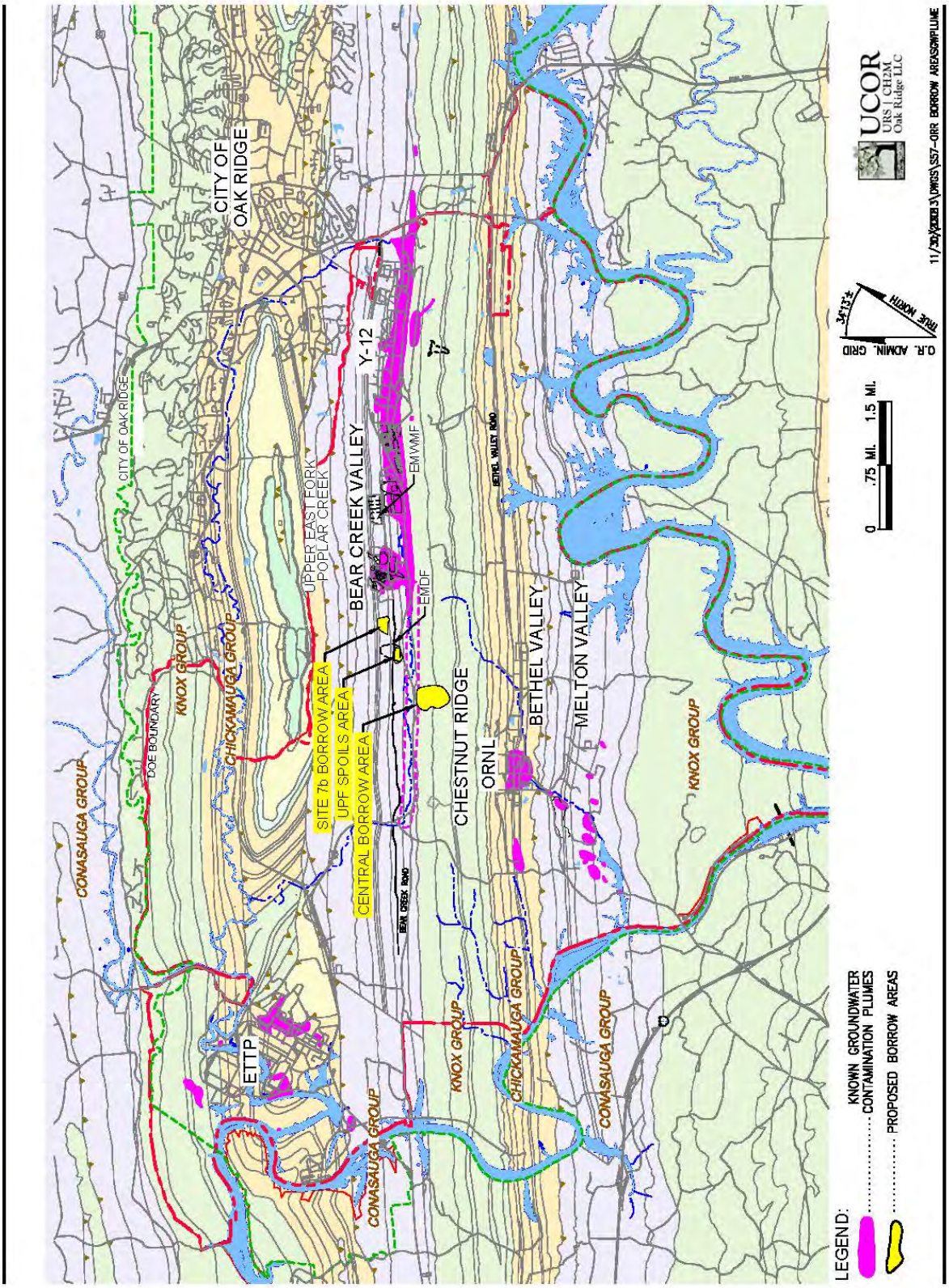

Fig. 3. Borrow Area locations and hydrogeologic setting.

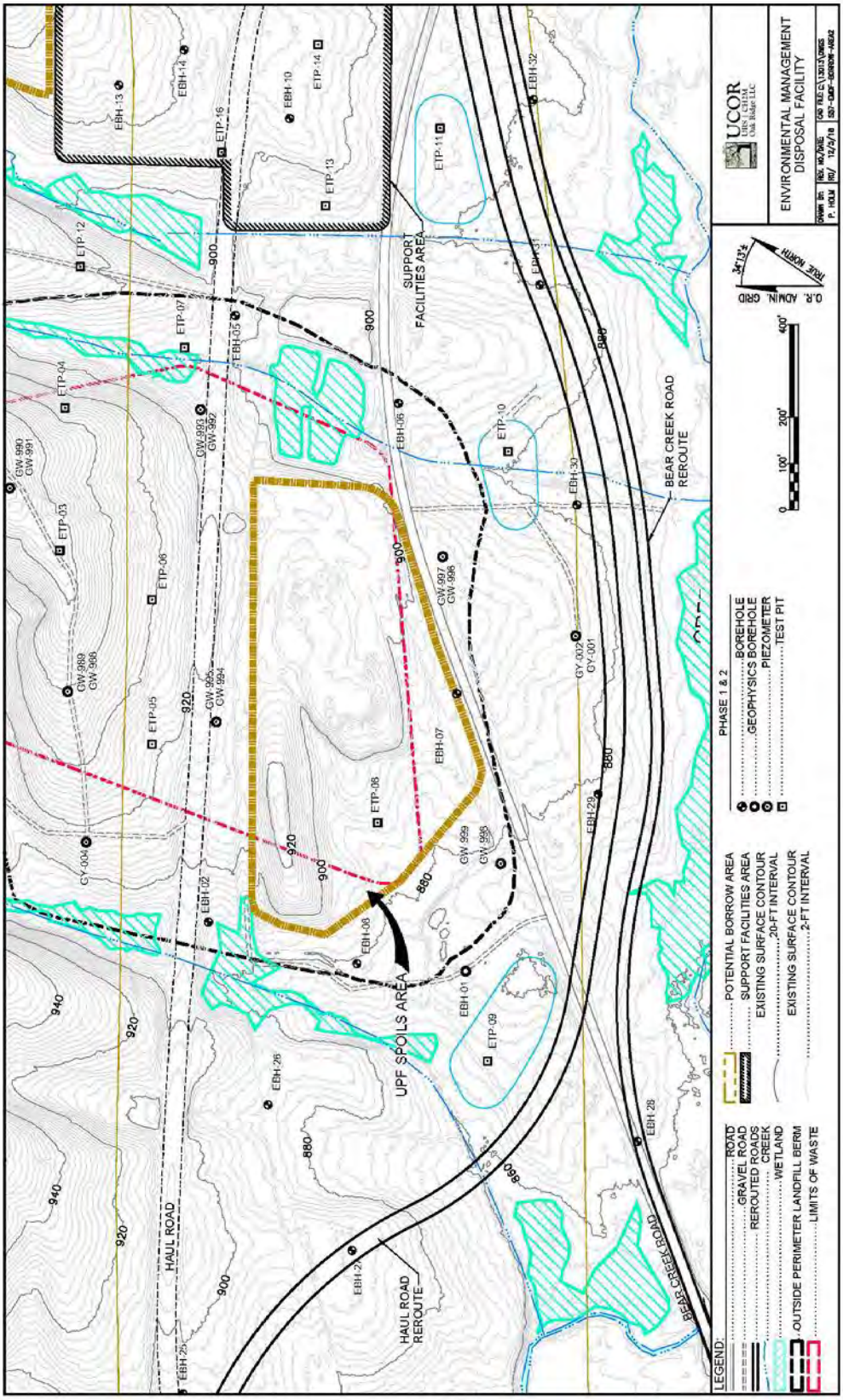

Fig. 4. UPF Spoils Area setting.

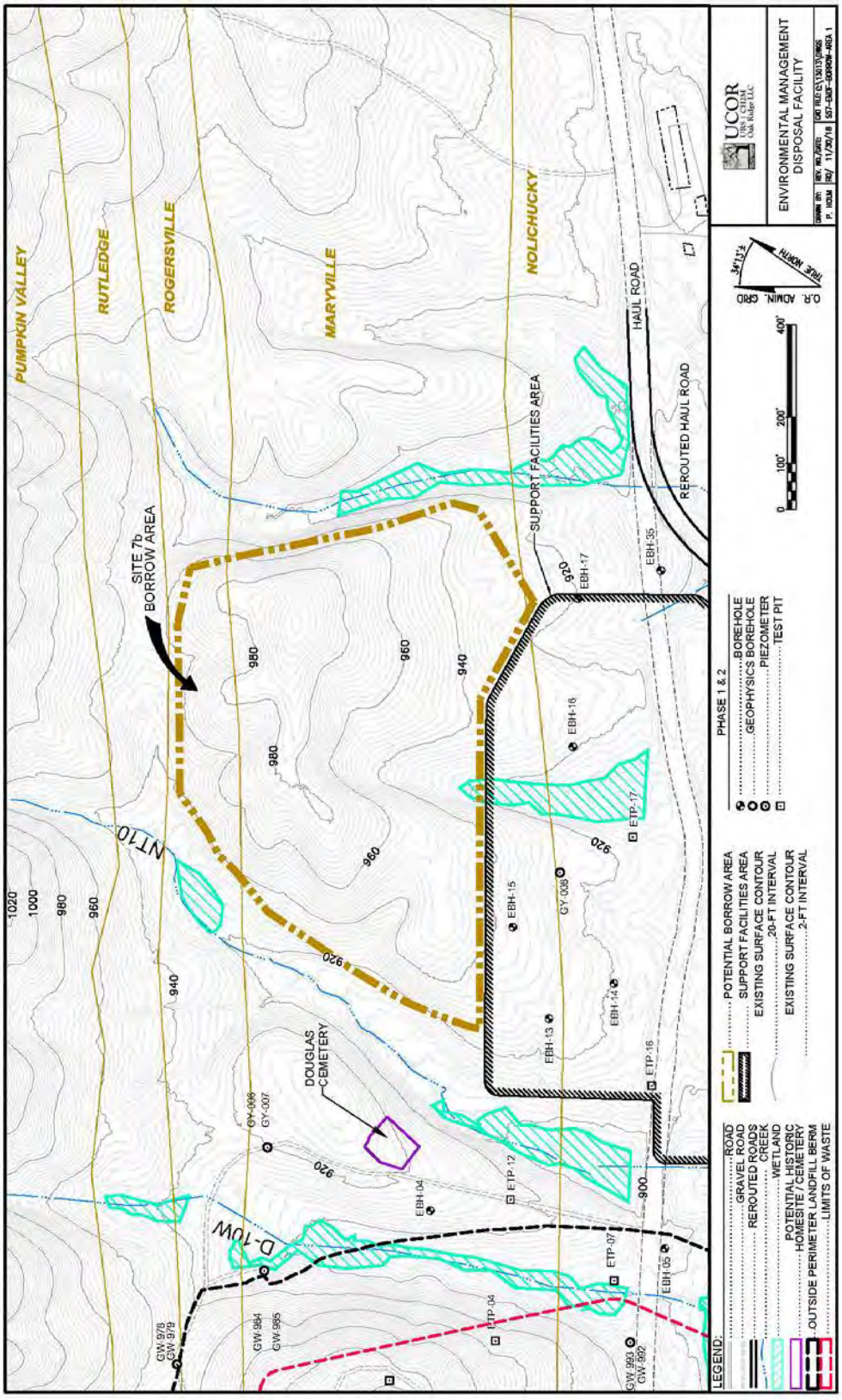

Fig. 5. Site 7b Borrow Area setting.

