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Field Sampling Plan for Baseline Groundwater and Surface Water Characterization at the Proposed Environmental Management Disposal Facility, Oak Ridge, Tennessee

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ACRONYMS

BCV	Bear Creek Valley
CBCV	Central Bear Creek Valley
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
COC	contaminant of concern
DOE	U.S. Department of Energy
DQO	data quality objective
EMDF	Environmental Management Disposal Facility
EMWMF	Environmental Management Waste Management Facility
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FSP	field sampling plan
LLW	low-level (radioactive) waste
NT	Northern Tributary
NTU	nephelometric turbidity unit
OREIS	Oak Ridge Environmental Information System
ORP	oxidation-reduction potential
ORR	Oak Ridge Reservation
PEMS	Project Environmental Measurements System
PQL	project quantitation limit
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RCRA	Resource Conservation and Recovery Act of 1976
SMO	Sample Management Office
UTL	upper tolerance limit
WRRP	Water Resources Restoration Program
Y-12	Y-12 National Security Complex

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1. INTRODUCTION

The mission of the U.S. Department of Energy (DOE) Oak Ridge Office of Environmental Management 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. 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 (EMWMF) 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/OR/01-2535&D5) evaluated several alternatives for the disposal of this waste, including no action, offsite disposal, and onsite disposal. As such, an approximately 70-acre tract in the Central Bear Creek Valley (CBCV) watershed has been proposed as the best site in terms of available capacity and location for an onsite landfill, termed the Environmental Management Disposal Facility (EMDF).

The proposed EMDF (Site 7c) is located in CBCV west of the Y-12 National Security Complex (Y-12) on the ORR (Fig. 1). The conceptual design is based on a total constructed volumetric capacity of approximately 2.2 million cy. EMDF will be equivalent to a Resource Conservation and Recovery Act of 1976 (RCRA) landfill, similar to EMWMF, and will accommodate disposal of both low-level (radioactive) waste (LLW) and mixed LLW, some of which may be classified.

This Field Sampling Plan (FSP) provides for baseline groundwater and surface water characterization for EMDF. The companion document to this FSP, *Quality Assurance Project Plan for the Water Resources Restoration Program, U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee* (UCOR-4049—QAPP), contains references to the sampling procedures.

After disposal operations begin, monitoring will be performed at EMDF to obtain the groundwater sampling and analysis data needed to ascertain if hazardous constituents derived from wastes managed and disposed at EMDF have entered the uppermost aquifer. This determination will be based on the comparison of monitoring results to baseline threshold/evaluation data. The groundwater sampling and analysis requirements described in this FSP comply with RCRA general groundwater monitoring requirements defined by the U.S. Environmental Protection Agency (EPA) under 40 *Code of Federal Regulations* (*CFR*) 264.97 (*Protection of Environment*, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," General ground-water monitoring requirements). These performance standards and associated data assessment/acceptance criteria are intended to ensure that baseline groundwater characterization is based on monitoring results that meet the applicable data quality objectives (DQOs) discussed in Chap. 2. This FSP also defines baseline characterization requirements for sampling/analysis of surface water in the northern tributaries of Bear Creek near EMDF. Surface water monitoring is included because groundwater from the uppermost aquifer primarily discharges to surface water features.

This FSP focuses on defining baseline groundwater and surface water conditions and describes the objectives, requirements, and approach to collecting baseline groundwater characterization data for EMDF. Baseline characterization will enhance the ability to evaluate groundwater compliance monitoring data collected during operations and as the facility enters post-closure care. This FSP is not the EMDF groundwater monitoring plan for evaluating compliance, which will be included with future EMDF design submittals.

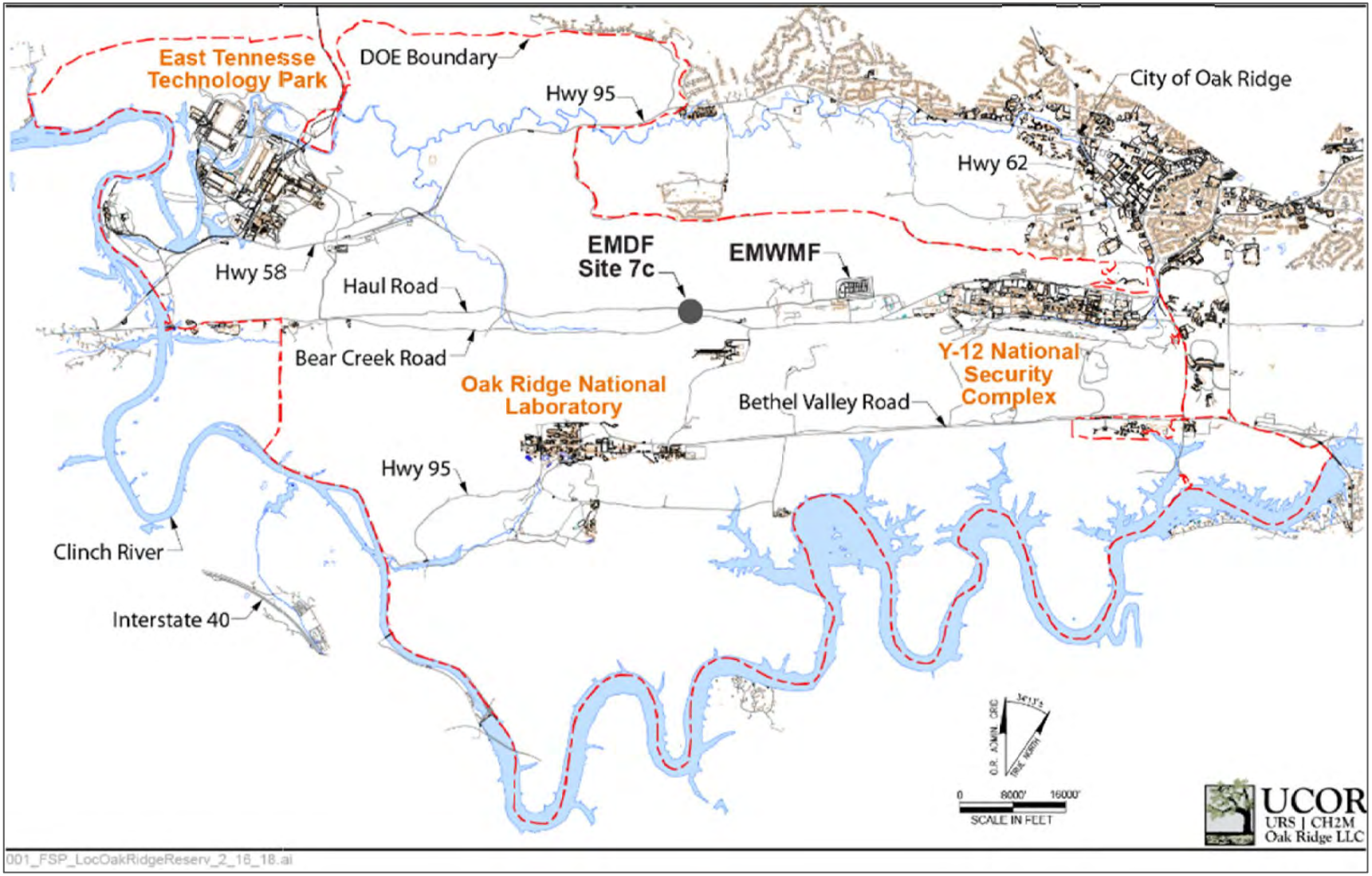

Fig. 1. Oak Ridge Reservation with proposed EMDF location.

The EMDF project will interface with the ORR Water Resources Restoration Program (WRRP), as necessary, during implementation of the QAPP as it relates to groundwater and surface water monitoring.

The site proposed for the EMDF is situated within an upland area located between north-south trending valleys of Northern Tributary (NT)-10 and NT-11. The site and surrounding areas are forested, except for areas along the south side between the Haul Road and Bear Creek Road, where the area has been cleared. Other surface water conveyances within the site are D-10W, parallel to and just west of NT-10, and D-11E, an east-west trending feature that drains westward into NT-11 near the center of the site.

The Bear Creek Valley (BCV) *Remedial Investigation/Feasibility Study for the Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal, Oak Ridge, Tennessee* (DOE/OR/01-2535&D5) included a hydrogeological conceptual model that integrated existing contaminant source areas and groundwater plumes within the overall context of the geology, and surface water and groundwater hydrology of the BCV watershed. Most relevant to the EMDF site, the conceptual model addressed the surface and subsurface flow conditions within and across the predominantly clastic formations of the Rome, Pumpkin Valley, Rutledge, Rogersville, Maryville, and Nolichucky formations that underlie most of the valley floor, and those within and across the predominantly carbonate formations of the Maynardville Limestone and lower Copper Ridge Dolomite that underlie a more narrow swath along the southern part of BCV.

The BCV conceptual model, which includes the EMDF site, makes an important distinction between surface water flow along the NTs to Bear Creek and groundwater flow within and across the outcrop belts of predominantly clastic rocks, versus surface water flow along Bear Creek and groundwater flow within the karst conduit network of the Maynardville Limestone. The groundwater flow paths through regolith materials and bedrock fractures within the predominantly clastic rocks differ from that of the karst network of the Maynardville. Across the clastic outcrop belts, overall shallow/intermediate level groundwater tends to flow south to southwest, whereas flow within the Maynardville and along Bear Creek tends to follow the geologic strike toward the southwest.

Key elements of the conceptual site model for the EMDF site are shown in Fig. 2. The footprint for EMDF predominantly overlies southeastward dipping bedrock of the Conasauga Group, including the Rutledge Formation, Rogersville Shale, Maryville Formation, and Nolichucky Shale (Fig. 2). These formations in the Conasauga Group are predominantly shales, siltstones, and mudstones, with some interbedded limestone. There is little limestone present in the bedrock underlying the proposed facility, even in the Maryville Formation. The crest of the knoll below the north center of the footprint is underlain by the erosion-resistant Maryville Formation. The typical weathering profile of topsoil, silty/clayey soil residuum, saprolite, and fractured bedrock occupy the undisturbed site areas.

