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

June 23, 2021

Ms. Constance A. Jones
Superfund and Emergency Management Division
U.S. Environmental Protection Agency
Region 4
Atlanta Federal Center
61 Forsyth Street
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:

DISTRIBUTION OF AN ERRATUM TO THE *BEAR CREEK VALLEY WATERSHED REMEDIAL ACTION REPORT COMPREHENSIVE MONITORING PLAN, OAK RIDGE, TENNESSEE (DOE/OR/01-2457&D4)*

Please find enclosed the Erratum to the *Bear Creek Valley Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee (DOE/OR/01-2457&D4).* For convenience, the Pathway to Errata flowchart is also enclosed.

The Erratum adds Appendix F to include the sampling approach to support the U.S. Environmental Protection Agency Administrator's Dispute Resolution Decision requirement for conducting a fish study to assess radionuclides in fish tissue in Bear Creek. The purpose of the fish sampling and analysis activities is primarily to determine whether the muscle tissues from commonly consumed fish, collected from Bear Creek, contain radionuclides that could adversely affect recreational fishermen. The *Federal Facility Agreement for the Oak Ridge Reservation* parties have identified the fish consumption pathway as the most conservative pathway to evaluate to ensure protection of human health and the environment. The data from the fish study will be used to support developing risk-based radiological discharge limits for the Environmental Management Waste Management Facility and the proposed Environmental Management Disposal Facility. This sampling approach (Erratum) was discussed and emailed for your review between April 7, 2021, and June 8, 2021, and agreed upon June 9, 2021. This Erratum incorporates the final edits provided by the U.S. Environmental Protection Agency on June 9, 2021. Enclosure 1 indicates our current status in the Erratum process; Enclosure 2 contains the red-lined changed pages. As shown in Enclosure 1, regulatory approvals are requested within 14 days of receipt of this Erratum.

DISTRIBUTION OF AN ERRATUM TO THE *BEAR CREEK VALLEY WATERSHED REMEDIAL ACTION REPORT COMPREHENSIVE MONITORING PLAN, OAK RIDGE, TENNESSEE (DOE/OR/01-2457&D4)*

If you have any questions or if we can be of further assistance, please contact Sam Scheffler at (865) 314-6158, or [redacted].

Sincerely,

ROGER PETRIE

Digitally signed by ROGER PETRIE
Date: 2021.06.17 16:07:34 -04'00'

Roger B. Petrie
Federal Facility Agreement Project Manager

Enclosures:
1. Flow diagram showing Pathway to Watershed Remedial Action Report Comprehensive Monitoring Plan changes
2. Erratum form for proposed Erratum FY21-BCV-01 to the *Bear Creek Valley Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee (DOE/OR/01-2457&D4)*

cc w/enclosures:
Rhonda Butler, Value Added Solutions
SSAB

cc w/o enclosures:
Carl Froede, EPA Region 4
Angel Perkey, TDEC, Oak Ridge
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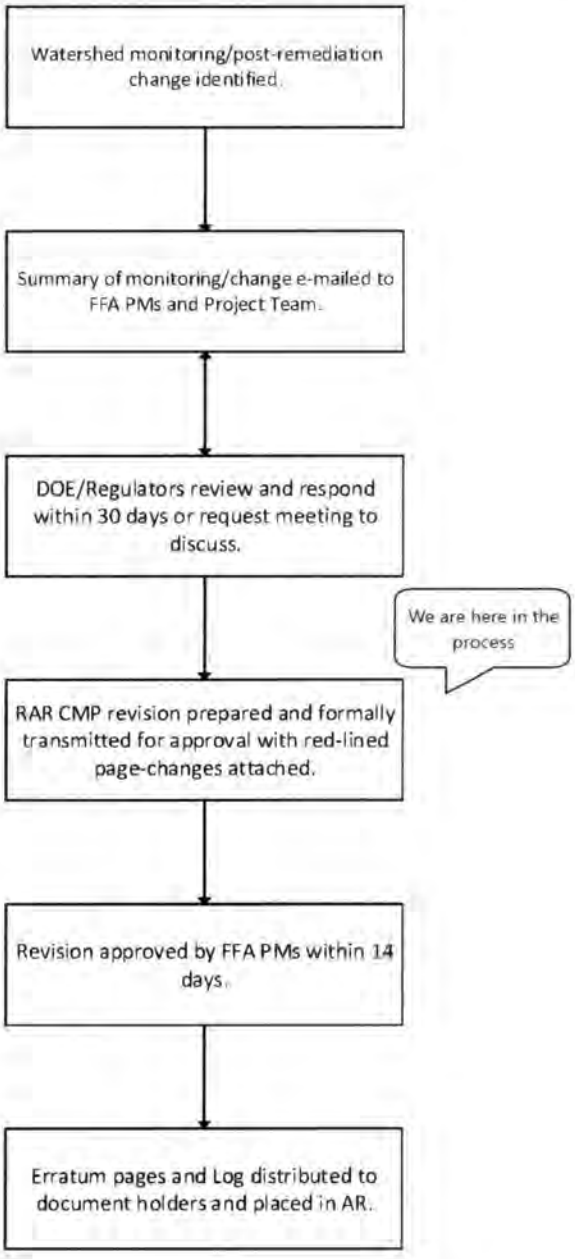
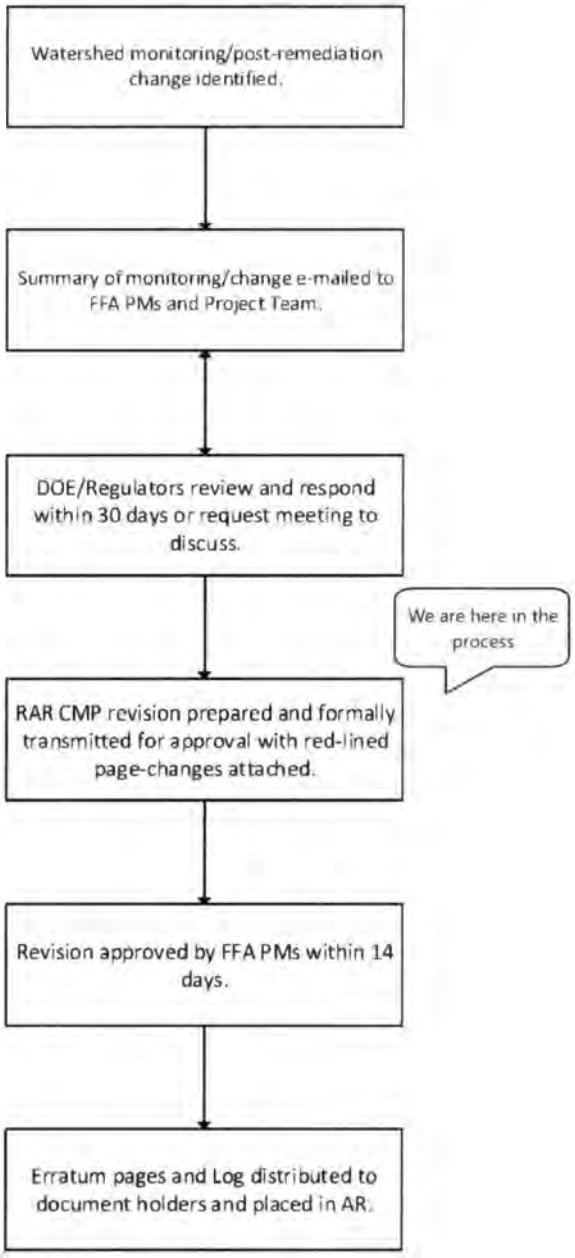
COMPREHENSIVE MONITORING PLAN CHANGES -PATHWAY TO ERRATUM
for *Bear Creek Valley Watershed Remedial Action Report Comprehensive Monitoring Plan*
(DOE/OR/01-2457&D4) Erratum FY21-BCV-01



COMPREHENSIVE MONITORING PLAN CHANGES -PATHWAY TO ERRATUM
for *Bear Creek Valley Watershed Remedial Action Report Comprehensive Monitoring Plan*
(DOE/OR/01-2457&D4) Erratum FY21-BCV-01



CERCLA PRIMARY DOCUMENT ERRATUM FORM

SAP ERRATUM NUMBER: FY21-BCV-01 **EFFECTIVE DATE:** April 5, 2021

Watershed affected by change:	☐ Melton Valley	☐ Bethel Valley
	☐ EFPC	☒ Bear Creek Valley
	☐ ETTP	☐ LWBR/CR/PC
	☐ N/A	☐ Chestnut Ridge

DOCUMENT NO. OF WATERSHED SAP AFFECTED BY CHANGE: DOE/OR/01-2457&D4

PRIMARY DOCUMENT(S) SUPERSEDED BY THIS WATERSHED SAP: *Bear Creek Valley Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee (DOE/OR/01-2457 &D4)*

Sampling Rationale:	☐ CERCLA performance	☐ Five-Year Review
	☐ CERCLA baseline	☒ Other Support of DRD for radiological discharge limits
	☐ N/A	

Description of Change: Sampling of fish tissue in response to the EPA Administrator's 12/31/2020 DRD letter related to radiological discharge limits.