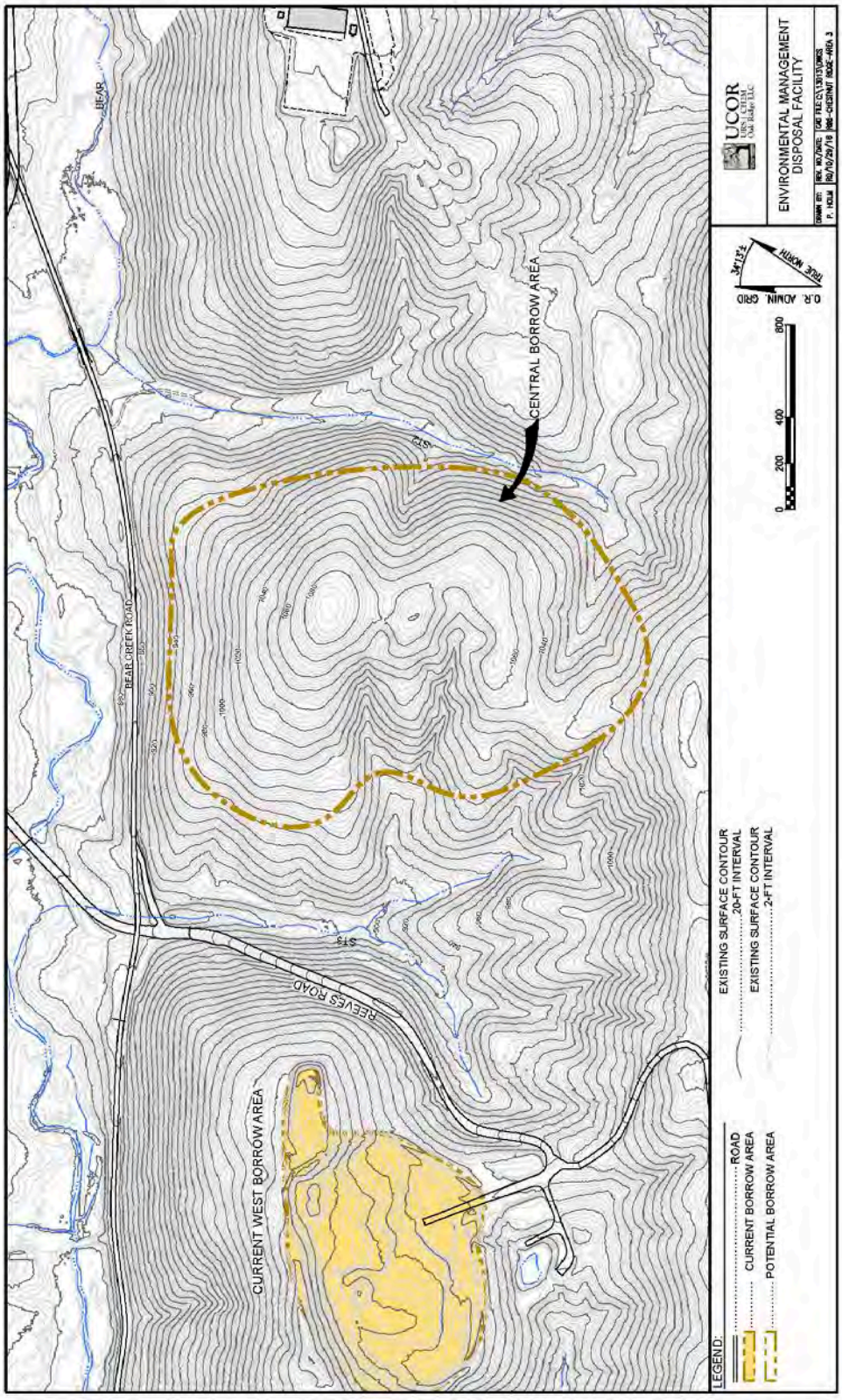

Fig. 6. Central Borrow Area setting.

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3. DATA QUALITY OBJECTIVES

This plan uses the DQO process (EPA 2006) to identify data needs that become the focus for this investigation. The DQOs are summarized in Table 1. Approximate Phase 3 investigation sampling locations are presented in Sect. 4.

Table 1. DQO summary for borrow area data acquisition.

DQO step	Foundation analysis
State the Problem	Soil excavated during EMDF construction will not provide the required quantity or quality of engineering fill materials needed. The borrow sites are being proposed for obtaining soil materials that may be used in the construction of berms, geologic buffer, compacted clay liner, interim or final cover, and operational soil fill. Each potential construction use has different quality requirements for the borrow soil.
Identify the Decision (the Design Criteria)	Design criteria for determining the use of borrow soils include recompacted strength, compressibility, permeability, grain size, and plasticity, depending on its construction use. The principal design questions include the following: (1) Can excavated borrow soils be used as structural fill, geologic buffer, compacted clay liner, interim cover, final cover, or operational soil fill? (2) How much excavated borrow material is available for each potential construction use? (3) What excavation slope would be stable during borrow area development, use, and/or following borrow area closure?
Identify Inputs to the Decision (to the Design Calculations)	The following is used to determine the geotechnical characteristics to support the decisions: • Geotechnical soil parameters, including shear strength of in-place and recompacted soils; compaction density (Proctor) and optimum moisture for recompacted soils; permeability of recompacted soils; consolidation properties of recompacted soils; and index properties, including moisture contents, Atterberg limits, grain-size analyses, unit weights, and specific gravities. Corrosion testing for Site 7b. • Thickness of each soil type and total depth to bedrock. • Depth to groundwater above bedrock.
Define the Study Boundaries	• The spatial boundaries of the study include the UPF Borrow Area (Fig. 4), Site 7b Borrow Area (Fig. 5), and Central Borrow Area (Fig. 6). Geotechnical explorations and tests for borrow area design will extend across each site. • The vertical boundary extends from the ground surface to the top of competent bedrock approximately 10–60 ft below the current ground surface.
Develop a Decision Rule	Design criteria decision rules include the following: • If the borrow material meets industry standards for use as structural fill (e.g., Tennessee Department of Transportation Standard specifications) for strength, gradation, plasticity, durability, and compactability, then the design is acceptable. If not, then the material must be conditioned or used as non-structural fill material. • If the magnitude and rate of both differential and total settlement of recompacted materials meets industry standards, then the design is acceptable. If not, then the material can be used as non-structural fill material, must be conditioned for use as structural fill material, or other fill must be used. • If the permeability of recompacted materials meets geologic buffer, compacted clay liner, or cover standards (e.g., Tennessee Division of Solid Waste rules), then the design is acceptable. If not, then the material can be used as non-structural fill material, must be conditioned for use as structural fill material, or other fill must be used.

Table 1. DQO summary for borrow area data acquisition (cont.)

DQO step	Foundation analysis
Develop a Decision Rule (cont.)	• If the static factor of safety against slope failure is adequate for borrow excavation slopes or long-term conditions, then the borrow area design is acceptable as proposed. Otherwise, the design must be modified to meet the slope stability requirements. • If corrosion testing results indicate potential corrosive conditions, then piping will be selected for the design to address the conditions. • If depth to groundwater is within the borrow materials, then groundwater controls may be required.
Specify Performance/ Acceptance Limits	• Data collection and analyses shall be established using the ASTM guidance/test methods provided in Sect. 4. • Geotechnical laboratories must be accredited by the American Association of State Highway and Transportation Officials for the specific ASTM laboratory testing procedures referenced in this FSP (Sect. 4). • Horizontal variations are expected to be minor across each individual site. Test locations spaced 200-400 ft apart are adequate to determine the overall geotechnical characteristics. • Vertical variations are expected with depth and changes in soil type. Samples collected at 2.5-ft intervals in residuum and 5-ft intervals in saprolite/weathered bedrock are adequate to determine changes in use of material with depth.
Optimize the Design	1. Characterize soils/saprolite stratigraphy within each individual borrow area using data gathered from geotechnical borings and test pits. In addition, data from previous Phases 1 and 2 studies performed for EMDF will be used as guidance for Site 7b borrow conditions (same geologic setting) and UPF (one test pit located in borrow area already), as appropriate. 2. Geotechnical boreholes will be drilled within each borrow area. These boreholes will be used to collect geotechnical data for borrow excavation slope design, stratigraphic data for estimating quantities of each soil type available, and geotechnical data for recompacted soil characterization, particularly shear strength, compressibility, permeability, grain size, and plasticity. Likewise, boreholes also will be used to define total depth to bedrock. • Two geotechnical boreholes will be drilled within the UPF Borrow Area, 8 within the Site 7b Borrow Area, and 10 within the Central Borrow Area. • Each geotechnical borehole will be drilled to refusal. It is anticipated soil drilling depths will vary from about 10-60 ft. 3. Geotechnical test pits will be excavated within each borrow area to collect bulk soil volumes for laboratory testing of recompacted soil. Six test pits will be excavated within the UPF Spoils Area, 12 within the Site 7b Borrow Area, and 20 within the Central Borrow Area. 4. Laboratory index tests (e.g., Atterberg limits, grain-size analyses, moisture contents, unit weights, and specific gravities) will be conducted on disturbed and undisturbed soil samples as provided in Sect. 4, including from each distinct soil type. 5. Shear strength, compressibility, and permeability properties of soils will be characterized, as follows, using ASTM guidance/test methods and UCOR procedures provided in Sect. 4. The number of tests may be adjusted depending on the type, quantity, and condition of materials encountered. • SPT data will be used to estimate shear strength and compressibility properties of the in-place soils/saprolite and collect disturbed samples. • Relatively undisturbed samples will be collected using a thin-walled (Shelby) tube and used to perform laboratory unit weight and shear strength testing of in-place soils.

Table 1. DQO summary for borrow area data acquisition (cont.)

DQO step	Foundation analysis
Optimize the Design (cont.)	• Laboratory consolidated-undrained triaxial shear strength, one-dimensional consolidation testing, and saturated hydraulic conductivity testing will be performed on recompacted soil samples. 6. The moisture-density relationship of sampled soils (compaction, moisture content, and specific gravity) will be characterized, as follows, using ASTM guidance/test methods and UCOR procedures provided in Sect. 4. Bulk disturbed samples obtained from auger cuttings or test pits and representative of each unique soil type will be selected for testing for compaction and specific gravity. The number of tests may be adjusted depending on the type and condition of materials encountered and the depth to refusal or bedrock.

ASTM = ASTM International
DQO = data quality objective
EMDF = Environmental Management Disposal Facility
FSP = Field Sampling Plan
SPT = standard penetration test
UPF = Uranium Processing Facility

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4. SAMPLING REQUIREMENTS AND DOCUMENTATION

The Phase 3 investigation sampling locations are summarized in Table 2. The approximate sampling locations are shown by area in Figs. 7, 8 and 9. Actual sampling locations will be determined in the field based on accessibility or site conditions encountered at the time of the investigation. Following completion, locations will be surveyed by a licensed land surveyor (including horizontal position within 1 ft and ground surface elevation at each boring or test pit within 0.1 ft).

Field activities will be conducted in compliance with UCOR work control documents, including, but not limited to, environmental safety and health, radiation control, facility management, access, excavation/penetration permits, and waste management.

The project-specific QAPP (Appendix A) will implement quality assurance (QA) requirements for use in sample collection, laboratory analysis, and data management needed to support design of the proposed borrow areas. These requirements ensure appropriate levels of QA and QC are achieved and maintained.

This section identifies the procedures that will be followed in the collection, custody, and handling of samples as well as management of laboratory data. The investigation approach and measurement and testing requirements are provided. The procedure, test method, or guidance that will be used to obtain geotechnical data also are provided. Documentation requirements are provided in Sect. 5.

Table 2. Summary of Phase 3 investigation locations

Location	Soil borings	Composite bulk samples	Shelby tubes[a]	SPTs	Test pits and interval bulk samples	Potential geotechnical laboratory samples
UPF Spoils Area						
EBH-36	●	●		●		●
EBH-37	●	●		●		●
ETP-18					●	●
ETP-19					●	●
ETP-20					●	●
ETP-21					●	●
ETP-22					●	●
ETP-23					●	●
Site 7b Borrow Area						
EBH-38	●	●	●	●		●
EBH-39	●	●	●	●		●
EBH-40	●	●		●		●
EBH-41	●	●		●		●
EBH-42	●	●	●	●		●
EBH-43	●	●		●		●
EBH-44	●	●		●		●
EBH-45	●	●	●	●		●
ETP-24					●	●
ETP-25					●	●
ETP-26					●	●
ETP-27					●	●
ETP-28					●	●
ETP-29					●	●
ETP-30					●	●
ETP-31					●	●
ETP-32					●	●
ETP-33					●	●
ETP-34					●	●
ETP-35					●	●

Table 2. Summary of Phase 3 investigation locations (cont.)