In BCV, the average dip of the strata is 45° southeast. Some microfolds to mesofolds are present. Fractures are present within the bedrock and exert substantial control on the location of the tributaries. These fractures and macro/micropores within the soils/saprolite and bedrock provide the primary routes for groundwater flow (and contaminant transport) (*2016 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee,* DOE/OR/01-2707&D2).

The depth to the water table or thickness of the unsaturated zone at the EMDF site varies with the topography. Vadose zone thickness is greatest below upland recharge areas such as those along the ridges of the Maryville Limestone outcrop belt. Away from these upland areas, the vadose zone thins into groundwater discharge zones along the NT valley floors where the water table is at or near the ground surface. The majority of flow from upland areas is directed towards the valley axis by the NTs to Bear Creek. Groundwater within the saturated zone converges and discharges slowly into NT stream channels supporting base flow along the valley floors, particularly during the wet season. During drier

periods, groundwater may make little or no contributions to stream channel base flow, but may continue to slowly migrate southward toward Bear Creek along the NT valley floor areas within alluvium, saprolite, and bedrock fractures below the active stream channels.

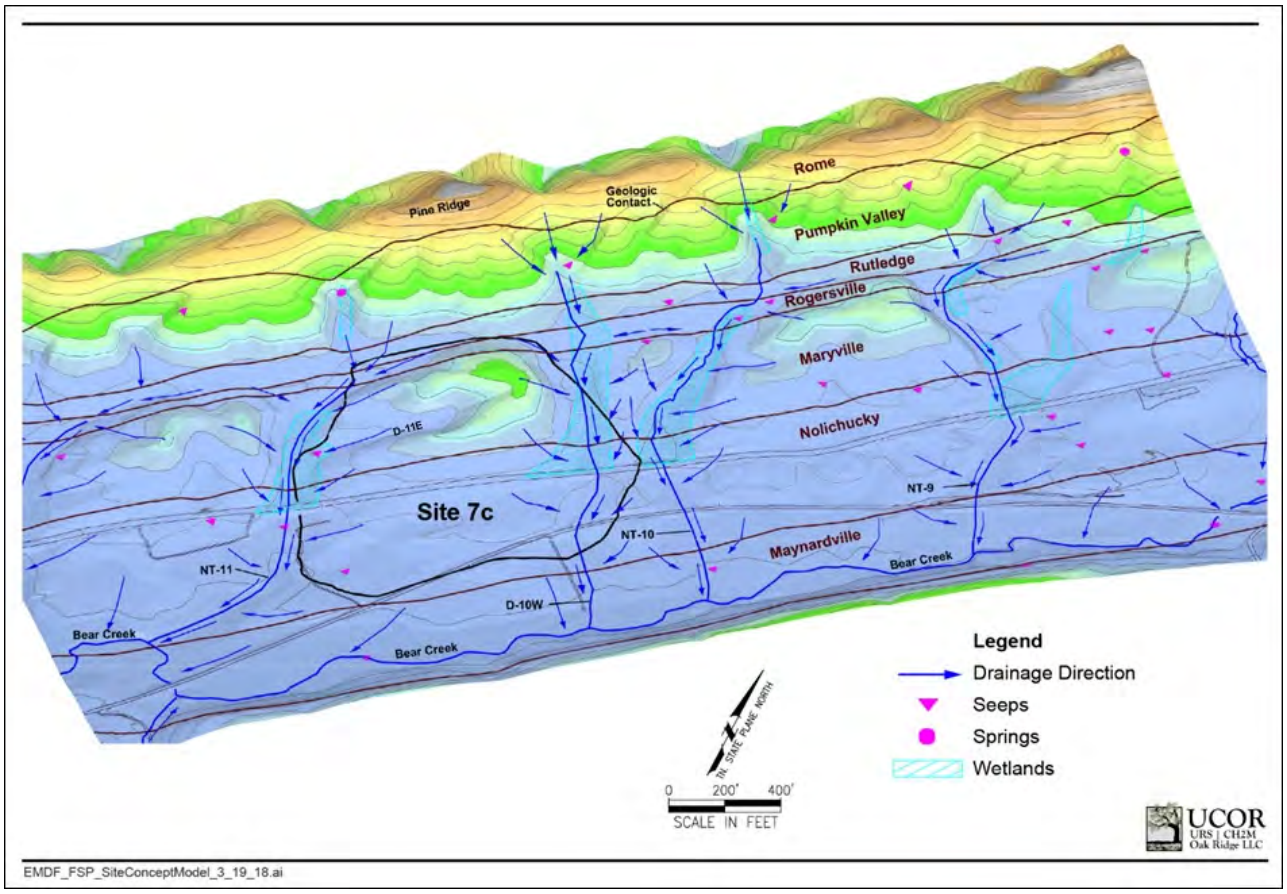

Fig. 2. Generalized flow paths for shallow/intermediate groundwater.

A smaller portion of the groundwater below the EMDF site (groundwater that does not readily discharge along strike to the NT valleys) moves southward toward Bear Creek along less dominant fracture pathways oriented perpendicular to geologic strike. Groundwater in bedrock that does not discharge directly to surface water (e.g., deep groundwater zones) can exhibit an upward gradient because of the pressure gradient from recharge along Pine Ridge and discharge into the Bear Creek–Maynardville Limestone drainage system, which is the regional discharge area for BCV. Bear Creek flows toward the west more or less continuously over non-karst bedrock, but loses flow to subsurface conduits where it crosses karst features in the Maynardville Limestone.

2. DATA QUALITY OBJECTIVES

The DQO process provides a structured approach to planning projects where data are used to support environmental decisions and evaluations. Use of the DQO process leads to efficient and effective expenditures of resources; consensus on the type, quality, and quantity of data needed to meet the project goals; and full documentation of actions taken during development of the project. DOE has applied the concepts defined in *Guidance on Systematic Planning Using the Data Quality Objectives Process* (*Guidance on Systematic Planning Using the Data Quality Objectives Process - EPA QA/G-4*, EPA/240/B-06/001) to the qualitative assessment of data needs.

These DQOs will support the collection, analysis, and evaluation of groundwater and surface water chemistry and constituents for initial development of baseline conditions for selected contaminants of concern (COCs). This is separate from a groundwater monitoring plan for compliance monitoring. Predisposal monitoring data will be used to develop a baseline for comparison with operational and post-operational monitoring results. Baseline groundwater and surface water characterization will begin during planning and development of the proposed disposal and support facilities.

2.1 DQO STEP 1: STATE THE PROBLEM

Data are needed to establish the baseline levels of naturally occurring constituents, including chemical and radionuclide constituents, in the vicinity of EMDF and evaluate whether other upgradient sources of groundwater and/or surface water contamination are present and, if so, impacting the facility footprint. Groundwater and surface water quality data will include landfill-specific constituents, selected COCs related to past operations, activities and known contaminants in upgradient groundwater, and general groundwater chemistry. Note, the EMDF is located in an area undisturbed by ORR operations and there are no known upgradient contamination sources on Pine Ridge. These data will provide the data for initial conditions to be used in supporting future compliance monitoring plans. This data need is related to developing threshold levels, or evaluation levels, for chemicals and radionuclides present in the groundwater or surface water prior to operation of EMDF.

Data needs are addressed in the following Problem Statement:

> *Groundwater and surface water data of sufficient quality and quantity are needed to establish baseline conditions and support future evaluation and assessment of potential adverse impacts to human health and the environment resulting from operation of the EMDF.*

2.2 DQO STEP 2: IDENTIFY THE GOAL OF THE STUDY

The purpose of DQO Step 2 is to define the principal study questions that need to be answered to address the problem identified in DQO Step 1. Principal study questions help focus the search for information that will address the problem. For the problem defined above, the principal study questions include the following:

- What are the baseline conditions?
- What is an appropriate monitoring network for establishing baseline?

- How do the existing, or baseline, chemical, and radionuclide concentrations in groundwater and surface water vary spatially and temporally in the vicinity of the EMDF?

The primary goal is to implement groundwater and surface water quality monitoring to generate representative data needed to provide for reliable baseline conditions for potential COCs derived from wastes disposed in EMDF that may be released to the groundwater flow system or from contaminant sources upgradient of the proposed facility. Analytical data will be used to evaluate the general groundwater and surface water chemistry and estimate the distribution of COCs in the vicinity of EMDF (upgradient and downgradient). The outcome will be an appropriate statistical measure of the distribution of COCs, along with a threshold value (e.g., upper tolerance limit [UTL]) calculated on that measure to reflect uncertainty.

2.3 DQO STEP 3: IDENTIFY INFORMATION INPUTS

Inputs for the principal study questions include the following:

1. The conceptual site model
2. Information related to adjacent (particularly upgradient) contamination sources
3. Groundwater quality data from wells located in the vicinity of EMDF (upgradient and downgradient) in the shallow water table and deep groundwater zones and existing surface water data
4. Static water level elevations (potentiometric data) from wells/piezometers located near EMDF, including wells located hydraulically upgradient and downgradient
5. Potential COCs for baseline determination.

2.4 DQO STEP 4: DEFINE THE BOUNDARIES OF THE STUDY

The following were considered in defining the areal boundaries for baseline characterization:

- Upgradient (topographic saddle on Pine Ridge on the north side of EMDF)
- Downgradient (Bear Creek, with special attention to the Nolichucky/Maynardville contact)
- Lateral (within 400 ft east of NT-10 and 400 ft west of NT-11).

The vertical boundaries are defined as the uppermost saturated unit, including the shallow zone at the saprolite/bedrock interface, and a deeper bedrock zone approximately 50 ft below that surface. For the temporal boundaries, analytical data is needed over a minimum of four quarters prior to facility operation.