Reason for Change(s):

Reviewed by: EDWARD ARNOLD (Affiliate) Digitally signed by EDWARD ARNOLD (Affiliate) Date: 2021.06.17 12:50:21 -04'00' Date: _____
(Manager responsible for data or authorized designee)

Approved by: LYNN SIMS (Affiliate) Digitally signed by LYNN SIMS (Affiliate) Date: 2021.06.17 12:30:52 -04'00' Date: _____
(UCOR WRAP Manager or authorized designee)

APPENDIX F
FISCAL YEAR 2021 FISH TISSUE SAMPLING IN BEAR CREEK IN SUPPORT OF THE EPA ADMINISTRATOR'S DISPUTE RESOLUTION DECISION FOR RADIOLOGICAL DISCHARGE LIMITS (DOE/OR/01-2457&D4) ERRATUM FY21-BCV-01

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CONTENTS

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FIGURES

TABLES

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ACRONYMS

BCK	Bear Creek kilometer
BMAP	Biological Monitoring and Abatement Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC	contaminant of concern
DOE	U.S. Department of Energy
DQO	data quality objective
DRD	Dispute Resolution Decision
EFPC	East Fork Poplar Creek
EIT	Emerging Issues Team
EMDF	Environmental Management Disposal Facility
EMWMF	Environmental Management Waste Management Facility
EPA	U.S. Environmental Protection Agency
ESD	Environmental Sciences Division
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PCB	polychlorinated biphenyl
POE	Point of Exposure
PRG	preliminary remediation goal
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
SAP	Sampling and Analysis Plan
TDEC	Tennessee Department of Environment and Conservation
WAC	waste acceptance criteria
WRPP	Water Resources Restoration Program

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1. INTRODUCTION

The U.S. Environmental Protection Agency (EPA) Administrator issued a final decision resolving the dispute among EPA, the Tennessee Department of Environment and Conservation (TDEC), and the U.S. Department of Energy (DOE) regarding the discharge to surface water of wastewaters generated during a response action under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, (CERCLA) at the Oak Ridge Reservation (ORR) facility (EPA 2020). This erratum to the *Bear Creek Valley Watershed Remedial Action Report Comprehensive Monitoring Plan Oak Ridge, Tennessee* (DOE/OR/01-2457&D4) includes information to support the EPA Administrator's Dispute Resolution Decision (DRD) requirement for conducting a fish study to assess radionuclides in fish tissue in Bear Creek.

The purpose of the fish sampling and analysis activities is primarily to determine whether the muscle tissues from commonly consumed fish, collected from Bear Creek, contain radionuclides that could adversely affect recreational fishermen. The FFA parties have identified the fish consumption pathway as the most conservative pathway to evaluate to ensure protection of human health and the environment. The data from the fish study will be used to support developing risk-based radiological discharge limits for the Environmental Management Waste Management Facility (EMWMF) and the proposed Environmental Management Disposal Facility (EMDF).

This initial sampling will be conducted in Spring 2021. An additional sampling event will be conducted in the Fall after the results of the Spring sampling event are evaluated and the Sampling Analysis Plan (SAP) will be modified as necessary based on the Spring sampling event results. The establishment of fisher-protective radionuclide discharge effluent levels will move forward with the Spring fish sampling/analysis results. The Fall fish sampling will provide confirmation of the Spring results. Any potential modifications determined to be required based on the Fall sampling will be addressed in EMDF post-ROD documents.

2. BACKGROUND

DOE operates the EMWMF, an existing CERCLA waste disposal facility on the ORR in Bear Creek Valley; a second waste disposal facility is also proposed for construction (EMDF). During facility operations, landfill wastewater is generated from precipitation that contacts the waste. This wastewater then accumulates in holding ponds and, after sampling to confirm that the water meets discharge limits, is subsequently discharged to Bear Creek. Sampling has indicated that the discharged water typically contains low levels of radionuclides that meet or are below the established discharge limits; these radionuclides may bio accumulate in fish, causing a potential increased risk to recreational fishermen who catch and eat the fish.

Bear Creek is classified for fish and aquatic life, recreation, livestock watering and wildlife, and irrigation uses as per Tennessee Administrative Code 0400-40-04 - Use Classifications for Surface Waters.

Fishing is not allowed on the ORR, including along Bear Creek Road (Fig. 1). In addition, the segment of Bear Creek east of Bear Creek kilometer (BCK) 4.5 is along the western access road into Y-12, a patrolled, access restricted road that is posted "No Trespassing" and "Notice, Authorization Required for Through Traffic." There is a TDEC fishing advisory to not eat fish from Bear Creek and Poplar Creek including East Fork Poplar Creek (EFPC) because of polychlorinated biphenyls (PCBs) and mercury, and areas are posted (https://www.tn.gov/content/dam/tn/environment/water/planning-and-standards/wr_wq_fish-advisories.pdf).

However, this SAP provides direction for identification of potential fishing sites along Bear Creek relative to the EMWMF and proposed EMDF that were identified as locations where catchable and edible fish are expected to be present and where a recreational fisher could potentially access Bear Creek to catch fish for consumption. At some of the sites, fishing may be limited (e.g., BCK 3.3) because catchable game fish species have historically been small, conservatively around 30 g (1 oz.), yielding 10 g of fillet (personal communication, Terry Mathews-ORNL ESD, May 2021). Depending on the size of the fish, several small fish would have to be caught and combined to obtain an 180 g (6 oz.) meal. (For example, approximately 18 1-oz fish must be caught and combined to obtain a 180 g (6 oz.) meal. Although there is no evidence on the ORR, a very small percent of fishers in larger fisheries near Oak Ridge report that they consume whole fish. As noted in Burger and Campbell (2008), interviews along East Fork Poplar Creek and Clinch River found that the percentage of fish eaten whole for all anglers interviewed was less than 4%, (3.82 +/- 1.51%) and for anglers in the study area was about 1.5% (1.43 +/- 0.92%).

Currently, there are no active beaver dams present in the reach of Bear Creek between Y-12 and BCK-4.5. Beaver dams can cause significant changes to the ecosystem by creating larger pools of water that can support larger fish, creating more attractive locations for recreational fishers. In addition, sediment is typically trapped behind the dams in the low energy environment, potentially accumulating contaminants. DOE has committed to continued removal of beaver dams in this reach of Bear Creek, although an appropriate decision document has not been identified. This agreement is anticipated to be included either in the BCV CMP or in an EMDF SAP.

Larger game fish are present in nearby Clinch River, Watts Bar Reservoir, and Melton Hill Reservoir that are much more attractive fishing destinations (TWRA TN Fishing Guide 2021/2022). It is possible that larger game fish (e.g., largemouth bass) from Poplar Creek may enter lower EFPC and eventually the lower reaches of Bear Creek, but based on available fish population data, there is no evidence to say that this is a common occurrence (ORNL/SPR-2020/1562). Because larger game fish (e.g., largemouth bass) move around more than sunfish, which are usually resident to a given location based on ESD field observations (personal communication, Terry Mathews-ORNL ESD, May 2021), their exposure to contaminants is not necessarily linked only to exposure at the POEs. Historically, available fish population data throughout Bear Creek show that the sunfish at all sampled sites are relatively small in size; sampling for bioaccumulation in the stream is challenging because the fish encountered are smaller than fish typically collected to assess human health risks in other streams on the ORR (ORNL/SPR-2020/1562, Appendix A).

The SAP has three objectives: (1) collect additional fish population data to determine the most appropriate location(s) to evaluate risk to fishermen who are consuming fish, (2) collect fish tissue data that will be used to define the human health risk from fish consumption from these sites and will be considered in determining the appropriate discharge limits for radionuclides from the EMWMF and proposed EMDF, and (3) assess possible radiologically contaminated fish along Bear Creek where security restrictions prevent a fisher access to the creek.

A data quality objective (DQO) session was held on April 1, 2021 between EPA, TDEC, DOE, and UCOR LLC, an Amentum-led partnership with Jacobs, to develop the approach for obtaining information to support the determination of risk-based radiological discharge limits for the EMWMF and the proposed EMDF. The DQO steps and tables are provided in Sect. 4.