Location	Soil borings	Composite bulk samples	Shelby tubes[a]	SPTs	Test pits and interval bulk samples	Potential geotechnical laboratory samples
Central Borrow Area						
EBH-46	●	●	●	●		●
EBH-47	●	●	●	●		●
EBH-48	●	●		●		●
EBH-49	●	●	●	●		●
EBH-50	●	●		●		●
EBH-51	●	●		●		●
EBH-52	●	●		●		●
EBH-53	●	●		●		●
EBH-54	●	●		●		●
EBH-55	●	●	●	●		●
ETP-36					●	●
ETP-37					●	●
ETP-38					●	●
ETP-39					●	●
ETP-40					●	●
ETP-41					●	●
ETP-42					●	●
ETP-43					●	●
ETP-44					●	●
ETP-45					●	●
ETP-46					●	●
ETP-47					●	●
ETP-48					●	●
ETP-49					●	●
ETP-50					●	●
ETP-51					●	●
ETP-52					●	●
ETP-53					●	●
ETP-54					●	●
ETP-55					●	●

[a]Shelby tube locations may be field adjusted.

SPT = standard penetration test
UPF = Uranium Processing Facility

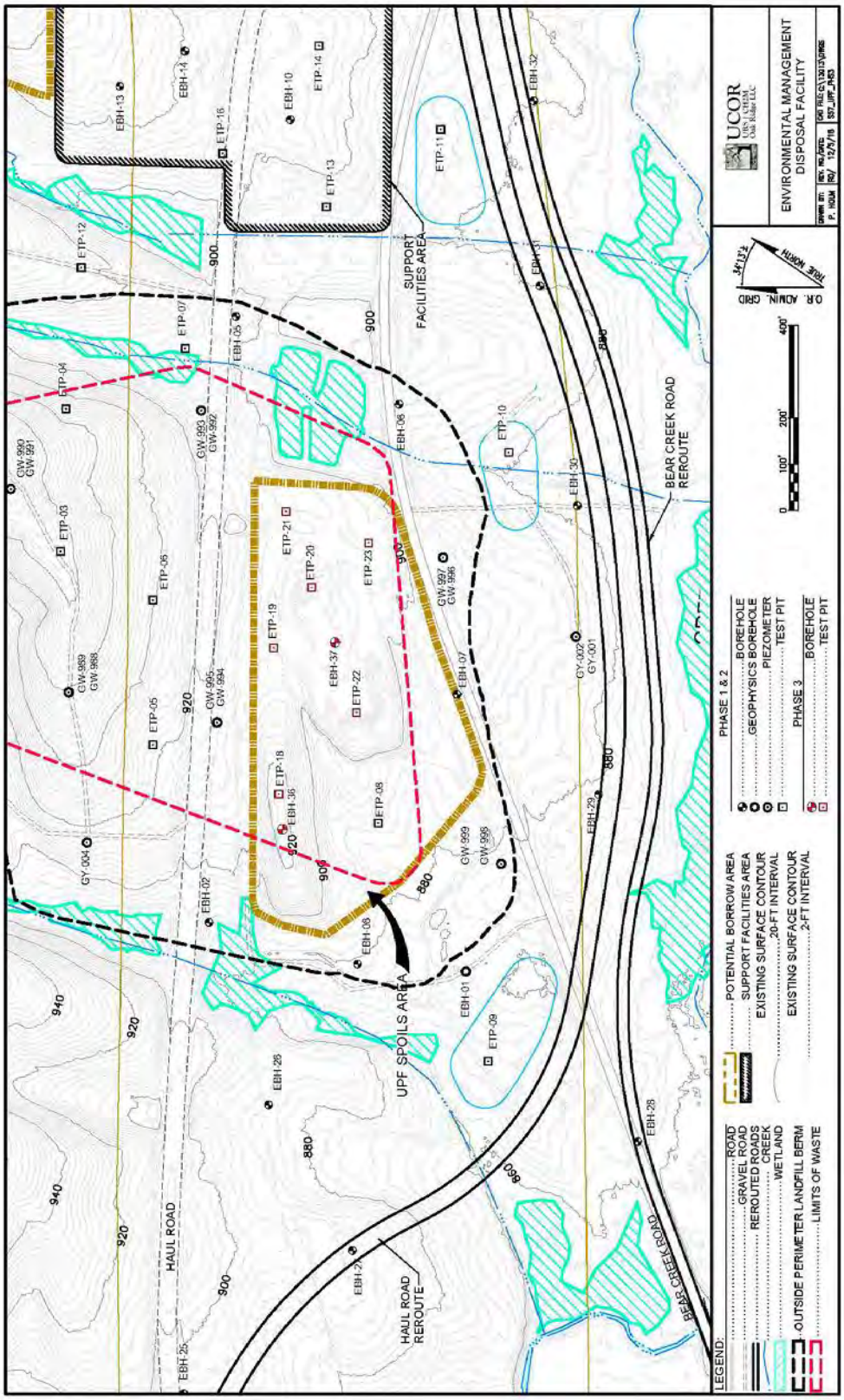

Fig. 7. UPF Spoils Area Phase 3 investigation sampling locations.

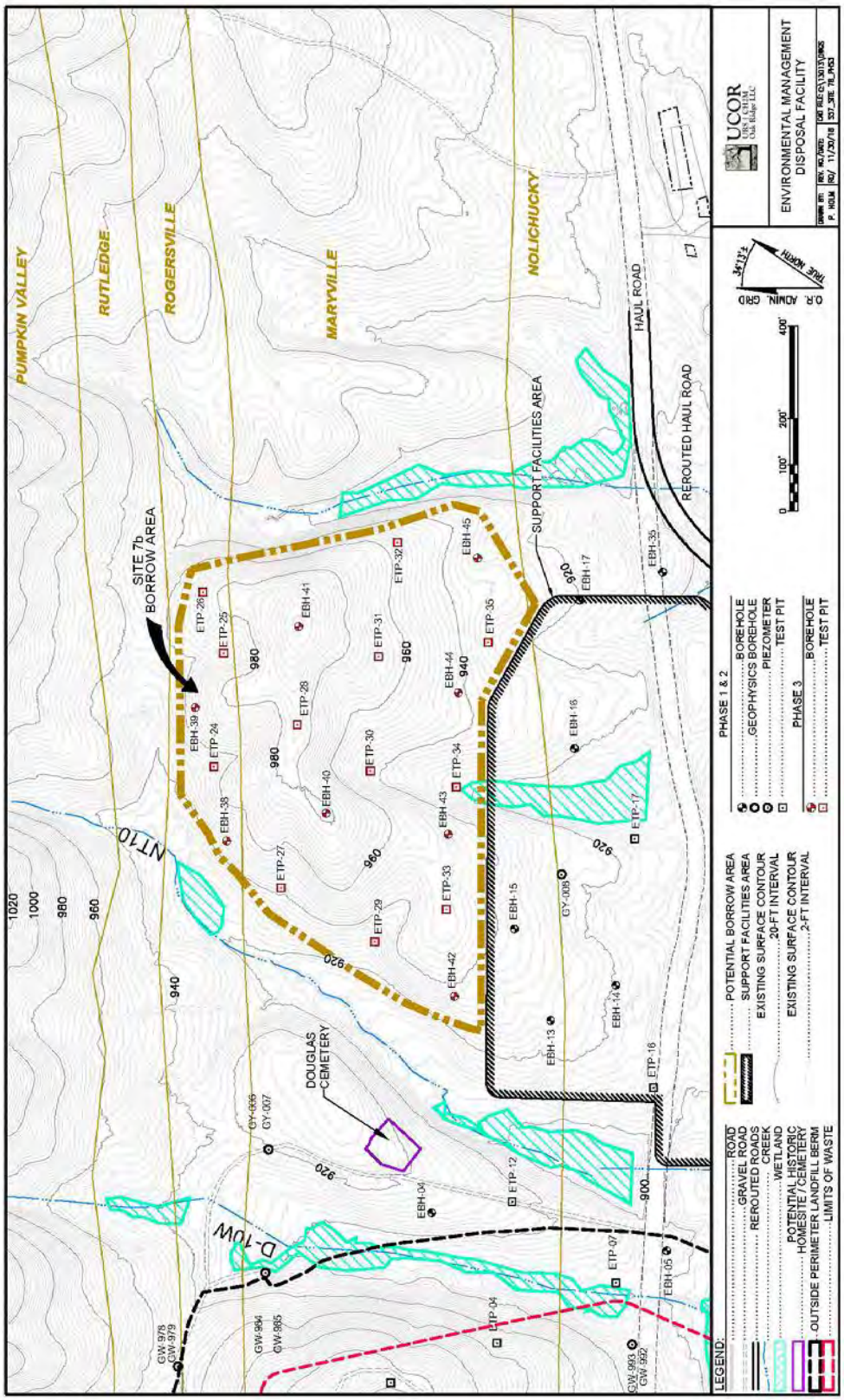

Fig. 8. Site 7b Borrow Area Phase 3 investigation sampling locations.

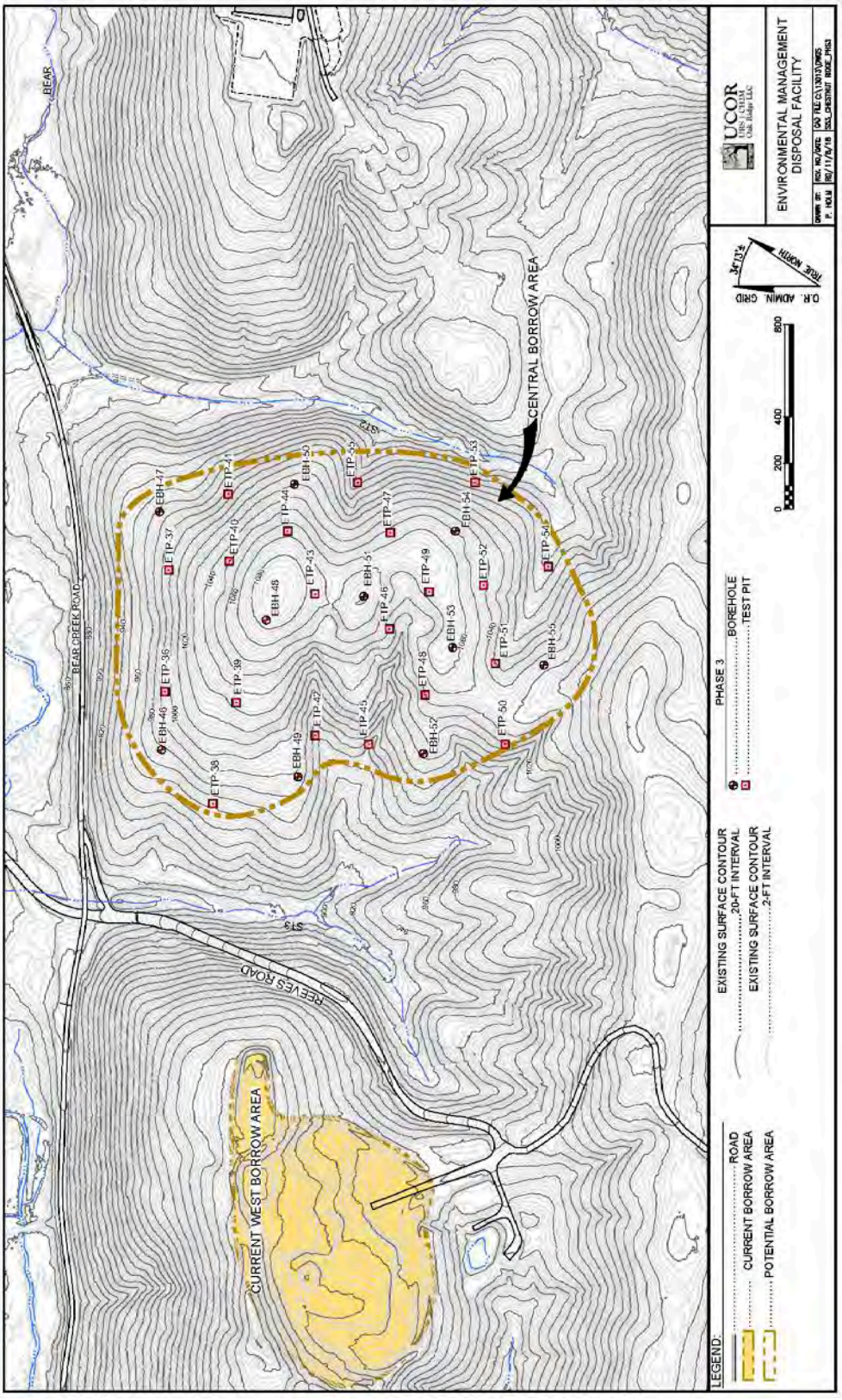

Fig. 9. Central Borrow Area Phase 3 investigation sampling locations.