2.5 DQO STEP 5: DEVELOP THE ANALYTIC APPROACH

The collected data will be used to provide distribution information on the potential COCs and arrive at an estimate of population parameters for baseline characterization. Analysis and interpretation of groundwater and surface water characterization data will be obtained to establish baseline groundwater conditions for EMDF.

The planned characterization approach will be groundwater and surface water monitoring to establish baseline conditions. Monitoring locations and analyses will be described in a baseline characterization FSP (this document) and include surface water and both the shallow water table and bedrock groundwater zones.

The baseline characterization data will provide the basis for establishing threshold/evaluation values consistent with TDEC 0400-11-01-.04 (*Solid Waste Processing and Disposal*, "Specific Requirements for Class I, II, III, and IV Disposal Facilities). Additional information on the approach will be presented at Project Team meetings and documented in the Baseline Characterization Report.

2.6 DQO STEP 6: SPECIFY PERFORMANCE OR ACCEPTANCE CRITERIA

Performance criteria, with the appropriate level of quality assurance (QA) practices, guide the design of data collection efforts, while acceptance criteria guide the design of procedures used to acquire and evaluate data relative to its intended use.

Threshold/evaluation values will be developed for use as the basis for comparison of baseline conditions to data generated from future EMDF monitoring events. The threshold/evaluation values will represent either baseline concentrations (for naturally occurring constituents) or project quantitation limits (PQLs) for non-naturally occurring constituents. DOE will monitor baseline levels for a minimum of four quarters prior to the start of operations (i.e., four quarters for 1 year). After the first year of sampling, baseline characterization sampling will continue semi-annually until the detection/operation monitoring program for EMDF is implemented. The semi-annual samples are expected to be collected during the first and third quarters of the calendar year to coincide with the typical wet and dry seasons.

Important considerations in collecting data and developing threshold/evaluation values include the following:

- Detection limits appropriate to meet PQLs
- Use of approved analytical methods
- Quality of analytical laboratories
- Approved procedures for monitoring/sample collection
- Statistical approach for developing threshold/evaluation values.

Where possible, threshold values will be calculated using UTLs for each COC in the proposed baseline monitoring wells. Surface water data will be evaluated separately from the groundwater data. Prior to developing the threshold values, distribution of analytical data for each parameter in the 14-well aggregate or surface water aggregate will be evaluated, along with the presence of any outliers. Use of UTLs for comparative criteria is consistent with RCRA guidance under 40 *CFR* 264.97(h). Final threshold/evaluation values will be proposed for regulatory approval.

Because of the similarities in the EMWMF and EMDF hydrogeological setting, the EMWMF baseline data will be used for comparison with EMDF data to determine if there is a potential outlier and if additional sampling is warranted to verify whether specific results are potential outliers. This comparison will continue to be used until sufficient data are available to use solely EMDF data.

2.7 DQO STEP 7: DEVELOP THE PLAN FOR OBTAINING DATA

This baseline characterization FSP includes the drilling and installation of 14 groundwater monitoring wells (six shallow/deep monitoring well pairs and two shallow monitoring wells) outside the perimeter landfill berms or area affected by landfill construction. The general locations of the monitoring wells and surface water locations proposed for baseline characterization are shown on Fig. 3. Final baseline monitoring well

locations will be determined in the field based on accessibility and site conditions. Monitoring well locations also may be adjusted to accommodate the design of support facilities and infrastructure. The baseline monitoring wells are not being proposed as compliance monitoring wells for EMDF during operations. If appropriate, some of these baseline monitoring locations could be used for compliance monitoring in the future.

A series of tributaries, numbered in ascending order downstream from the Bear Creek headwaters at the west end of Y-12, traverse the southern flank of Pine Ridge. Two surface water sampling stations will serve the purposes of baseline characterization at EMDF: SF-1 on NT-11 and SF-6 on NT-10. These two surface water stations are located at flumes installed in the tributaries during a previous hydrogeological characterization project.

The specific requirements applicable to the collection of groundwater and surface water sampling data for the purposes of baseline characterization at EMDF are described in this FSP and the WRRP QAPP. These documents identify required sampling protocols, technical procedures and sampling/analysis methods (including field and laboratory QA and quality control [QC] sampling requirements), data acceptance criteria, and data evaluation.

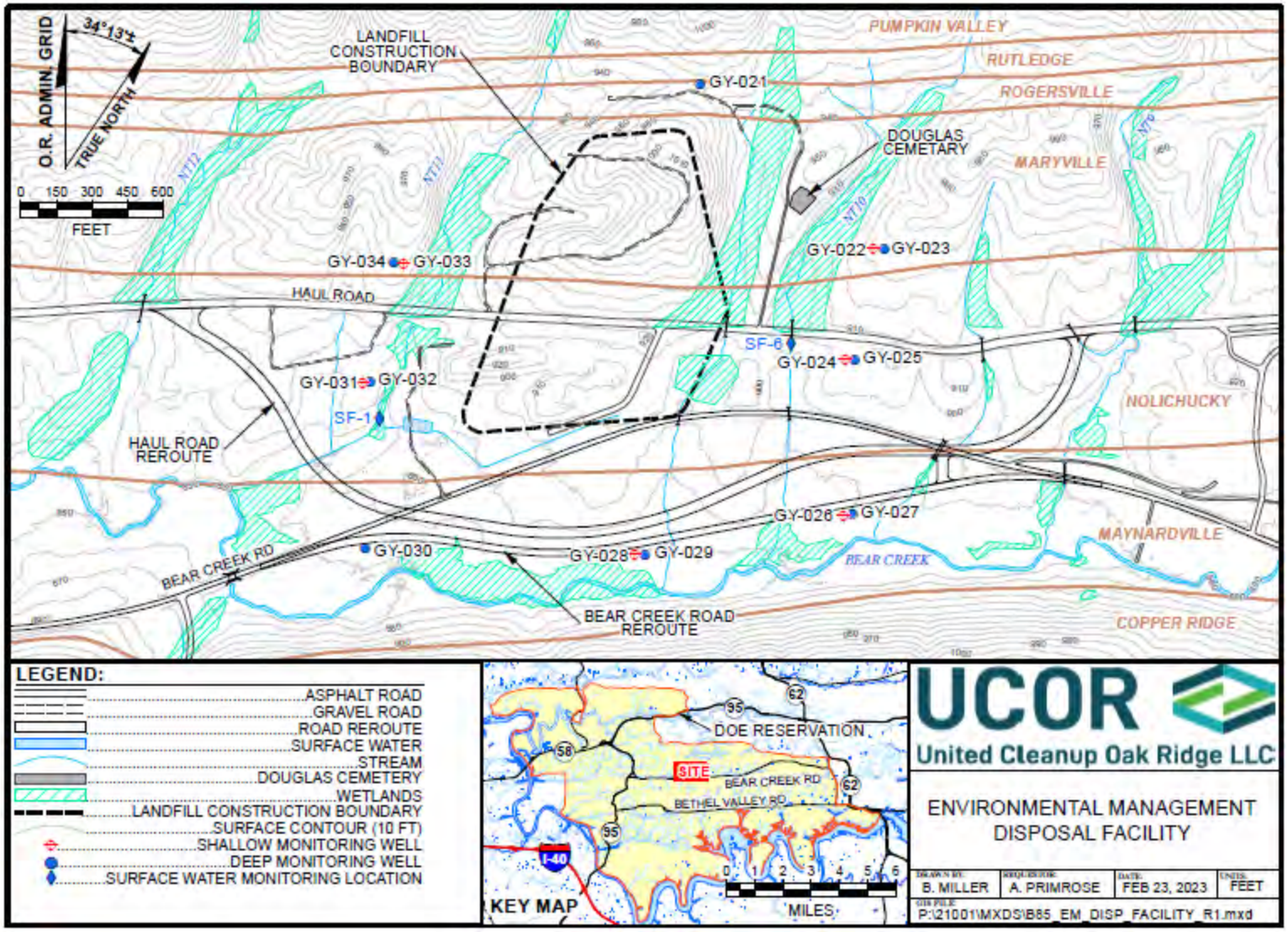

Fig. 3. Baseline monitoring locations.

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3. BASELINE MONITORING APPROACH

Sampling and analysis requirements for baseline characterization at EMDF comply with RCRA applicable or relevant and appropriate requirements (i.e., 40 *CFR* §264.97[g]). The monitoring approach is intended to provide a framework for consistent sampling and analysis designed to ensure monitoring provides an accurate representation of groundwater and surface water conditions in the vicinity of EMDF.

In accordance with the EMDF Record of Decision, baseline groundwater conditions for a detection monitoring program must be documented before disposal facility operations begin. Results from at least four consecutive quarters of water quality sampling and laboratory analysis must be reported to establish baseline water quality to be used as a basis for future monitoring. Therefore, baseline groundwater monitoring is currently planned for calendar years 2028-2029, at least one year prior to the opening of EMDF. This period is expected to change based on the schedule for opening EMDF.

Guidance from the Oak Ridge National Laboratory Natural Resources group will be used to place well pads and access roads to minimize impacts to sensitive resources. Bat-roosting trees will be identified in advance and removed prior to the summer foraging season.

3.1 MONITORING NETWORK

EMDF is located in the CBCV watershed. Hydrogeologic data from site characterization studies have been used to identify monitoring well locations and groundwater sampling depths to provide reliable information concerning the pre-existing chemical and radiological constituents in groundwater, as well as contaminants that may be entering the EMDF vicinity from upgradient sources.

A summary of monitoring well installation parameters (e.g., screen intervals) is provided in Table 1. Baseline groundwater characterization monitoring wells will be installed upgradient, downgradient, and lateral to EMDF and will monitor both shallow and deep groundwater zones. However, these monitoring wells are not being proposed as compliance monitoring wells for EMDF. The compliance monitoring network will be developed as part of the EMDF design package and included in the future EMDF Sampling and Analysis Plan/QAPP for landfill operations monitoring. Baseline monitoring locations were selected to avoid wetlands, to be located beyond the limits of disposal cell construction to avoid future disturbance, and to avoid future road rerouting activities. Final monitoring well locations will be determined in the field based on accessibility and site conditions, and locations will be surveyed by a licensed land surveyor following installation.