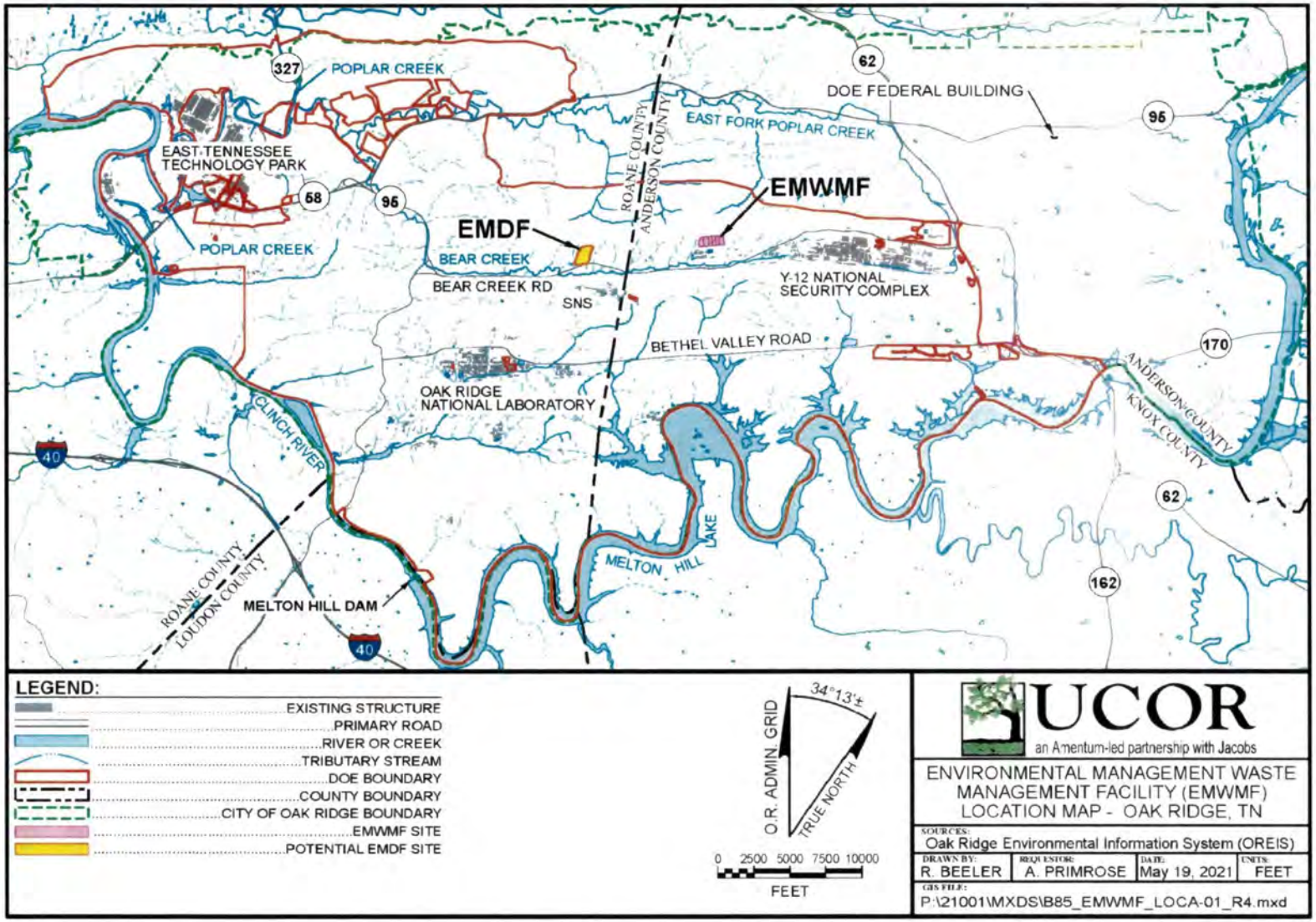


Fig. 1. Location of Bear Creek on the ORR.

3. MONITORING DESIGN

3.1 APPROACH

3.1.1 Sample Locations

Fish will be collected from the stream reaches comprising the three Points of Exposure (POEs) (BCK 3.3 – 4.5, BCK 0.5 – 1.5, EFK 0 – 1.0) as identified in the DQO (Sect. 4) and reference location Brushy Fork. Figures 2 and 3 show sample locations and historical past biota sampling locations. The Figure 2 inset shows the reference location. Note, sampling activities previously conducted at the biota sampling locations were for non-radionuclides. There are no existing radiological data available from these biota sampling sites, except from the frozen fish tissue samples recently analyzed from BCK 3.3.

The reference location at Brushy Fork will be used. Bear Creek is in a basin dominated by shales of the Conasauga Group with water baseflow largely originating from the Maynardville Limestone/Copper Ridge Dolomite system. The reference stream with underlying soil and bedrock most similar to Bear Creek is Brushy Fork Creek. Brushy Fork Creek is located upstream of the ORR and therefore not expected to be impacted by ORR activities. Brushy Fork Creek is located at the northwestern edge of the City of Oak Ridge at the toe of Black Oak Ridge. Similar to Bear Creek, the stream flows on a valley floor underlain by the Maynardville Limestone and a broader portion of its watershed drains terrain underlain by Conasauga Group and Rome Formation bedrock and residual soils. The watershed land use is rural residential with some light industry and small-scale agriculture.

Fish will also be collected upstream of the POEs at BCK 7.0 – BCK 9.9 and 11.9 - 12.4 to determine the levels and types of radiological contamination present within fish (whole body) at these locations. The length of the sample reach for BCK 7.0 – 9.9 is needed to collect samples as close as possible to the BCK 9.9 site and still find fish of a suitable size (albeit still very small fish). The habitat above BCK 8.0 is more limited in pool and undercut banks that provide sunfish habitat. As a result of the limited habitat available in this reach, fish samples will be collected from BCK 7.0- 8.0.

3.1.2 Fish Population Surveys

Fish will be collected from the stream reaches at three POEs (BCK 3.3 – 4.5, BCK 0.5 – 1.5, EFK 0 – 1.0) in Bear Creek/Poplar Creek and the reference location at Brushy Fork. These stream reach locations have similar habitat and fishers have potential to access these reaches. Based on previous fish population surveys, sunfish, and bass are expected at these locations. However, the assumption is that all game fish species are equivalent for human consumption with respect to radiological contaminants of concern (COCs) for this study (i.e., sunfish, and bass). To collect 8 to 10 samples, gamefish that are 30 g by weight or larger will be used, regardless of species. Larger game fish will be collected if present. In addition, fish population surveys will be conducted at the additional evaluation points BCK 7.0 to 9.9 and 11.9 - 12.4.

Fish population surveys will be completed at each location to determine fish availability and size, species richness and diversity in a reach of stream through field identification and enumeration of individuals. Fish population surveys are performed over about an 80- to 100-m stretch. The stretch will be documented. Fish will be collected by electroshock (see Sect. 3.2 for procedures).

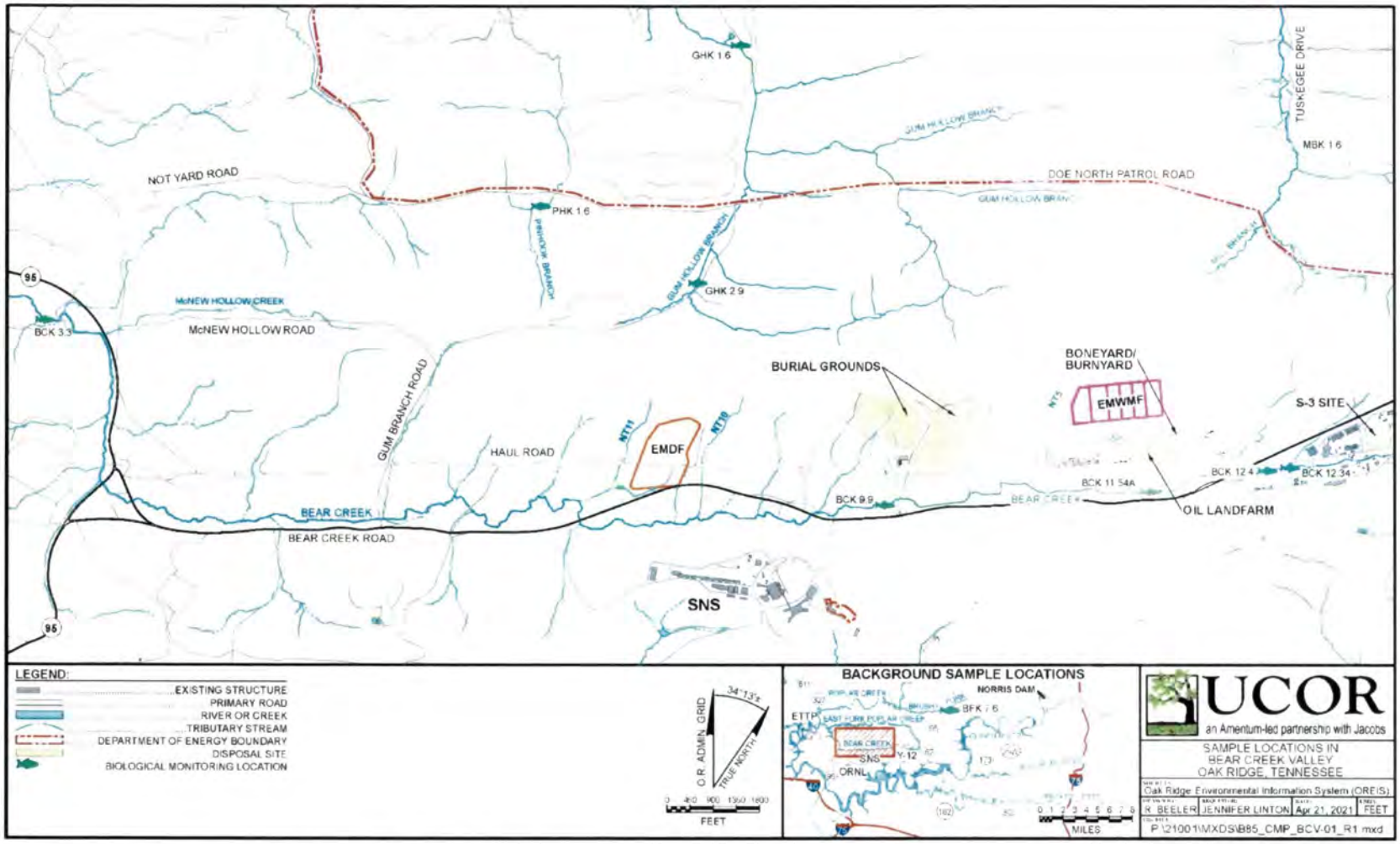


Fig. 2. Background locations and existing biota sampling locations in Bear Creek.