4.1 GEOTECHNICAL EXPLORATION

Geotechnical boreholes and test pits will be used to evaluate site-specific conditions and collect samples from across each of the borrow area sites. Samples collected will be evaluated and specific samples will be submitted for laboratory testing at a qualified laboratory (Sect. 4.3). Geotechnical data acquisition will be performed by qualified personnel with field oversight provided by a geotechnical engineer or geologist with geotechnical experience.

Data collected will be used to estimate quantities of each soil type available, define total depth to bedrock, and collect geotechnical data for recompacted soil characterization, particularly shear strength, compressibility, permeability, grain size, and plasticity for determining appropriate use of each soil type.

Boreholes will be drilled as specified in the latest version of SPG-00000-A005, *Standard Specification for Well Drilling, Installation and Abandonment* (UCOR 2016), by Tennessee-qualified monitoring well drillers. Representative samples will be collected from boreholes, but the method will vary depending on the material and tests performed, as described below. A boring log form will be used to document the soil characteristics and pertinent field data during soil boring activities. The specific methods for data collection and logging are provided in Table 3.

Table 3. Specific methods for data collection and logging

ASTM standard or UCOR procedure	Citation[a]
ASTM D1586	ASTM D1586-11, *Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*, ASTM International, West Conshohocken, PA, 2011.
ASTM D1587/ D1587M-15	ASTM D1587 / D1587M-15, *Standard Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes*, ASTM International, West Conshohocken, PA, 2015.
ASTM D2488	ASTM D2488-17e1, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)*, ASTM International, West Conshohocken, PA, 2017.
ASTM D4220/ D4220M-14	ASTM D4220 / D4220M-14, *Standard Practices for Preserving and Transporting Soil Samples*, ASTM International, West Conshohocken, PA, 2014.
ASTM D4633	ASTM D4633-16, *Standard Test Method for Energy Measurement for Dynamic Penetrometers*, ASTM International, West Conshohocken, PA, 2016.
ASTM D6169/D6169M-13	ASTM D6169/D6169M-13, *Standard Guide for Selection of Soil and Rock Sampling Devices Used with Drill Rigs for Environmental Investigations*, ASTM International, West Conshohocken, PA, 2013.
PROC-ES-2303	*Borehole Logging*, PROC-ES-2303, latest revision, UCOR, Oak Ridge, TN.

[a]Most current version of the procedure shall be used.
ASTM = ASTM International

Each geotechnical borehole will be drilled by hollow stem auger to refusal with concurrent standard penetration tests (SPTs). Additional undisturbed samples will be collected in specified boreholes using Shelby tubes or similar equipment. Drilling will be conducted using a qualified driller with field oversight provided by a geotechnical engineer or geologist with geotechnical experience. Efficiency of the SPT hammer will be provided prior to initiating fieldwork. SPT data will be used to estimate relative density and consistency of the in-place soils/saprolite to determine when to collect undisturbed samples.

SPTs will begin at the ground surface or beneath any drill pads that are present to allow measurement of the topsoil layer thickness. SPTs will be conducted at 2.5-ft intervals throughout the soil profile until the top of saprolite/weathered rock is encountered and at 5-ft intervals thereafter until competent rock and/or drilling refusal is encountered. SPT data will be collected by driving a split spoon sampler 18 in. and recording the blow counts every 6 in. Subsequently, the borehole will be drilled to the next sample interval. Drilling depths are expected to range from 10-60 ft, depending on area.

A boring log will be maintained for each borehole and will include a description of the soil types encountered and the associated blow counts per depth intervals for SPTs. Field descriptions will include information regarding drilling data, such as material changes between samples, pertinent driller's observations, circulation loss, and similar information. Field measurements of compressive strength in cohesive soils will be made using a pocket penetrometer or shear vane.

Relatively undisturbed geotechnical samples will be collected from specified depths within the borehole, such as every 5 ft in intervals with SPT blow counts of 15 or less (if encountered) or offsets of selected boreholes following review by geotechnical engineers of the SPT data and primary borehole log. These relatively undisturbed samples will target representative cohesive soils for permeability, laboratory shear strength, and consolidation tests. Within the residuum where SPT blow counts are less than 15 blows/in., relatively undisturbed samples may be collected by pushing Shelby tubes. For Phase 3 sampling, relatively undisturbed samples will not be taken within the stiffer saprolite materials where SPT blow counts exceed 15 blows/in. The collected soil sample will be relatively undisturbed (pushed rather than advanced by hammering or rotating) and intact in a Shelby tube. The tube will be sealed using heated paraffin wax or equivalent immediately following recovery of the tube. Additional bulk samples will be collected from the drill cuttings as shown in Table 2.

Following completion of sample collection, the depth to groundwater will be measured and recorded on the borehole logs. Then, boreholes will be plugged and abandoned in accordance with SPG-00000-A005, *Standard Specification for Well Drilling, Installation, and Abandonment* (UCOR 2016).

Test pits will be used to collect discrete larger volume bulk soil samples for laboratory testing of recompacted soil. These test pits will be backfilled immediately following sample collection and photographic documentation of conditions encountered in the test pit. The excavated soil from the test pit will be replaced in lifts, not to exceed 3 ft, and compacted by tamping with a bucket or tracking across the backfilled soil a minimum of three times to achieve a relatively smooth and level ground surface that minimizes stormwater collection.

4.2 SAMPLE COLLECTION, IDENTIFICATION, AND LABELING

Sampling data generated during all phases of this project must be of acceptable quality. The UCOR Characterization Lead is responsible for implementation and performance of field activities including sample collection, quality checks, and monitoring activities.

Draft boring logs and test pit logs will be provided to the geotechnical engineer to determine the number and types of tests. Sample packaging for shipment to the laboratory will be as described in the specific ASTM International (ASTM) and will prevent physical damage. The estimated tests and frequency are provided in Sect. 4.3.

The QAPP (Appendix A) contains the requirements for field documentation, sample containers, sample packaging, equipment and devices decontamination, sample identification and traceability (including chains of custody), and the process for field changes.

4.3 LABORATORY ANALYSIS

Laboratory testing will include index tests (e.g., Atterberg limits, grain-size analyses, moisture contents, unit weights, and specific gravities) from each distinct soil type. The moisture-density relationship of sampled soils (compaction, moisture content, and specific gravity) as well as shear strength, compressibility, and permeability properties will be characterized. Additional corrosion tests will be performed, primarily in Site 7b Borrow Area.

The tests to be performed (the number of tests are approximate) are listed in Table 4. No specific criteria are developed in advance for sample selection. The total number of tests, specific locations, and depths will be determined in consultation with geotechnical engineers and the geotechnical laboratory following review of the borehole logs and collected samples. The selection of samples for each test will be based on professional judgment by the design team and the laboratory based on the subsurface conditions encountered, the engineering parameters needed for design, sample quantity and quality, and budget.

Geotechnical sample analysis will be performed by a geotechnical laboratory accredited by the American Association of State Highway and Transportation Officials for the specific ASTM laboratory testing procedures specified in Table 4. Laboratory equipment will be maintained in accordance with the laboratory's internal QA procedures.

Table 4. Geotechnical tests to be performed

Geotechnical tests	Expected quantity	Applicable ASTM standards[a]	Notes
Moisture content	113	ASTM D2216-10, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass,* ASTM International, West Conshohocken, PA, 2010.	[b]
Unified soil classification	20	ASTM D2487-17, *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System),* ASTM International, West Conshohocken, PA, 2017.	[b]
Atterberg limits	40	ASTM D4318-17e1, *Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils,* ASTM International, West Conshohocken, PA, 2017.	[c]
Sieve analyses and P200 with Hydrometer	15	ASTM D422-63(2007)e2, *Standard Test Method for Particle-Size Analysis of Soils* (withdrawn in 2016 and no replacement, latest version will be used), ASTM International, West Conshohocken, PA, 2007.	[c]
Sieve analyses and P200 without Hydrometer	45	ASTM D422-63(2007)e2, *Standard Test Method for Particle-Size Analysis of Soils* (withdrawn in 2016 and no replacement, latest version will be used), ASTM International, West Conshohocken, PA, 2007.	[c]
Density of soil/unit weight	10	ASTM D7263-09(2018)e2, *Standard Test Methods for Laboratory Determination of Density (Unit Weight) of Soil Specimens,* ASTM International, West Conshohocken, PA, 2018.	[c]
Specific gravity	10	ASTM D854-14, *Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer,* ASTM International, West Conshohocken, PA, 2014.	[c]

Table 4. Geotechnical tests to be performed (cont.)

Geotechnical tests	Expected quantity	Applicable ASTM Standards[a]	Notes
Hydraulic conductivity (permeability)	24	ASTM D5084-16a, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter,* ASTM International, West Conshohocken, PA, 2016.	[c]
Consolidated undrained triaxial compression	10 (3 points each)	ASTM D4767-11, *Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils,* ASTM International, West Conshohocken, PA, 2011.	[c]
Modified and/or standard proctor compaction	38	ASTM D1557-12e1/D698-12e2, *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))/Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)),* ASTM International, West Conshohocken, PA, 2012.	[c]
Corrosion testing suite – chlorides	6	ASTM D512-12, *Standard Test Methods for Chloride Ion In Water*, ASTM International, West Conshohocken, PA, 2012, or AASHTO T291, *Standard Method of Test for Determining Water-Soluble Chloride Ion Content in Soil,* American Association of State Highway and Transportation Officials, 1994.	[c]
Corrosion testing suite – sulfates	6	ASTM C1580-15, *Standard Test Method for Water-Soluble Sulfate in Soil,* ASTM International, West Conshohocken, PA, 2015.	[c]
Corrosion testing suite – sulfides	6	AWWA C105A.1.4 Qualitative Test, *Polyethylene Encasement for Ductile-Iron Pipe Systems,* American Water Works Association, 2010.	[c]
Corrosion testing suite – soil resistivity	6	ASTM G187-18, *Standard Test Method for Measurement of Soil Resistivity Using the Two-Electrode Soil Box Method,* ASTM International, West Conshohocken, PA, 2018.	[c]
Corrosion testing suite – moisture content	6	Laboratory methods.	[c]
Corrosion testing suite – redox potential	6	ASTM G200-09(2014), *Standard Test Method for Measurement of Oxidation-Reduction Potential (ORP) of Soil,* ASTM International, West Conshohocken, PA, 2014.	[c]
Corrosion testing suite – pH	6	ASTM G51-95(2012), *Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing,* ASTM International, West Conshohocken, PA, 2012.	[c]

[a]Most current version of each procedure, standard, or test method shall be used.
[b]Laboratory tests may be performed separately or in conjunction with other laboratory tests (e.g., sieve analysis).
[c]Specific samples (boring or test pit, and depth) will be assigned following review of borehole and test pit logs and collected samples.

ASTM = ASTM International
AWWA = American Water Works Association

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5. DATA MANAGEMENT

5.1 DATA VERIFICATION AND REVIEW

A project geotechnical engineer or geologist will review the data to verify that the results are reasonable. Results that appear anomalous will be evaluated in greater detail, which will include discussions with the laboratory, as appropriate, to confirm the validity of the results.

5.2 DATA REPORTING

A geotechnical data report will be prepared with the geotechnical results from the Phase 3 field investigation. These data will be used to design the borrow areas and provide input on the material use from each site. The geotechnical data report(s) will be placed into the Oak Ridge Environmental Information System database and the data will be used in support of the remedial design report.

The QAPP (Appendix A, Sect. A.10) contains the specific requirements for data reporting.