Placement and targeted depth of screening for baseline characterization monitoring wells was developed based on prior hydrogeological characterization of the area in which EMDF is to be constructed. These locations and screened intervals may be modified based on field conditions in consultation with the Federal Facility Agreement (FFA) parties.

Wells installed in the Maynardville Limestone south, or downgradient, of EMDF will obtain baseline data from an area noted to have "periodic plume extension" from the upgradient groundwater plumes migrating along BCV (*2018 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/01-2757&D1). The *Groundwater Strategy for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2628/V1&D2) identifies this data gap concerning quantifying the nature and extent of groundwater contaminant migration southwestward along the valley axis. Because contamination is expected to be present in the downgradient Maynardville Limestone baseline monitoring wells, these data are expected to provide baseline conditions

at these locations to differentiate between potential leakage from EMDF and what is already present in the groundwater.

The 30-ft screening interval for the deeper bedrock wells was selected to maximize the range for collecting groundwater and increase the opportunity for detecting any constituents that may be present. As observed at EMWMF, deeper wells have slower recharge and recovery. The 30-ft screen interval allows for capturing sufficient zones of interest to consistently produce a sample. Deep monitoring well screen interval depths are based on current EMDF design information and data collected during geotechnical and hydrogeological characterization projects (e.g., groundwater levels, transmissive zones).

The shallow monitoring wells will be screened at, or just below, the saprolite/bedrock interface and have 15-ft screening intervals (estimated screen interval depths provided in Table 1 may be changed in the field during installation based upon field conditions). Because of the variation in groundwater levels in areas of EMDF, a 15-ft screen interval was selected to provide the best opportunity to collect samples throughout the year. The 15-ft screen interval should be adequate for intersecting fractures within the upper portion of the bedrock and any saturated groundwater zones at the saprolite/bedrock interface.

For well pairs, there is expected to be a minimum separation between the uppermost and lowermost screened intervals to ensure these screened intervals are monitoring separate zones. However, the screened intervals and amount of separation will be based on field conditions and water-bearing zones encountered.

Monitoring wells with 2-in. stainless-steel casings and screens will be installed by Tennessee-qualified monitoring well drillers in accordance with ORR requirements as specified in *Standard Specification for Well Drilling, Installation, and Abandonment* (SPG-00000-A005).

Table 1. Estimated baseline monitoring well installation depths and screen intervals

Well ID	Geologic formation	Shallow/ deep	Estimated ground elevation	Estimated screen interval	Screen length (ft)	Location rationale	Estimated drilling depths (ft)
GY-021	Rutledge	S	955	930-915	15	Upgradient	40
GY-022	Maryville	D	935	870-840	30	Lateral (east)	95
GY-023	Maryville	S	935	905-890	15	Lateral (east)	45
GY-024	Nolichucky	D	905	855-825	30	Lateral (east)	80
GY-025	Nolichucky	S	905	885-870	15	Lateral (east)	35
GY-026	Maynardville	D	878	810-780	30	Downgradient	98
GY-027	Maynardville	S	878	855-840	15	Downgradient	38
GY-028	Maynardville	D	870	810-780	30	Downgradient	90
GY-029	Maynardville	S	870	850-835	15	Downgradient	35
GY-030	Maynardville	S	865	850-835	15	Downgradient	30
GY-031	Nolichucky	D	885	845-815	30	Lateral (west)	70
GY-032	Nolichucky	S	885	870-855	15	Lateral (west)	30
GY-033	Maryville	D	930	860-830	30	Lateral (west)	100
GY-034	Maryville	S	930	905-890	15	Lateral (west)	40

D = deep
ID = identification
S = shallow

Surface water sampling will occur at three locations; flumes SF-1 located on NT-11 and SF-6 located on NT-10 installed during a previous EMDF hydrogeological characterization project, and the existing Bear Creek monitoring station at the NT-11 confluence with Bear Creek.

3.2 SAMPLE FREQUENCY TO ESTABLISH BASELINE

Baseline characterization will begin at least one year prior to operation of EMDF to provide a minimum of four quarters of sampling results (i.e., four quarters for 1 year). After the first year of sampling, baseline characterization sampling will continue as part of the detection/operation monitoring program for EMDF, unless specific wells are removed from the network by agreement with the FFA parties. During each sampling event for establishment of the baseline, groundwater and surface water samples from all applicable locations will be collected over a short period of time. Groundwater and surface water samples will be obtained during the same sampling event, unless insufficient surface water flow is available due to dry weather. In such instances, the field personnel will log the date and time of the sampling attempt and the observation that the station is dry.

3.3 CONTAMINANTS OF CONCERN

The parameters, or constituents, for analysis are provided for baseline determination of the groundwater and surface water characteristics in the EMDF area. Potential COCs for baseline characterization were identified for EMDF based upon potential abundance in the projected waste (using process knowledge from EMWMF and potential future source inventory for EMDF), mobility, and/or potential risk, and based on contaminants known to be present in identified groundwater plumes in BCV (primarily volatile organic compounds, nitrate, and radionuclides). The COCs for determining the baseline conditions were based on the COCs expected in water as described in the *Record of Decision for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal at the Environmental Management Disposal Facility, Oak Ridge, Tennessee* (DOE/OR/01-2794&D2/R2), Tables 2.8 and 2.9) and as described in the *Focused Feasibility Study for Water Management for the Disposal of CERCLA Waste on the Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2664&D4/R1) (see Sect. 4.4). After the first year of characterization, the COC list will be evaluated to determine the COC list for continued monitoring until the detection/operation monitoring program for EMDF is implemented.

4. SAMPLE PLANNING, COLLECTION, AND ANALYSES

Qualified personnel with all required specialized training will perform all field activities in accordance with the most recent version of procedures specified in the QAPP or EPA-approved technically equivalent procedures.

4.1 GROUNDWATER

4.1.1 Groundwater Level Measurement

Depth-to-water in monitoring wells will be measured to the nearest 0.01 ft using an electronic water level indicator at the beginning of each sampling event (prior to purging) in accordance with procedure PROC-ES-2100, *Groundwater Level Measurement*. All depth-to-water measurements collected for a sampling event will be recorded in a field logbook or on an appropriate field data form.

4.1.2 Well Purging and Sampling

Baseline groundwater characterization activities will be conducted under the ORR WRRP QAPP. Well purging and sampling will follow approved procedure PROC-ES-2101, *Groundwater Sampling Wells or Piezometers*.

The pump intake will be positioned near the approximate midpoint of the screened interval. Purging will be completed using dedicated bladder pumps installed in each monitoring well. Depending on the recharge capacity of the monitoring wells, either low-flow, minimal drawdown sampling (micropurging), or conventional three-casing volume purging and sampling methods will be used as specified in the sampling procedure. The initial purging attempts will be performed using the micropurge method, the preferred method, to determine if the well can be purged without inducing excessive drawdown. If maintaining drawdown to within specifications is difficult, the conventional three-casing volume method will be used instead. The selected purge method for each monitoring well will be used for subsequent monitoring events.

For the micropurging sampling method, monitoring wells are purged at a low rate (typically 300 mL/min or less) to ensure minimal drawdown of the water level in the well (< 0.1 ft per quarter hour). Groundwater samples are collected upon stabilization of water levels and selected indicator parameters over four consecutive readings at 5-minute intervals (pH +/- 0.1 unit, specific conductance +/- 10 percent, constant temperature over three consecutive readings, and turbidity less than 10 nephelometric turbidity units [NTUs]).

Under the conventional three-volume purge method, the well is purged until a minimum of three times the volume of water within the inner casing is removed and the selected indicator parameters have stabilized or the well goes dry. For the three-volume purging methods, indicator parameter stabilization is defined as pH +/- 0.1 unit, specific conductance +/- 10 percent, constant temperature over three consecutive readings, and turbidity less than 10 NTUs.

4.2 SURFACE WATER

Surface water samples will be obtained in accordance with the container submergence (grab sampling) method described in PROC-ES-2203, *Surface Water Sampling – Manual and Automated*. Surface water samples will be collected during the same sampling event as the groundwater samples. If surface water flow

is insufficient due to dry weather, the field personnel will log the date and time of the sampling attempt and the observation that the station is dry.

4.3 SAMPLE DOCUMENTATION, PACKING, AND SHIPMENT

The selection criteria for the appropriate sample containers, sample preservatives, and holding times shall be in accordance with the WRRP QAPP and EPA guidance. Sample containers, preservatives, and holding times are specified in the WRRP QAPP (Table D.49). The sample volume to be collected is dependent on the methodology to be used and the specific minimum detection levels. The laboratory typically provides this information prior to a project laboratory readiness review. Types of sample containers and sample preservation methods used will be documented in the field logbook and/or on the chain-of-custody form. The chain-of-custody forms will indicate the sample holding time prior to analyses.

The chain-of-custody control is critical for documenting the integrity of the samples following collection, during transport to the laboratory, and at the laboratory. Consequently, the label for each sample container shall be completed to document the sample collection activities. After labeling the sample containers, the sample numbers should be documented on the chain-of-custody form prior to mobilization to the next sample point. In addition, the chain-of-custody form will be signed by the sampling personnel and the receiving agent with the date and time of transfer noted. The completed chain-of-custody form will be maintained with the samples.

Groundwater and surface water samples will be properly packaged and shipped in accordance with procedure PROC-ES-2706, *Shipping Samples, Dangerous Goods and Non-Bulk Hazardous Materials*, which provides general technical requirements and guidelines for the proper packing and shipping of environmental samples. This procedure has been developed to reduce the risk of damage to the environmental samples, comply with regulatory requirements, verify and maintain chain-of-custody, and maintain sample temperature upon sample receipt and throughout shipment to the appropriate laboratory. Field sampling personnel will transport the samples in ice-filled coolers, as applicable, and retain full responsibility for transportation of the samples until they relinquish chain-of-custody control to the designated shipping or laboratory personnel.