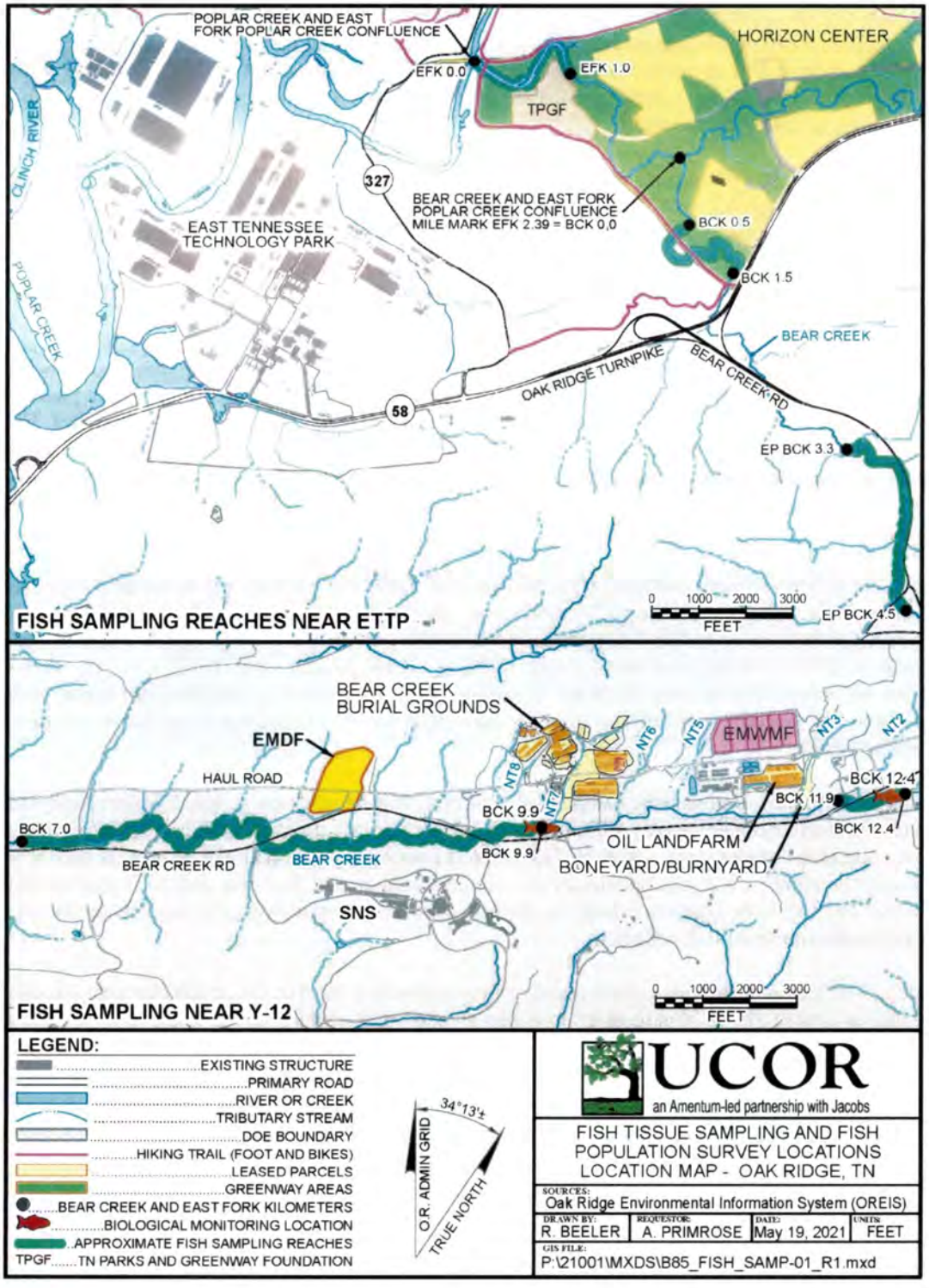


Fig. 3. Fish tissue sampling and fish population survey locations.

3.1.3 Fish Tissue Sampling

Fish tissue will be collected for radionuclide analyses. Fish tissue sample locations are provided in Table 1 below. At each location fish population surveys will be performed and fish tissue samples will be collected; sampling is expected to occur in May 2021. An additional sampling event will be conducted in the Fall after the results of the Spring sampling event are evaluated. This SAP will be modified as necessary based on the Spring sampling event results.

The necessary sample size to perform the radionuclide analyses is approximately 40 - 60 g (1.4- 2.1 oz.) of fish fillet from fish greater than 30 g size. If present, larger fish will be preferably collected that are large enough to provide sufficient fish tissue for an individual 40 – 60 g sample. Larger fish fillets will be analyzed as discrete samples (if present). However, for calculation of potential risk, estimates from composite and discrete samples will be combined in the statistical analysis. This is appropriate because people who consume fish typically combine all types of fish in their meals.

If sufficient larger fish are not present at a given location to be used as discrete samples, then enough mass for fish tissue sampling will be obtained by collecting smaller fish greater than 30 g. The typical size for most catchable, edible fish to be collected at the POEs for analysis is 4.5 in. in length and weigh 30 g (1.1 oz.). These fish can only produce 10 to 12 g of fillet, which requires multiple fish for a single radiological sample. Additionally, approximately 8 to 10 fish tissue samples (40 - 60 g each) are necessary to perform a statistical analysis of the fish tissue data. Samples (preferably) should be of same type (discrete or composite).

If sufficient fish tissue is not collected at the first attempt, additional attempts will be made at each sampling location to collect fish tissue during a 2-week period. The stretches sampled and the level of effort required to collect fish will be recorded. Multiple sampling passes within the 2-week period are expected to be adequate to collect fish representative of each location, except possibly POE BCK 3.3 – 4.5, where there may not be enough fish present for 8 to 10 samples plus a duplicate. If insufficient sample volume is collected at any location, then smaller fish (less than 30 g) will be filleted and those fillets included in the composite sample.

The decision on how to composite samples at each POE will be made by selected project team members after the fish have been collected. An initial approach for compositing fish into the requisite samples will be recommended based on the existing BMAP sampling approach. An email will be provided to the project team with the number, size and species of the fish collected at each location, and the initial compositing approach. The fish to be composited will be identified by the selected project team members based on the size, type and number of fish collected.

At each POE location, the carcasses remaining from collecting the fish tissue samples (not including the guts, fins or scales) will be homogenized to obtain an additional sample for the whole body to be analyzed separately for each POE. This approach minimizes the impacts to the stream and maximizes the amount of useable sample volume. These sample results will be added to the fish tissue sample results using ESD procedure ORNL TM-202, *Estimation of Whole-Fish Contaminant Concentrations from Fish Fillet Data* (1997) to reconstruct whole fish sample results. The reconstructed whole fish results and fillet results will be reported separately.

Table 1. Sampling locations

Reach	Site name	Location description
EFK 0.0 to 1.0	EFK 0.0	Lower EFPC accessible by bridge from greenway trail
BCK 0.5 to 1.5	BCK 0.5	Stream crossing on greenway trail
BCK 3.3 to 4.5	BCK 3.3	Stream access from unnamed gravel road off Hwy 95 upstream to triangle intersection of Hwy 95 and Bear Creek Rd.
BCK 7.0 - 9.9	BCK 9.9	Stream reach at Bear Creek BMAP location
BCK 11.9 - 12.4	BCK 12.4	Stream reach at Bear Creek BMAP location
BFK 7.6	BFK 7.6	Reference reach on Brushy Fork of Poplar Creek

BCK = Bear Creek kilometer
BFK = Brushy Fork kilometer
BMAP = Biological Monitoring and Abatement Program
EFK = East Fork kilometer
EFPC = East Fork Poplar Creek

If fish with malformations/deformities are found, then these will be noted and recorded. Any malformed or deformed fish collected will be included in the analytical sample if it is a gamefish 30 g (1 oz.) or larger.