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6. INVESTIGATION SCHEDULE/APPROACH

The investigation schedule will depend on the availability of specialty subcontractors and the site-specific conditions encountered. The field activities can be performed in phases, with only a subset of activities performed at any given time. However, the following sequence is anticipated for Phase 3:

- Procure specialty subcontractors (as required for Phase 3) – Winter 2019
- Develop specific project plans, work control documents, and internal work permits (e.g., excavation/penetration permits) – Winter 2019
- Hold point – ensure project plans, work control documents, specialty contractors, and designated personnel qualifications and training meet the requirements listed in the FSP and QAPP, including the DQOs, prior to performing specified work scope
- Mobilize – Spring 2019
- Drill boreholes with collection of geotechnical samples – Spring 2019
- Complete test pits (independent activity from drilling may occur before, during, or after drilling) – Spring 2019
- Demobilize – Spring 2019
- Complete laboratory testing and finalize report for Phase 3 – Summer 2019

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APPENDIX A.
QUALITY ASSURANCE PROJECT PLAN FOR THE PROPOSED EMDF PHASE 3 BORROW AREA INVESTIGATION, OAK RIDGE, TENNESSEE

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CONTENTS

FIGURES

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ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
ASTM	ASTM International
CFR	*Code of Federal Regulations*
COC	chain-of-custody
DMC	Document Management Center
DOE	U.S. Department of Energy
DOE O	DOE Order
DOT	U.S. Department of Transportation
DQO	data quality objective
EMDF	Environmental Management Disposal Facility
EPA	U.S. Environmental Protection Agency
ES&H	Environment, Safety, and Health
FDF	field data form
FSP	Field Sampling Plan
LCOC	laboratory chain-of-custody
LOR	Letter of Receipt
NCR	Nonconformance Report
OREIS	Oak Ridge Environmental Information System
OREM	Oak Ridge Office of Environmental Management
PM	Project Manager
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
SME	subject matter expert
SMO	Sample Management Office
SOP	standard operating procedure

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A.1 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been developed to identify and implement quality assurance (QA) requirements for use in sample collection, laboratory analysis, and data management of geotechnical data needed to support the design of the proposed Environmental Management Disposal Facility (EMDF) on the U.S. Department of Energy (DOE) Oak Ridge Reservation (ORR) located in Oak Ridge, Tennessee. These requirements ensure that the appropriate levels of QA and quality control (QC) are achieved and maintained. This plan identifies the procedures that will be followed in the collection, custody, and handling of samples as well as environmental/laboratory data used in the Field Sampling Plans (FSPs) generated to support the EMDF project. The work to be performed is described in Sect. 4 of the FSP.

This Plan provides the QA for collecting geotechnical data in an uncontaminated setting for the Phase 3 design investigation. Samples will be collected for geotechnical laboratory analyses, not for chemical or radiological analyses. In addition, this QAPP establishes the requirements and responsibilities applicable to project participants as well as the methods through which project personnel implement the requirements of the UCOR, an AECOM-led partnership with Jacobs, QA programs. Any changes to this QAPP will require completion of the EMDF QAPP Addendum form provided in Attachment A.1.

This QAPP meets the requirements of *EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5)* (U.S. Environmental Protection Agency [EPA] 2001), *URS | CH2M Oak Ridge LLC Quality Assurance Program Plan* (UCOR 2016a), and 10 *Code of Federal Regulations (CFR)* 830.122, *Quality Assurance Criteria* (DOE 2011).

Stakeholders and data users involved in the operation of the EMDF design investigation sampling and analysis effort include the Oak Ridge Office of Environmental Management (OREM), EPA Region 4, and the Tennessee Department of Environment and Conservation. UCOR is tasked with implementation of the FSP using the QA requirements in this QAPP.

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A.2 PROJECT ORGANIZATION

The organizational structure for this characterization project is presented in Fig. A.1.

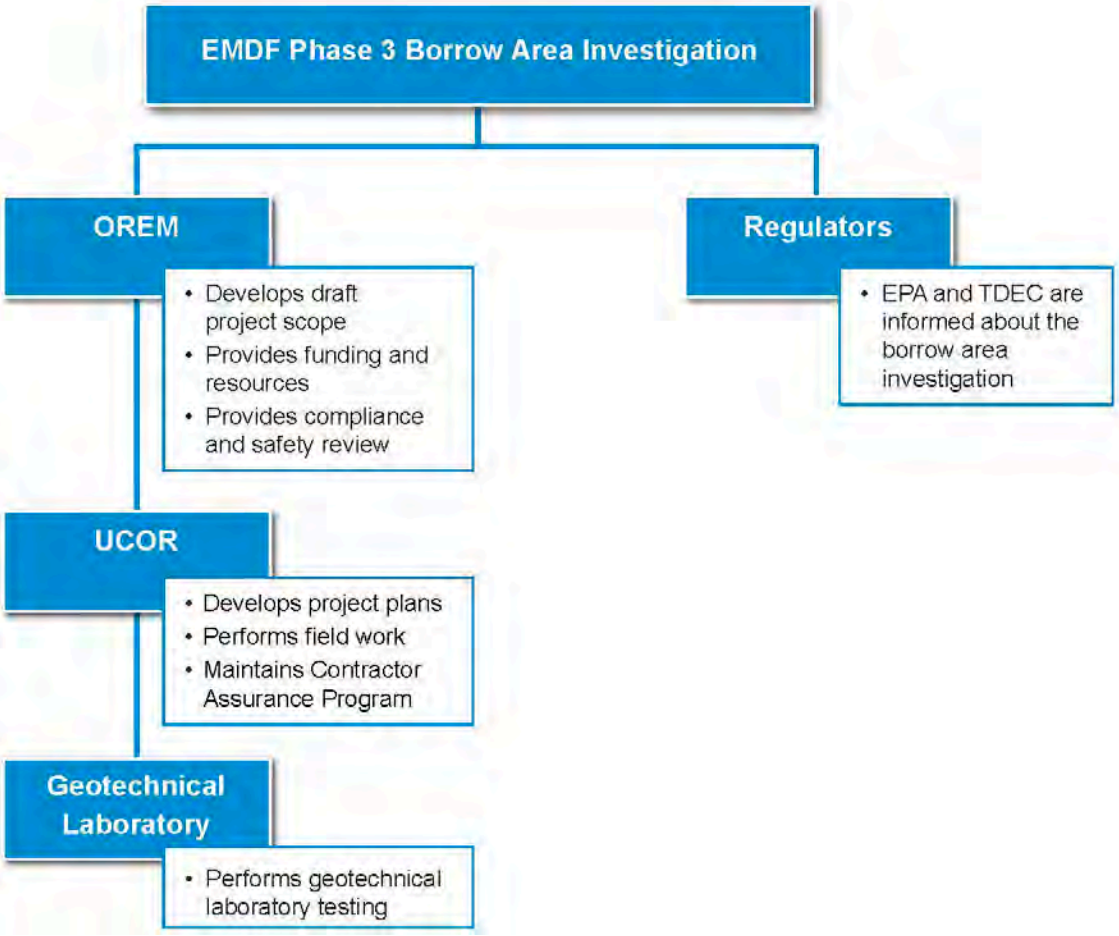

Fig. A.1. Project organization.

A.2.1 ROLES AND RESPONSIBILITIES

In accordance with DOE Order (O) 450.2, CHG 1 (MINCHG), *Integrated Safety Management*, and *Integrated Safety Management System Program Description* (DOE 2017), the authority and expectation to suspend work is extended to all employees and UCOR subcontractors. All employees are empowered to refuse to perform work that is unsafe or may cause environmental impact without fear of reprisal, even if directed to do so by supervisors, customers, or other prime contractors on shared sites. Work that is suspected or proven to place the workers, the public, or the environment at risk is to be stopped until it can be demonstrated that changes have been made, and it is safe to proceed with the work.

Roles and responsibilities of the major EMDF project administrative and functional interfaces are discussed below (see Fig. A.1). Positions may be combined and/or performed by one or more individuals. The project contact list is provided in Attachment A.2.

A.2.1.1 OREM

OREM is responsible for ensuring the work scope is performed in a safe, compliant, and effective manner, and for maintaining the project scope, schedule, and costs. OREM also is responsible for approving deliverables and providing funding/resources to the project. The responsible OREM personnel for this project include the following:

OREM Landfills Project Manager (PM). The OREM Landfills PM is responsible for maintaining overall scope, schedule, and costs for this characterization project.

OREM staff. The OREM staff includes subject matter experts (SMEs) and facility representatives responsible for providing general oversight of the contractor's safety and compliance performance.

A.2.1.2 UCOR

UCOR is responsible for completion of the project scope as specified in the FSP. UCOR also is responsible for procurement and oversight of specialty subcontractors to perform the Phase 3 characterization field work and geotechnical laboratory testing.

EMDF PM. The EMDF PM is responsible for all aspects of the EMDF project and has overall responsibility for ensuring the sampling effort results in information needed to support the future design of EMDF.

Characterization Lead. The Characterization Lead provides overall direction for the field project and serves as the primary interface between OREM, subcontractors, and SMEs for the technical aspects of the FSP. As changes occur in the field, the Characterization Lead will communicate with the EMDF PM and the OREM Landfills PM for concurrence of the changes. The Characterization Lead also is responsible for ensuring the applicable data are uploaded into Oak Ridge Environmental Information System (OREIS) as needed.

The Characterization Lead is responsible for ensuring the overall sampling plan details are implemented in the field as specified in the FSP/QAPP to confirm that data collected will support the future design efforts. There may be multiple technical representatives for the various elements of this scope that will be informed of project progress.

The Characterization Lead will observe boring and other field activities, review field and laboratory results to verify the appropriate data are collected, and consult with the geotechnical laboratory on sample location selection and testing parameters.

Field Lead. The Field Lead is responsible for the effective execution of field tasks under this characterization project and serves as the point-of-contact for field activities. The Field Lead oversees the activities of all field personnel, ensures compliance with the FSP, and controls project consistency. The Field Lead supervises sampling activities and coordinates all planning, data collection, and reporting.

The Field Lead is responsible for the following:

- Controlling site access
- Ensuring appropriate work controls are in place and work is released in accordance with UCOR procedures

- Coordinating inbound/outbound equipment and that radiological surveys and samples are appropriately released for shipping offsite
- Ensuring work is performed in accordance with this FSP/QAPP and all applicable and appropriate procedures
- Coordinating activities of the field sampling personnel
- Ensuring all FSP/QAPP requirements are met and sampling procedures are followed by the samplers
- Directing the planning and technical implementation of the FSP/QAPP and sampling procedures for all sampling activities
- Ensuring the proper collection, containerization, and storage/preservation of samples in accordance with the FSP/QAPP and applicable approved methods
- Ensuring delivery of samples to the laboratory as directed
- Confirming training and certification requirements are met for all Phase 3 characterization personnel
- Ensuring adherence to QC requirements identified in this plan

Environment, Safety, and Health (ES&H) Representative. The ES&H Representative independently reports to the EMDF PM on matters concerning project safety and health. The ES&H Representative is responsible for the following:

- Assisting in addressing and resolving health and safety concerns involved in sampling events
- Providing oversight of controls required for protection from hazards associated with the sampling event
- Ensuing all work is planned and conducted in a safe manner and in accordance with the five core functions of Integrated Safety Management
- Reviewing and approving applicable job hazard analyses

QA Representative. The QA Representative independently reports to the EMDF PM on matters concerning QA aspects of the project. The project QA Representative is responsible for the following functions:

- Providing independent oversight for QA pertaining to work performed by the project
- Reviewing the overall quality of project plans and reports
- Coordinating with technical members of the project team to evaluate status, procedures, and nonconformances from a quality program standpoint
- Coordinating quality improvement, QA/QC, and quality assessments for the project

Sample Manager. The Sample Manager supports the planning and execution of characterization field activities. The Sample Manager is responsible for maintaining chain-of-custody (COC) forms and field logbooks; coordinating with the Geotechnical Laboratory Manager to ensure sample technicians have the proper labels, containers, preservatives, etc., to satisfy data quality objectives (DQOs); and coordinating sample shipment.