4.4 FIELD MEASUREMENTS AND LABORATORY ANALYSES

Field measurements will be collected during each baseline sampling event. Sampling personnel will record field measurements of groundwater temperature, conductivity, dissolved oxygen, pH, oxidation-reduction potential (ORP), and turbidity when each well is sampled. During surface water sampling, field personnel will record field measurements of water temperature, conductivity, dissolved oxygen, pH, ORP, and turbidity when each station is sampled. These field measurements, including instrument calibration, will be performed in accordance with the most recent versions of the governing groundwater and surface water sampling procedures specified in the QAPP (or EPA-approved technically equivalent procedures) and in accordance with the manufacturer's instrument calibration procedures.

Laboratory analyses will be performed by laboratories designated by the Sample Management Office (SMO). The COCs, specified analytical methods, and quantitation limits required for this baseline characterization FSP are listed in Table 2. Only qualified commercial laboratories approved by the SMO will be subcontracted to provide analytical services. Laboratory analyses of the samples will be performed in accordance with the most current version of the analytical methods/procedures specified in the analytical parameter tables provided in Table 2 (or EPA-approved technically equivalent methods). Analytical results also will be reported in accordance with the units and PQLs specified in Table 2.

Applicable laboratory analytical results for groundwater and surface water samples will be reported with associated data qualifiers (and specified reason codes), as warranted, including "B" for analytes detected in the laboratory blanks, "J" for estimated values, and "U" for non-detect results.

Table 2. Baseline characterization COCs and analytical requirements

Analyte	CAS number	Method[a]	PQL	Units
Metals				
Arsenic	7440-38-2	SW846-6010B or SW846-6020	5	µg/L
Cadmium[b]	7440-43-9		1	µg/L
Chromium	7440-47-3		5	µg/L
Copper	7440-50-8		5	µg/L
Lead	7439-92-1		3	µg/L
Nickel[b]	7440-02-0		10	µg/L
Uranium[b]	7440-61-1		15	µg/L
Chromium (VI)	18540-29-9	ASTM-D5257	6	µg/L
Mercury	7439-97-6	EPA-1631	0.001	µg/L
Radionuclides				
Americium-241	145-10-2	Rad-Am Iso by Alpha	0.5	pCi/L
Carbon-14	147-75-5	Rad-Carbon-14 Lsc	25	pCi/L
Cesium-137	10045-97-3	EPA-901.1	10	pCi/L
Clorine-36	13981-43-6	Rad-Cl-36 by beta LSC	25	pCi/L
Cobalt-60	10198-40-0	EPA-901.1	5	pCi/L
Europium-154	15585-10-1	EPA-901.1	5	pCi/L
Iodine-129	15046-84-1	Rad-I-129 by Leps	5	pCi/L
Neptunium-237	13994-20-2	Rad-Np Iso by Alpha	0.5	pCi/L
Plutonium-238	13981-16-3	Rad-Pu Iso by Alpha	0.5	pCi/L
Plutonium-239/240	E52450475	Rad-Pu Iso by Alpha	0.5	pCi/L
Radium-226	13982-63-3	Rad-Ra-226 Iso by Alpha	0.5	pCi/L
Radium-228	13994-20-2	Rad-Ra-228 Iso by Beta[a]	0.5	pCi/L
Strontium-90	10098-97-2	Rad-Sr-90 by Beta[a]	1	pCi/L
Technetium-99	14133-76-7	Rad-Tc-99 by LSC	4	pCi/L
Thorium-228	14274-82-9	Rad-Th Iso by alpha	0.5	pCi/L
Thorium-230	14269-63-7		0.5	pCi/L
Thorium-232	N2608	Rad-Th Iso by alpha	0.5	pCi/L
Tritium	10028-17-8	SM 7500-3H B	300	pCi/L
Uranium-233/234	NS632	SM 7500-U B	0.5	pCi/L
Uranium-235/236	15117-76-1		0.5	pCi/L
Uranium-238	24678-82-8		0.5	pCi/L

Table 2. Baseline characterization COCs and analytical requirements (cont.)

Analyte	CAS number	Method[a]	PQL	Units
Pesticides				
4,4'-DDD	72-54-8	SW846-8082	0.04	µg/L
4,4'-DDE	72-55-9		0.04	µg/L
4,4'-DDT	50-29-3		0.04	µg/L
Aldrin	309-00-2		0.02	µg/L
beta-BHC[b]	319-85-7		0.02	µg/L
Dieldrin	60-57-1		0.04	µg/L
Other				
Cyanide	57-12-5	EPA-335.4 or SW846 9012 B	5	µg/L
Total dissolved solids[b]	N793	EPA-160.1, SM 2540C	1,000	µg/L
Suspended Solids[b]	N873	EPA 160.2, SM 2540D	2,500	µg/L
Total Organic Carbon[b]	N997	EPA 415.1, SW846 9060A, SM 5310D	1,000	µg/L

[a]An equivalent method may be used to achieve the requested quantitation limit.
[b]COC included in the FFS

ASTM = American Society for Testing and Materials
BHC = benzenehexachloride
CAS = Chemical Abstracts Service
DDD = dichlorodiphenyldichloroethane
DDE = dichlorodiphenyldichloroethylene
DDT = dichlorodiphenyltrichloroethane
EPA = U.S. Environmental Protection Agency
NA = not applicable
PQL = project quantitation limit
SW846 = EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods

5. QUALITY ASSURANCE/QUALITY CONTROL MONITORING

Laboratory blanks (method blanks), trip blanks, and duplicate samples will be prepared/collected and analyzed for QA/QC purposes. Trip blank samples will be prepared for each cooler used to transport samples that were collected to be analyzed for organic compounds. In addition, laboratory QA/QC samples, including laboratory blanks, matrix spike samples, and matrix spike duplicate samples, will be prepared and analyzed by the applicable laboratory. All field and laboratory QA/QC sampling will be performed in accordance with applicable requirements specified or referenced in the WRRP QAPP.

For the purposes of baseline characterization, duplicate samples are required and will be collected from one of every 10 sampling locations during each sampling event. Laboratory analyses of the duplicate samples will be performed for the same analytes as specified in Table 2.

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6. DATA MANAGEMENT AND ASSESSMENT

The groundwater and surface water monitoring data obtained for EMDF will be managed consistent with the *Data Management Implementation Plan for the Water Resources Restoration Program, Oak Ridge, Tennessee* (*Data Management Implementation Plan for the Water Resources Restoration Program, Oak Ridge Reservation, Oak Ridge, Tennessee,* UCOR-4160) and maintained in both the Project Environmental Measurements System (PEMS) and Oak Ridge Environmental Information System (OREIS) databases or equivalents. Personnel with the SMO will pre-populate the database with information (e.g., tasks and locations) specified in this FSP. As the sampling events progress, the associated field measurements and chain-of-custody information will be manually entered into the pre-populated database. All manually entered data will be verified for accuracy in accordance with the QAPP and sampling procedures. In addition, contract compliance verification is performed on all laboratory data in accordance to the QAPP.

Groundwater and surface water monitoring data obtained for the purposes of baseline characterization at EMDF will be assessed, as outlined below, based on the following process for data verification, data validation, data quality assessment, data finalization, and data reporting.

Data Verification. When the required laboratory analyses are completed, qualified personnel with the applicable laboratory will upload the analytical results into the PEMS database (or equivalent) and will submit a corresponding record copy to personnel with the SMO, who will verify 100 percent of the electronic data. Verification of the data is performed to (1) resolve any discrepancies between the results loaded into the PEMS database and the corresponding hard-copy laboratory reports, (2) verify that the laboratory analytes specified for each sampling location were performed, and (3) identify any gaps in the associated chain-of-custody information or any violations of required sample holding times and/or analytical turnaround times.

Data Validation. At least 10 percent of the laboratory analytical results will undergo data validation in accordance with SMO Analytical Support Level 3 guidelines and procedures. Samples selected for validation will be on a random basis, unless there are analytical results that are suspect and that need to be investigated further (those will be performed as requested). The level of validation is dependent on the detection or potential outlier. Level 3 validation is the base validation level, greater than Level 3 validation is reserved for suspected outliers.

Based on the findings of the Level 3 data validation and the professional judgment of the data validation personnel, analytical results for the applicable groundwater or surface water monitoring stations that are considered unusable will be flagged with an "R" (unusable) data qualifier (in addition to any laboratory data qualifiers). Reason codes for validation data qualifiers are documented in the PEMS database.

Data Quality Assessment. All laboratory analytical data reported for groundwater and surface water samples will undergo a computer-based electronic data assessment of data quality and usability. This data assessment, which has proven to be a highly effective supplement to the rigorous QA/QC measures required of the laboratories that perform the analyses, includes comparison of the (1) corresponding analytical results for duplicate samples, (2) organic results to associated blank sample results, (3) each radioanalyte result to the corresponding minimum detectable activity and associated total propagated uncertainty, and (4) each result with available historical monitoring data for each applicable location. Based on the outcome of the data quality assessment, analytical results deemed unusable (e.g., duplicate results that differ by an order of magnitude) will be flagged with an "R" data assessment qualifier. Data assessment qualifiers and applicable reason codes will be applied to all analytical results. These qualifiers and reason codes currently are documented in the PEMS database.

Data Finalization. After the applicable qualifiers from data validation and assessment have been applied to the results for each monitoring event, all of the environmental monitoring data will be transferred from PEMS to OREIS. The OREIS database is the final repository for all environmental data collected on the DOE ORR. To submit the data, OREIS ready-to-load files will be prepared, which include a transmittal form that documents the program (EMDF), sampling dates, and other pertinent information (project manager, etc.). Before uploading in OREIS, the data will be cleared for public release.