3.1.4 Baseline Conditions

As shown in Table 3, whole fish will also be collected for analyses from stream reaches located at BCK 7.0 - 9.9 and 11.9 - 12.4 to establish baseline conditions. In addition, additional whole fish not required for fish tissue sampling will be collected at BCK 3.3 and BCK 0.5. These will also be used to establish baseline conditions. These whole fish samples will not be used for the purposes of establishing radiological discharge limits. Larger fish are preferred, however, whatever fish are available will be collected to obtain the sample mass necessary. Because of the limited fish expected to be available at these two locations, a slightly smaller suite of 17 of the 22 radionuclides will be collected to reduce the number of fish required for each sample (Table 3).

For the BCK 9.9 and 12.4 samples, attempts will be made to collect three individual samples, each sample composited from approximately 10 fish or enough to obtain a mass of 40 – 60 g. [Note: For BCK 3.3, one approximately 76 g (2.7 oz.) largemouth bass was collected and will be used for one whole fish sample. For BCK 0.5, two warmouth sunfish totaling 40 g (1.4 oz.) were collected and will be used for one additional whole fish sample.]

3.1.5 Future Bear Creek Characterization Project

As a future project, additional fish, water, and sediment (as appropriate) may be collected through Bear Creek to determine the levels and types of contamination present at different locations. This characterization may be repeated at some frequency to be agreed upon later as part of the BCV CMP or other primary document. A separate DQO session will be held to determine the objectives and approach for this sampling program.

3.2 METHODS

The *Quality Assurance Project Plan for the Water Resources Restoration Program, U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee* (WRRP QAPP; UCOR-4049) includes the sampling procedures and analytical methods used for this sampling and analysis plan. Fish sampling and surveying activities will be performed in accordance with the latest revisions of applicable Oak Ridge National Laboratory (ORNL) Environmental Sciences Division (ESD) biota sampling procedures. Table 2 below provides the procedures to be used for execution of this SAP for completeness as referenced in the WRRP QAPP. Quality assurance/quality control (QA/QC) samples will consist of duplicate samples collected at each location.

Table 2. Sampling procedures

Procedure No.	Procedure Title	Rev.
BAA-SOP-2	Collecting and Handling of Resident Aquatic Organisms for Bioaccumulation Studies	5
BAA-SOP-3	Processing of Aquatic Organisms for Contaminant Analysis	4
BAA-SOP-4	Recording Data and Chain-of-Custody Information	3
FHA-SOP-1	Collection of Fish and Blood Samples	6
FHA-SOP-3	Processing of Fish Samples	6
FHA-SOP-4	Fish Health Assessment Methodology	3
FCS-SOP-1	Selection of Site Samples	4
FCS-SOP-2	Stream Electro-Fishing for Quantitative Fish Population Estimation	8
FCS-SOP-3	Field Processing for Fish Population Estimation	5
FCS-SOP-4	Data Recording and Management for Fish Population Estimation Data Sheets	4
FCS-SOP-6	Measurement of Area Sampled for Fish Population Estimation	4
FCS-SOP-8	Calculating Estimates of Fish Population Size, Density, Biomass and Production	4
FCS-SOP-16	Field Standardization and Use of Pesola Spring Scales	4
FCS-SOP-17	Field Procedures for Qualitative Sampling of Fish Populations	3
FCS-SOP-19	Processing and Verifying Fish Population Data	3
MCS-SOP-1	Site Selection, Identification and Naming	3
MCS-SOP-2	Replicate Sample Specific Physical Characteristics: Stream Samples	4
MCS-SOP-3	Water Quality Measurements	4
MCS-SOP-4	Selection of Specific Locations to Collect Replicate Samples	3
MCS-SOP-5	Quantitative Sample Collection	4
MCS-SOP-6	Qualitative Sample Collection	3
MCS-SOP-7	Sample Chain-of-Custody	4
MCS-SOP-9	Sample Storage and Maintenance	5
MCS-SOP-10	Management and Quality Assurance of Data	3
MCS-SOP-13	Biomass Measurement	2
MCS-SOP-14	Preparation of Specimens for Reference Collections and Verification	3
MCS-SOP-15	Access Control to Sample Custody Facility at Building 0907	6

Table 3 provides the fish tissue sampling COCs. Table 4 provides the analytical methods and detection limits for these COCs (table provided in the WRRP QAPP, but included here for completeness). Analytical methods will be wet weight fish tissue analyses.

Table 3. Fish tissue sampling COCs

Monitoring Location	Stream Reach or Location	Media	Parameters/Analyses	Comments
East Fork Poplar Creek				
EFK 0.0	EFK 0.0 – EFK 1.0	Fish Tissue	^{241}Am, ^{14}C, ^{36}Cl, ^{60}Co, ^{137}Cs, ^{154}Eu, ^{3}H, ^{129}I, ^{237}Np, ^{210}Pb, ^{238}Pu, $^{239/240}Pu$, ^{226}Ra, ^{228}Ra, ^{90}Sr, ^{99}Tc, ^{228}Th, ^{230}Th, ^{232}Th, $^{233/234}U$, $^{235/236}U$, ^{238}U	Bioaccumulation of COCs (radiological) in fish fillet samples to assess risk to recreational fishermen.
Bear Creek				
BCK 0.5	BCK 0.5 – BCK 1.5	Fish Tissue	^{241}Am, ^{14}C, ^{36}Cl, ^{60}Co, ^{137}Cs, ^{154}Eu, ^{3}H, ^{129}I, ^{237}Np, ^{210}Pb, ^{238}Pu, $^{239/240}Pu$, ^{226}Ra, ^{228}Ra, ^{90}Sr, ^{99}Tc, ^{228}Th, ^{230}Th, ^{232}Th, $^{233/234}U$, $^{235/236}U$, ^{238}U	Bioaccumulation of COCs (radiological) in fish fillet samples to assess risk to recreational fishermen.
BCK 0.5	BCK 0.5 – BCK 1.5	Whole fish	^{60}Co, ^{137}Cs, ^{154}Eu, ^{3}H, ^{129}I, ^{237}Np, $^{239/240}Pu$, ^{226}Ra, ^{228}Ra, ^{90}Sr, ^{99}Tc, ^{228}Th, ^{230}Th, ^{232}Th, $^{233/234}U$, $^{235/236}U$, ^{238}U	Bioaccumulation of COCs (radiological) in whole body fish samples to assess stream conditions.
BCK 3.3	BCK 3.3 – BCK 4.5	Fish Tissue	^{241}Am, ^{14}C, ^{36}Cl, ^{60}Co, ^{137}Cs, ^{154}Eu, ^{3}H, ^{129}I, ^{237}Np, ^{210}Pb, ^{238}Pu, $^{239/240}Pu$, ^{226}Ra, ^{228}Ra, ^{90}Sr, ^{99}Tc, ^{228}Th, ^{230}Th, ^{232}Th, $^{233/234}U$, $^{235/236}U$, ^{238}U	Bioaccumulation of COCs (radiological) in fish fillet samples to assess risk to recreational fishermen.
BCK 3.3	BCK 3.3 – BCK 4.5	Whole fish	^{60}Co, ^{137}Cs, ^{154}Eu, ^{3}H, ^{129}I, ^{237}Np, $^{239/240}Pu$, ^{226}Ra, ^{228}Ra, ^{90}Sr, ^{99}Tc, ^{228}Th, ^{230}Th, ^{232}Th, $^{233/234}U$, $^{235/236}U$, ^{238}U	Bioaccumulation of COCs (radiological) in whole body fish samples to assess stream conditions.
BCK 9.9	BCK 7.0-9.9	Whole fish	^{60}Co, ^{137}Cs, ^{154}Eu, ^{3}H, ^{129}I, ^{237}Np, $^{239/240}Pu$, ^{226}Ra, ^{228}Ra, ^{90}Sr, ^{99}Tc, ^{228}Th, ^{230}Th, ^{232}Th, $^{233/234}U$, $^{235/236}U$, ^{238}U	Bioaccumulation of COCs (radiological) in whole body fish samples to assess stream conditions.
BCK 12.4	BCK 11.9 - 12.4	Whole fish	^{60}Co, ^{137}Cs, ^{154}Eu, ^{3}H, ^{129}I, ^{237}Np, $^{239/240}Pu$, ^{226}Ra, ^{228}Ra, ^{90}Sr, ^{99}Tc, ^{228}Th, ^{230}Th, ^{232}Th, $^{233/234}U$, $^{235/236}U$, ^{238}U	Bioaccumulation of COCs (radiological) in whole body fish samples to assess stream conditions.
Brushy Fork				
BFK 7.6	BFK 7.6	Fish Tissue	^{241}Am, ^{14}C, ^{36}Cl, ^{60}Co, ^{137}Cs, ^{154}Eu, ^{3}H, ^{129}I, ^{237}Np, ^{210}Pb, ^{238}Pu, $^{239/240}Pu$, ^{226}Ra, ^{228}Ra, ^{90}Sr, ^{99}Tc, ^{228}Th, ^{230}Th, ^{232}Th, $^{233/234}U$, $^{235/236}U$, ^{238}U	Bioaccumulation of COCs (radiological) in reference site fish fillet samples.