The Sample Manager interfaces with project team personnel and is responsible for the following services:

- Reviewing field-generated project documentation for completeness and accuracy and ensuring field documents are appropriately filed and stored
- Participating in field decisions and preparing field change notices to document variances in the field
- Ensuring proper disposal of samples, including receiving certificates of disposal
- Providing oversight and support necessary to ensure sample shipments are conducted according to applicable U.S. Department of Transportation (DOT) procedures
- Determining the appropriate hazard classifications for sample shipments
- Directing sample shipments, including appropriate marking, labeling, and placarding, in accordance with applicable standards
- Ensuring sampling personnel are adequately trained in the applicable sample packaging

Data Manager. The Data Manager works with the project team and geotechnical laboratory to ensure the complete and accurate transfer of samples and information from the field to the laboratory. The Data Manager is responsible for the following services:

- Verifying receipt of incoming field data and geotechnical data from the laboratory in both hard copy and electronic formats
- Overseeing and tracking the data review process and preparing and submitting deliverables to the UCOR Characterization Lead
- Identifying and resolving analysis issues and nonconformances
- Ensuring the laboratory is aware of the project DQOs, program goals, and QA/QC objectives
- Monitoring the QA/QC deliverables from the laboratory, ensuring conformance with authorized procedures and sound practices, and assisting in identification and resolving nonconformances
- Communicating the schedule of sample shipments and shipment contents to the laboratory and providing the status of sample shipments to the project team

A.2.1.3 UCOR Geotechnical Laboratory Subcontractor

The geotechnical laboratory subcontractor is responsible for providing the resources needed to complete the designated scope of geotechnical laboratory testing work as described. The geotechnical laboratory subcontractor will report to the UCOR Characterization Lead for overall project direction, scope, cost, and schedules.

The geotechnical laboratory subcontractor will provide laboratory data in the appropriate format to support uploading test results into OREIS, as appropriate.

A.2.2 TRAINING AND QUALIFICATION OF PERSONNEL

UCOR and its subcontractors will provide trained and qualified personnel as governed by their contract and DOE O 426.2, *Personnel Selection, Training, Qualification and Certification Requirements for DOE*

Nuclear Facilities (DOE 2013). Confirming the qualifications of personnel includes consideration of experience, education, and training as well as demonstrations or testing to verify acquired skills.

The training program focuses on an approach to ensure the employees and subcontractors are trained and qualified commensurate with their responsibilities. Training includes mandatory company, access-specific, functional-specific, project-specific, facility-specific, job-specific, and professional qualification training.

All project personnel must be qualified and experienced in the project task(s) for which they are responsible. For those personnel actively involved in fieldwork, training will include applicable Occupational Safety and Health Administration training, general employee training, and site required orientation, at a minimum. All field personnel will be trained on the applicable work packages and this FSP/QAPP.

Additional training to standard operating procedures (SOPs) and other training that becomes identified as specific to the activities identified in this FSP/QAPP also must be completed before installing any borings or collecting any samples. In addition, site workers will receive training in personal protective equipment, daily tailgate safety meetings, and daily pre-job briefings. Data management personnel will require additional training in the use of OREIS. Documentation of UCOR training will be maintained in the UCOR records.

Additional training that may be required for specific equipment or by ES&H and/or Transportation is not addressed in this QAPP, but will be addressed in the task-specific work control documents.

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A.3 DATA QUALITY OBJECTIVES

The EMDF Phase 3 FSP and this QAPP together describe the data collection and sample analyses requirements.

Quality objectives for data collection and analysis are developed as DQOs for this project in accordance with UCOR procedure PROC-ES-1004, *Implementing and Documenting the Data Quality Objective Process* (UCOR 2014). The DQOs are provided in Sect. 3 of this FSP. However, the general quality objectives for the hydrogeological, geotechnical, and geophysical data are as follows:

- Field data generated will withstand scientific and technical scrutiny
- Geotechnical data will be generated using appropriate procedures for analysis, COC, data documentation, and reporting
- Geotechnical data will be of known representativeness, comparability, and sensitivity

QC requirements will be communicated to the contracted laboratory accredited by the American Association of State Highway and Transportation Officials (AASHTO) for the specific ASTM International (ASTM) laboratory testing procedures referred to in Sect. 6 of this FSP. Any necessary changes to these requirements will be documented, reviewed, and approved by the Characterization Lead. Analyses will be scheduled according to the program needs and will be consistent with ASTM/AASHTO standards. These requirements will be included in any contractual agreement between UCOR and the AASHTO-accredited laboratory.

Quality objectives for all field and laboratory data are to obtain reproducible, precise, and accurate measurements consistent with the intended use of the data and limitations of the sampling and laboratory procedures. The geological and geotechnical data generated are identified in detail in this FSP. Geotechnical laboratory data will be provided in electronic and hard copy format as described in Sect. A.10. Data reported will comply with ASTM/AASHTO standards.

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A.4 PROCUREMENT, SUPPLIES, AND CONSUMABLES

All field instrumentation, sample containers, and other equipment or materials purchased for use will be purchased in accordance with DOE Guide 414.1-3, *Suspect/Counterfeit Items Guide for Use with 10 CFR 830 Subpart A, Quality Assurance Requirements and DOE O 414.1c, Quality Assurance* (DOE 2004), as implemented through the UCOR QA program plan/procurement plan and applicable procedures. If applicable, all critical elements of the equipment or materials being purchased will be specified in the purchase order to the vendor.

Receipt, inspection, and acceptance of supplies and consumables will be in accordance with the UCOR QA program plan/procurement plan/inspection and acceptance testing requirements.

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A.5 SAMPLE COLLECTION PROCEDURES

Sampling data generated during all phases of this project must be of acceptable quality. The Field Lead is responsible for implementation and performance of sample collection, quality checks, and monitoring activities.

This section discusses field documentation, sample containers, sample packaging, equipment and devices decontamination, sample identification and traceability, and field variance systems integral to the collection of samples. Related activities are performed in accordance with ASTM/AASHTO standards as described herein.

The measurement and testing locations are shown on Fig. 5, and a summary of field sampling activities is provided in Table 4 of this FSP. The specific sampling approach for the field activities is discussed in Sect. 4.

A.5.1 FIELD DOCUMENTATION

An integral part of field exploration and sampling activities is the maintenance of current, accurate, and complete field records. Field records include COC forms, field logbooks, field testing reports, and drilling/boring logs. The COC (i.e., laboratory chain-of-custody [LCOC]) form, or equivalent, shall document the transfer of sample custody from time of sample collection to laboratory receipt and will be in accordance with ASTM/AASHTO standards. The COC form will accompany the samples from the field to the AASHTO-accredited laboratory. All applicable information on the COC will be filled out completely and legibly using indelible black ink. No blank spaces should appear on completed COC forms.

Field records will be reviewed by a field team member other than the person completing the record (e.g., boring/drilling logs), and the review will be documented with the reviewer's initials and date. All field records and documentation will be maintained and controlled in accordance with ASTM/AASHTO standards.

A.5.1.1 Field Logbook and Field Data Forms

A bound logbook will be used to document all field activities. The logbook will include descriptions of daily progress of the fieldwork for the area of investigation. Field logbooks become part of the project record. Guidelines for the minimum entries made into field logbooks are provided in PROC-ES-2700, *Field Logbooks and Field Data Forms* (UCOR 2015a) (FDF). The field logbooks are used to document a broad range of field activities, including, but not limited to, inspections, sampling, and testing and/or measurements. Field logbooks will be maintained by assigned personnel to document field activities such as borehole drilling, geotechnical sampling, and geophysical logging/testing.

Borehole and test pit logs will document subsurface information (Sect. 6). Sample collection depths will be noted on the logs. Additional information provided in the field logbooks will include the following:

- Name of person entering information into the logbook
- Project name and location
- Dates and times
- General weather conditions

- Field observations
- Sampling performed, including locations, sample numbers, and analyses
- Deviations from the FSP
- Problems encountered and corrective actions taken
- QC activities

A.5.1.2 Field Documentation Checks

Documented quality check reviews of field logbooks are performed daily to ensure collection of the information as outlined in *Field Logbook and Field Data Forms* (UCOR 2015a). This review includes a quality check of sample times and dates entered in the field logbook or other associated FDFs used for the day's activity (i.e., groundwater purge/sampling form). Field documentation reviews are conducted by a Quality Check Reviewer or designee (i.e., peer). If deficiencies are encountered, the Quality Check Reviewer will notify the appropriate author to fully document (e.g., perform a late entry to the field logbook) or amend documentation as appropriate and in accordance with the UCOR procedure (UCOR 2015a).

A.5.1.3 Field Changes

Procedures cannot fully encompass all conditions encountered during field activities, therefore, changes from the field sampling procedures and/or ES&H Plan must be documented in the field logbook. Changes from the approved scope of the project shall be approved in advance by the UCOR Characterization Lead in consultation with the UCOR Landfill PM.

Controlling and documenting field changes will be in accordance with the ASTM/AASHTO standards. Any deviation from procedural requirements or one-time difficulties will be reported to and authorized by the UCOR Characterization Lead in consultation with the UCOR Field Lead and UCOR Landfill PM. Deviation from the requirements will be sufficiently documented in the field logbook.

A.5.2 SAMPLE CONTAINERS

The selection criteria for appropriate sample containers shall be in accordance with ASTM/AASHTO standards. The sample volume to be collected is dependent on the methodology to be used. The AASHTO-accredited laboratory shall provide this information prior to sample collection. The types of sample containers used will be documented in the drilling/boring log and/or on the COC. Sample containers will be provided or specified by the geotechnical laboratory in accordance with the ASTM/AASHTO standards.

A.5.3 SAMPLE IDENTIFICATION AND TRACEABILITY

Sample numbers will be generated and will include the following information:

- EMDF project
- Location identifier (e.g., GW-999)
- Depth

Sample containers will be labeled with a unique sample identification prior to sample collection. The sample labels will be completed with indelible black ink and in accordance with ASTM/AASHTO standards. Corrections will be made by drawing a single line through the erroneous information and initialing and dating the correction. Sample identification will be recorded in the drilling/boring log and COC form. Sample identification shall be associated with the sample type and location, thereby ensuring traceability of samples to the specific sample location.

A.5.4 TYPE AND FREQUENCY OF QC SAMPLES

No field QC samples will be required for this activity. Laboratory QC samples will be in accordance with the specified ASTM standard.

A.5.5 SAMPLE PACKAGING

Sample containers must comply with ASTM standards. Samples will be handled to avoid contamination from outside sources and prevent sample moisture evaporation during and after collection. Sample preservation, storage, packaging, shipping, and handling will be in accordance with ASTM/AASHTO standards, the laboratory statement of work, and DOT requirements.

After sample collection, the sampling team shall store samples in accordance with ASTM/AASHTO standards until packaging and shipment to an AASHTO-accredited laboratory.

The Sample Manager will package the samples, complete the required sections on the COC (i.e., records signature, time, date, air bill number), and seal the original COC in a watertight bag inside the shipping container.

A.5.6 STORAGE AND SHIPMENT OF SAMPLES

Samples will not be stored onsite and shall be transported to controlled storage or the appropriate laboratory on the same day. Sample packaging for shipment to a laboratory will follow ASTM D4220/D4220M-14, *Standard Practices for Preserving and Transporting Soil Samples* (ASTM 2014) to prevent physical damage. Samples collected, packaged, and shipped to the laboratory for analyses will be tracked using the carrier's tracking system (e.g., United Parcel Service, Federal Express), if not hand delivered.

Samples of material shipped from a site to a laboratory for analysis must be classified and prepared for the carrier in accordance with the regulatory requirements found in the International Air Transport Association regulations and DOT 49 *CFR* Parts 100 through 177, *Transportation* (DOT 2011), as outlined in PROC-TR-9503, *Shipping Samples from a Company Site* (UCOR 2012). Samples are not expected to meet the definition of a hazardous material or dangerous goods.

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A.6 SAMPLE CUSTODY

A sample is in custody if it is in the actual possession of a sample custodian, is in the view of a sample custodian after being in their physical possession, was in the physical possession of a sample custodian and then secured to prevent tampering (e.g., affixed with custody/tamper seals), and is placed in a secured area. Custody/tamper seals are placed on the container lid and side of the sample container to guard against and detect any sample tampering between the time of sample collection and receipt by the laboratory. Sample shipment containers (i.e., ice chest or coolers) will have custody/tamper seals placed across the hinge of the lid and opposite side (back and front) of the lid to guard against or detect tampering.