Data Reporting. Results of baseline characterization will be compiled in a report that will provide a summary of the characterization project; a data summary, including tables, charts, and graphs with appropriate sample identification or station location numbers, results, and units; and the data quality flags, conclusions, and recommendations.

Statistical data evaluation will be performed to provide summary statistics, distribution characteristics, and preliminary threshold/evaluation values. The threshold/evaluation values will be developed as comparative criteria for future monitoring at EMDF. Some of the processes used to develop baseline summary statistics and threshold values are discussed below.

Descriptive statistics (e.g., mean, maximum, minimum, standard deviation) will be developed for the analytes. The well data groups, or aggregates, proposed for evaluating and summarizing the data are as follows:

- All 14 wells combined
- All 14 individual wells
- Shallow wells
- Deep wells
- Upgradient wells
- Lateral/downgradient wells
- Both surface water locations combined
- Both surface water locations individually.

Table 3 shows how the 14 wells are categorized by location (relative to hydraulic gradient) and depth.

Table 3. Baseline characterization wells by gradient and depth

	Depth	
Gradient	**Deep**	**Shallow**
Upgradient		GY-021
Lateral/downgradient	GY-022	GY-023
	GY-024	GY-025
	GY-026	GY-027
	GY-028	GY-029
	GY-031	GY-030
	GY-033	GY-032
		GY-034

Threshold/evaluation values will be developed for use as the basis for comparison of baseline conditions to data generated from future monitoring events. Prior to developing threshold/evaluation values, the data

distributions of each parameter will be evaluated and the presence of outliers will be assessed. The data distribution tests allow selection of the appropriate type of statistical method to be selected for those constituents for which UTLs may be calculated.

Where possible, the threshold values will be calculated using UTLs for each parameter in the 14-well data aggregate. Use of UTLs for comparative criteria is consistent with RCRA detection monitoring program regulatory guidance under 40 *CFR* 264.97(h) and EPA guidance (*Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities-Unified Guidance,* EPA 530/R-09-007). Where the detection frequencies are too low to establish UTLs, the PQLs may be used to establish proxy threshold/evaluation values.

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7. REFERENCES

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Comment Resolution Form

Document Number: DOE/OR/01-2812&D1	**Document Title:** *Field Sampling Plan for Baseline Groundwater and Surface Water Characterization at the Proposed Environmental Management Disposal Facility, Oak Ridge, Tennessee*	
Name of Reviewer: Randy Young	**Organization:** TDEC	**Date Comments Transmitted:** 10-21-2022

Comment No.	Sect/ Page	Comment	Response
1	Sect. 2.6 pg 7 2nd para and 1st bullet	In compliance with TDEC 0400-40-03-.05(8), revise the text to state threshold/evaluation values for non-naturally-occurring COCs will be based on "sufficiently sensitive" analytical methods with quantitation limits low enough to detect and measure constituents at, or below, applicable water quality criteria limits. Revise Table 3 and corresponding text on pages 17 and 25 accordingly.	Clarification provided. As noted in TDEC 0400-40-03-.05(8), "There are cases in which the in-stream criteria as established by this rule are less than current chemical technological capabilities for analytical detection. In instances where permit limits established through implementation of these criteria are below analytical capabilities, compliance with those limits will be determined using the following reporting limits, unless in specific cases other reporting limits are demonstrated to be the best achievable because of the particular nature of the wastewater being analyzed." In these cases, the applicable reporting limit is used. Table 3 (now Table 2) was revised to ensure the reporting limits that have changed since the original issue of this document are incorporated.
2	Sect. 2.6 pg 7 last para	Revise the text to explain how results are determined to be outliers. If the procedure is documented in another plan, cite that document.	Agree. The text was revised to include the following: "Because of the similarities in the EMWMF and EMDF hydrogeological setting, the EMWMF baseline data will be used for comparison with EMDF data to determine if there is a potential outlier and if additional sampling is warranted to verify whether specific results are potential outliers. This comparison will continue to be used until sufficient data are available to use solely EMDF data. "
3	Sect. 2.7 pg 7 last para	For clarity, change ... *downstream from the creek headwaters... to ...downstream from the Bear Creek headwaters....*	Agree. Text revised as suggested.
4	Fig. 3 pg 8	a. As acknowledged on page 4 and consistent with various DOE publications, a component of EMDF groundwater flow likely moves toward the west (grid direction) or southwest (true direction) along the geologic strike of the fractured bedrock and saprolite. TDEC expects the future detection monitoring well network will include at least three	a. Clarification provided. Consideration of detection monitoring wells will be deferred until the detection monitoring network is established to avoid interference with landfill construction activities.

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		shallow/deep well pairs along the western/southwestern landfill boundary. Therefore, TDEC recommends another shallow/deep well pair in the baseline monitoring network near the northwestern/western corner of the landfill footprint-Le., uphill from the planned location of GY-033/034. b. Are any of the existing site characterization piezometers-not shown on the map suitable for baseline groundwater sampling? Piezometer construction information presented in TM-2 suggests they may fit for sample collection.[1] Some existing piezometers appear to be outside the planned landfill footprint. If those piezometers are not used for baseline groundwater sampling, DOE should consider continuing groundwater level recording at those locations to support baseline monitoring and the groundwater field demonstration. c. Add a north arrow, and indicate whether it represents true north or grid north. d. Define the polygons in the legend. 1 *Technical Memorandum #2, Environmental Management Disposal Facility Phase 1 Monitoring, Oak Ridge, Tennessee (DOE/OR/01-2785&D1) and Responses to Comments on Technical Memorandum #1, Environmental Management Disposal Facility Phase 1 Monitoring, Oak Ridge, Tennessee* (DOE/OR/01-2785).	b. Clarification provided. The site characterization piezometers will not be used for baseline monitoring because these do not meet the requirements for an ORR monitoring well. Piezometers continue to be used for groundwater level recording, but will be plugged and abandoned when landfill construction activities begin. c. Agree. d. Agree. The proposed sediment basins were removed and the figure was updated to match the current design configuration.
5	Sect. 3.1 pg 11	a. TDEC understands it may not be practical to retain all baseline wells for subsequent use in the detection monitoring network. However, TDEC recommends the baseline wells be installed following the same procedures that will be used for drilling, borehole characterization, and construction of the detection monitoring wells. This will maximize consistency between the baseline and detection monitoring data sets, as well as the potential for using baseline wells in the detection monitoring network. b. Given the fractured nature of the bedrock and saprolite at the EMDF site, screen intervals for baseline monitoring and detection monitoring should be determined by the FFA parties based on borehole characterization results. This approach was successful during previous site	a. Agree. The baseline wells are planned to be constructed consistent with the requirements for detection monitoring wells. b. Agree. The preliminary screened intervals were provided and will be adjusted as necessary based on field conditions and with agreement from the FFA parties. The following text was added: "These locations and screened intervals may be modified

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		characterization efforts, as documented in TM-2.	based on field conditions in consultation with the Federal Facility Agreement (FFA) parties."
		c. Revise the text to provide additional explanation of the rationale for 15-foot (ft) screened intervals in the shallower wells. It is unclear whether the intent is to increase the number of fractures encountered and associated groundwater yield or to maximize the volume of water available in the well for sampling. Ideally, adequate borehole characterization will identify the appropriate zones for low-flow monitoring, minimizing the need for longer well screens. It will also minimize the volume of water to be purged for wells requiring the removal of three casing volumes.	c. Agree. The following text was added: "Because of the variation in groundwater levels in areas of EMDF, a 15 ft screen interval was selected to provide the best opportunity to collect samples throughout the year."
		d. Similarly, revise the text to provide additional explanation of the rationale for 30-ft screened intervals in the deeper wells.	d. Agree. The following text was added: "As observed at EMWMF, deeper wells have slower recharge and recovery. The 30-ft screen interval allows for capturing sufficient zones of interest to consistently produce a sample."
		e. What is the rationale for using stainless steel casings and screens? Available guidance and literature indicate polyvinyl chloride (PVC) materials are generally better suited for groundwater monitoring, particularly for radionuclides and metals, unless volatile organic compounds are expected to be present at very high concentrations.	e. Clarification provided. The EMDF monitoring wells will be constructed with stainless steel casings and screens consistent with the monitoring wells throughout the ORR.
		f. TDEC recommends initiation of baseline sampling before significant land disturbance. Revise the plan to clarify whether the project schedule aligns with this recommendation.	f. Clarification provided. Per the ROD (Sect. 2.12.2.7), baseline groundwater conditions must be documented before disposal facility operations begin, with results from at least four consecutive quarters of water quality sampling and analysis to establish baseline water quality that will be used as the basis for future monitoring. Text in Sect. 3 has been revised as follows: "In accordance with the EMDF Record of Decision, baseline groundwater conditions for a detection monitoring program must be documented before disposal facility operations begin. Results from at least four consecutive quarters of water quality sampling and laboratory analysis must be

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			reported to establish baseline water quality to be used as a basis for future monitoring. Therefore, baseline groundwater monitoring is currently planned for calendar year 2028–2029, at least one year prior to the opening of the EMDF. This period is expected to change based on the schedule for opening the EMDF." g. Agree. The following text was added to Section 3. "Guidance from the ORNL Natural Resources group will be used to place well pads and access roads to minimize impacts to sensitive resources. Bat roosting trees will be identified in advance and removed prior to the summer foraging season."
		g. The plan should also indicate whether any clearing will be necessary to install the baseline well network and, if so, how tree removal will be scheduled to follow this key recommendation from TDEC's *Acoustic Survey of Bats at the Proposed EMDF Site 7a/7c, Bear Creek Valley, Oak Ridge Reservation* (Feb. 2017). Seasonal timber removal should be coordinated with the USFWS during the consultation process. The USFWS has published a framework suggesting timber removal at a project site should only occur during the fall/winter season (bat hibernation period). In other words, trees should not be harvested during spring/summer season when bats are using trees (and forests) for foraging, roosting, and while females are raising their young (USFWS 2016a, 2016b, 2016c).	
6	pg 13 1st sentence	The *Focused Feasibility Study for Water Management for the Disposal of CERCLA Waste on the Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2664&D4/R1) [FFS] states landfill wastewater discharge limits will be calculated when the discharge location and Bear Creek flow rates are determined. Regardless of the point of discharge, it will be necessary to monitor Bear Creek surface water during landfill operations. Therefore, TDEC recommends baseline surface water sampling in Bear Creek at the existing station at the NT-11 confluence and a new station at the NT-10 confluence. TDEC supports the plan to sample surface water in NT-10 and NT-11 to support detection and/or operational monitoring and in case landfill wastewater is eventually discharged to one or both streams.	Agree in part. Baseline data will be collected from Bear Creek at the NT-11 confluence, which is expected to be upstream of the to-be-determined discharge location. Note: The EMDF does not plan to discharge to NT-10 or NT-11, therefore, baseline sampling is not required. Section 3.1 last paragraph was revised as follows: "Surface water sampling will occur at three locations: flumes SF-1 located on NT-11, and SF 6 located on NT-10, installed during a previous EMDF hydrogeological characterization project, and the existing Bear Creek monitoring station at the NT-11 confluence with Bear Creek."