Table 3. Fish tissue sampling COCs (cont.)

Monitoring Location	Stream Reach or Location	Media	Parameters/Analyses	Comments
East Fork Poplar Creek				
EFK 0.0	EFK 0.0 – EFK 1.0	Fish	Fish Population Survey	Fish species richness and density survey to evaluate the population in East Fork Poplar Creek. Includes measurements of length and weight and species identification.
Bear Creek				
BCK 0.5	BCK 0.5 – BCK 1.5	Fish	Fish Population Survey	Fish species richness and density survey to evaluate the population in Bear Creek. Includes measurements of length and weight and species identification.
BCK 3.3	BCK 3.3 – BCK 4.5	Fish	Fish Population Survey	Fish species richness and density survey to evaluate the population in Bear Creek. Includes measurements of length and weight and species identification.
BCK 9.9	BCK 7.0-9.9	Fish	Fish Population Survey	Fish species richness and density survey to evaluate the population in Bear Creek. Includes measurements of length and weight and species identification.
BCK 12.4	BCK 11.9 - 12.4	Fish	Fish Population Survey	Fish species richness and density survey to evaluate the population in Bear Creek. Includes measurements of length and weight and species identification.
Brushy Fork				
BFK 7.6	BFK 7.6	Fish	Fish Population Survey	Fish species richness and density survey to evaluate the population in Brushy Fork reference site. Includes measurements of length and weight and species identification.

NOTE: Stream reaches may be expanded in order to attain the target number/mass of biota.

BCK = Bear Creek kilometer
BFK = Brushy Fork kilometer
COC = contaminant of concern
EFK = East Fork kilometer

Table 4. Fish tissue sampling analytical methods and method detection limits

Analyte	Method Alias	CAS No.	Method*	Requested Reporting Limit**	Units
Americium-241	Alpha Spectroscopy	14596-10-2	EPA-908.0	0.1	pCi/g
Carbon-14	Carbon-14 by LSC	14762-75-5	EPA-906.0	3	pCi/g
Chlorine-36	GFPC	13981-43-6	EPA-904.0	0.4	pCi/g
Cobalt-60	Gamma Spectroscopy***	10198-40-0	EPA-901.1	0.1	pCi/g
Cesium-137	Gamma Spectroscopy***	10045-97-3	EPA-901.1	0.1	pCi/g
Europium-154	Gamma Spectroscopy***	15585-10-1	EPA-901.1	0.5	pCi/g
Tritium	LSC	10028-17-8	EPA-906.0	3	pCi/g
Iodine-129	Gamma Spectroscopy (LEPS)	15046-84-1	EPA-901.1 (LEPS)	0.1	pCi/g
Lead-210	GFPC	14255-04-0	EPA-904.0	0.1	pCi/g
Neptunium-237	Alpha Spectroscopy	13994-20-2	EPA-907.0	0.01	pCi/g
Plutonium-238	Alpha Spectroscopy	13981-16-3	EPA-907.0	0.01	pCi/g
Plutonium-239/240	Alpha Spectroscopy	E52450475	EPA-907.0	0.01	pCi/g
Radium-226	Lucas Cell	13982-63-3	EPA-903.1	0.1	pCi/g
Radium-228	GFPC	15262-20-1	EPA-904.0	0.2	pCi/g
Strontium-90	Beta GFPC	10098-97-2	EPA-905.0	0.5	pCi/g
Technetium-99	Beta LSC	14133-76-7	Beta Liquid Scintillation	0.5	pCi/g
Thorium-228	Alpha Spectroscopy	14274-82-9	EPA-907.0	0.1	pCi/g
Thorium-230	Alpha Spectroscopy	14269-63-7	EPA-907.0	0.1	pCi/g
Thorium-232	Alpha Spectroscopy	N2608	EPA-907.0	0.1	pCi/g
Uranium-233/234	Alpha Spectroscopy	NS632	EPA-908.0	0.1	pCi/g
Uranium-235/236	Alpha Spectroscopy	N1047	EPA-908.0	0.1	pCi/g
Uranium-238	Alpha Spectroscopy	24678-82-8	EPA-908.0	0.1	pCi/g

* Methods modified for fish tissue.
** Samples for Gamma Spectroscopy can be reused for other analyses.
***Detection limits were selected for each analysis that are reasonably achievable and fully protective based on other projects in the past.

GFPC = Gas flow proportional counting
LSC = Liquid scintillation counting
LEPS = Low-Energy Photon Spectroscopy

3.3 EVALUATION OF RESULTS

3.3.1 Fish Population Surveys

Results of the fish population surveys will be reviewed along with site-specific information included in the DQO, including *Fishing and consumption patterns of anglers adjacent to the Oak Ridge Reservation, Tennessee: higher income anglers ate more fish and are more at risk* (Burger, J. and Campbell, K. R. 2008). This information will be used to inform the approximate meal size and number of meals available from each sample location as part of the follow-on preliminary remediation goal (PRG) development. These results will be based on the presence of 30 g or larger fish, regardless of species.

After evaluation, a conservative number of fish meals per year will be developed for each POE location for input into the PRG calculator based on this information and other assumptions. This follow-on scope is not part of the SAP effort. Instead, discussions will be held with the DOE/UCOR, EPA, and TDEC risk assessors after the results of the fish population survey are known.

Fish population surveys at BCK 9.9 and 12.4 will be used to establish baseline conditions in these areas of the creek.

3.3.2 Fish Tissue Sampling

Results of the fish tissue and whole fish analyses will be reviewed and evaluated along with existing literature to determine which radionuclides on the COC list are present and the concentrations of each detected radionuclides. These results will be used as part of the evaluation of risk to a recreational fisher (fish tissue) and to establish baseline conditions (whole fish).

Naturally occurring background concentrations are expected for several of the COCs, including uranium and radium isotopes and carbon-14. In addition, anthropogenic COCs may be present as a result of fossil fuel power plant emissions and fallout from operations and testing, such as cesium-137 and strontium-90. Results will be compared to background concentrations to determine which may result from ORR discharges into Bear Creek.

All parties recognize that the method used to translate radiological instream water quality levels to radionuclide-specific effluent discharge limits has not been clearly developed. This issue remains subject to further discussion and agreement.

Results of the fish analyses at BCK 9.9 and 12.4 will be used to establish baseline conditions in these areas of the creek.

4. DQOs

DQO Step 1 - Overarching Problem Statement

What is the problem described in the EPA Administrator letter (DQO session – April 1, 2021)

> *Cleanup levels for discharges of carcinogens from a NPL site also cannot be less stringent than the CERCLA risk range.4 For these CERCLA on-site landfills at ORR, I have determined that the PRGs at a minimum should reflect a risk level of 10-5, based on the Tennessee General Water Quality Criteria regulations that are used to establish Ambient Water Quality Criteria to protect the designated uses established by Tennessee's Water Quality Standards regulations from pollutants that are carcinogens.*

The EPA will not require use of default exposure assumptions from CWA guidance documents regarding fish consumption to develop PRGs, or any other default exposure assumptions that are in dispute, such as ingestion. Instead, the DOE will establish PRGs based on site-specific exposure information and will use that information both to develop CWA effluent discharge limits and to apportion the dose of radionuclides among various sources under the NRC regulations.

Default assumptions regarding fish consumption do not represent reasonable maximum exposure at ORR and do not appropriately take reasonably anticipated future land use into account. Other default exposure assumptions may present the same issues. It is longstanding EPA policy to consider reasonably anticipated future land use in conducting a baseline risk assessment.7 For the purpose of the FFS, given that the state's most restrictive use designation for the receiving water (Bear Creek for the existing landfill) is recreational (including recreational fishing)8 the individual with the potential maximum exposure to radionuclides in effluent from ORR landfills would be a recreational fisherman who fishes from Bear Creek, if the fish are contaminated by radionuclides. Reasonably anticipated future land use, and thus the location of this exposure, will depend on the DOE's land use designations.

Develop risk based radiological discharge limits for EMWMF and future EMDF considering site-specific conditions using the EPA PRG calculator, fish tissue radiological data, acknowledging the land use controls placed by TDEC on fishing. DOE will focus on where there are catchable fish and location characteristics. These include BCK 3.3 and EFPC and their characteristics for fishing and fish populations. DOE will establish baseline conditions at potential exposure points and upstream locations in Bear Creek.

Therefore, the problem statement is: Discharged radionuclides into Bear Creek may bio accumulate in fish, causing an increased risk to a recreational fisherman that catches and eats the fish.

This SAP was developed to establish baseline conditions of radionuclides in fish in Bear Creek and to support the collection of data needed for the development of radiological discharge limits for EMWMF and EMDF landfill wastewater including finalizing field approach/procedures, analytical methods, and number of samples.