A.6.1 CUSTODY SEALS

Custody/tamper seals are affixed to sample containers and sample shipment containers in accordance with the UCOR COC protocol for environmental sampling. The application of custody/tamper seals on shipping containers may be waived if the sample team maintains sample custody as defined in PROC-ES-2708, *Chain of Custody Protocol for Environmental Sampling,* Sect. 4[2] (UCOR 2016b), from the time of collection until the samples are relinquished to the Transportation Specialist. Certain sample containers may be placed in a resealable bag with a custody seal affixed such that the seal must be broken when the bag is opened (i.e., over the bag opening).

A.6.2 SAMPLE TRACKING

The COC form documents the transfer of sample custody from the time of sample collection to laboratory receipt (Fig. A.2). The COC custody record will be initiated at the time of sample collection and will remain with the sample from the field to storage and sample shipment to the laboratory.

Upon laboratory receipt, the laboratory custodian will complete the required sections of the COC, thereby accepting custody of the samples. Sample shipments will be examined immediately upon receipt by the laboratory to determine damage, loss, or inconsistencies. A Letter of Receipt (LOR) or equivalent will be completed by the laboratory that indicates sample condition, documentation inconsistency, and any problems discovered. If samples are damaged or the shipment has been otherwise compromised, the laboratory will immediately notify the Sample Management Office (SMO).

Samples will be logged into the laboratory and will be tracked and maintained under conditions appropriate to the specific laboratory methods throughout the laboratory process as described in the laboratory QC manual. After appropriate information and required signatures have been added to the COC form and LOR, the laboratory will return signed copies of both to the SMO as soon as practicable (e.g., usually within 24 hours). The LOR may be in the form of an electronic confirmation (e.g., email, pdf). The laboratory shall include a copy of the LOR and documentation of the analytical login (project sample number, laboratory sample number, analysis scheduled, etc.) in this sample receiving report.

CHAIN-OF-CUSTODY FORM

MACTEC Engineering & Consulting, Inc. - Knoxville Branch
1725 Louisville Drive - Knoxville, TN 37921-5904

Job Number:	Date:
Client Name:	___ of ___ Samples
Job Name:	Rush? Yes or No
Building:	
Inspectors:	

Sample I.D. Number	Location	Source Description	Lab I.D. Number	Comments

Friable Material:	Shipped Via: Ground unless other noted	Lab Shipped To: (If Required)
Non-Friable Material	(other: Airborne, Fed-Ex, UPS, US Mail, Etc.)	
Field Collection:	1st Transfer Facility:	2nd Transfer Facility: Disposal:
Name:	Name:	Name:
Signature:	Signature:	Signature:
Date:	Date:	Date:

Fig. A.2. LCOC example.

The original COC will be returned by the laboratory to the SMO with the data package. Original COC forms will be stored with the associated data deliverables or electronic data deliverables and provided as records at project completion.

A.6.3 SAMPLE DISPOSAL

Samples will be held for a minimum of 90 days following reporting. Samples will be stored by the laboratory in appropriate containers and under conditions appropriate to the specific laboratory methods.

The laboratory will be responsible for the return of residual samples after the minimum retention period and upon approval by the project. Returns will be coordinated with the Characterization Lead.

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A.7 DECONTAMINATION OF EQUIPMENT AND DEVICES

The Uranium Processing Facility Spoils Area, Site 7b Borrow Area, and Central Borrow Area are all located in an uncontaminated area. However, as a best management practice, all equipment and downhole tools will be cleaned with water to remove excess mud/soils prior to mobilization to the project site. Cleaning will consist of the removal of adhering soil and subsurface materials from the downhole tools prior to use and between sampling locations and intervals in accordance with the applicable standards. Field decontamination activities will be recorded in the applicable field notebook or on the drilling/boring log.

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A.8 CALIBRATION PROCEDURES AND FREQUENCY

A.8.1 FIELD INSTRUMENT CALIBRATION PROCEDURES AND FREQUENCY

While not anticipated for this project, if used, field instrumentation and measurement equipment will be calibrated by qualified individuals and will be maintained using certified equipment and/or standards having known valid traceability in accordance with ASTM/AASHTO standards. Field logbooks shall be used to record calibration, standardization, and field measurement data associated with field instruments and measurement equipment in accordance with ASTM/AASHTO standards.

Where radiological monitoring is required for samples, equipment, or certain activities, Radiological Protection personnel shall ensure radiological monitoring equipment is calibrated daily (e.g., daily source checks). Radiological monitoring instrument calibration records are established and maintained by UCOR Radiological Protection personnel.

If an instrument malfunctions prior to use, the device will be removed from service and tagged so it is not inadvertently used and the project field personnel will be notified. If an instrument is discovered to be out of calibration while in the field, the Field Lead or designee will be notified and related field work will be discontinued until a properly calibrated instrument is obtained. Project field personnel will ensure that an instrument discovered to be out of calibration will be tagged or segregated from other equipment (not to be used) and properly calibrated or disposed, as appropriate.

If an instrument is found to be out of calibration and inadvertently used to obtain field measurement data, a Nonconformance Report (NCR) will be completed and the sample will be considered null and void, resulting in a retest. The nonconformance will be documented by the appropriate project personnel in the field logbook, along with the validity of the previous calibration or inspection with test results and the acceptability of similar equipment previously calibrated or inspected and tested.

A.8.2 LABORATORY INSTRUMENT CALIBRATION PROCEDURES AND FREQUENCY

Laboratory equipment will be calibrated according to ASTM/AASHTO standards. Calibration frequency will be based on the standard used, type of equipment, inherent stability, manufacturer's recommendations, values given in the AASHTO-accredited laboratory QC manual, intended use, and experience. All standards used for equipment calibration will be traceable to ASTM/AASHTO standards. The source of the standard used must be documented in the laboratory records.

For volumetric laboratory measurements, ASTM/AASHTO-approved volumetric equipment shall be used by trained and qualified technicians to prepare calibration standards, bench standards, samples for analysis, etc. For gravimetric measurements, calibration of analytical balances must be performed by trained and qualified instrument technicians using weights traceable to the National Institute of Standards and Technology.

It should be noted that other instrumentation (e.g., thermometers) must be properly maintained and calibrated to ASTM/AASHTO standards. The temperature of ovens used in sample handling will be recorded and the control limits shall be defined. When these limits are not met, the sample will be considered null and void and a retest of the sample must occur.

A.8.3 CALIBRATION FAILURES

Laboratory equipment failures are addressed in the laboratory QC manual, which is audited by AASHTO. If a laboratory equipment failure occurs, then the sample will be considered null and void and a retest of the sample must occur once adequate equipment is acquired.

A.8.4 CALIBRATION RECORDS

Calibration data will be recorded in the laboratory records. The information will include the date, calibrator's initials, and standard used during the calibration process. Records that demonstrate the traceability of all calibration standards used in calibrations to the certified source will be maintained in accordance with ASTM/AASHTO standards.

The appropriate project personnel will ensure field calibration data records are maintained. Records for the field instruments used will be maintained in the project files.

Records for laboratory equipment will be maintained as specified in the geotechnical laboratory QC manual in accordance with the laboratory's QC system.

A.9 PROJECT DATA QUALITY ASSESSMENT

The data assessment objectives for laboratory analysis will produce data of known and sufficient quality to support the project and resultant decisions. Appropriate procedures and QC checks will be used to assess the level of acceptance of these parameters. Applicable QC data will be reported for the project with the sample results. When the sample set is completed, QC data will be reviewed and evaluated to validate the information. Acceptance criteria and evaluation of laboratory results for the representativeness, comparability, and sensitivity parameters will be determined in compliance with ASTM/AASHTO standards.

The following quality parameters will be used to evaluate data quality:

- Representativeness
- Comparability
- Sensitivity

In determining data usability, especially in the decision-making process, the integrity and authenticity of the data must be evaluated and the measurement uncertainty must be determined. The laboratory analyzing the data must be accredited by AASHTO through the certification program involving standard analysis in accordance with AASHTO procedures.

A.9.1 REPRESENTATIVENESS

Representativeness expresses the relative degree to which the data depict the characteristics of a population, parameter, sampling point, process condition, or environmental condition. The objective of this study is to accurately represent the material properties.

Representative samples for this investigation will be acquired through implementation of ASTM/AASHTO standards that will generate data representative of the sampling point location. Sampling procedures are designed to minimally impact the sample obtained so that conditions representative of the sampling location will be maintained. Representativeness also is provided through the sample selection for geotechnical analysis by the UCOR Field Representative and geotechnical laboratory personnel. The combined consultation will ensure the interval selected for analysis represents the site conditions and provides the most useful information for the future engineering design.

The goal for representative sample data will be met through proper documentation of field and standard protocols as well as through SME consultation and sample interval selection. Review of the data, documentation, and field information also will be implemented to identify sample population, parameter, or process characteristics relative to representativeness.

A.9.2 COMPARABILITY

Comparability expresses the confidence with which one data set can be compared with another. Comparability of the data generated in this investigation will be obtained through the implementation of the identified protocols for sampling and analysis of samples. Expression of results in standard units and successful participation by the laboratories in external performance evaluation programs will enable the data produced through this investigation to be compared with future geotechnical data sets.

A.9.3 SENSITIVITY

Procedures to attain sensitivity objectives include the following:

- Uniform training and certification for staff
- Standard provisions for inspection, maintenance, and repair
- Provision of SOPs to technical staff
- Reference to SOPs in the field and laboratory QAPPs
- Field/laboratory QA inspections to determine compliance with the appropriate ASTM standards or UCOR procedures.

A.10 DATA REPORTING

The field investigation results will be presented in a laboratory report for use by the project engineers as described in Sect. 9.

A.10.1 FIELD DATA REDUCTION AND EVALUATION

Data measurements collected during field activities will be evaluated by comparing the data to similar measurements, as applicable. Field measurements will be collected in accordance with ASTM/AASHTO standards or other approved UCOR procedures. The appropriate project personnel will be responsible for verifying that sampling protocols have been observed.

The QA Representative may perform a surveillance of the sampling protocols. These reviews may include checking the sample collection date and times, applicable procedures, calibration methods and frequency, COC, field logbook and/or drilling/boring logs, and other applicable information and documentation.

A.10.2 GEOTECHNICAL LABORATORY DATA REDUCTION AND EVALUATION

In general, the analyst will process the data either manually or by inputting the data into a relevant software program. If calculations are not performed directly on the data sheet, the calculations must be provided on company letterhead paper and attached to the data sheets. All pages of the calculations must be signed and dated by the analyst performing the calculations and by the individual verifying the calculations.

For data input by an analyst and processed using a relevant software program, a copy of the input must be retained and uniquely identified with the project number and other pertinent information, as necessary. The samples to which the data processing refers must be clearly stated and the input must be signed and dated by the analyst performing the input and the individual verifying the process. When processing data are acquired from instrumentation, the analyst and the oversight individual must verify that the correct project sample numbers are present.

A.10.2.1 Laboratory Data Review

The laboratory is responsible for ensuring the data reduction and calculations follow the correct procedures, are documented, and are checked by qualified personnel in accordance with the laboratories' internal QC manual. All information, including reduced and summarized data, will be retained with the raw data. Specific calculations used for data reduction also will be included. The laboratory is responsible for maintaining comprehensive documentation for all data produced, including the following:

- Appropriateness of equations used
- Correctness of numerical input (both record copy and electronic)
- Numerical correctness of all calculations
- Interpretation of laboratory analysis output
- Comparability and correctness of initial and continuing calibration results
- Traceability of samples from receipt to data report by internal custody and tracking procedures
- Evaluation of data deliverable completeness and legibility

A.10.2.2 Data Reporting and Deliverables

Geotechnical reports, including borehole logs and laboratory data, will be provided to the project engineers for use in designing the borrow areas. The geotechnical data report (i.e., content and format) will be developed in accordance with ASTM/AASHTO standards.