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7	Sect. 3.2 pg 13 2nd sentence	TDEC recommends deleting the sentence. Baseline monitoring should establish a statistically defensible data set, which requires more than four data points for each COC. If four results fail to adequately represent a COCs baseline variability, there is a risk that detection monitoring results may trigger undue concern. This is particularly true if a COC is not detected during the first four quarterly sampling events and the baseline value is established at the project quantitation limit. Collection of more than four results will support evaluation of how frequently to sample a COC during detection monitoring. For example, multiple (more than four) non-detect results may support sampling a COC less often once detection monitoring begins.	Disagree. Per the ROD (Sect. 2.12.2.7), baseline groundwater conditions must be documented before disposal facility operations begin, with results from at least four consecutive quarters of water quality sampling and analysis to establish baseline water quality that will be used as the basis for future monitoring. However, the text was modified to show that these wells are intended to continue to be monitored as follows, "After the first year of sampling, baseline characterization sampling will continue as part of the detection/operation monitoring program for EMDF, unless specific wells are removed from the network by agreement with the FFA parties."
8	Table 2 pg 14	Baseline monitoring should include all analyses planned for detection monitoring. Therefore, Table 2 should include analyses documented in Table K.1.16 and Appendix C, Attachment 4 of the *Focused Feasibility Study for Water Management for the Disposal of CERCLA Waste on the Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2664&D4/R1) [FFS]. It appears the following surface water analyses should be added to Table 2. • Ammonia Nitrogen, Total as N • Hardness as CaCO3, mg/I • Nitrogen, total (as N) • Phosphorus, total as P • Total Suspended Solids • Whole effluent toxicity - chronic/acute	Disagree. Construction of the EMDF will be in progress during the baseline sampling, including soil disturbances, reseeding and hydro-mulching. Even with erosion and sediment controls, it is likely that monitoring during construction activities will not be representative of baseline surface water conditions. Therefore, with the exception of total suspended solids, these constituents were not added to Table 2 for baseline samples.
9	pg 15	For clarity, reword *Qualified and trained personnel with all specialized training requirements will perform...* as follows: *Qualified personnel with all required specialized training will perform...* or *Qualified and trained personnel meeting all specialized training requirements will perform....*	Agree. Text revised as suggested.
10	Sect. 4.1.2 pg 15 3rd and 4th para	Consider switching the order of these paragraphs because low-flow sampling is mentioned first and is the preferred sampling method.	Agree. Text revised as suggested.
11	Sect. 4.2 pg 15	Baseline sampling should begin as soon as possible, given the need for a statistically meaningful baseline data set before landfill operations begin and the likelihood that dry streams will prevent data collection during some sampling events.	See response to Comment 7.

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12	Table 4 pg 24	Check the well dentification numbers in each column (deep and shallow) and correct if needed. They match Figure 3, but the last two deep well numbers are odd, whereas the first four are even.	Clarification provided. The table is correct.
11	Sect. 4.4 pg 16 2nd para 1st sentence	Editorial suggestion Change *The list...are found...* to *The list... is found ....*	Agree. Note that text revisions deleted this sentence.

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Comment Resolution Form

Document Number: DOE/OR/01-2812&D1	**Document Title:** *Field Sampling Plan for Baseline Groundwater and Surface Water Characterization at the Proposed Environmental Management Disposal Facility, Oak Ridge, Tennessee*	
Name of Reviewer: Carl Froede	**Organization:** EPA	**Date Comments Transmitted:** 12-1-2022

Comment No.	Sect/ Page	Comment	Response
		GENERAL COMMENTS	
1		The eleven radionuclides proposed for baseline monitoring in surface water and groundwater (C-14, Cs-137, H-3, 1-129, Sr-90, Tc-99, Th-228, Th-230, U-233/234, U-235, and U-238) are all either naturally occurring and/or fission products and known to be widely distributed in the environment, (but which could also be site related contaminants based on their concentration). EPA requests the following radionuclides be added because they are also naturally occurring but could also be site related: Cl-36, Ra-226, Ra-228, and Th-232. Additionally, EPA wants the DOE to sample at least once for all EMDF radionuclides that are not naturally occurring but which are known to have been used or generated during operations at the ORR, and which will be included in EMDF wastewater monitoring plan: Am-241, Co-60, Eu-154, Np-237, Pu-238, Pu-239/240.	Agree. Since the D1 FSP was issued for review in March 2019, both the ROD and the FFS were finalized and approved and contain the EMDF COCs expected to be present in water. Table 3 (now Table 2) has been updated with the additional radionuclides based on the ROD and the FFS, consistent with this comment. Note, the original Table 2 was redundant and has been deleted. The COCs previously selected for sampling have been replaced with the updated COCs from the EMDF ROD and the FFS, specifically from Table 2.8 Numeric AWQC that are chemical-specific ARARs for key COCs in EMDF Landfill Wastewater and Table 2.9 Instream surface water and fish tissue PRG/cleanup levels for EMDF.
2		The FSP does not discuss the rationale for the proposed locations of the monitoring wells and surface water locations for the baseline characterization. As noted in Section 2.2 (DQO Step 2: Identify the Goal of the Study), one of the study questions is to define an appropriate monitoring network for establishing baseline conditions. However, it is unclear how the proposed network was determined to be appropriate for the baseline characterization. The following issues should be addressed: a. Section 2.1 (DQO Step 1: State the Problem) states that groundwater and surface water data of sufficient quality and quantity are needed to evaluate if upgradient contaminant sources are present; however, according to Figure 3 (Baseline monitoring locations) only one upgradient shallow groundwater monitoring well location (i.e., GY-021) is proposed. It is unclear why one location	a. The DQO Step 1 was revised to add "Note, the EMDF is located in an area undisturbed by ORR operations and there are no known upgradient contamination sources on Pine Ridge." Therefore, the proposed well is expected to be representative of upgradient water quality. In addition, the

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		was deemed a sufficient quantity to characterize the upgradient groundwater quality and why a deeper (bedrock) groundwater monitoring well is not proposed. It is also unclear why upgradient surface water samples are not proposed to ensure a sufficient quantity of surface water data is collected. Please revise the FSP to include the rationale for the proposed upgradient sample locations, and ensure the FSP discusses how the proposed number of samples will be of sufficient quantity for the evaluation of whether potential upgradient contaminant sources are present. b. The surface water samples shown on Figure 3 are located within two of the northern tributaries (NTs) (i.e., NT11 and NT10) on the west and east sides, respectively of the site. However, it is unclear why surface water samples are not proposed for Bear Creek (i.e., the downgradient boundary noted in Section 2.4 [DQO Step 4: Define the Boundaries of the Study]) or the tributary located along the eastern side of the site (i.e., D-10W). In addition, as noted in Section 1 (Introduction, page 3), the groundwater discharges along the NT valley floors where the water table is at or near the ground surface. Therefore, it appears this tributary could be impacted and baseline conditions should be assessed. Please revise the FSP to include the rationale for the number and locations of the surface water samples.	proposed future detection monitoring network will monitor the shallow water bearing units, so a deep bedrock well is not proposed in this area. b. Agree in part. A sample location was added to Bear Creek where NT-11 discharges into Bear Creek. Section 3.1 last paragraph was revised as follows: "Surface water sampling will occur at three locations: flumes SF-1 located on NT-11, and SF 6 located on NT 10, installed during a previous EMDF hydrogeological characterization project, and the existing Bear Creek monitoring station at the NT-11 confluence with Bear Creek." D-10W will be rerouted and the channel backfilled during EMDF construction. Samples collected at this time are not anticipated to reflect post-construction baseline conditions.
3		The FSP does not provide sufficient information how the baseline data will be used to determine upper threshold limits (UTLs). Section 2.5 (DQO Step 5: Develop the Analytic Approach) states that the baseline characterization data will provide the basis for establishing threshold/evaluation values; however, the text does not describe how these values will be calculated. For example, it is unclear how UTLs will incorporate seasonal variability and how non-detections will be treated. Section 6 (Data Management and Assessment) states that low detection frequencies may lead to the use of project quantitation limits (PQLs) for the proxy UTL values, but it is	Clarification provided. The text was revised to add "…consistent with TDEC 0400-11-01-.04 (*Solid Waste Processing and Disposal*, "Specific Requirements for Class I, II, III, and IV Disposal Facilities).. Additional information on the approach will be presented at Project Team meetings and documented in the Baseline Characterization Report."