Optimization of the SAP will be performed using Step #5 Decision Rules, focusing on collecting data that address data gaps.

DQO Step 2 - Identify the Decisions

Decision 1: What levels of radionuclides in the EMWMF and EMDF discharge water are protective of human health and the environment based on the requirements of CERCLA 10^{-5} risk?

- D1.1 What is the likely location where the fisherman catch fish for consumption (e.g., current/future land use)? [POEs].
- D1.2 What other CERCLA inputs are relevant to this decision, such as PRG Calculator inputs/parameters? [e.g., fishing practices, fish ingestion rate, meals per year available at each location (i.e., edible fish distribution to illustrate size of catchable fish that a recreational fisherman is likely to catch)].
- D1.3 What are the list of radionuclides to evaluate in fish? Currently considering list of 20 radionuclides present in edible fish that pose a risk to the recreational fisherman?
- D1.4 What is the existing baseline risk in fish at the point(s) of exposure? Related, what are the radionuclide concentrations in fish from background reference area (Brushy Fork)?

DQO Step 3. Identify Inputs to the Decisions

Table 5. DQO decision inputs

Decision element	Evaluation method	Existing inputs	Additional information needs
D1 – What levels of radionuclides in the EMWMF and EMDF discharge water are protective of human health and the environment based on the requirements of CERCLA 10^{-5} risk?			
D1.1 What is the likely location where the fisherman catches fish for consumption (e.g., current and future land use)? [Point of Exposure]	Evaluate all site-specific information along with controls to develop likely exposure point(s).	Existing CSM Current and future land use controls including CERCLA controls and fish advisories are used to inform the locations to be selected but are not the driving criterion. No locations are within walking distance of Oak Ridge, although one location is near trail. Transportation needed to reach locations, providing opportunity to fish in nearby, much more productive areas.	Results from fish population surveys including 'catchable/edible fish', fish numbers, and types of fish.
D1.2 What other CERCLA inputs are relevant to this decision, such as PRG Calculator inputs/parameters? (e.g., fishing practices, meals per year available at each location [i.e., edible fish distribution to illustrate size of catchable fish that a recreational fisherman is likely to catch]).	Evaluate all site-specific information Poplar Creek, EFPC supports a population of edible fish. Water contact and fish consumption advisories are in effect. This location is expected to have the highest number of catchable, edible fish in the study area.	Fish advisories and use controls are in place at all locations. CY2019 Bear Creek fish survey ORNL designates catchable fish as at least 30 g (1 oz.), ~4.5 in. long (small fish). Edible tissue is between 10 and 12 g (0.3 and 0.4 oz.), will require several fish for a meal. 54 g/day (1.9 oz./day) is the default in the OSWER directive, based on approximately two 8-oz (226 g) fish meals/wk. Previous recreational fishing practices and fish consumption studies (Campbell et al. 2002; Burger and Campbell 2008)	Frequency and meal size will be adjusted by what can be supported by the fishery over the course of a year. How many meals per year are feasible at each location. • Need population survey in BCK 0 to 1.6. • EFPC EFK-0

Table 5. DQO decision inputs (cont.)

Decision element	Evaluation method	Existing inputs	Additional information needs
D1.3 What are the list of radionuclides to evaluate in fish? ***Currently considering preliminary list of 20 radionuclides evaluated by DOE and EPA?***	Evaluate all site-specific information along with analytical data	Existing concentration and contaminant data from the EMWMF and projected EMDF. Key COC list for radionuclides agreed upon by the FFA parties and formalized in the EMWMF SAP. Similar waste types and waste streams expected for the EMDF as were received by the EMWMF, with primary waste from Y-12 and ORNL. Developed as part of the design.	Finalized list of radionuclides.
D1.4 What is the existing baseline level of radionuclides in fish, and the corresponding risk to a recreational fisher at the point(s) of exposure? Related, what are the radionuclide concentrations in fish from the background reference area? ***Note: EMWMF radiological discharge already included in the Bear Creek water experienced by the fish.***	Evaluate all site-specific information and analytical data, including from background reference area. PRG calculator	Existing frozen fish data from BCK 3.3 and Hinds Creek was used as a reference to inform the DQO and SAP. Existing Clinch River fish data downstream of ORR. Identification of Points of Exposure. WRRP data. Identification of preliminary exposure parameters from previously performed PRG runs. Identification of radionuclide COCs from EMWMF and proposed EMDF (D1.3).	Fish tissue collected and analyzed for the radionuclide COCs at the likely Points of Exposure/fishing locations. Fish population surveys determining number of catchable and the edible fish by size range at each location. Determine how many fish can be caught/meals possible (D1.1) Input from D1.1

BCK = Bear Creek kilometer
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC = contaminant of concern
CSM = Conceptual Site Model
CY = calendar year
DOE = U.S. Department of Energy
DQO = data quality objective
EFPC = East Fork Poplar Creek
EMDF = Environmental Management Disposal Facility
EMWMF = Environmental Management Waste Management Facility
EPA = U.S. Environmental Protection Agency
FFA = Federal Facilities Agreement
FY = fiscal year
ORNL = Oak Ridge National Laboratory
ORR = Oak Ridge Reservation
OSWER = Office of Solid Waste and Emergency Response
PRG = preliminary remediation goal
SAP = sampling and analysis plan
WRRP = Water Resources Restoration Program
Y-12 = Y-12 National Security Complex

DQO Step 4. Define the Study Boundaries

The study area is limited to Bear Creek from BCK 12.4 to confluence of EFPC and Poplar Creek.

Temporal limit –A spring fish tissue sampling event will be performed to obtain analytical results. Flow will be matched to this flow event or an annual average will be selected to account for variation because fish tissue concentrations capture a time-integrated measure of exposure at these sites from surface water. An additional sampling event will take place in the fall.

DQO Step 5. Develop the Decision Rules

The fifth step of the DQO process converts the decision statement into a decision rule, with the decision rule based on the expected inputs to the decision. The decision rules are presented in the following paragraphs.

D1.1 What is likely location where the fisherman catches fish for consumption (e.g., current/future land use)?

IF the candidate point of exposure produces the highest risk to the recreational fisherman based on combination of fish tissue concentrations and availability of edible fish,

THEN it is the point of reasonable maximum exposure, and will be identified as the point of exposure for determining radiological discharge limits for landfill wastewater.

D1.2 What other CERCLA inputs are relevant to this decision, such as PRG Calculator inputs/parameters? [e.g., fishing practices, fish ingestion rate, meals available per year at each location (i.e., edible fish distribution to illustrate size of catchable/edible fish that a recreational fisherman is likely to catch)]?

IF the current available data for determination of site-specific parameters (e.g., fish ingestion rate, meals per year, etc.) is sufficient at a candidate POE,

THEN proceed with the determination of site-specific parameters based on existing information.

IF the available data for determination of site-specific parameters is inadequate or does not exist,

THEN conduct fish population surveys of "catchable fish" (fish numbers and species of fish) at identified POE locations to determine the site-specific parameter.

Note: Few fish may be present at any given POE, limiting sample size.

D1.3 What are the list of radionuclides to evaluate in fish? [Currently considering preliminary list of 20 radionuclides evaluated by DOE and EPA]

IF the list of ~20 radionuclides is adequate, appropriate and complete based on current and anticipated radionuclide concentrations in landfill discharge water,

THEN determine rad discharge limits for those radionuclides.

IF the list of ~ 20 radionuclides is determined to be inadequate/incomplete based on current and anticipated radionuclide concentrations in landfill discharge water,

THEN define approach for how radionuclides can be added to or removed from the list. Determine rad discharge limits for new radionuclides.

D1.4 What is the existing level of radionuclides in fish in Bear Creek, and what is the corresponding baseline risk to a recreational fisherman at the POEs?

IF the current available data for radionuclide concentrations in fish is sufficient at a candidate POE,

THEN proceed with the determination of baseline risk from current fish tissue concentrations at the POE based on existing information.

IF the available data for radionuclide concentrations in fish is inadequate or does not exist,

THEN conduct fish tissue sampling of "catchable fish" at identified POE locations for radionuclide analyses at analytical labs that ensure detection limits satisfy measurement quality objectives.

IF radioanalytical data are generated for fish tissue samples,

THEN calculate mean concentrations and uncertainties for each radionuclide of concern, and calculate risk based on measured fish tissue concentrations.

IF team determines existing baseline risk should be assessed relative to background reference location,

THEN conduct sampling and analysis of fish tissue from Brushy Fork background reference location to provide a comparison of baseline risk to POE locations.

DQO Step 6. Specify Performance or Acceptance Criteria

This step specifies the probability limits for false rejection and false acceptance decision errors and develops performance criteria for new data being collected or acceptable criteria for existing data being considered for use.

Probability limits will be difficult to meet based on the likely paucity of available consumable fish at some locations which limits the sample size.