A.11 RECORDS AND DOCUMENT CONTROL

A.11.1 RECORDS CONTROL

All QA records concerning the project (internal and external correspondence, FSP, QAPP, field logbooks, LCOC forms, data packages, audit reports, surveillance reports, NCRs, corrective action reports, management assessments, etc.) and other quality records will be submitted to the Characterization Lead at the end of each phase of the project. These records will be submitted to the UCOR Document Management Center (DMC) in accordance with PROC-OS-1001, *Records Management, Including Document Control* (UCOR 2017).

The DMC Controlled Document Worksheet (Fig. A.3) will be completed by the UCOR Characterization Lead to identify all recipients of a controlled record copy of the FSP/QAPP. The DMC Supervisor, or designee, will issue revised electronically controlled documents (or hard copy upon request) to those on the distribution list (see last page of this QAPP).

A.11.2 RECORDS RETENTION

Records generated from this investigation will be retained and maintained in accordance with the length of time specified in DOE records retention schedules and PROC-OS-1003, *Administrative Record Program* (UCOR 2015b). The DMC obtains authorization for records turnover to the Federal Records Center or records destruction from the UCOR DMC Records Manager, Legal, and originating organization, if different from the originator, during the 6 months before the records' scheduled destruction date.

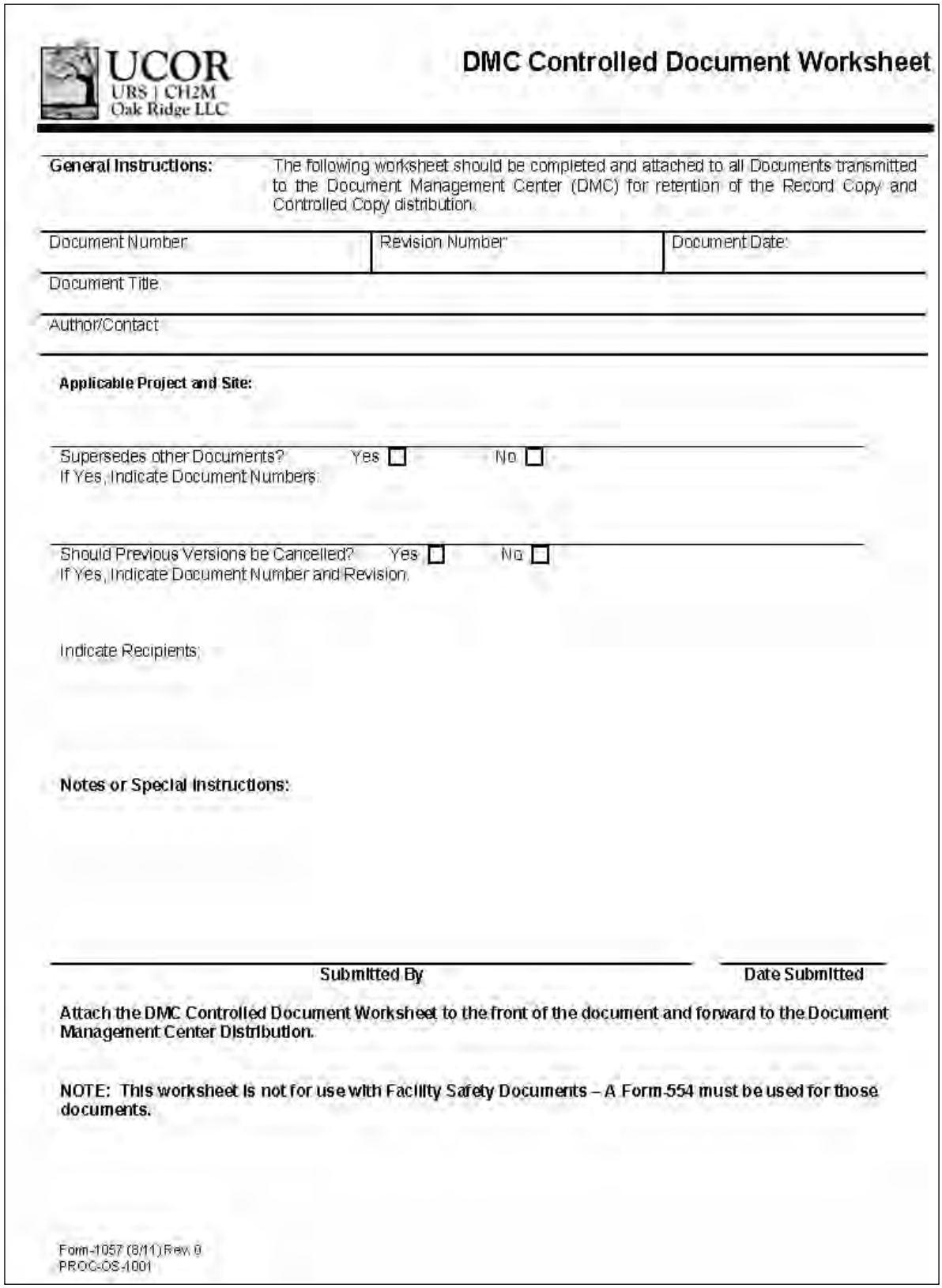
A.11.3 RECORDS STORAGE

Prior to transmittal of documents to the DMC, the Record Copy material will reside with the project team in suitable storage locations that ensure the protection of Record Copy (hard copy and electronic) records. The protection includes, but is not limited to, reasonable safeguards against fire, theft, water damage, rodents, insect infiltration, or floods.

QA Records are a subcategory of Category I Records, which are records that require a rigorous level of protection because of their content or value. Non-lifetime QA records (non-permanent records) are Category II records, which have less stringent requirements. Records storage shall provide control and protection to records.

Category I and II records are maintained with the following storage requirements:

- Records maintained in a lockable file cabinet or lockable room that contains file cabinets, open shelving, or racks (in a lockable room, records may be boxed and stored on racks or other means to prevent boxes from residing directly on the floor)
- Access control established to prevent unauthorized use, disclosure, theft, or destruction
- Posted list indicating designated personnel approved for unescorted access to records filing areas
- Index system facilitating ease of records retrieval and accounts for records removed from the storage area



UCOR
URS | CH2M
Oak Ridge LLC

DMC Controlled Document Worksheet

General Instructions: The following worksheet should be completed and attached to all Documents transmitted to the Document Management Center (DMC) for retention of the Record Copy and Controlled Copy distribution.

Document Number:	Revision Number:	Document Date:

Document Title:

Author/Contact:

Applicable Project and Site:

Supersedes other Documents? Yes ☐ No ☐
If Yes, Indicate Document Numbers:

Should Previous Versions be Cancelled? Yes ☐ No ☐
If Yes, Indicate Document Number and Revision:

Indicate Recipients:

Notes or Special Instructions:

Submitted By **Date Submitted**

Attach the DMC Controlled Document Worksheet to the front of the document and forward to the Document Management Center Distribution.

NOTE: This worksheet is not for use with Facility Safety Documents – A Form-554 must be used for those documents.

Form-1057 (8/11) Rev. 0
PROC-OS-1001

Fig. A.3. UCOR Form-1057, DMC Controlled Document Worksheet.

Category I records include one of the following additional storage requirements:

- Records vault, 1-hour fire-rated cabinet, plus smoke detection system
- Fire suppression system and reasonable safeguards against theft, water damage, rodent or insect infiltration, or floods
- Duplicate records maintained in an identified duplicate storage area in a separate location (locations shall be sufficiently remote from each other to eliminate the chance of exposure to a single hazard)
- Duplicate information on other record media stored in a separate location

If required, electronic records and databases (i.e., OREIS, Project Environmental Measurement System, and Tracker) are protected from damage and loss by full weekly and incremental nightly backups.

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A.12 REFERENCES

ASTM 2014. *Standard Practices for Preserving and Transporting Soil Samples,* ASTM D4220/ D4220M-14, ASTM International, West Conshohocken, PA.

DOE 2004. *Suspect/Counterfeit Items Guide for Use with 10 CFR 830 Subpart A, Quality Assurance Requirements, and DOE O 414.1c, Quality Assurance*, DOE Guide 414.1-3, U.S. Department of Energy, Washington, D.C., November.

DOE 2011. *Quality Assurance Criteria*, 10 *Code of Federal Regulations* 830.122, U.S. Department of Energy, Washington, D.C., January

DOE 2013. *Personnel Selection, Training, Qualification and Certification Requirements for DOE Nuclear Facilities*, DOE Order 426.2, U.S. Department of Energy, Washington, D.C., July 29.

DOE 2017. *Integrated Safety Management*, and *Integrated Safety Management System Program Description*, DOE Order 450.2, CHG 1 (MINCHG), U.S. Department of Energy, Washington, D.C., January 17.

DOT 2011. *Transportation*, 49 *Code of Federal Regulations*, Parts 100 through 177, U.S. Department of Transportation, Washington, D.C., October.

EPA 2001. *EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5),* EPA/240/B-01/003. U.S. Environmental Protection Agency, Washington, D.C., March.

UCOR 2012. *Shipping Samples from a Company Site,* PROC-TR-9503, latest revision, UCOR, Oak Ridge, TN.

UCOR 2014. *Implementing and Documenting the Data Quality Objective (DQO) Process*, PROC-ES-1004, latest revision, UCOR, Oak Ridge, TN.

UCOR 2015a. *Field Logbooks and Field Data Forms,* PROC-ES-2700, latest revision, UCOR, Oak Ridge, TN.

UCOR 2015b. *Administrative Record Program*, PROC-OS-1003, latest revision, UCOR, Oak Ridge, TN.

UCOR 2016a. *URS | CH2M Oak Ridge LLC (UCOR) Quality Assurance Program Plan, Oak Ridge, Tennessee,* UCOR-4141, latest revision, UCOR, Oak Ridge, TN.

UCOR 2016b. *Chain of Custody Protocol for Environmental Sampling*, PROC-ES-2708, latest revision, UCOR, Oak Ridge, TN.

UCOR 2017. *Records Management, Including Document Control,* PROC-OS-1001, latest revision, UCOR, Oak Ridge, TN.

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ATTACHMENT 1.
ENVIRONMENTAL MANAGEMENT DISPOSAL FACILITY
QUALITY ASSURANCE PROGRAM PLAN
ADDENDUM FORM

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Addendum Form
Environmental Management Disposal Facility
Quality Assurance Project Plan

Addendum No.: FY19-_____ **Effective Date: _____**

Type of Change (check all that apply):

☐ Change in project organization

☐ Change in procedure or process for conducting an element of work

☐ Change in personnel listed in Appendix C – Contact List

☐ Other: _____

_____

Attach copies of the pages affected by the change for insertion into the QAPP.

Change is: ☐ Permanent (i.e., >1 year) ☐ Temporary (i.e., <1 year)

Reason for Change(s):

Requester: _____ Date: _____
(Person requesting revision to QAPP)

Approved by: _____ Date: _____
(UCOR Landfills Project Manager or authorized designee)

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ATTACHMENT 2.
ENVIRONMENTAL MANAGEMENT DISPOSAL FACILITY
QUALITY ASSURANCE PROGRAM PLAN CONTACT LIST

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EMDF Phase 3 Design Characterization Key Personnel Contact List

Role	Name	Organization	Telephone	Email
OREM Landfills Project Manager	Jim Daffron	OREM	(865) 241-9504	James.Daffron@orem.doe.gov
UCOR EMDF Project Manager	Julie Pfeffer	UCOR	(865) 712-4172	julie.pfeffer@ettp.doe.gov
UCOR Characterization Lead	Annette Primrose	UCOR	(865) 576-9170	annette.primrose@ettp.doe.gov
UCOR Field Lead	TBD	UCOR	TBD	TBD
UCOR Environmental, Safety, and Health Representative	Lester Barwick	UCOR	(865) 241-1368	Lester.Barwick@ettp.doe.gov
UCOR Quality Assurance Representative	TBD	TBD	TBD	TBD
UCOR Sample Manager	TBD	TBD	TBD	TBD
UCOR Data Manager	TBD	TBD	TBD	TBD
Geotechnical Laboratory Point of Contact	TBD	TBD	TBD	TBD

EMDF = Environmental Management Disposal Facility
OREM = Oak Ridge Office of Environmental Management
TBD = to be determined

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RECORD COPY DISTRIBUTION

File—DMC—RC