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		unclear how many detections are needed for the UTL calculation. To ensure the proposed sampling will provide sufficient data for the calculation of UTLs, please revise this section to discuss how the threshold values will be determined.	
4		The FSP does not specify the laboratory that will be used for the groundwater and surface water analyses. The laboratory should be identified prior to sampling to ensure the PQLs in Table 3 (Baseline characterization analytical requirements) and the quality control (QC) criteria in the Quality Assurance Project Plan (QAPP) can be achieved. Please revise the FSP to specify the laboratory and to provide the laboratory-specific information to ensure that the necessary PQLs and QC criteria can be met.	Clarification provided. The UCOR Sample Management Office has a robust analytical lab program that certifies labs in advance that meet the required statement of work for specific analyses. The lab will be selected from the certified labs available for the specific analyses at the time of sampling.
5		The FSP indicates that semiannual baseline characterization sampling will continue after the first year of quarterly sampling; however, it is unclear which quarters will be selected for the continued semiannual monitoring. For example, the quarter exhibiting the highest water table or highest concentrations could be selected for semiannual monitoring. Please revise the FSP to clarify how it will be determined which quarters will be used for the continued semiannual groundwater sampling.	The FSP has been revised to state that continued semiannual sampling is expected to be performed during the 1st and 3rd calendar year quarters to coincide with the typical wet and dry seasons.
6		The FSP does not include sampling for PFAS compounds. PFAS has been identified in contaminated media across the DOE Oak Ridge Reservation and should be included here to establish a baseline for both groundwater and surface water conditions before waste disposal occurs.	PFAS sampling at EMDF is not planned at this time. The need to perform sampling to determine baseline PFAS concentrations in the area will be determined after PFAS evaluation criteria and analytical methods are finalized by EPA.

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		SPECIFIC COMMENTS	
1	Sect. 1 pg 3	Introduction The last paragraph on this page discusses the depth to groundwater and vadose zone thickness in relative terms, but the depth to groundwater at Site 7c is not specified. In addition, Section 2.4 (DQO Step 4: Define the Boundaries of the Study) refers to a shallow zone of saprolite and a deeper bedrock zone, but the hydrogeology at the site is not discussed. Since the proposed monitoring wells target shallow and deep groundwater zones, the hydrogeology should be described to support the proposed monitoring of both zones. Please revise the FSP to provide additional information for the depth to groundwater and hydrogeology at the site.	Clarification provided. The hydrogeology of the EMDF area is described on pages 3 and 4. As noted in the last paragraph on page 3, the depth to groundwater varies with the topography. Therefore, the expected depth to groundwater was based by the topography at each location.
2	Sect. 2.6	The last paragraph begins with the sentence "Where possible, threshold values will be calculated using UTLs for each COC in the proposed baseline monitoring wells." If this proposed approach is determined to not be possible, then an alternative approach for determining threshold values will be needed. An alternative to this approach should be proposed in the FSP.	Clarification provided. If the proposed approach is not determined to be possible, then an alternative approach will be discussed with the FFA parties and determined in compliance with TDEC 0400-11-01.
3	Sect. 2.7	Some rationale needs to be included for why proposed shallow wells GY-021 and GY-030 are not paired with a deeper monitoring well, unlike the remaining six well pairs. Absence of a paired deep well with GY-030 is especially concerning as this shallow well appears to be proposed for location in the Maynardville Limestone strike belt. This placement could be where significant bedrock groundwater contamination from any EMDF leakage would most likely be observed.	Clarification provided. See response to 2a for GY-021. GY-030 is located in the Maynardville Fm which is known to have significant flow along strike. It is located west of the two additional well pairs with no contaminant source in between. Therefore, the deeper wells of the two upgradient well pairs will be sufficient to collect baseline information from the Maynardville Fm. Please note that these wells are designed to collect baseline data and the detection monitoring network has not yet been determined.

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4	Fig. 3 pg 8	Baseline monitoring locations The figure Legend does not define the four outlined areas that are shown. Additionally, the blue colored outlined areas near NT-11, D-10W and NT-10 are not shown or defined in the Legend. Furthermore, the figure does not include a north arrow for reference. Please revise Figure 3 to include this information and any other information necessary to understand the figure.	Agree. The figure was updated, the proposed sediment basins were not necessary and were removed and a north arrow was added.
5	Sect. 3.1 pg 11	Monitoring Network The text states that the downgradient wells installed in the Maynardville Limestone will obtain baseline data from an area noted to have "periodic plume extension" from the upgradient groundwater plumes migrating along Bear Creek; however, it is unclear what contaminants these upgradient plumes contain. Also, it is unclear how the future sampling results will be assessed if the plume extensions impact baseline values. For example, it is unclear if an additional downgradient well located closer to the EMDF or an additional upgradient well along Bear Creek would be useful. Please revise this section to discuss the contaminants in the upgradient plumes and how future sample results will be evaluated if the plume expansions impact the baseline characterization results.	Agree. The following text was added: "Because contamination is expected to be present in the downgradient Maynardville Limestone baseline monitoring wells, these data are expected to provide baseline conditions at these locations to differentiate between potential future leakage from the EMDF and what is already present in the groundwater."
6		The vertical separation between the base of the shallow well screen and the top of the paired deep well screen varies between different well pairs (refer to Table 1). There needs to be some discussion of the thinking that was used to propose the well screening depths of the well pairs.	Agree. The following text was added to pg 13 following discussion of the shallow monitoring wells: "For well pairs, there is expected to be a minimum separation between the uppermost and lowermost screened intervals to ensure these screened intervals are monitoring separate zones. However, the screened intervals and amount of separation will be based on field conditions and water-bearing zones encountered."

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7	Sect. 6 pg 23	Data Management and Assessment The text under the subheading Data Validation states, "at least 10 percent (%) of the laboratory analytical results will undergo data validation in accordance with SMO Analytical Support Level 3 guidelines and procedures;" however, it is unclear what is included in this level of validation and how the 10% to be validated will be selected (e.g., randomly). Please revise this section to clarify what is included in a Level 3 data validation and how 10% of the data will be selected for validation.	Agree. The text was revised as follows: "At least 10 percent of the laboratory analytical results will undergo data validation in accordance with SMO Analytical Support Level 3 guidelines and procedures. Samples selected for validation will be on a random basis, unless there are analytical results that are suspect and that need to be investigated further (those will be performed as requested). The level of validation is dependent on the detection or potential outlier. Level 3 validation is the base validation level, greater than Level 3 validation is reserved for suspected outliers. Based on the findings of the Level 3 data validation and the professional judgment of the data validation personnel, analytical results for the applicable groundwater or surface water monitoring stations that are considered unusable will be flagged with an "R" (unusable) data qualifier (in addition to any laboratory data qualifiers). Reason codes for validation data qualifiers are documented in the PEMS database."
8	Sect. 6 pg 23	Data Management and Assessment The text discusses manual data entry into a pre-populated database and entry of data validation qualifiers into the database after data assessment, but it is unclear if the data entry will be verified for accuracy. Please revise Section 6 to indicate that all data entry into the database will be verified for accuracy.	Agree. The following text was added to the end of the first paragraph: "All manually entered data will be verified for accuracy in accordance with the QAPP and sampling procedures. In addition, contract compliance verification is performed on all laboratory data in accordance to the QAPP."

Department of Energy

Oak Ridge Office of Environmental Management
P.O. Box 2001
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March 24, 2023

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Mr. Randy C. Young
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Department of Environment and Conservation
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Oak Ridge, Tennessee 37830-7072

Dear Ms. Urquhart-Foster and Mr. Young:

SUBMITTAL OF *THE FIELD SAMPLING PLAN FOR BASELINE GROUNDWATER AND SURFACE WATER CHARACTERIZATION AT THE PROPOSED ENVIRONMENTAL MANAGEMENT DISPOSAL FACILITY, OAK RIDGE, TENNESSEE* (DOE/OR/01-2812&D2)

Enclosed is the *Field Sampling Plan for Baseline Groundwater and Surface Water Characterization at the Proposed Environmental Management Disposal Facility, Oak Ridge, Tennessee* (DOE/OR/01-2812&D2). The Field Sampling Plan provides for baseline groundwater and surface water characterization for the Environmental Management Disposal Facility.

The *Federal Facility Agreement for the Oak Ridge Reservation*, Section XXI B.2, *General Process*, for Remedial Investigation/Feasibility Study and Remedial Design/Remedial Action documents, states, "D1 secondary documents are issued by the DOE subject to review and comment by EPA and TDEC. Although the DOE will respond to comments received, the D1 secondary documents may be finalized in the context of the corresponding primary documents."

Therefore, this letter and the copy of the enclosed responses to comments and revised document are provided in response to the comments received on the D1. The Environmental Management Disposal Facility Baseline Characterization Report will be the primary document that will address and/or utilize the information contained in this subject document.

SUBMITTAL OF *THE FIELD SAMPLING PLAN FOR BASELINE GROUNDWATER AND SURFACE WATER CHARACTERIZATION AT THE PROPOSED ENVIRONMENTAL MANAGEMENT DISPOSAL FACILITY, OAK RIDGE, TENNESSEE* (DOE/OR/01-2812&D2)

If you have any questions or if we can be of further assistance, please contact Roger Petrie at (865) 316-0463 or Brian Henry at (865) 241-8340.

Sincerely,

Brian Henry Digitally signed by Brian Henry Date: 2023.03.24 07:46:05 -04'00'

Brian T. Henry
Portfolio Federal Project Director

Roger B. Petrie Digitally signed by Roger B. Petrie Date: 2023.03.21 10:13:12 -04'00'

Roger B. Petrie
Federal Facility Agreement Project Manager

Enclosures:
1. Field Sampling Plan for Baseline Groundwater and Surface Water Characterization at the Proposed Environmental Management Disposal Facility, Oak Ridge, Tennessee (DOE/OR/01-2812&D2)
2. U.S. Environmental Protection Agency Comment Resolution Form
3. Tennessee Department of Environment and Conservation Comment Resolution Form

cc w/enclosures:
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