Errors in sampling and analysis will be minimized to the extent practicable by attempting to collect sufficient mass and numbers of samples to obtain a statistically valid sample population and using well established laboratories and QA/QC requirements.

Verification and validation of the data ensures that the requested analyses have been reported using the correct analytical methods, reporting limits, and units. This process will include also ensuring that the documentation in the data package is complete and consistent with the electronic data deliverable provided by the laboratory. Validation of the data examines the data from a technical perspective.

The fish tissue study will be help bound uncertainties associated with the PRG Calculator parameter, meals per year. This parameter value depends on the number and size of "catchable and edible" fish at each candidate POE. Relevant literature (Burger studies) and expert judgment (ORNL ESD) will be used to help assess meals per year parameter uncertainties.

DQO Step 7. Optimize the Design

The final step of the DQO process takes the results of the first six steps, and uses them to prepare a SAP that achieves the desired goals for this project.

5. ADDITIONAL COCS CONSIDERED

The following COCs were considered but not selected as part of the evaluation process for this sampling and analysis plan:

- Cesium-134
- Cesium-135
- Curium isotopes
- Polonium-210
- Total Uranium

Cesium-134

This radionuclide is a short-lived fission product with a half-life of about 2 years. While there is a reactor operating on the ORR, the reactor is not a CERCLA project, and therefore associated waste does not meet the EMWMF waste acceptance criteria (WAC) or the proposed EMDF WAC. This radionuclide is not described in EMWMF waste streams or other Bear Creek Valley legacy waste areas.

Based on the short half-life and lack of inventory, this radionuclide was not included in the COC list.

Cesium-135

Produced by nuclear fission, this very long-lived isotope is not abundant at ORR CERCLA projects and is not included in the EMWMF or EMDF waste inventories. It is generally present at very low quantities with Cs-137 (a COC) which is expected in waste streams. Based on research performed for Fukushima, this isotope was found at about 100,000 times lower concentrations than Cs-137. This isotope has very low (beta) decay energy, making it much less hazardous than Cs-137 and very difficult to detect in a conventional radiochemical analytical lab.

This was not added to the COC list because: 1) not expected to be present in any appreciable quantity relative to Cs-137, 2) extremely difficult to detect (low energy beta emitter) and 3) risk factor for food ingestion is only 15.7 percent of that of Cs-137 (3.74E-11 risk/pCi), or 5.88E-12 risk/pCi (for Cs-135).

Curium Isotopes

Produced by neutron bombardment of plutonium and uranium in nuclear reactors, these are minor contributors to CERCLA waste inventories due to limited occurrence at ORR CERCLA sites. Most isotopes have low specific activity (low hazard). The highest specific activity isotope is Cm-242 with the shortest half-life of less than 1 yr. These isotopes are not particularly mobile in the environment. A dose impact to a recreational fisher is not expected based on low mobility and low bioaccumulation factors.

These isotopes were not added to the COC list due to limited expected inventory, low bioaccumulation and low activity/risk to a recreational fisher.

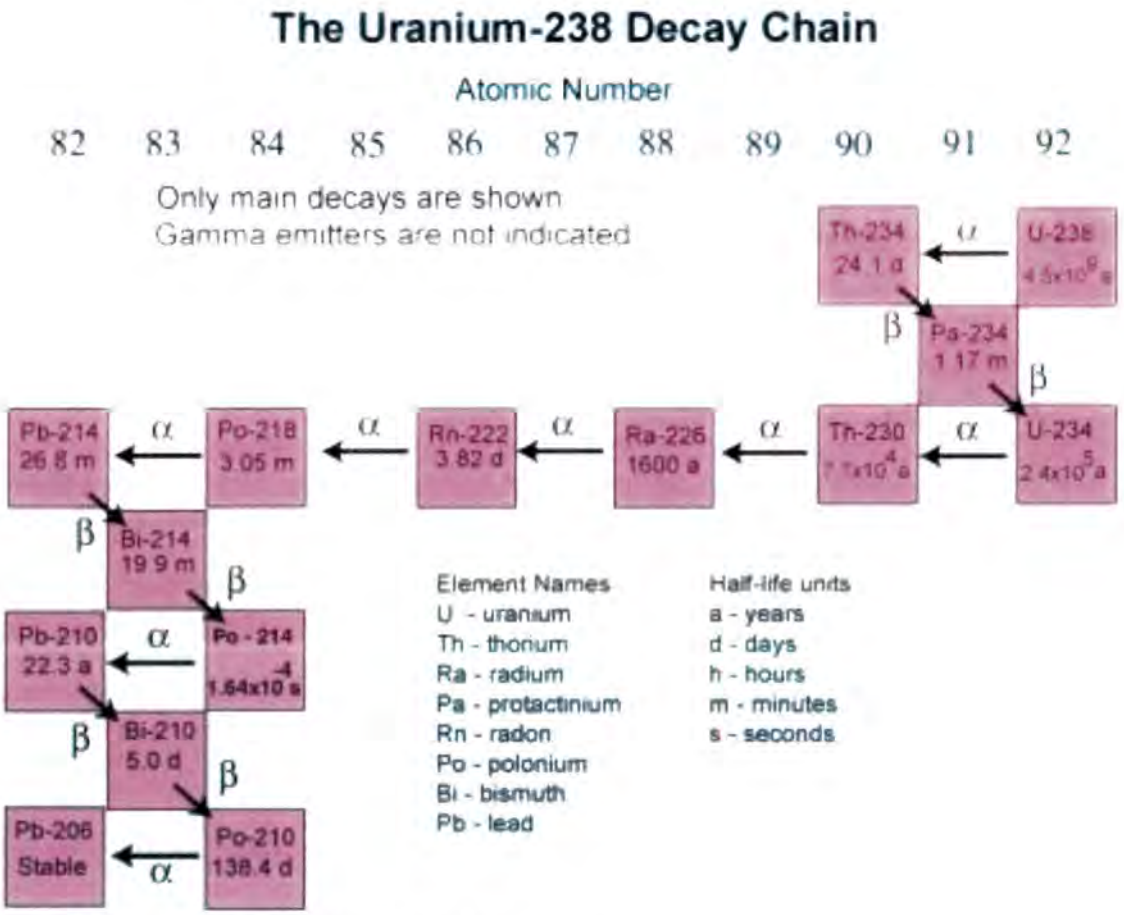
Polonium-210

Polonium-210 is a short-lived decay product of the very long decay chain from naturally occurring uranium (Uranium-238), around 4.5 billion years (see Fig 4). The uranium source used at the ETTP for enrichment was processed at other locations prior to coming to Oak Ridge. As a result, the vast majority of the radionuclides in the U series below U-234 are not present in any appreciable quantities (including Ra-226, a precursor of Polonium-210).

Polonium-208 was produced at ORNL in 1951 (Production of Polonium 208 - August 1952, Final Report on Termination of Project (ORNL-1392)). This isotope has a half-life of slightly less than 3 years and is not expected to be in the environment as a result of these activities.

Po-210 is also produced from the decay of uranium-238 and radon-222 gas, both naturally occurring associated with the black shales in Bear Creek Valley and from uranium disposed in Bear Creek Valley.

This was not added to the COC list because of the very short half-life and the low source term because uranium source material was processed prior to coming to ORR, removing the vast majority of potential Po-210 source material.



Source: USGS https://pubs.usgs.gov/of/2004/1050/uranium.htm

Fig. 4. Uranium decay chain.

Uranium metal (total uranium)

There is a toxicity risk from uranium metal that is required to be evaluated, although it is not a COC for the radiological dispute resolution process. This analyte is being evaluated as part of the ongoing Focused Feasibility Study for EMWMF and EMDF wastewater discharge.

6. SUMMARY

This SAP addresses the requirement in the EPA Administrator's DRD letter dated December 31, 2020 to collect fish tissue radiological data to support development of risk based radiological discharge limits for EMWMF and future EMDF. While the area is currently not open to fishing, reasonable potential fishing sites were identified where catchable and edible fish are expected to be present. These sites are considered conservative because fishing is currently not observed at these locations.

Sampling requirements were established using the DQO process. Fish population surveys will be performed at the identified locations and fish tissue samples will be collected along with one sample composed of the residual fish carcasses (without guts, fins, or scales) sampled at each POE.

Fish population surveys will also be performed and whole fish samples will be collected at BCK 9.9 and 12.4 to determine baseline conditions at these locations. The initial set of COCs will be analyzed for these fish (not including the additional TDEC COCs).

As a future project, additional fish, water, and sediment (as appropriate) may be collected through Bear Creek to determine the levels and types of contamination present at different locations. This characterization may be repeated at some frequency to be agreed upon later as part of the BCV CMP or other primary document. A separate DQO session will be held to determine the objectives and approach for this sampling program.

Fish tissue, residual carcass, and whole body samples will be analyzed for the specified COCs at analytical labs using established radiological methodologies. Results will be used to guide development of the radiological discharge limits that will be summarized in the EMWMF/EMDF water management FFS, RODs or other primary documents.

7. REFERENCES

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